**Clean Energy**

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"In the late 16th century, when the increasing cost of firewood forced ordinary Londoners to switch reluctantly to coal, Elizabethan preachers railed against a fuel they believed to be, literally, the Devil's excrement. Coal was black, after all, dirty, found in layers underground — down toward Hell at the center of the earth — and smelled strongly of sulfur when it burned."

Richard Rhoades (2019) The burning of fossil fuels to produce energy is a straight path to the continuation of our climate change problem. Some of the reasons we are still using fossil fuels are very accessible, easy transportation, and can generate a large amount of electricity in one location. Nuclear energy is the realistic second option, but our society has mixed feelings about nuclear energy. The main issue is that many think it is still dangerous, as we know in the past there have been devastating incidents caused by nuclear energy production. Secondly, nuclear energy is unsustainable because of the creation of nuclear waste, nuclear power is harmful to the environment because of the radiation that it emits, and it is expensive. In this essay, I will explain the misconceptions and possible negatives that nuclear energy has. From the research I have done so far, nuclear energy is the solution to our energy in the foreseeable future.

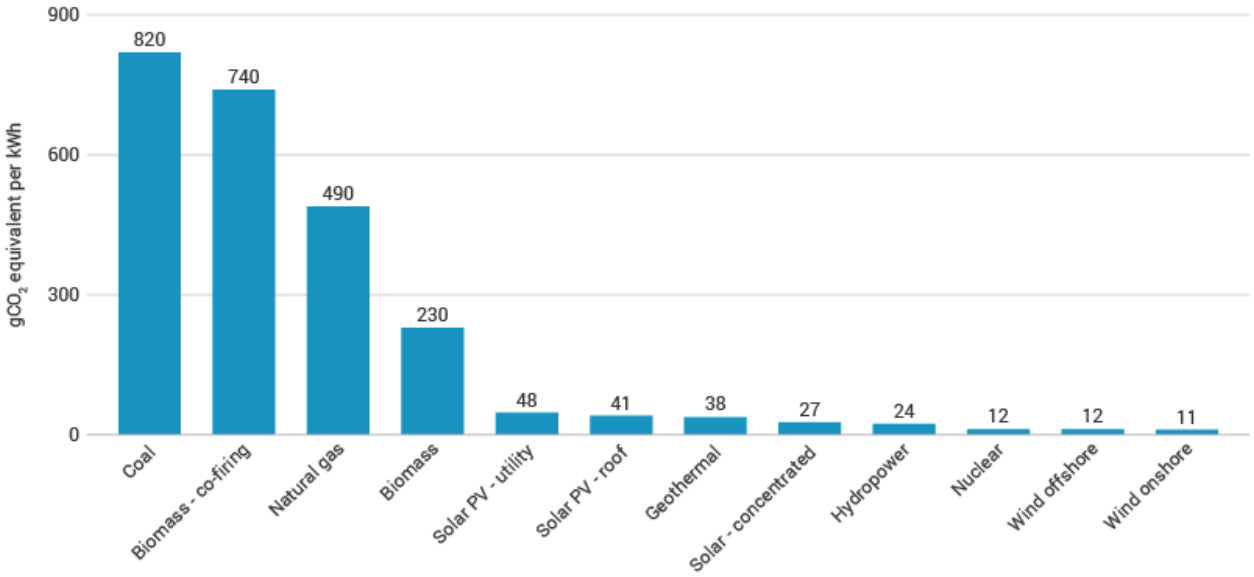
Firstly, what is nuclear power? Kurzgesagt (2015)" Nuclear fission releases several million times more energy than any other chemical reaction can." The unstable element of uranium gets bombarded with neutrons and absorbs them. Most of the time it instantly splits the center of the atom into fast-moving lighter elements, some extra neutrons, and energy in the form of radiation. The main misconception about nuclear energy is that it is dangerous. Chornobyl "was the Soviet Union during improper testing at low power, resulted in the loss of control that led to an explosion and fire that demolished the reactor building" IAEA (2021). They also state that the safety measures were ignore indicating that this was a result of human error. March 28th, 1979, the nuclear failure of 3 Mile Island took place. Office of Nuclear Energy (2022) states that "A combination of equipment failure and operator error led to the partial meltdown of the power plant's Unit 2 reactor that resulted in the release of a small amount of radioactive material." Again, with the proper precautions, these incidents will not happen repeat. Lastly, the most

recent nuclear incident off the coast of Japan in the city of Fukushima, in which the plant was hit by a massive tsunami and suffered major damage. James Action, Mark Hibbs, George Perkovich (2023) states that “it is conceivable that they would have predicted the possibility of the plant being struck by a massive tsunami. Even if they had failed to do so, upgrades in plant design in accordance with state-of-the-art safety approaches would have prevented the tsunami from sparking a major accident. The Fukushima accident—like the Chornobyl and Three Mile Island accidents—was therefore preventable.” These incidents could have been avoided with proper planning in addition to our modern technology.

Furthermore, many are concerned with the disposal of nuclear waste. Nuclear waste is a product of nuclear fission, it is highly radioactive and takes thousands of years to decay. However, it is no longer a problem, “Most U.S. spent fuel, more than 90 percent of which could be recycled to extend nuclear power production by hundreds of years, is stored at present safely in impenetrable concrete-and-steel dry casks on the grounds of operating reactors, its radiation slowly declining” [...] In the US it is called “The Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico currently stores low-level and transuranic military waste and could store commercial nuclear waste in a 2-kilometer thick bed of crystalline salt. [...] It could easily accommodate the entire world’s nuclear waste for the next thousand years.” Rhodes (2018). From the evidence stated above, it is clear the storage of nuclear waste is not an issue for the United States in the far future.

Moreover, many might have the notion that climate change is a product of nuclear energy and that the radiation it emits is unsafe. These are both untrue. Statistically, nuclear produces 12g

CO2 equivalent per KW/h compared to the 820 that coal produces. As of 2018, Carbon Dioxide emissions related to energy are continuing to rise, reaching 33.1 billion Tonnes and a 40% increase from the year 2000 (World Nuclear Association, 2018). We are seeing this in effect too, as “big nuclear players like France, Saudi Arabia, Canada, and South Korea being among the countries that recorded the fastest decline in carbon intensity” (Martina Igini, 2023). The EPA (2023) states that the radioactivity of nuclear power plants is nothing to fear either, “During normal operation, nuclear power plants release very low amounts of radioactive materials into the air.”. What's more, coal-fired plant “waste contributes far more radiation to the environment than nuclear power stations. The radioactivity comes from the trace amounts of uranium and thorium contained in coal.” [...] In addition, “coal and oil act as ‘invisible killers’ and are responsible for 1 in 5 deaths worldwide.” (Martina Igini, 2023). To sum it up, nuclear power is incredibly clean for the environment, while also not producing any radiation dissimilar to its counterpart.




Average life-cycle carbon dioxide-equivalent emissions for different electricity generators (IPCC)

Many people think the cost is another large problem with nuclear energy, but is it? The short-term cost of nuclear energy can be frightening, so is building a massive plant worth what it produces? Mecklin J. (2019) expresses that “The capital costs of a nuclear power plant are much higher than for energy sources such as coal and natural gas—and the annual cost of repaying the initial investment is substantially higher than the annual operating costs. This is because nuclear power plants are technically complex and must satisfy strict licensing and design requirements.” There are many assorted designs from complex ones that maximize safety and efficiency or a more standard and simplistic design with smaller reactors, the most coherent for cost is the smaller simplistic approach states Daria Iurshina, Nikita Karpov, Marie Kirkegaard, Evgeny Semenov, 2019. In the long term, the cost evens out, when fully accounting for the external costs of different energy systems would find nuclear cheaper than coal or natural gas. Most nuclear plants are in operation for up to 60 years, and they are in operation almost twice as many days out of the year in comparison to coal plants. There are so many assorted designs from complex ones that maximize safety and efficiency or a more standard and simplistic design with smaller reactors, however, the most coherent for cost is the smaller simplistic approach. The initial investment is quite a large one, but the compensation in return is much greater.

Another myth is that nuclear energy can be replaced by wind and solar power. Renewables like wind and carbon have seen tremendous growth in recent years, but there are innate limitations that prevent them from replacing nuclear power. Wind and solar are entirely influenced by the weather conditions, resulting in fluctuations in their outputs. A study finds that countries on average would experience 788 hours (about 1 month) of blackout yearly (Cornelis

van Kooten, 2021). Soley relying on renewables over nuclear energy or other power sources could lead to increased storage requirements and higher costs to maintain it. Additionally, the land area needed to use these forms of energy would usher conflicts with the environment. The recyclability of the used panels and windmills adds to the uncertainty. Cornelis van Kooten states that "While the steel can be recycled, the same is not true of the concrete foundation or the materials that comprise the huge blades, which are generally cut up and buried." While wind and solar appear to be a great energy source, the left-over materials combined with their inefficiency make them subservient.

Lastly, a conflict that arises when it comes to nuclear power is the transportation of its radioactive waste. There have been a few occurrences when disaster struck, but most of them happened decades ago. Currently the Department of Energy "is currently evaluating nuclear power plant sites and nearby transportation infrastructure to support the eventual transport of used fuel away from these sites. It is also developing new, specially designed railcars to support large-scale transport of used fuel in the future." (Department of Nuclear Energy, 2021). The transportation of nuclear waste can be troublesome, but not in comparison to fossil fuels, and, as said, is safe and becoming even safer with the coming years.

Given the circumstances, with the ongoing problem that is climate change, nuclear energy emerges as a fantastic alternative to fossil fuels. While there is some disbelief and concern, closer examination reveals that the negatives of nuclear energy are based on outdated information and nuclear accidents that remind us of human error and insufficient safety measures. The advancements in design and safety ensure the plants can operate securely and

efficiently. Additionally, nuclear energy's initial investment is heavy, lost term benefits, like reliable energy and reduced impact on the environment outweigh the expenses. As we come to future generations, we must embrace nuclear energy because it is essential in promising them a better future.

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