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Should nuclear energy be used in the future?

Introduction

In recent light, nuclear energy has become a major breakthrough across the globe. Many controversial opinions have been circulating on this topic, with many for its use in the future, and many against its use in the future. Here, the global relevance stands amongst countries worldwide, as they are considering the change to nuclear energy from the traditional fossil fuels in order to combat climate change. According to the National Aeronautics and Space Administration (NASA), an American administration focusing on the Earth and anything beyond Earth, it defines climate change as “... a long-term change in the average weather patterns that have come to define Earth’s local, regional and global climates.”(NASA, 2023). Nuclear energy offers a cleaner source of energy, rather than the traditional fossil fuels, which leaves a major carbon footprint on the environment when used. With its increasing demand worldwide, and the growing concerns on climate change, this controversy has taken the world by storm.

According to the Department of Energy’s Office of Nuclear Energy, which oversees anything related to energy in the United States, it outlines the process of nuclear energy in simple terms (ONE, 2021). The way that nuclear energy is made is through a process called nuclear fission. Nuclear fission is a process in which the nucleus of an atom is split, causing energy to be released in the form of heat. This heat is then harvested to create steam, which propels turbines that produce electricity. A typical nuclear power plant uses uranium as its source of fuel. Uranium is a naturally occurring element that is enriched to make the fuel rods that are used in nuclear reactors. Uranium enrichment is the process of increasing the concentration of uranium-235, which is the isotope of uranium that’s used in the fuel rods (Department of Energy, 2021).

This process of creating nuclear energy comes with both economic and scientific benefits. Scientifically, this is a clean and reliable source of energy that can reduce carbon emissions. Economically, nuclear energy is cost-effective in the long run, as the cost of fuel (uranium-235) is relatively low compared to other sources of fuel. On the other side, many argue against it for economic and scientific downsides. Scientifically, it poses major issues in risking a radiation leak, and nuclear waste management. Economically, it is expensive to construct and maintain a nuclear reactor. Ultimately, this raises the question; should nuclear energy be used in the future?

Scientific: Yes

Through recent technology, harvesting fossil fuels has become significantly easier. With more exports in the global market, its use has increased rapidly. Subsequently, it came with an influx in greenhouse gas emissions. Since it is the most used energy, it has posed environmental problems. According to the London School of Economics' Grantham Research Institute on Climate Change and the Environment, fossil fuels emit 450 - 1,050 grams of carbon dioxide per kilowatt hour, while nuclear energy emits 15 - 50 grams of carbon dioxide per kilowatt hour. Fossil fuels emit around 30 times more carbon dioxide into the atmosphere than nuclear energy does. Because of this, "Nuclear energy can therefore contribute to the decarbonisation of the global energy system" (LSE, 2022). Thus, making it a crucial piece in climate change. Aside from this, nuclear energy comes with another benefit.

Another main benefit of using nuclear energy in the future is the high capacity factor of these plants. They can produce electricity continuously for 24 hours a day, 7 days a week. This means that external environmental factors won't affect the processes of these power plants. Unlike wind and solar energy, which require certain conditions to function. Nuclear energy

outperforms these alternate energy sources. According to a study by the Department of Energy, “Nuclear power plants are designed to run 24 hours a day, 7 days a week because they require less maintenance and can operate for longer stretches before refueling (typically every 1.5 or 2 years).”(ONE, 2019). This continuous use allows it to be favorable for countries that experience extreme weather patterns, or a shortage of nuclear specialists. Moreover, since the 1986 Chernobyl disaster, nuclear plants have seen an improvement in safety features and protocols. They act as preventative features to reduce fatality rates in these facilities. A study published by Kharecha in the Journal Energy Policy, found that nuclear power plants have a significantly lower death and injury rate in comparison to coal and oil power plants (Kharecha, 2013). Overall, the scientific benefits of nuclear energy projections have favorable properties for countries, proving its worth as a primary source of energy.

Economic: Yes

As a popular energy source, fossil fuels come at a price. According to David Schlissel, a senior consultant with Synapse Energy Economics, who has worked in energy management issues for 30 years, in a report from July 2008, he found that “... the estimated costs of building new coal plants have reached \$3,500 per kilowatt hour (kW)” (Schlissel et al., 2008). According to David Fritsch, who is associated with the Energy Information Administration, the average coal plant lasts for about 50 years (Fritsch, 2021). Jessica Aizarani from Statista says, the average nuclear power plant costs \$7,800 per kilowatt hour, and lasts about the same life span (Aizarani, 2023). At first, this may seem like coal plants are far more economically beneficial, however, the Nuclear Energy Institute proves this to be the opposite. In looking at fuel power output, one uranium fuel pellet equates to one ton of coal, in terms of energy produced (NEI, 2020). The

average nuclear power plant holds 18 million uranium pellets, meaning that it produces around 18 million tons of coal equivalent. The prices of a uranium pellet versus the cost of a ton of coal is a drastic difference. The Uranium pellet costs far less, therefore making nuclear power plants more economically efficient.

Another big benefit of these plants is their independence from the global market. If Saudi Arabia –which is the largest exporter of oil– decides to increase their export costs, then the global cost of fuel will rise. However, since nuclear power plants are independent of global exports and imports, the country hosting these reactors doesn't have to rely on the inflated price of oils and other fuel sources. Making nuclear energy an economically secure form of energy. Furthermore, for developing countries, small modular reactors (SMRs) have the full capability of reducing the capital costs of nuclear energy even lower, making it more accessible to third world countries. A study published in the journal Renewable and Sustainable Energy Reviews saw a spike in the use of SMRs for small scale applications, while still being cost-effective (Nissan et al., 2017). Overall, the versatility and cost effectiveness of nuclear power plants makes them economically favorable for their dominant use in the future.

Scientific: No

Although nuclear power is a strong proponent for climate change, a major byproduct is created, which contradicts the environmentally friendly nature of these reactors. This byproduct being nuclear waste. This causes a new dilemma of storing it, as it is highly toxic. In some cases, it could even cause radiation leaks if not stored properly. According to Sarah Zielinski, who is an award-winning science writer and editor, who works for the Smithsonian, an international organization, a nuclear meltdown, the most common incident with nuclear power plants, is when

the core of a reactor overheats and gets damaged (Zielinski, 2011). A prime example of this could be seen by the Fukushima Daiichi disaster in Japan in 2011. Here, an earthquake caused the reactor's cooling system to shut off, which led to the core overheating. Similarly, a well known incident in Ukraine, the Chernobyl disaster in 1986, was also caused by a meltdown. According to the World Nuclear Association (WNA), this disaster was caused by a flaw in the reactor design, which led to a massive explosion. This explosion released 5% of the toxic radioactive core into the environment (WNA, 2022). The radiation that was released killed 28 people, and resulted in 5000 cases of cancer in people surrounding the disaster across multiple decades.

This leads to the next downside, being that the nuclear waste can remain dangerous for thousands of years, which requires special storage and disposal methods. The International Atomic Energy Agency (IAEA), which is a global agency that specializes in nuclear energy, says that through the methods of “incineration of solid waste and evaporation of liquid waste”, a third step of conditioning allows the waste to be in a safe, stable, and manageable form for transportation, storage, and disposal (IAEA, 2016). However, although these methods may work most of the time, the chances of a nuclear disaster happening isn't zero. Spencer Wheatley, a physics major who is from Cornell University, through a large scale statistical analysis study of nuclear accidents in 2015, there is a 50% chance of a nuclear disaster happening before 2050 (Wheatley et al., 2015). This in itself raises the risk of implementing nuclear power plants for the future. Therefore, the use of nuclear energy for the future is a risky leap for global energy production.

Economic: No

Although nuclear power plants have a cost efficient price to kilowatt hour ratio, which in turn makes them a long term investment, the upfront cost of a nuclear power plant is staggering. According to the same report from Synapse Energy Economics Inc by David Schlissel, he says that the upfront cost of building a nuclear power plant reaches between \$6 billion and \$9 billion for a 1,100 MW plant (Schlissel et al., 2008). In comparison to coal plants, in the same report, David Schlissel says that the upfront costs of a coal power plant is around \$2 billion for a 600 MW plant (Schlissel et al., 2008). The difference in the costs of nuclear versus coal plants is that nuclear plants cost about 3-4 times more than coal power plants. This huge difference is a crucial consideration for developing countries, as they don't have the necessary funds. In a time of rising demands, although building a nuclear power plant is a viable investment for these countries, they don't have the spending budget for it. For example, Mali, which is a third world developing country, has an extremely low budget for energy spending. According to the West African Economic Monetary Union, which oversees and builds economic spaces in West Africa, it released a report outlining that Mali's 2023 budget is approximately \$3.65 billion (Ecofin Agency, 2023). Showing that they would have the sufficient funds for a coal power plant and not for a nuclear power plant. Therefore, there is a major economic downside of nuclear plants: their high upfront cost. This harms developing third world countries aiming to grow.

Verdict

Prior to starting my research, I initially believed that nuclear energy shouldn't be used in the future as it has massive environmental issues. However, after reading all of the research, synthesizing my sources, and weighing both sides, I have come to the opinion that nuclear energy should be used in the future. This is because of energy outputs that come as a result of

nuclear plants. It is also far more reliable than coal and other natural sources, as it reduces carbon emissions. Therefore, my viewpoint evolved from being against nuclear energy, to becoming a proponent for it.

Conclusion

After assessing both sides of the arguments, further research should be made in both lenses. There should be more studies assessing the energy output to price ratio for SMRs and other types. This would help bridge the gap between both lenses, as it would allow for a better synthesis of the lenses in advocacy for each side. Ultimately, the use of nuclear energy in the future should replace traditional sources.

Word Count: 1996

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