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Nuclear Energy as a Highly Viable Source to Mitigate Rapid Warming

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ABSTRACT

The longstanding issue of global warming has taken its toll on countries around the world. Global warming has become one of the major issues that humans need to face together in the 21st century. A highly viable solution to this issue is adopting nuclear energy as one of the world's major energy sources. Nuclear energy is more reliable and consistent than renewable energy and cost-efficient in energy generation in the long run, making it a suitable replacement for acquiring energy from traditional fossil fuels. In addition, nuclear power and renewable energy should both be considered as possible solutions for mitigating global warming, rather than as rivals contending for superiority. Currently, the two major challenges of using nuclear energy include the high short-term cost of building nuclear power plants and nuclear fear by the general public. At the current rate of warming, it is necessary to use every viable means to slow down the process of warming enough for better solutions to climate change to be devised.

Introduction

As the effects of climate change become more pronounced and countries around the world struggle to reduce greenhouse gas emissions to net-zero, it is becoming imperative for the world to decide on the optimal energy source to replace fossil fuels, which have been clearly shown to be unsustainable (UN Environment and International Resource Panel, 2019). In 2018, three-quarters of global emissions were released by burning fossil fuels (US EPA, 2016). Currently, 84% of the world's primary energy comes from fossil fuels, with 33% from oil, 27% from coal, and 24% from natural gas (bp & Ember, 2021). The remaining 16% consists of 7% hydro, 5% wind, solar, bioenergy, tidal and geothermal, and merely 4% from nuclear.

It has been well-established that nuclear energy emits orders of magnitude smaller amounts of CO2 than the burning of fossil fuels (IPCC, 2014). Nuclear generators do not produce direct carbon emissions in operation, although the process of mining, refining, and transporting uranium requires energy. However, the impact of nuclear energy on the environment is low compared to that of traditional fossil fuels (IPCC, 2014). According to the Nuclear Energy Institute, by using nuclear energy, the United States avoided more than 471.3 million metric tons of carbon dioxide emissions in 2020 (Nuclear Energy Institute, 2021).

Human civilization currently requires fossil fuels to function because of the world's overall energy demand. It is impractical to stop the use of fossil fuel overnight because there is currently no other source that can meet such a gargantuan demand. For instance, the total electricity consumption of China and the US in 2019 alone reached 11,895,219 million kilowatt-hours (UNdata, n.d.). The world's usage of electricity has been growing year by year and has increased by 73% in the past two decades (bp & Ember, 2021). Unfortunately, reducing emissions often equals reducing the quality of life for a large portion of the world's population, which is one of the primary reasons most countries are reluctant to do so. While it is possible to produce electricity with low-emission technologies such as solar, wind, and nuclear, these are still not easy solutions, and most of

our energy is still being generated by the burning of fossil fuels. Although more renewable energy sources are being built, the amount of fossil fuels being burnt is still rising to keep up with ever-increasing usage.

Nuclear and Renewables

Nuclear energy may be a strong alternative to replace fossil fuel burning. An advantage of making a large-scale shift in our energy production method to nuclear power is that this form of energy is reliable and consistent, just like fossil fuels. Even though renewable sources such as wind and solar power are environmentally friendly and scalable, they offer significantly less reliability because of their reliance on external factors. For example, windmills require the presence of wind in order to generate electricity, and solar panels need sunlight to function. It cannot be guaranteed that every day will be sunny and windy, but electricity is needed every day. Even with modern technology, there is no established method to store all the electricity generated on fine days for long-term use. Until an adequate storage solution can be developed, the inconsistency of renewable energy generation methods remains one of its major drawbacks when compared to nuclear energy.

Consequently, nuclear power can be used as a substitute for fossil fuel burning in the absence of a zero-emission energy source. Instead of viewing nuclear and other renewables as opposing contestants competing over a position in the world, it is wiser to regard them both as alternative energy sources that can work together to save the environment. Under such a desperately precarious situation, the current utilization of nuclear energy is a highly feasible option to slow the greenhouse effect's advance long enough for technological advancements and new energy sources to provide a better solution.

Unfortunately, in the last 20 years, worldwide nuclear energy production has stagnated despite the power source's utility. Despite countries such as China and India building more, other nations like Germany, Japan, the UK, and the US have been taking their nuclear generators offline due to reasons such as public opinion and the expense of disaster remediation. For instance, the annual carbon dioxide emission avoided by the US nuclear power plants has been steadily declining, from 696.6 million metric tons in 2004 to 471.3 million metric tons in 2020 (Nuclear Energy Institute, 2021). This global trend of uncertainty towards nuclear energy does not contribute to reducing carbon emissions, since countries with the least carbon produced from generating electricity mainly rely on either nuclear or hydro. France is a perfect example: only 10% of France's total energy comes from fossil fuels, while 67% comes from nuclear and 23% from other types of renewable energy, showcasing how nuclear energy can be used as a reliable and consistent primary source of energy in a country (Statistical Review of World Energy, 2021). The irrational public fear of nuclear energy and the lack of investment in it are some of the major challenges that prevent countries from shifting towards nuclear energy, and overcoming these barriers is crucial for shifting away from fossil fuel power sources.

The Expense of Nuclear Power Plants

However, some problems with using nuclear energy as a primary source of power still need to be addressed. The first problem is solely based on monetary concerns: nuclear power plants are expensive. Companies that are planning new nuclear units are currently indicating that the total costs (including escalation and financing costs) will be in the range of $5,500/kW to $8,100/kW, or between $6 billion and $9 billion for each 1,100 MW plant (Schlissel and Biewald, 2008). Compare that to fossil fuel generators, which take around $2 billion for each 600 MW plant and create power at a cost of $3,000/kW (Schlissel and Biewald, 2008). This discrepancy is due to three main factors. To begin with the technical aspect, there has been little innovation in nuclear technology in the last few decades due to a decreased amount of investment. Therefore, most of the world's

nuclear reactors are made with old technology that is very costly to replace. Second, in most western countries, building nuclear reactors has become very expensive because of a loss of know-how in constructing them, and this, along with policy changes and increased regulatory constraints, has resulted in construction taking decades or longer on a single plant (Lovering et al, 2016). Finally, from the sociological perspective, as nuclear power plants take a long time to build, and even longer to produce electricity at a lower cost, people are often against them because they do not see instant benefits. All these drawbacks of erecting nuclear power plants lead anti-nuclear activists to debase nuclear power as just an expensive and time-consuming way to boil water to generate electricity.

However, despite the expensive building cost and inefficiency of nuclear power plants in the short run, nuclear energy is actually cheaper compared to fossil fuels in the long run. Even as the average age of American nuclear reactors approaches 40 years old, experts say there are no technical limits to these units churning out clean and reliable energy for an additional 40 years or longer. In comparison, fossil fuel generators typically only last around 30-50 years before needing to be replaced. In addition, the amount of energy obtained from both sources should also be taken into consideration, as the usage of nuclear fuel yields exponentially more electricity than the burning of fossil fuels. In fact, it takes 20,000 units of coal to give off the equivalent amount of energy generated from one unit of uranium. (Canada West Foundation, 2017). For example, in Ontario, electricity generated by nuclear power only costs about 7-8 cents/kWh compared to fossil fuel, which costs around 14 cents/kWh (OSPE, 2014). The cost of electricity generation with nuclear energy is nearly half of that of fossil fuels, which shows that nuclear power is more cost-efficient in energy generation in the long term.

Additionally, given the amount of money intended to be invested in fighting climate change in recent years, investing in building new nuclear generators is far more reasonable than spending on dealing with the aftermath of climate change. The Paris Agreement's goal is to limit further warming by 1.5 degrees Celsius; a total of at least $4.13 trillion in investments to combat global warming is needed to be on track for this goal by 2030 (Nations, n.d.). Should a fraction of this money be spent on building new nuclear power plants, it would make a significant difference in mitigating climate change from the source.

The Fear of Nuclear Power

The second major challenge is the fear of nuclear power plants relating to public health and safety. Historically, nuclear power was used in war, and at least 129,000 people died just from the two bombs dropped in Japan (Tomonaga, 2019). Moreover, the nuclear arms race of the Cold War prompted the creation of nuclear apocalypse fiction to dominate mid-century media, in which nuclear power was portrayed as a way to end the human species and a dangerous threat to society, like in the movie *Godzilla*. This trend created the social tendency of viewing nuclear power as an awe-inspiring yet menacing source of energy. As a result of this fear, nuclear bombs and total nuclear annihilation became intertwined with nuclear energy, despite their clear differences in form and function.

From a purely statistical perspective, nuclear energy is one of the safest options of large-scale energy generation. A study conducted in 2013 by NASA showed that nuclear energy prevented 1.8 million deaths between 1976 and 2009 (Kharecha and Hansen, 2013). Even including the total number of deaths from catastrophic nuclear meltdowns in Chernobyl and Fukushima, two of the most infamous nuclear incidents, nuclear energy ranks last in death per energy unit produced for non-renewable sources, with a 0.07 death rate from energy production per TWh (Our World in Data, n.d.). This number is smaller than the number of deaths from the air pollution caused by burning coal, brown coal, and gas, with death rates per TWh of 32.72, 24.62, and 18.43 respectively (Our World in Data, n.d.).

In addition, even though nuclear waste is very toxic, it is not directly emitted into our atmosphere and does not have direct and immediate impacts on our health like the burning of fossil fuels does. The probability of a core-meltdown accident within 1 year of reactor operation is 1 in 3704 reactor years (Rose and Sweeting,

2016), whereas at least five million people die prematurely every year as a result of air pollution induced by burning fossil fuels for electricity (Our World in Data, n.d.).

Regrettably, humans do not always choose the best option, but the option that causes the least psychological concern. To the general public, weighing the risks of nuclear energy and fossil fuel burning is like comparing flying versus driving: even though flying is almost always safer than driving (Sivak et. al., 1991), a significant number of people would drive cars to work every day but refuse to take airplanes for business trips. The public is more accepting of slow, gradual deaths compared to fast and instant ones, even if the former results in far more deaths in total.

The Future of Nuclear Power

As mentioned above, climate change is a global issue and should be solved with a globally combined effort. Eradicating the fear and normalizing the use of nuclear generators everywhere around the world constitutes a big step towards this goal, and can be done in several ways. To begin with, education is instrumental for children, teens, and young adults to learn about the devastation caused by global warming and how useful and efficient nuclear power is, as well as the true statistics surrounding the risk of dying or developing health issues from nuclear energy compared to other energy sources. Without the irrational fear that has plagued older generations, younger generations are more likely to adapt to nuclear power upon learning the truth about it. As future world leaders, they will also be willing to make changes upon being properly presented with the global warming conundrum and seeing for themselves the progressively devastating effects of global warming left unchecked. In addition, the immense potential of social media can be harnessed to begin pro-nuclear energy campaigns that spread awareness and call for action. Currently, with more than 4 billion people around the world using social media, it is guaranteed that videos about nuclear energy will be seen by many. Spreading knowledge about nuclear power on the internet will not only reach Generation Z and millennials but many other adults who can help voice their support for normalizing the use of nuclear power as well. Finally, governments can also post scientifically correct information about nuclear energy on government websites and establish policies to encourage a common agreement on the benefits of using nuclear energy. Benefiting from less money spent on fixing air pollution and less intense global warming brought about by shifting to nuclear power, enlightened governments that make the shift could reap more environmental and economical benefits in the long term. Until technology progresses and better ways to use nuclear power surface, such efforts can lead us to finally move on from the warming-inducing and pollutive fossil fuel energy to the cleaner, more efficient, and more reliable nuclear power.

Conclusion

Climate change and the global emissions driving the environmental crisis stemming from unsustainable power sources continue to worsen exponentially. It has grown increasingly clear that globally, we need a change in perspective regarding nuclear power. As discussed above, nuclear power is a cheaper and greener source of energy than fossil fuels, and could serve as a reliable and consistent replacement for energy from fossil fuels. Given the unsustainability of fossil fuel energy, alternatives need to be harnessed on a large-scale basis for production in order to replace fossil fuels, and nuclear energy may be one of the most viable options currently available. A major shift to nuclear power, coupled with supporting renewable energy incentives, needs to be made quickly and efficiently in order to create significant positive effects in the near future, before the climate change countdown clock makes its final few ticks.

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