

Exploring the correlation of the State of the Economy with Nuclear Energy Usage: How would countries with different economies decide to use nuclear energy?

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Abstract

The growth of the human population, currently the highest of all time at more than 8 billion, requires a greater expenditure of energy. In order to solve the energy problem, there are many different candidates, such as fossil fuels, solar energy, wind energy, etc. However, different sources of energy have different advantages and disadvantages, meaning more than just a single energy source is sufficient for global usage. As a candidate, nuclear energy usage has been steeply growing in certain countries in the last few decades.

This paper will look into the impact of using nuclear energy, the cause of utilizing nuclear power, and the situation of different countries regarding their decision on the usage of nuclear energy. Specifically, the relationship between the economy of countries represented in the form of GDP and the usage of nuclear power will be reviewed, as well as the reasons why specific countries use nuclear energy more often than others will be taken into account, which can be considered for the situation of different countries. Numerous sources, especially government reports of energy consumption, were used along with reports from professional atomic physicists.

However, countries such as Germany, Japan, and Great Britain have decided to decrease their nuclear energy usage. Governments have spent different investments on atomic power plants, resulting in an efficiency difference. In the future, the difference in nuclear power plant usage between countries will grow even further after debates about the usefulness of atomic energy.

Keywords: Energy expenditure, energy sources, nuclear power, economy.

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I. Introduction

Globally, world energy consumption has been growing at the fastest rate since the industrial revolution. Due to the controversial practicality of using nuclear energy, countries' decision on the usage of nuclear energy varies. China, India, and South Korea have all decided to increase their nuclear energy output, while Germany, Japan, and Great Britain have been "actively taking their nuclear plants offline" (see Figure 1).

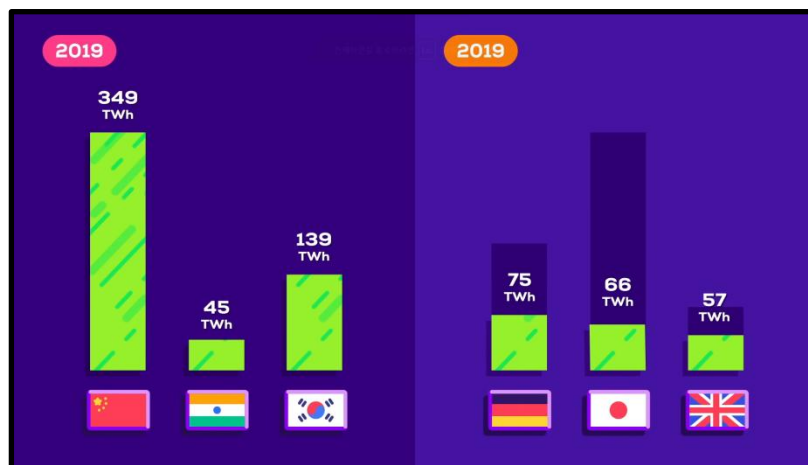


Figure 1: Comparison of nominal and changed values of observed countries' nuclear output. Kurzgesagt (2021)

All countries have taken numerous factors into account, mainly the development of nuclear power plant technology. New nuclear reactors are being developed, such as small modular reactors or SMRs. SMRs are smaller, simpler, and safer versions of nuclear reactors (Liou, 2021) that might be able to successfully promote sustainable development by being able to customize, assemble in factories, and automatically shut down during atypical situations (Idaho). Countries may have chosen not to invest in SRS due to not seeing a guaranteed return, which impacted the countries' nuclear energy usage rate.

II. Materials & Methods

Primary research, the countries' reports, show their economic strength in GDP measurements, as well as their energy consumption and nuclear energy usage. Secondary research was undertaken to assimilate the relationships between countries' economies and energy consumption, which were largely from online articles explaining the phenomenon from different perspectives. The results have been analyzed and compared.

The researches provide diverse, sufficient information which can be used to develop and support a new idea. Numerous studies lead to a variety of perspectives and reliability of sources.

III. Results

Although various countries with relatively lower GDPs constructed nuclear power plants initially, the generation of energy both nominally and comparatively has been the highest in regions with the highest GDP. The majority of the countries with the most nuclear reactors have been reported to be countries with a stable economy. This is due to the countries with better economies being able to afford the necessary infrastructures. Various statistics discussed describe this phenomenon.

The Economy during the Initial Construction

An article explains different nations' history of GDP per capita at the time they began nuclear energy projects. All the data from the blog has been taken from the Institute for Health Metrics and Evaluation (IHME), which provided a "comprehensive time series of GDP per capita for 210 countries from 1950 to 2015" (GHDx). In the analysis, Lovering (2020) explains the history of nuclear energy and its usage among low-income countries. When the first reactor has been built, only US, Russia, Britain, and Canada were considered economically developed. Countries such as India, Pakistan, China, Brazil, and South Korea all had GDP per capita lower than \$10,000. Recently as well, Bangladesh had a GDP of \$2,000, which Kenya and Ghana couldn't reach (Lovering, 2020). The graph shows the relationships between the GDP per capita of countries in 2005 and the construction year of the first nuclear reactor (see Figure 2).

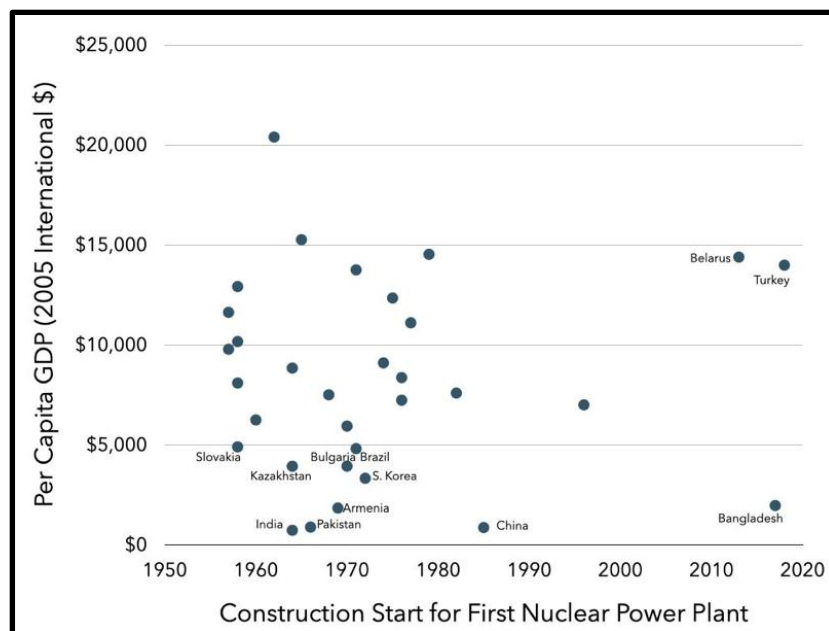


Figure 2: Relationship between GDP per capita in 2005 and construction start for the first nuclear power plant (GHDx).

Nuclear Reactors by Regions and Countries

A report describing the situations of countries five years after the 2011 Fukushima disaster illustrates the global spread of nuclear power plants (Bloomberg, 2023). The paper utilizes data from numerous sources, such as *Carbon Brief*, and International Atomic Energy Agency Data. According to the report, *Carbon Brief* provides a map that shows how numerous regions are stopping themselves from using nuclear power, where about 33 gigawatts have decreased from 378 to 345 in 2015. Nonetheless, the map also shows North America, Western Europe, and East Asia operating and constructing nuclear reactors (see Figure 3).



Figure 3: Status of nuclear reactors globally (Misra, 2023)

Another infographic describes the global distribution of GDP by region (see Figure 4). Each hexagon in the infographics represents one-thousandths of the world’s net GDP. North America constitutes 80% of the world’s GDP or \$75 trillion, with East Asia and Europe following. The order of the wealthiest regions correlates with Figure 3.

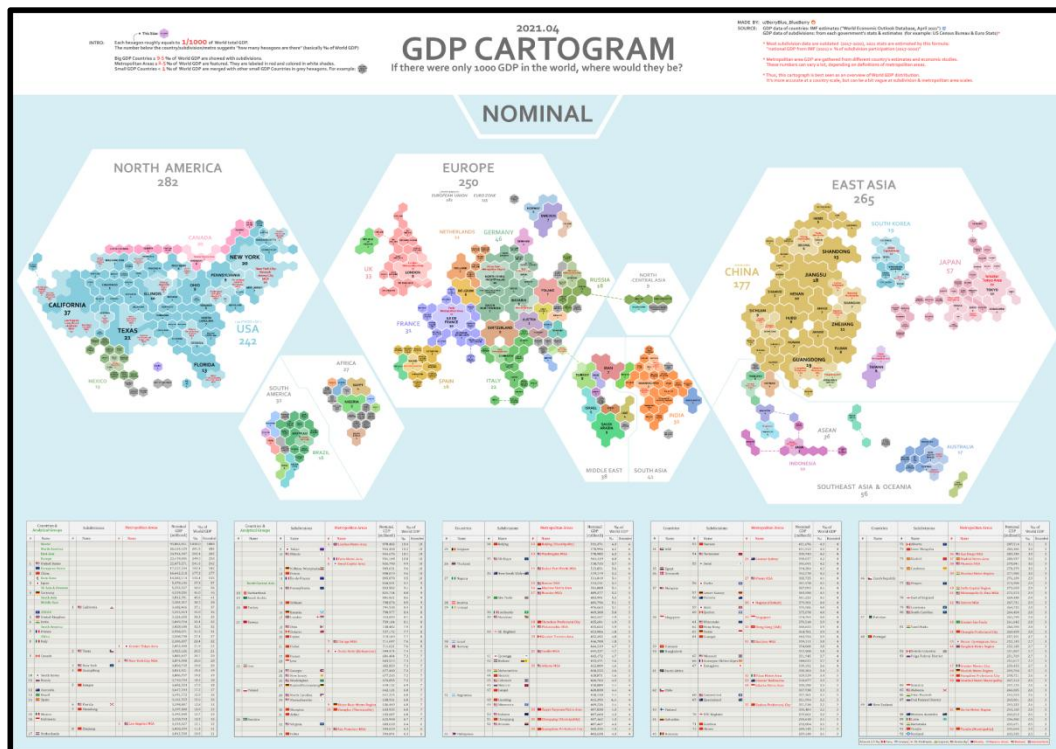


Figure 4: Global GDP distributed by regions (Deshmukh, 2023)

Nuclear Power Plants Construction Cost

Constructing a nuclear reactor costs an immense financial burden on nations. The EIA calculated that about \$5,300 are needed to produce one kilowatt (Plumer, 2016). Building one additional nuclear reactor costs about \$5 billion to \$10 billion. As an example, another research claims that building two new nuclear power plants would cost about \$9.8 billion (David & Bruce, 2008).

IV. Discussion

The positive relationship between nuclear energy usage and the GDP level of countries leads to the conclusion that the more developed a country is, the more energy is provided using atomic reactors. However, at the same time, there was no strong correlation between the countries' initial construction and the economic situation at that time. This explains that the countries built their first atomic reactors even when they were not economically developed.

V. Conclusion

The extreme cost of constructing, managing, and investing in nuclear reactors allows countries with better economies to better utilize atomic energy. Worsening of this difference might lead to delay energy development in certain regions, further affecting the climate change consequences. As an example, Türkiye has suffered a heavy flood due to global warming. However, the construction of the first nuclear reactors did not have a high correlation with GDP, meaning countries still attempt to deploy nuclear energy despite its affordability. To conclude, accepting atomic energy is not characterized by countries' economic situation, yet by consumption.

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