Exploring the Utilization of Nuclear Energy Production and Its Costs/Benefits

Introduction

Picture this. It's been a long, hard day on the job site, with the foremen keeping you and the crew around an extra hour to finish some concrete work. "Who cares?" you think to yourself, appreciating the overtime. However, once you reach your apartment, you're dead tired, pretty much ready to just head inside and eat a quick meal before falling asleep. The first thing you, and millions of other Americans, do when entering your house is flick on the light switch, but have you ever come to really consider where the source of your power comes from? For about 20-25% of the United States population, the answer to the question would be nuclear power plants, which may surprise the average reader. (Taken from US Dept. Energy, 2023) But, why is it that nuclear power is so misunderstood and unknown among the general public? What are some of the reasons why Americans should and should not look to utilize this energy production strategy? Well, readers of this research paper, that's exactly what we plan on answering.

A Brief History of Nuclear Energy

In December of 1942, Dr Enrico Fermi became the first known researcher to successfully set off a controlled nuclear chain reaction, cementing himself as a pillar in the history books of nuclear energy. Famously and quite viciously, US President Harry S. Truman became the first person to demonstrate the destructive power of nuclear energy, dropping two atomic bombs on the highly-populated cities of Hiroshima and Nagasaki, effectively forcing the Japanese to

surrender and ending World War II. It wasn't until the late 1950s that Americans began to consider using nuclear energy for positive purposes, such as creating sustainable energy. After some long years of testing around the county, involving much investment and failure, the Sodium Reactor Experiment in Santa Susana, California announced they were the first nuclear power plant to officially go on the grid in 1957. From there, electric corporations slowly began creating the nuclear energy industry in America as we know it today, with over ninety-three reactors active at any time around the nation. (Taken from PBS, 2022)

Understanding How Nuclear Energy is Created and Understanding Its Value

To really grasp why nuclear energy is so valuable, it's important to first understand how the process actually works. In your average nuclear energy production facility, you'll have one large building housing your "reactor" with several funnel-shaped, "smokestacks" surrounding the property. Inside the building, you'll typically have a sizable pool of water, with a large casing of metal submerged within. Inside the casing, or the "reactor" as it's known, nearly 200 rods of steel are submerged in the water, each packed full of uranium pellets. When submerged, the uranium in the rods undergoes nuclear chain reactions, causing an immense amount of heat to be expelled into the water around them. In a matter of seconds, the water inside the casing is being boiled instantly, turning into steam and escaping through multiple air ducts. From here, the steam, still at unimaginable temperatures, is piped through multiple turbines on the property, producing carbon-free, storable energy for the facility. The "smokestacks" that you'll often see driving by nuclear power plants (and the image most commonly associated with nuclear energy) are where a majority of the excess steam and by-products are released. This process, known as "nuclear

fission", is repeated over and over again inside this reactor to help keep the lights on for many Americans each day. (Taken from US Dept. of Energy, 2021)

For nearly six decades, Americans have been dipping their toes into the nuclear energy market, hoping to strike it rich in the new sustainable energy space. During that time, nearly 28 states have constructed nuclear power production plants within their borders, showcasing the acceptance of the practice as a viable reliable energy source. Today, the average nuclear power plant in the United States produces about one gigawatt of power each day, enough to power roughly 100 million LED light bulbs. With the ability to produce power at such high rates by utilizing this nuclear technology, the act of building one of these power plants comes with no small price tag, though it is often deemed to ultimately be profitable in the end. (Taken from US Dept. of Energy, 2021)

The Pros of Utilizing Nuclear Energy

For generations, America has historically moved from one non-sustainable energy resource to another, with famous examples being coal and natural gas. However, as our populations have swelled in size and the demand for power has continued to surge, researchers and businessmen alike have been exploring and implementing different forms of sustainable energy production practices, hoping to spark a change in the world's outlook on long-term power generation. In the front and center of it all, alongside wind and solar, has been nuclear energy production, establishing itself as a viable option for many states and localities around the nation.

One of the reasons many administrations have opted to utilize nuclear power production is because of its positive effects on the environment. According to the World Health Organization

(WHO), air pollution is one man-made environmental issue that has led to millions of deaths around the world, and nuclear energy stands as one way to help combat this. Unlike many other forms of energy production such as coal and natural gas, nuclear fission produces no tangible air pollution, helping to keep the amount of greenhouse gasses emitted into the atmosphere at a minimum. On average, those localities that choose to utilize nuclear energy combine to protect the atmosphere from just over 400 million metric tons of carbon dioxide emissions. For those keeping count, that's roughly the same amount of emissions output as nearly 100 million vehicles. (Referenced: Nuclear Energy Institute, 2022)

Another key reason localities have chosen to utilize nuclear energy production is due to the number of jobs they can create for an area. On average, just under 500,000 people find themselves employed in the field of nuclear energy production, making it responsible for creating more jobs than any other sector of the energy generation market. (Referenced: Nuclear Energy Institute, 2022) In addition to being green-friendly, the addition of a nuclear power plant can lend itself as a welcome boost to any locality's job market.

With the US Government looking to constantly enforce the Clean Air Act on states, nuclear energy stands as one of the best and most budget-friendly options for states to help them meet the law's requirements while also fostering a better, more green-friendly environment in the process. According to the Nuclear Energy Institute, nuclear power plants were actually found to produce more energy on less land than their wind-powered counterparts. Additionally, while they promote the production of clean energy more so than any other form of energy production, they also offer states the best average return on their investment over time. (Referenced: Nuclear Energy Institute, 2022)

The Cons of Utilizing Nuclear Energy

As with most positive things in life, there's usually a small kicker behind it all. While nuclear energy doesn't have many reasons as to why localities should shy away from the idea, there are a few notable ones to mention.

For one, and as we mentioned at the beginning of this research article, much of the general public doesn't really understand the inter-workings of nuclear energy production, which can lead to a general fear and mistrust of the practice. Additionally, the process of nuclear fission produces a toxic by-product known as "radiation". This toxin, if exposed to the human body without following proper precautions, can cause humans to become incredibly ill, contracting what's usually known as "radiation poisoning", often causing them to die a horrible, painful death. Usually, and in most cases, the radiation produced from the process of fission is contained inside the reactor, never to be exposed to the outside world. However, there have been documented situations in which workers and researchers were unable to keep reactors stabilized, causing the facility to "meltdown". In the event this happens, the reactor core essentially explodes from the internal pressure and exposes the surrounding outside world to the high levels of radiation previously locked away. (Referenced: US EIA Dept.)

One of the most famous examples of this tragic situation occurring is known as the disaster at Chornobyl. Chornobyl was a peaceful Russian city home to several millions of residents while also playing host to one of the republic's largest nuclear power plants. Unfortunately, during one regularly scheduled work day in 1986, researchers lost control of one of the site's reactors, causing a full-scale meltdown. In the wake of this tragedy, hundreds of

thousands of residents were exposed to poisonous radiation, with many going on to develop dangerous and deadly forms of cancer and other ailments. This unfortunate event still remains a huge talking point in pop culture and among the population, so a general fear of the possibility of a similar situation occurring exists in many people's minds. (Referenced: NRC.Gov, 2008)

It's important to highlight in this section that while the process of nuclear energy production does not emit any known air pollution, it does produce a harmful, toxic sludge during fission known as "nuclear waste". Nuclear waste is chemically toxic to anyone who even comes remotely near it, as the radiation emitted from the waste is of extreme levels. Much of this toxic waste is forced to be locked away in sealed bunkers/cooling ponds around the nation, with these storage facilities often being found close to the power plants themselves. In addition to the by-product being toxic, it also takes several millions of years for nuclear waste to eventually become non-lethal, making it a difficult issue to deal with. (Referenced: NRC.Gov, 2008)

One of the final reasons some localities may opt not to invest in nuclear energy may be because the average financial returns of a facility aren't eye-popping. As green-friendly and atmosphere-assisting as these facilities may be, nuclear energy production centers have been shown to largely be an investment that requires a massive upfront cost, while offering slow, lengthy returns. (Taken from: NRC.Gov, 2008) As we mentioned before, the price to produce this magnitude of electricity doesn't come cheap, and some states/cities simply aren't willing to wait five-to-ten years to see a reasonable return on their investment.

The Future of Nuclear Energy in America

While there are certainly some notable drawbacks that come with attempting to harness nuclear energy, the pros almost certainly outweigh the cons in most situations. According to the World Nuclear Association (WNO), the electricity demand within the United States is expected to increase by about half of our current demand, meaning the need for energy-producing strategies such as nuclear fission is also expected to rise. (Referenced: World Nuclear Association) With this massive influx of demand for energy expected across the nation, policymakers and businessmen alike will be searching for not only the most wallet-friendly, but most effective bang-for-their-buck strategy of energy generation and nuclear power stands right there as a viable option. The role nuclear energy currently plays in keeping our nation lit up each and every day is huge, with around a quarter of the nation relying on nuclear power plants to function day to day. That being said, there's almost certainly a bright future for the utilization of nuclear energy within the United States.

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