The Economics of Renewable Energy

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Project Overview

Question: How do developing countries use clean energy, and how have they improved over the years? How do these upcoming technologies create progress in these countries?

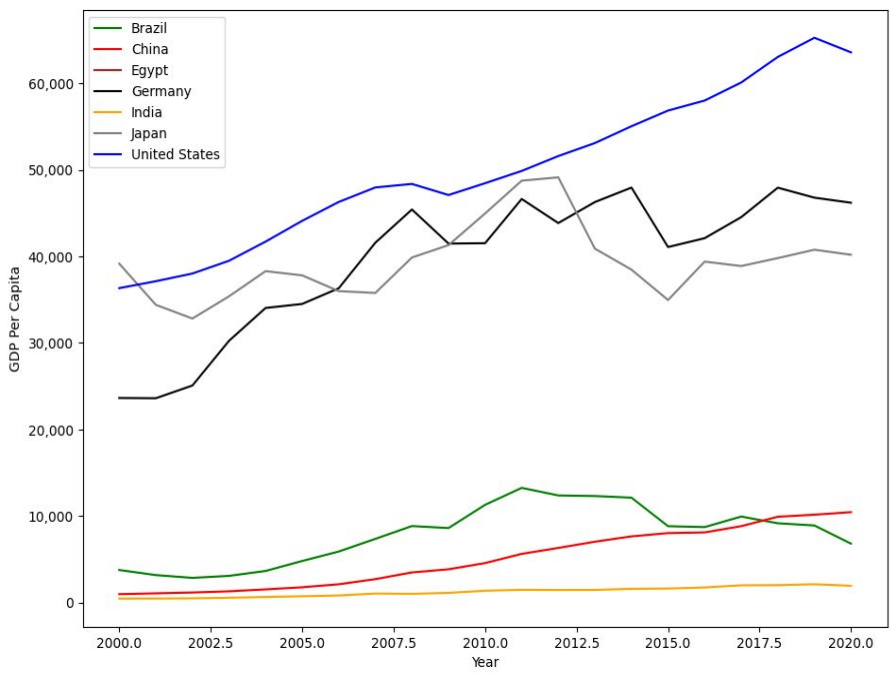
Why I chose this topic:

- Renewable energy is an extremely important topic in the modern day.
- Economies of scale are very informative and can show hidden trends in data.

Dataset Overview

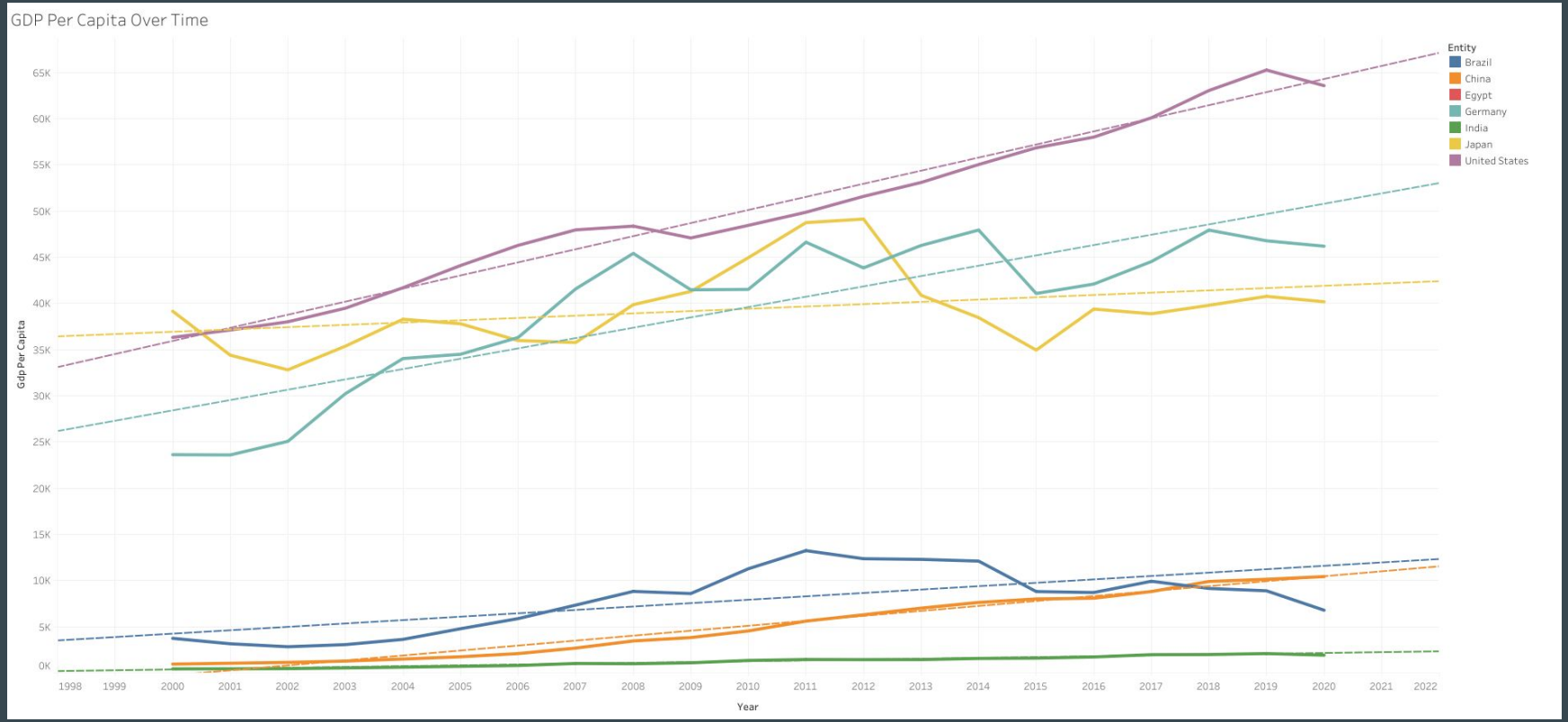
- Source from Kaggle
- Countries that were not needed for analysis were not used
- Countries such as the US, China, and Germany used as benchmarks for developed nations.
- Brazil is the country that is most defined as a “developing” country in my analysis.

GDP Per Capita Over Time




```python
import pandas as pd
from matplotlib import pyplot as plt
from itertools import cycle
from matplotlib.ticker import FuncFormatter


energy_data = pd.read_csv('sustainable-energy.csv')
countries = energy_data['Entity'].unique()


custom_colors = {
    'Brazil': 'purple',
    'China': 'red',
    'Egypt': 'brown',
    'Germany': 'black',
    'India': 'orange',
    'Japan': 'grey',
    'United States': 'blue'

}

plt.figure(figsize=(11, 8))
for country in countries:
    country_data = energy_data[energy_data['Entity'] == country]
    color = custom_colors.get(country, 'black')  # Gets color for country to graph
    ##Sets values for axes
    plt.plot(country_data['Year'], country_data['gdp_per_capita'], label=country, color=color)

#Plotting
plt.xlabel('Year')
plt.ylabel('Electricity from renewables (TWh)')
plt.legend()
plt.ticklabel_format(style='plain', axis='y')
plt.gca().get_yaxis().set_major_formatter(FuncFormatter(lambda x, _: '{:,.0f}'.format(x)))

plt.show()
```

GDP Per Capita Over Time (cont.)



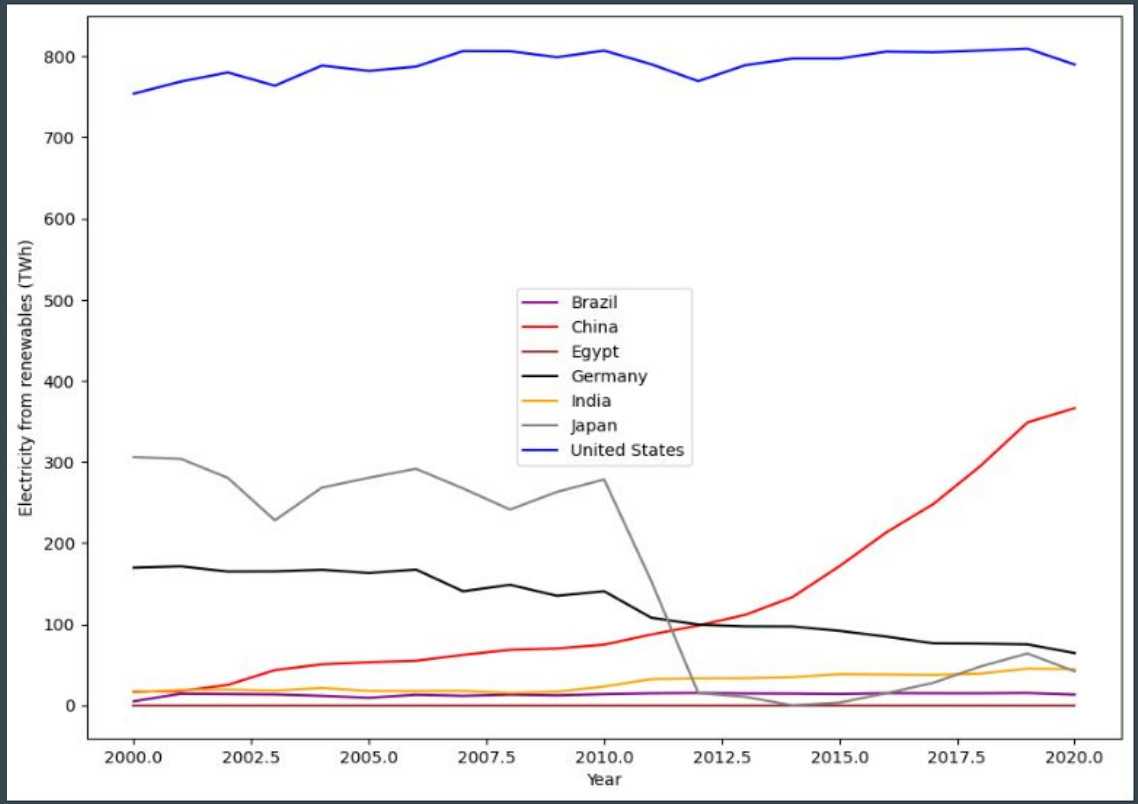
GDP Per Capita Over Time (cont.)

- Observations
  - Wide range of values for various countries
  - China and India
    - Relatively low due to extremely high population and relatively weak currency
    - GNP can be used as a better measure for development
    - China's GNP is much higher than that of the US
      - 30 trillion PPP dollars and 26 trillion PPP dollars, respectively
        - Currency that equalizes the purchasing power of various countries looking to trade.
    - Result of higher levels of manufacturing and exporting of goods.
  - Drop around 2019, likely due to Covid and lockdowns

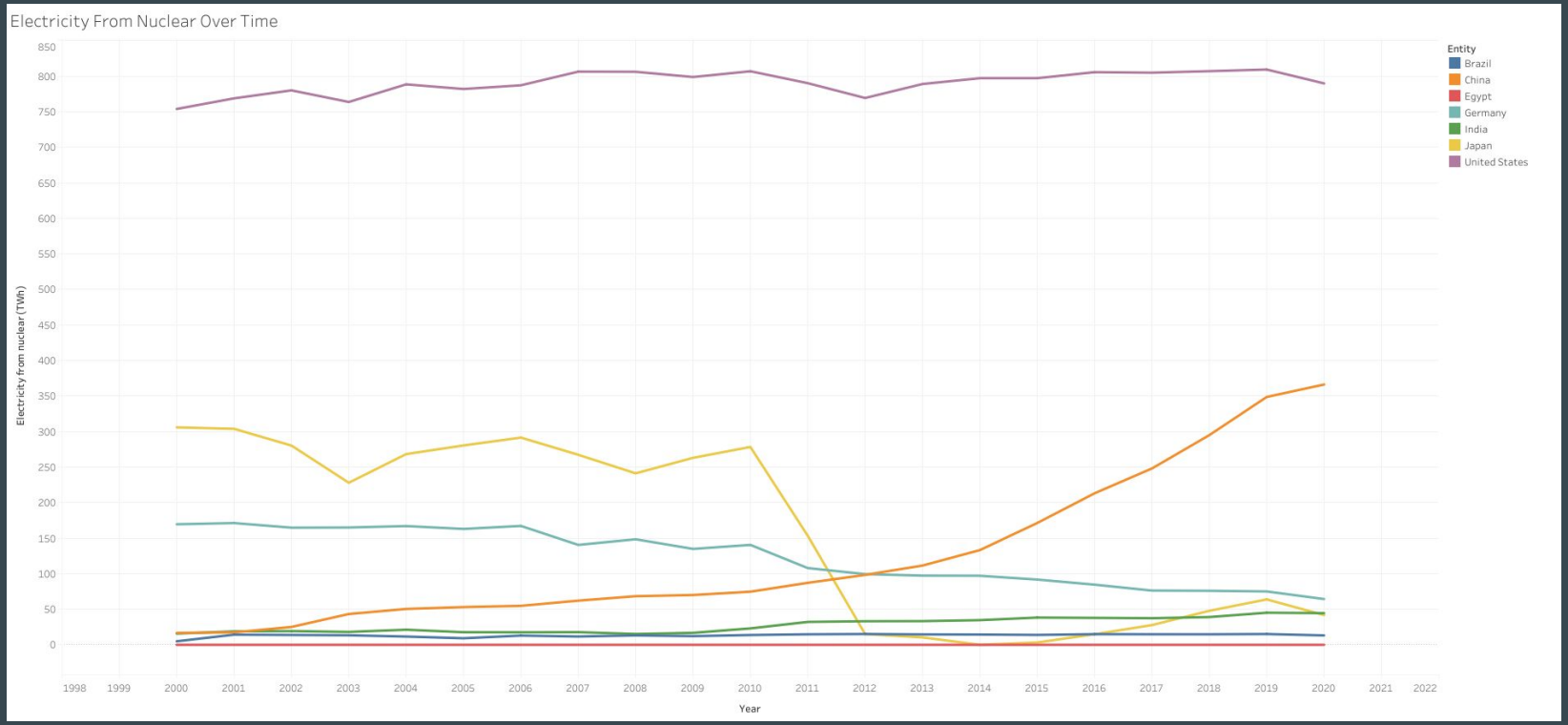
GDP Per Capita Over Time (cont.)

- Observations
  - Looking at countries like Brazil, a developing nation, a rising GDP leads to rising quality of life.
    - HDI index used to measure growth of nations and quality of life standards (UN Human Development Reports)
    - 2009 HDI index value of 0.717 compared to 2011 HDI index value of 0.727
      - Shows clear increase over time as GDP rose
      - Similarly, GDP decline led to lower HDI index value
      - 2019 to 2020 index went from 0.764 to 0.758 as GDP/capita dropped over 2000 dollars

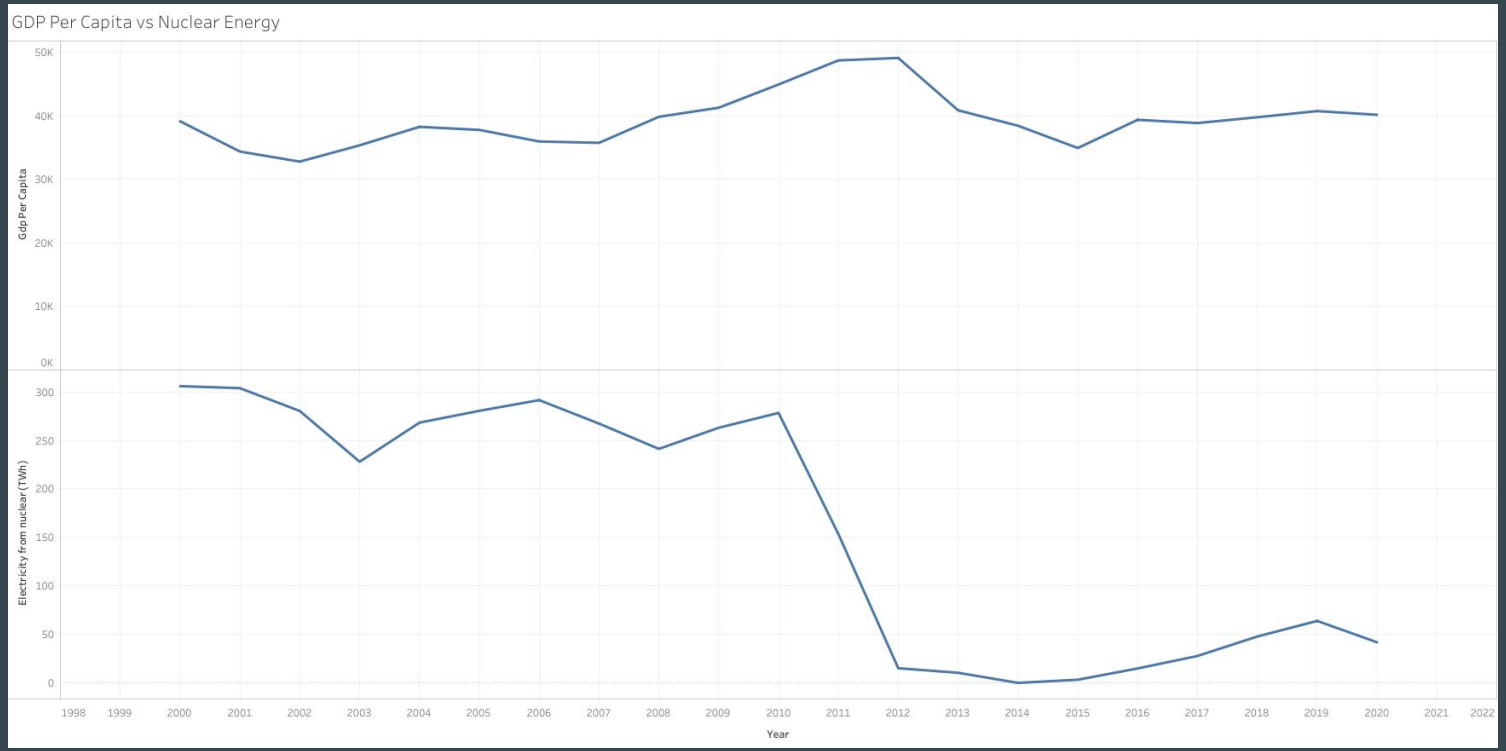
Nuclear Energy



Nuclear Energy (cont.)



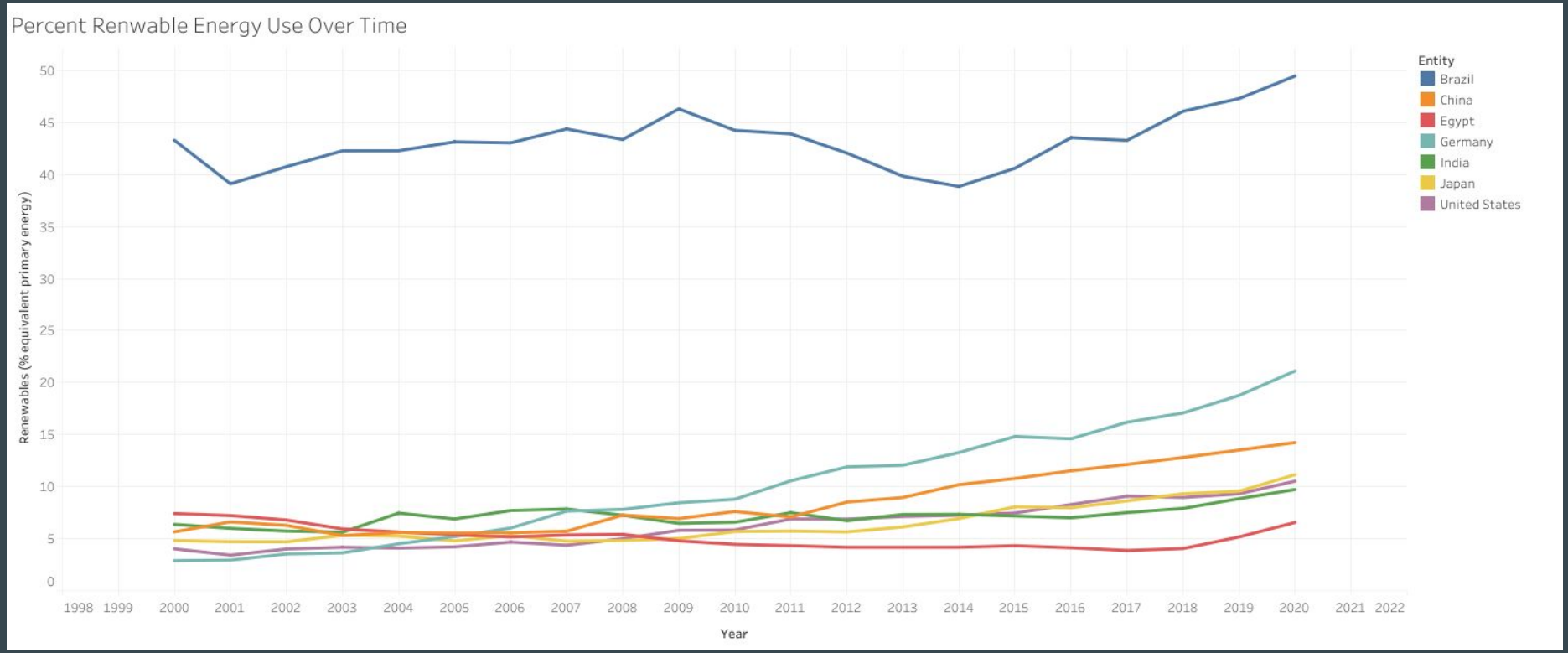
Nuclear Energy (cont.)



Nuclear Energy (cont.)

- Observations
  - Extremely large drop in electricity production for Japan from 2010-2012
    - Result of Fukushima nuclear disaster
      - Caused by massive tsunami in the area
    - Decreased nuclear electricity production by approximately 94.6% over the course of the 2 years after the meltdown.
    - Anywhere from 119,000 to 164,000 residents were displaced.
    - Resulted in the creation of many other types of clean energy such as hydroelectric and wind power.
  - GDP dropped during the years following the accident, likely as the government attempted to clean up and decontaminate the area, an extremely expensive project.
    - “In 2016, Japan's Ministry of Economy, Trade and Industry estimated the total cost of dealing with the Fukushima disaster at ¥21.5 trillion (US$187 billion), almost twice the previous estimate of ¥11 trillion (US$96 billion).” (Fukushima Disaster Cleanup).

Brazil's Energy Use



Brazil's Energy Use (cont.)

- Observations
  - Drop in clean energy use around the years 2000 - 2001
    - Caused by large drought
    - Led to the reduction of water levels at Brazil's many hydroelectric dams
      - Largest source of clean energy for the country
      - "Brazil has a generating system with installed capacity of more than 150 GW, with most of the energy coming from hydro, due to Brazil's abundance of powerful rivers." (International Trade Administration)
      - The Amazon rainforest is currently untapped and can generate even more hydroelectric energy in the near future.
        - Protected area within Brazil
        - Restricts access for electrical and energy companies

Ethical Considerations

- Sources of Errors in Analysis
  - It is possible that many other factors could have led to the increase and decrease of the variable in my analysis.
    - For example, the global economy generally tends to fluctuate over time
    - Wars and global conflicts could also play a key role in the increase and decrease of renewable energy use
- Biases in the dataset
  - There are not many biases involved in the dataset as it is simply a compilation of many data points over time.
- No personal or sensitive information was revealed in the dataset

Summary

- Findings
  - The use of clean energy can drastically affect the economy of a nation.
    - Improved economy can improve quality of life and overall living conditions
    - Large scale shutdowns of energy systems can lead to economic loss
  - Countries often use their natural resource effectively and specialize in certain types of clean energy
    - Japan has a large dependency on nuclear energy, showcased by the drop in GDP after the Fukushima disaster.
    - Brazil as an example largely focuses on hydroelectric power, effectively utilizing a resource they have an abundance of.

Thank you!

Works Cited

"Fukushima Disaster Cleanup." Wikipedia, 11 Jan. 2024, en.wikipedia.org/wiki/Fukushima_disaster_cleanup#:~:text=In%202016%2C%20Japan%27s%20Ministry%20of.

International Trade Administration. "Brazil - Renewable Energy Infrastructure." Www.trade.gov, 4 Dec. 2023, www.trade.gov/country-commercial-guides/brazil-renewable-energy-infrastructure-0.

Nations, United. "Specific Country Data." Hdr.undp.org, 8 Sept. 2022, hdr.undp.org/data-center/specific-country-data#/countries/BRA.