Nuclear Power: Benefits And Drawbacks

With the demands in the world shifting towards society needing more electricity, nuclear power has been a way to meet power needs while keeping the carbon footprint low. Nuclear power as a whole may have a stigma attached to it. One would assume, the majority of the world's population is not well educated on the benefits of nuclear power. Nuclear power is perceived as dangerous and deadly. Contrary to popular beliefs, nuclear power is efficient, clean (power) and inexpensive after the initial investment.

Nuclear power occurs from a term called nuclear fission. Nuclear fission by definition is a nuclear reaction in which a heavy nucleus splits spontaneously or on impact with another particle, with the release of energy (Lexico-Oxford Dictionary). In science, atoms have the appearance of solar systems on a microscopic level. The nucleus is always the center of an atom held together by forces of nature. Also, in the nucleus are protons and neutrons, when the nucleus is hit by a neutron the atom can be split apart.

In the case of nuclear power, it is taking one of the lightest elements, Hydrogen; which has one proton, and Uranium; which has 92 protons and colliding them together thus splitting them. The split then releases neutrons from the uranium that collide with other atoms, causing a chain reaction (Union of Concerned Scientists). The neutrons that are released during nuclear fission are then absorbed through control rods. In the center of a nuclear reactor, when nuclear fission occurs the heat released heats the water to over 500 degrees Fahrenheit. It is the hot water or steam is what actually produces electricity through turbines connected through generators.

Statistically speaking less than 5% of the world's energy is produced by nuclear power (Amadeo, 2019). Approximately 20% of America's power comes from nuclear energy. Nuclear energy contributes nearly 60% of the carbon-free footprint in the United States (Duke Energy Corp.).

Demand for power has been increasing substantially with all of the technological breakthroughs such as electric-powered vehicles, even how traffic light systems, and even the entire regional grid. The demands for electric-powered vehicles have been determined to vary on geographic location and when the vehicles are being charged (Davidson, 2018). Grid operators would theoretically concern about peak demand. Now there is a term known as "evening ramp" where renewable energy crosses over to other sources of energy (Specht, 2019).

Constructing or commissioning a nuclear power plant is an investment. General cost is calculated by the average range for kilowatt-hours (kW). In the early 2000's the initial investment to build one nuclear plant was $2 to $4 billion. The estimated cost impacts are largely due to the materials needed such as concrete, copper, steel, etc. Not to mention the skilled labor involved to construct a specialized structure.

As with most construction, there are different areas of expertise within different sectors, for example, hospitals, schools, water, etc. It is obvious any type of nuclear construction would require nuclear power expertise. One would assume there is not a lot of skilled labor with enough experience in the United States. With that being said, labor and materials must be

imported (Schlissel & Biewald, 2008). Couple that with exchange rates and import taxes the dollars add up pretty quickly.

The duration of time to build a nuclear power plant can take quite a long time this typically would depend on construction and design. Prior to construction for this size of project it could take upwards of 12 months to clear the site and prepare the area for the infrastructure such as drainage, sewer, heavy haul roads, housing, water, electricity, field offices, etc. Grubbing, clearing, excavation, and grading is done during this time. Generally, construction can take 40-60 months from the first concrete pour to the end of construction when fuel is loaded into the holding tanks. After fuel is loaded, roughly another 6 months of start-up testing is performed to make sure the plant will perform as licensed and designed. Inspections would be happening in from the building department almost daily. After this period, the plant is cleared to start pumping power to the grid with a certificate of operation or occupancy. Commissioned nuclear power plants are traditionally in use for any here between 50-70 years (Voosen, 2009).

Decommissioning costs are approximately 5-15% of the initial capital cost of a nuclear power plant. If these costs are discounted over the lifetime of the plant, they contribute only a few percent to the investment cost and even less to the generation cost. In the USA this discount accounts for no more than 5% of the cost of the electricity produced (OECD International Energy Agency, OECD Nuclear Energy Agency, Projected Costs of Generating Electricity, & International Energy Agency, World Energy Outlook, 2019). Typically these costs are included in the consumers monthly energy bills.

Radioactive waste can be dangerous for thousands of years. Therefore, radioactive waste is a concern. Most radioactive waste including used reactor fuel, is stored on-site at the power plants. There is only a certain amount of storage space on site. This created an issue that needed to be resolved, where would the remaining waste go? At the end of 2011, over 65,000 metric tons of radioactive waste had been produced by American nuclear reactors. This figure increases by 2,000 metric tons per year (Union of Concerned Scientists).

The Department of Energy has done extensive research for long-term burial nuclear waste areas. Yucca Mountain in Arizona was chosen for storage due to the location. For $5 billion several tunnels were constructed into the mountain to gain access for disposal. This is a remarkable investment seeing as it has not been officially selected, and there are no other areas in consideration. For the long term, off-site storage radioactive waste is placed in casks (Kivi, 2019).

It seems as if the benefit certainly outweighs the risk of what can happen in the event of a catastrophic event. In 2011, there have been 33 accidents and incidents recorded. Incidents are recorded by levels. Level 1 is an anomaly to Level 7 being a major accident (Rogers, 2011). The most recent incidents that we can recall are Fukushima Daiichi, Fukushima, Japan in March 2011 and Chernobyl, Ukraine (former USSR) in April 1986.

Fukushima is one of two nuclear power plants to suffer a disaster at the highest level, major accident. Fukushima is considered a Level 7 on the International Nuclear Event Scale. Fukushima Daiichi occurred as a result of an earthquake and tsunami that hit eastern Japan. In March 2011 the Eastern coast suffered an earthquake which was determined to be a 9 on the Richter scale (World Nuclear Association). Shortly thereafter a large tsunami was created and caused even more damage to the area.

When the tsunami hit it swelled over the plant’s seawall and followed the power plants lower floors. As the earthquake disabled all power to the reactors, backup power kicked in. Once the tsunami hit, the plant reached more than twice the levels of water the plant was designed to withstand. When that happened the reactor cooling systems seized up. The fuel overheated in the reactor cores and lead to hydrogen explosions. While Japan was reeling in from two natural disasters, the local community was forced to evacuate nearly 500,000 residents to safety (Union of Concerned Scientists). To date, Fukushima is functioning properly with only one death attributed to this disaster.

The second nuclear power plant to suffer a level 7 disaster is Chernobyl. Chernobyl is known as the worst nuclear disaster to date. Chernobyl occurred due to a surge in power during a routine reactor systems test. The test was meant to determine the plant's ability to provide power to the reactor core (Union of Concerned Scientists). An operator tested the system and there was a power surge and reactor Unit 4 failed.

Lack of safety training is largely to blame for this incident. There was a standard operating procedure to have a minimum of 30 control rods to retain “reactor control”. At the time of the incident, less than 8 were used. Most of the control rods were withdrawn to overcompensate for a buildup of an absorber of neutrons, xenon. In the event of this happening, it would take less than 30 sections to lower control rods and shut the reactor down. Despite all of this the operator continued the test. (The Editors of Encyclopedia Britannica, 2019).

Chernobyl recently gained a lot of notoriety large in part due to a docuseries on HBO. It was critically acclaimed with Primetime Emmy Awards in 2019.