Nuclear Power in the United States

Introduction

Nuclear power is one of the few zero carbon emission sources of electricity that is currently available. When weighing the risks against the benefits of nuclear power, it clearly stands out as a valuable resource, one that should be more thoroughly utilized. The United States should increase their allocation of funding for nuclear power research and development. Nuclear power is one of the few energy resources that can keep up with the ever increasing demand for energy, while not contributing to the increasing levels of carbon dioxide. Despite not contributing to the increase of carbon dioxide levels, nuclear power is only used to meet a fraction of the current energy demands in the United States.

While there are many nuclear power generators currently in the United States, none of them have been built recently, and many of them are outdated. Nuclear power generates electricity through the process of fission, using the element uranium as fuel. The uranium used is abundant and located throughout the world. The United States has many domestic uranium mines, providing the country with a local source of fuel for nuclear power. Like nuclear power, there are risks associated with the mining of uranium. Developments in nuclear power and uranium mining will limit these risks in the future. Nuclear power has been used as a dependable source of energy in the past, and should continue to do so in the future.

Nuclear Power in the United States

Nuclear power is one of the many methods of generating electricity in the United States. It is considered a non-renewable energy source because it is dependent on uranium, which is a naturally-occurring element found on Earth. Like other non-renewable sources such as coal and natural gas, once the energy source is used it is gone. This is in contrast with renewable sources of energy like solar and wind generation, whose sources can be used repeatedly. Nuclear power currently provides twenty precent of the energy generated in the United States, and produces seventy percent of carbon dioxide free electricity (U.S. DOE Nuclear Energy Performance Plan, 2010).

The production of electricity is responsible for forty-one percent of all carbon dioxide emissions in the United States (U.S. EPA, 2010). The burning of coal alone is responsible for over half of the forty-one percent (Sweet, 2007). As carbon emissions increase due to greater demands for electricity, their contribution to global climate change also increases. It is important to develop and support low and zero carbon emission energy sources to combat the problem of climate change. Nuclear power is one of theses options.

In the United States there are currently one hundred and four commercial nuclear reactors (Figure 1), the majority which are located on the East Coast (U.S. NRC, 2008). The majority of these reactors were built years ago; no new reactors have been built in the last thirty years (U.S. DOE Nuclear Energy Performance Plan, 2010). Despite providing a zero carbon emission source of energy, there has been a virtual stand still in the progression of nuclear power plant development.

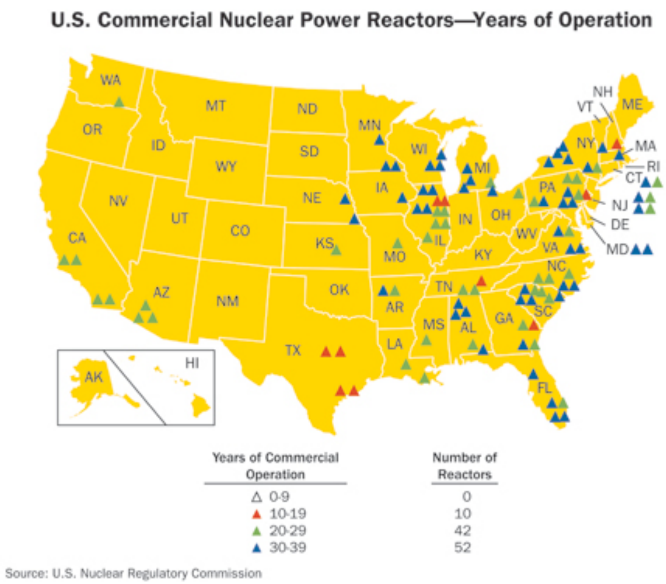

Figure 1. U.S. Commercial Nuclear Power Reactors- Years of Operation (NRC, 2008)

Process of Nuclear Power Energy Generation

The source of nuclear power is the element uranium. In a nuclear reactor the atoms of uranium are hit with neutrons. This causes the atoms to break apart. When the atoms break apart, one of the byproducts is heat. This process is called fission. The heat generated is then used to boil water which creates steam. The steam is then used to power turbines, which generates electricity (DOE- Office of Nuclear Energy, 2010). This process of heating water to generate steam is the same used with burning coal. The difference is in the fuel source used, and the process used to generate heat. Another difference is in the byproducts produced in the process. When coal is burned, it releases carbon dioxide into the air. When uranium atoms are split there is radioactive waste left behind. It is vital that this waste is disposed of carefully as to prevent radioactive contamination.

There is concern about the safety of radioactive waste from nuclear power plants, but there are concerns about the waste of other methods of energy production as well. While nuclear power creates radioactive waste, there is only about two thousand tons of it generated per year in the United States. Compare that two thousand tons to the over two billion tons of carbon dioxide produced annually by burning coal (Sweet, 2007).

While there is a small amount of nuclear waste generated, this waste is radioactive and needs to be handled carefully. The disposal of nuclear waste is one of the biggest drawbacks to nuclear power. The spent nuclear reactor fuel is highly radioactive, and remains so for thousands of years (U.S. EPA, 2010). There are currently no permanent disposal facilities for this waste, so it is stored in water pools at the power plant that generates it (U.S. NRC, 2002; U.S. EPA, 2010). There was a proposal to develop a permanent radioactive waste disposal location at Yucca Mountain in Nevada, but on March 3, 2010, the license was withdrawn (U.S. DOE, 2010).

The uranium used to power nuclear plants is mined from the Earth. It is located in abundance in the earth's crust (NEI, 2010). Large deposits of natural uranium ore usually contain one percent concentration and require extensive mining. However, there are deposits in Canada and Australia that have concentrations from ten to twenty percent, resulting in much more efficient mining (MIT study, 2003).

The Mining of Uranium

The mining of uranium in the United States is growing. Since 2004, the number of companies with mining and exploring rights has exploded from five thousand to over thirty-two thousand (Moscou, 2007). Figure 2 shows that uranium mines are located throughout the United States, primarily in the West where there are currently over fourteen thousand (EPA Uranium Mining Report, 2006; EPA Uranium Location Database, 2006).

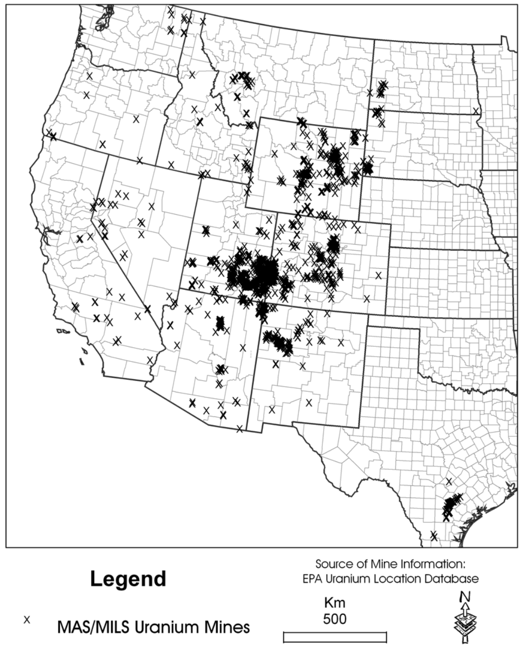

Figure 2. Location Of Uranium Mines in the Western United States (EPA Uranium Location Database, 2006)

There are four different ways to mine uranium: open pit (or surface mining), underground mining, heap leaching (which is no longer common in the United States) and in situ leaching (EPA Office of Radiation and Indoor Air, 2006). Open pit mining is used when the uranium ore is deposited close to the surface. Using heavy machinery, the ore is dug out of the ground. The soil that is displaced is stored nearby until the mining is complete. It is then used to fill in the mine. Underground mining is used to obtain the uranium ore that is deeper in the ground. There are several different methods used to do this, most rely on leaving natural pillars or walls within the ground to provide support to the mine. The ore and the excess soil are moved to the surface with rail cars (EPA Office of Radiation and Indoor Air, 2006).

Heap leaching uses either open pit or underground mined uranium and crushes the ore to sand-sized particles (EPA Office of Radiation and Indoor Air, 2006). The particles are deposited in a heap onto a pad of clay or coated concrete. A sprinkler system sprays the leach solution onto the heap, and as the solution trickles down it moves the uranium with it. This solution is then processed to remove the uranium and made into yellowcake. Yellowcake is a concentrated powder that contains around eighty percent uranium oxide. The most common type of uranium mining is in situ leaching (Figure 3); it is also the most economical. Injection wells are dug on either side of a production well. The injection wells are where the lixiviant solution (a combination of carbon dioxide, water, and oxygen) is pumped into the ground. The lixiviant dissolves the uranium and it flows to the production well. From the production well the solution is processed to make yellowcake (EPA Office of Radiation and Indoor Air, 2006; CVMBS, 2010).

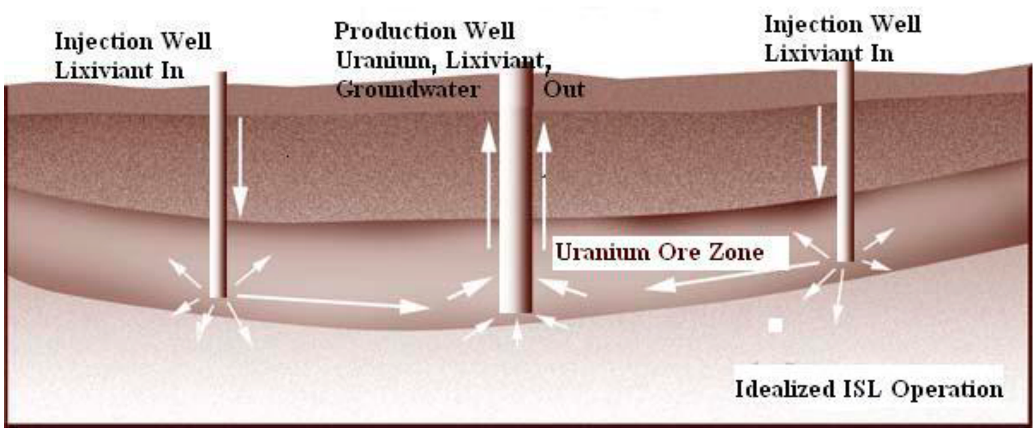

Figure 3. In Situ Leaching (EPA Office of Radiation and Indoor Air, 2006)

Risks of Uranium Mining

There are both environmental and health hazards associated with the mining of uranium ore. By using in situ leaching, there are fewer risks to the miners from accidents, dust, and radiation (WISE, 2010). There is a risk that the surrounding groundwater can be contaminated by the leaching solution. After the mining is complete, the groundwater needs to be returned to the

EPA drinking water maximum contaminant limit levels if possible (EPA Office of Radiation and Indoor Air, 2006). Depending on the type of rock, the leaching solution may permeate the area and not be able to be removed.

The health hazards in relation to uranium mining are currently under debate. It is agreed that exposure to the uranium can affect the renal system, causing problems with the urinary tract and kidneys. According to the Agency for Toxic Substances and Disease Registry (a branch of the Center for Disease Control), there is not a link between naturally occurring uranium ore and cancer (ASTDR, 1999). Other groups, such as those that protest the use of nuclear power, say that there is a direct link between mining and cancer (WISE, 2010). As mining continues, testing and research will look for a definitive answer to this connection.

Conclusion

The United States' population is going to continue to grow, and with it the demand for more energy. As carbon emissions continue to increase the effects of global climate change, we cannot continue to depend on the burning of coal to supply our energy. We must look for low or zero carbon emission sources of energy. Nuclear power is one of those sources. It does have risks associated with it, but every energy source has drawbacks. The disposal of radioactive waste and contamination of groundwater are valid concerns regarding nuclear energy. The United States should focus on finding solutions to these problems, because nuclear energy could be the solution to the carbon emission problem.