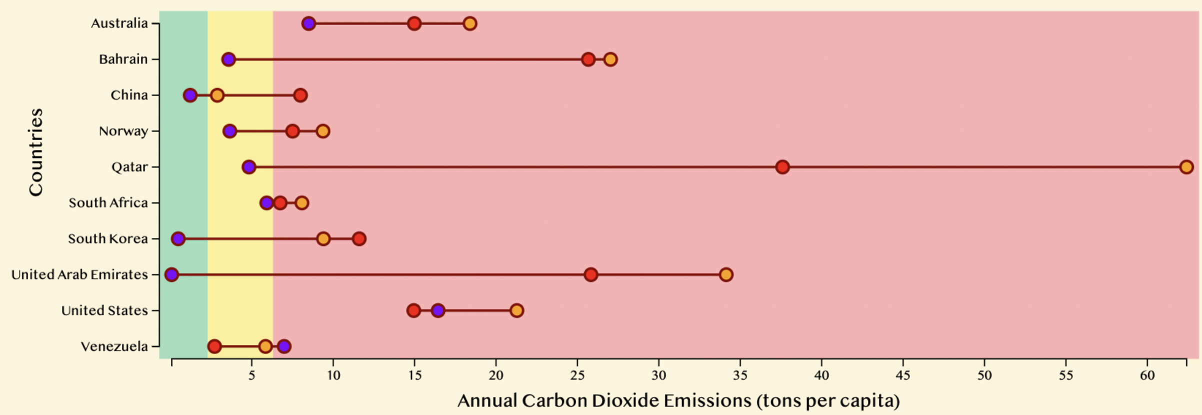
Final Report

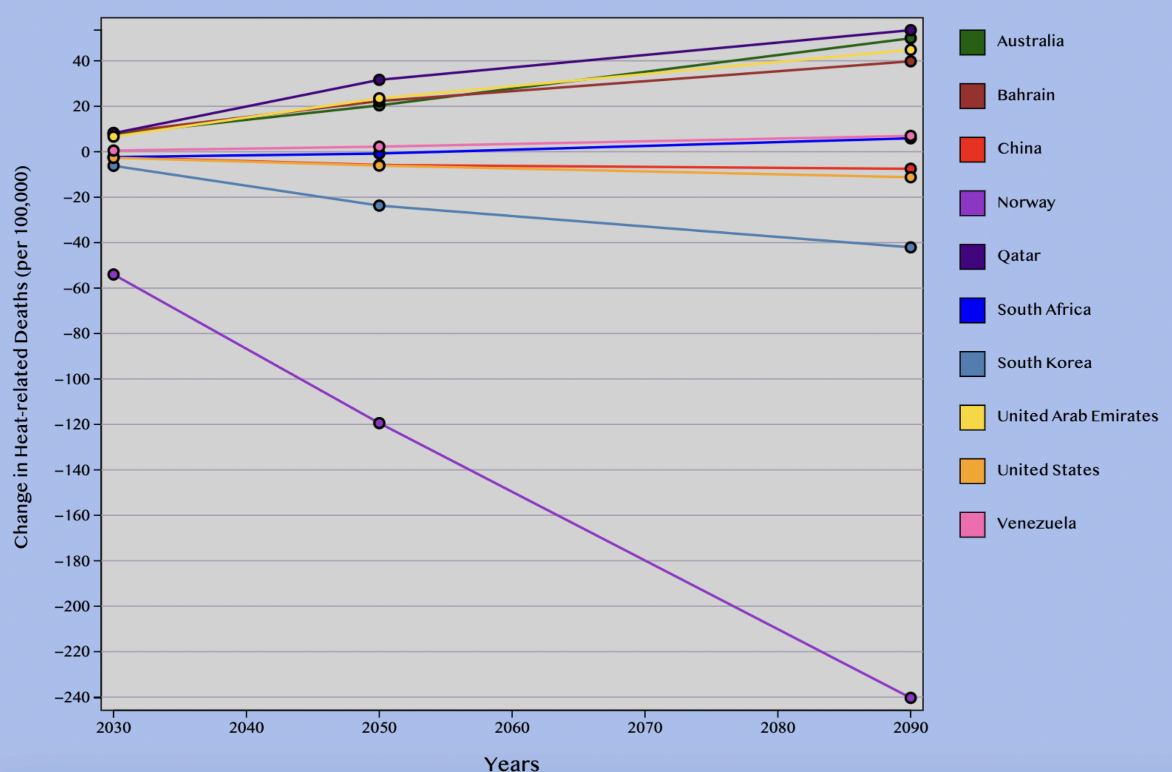
Carbon Dioxide Emissions Over Time

This graph shows the change in carbon dioxide (CO2) emissions from 1960 to 2022 for 10 countries. The graph is split into three sections, according to key data points derived from Enerdata's projections. The green section represents the ideal emissions zone, which is between 0 - 2.3 tons CO2 emitted per capita. The yellow section represents the warning zone, which is between 2.3 - 6.3 tons per capita. Lastly, the red section represents the dangerous emissions zone, which is greater than 6.3 tons per capita.



Projected Change in Heat-related Deaths from 2030 to 2090

This timeline shows the projected change in deaths due to non-optimal temperatures in 2030, 2050, and 2090 for the same countries represented in the emissions graph above, based on the Representative Concentration Pathway (RCP 4.5); this is a relatively moderate climate scenario where global temperatures increase by approximately 2.5 C by 2100. Comparing the two graphs, we can see that countries with higher CO2 emissions per capita are likely to experience a greater rate of heat-related deaths.



Data Description:

For our graphs, we got our data from ourworldindata.org. We used two different datasets for the two graphs. The first dataset included country name, country code, year, heat-related death rate, annual CO2 emissions (per capita), and continent, while the second dataset just included country name, country code, year, and heat-related death rate. We filtered the datasets to include only the 10 countries we wanted to analyze.

In the first graph, we used the country, year, and emissions variables, with the x-axis representing the emissions and the y-axis representing the countries. In the second graph, we used the country, year, and heat-related death rate variables, where the x-axis represented the years and the y-axis represented the change in death rate due to non-optimal temperatures. For each country, we created a line to show the change in death rate over time.

When selecting the countries we wanted to represent in our graph, we ensured to have a lot of diversity. We included countries from all the continents, including both developing and developed countries and key players in the world's economy. We also made sure to choose countries that had ample amounts of data for us to analyze.

For the first graph, we used additional data to determine ideal, warning, and dangerous levels of emissions. From the Enerdata organization, which is a research firm specializing in global energy market analysis, we found out how scientists group CO_2 emissions. Scientists consider anything below 2.3 tons per capita CO_2 emissions as the ideal level, 2.3-6.3 as the warning zone and anything above 6.3 as a dangerous zone.

Design Rationale:

First Graph:

For the first graph, we wanted to visualize the differences in CO_2 emissions for a range of different countries. We decided to use a line graph of countries vs emissions, with data sampled across time, which makes it easy to compare emissions between countries. One trade-off of this is that it's a bit difficult to see the change of emissions over time, but our main goal was to demonstrate the differences between countries, so this was an acceptable sacrifice.

Another goal for this graph was to give a reference to what scientists consider an ideal level, warning level, and dangerous level of emissions. We did this by breaking up the graph into three sections and coloring each section green, yellow, and red to intuitively correspond each level of emissions with its respective sentiment. One trade-off in this was choosing a purple color for the 1960 data points since it didn't relate to a respective sentiment . However, we needed to make the visualization user-friendly in terms of visibility which justifies this design choice.

The marks are circles and the connecting lines. The connecting lines make it easier to keep track of the data points as you move your eyes across the x-axis and also offer a non-obstructive way to separate each country's data. The channels are the color hue of the circles, the color hue of the background, and the vertical aligned and horizontal aligned positions. The circles are colored purple, orange, or red depending on if the data is from 1960, 2000, or 2022, respectively. We chose these colors because they offered a nice gradient and having red as the value for 2022 creates a sense of urgency and corresponds to our theme of present time being darker due to global warming. We assigned a profound stroke color and width to the circles, alongside the connecting lines to ensure that each point stands out. The horizontal position is based on the CO_2 emissions. The vertical position is based on the country, and the countries are ordered alphabetically. We decided to locate the legend on the top right corner so it wouldn't interfere with the graph but still stands out to the viewer.

Second Graph:

For the second graph, we wanted to visualize how the rate of heat-related deaths will change in the future for the same countries as in graph 1. We chose to do this using a line graph of death rate vs time, which makes it easier to visualize the trends over time and compare data between different countries. One trade-off of this design is that the lines for some countries are close together and difficult to differentiate. We decided to add horizontal gridlines to make it easier to keep track of trends, which is especially useful for lines that are close together by offering a point of reference. For trends without an especially steep slope, the gridlines help the viewer assess the change over time.

For choosing the background colors, we employed a similar idea as in graph 1, where the background of the chart itself and the svg are different and offer a nice contrast. This makes the chart itself stand out better and the gray background makes it easy to see the data. We chose a blue background for the svg because blue is associated with sadness, and we wanted to emphasize the bleak future of climate change.

The marks for this graph are circles and the connecting lines. We chose to include circle marks in addition to the lines in order to emphasize the key points in the data. The connecting lines represent the idea that death rates are changing over time. The channels are color hue, vertical aligned position, and horizontal aligned position. We used color hue, with a different hue for each country, because the countries are nominal data. We chose 10 different colors that would stand out on the graph and also wouldn't clash with each other. We put a legend on the side of the graph so viewers can easily cross-reference the data with their respective country.

The story:

Prior to starting this project, we knew we wanted to visualize something that delved deeper into an important societal issue. After some consideration, we decided to create 2 visualizations centered around climate change—a slow moving but catastrophic phenomenon driven by human activity. Our visualizations are meant to give the reader greater context and demonstrate the potential impacts of CO_2 emissions worldwide. The first graph gives an overview of the change of CO_2 emissions over time for a representative range of countries. The second graph builds off this by demonstrating the potential future impacts of current and past emissions visualized in graph 1. Graph 2 was meant to augment graph 1 and add new insights by giving information on the projected change in deaths from non-optimal temperatures due to climate change. By combining these two visualizations, we want to convey to the viewer that emitting fossil fuels will have real-life, quantifiable impacts on the human population in the years to come, and is indeed a pressing issue.

We were initially surprised that some countries experienced a decrease in CO_2 emissions, especially from 2000 to 2022. However, this makes sense because the world has a greater understanding of the effect of CO_2 emissions on our environment and thus, more efforts have been made to transition to energy sources that do not emit as much CO_2 . Every-day tools like refrigerators and air conditioners also became more energy efficient, thus not using as much electricity. However, South Korea and China steadily increased their CO_2 emissions, compared to the other countries. This stems partly due to rapid industrialization, wherein manufacturing serves as one of the largest emitters of CO_2. Furthermore,from 1960-2022, China slowly became the manufacturing hub of the world.

Similarly, South Korea is one of the largest exporters of automobiles, cell phones and semiconductors, three very energy-intensive products. So, while some countries might be experiencing an overall decrease in CO_2 emissions, a large portion of it can be explained by the movement of CO_2 emitting sources, like manufacturing being moved abroad. These visualizations reveal stark contrasts in CO2 emission trends across different countries throughout, with some countries increasing in emissions from 2000 to 2022 (e.g., South Korea) in terms of tons per capita, and others decreasing in emissions (e.g., Venezuela); this rate of change can also vary quite dramatically across countries in terms of scale (e.g., Qatar).

The second graph shows that almost all countries will experience an increase in deaths due to heat. We are already experiencing this trend right now. This past summer was one of the highest recorded temperatures across North America and Europe and subsequently led to many deaths. However, there are also some countries projected to experience a decrease in rate, with the most significant being Norway. This can be attributed to numerous reasons, mainly, the country's already cold climate where an increase in temperature would bring it to more moderate levels. Other countries, which already experience warm summers, may face an increase in vulnerability in part due to this fact.

Overall, we hoped to convey to the reader that this is a nuanced issue with a complex interplay of factors influencing emissions, such as economic and technological development. And with our second visualization showcasing not just the profound (potential) consequences of climate change, but also the disparities in the projected impacts across different countries, we wanted to emphasize that there isn't a simple "one size fits all" solution. There is a complex relationship between current emissions, geographic location, and future climate impacts, prompting the need for a multifaceted approach where adaptation strategies are tailored. Overall, we hoped to portray a view of climate change as an intricate, global issue with real and profound human consequences, stressing the need for coordinated efforts globally whilst emphasizing the potential for positive change via policy implementation.

Outline of team contributions to the project:

Throughout the project, we group-programmed. Every member attended each meeting, where one person would code while the others aided with coding and/or researching. We took turns coding and did some asynchronous debugging when necessary. The team went to office hours when we were stuck.

This project took **14 hours 30 minutes 17 seconds and 21 milliseconds**. The initial brainstorm took 1 hr 36 minutes and 11 seconds and 10 milliseconds. The first graph took 8 hours 25 minutes 33 seconds and 99 milliseconds. The second graph took 4 hours 28 minutes 32 seconds and 12 milliseconds. The first graph and finding the data sets took the most time.