Reduce harmful CO2 emissions

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1 Introduction

1.1 Motivation

The delicate balance of greenhouse gases has played a crucial role in maintaining a livable climate for humans and the diverse array of species that inhabit our planet. However, this equilibrium has been disrupted, posing a significant threat to the survival and distribution of life on Earth. The concentration of carbon dioxide, the most abundant and dangerous greenhouse gas, has reached unprecedented levels in our atmosphere. This alarming increase is primarily attributed to human activities, particularly the burning of fossil fuels. As these gases are released into the air, they absorb solar energy and trap heat near the Earth's surface, a phenomenon known as the greenhouse effect. This heightened greenhouse effect has far-reaching implications. It hinders the natural dissipation of heat into space, leading to rising temperatures and climate disruptions. These changes in our climate system have the potential to reshape the distribution of habitats and alter the conditions necessary for various organisms to thrive [5].

According to experts [4], the continuous increase in greenhouse gases is projected to lead to a significant rise in global temperatures. It is estimated that by 2099, the world could be 4°C warmer than pre-Industrial Revolution levels. This alarming trend in rising temperatures could have severe consequences, including the melting of ice caps and warming of oceans, resulting in rising sea levels. Moreover, it is expected to bring about extreme weather events such as heatwaves, heavy downpours, and wildfires. The changing climate conditions could also impact the habitats and survival of various wildlife populations. Additionally, there may be disruptions in access to food, posing challenges for agricultural systems. Above all that, the spread of diseases like malaria may increase due to the changing climate patterns. These projections highlight the urgent need to address greenhouse gas emissions and mitigate the potential risks associated with climate change.

By recognizing the urgency of this situation, we can strive to restore the delicate balance of greenhouse gases and mitigate the impacts of climate change. Implementing sustainable practices, transitioning to renewable energy sources, improving energy efficiency, and adopting environmentally conscious lifestyles are all crucial steps in reducing greenhouse gas emissions and especially the CO2 emission, to ensure a healthier, more resilient environment for generations to come. I decided to undertake a project on CO2 emissions due to my deep love and concern for the environment. As an eco-friendly individual, I am passionate about preserving the natural world and its precious resources. My affection for animals further motivates me to take action against climate change and reduce my carbon footprint. I actively strive to make sustainable choices in my daily life, such as recycling waste, limiting the amount of water I am using and minimizing air travel whenever possible by taking the train, as I understand the significant impact it has on CO2 emissions. By delving into the topic of CO2 emissions, I aim to gain a deeper understanding of the issue and contribute to finding effective solutions that can mitigate the environmental challenges we face.

1.2 Decision Makers

In tackling the challenge of reducing CO2 emissions, several key decision makers play critical roles in driving change and implementing effective strategies. These decision makers include:

- **Government and Policy Makers:** Governments have a crucial role in developing and implementing policies, regulations, and legislation to address climate change and reduce CO2 emissions. They set targets, establish emission reduction frameworks, and provide incentives for sustainable practices.
- **International Organizations and NGOs:** International organizations such as the United Nations (UN), the Intergovernmental Panel on Climate Change (IPCC), and the World Bank are instrumental in shaping global climate policies and fostering international cooperation. They facilitate negotiations, coordinate climate action initiatives, and provide technical expertise and financial support to countries in their efforts to reduce CO2 emissions
- **Industries and Heads of Factories:** The private sector, including large corporations, industries, and businesses, plays a vital role in reducing CO2 emissions. By adopting sustainable practices, investing in clean technologies, and implementing energy-efficient measures, businesses can significantly contribute to emission reduction.
- **Individuals and Consumers:** Each individual can make a difference by adopting a sustainable lifestyle, reducing personal carbon footprints, and making conscious choices in areas such as transportation, energy use, and consumption patterns.

By recognizing the roles and responsibilities of these decision makers, we can provide them with recommendations, based on the analysis conducted on Tableau, towards reducing CO2 emissions. The collective actions of governments, international organizations, industries, and individuals are essential in achieving a sustainable and low-carbon future.

1.3 Available Datasets

1.3.1 CO2 and Greenhouse Gas Emissions - Our World in Data

The dataset [6] of 79 columns and 50598 rows contains a wide range of variables related to carbon dioxide (CO2) emissions and other environmental factors. The dataset includes information on various aspects such as country, year of observation, geographic location, population, gross domestic product (GDP), and energy consumption. The emissions data cover different fossil fuel types, including cement production, coal emissions, flaring, gas emissions, oil emissions, and emissions from other industries. These emissions are measured in million tonnes and tonnes per person. The dataset also provides information on cumulative emissions, land-use change emissions, primary energy consumption, and greenhouse gas (GHG) emissions. The data sources for this dataset include Our World in Data, the International Organization for Standardization, the Maddison Project Database, and the Global Carbon Project. It is important to note that the emissions reported are based on territorial emissions, excluding emissions embedded in traded goods. The dataset offers valuable insights into the carbon footprint of various countries and can be used to analyze trends and patterns in CO2 emissions and their relationship with population, GDP, energy consumption and the different fossil fuels.

1.3.2 Extreme Poverty - Kaggle

The dataset [1] of 4 columns and 6942 rows provides valuable insights into the percentage of the population living below the poverty line, specifically focusing on those earning less than 30$ per day. It encompasses data from various countries and spans multiple years. By combining this "Extreme Poverty" dataset with our CO2 emissions dataset, we can gain a deeper understanding of the relationship between poverty and environmental factors. Poverty has long been recognized as a significant determinant of environmental vulnerability, and its implications extend to carbon dioxide (CO2) emissions. By examining the intersection of poverty and CO2 emissions, we can uncover potential patterns and correlations that highlight the socio-economic aspects of environmental impact. By merging the "Extreme Poverty" dataset with our CO2 dataset, we aim to explore the possible links between poverty levels and CO2 emissions. This analysis has the potential to shed light on how poverty reduction efforts and sustainable development initiatives can be synergized, leading to more effective strategies for addressing both social and environmental challenges.

1.3.3 CO2 emissions of all world countries - EDGAR

The dataset [3] of 56 columns and 1036 rows provides comprehensive information on CO2 emissions from various sectors, including the Power Industry, Buildings, Transports, and Other Industries, in different countries spanning the period from 1970 to 2021. The dataset quantifies the emissions in metric tons and captures the sector-wise contributions to CO2 emissions within each country. This dataset offers valuable insights into the temporal trends and variations in CO2 emissions in several sectors across nations. By merging this dataset with the CO2 dataset from Our World in Data, I will be able to analyze the respective contributions of different sectors to CO2 emissions over the years. Additionally, the combined dataset will facilitate the examination of the relationship between fuel types (such as oil, gas, and cement) and the various sectors, enabling a more comprehensive understanding of the factors influencing CO2 emissions.

2 Data Modeling and Preparation

2.1 Conceptual Entity-Relationship schema

In the process of data modeling using JMerise, several steps were undertaken to establish the relationships and entities for the datasets. Firstly, a thorough examination of the column variables in the three datasets was conducted, with a focus on identifying common columns for linking purposes in python. Duplicates were then removed, resulting in a refined list of variables to be considered. The initial entity created was "Country," which encompassed the primary key of country code, along with attributes such as country name, GDP, population (derived from the first dataset), and the share of population below the poverty line (obtained from the second dataset). The inclusion of the poverty line share under the country entity was justified by its relevance to the country entity itself. Following this, the "Year" entity was intuitively established, as it was evident that the country attributes were time-dependent. The "Year" entity consisted of a single attribute, year, serving as the primary key. The third entity formed was "Sector", necessitating the creation of a sector code as the primary key through Python programming, as it was not available in the third dataset. The sectors' names, present in the third dataset, were associated with the "Sector" entity. Similarly, the fourth entity constructed was "Fuel Type", requiring the creation of a fuel type code as the primary key through Python programming, as it was not available in the first dataset. The fuel types' names, mentioned in the first dataset, were linked to the "Fuel Type" entity. To establish relationships between the entities, a ternary relationship was developed among "Sector", "Country", and "Year". This relationship acknowledged that the CO2 emissions by sector in a specific year were influenced by the country, sector, and year attributes. The relationship's only attribute is "CO2 by sector". Likewise, a ternary relationship was established between "Fuel Type," "Country," and "Year," recognizing the association between CO2 emissions by fuel type in a specific year with the country, fuel type, and year attributes. The relationship incorporated attributes such as CO2 by fuel type, CO2 per capita by fuel type, cumulative CO2 by fuel type, share of global CO2 by fuel type, and cumulative share of global CO2 by fuel type. A binary relationship between "Country" and "Year" was established, incorporating attributes such as CO2 emissions, CO2 per capita, cumulative CO2, share of global CO2, and more. Additionally, three separate binary relationships between "Country" and "Year" were created to enhance comprehensibility and facilitate viewer understanding. These relationships covered aspects such as GHG emissions (including rates of methane, nitrous oxide, and total GHG, along with per capita rates), energy consumption (including primary energy consumption, energy per capita, energy per GDP, and CO2 per unit energy), and temperature change (including temperature change from CO2, CH4, N2O, and GHG). Figure 1 represents the conceptual entity-relationship schema accomplished in JMerise, providing a visual representation of the established relationships and entities.

2.2 Logical Snowflake Schema

After constructing the ER schema using JMerise, the logical snowflake schema was derived from the conversion of the MCD file, as illustrated in Figure 2. To identify the fact tables, which are tables resulting from mapping binary N-N relationships or n-ary relationships from the ER schema, we focused on tables with primary keys composed of foreign keys (derived from primary keys of other tables). In total, six fact tables were identified: CO2 emission (snowflake: Country, CO2 emission, Year),

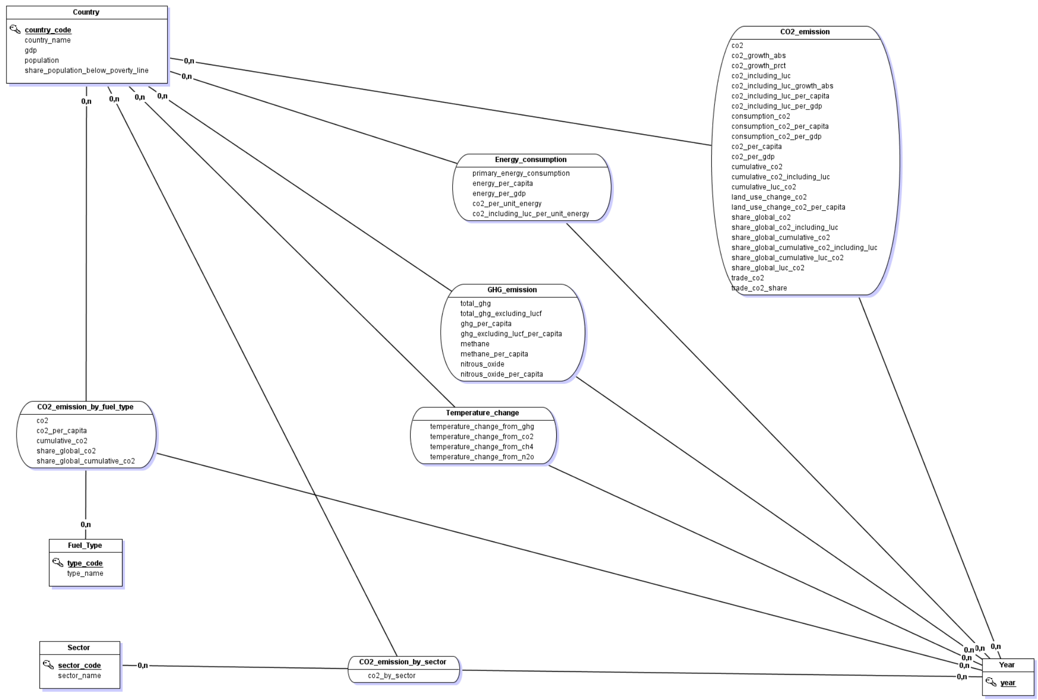

Figure 1: The conceptual Entity-Relation schema of CO2 emissions

CO2 emission by sector (snowflake: Country, CO2 emission by sector, Year, Sector), CO2 emission by fuel type (snowflake: Country, CO2 emission by fuel type, Year, Fuel Type), Temperature change (snowflake: Country, Temperature Change, Year), GHG emission (snowflake: Country, GHG emission, Year) and Energy consumption (snowflake: Country, Energy Consumption, Year). Each fact table in the snowflake schema was represented as a separate snowflake, which included the fact table itself and all directly or indirectly linked tables, as indicated by the arrows (representing the relationships between foreign keys and primary keys). The colors employed in the figure distinguished the six fact table (I didn't have an iPad so it was hard for me to draw the snowflakes). The implementation of the relational schema involved creating individual Excel sheets for each table. However, the Year table did not need to be represented separately since single-attribute tables were not implemented. Consequently, a total of nine tables were included in the Excel implementation: CO2 emission, CO2 emission by sector, CO2 emission by fuel type, Temperature change, GHG emission, Energy consumption, Country, Sector, and Fuel Type. These tables collectively formed the foundation for further analysis and exploration of the data in Tableau and I will explain in the next section how I cleaned the data and created the 9 sheets in Excel.

2.3 Data Preparation

Upon examining the three datasets, I determined the time periods covered by each of them. The first dataset, "CO2 and Greenhouse Gas Emissions," spans from 1750 to 2021, providing a comprehensive historical perspective. The second dataset, "Extreme Poverty," covers the years from 1981 to 2021, offering a more recent focus on poverty-related data. Lastly, the dataset titled "CO2 emissions of all world countries" encompasses the years from 1970 to 2021, providing a broader range of information on CO2 emissions. To ensure a meaningful intersection among the datasets and minimize the presence of missing values, I made the decision to retain only the observations from 1981 to 2021. This narrower time frame allows for a consistent and aligned analysis across the datasets, enabling effective comparison and exploration of the data. With the data aligned in terms of time period, I proceeded to analyze each dataset individually.

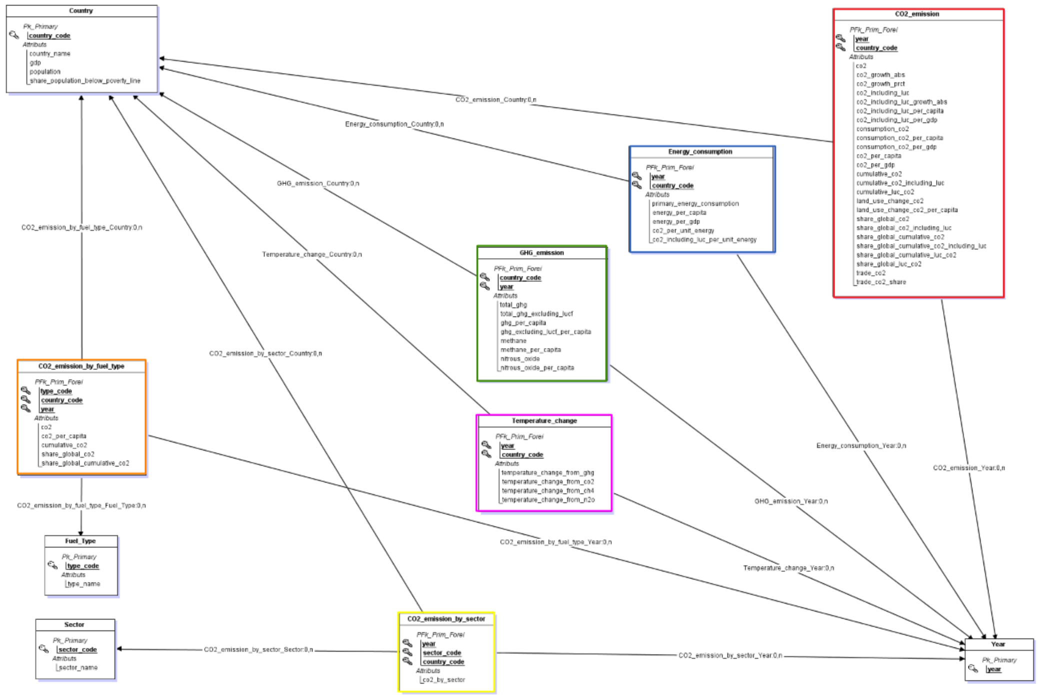

Figure 2: The logical snowflake schema of CO2 emissions

2.3.1 CO2 and Greenhouse Gas Emissions - Our World in Data

During the data exploration phase, I conducted a thorough analysis of the columns containing missing values. One issue I identified was the presence of missing country codes. To address this, I closely examined each country name associated with a missing code. Upon further investigation, I discovered that certain countries belonged to GCP regions, which are geographical regions used for hosting GCP resources. Since these regions were not relevant to my analysis, I decided to drop the corresponding rows from the dataset. Next, I turned my attention to the continents. To facilitate their identification in Tableau, I created a two-number ISO code for each continent. This coding system allowed for easy categorization and analysis within the visualization tool. Additionally, I encountered two countries, Kosovo and Timor, that were missing country codes. To resolve this, I referred to reputable sources, such as the "Country Calling Codes" database [2], to obtain their respective country codes. Having addressed the missing values in the country code column, I then focused on handling missing values in other columns. Since these columns contained float data, I opted to replace the missing values with the mean of the column grouped by country. This approach ensured that the analysis would not be skewed by extreme values, as substituting missing values with the minimum could potentially lead to erroneous interpretations. Moreover, it was crucial to eliminate missing values to maintain a consistent timeline across the years. By using the mean, I achieved a balance that allowed for accurate analysis without introducing unnecessary gaps in the data. With the missing values successfully handled, I proceeded to prepare the Excel sheets for each corresponding table. For the "Country" table, I extracted its five relevant attributes from the complete dataframe, changed the name of the columns for generality between sheets and stored them in a separate sheet in Excel. Similarly, I followed this process for the "CO2 Emission," "Energy Consumption," "Temperature Change," and "GHG Emission" tables, ensuring that each table contained the necessary attributes and all the primary keys and foreign keys for further analysis and integration. In addition to the aforementioned tables, I also created the "Fuel Type" table to capture the various fuel types present in the dataset. To facilitate analysis and integration, I assigned a unique numerical code to each fuel type and stored this information in a dedicated sheet. For example, I assigned the code "0" to represent coal, "1" for oil, and so on. To further enhance the analysis of CO2 emissions, I constructed the "CO2 Emission by Fuel Type" table. This involved transforming the original dataFrame rows into multiple rows, each representing a specific fuel type. I introduced a numerical code to identify each fuel type and subsequently mapped these codes to their corresponding names. This transformation enables a more straightforward examination and comparison of CO2 emissions data based on different fuel types. You can find the entire code with comments in the zip file or just here.

2.3.2 Extreme Poverty - Kaggle

To address the issue of missing values, I focused on the country code column, which contained the majority of the NA values. After careful consideration, I made the decision to drop this column from the analysis. This allowed me to seamlessly merge the two datasets, namely the "CO2 and Greenhouse Gas Emissions" dataset and the "Extreme Poverty" dataset, using the common attributes of country name and year as the basis for the join operation. To ensure the accuracy and reliability of the merge, I verified that all country names from the "Extreme Poverty" dataset matched those from the "CO2 and Greenhouse Gas Emissions" dataset. Subsequently, I proceeded to enrich the "Country" table by incorporating the pertinent information from the "Share Population Below Poverty Line" column of the "Extreme Poverty" dataset that will be useful for insights in Tableau.

2.3.3 CO2 emissions of all world countries - EDGAR

To streamline and standardize the dataset, several key steps were undertaken. Firstly, the "Substance" column, which contained only one substance (CO2), was dropped as it no longer provided meaningful variation in the data. I proceeded to rename the columns, employing a generalized approach that harmonized the column names across all three datasets to be able to join them together. Addressing the issue of missing values in the "CO2 by Sector" column, instead of simply omitting or imputing the missing values, I opted to substitute them by calculating the average CO2 emissions by sector across the years. This approach ensured that the missing values were replaced with statistically representative estimates, maintaining the integrity of the data while minimizing any potential biases. With the data properly prepared and cleansed, the next step involved creating the necessary sheets to represent the entities accurately. For the "Sector" table, I assigned a unique sector code to each sector name, thus establishing a clear and standardized identification system. To construct the "CO2 Emission by Sector" table, I transformed the original DataFrame by splitting the rows into multiple rows, each corresponding to a different sector. The full code is here.

3 Application

In Tableau, I did a story where I show all my plots and dashboards, I just included here the most relevant ones and the rest of the plots are in my tableau file in the story section: Reduce CO2 emission.

3.1 Insights

The visual representation in Figure 3 illustrates the global distribution of average CO2 emissions on a world map, specifically focusing on data from the year 2000 onward. This chart is showing the increase of carbon dioxide emissions over the world as the blue color is getting darker and darker over the years in most of the countries (clear in the Tableau file while running the video). The map highlights the significant role played by a country's level of development in contributing to CO2 emissions. Developed countries, such as China, tend to have the highest levels of CO2 emissions and have consistently ranked at the top for the past two decades. India is also a major contributor to CO2 emissions and faces significant challenges in addressing this issue. Russia is also playing an important role in the increase of CO2 emission in the last 10 years.
In Figure 4, the most problematic countries occupy the most significant area. Each country is represented by blocks of varying colors and sizes, arranged in order of severity from the top-left corner to the bottom-left corner. From 1981 till 2005, the United states were leading, but China was growing step by step. After 2006, China stands out as the leading contributor to global CO2 emissions, followed by the United States in second place, followed by India in third place. The percentage next to each country represent its global share of CO2. China, United States, India, Russia and Japan account for more than 50% of the whole CO2 emission over the world. This plot also proves the increase of CO2

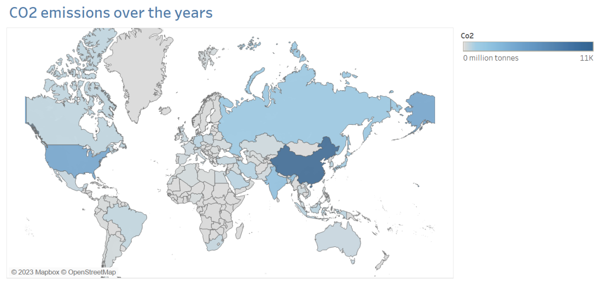

Figure 3: CO2 Emissions over the years

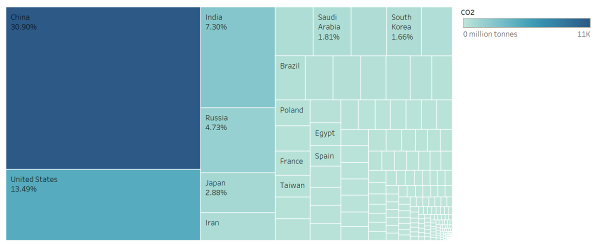

Figure 4: Treemap showing the global share of CO2 in each country

emission over the world from 1981 till 2021 since the big square is getting bigger and bigger (clear in the Tableau file while running the video).
Taking a different perspective, it's interesting to observe that the countries with the highest CO2 emissions (over all the years from 1981 till 2021) are predominantly the developed nations, which coincidentally have higher income levels, as shown in Figure 5. This correlation suggests a strong link between economic prosperity and carbon emissions.
The first graph in Figure 6 showcases a strong positive correlation between economic growth and CO2 emissions. As the GDP of a country is higher, so does its CO2 emissions. When hovering over a scatter dot, we can observe the average CO2 emissions per capita and CO2 emissions per gdp over the years for that specific country. For instance, China has experienced a significant surge in CO2 emissions per capita over the past decade, while we see in the Covid period a decrease in CO2 per GDP, probably because industries and transportation means were closed. Additionally, the graph highlights the percentage change in CO2 emissions over the last 10 years. China's percentage change reveals a constant increase.
Let us examine both the fuel type and sector dimensions over the years. As we embark on this exploration, shown in Figure 7 a clear narrative begins to emerge. Coal stands out prominently as the dominant fuel type, consistently maintaining its leading position throughout the years. Similarly, the Power Industry emerges as the prominent sector, demonstrating a sustained influence on CO2 emissions over time. When we shift our focus to the countries contributing to CO2 emissions, a striking revelation awaits us. China, a powerhouse in both production and population, emerges as the primary behind coal-related emissions. With a staggering total of 7,956 million tons emitted by coal,

Figure 5: Treemap showing the global share of CO2 in countries by income level

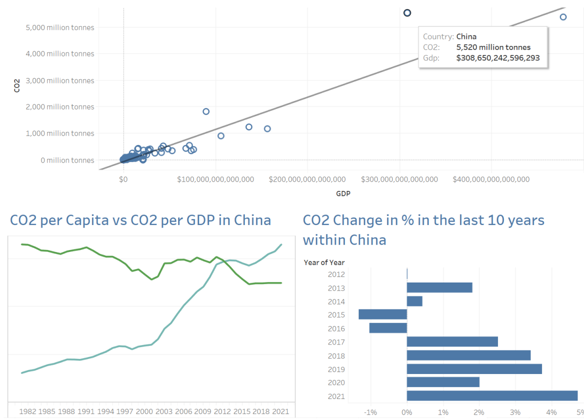

Figure 6: CO2 emission vs GDP

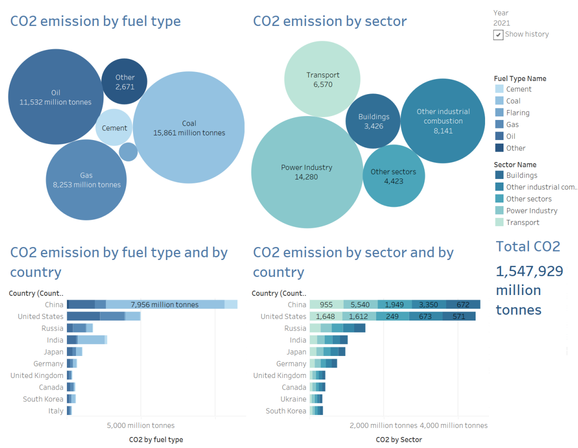

Figure 7: CO2 emission by fuel type and CO2 emission by sector over the years

China's significant contribution accounts for nearly half of the global coal-related CO2 emissions. In comparison, the rest of the world combined amounts to 15,861 million tons—a noteworthy disparity. Furthermore, an intriguing correlation emerges as we analyze the top-ranking countries in terms of both fuel type and sector. The top five countries leading in CO2 emissions align remarkably across both dimensions. This convergence underscores the critical role these nations play in the global CO2 landscape, emphasizing their responsibility and potential impact in mitigating CO2 emissions. These findings highlight the imperative for concerted efforts from these top-ranking countries to address and reduce CO2 emissions. With their substantial contributions to both the fuel type and sector emissions, these nations hold significant potential for implementing effective strategies and initiatives aimed at curbing CO2 output.

CO2 plays a central role in driving global climate change, but it's important to recognize that it is not the sole greenhouse gas responsible for this phenomenon. Other greenhouse gases, such as methane (CH4) and nitrous oxide (N2O), also contribute significantly to global warming. Understanding the relative contributions of these gases is essential in addressing climate change effectively. By analyzing the percentage of CO2 emissions compared to other greenhouse gases, we can gain valuable insights. Over the years, the percentage of CO2 emissions has been steadily increasing. In 1981, CO2 accounted for 60.4% of total greenhouse gas emissions, and by 2021, this figure rose to 74.56% as shown in Figure 8. In addition to the increasing percentage of CO2 emissions compared to other greenhouse gases, it is noteworthy that the overall quantity of greenhouse gas (GHG) emissions is also on the rise. This means that not only is the proportion of CO2 emissions rising, but the overall quantity of GHG emissions is also growing. This upward trend underscores the urgent need to reduce CO2 emissions as a crucial step in mitigating the impact of greenhouse gases on our climate. In the second graph, we observe

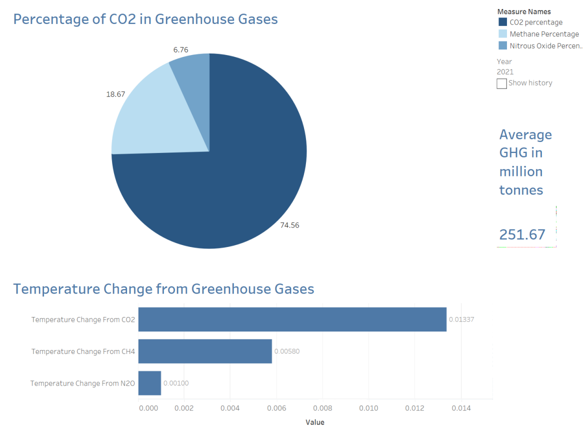

Figure 8: CO_2 compared to other greenhouse gases in 2021

the temperature effects generated by different greenhouse gases. It is evident that CO_2 contributes to higher temperature changes compared to CH_4 and N_2O. This finding highlights the significant role of CO_2 as the most potent greenhouse gas driving climate change. It underscores the imperative for immediate action to curb CO_2 emissions and address the primary driver of global warming.

3.2 Recommendations

In order to effectively reduce CO_2 emissions, it is crucial for decision makers to take proactive measures. The following recommendations are tailored to each specific decision maker:

3.2.1 Government and Policy Makers

- **Transition to Renewable Energy:** Implement policies that encourage the deployment of renewable energy infrastructure such as solar, wind, hydro, and geothermal power to reduce CO_2 emissions from the Power Industry sector and fuel types such as Coal.
- **Carbon Pricing and Emissions Trading:** Introduce carbon taxes that provide economic incentives for businesses to reduce their CO_2 emissions and invest in cleaner technologies.
- **Sustainable Transportation:** Promote the use of public transportation to reduce emissions from the Transportation sector by creating special discounts (e.g., carte avantage) + Invest in the development of charging infrastructure for electric vehicles and encourage the adoption of fuel-efficient and low-emission vehicles.
- **Sustainable Urban Planning:** Establish green building practices and energy-efficient construction standards and regulations to reduce emissions from the Building sector.

3.2.2 International Organizations and NGOs

- **Public Awareness and Education:** Launch public awareness campaigns to educate the public about the importance of reducing CO_2 emissions and the individual actions they can take + Foster a culture of sustainability and environmental responsibility through education and community engagement.
- **International Cooperation:** Collaborate with other countries and actively participate in international agreements and initiatives aimed at reducing CO_2 emissions, such as the Paris Agreement.
- **Monitoring and Reporting:** Support the establishment of robust monitoring, reporting, and verification systems to track progress in reducing CO_2 emissions.

- **Research and Innovation:** Support research and innovation in clean energy technologies, sustainable practices, and climate solutions by funding these projects.

3.2.3 Industries and Head of Factories

- **Energy Efficiency Improvements:** Conduct energy audits, upgrade equipment and machinery to energy-efficient models, improve insulation, and adopt smart energy management systems.
- **Transition to Renewable Energy:** Invest in renewable energy sources such as solar, wind, and hydropower to meet the energy needs of factories + Install on-site or off-site renewable energy generation systems to reduce reliance on fossil fuels.
- **Carbon Capture and Storage (CCS):** Explore the feasibility of implementing CCS technologies to capture and store CO2 emissions from industrial processes. This can significantly reduce carbon footprints by capturing CO2 and preventing its release into the atmosphere.
- **Employee Engagement and Training:** Educate and engage employees in sustainable practices and provide training on energy efficiency, waste reduction, and emission control.

3.2.4 Individuals and Consumers

- **Energy Conservation:** Reduce energy consumption in your daily life by turning off lights and appliances when not in use, using energy-efficient LED bulbs, and optimizing heating and cooling settings.
- **Transportation Choices:** Opt for sustainable transportation options like public transportation, carpooling, biking, or walking instead of relying heavily on personal vehicles.
- **Reduce, Reuse, Recycle:** Practice the principles of the circular economy by reducing waste generation, reusing items, and recycling materials.
- **Conscious Consumption:** Make informed choices when purchasing goods and services. Prioritize products that are sustainably produced, energy-efficient, and have a lower environmental impact.

By implementing these recommendations, we can collectively contribute to the reduction of CO2 emissions and work towards a sustainable and low-carbon future.

4 Conclusion

In this project, I utilized advanced data analysis techniques and IT tools to explore and analyze CO2 emissions data from multiple sources. The IT tool, JMerise, was a positive experience as it provided a user-friendly interface for building the ER schema and converting it to a logical snowflake schema. I was able to see what are the tables that should be implemented seperately in Excel to facilitate the work in Tableau. The IT tool, Tableau, played a crucial role in visualizing and analyzing the data. Its interactive and intuitive interface allowed for a comprehensive exploration of the datasets, enabling me to identify trends, patterns, and correlations among different variables. By leveraging the power of Tableau, I was able to generate meaningful visualizations and gain valuable insights into the factors driving CO2 emissions. Additionally, the selection of relevant and reliable data sources greatly contributed to the accuracy and comprehensiveness of my analysis. By considering multiple datasets covering various aspects of CO2 emissions, I was able to gain a holistic understanding of the problem and make informed recommendations. From this project, I have learned the critical role that data analysis and IT tools play in tackling complex environmental issues such as CO2 emissions. The combinations of JMerise, Python and Tableau, coupled with comprehensive and reliable data sources, was a must in analyzing CO2 emissions data in depth and generating actionable insights. Through this project, I have gained valuable knowledge about the importance of reducing CO2 emissions, the role of different decision makers, and the actions that can be taken at various levels to combat climate change. Thank you Professor Prat!

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