COM-480 Process BOOK
Minerals involved in the Energy Transition

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Introduction

How can we discuss the energy transition without considering all the necessary conditions and prerequisites? Today, much of the conversation focuses on global warming, its consequences, and the actions needed to mitigate it. A significant part of this discussion is about the energy transition, specifically moving from fossil fuels to renewable energies. However, there is little talk about the resources needed to build a wind turbine or make a solar panel. In this project, I examine the minerals essential for this energy transition and ask: is transitioning to renewable energies truly a solution for reducing our carbon footprint ?

By exploring this question, I aim to highlight the stakes involved in this transition, particularly concerning global warming and how renewable energies can potentially replace fossil fuels. My visualizations will show the impact of minerals on the planet, from extraction to power generation. Ultimately, I will assess the feasibility of such a transition, considering both mineral reserves and the carbon footprint required. This comprehensive approach will provide a clearer understanding of what is needed for a successful energy transition and its broader implications for our planet.

Project focus

In choosing the subject for this project, I aimed to address an important and impactful issue. Global warming is one of the most urgent challenges of our time, but it has been explored extensively from many angles. To contribute meaningfully to this discussion, I sought a fresh perspective that could provide new insights and deepen our understanding of the complexities involved.

My decision to focus on the minerals needed for the energy transition came from this desire to find a unique angle. While the shift from fossil fuels to renewable energies is widely discussed, the critical role of minerals in making this transition possible often goes unnoticed. By looking at the extraction, use, and environmental impact of these minerals, I aim to shed light on an often overlooked aspect of the energy transition debate.

This approach allows me to explore the broader implications of moving to renewable energies. It raises questions about the sustainability and feasibility of such a shift, considering not only the availability of mineral resources but also the environmental costs of their extraction and use. By doing so, I hope to provide a more comprehensive view of what an energy transition entails, emphasizing the need to address all parts of the problem to develop truly sustainable solutions.

In summary, my subject choice reflects a commitment to addressing global warming from a novel and impactful perspective. By focusing on the minerals essential for renewable energy technologies, I aim to contribute valuable insights to the ongoing conversation about how best to achieve a sustainable future.

Dataset

The first stage of the project was to find good datasets to illustrate what I wanted to say and show. This was a fastidious process, as minerals are a subject that isn't often covered, and few datasets exist illustrating minerals in the renewable energy spectrum. What's more, as the vast majority of mines are private companies, they don't share their information and figures very widely, making this work all the more complicated. As I wanted to create a project starting with an overview and zooming in more and more, I needed several datasets to link the elements and have a minimum of coherence in my results. The same goes for data concerning pollution caused by mineral extraction: this is very sensitive data that companies try to conceal as much as possible, so it's quite complicated to find. In cases where I didn't have a dataset, I had to create my own using the various pieces of information I found. So, it took some time to find the data, check its veracity by cross-checking with various sources, etc...

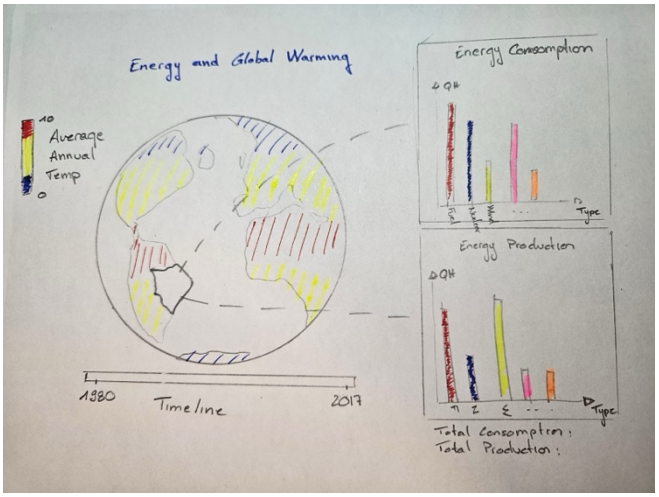
- **Climate Change Earth Surface Temperature Data (Link):** provides data on the average temperature by country around the globe and across the age.
- **Global Energy Consumption & Renewable Generation (Link):** provides data of the energy production and energy consumption for some country.
- **World Energy Statistics and Balances (Link):** provides comprehensive information on global energy statistics
- **Renewable Energy (Link):** provides data on renewable energy production by country.
- **Global Material Flows (Link):** provides data on the mineral extraction of different country from 1970 to 2024.
- **Open Database on Global Coal and Metal Mine Production (Link):** covers global extraction and production of coal and metal ores at the mine level.

These datasets collectively form the foundation of my analysis, enabling a thorough exploration of the critical role of minerals in the energy transition and its broader implications for sustainability and global warming.

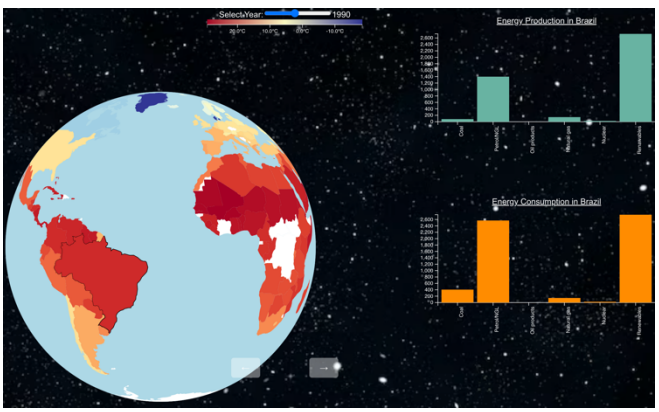
Project Plan

After finding the datasets, it was necessary to organize them and develop a plan for the project to clearly illustrate the issue. The initial plan for this project was structured around four key components, each designed to build upon the previous one to create a comprehensive visualization of the energy transition and its mineral implications. This phased approach was designed to provide a layered and detailed understanding of the interconnectedness of global warming, renewable energy production, and the critical role of minerals.

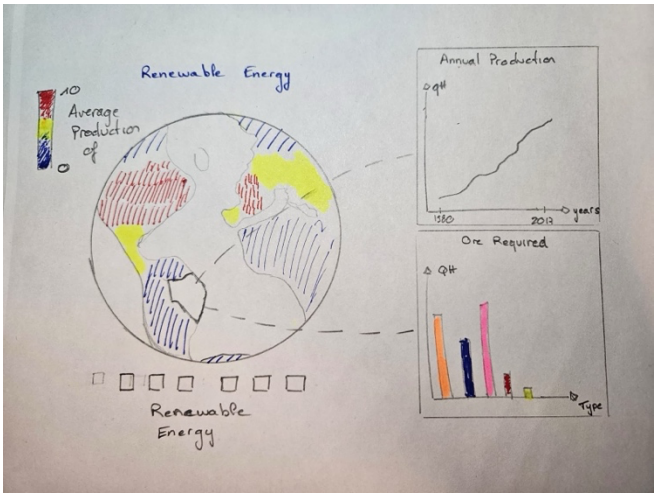
First, the **Global Warming and Energy** component aimed to display average temperatures by country and link this data to energy production and consumption figures, illustrating the correlation between energy use and climate change.



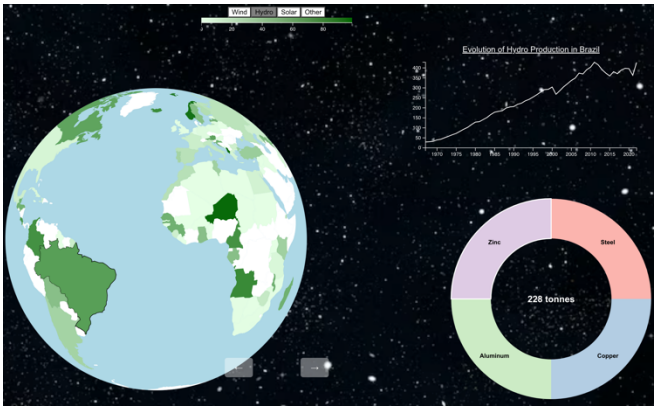
This first visualization is almost the same in the final result:



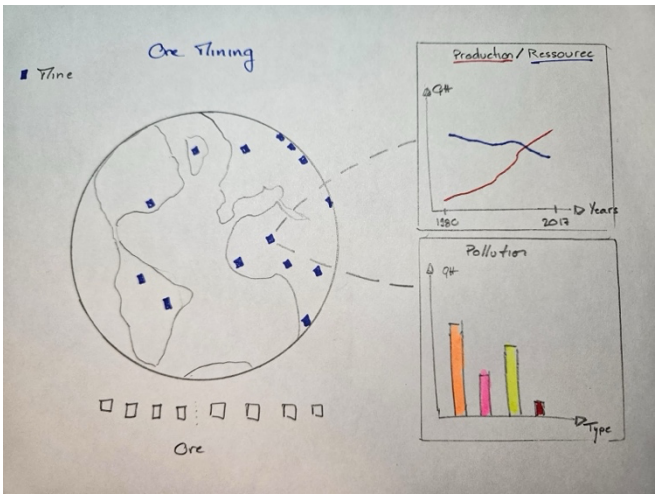
Next, the **Renewable Energy** phase go one step further and focused on visualizing renewable energy production, highlighting the leading countries in this field and identifying the specific minerals required for each type of renewable energy.



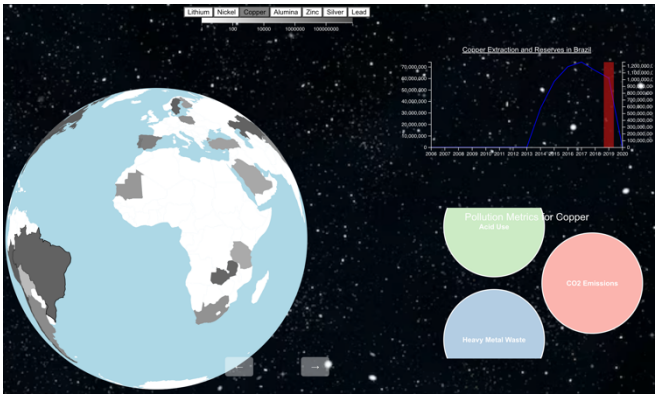
For this part, there is some modification, I reduced the number of renewable energies by grouping together the less significant ones under 'Other'. Also, the bar chart for the required ore became a donut chart showing the different mineral and the quantity when we fly over a part as we can see below.



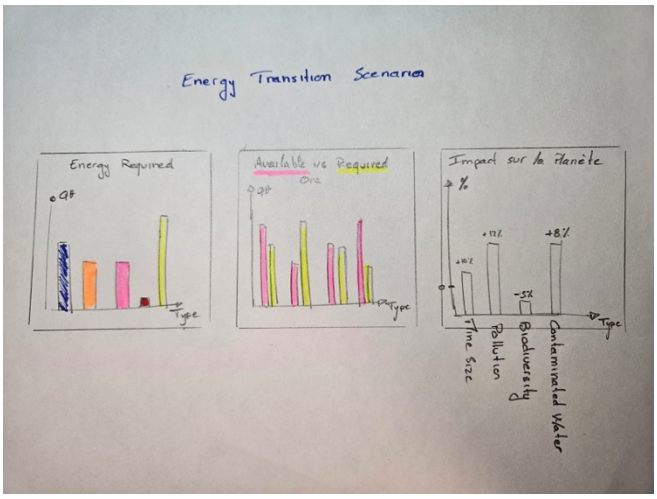
Following this part, the **Mineral Extraction** segment sought to map out mining activities worldwide, showing the environmental impact of mineral extraction necessary for the energy transition.



Again here, there is some small changes between the sketch and the final version due to a lack of data. As I didn't find the reserve quantity across the age for the mineral I just plot a bar with the quantity I found. Also, the bar chart for the pollution changed to a bubble chart with one buble for each type of pollution and a little explanation when we fly over it. I changed this because I didn't find good dataset with the amount of each type of pollution and to change a bit from the others visualization.

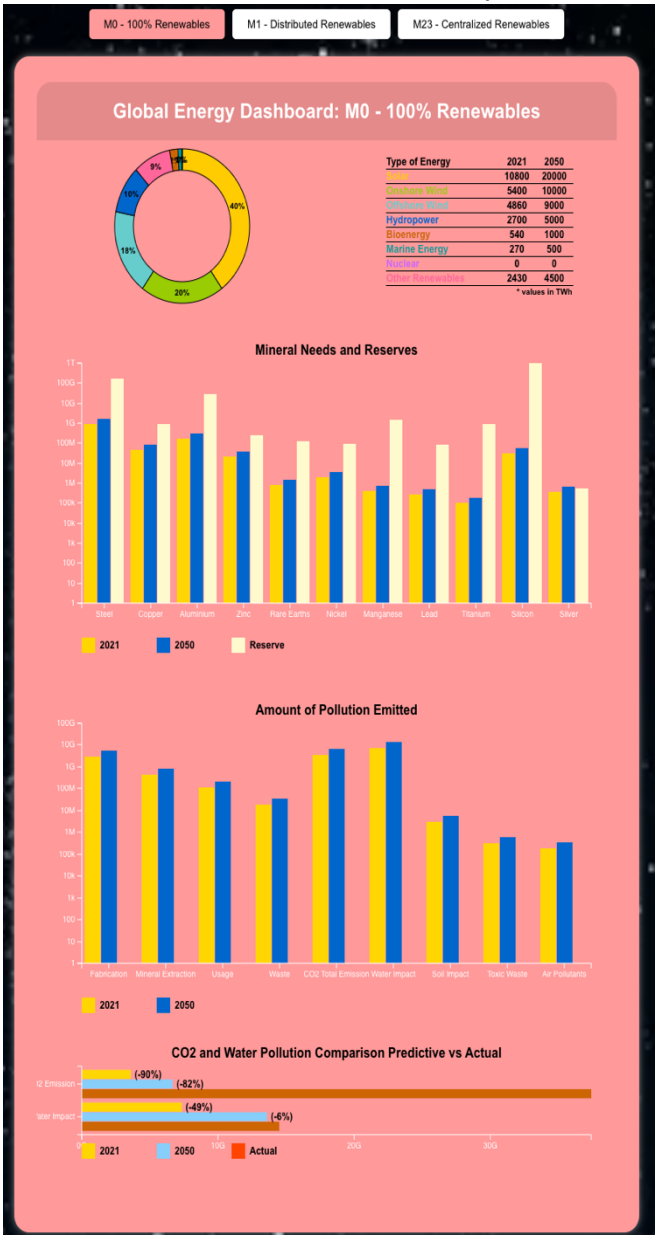


Finally, the **Energy Transition Scenarios** component aimed to explore potential future scenarios for the energy transition, assessing their implications for mineral extraction and overall environmental impact.



The last part is the one that changed the most between the sketch and the final version as we can see below. We've gone from 3 graphs next to each other to 4 visualizations with a table. These changes were made with the aim of making the page clearer and easier to understand, as it brings the project to a close, so it was important to make the information easy to read. The objective of each of the graphs has remained the same, i.e. to show the distribution of energy production in the scenario, to show how resources react and what pollution is induced. The 4th graph shows the impact of the scenario on CO2 emissions and water pollution.

What's more, the basic idea was to see the evolution of a single scenario, so no comparison was possible, which explains the choice of several scenarios.



Challenge

Data availability

The first challenge was to find the data, as mentioned earlier, and understand how to use it. Indeed, even if I found datasets that seemed good at first sight, it was impossible to exploit them for various reasons: either the dictionary files explaining what the different IDs were were missing, or they were not free. As many of these datasets are private, there are plenty of paid datasets too. So, I spent a lot of time finding data, creating datasets (if necessary) from the bits of information I found, processing the data etc.

Data usage

Uploading data to the site was also a challenge. It took me a long time to manage to load my data and apply it to the globe according to countries, etc. This work of retrieving the country name and searching in the dataset was quite complicated for someone who had never touched javascript before. The same goes for finding data in one dataset based on data in another dataset, as I needed for the dashboard on the last page, for example. But with the help of many tutorials, I managed to figure out where my problem was coming from and fix it.

Peer Assessment

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As I was alone on this project, I did it all myself. There is 2 contributors on the repository because I didn't check on which github account I was when I pushed but both are my account, one with epfl mail and one with my professional mail.