Nuclear Energy: A Bad Bet for Business

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Abstract

There are many dangers associated with nuclear energy, which include, but are not limited to terrorism, nuclear accidents, and radioactive nuclear waste. Although there are many supporters of nuclear energy because it is seen as a "clean" energy source and does not produce greenhouse gas emissions or air pollution, this seems like a minuscule benefit when compared to the other types of pollution produced by nuclear energy, including thermal pollution of land, water, soil, and crops. Additionally, the production of nuclear power in itself may not produce pollution of the air directly, but accidents that the nuclear power plants are quite vulnerable to, as shown by past nuclear disasters such as Three Mile Island, Chernobyl, and Fukushima, can release harmful radiation into the environment, making conditions in areas surrounding the disaster site unlivable for humans and even wildlife. Other sources of energy that are renewable, however, seem to be safer alternatives to nuclear energy, especially those such as biomass and solar energy. The most important aspect when it comes to choosing the type of energy sources to use is determining how they will affect the safety of humans, wildlife, and the environment. Consequently, the use of nuclear energy and the negative impacts it has had on mankind and the earth in the past seems to show that it has done more harm than good.

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The 1930s was a decade of countless scientific milestones, including the discovery of the neutron by James Chadwick in 1932, the first artificial splitting of a nucleus through bombarding the nucleus with accelerated protons accomplished also in 1932 by Cockcroft and Walton, and in 1938, picking up from previous experiments completed by Enrico Fermi, Otto Hahn and Fritz Strassman concluding that lighter elements such as barium produced from uranium showed that atomic fission had occurred, a process that was found to release a tremendous amount of energy. In modern times, this energy is referred to as nuclear energy, which, according to an article in the Gale Opposing Viewpoints Online Collection (2017), made up 11 percent of global energy in 2017, and is continuing to expand. Although there are multiple benefits of this newly established source of energy, there are also risks associated that tremendously outweigh those benefits, such as terrorism and nuclear weapons, catastrophic nuclear disasters, and thermal pollution of land, water, and crops, making other energy resources such as solar and biomass seem like much safer alternatives that will not put as many human lives in danger.

One of several dangers of using nuclear energy is the threat of nuclear power plants becoming suspected targets for terrorism, sabotage, or cyberattacks. Additionally, a large quantity of weapons has been developed using nuclear power, most from which an immense amount of destructive force is released that could obliterate sizable areas of land, along with killing a countless number of human lives. For example, the two atomic bombs created during the Manhattan Project in 1945 called “Little Boy” and “Fat Man” were released by the United States onto the two Japanese cities of Hiroshima and Nagasaki, and according to an article written by the Atomic Heritage Foundation (2014), this caused nearly 80,000 deaths in both

cities combined, the majority dying immediately after the bombing and another 60,000 people suffering severe injuries. This goes to show that while nuclear power is beneficial to harness electrical energy, it is also very dangerous and should only be used as a last resort.

Another potential danger of using nuclear energy is that simple mistakes or errors can cause catastrophic damage and lead to the exposure of excessive and even fatal radiation. However, human error is a given at the current moment as technology is not yet advanced enough to program a nuclear power plant to run on its own without human advisory, and even then, as a human will be required to program it, mistakes will still be bound to happen. To date, there have been three major nuclear accidents that have occurred, two of them as a result of human error.

The first known nuclear accident that took place was at the Three Mile Island Nuclear Generating Station in Pennsylvania on March 28, 1979. This nuclear power plant suffered from a partial meltdown as well as a fire. The fire was seemingly caused by a water hammer when water and steam were flowing together in the piping systems that lead to the compression and ignition of flammable gases, which were mostly made up of hydrogen and air that were mixed and formed due to radiolysis, or the radioactive breakdown of water into hydrogen and oxygen. As the piping near the safety valve began to increase in temperature, pressure also increased, which caused the safety valve to open and the fire to ignite. To sum all of this up, this nuclear disaster was caused by a sequence of human errors, failures in the machinery, and flaws in the design of the nuclear power plant, which ultimately lead to coolant being lost that was important for the reactor. Although the amount of radiation released among the citizens in the surrounding area of the Three Mile Island nuclear accident was relatively low-level, a few studies have shown a small increase in the trend of cancer in the years following the incident, specifically non-

Hodgkin lymphoma; however, the increase in the amount of cancer was in the following years was not significant enough to be directly linked to the accident (Talbott et al., 2000).

The second major nuclear disaster, and probably the most well-known as well as the worst one in history, occurred on April 26, 1986, at the Chernobyl nuclear power plant in the city of Chernobyl, Ukraine. Once again, this nuclear accident was also ultimately caused by human error, including an experiment that went awry and sent the Reactor 4 into meltdown, several violations of safety within the nuclear power plant, and complicated design of the reactor which made it hard to control and operate. The root cause of the accident, however, was a part of the nuclear power plant design that made the fission reaction increase while the cooling water density decreases. This process is referred to as a positive void coefficient, which can lead to a rapid increase in power if there is over-boiling taking place or a loss of cooling water. The positive void coefficient that occurred during this nuclear disaster became so strong that it ultimately made the situation out of control for the operators who were attempting the experiment inside the Chernobyl nuclear power plant. As pressure increased at an alarming rate, this led to the cooling channels rupturing as well as an intense thermal explosion that obliterated the reactor and caused parts of the building structure to fail. This resulted in a series of explosions that scattered dangerous radioactive material onto the land surrounding the plant, causing several fires to break out. Although the countries of Ukraine, Russia, and Belarus sustained the most damage from the nuclear disaster that occurred in the city of Chernobyl, there was an increase in radiation that was detected far across Europe as well. According to an article called “Chernobyl: errors and design flaws”, within one day the entire town was evacuated, and a few days later those living within 30 kilometers of the nuclear power plant were also evacuated, totaling around 135,000 people, and after roughly four months 31 people had died from radiation

sickness and burns (Norman, 1986). Although the accident occurred in only a matter of minutes, it will take several decades to recover from this nuclear catastrophe.

The third and most recent nuclear accident occurred at the Fukushima Daiichi Nuclear Power Plant in the city of Fukushima, Japan, on March 11, 2011. The accident was a result of a severely destructive earthquake followed by a tsunami, and since the nuclear power plant was located on the coast, it was a huge target for those two natural disasters. This led to a reactor core melt, which makes this nuclear disaster unique from the previous disasters at the Three Mile Island and Chernobyl nuclear power plants. "As three of the four clustered Fukushima Dai-ichi nuclear power plant nuclear reactor cores melted (releasing massive quantities of radiation into the local communities), over 120,000 people evacuated their homes (Reconstruction Agency of Japan, 2014) and some will never return home" (Eddy & Sase, 2015). After being hit, the plant experienced hydrogen explosions and the melting of fuel in a few of its reactors. The destruction of this nuclear power plant released massive amounts of radionuclides into the ocean as well as onto the surface of the water and land, making the conditions unlivable for both humans and wildlife alike. Although this nuclear disaster was ultimately not caused by human error, it goes to show exactly how vulnerable and dangerous these nuclear power plants can be. When that vulnerability is put to the test, as shown through the destruction of the Fukushima Daiichi Nuclear Power Plant by uncontrollable factors like earthquakes and tsunamis, the environment and innocent people often suffer as a result, leading to the exposure of dangerous amounts of contamination and radiation. One indicating result of the nuclear disaster that occurred in Fukushima was a large increase in specific types of breast cancer in women, which could also increase 10-15 years after the accident, as this was shown after the Chernobyl nuclear disaster. "There was a significantly higher proportion of HR-positive breast cancer after the disaster,

compared with the pre-disaster period (91.8% vs. 65.6%, $p < 0.001$)" (Ozaki et al., 2017). Additionally, people had to start being warier about the amount of time they spent outside and the location from where their food was produced/harvested and their water was retrieved to avoid contact with radionuclides as well as other forms of radiation exposure, even in cities surrounding the Fukushima Daiichi Nuclear Power Plant.

These three nuclear disasters that occurred at Three Mile Island, Chernobyl, and Fukushima, as well as the aftermath of these disasters, are all the evidence that is needed to show just how dangerous and vulnerable the using and harnessing of nuclear energy can be, and that nuclear disasters have three major causes: intentional (which could include but is not limited to terrorism), accidental, and uncontrollable factors such as natural disasters (earthquakes, tsunamis, etc.). It is nearly impossible to prevent disasters such as these occurring again in the future for these three reasons, as stated by Eddy and Sase (2015), "...all geographic locations in the world are potentially vulnerable to intentional man-made acts of terrorism or other adverse event occurrences that are likely to occur in that community". Ultimately, it is important to learn from history so that it is possible to prevent mistakes from historical events such as these from repeating themselves. Although it would be a stretch to say that the use of nuclear energy will be put to an end from an international perspective anytime soon since even though it is not currently the primary energy source being put to use but still makes up a significant portion of sources used for energy generation, especially in developed countries, it goes without saying that the use and production of nuclear energy do not need to expand as the risks are far too overwhelming to justify the benefits.

In addition to the possibility of nuclear disasters to occur, the process of generating nuclear energy is harmful nonetheless, especially to the environment. The reason for this is that,

despite progressing technology, there is not yet a reasonable and risk-averting method to handle, store, and dispose of the radioactive nuclear waste that is produced as a by-product. Right now, the best option is to store the waste under the surface of the Earth, which could lead to environmental complications, and ultimately, contamination of resources that could otherwise be used for humans or wildlife, in the future. As tempting as it is to put the nuclear waste out of sight and out of mind while pretending like it doesn't exist, it is more important to think about how this waste will affect the environment and humans in the future, as storage could be required to last up to one million years. According to an article from the Gale Opposing Viewpoints Online Collection (2017) that outlines the effects of human and environmental exposure to radioactive waste, "Nuclear power plants produce radioactive waste as a byproduct of power generation. If radiation is released into the environment, it can contaminate soil, water, and food crops. Exposure to radiation through these pathways can damage human cells, resulting in genetic changes that increase the risk of cancer, birth defects, and other health effects". As of now, most nuclear power plants store the spent nuclear fuel rods in pools of water to cool them and prevent exposure to humans and the environment, but this leads to thermal pollution and contamination of water. Another idea that has been debated, especially in the United States, is to store the nuclear waste at a volcanic ridge located in the state of Nevada called Yucca Mountain. There are many supporters of this idea to store away the nuclear waste (specifically high-level nuclear waste, which is classified as the most dangerous) in this location because of its dry and desert-like geological features, however, no place will be perfect, as this area also contains two fault lines and the volcano is quite dormant, suggesting that no earthquakes or volcanic eruptions are expected to take place in this area for several thousand years, which is a lot shorter of a timespan compared to how long certain types of nuclear waste will need to be stored (some

nuclear waste has to be stored for 1 to 2 million years). Although the storage of nuclear waste is a good temporary fix since it prevents humans and wildlife abiding in occupied areas from becoming exposed to the nuclear waste, it seems to be a better proposal to stop the problem at the source; after all, having to worry about where to store nuclear waste is out of the question if the nuclear waste is not produced in the first place. Of course, the nuclear waste that has been produced will have to be stored away from exposure eventually, but the best course of action would be to stop the creation of nuclear waste.

There are also a few risks of using nuclear energy that are not quite as major or obvious as terrorism, nuclear disasters and nuclear waste, such as that it is more costly than other renewable sources of energy, especially when referring to the cost of building the complex nuclear power plants (which could include construction delays and cost overruns as well), the cost of decommissioning, or tearing down the nuclear power plants after they are no longer fit for use, and the cost to dispose of the nuclear waste. Another disadvantage of nuclear energy is that it is nonrenewable since the main element used for its production, uranium, is not infinitely abundant upon this earth. Two alternative sources of energy that do not hold as many risks as nuclear energy include biomass and solar energy, they seem to have a lot less of an impact on the environment and do not endanger the lives of humans and wildlife for the most part.

When it comes to the consideration of the different options available to use as an energy source, the safety of mankind, wildlife, and the environment, should always be the top priority. Although there are disadvantages to every type of energy source, nuclear energy seems to have risks that largely outweigh the benefits and have the potential to threaten any form of life on this earth in multiple different ways, including through terrorism, disasters, and dangerously radioactive waste. The United States and several other developed countries do not seem to be

moving away from nuclear energy anytime soon, but they all have the power and responsibility to explore the variety of energy sources that have been discovered to date, and scientific and technological advancements in the future can further ensure and improve the safety and usefulness of these sources. However, learning from historical mistakes will always continue to be an important part of shaping and creating a better future for ourselves and the planet.

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