Forum: General Assembly

Issue: Question of the disposal of nuclear waste

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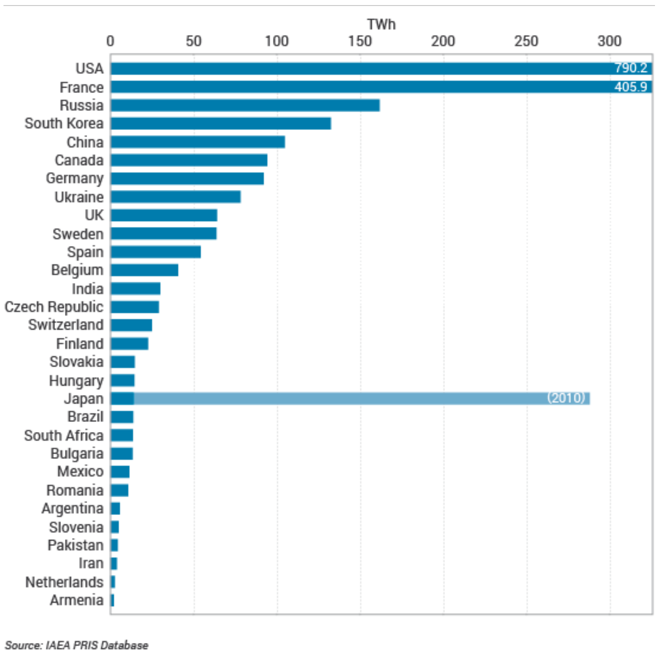
Introduction

In terms of producing electricity, there are several different methods to suit humanity's needs. Environmentally friendly methods such as solar power plants, wind power plants, and hydroelectric dams are renewable, but often are expensive and rely on the environment. On the other hand, the usage of coal and oil may be inexpensive but lead to heavy taxing on the environment. Though expensive to construct, nuclear power plants are one of the most effective methods to produce energy, supplying 11.5% of global electricity needs. Nuclear power plants are environmentally friendly, as they depend on the heat produced from the nuclear fission of uranium fuel pellets in order to boil water, which consequently powers a turbine, rather than the burning of fuels in order to create smoke. However, a byproduct of fission is nuclear waste, which comes in the form of highly radioactive liquid waste. These highly radioactive byproducts are also known as High-Level Waste (HLW), whose half-lives, the time that it takes for their radioactivity to fall to half the value, can range from ten thousand to two million years. The amount of energy used to manage and dispose of such nuclear waste takes up 5% of the total energy generated from nuclear power plants. Due to the radioactivity of HLWs, they can have many pernicious effects on the environment and humans. The effects of radioactive exposure range from the ruining of water and soil quality in the environment to fatal diseases such as cancer and leukemia. As a consequence, HLWs must be cooled, processed into a solid,



Energy generation through nuclear power plants in 2013 transferred into dry casks for storage, and subsequently transferred to mined deep geological repositories (DGR) underground in order to be isolated from both the environment and any humans. Having said that, this form of storage is the main issue concerning the disposal of nuclear waste. As the half-lives of HLWs can range from ten thousand to two million years, such casks that have been stored are likely to remain where they are for a long time and take up space indefinitely before their radioactivity has decayed down. Over time, the amount of underground repositories will prove to be problematic, as the land can be used for systems of greater values for countries. Additionally, estimated costs for the construction of deep geological repositories can range from a few billion US dollars to several hundred million. Moreover, the cost for repairs in the event of unexpected chemical explosions can be great as well, with the example of the 2014 nuclear waste explosion in New Mexico. For these reasons, we must find a more viable option than storing mass amounts of HLWs underground or improve our current DGR system to benefit the present and save resources for the future.

Definition of Key Terms

Nuclear Waste

Nuclear waste refers to the highly radioactive liquid product as a result of nuclear fission. This nuclear waste is often referred to as high-level waste (HLW). Due to its radioactivity, nuclear waste produces intense heat and poses a significant threat if not disposed of, or contained properly. HLWs must be cooled from 10-20 years in spent fuel pools, then transferred to deep geological repositories after being packed into dry casks. The current agreed method of disposal of HLWs is storage in deep geological repositories.

Nuclear Fission

Nuclear power plants do not burn fuel, rather use uranium or other radioactive element-based fuel pellets that are packaged into long, vertical tubes. The process that nuclear power plants utilize in order to generate power is known as nuclear fission. Nuclear fission is the splitting of atoms through a nuclear reaction to produce neutrons and gamma photons, which are evident in the immense amounts of heat and energy produced. This heat is used to boil water, whose steam product powers a turbine. Though no smoke is produced, high-level waste is produced when the concentration of neutrons drops.

Deep Geological Repository

Deep geological repositories (DGR) are manmade underground storage sites created with the purpose of safely keeping nuclear waste. HLW waste is cooled for 10-20 years in spent fuel pools, packed into dry casks, then consequently transferred to deep geological repositories to be stored for an indefinite amount of time. DGRs must be built on geologically stable plots of land to prevent the risk of natural disasters. Scientists and governments agree that as of our current scientific state, DGRs are the best available solution for dealing with the nuclear waste issue. Currently, DGRs are in development in Finland, France, Sweden, and Switzerland.

General Overview

Nuclear power against the world

Nuclear fission is an extremely efficient method to produce large amounts of energy. However, this technique produces HLW, which is difficult to dispose of and manage. Seeing this, one may believe that investing in other forms of energy are more effective. However, this is not necessarily true. Nuclear power plants are reliable, safe, and efficient, producing energy over 90% of the time that they are active. Another benefit of nuclear energy is the environmental and financial cost. Though nuclear power plants may initially cost a great sum and take up the area of roughly a football field, the total area consumed and operation costs to run the facility are far lower than other forms of energies. Additionally, the fuel used in nuclear fission is unlike fossil fuels, which produces greenhouse gases, which contribute towards global warming and other adverse environmental effects. On the other hand, the mining and enrichment of uranium to be used in fuel rods does produce greenhouse gases, though the total amount of gas produced from other power sources are far more.

	Lifecycle emissions (gCO_2eq/kWh)[6, a]	Estimated emissions to produce 2417 TWh electricity (million tonnes CO_2)	Potential emissions avoided through use of nuclear power (million tonnes CO_2)	Potential emissions avoided through use of nuclear (million cars equivalent)[7, b]
Nuclear power	12	29	NA	NA
Gas (CCS)	490	1184	1155	c. 250
Coal	820	1981	1952	c. 400

Note: Lifecycle emissions estimates from the IPCC. Estimate of average emissions per vehicle from the EPA.

Estimated carbon dioxide emissions in nuclear, gas, and coal power

In comparison to other sources of energy, nuclear energy may not be renewable. A renewable energy source is defined by its ability to generate energy from natural processes that are continually replenished. Spent fuel can be reprocessed back into usable fuel by separating uranium or plutonium from HLWs. Though this may seem as though more fuel is being produced along with the reduction of waste, such refined fuels can also be used for many adverse purposes. Separated uranium or plutonium is highly concentrated and can be easily used to construct nuclear weapons, increasing the proliferation of nuclear arms significantly. In addition, in the late 1970s, the United States decided not to reprocess spent fuels, and instead, send them to deep geological repositories. As of now, nuclear energy is not renewable, so therefore other forms of energy production are more widely accepted over nuclear energy.

Harmful effects of HLWs

HLW is the waste byproduct of nuclear fission. Though HLWs poses no threat if disposed of properly, faulty or inadequate disposal paired with its exposure will result in adverse effects on the environment, animals, plants, and humans. Effects on the environment, plants, and animals indirectly effect humans as well, because humans can ingest radioactive toxins through inhalation, or through the food chain (eating). Examples of such effects on the environment can be shown through an accident in February 2000, regarding the 200 gallons of radioactive water being dumped into the Hudson River. Furthermore, a report in January 2007 noted that four out of twelve fish in the Hudson River contained harmful radioactive toxins. If radioactive fish were to be eaten, the consumer would be subjected radioactive poisoning, whether it be acute radiation syndrome, effects that show up shortly after exposure to radiation, or chronic radiation syndrome, effects that show up months or even years after exposure to radiation. Such syndromes range from induced cancer to chromosomal aberrations, mutations caused due to DNA being damaged.

Previous and current means to solve the issue of the disposal of nuclear waste

The disposal of nuclear waste is highly important, because if such waste is not disposed properly, there will be many adverse effects on both humans and the environment. In the past, there have been several different proposed means to get rid of nuclear waste, ranging from the injection of HLWs into rock layers' deep underground to launching rockets full of HLWs into space. However, many to all of such proposed ideas have individual flaws – whether it be too costly or too risky for the environment – and are much overshadowed by the concept of DGRs.

Storage within deep geological repositories

Deep geological repositories are manmade underground storages created for the purpose of safely storing nuclear waste. Storage of nuclear wastes in DGRs began in Forsmark, Sweden

1988. Scientists and experts agree that DGRs are currently the best method to dispose of nuclear waste.

Vitrification of nuclear waste

The term vitrification suggests the conversion of a substance into a glass-like material. Though the process of vitrification does not make a substance less radioactive, it can turn liquid HLWs into solid, glass-like HLWs that can be more easily managed and placed in transported around. The process of vitrification is a common practice that is used in order to make the transportation and storage of HLWs more convenient.

Outer space disposal of nuclear waste

A previously explored technique of the disposal of nuclear waste was the ejection of waste into outer space through a rocket. Several destinations were planned to make sure that the waste would never come back, with the example of launching the waste directly into the sun. The plausibility of this technique was explored in the USA by NASA in the late 1970s and early 1980s. Ultimately, the idea was abandoned due to the consequences in relationship to launch failure and the high cost.

Sea disposal of nuclear waste

Another previously explored technique regarding the disposal of nuclear waste was dumping nuclear waste into the sea. The containers holding the nuclear waste would either implode upon reaching certain depths of the ocean or slowly fail over time, with both means dispersing radionuclides throughout the ocean. Though this method is used for smaller, less radioactive types of waste, the implementation of HLWs in this technique has never occurred, and likely will not ever due to the risk of water pollution.

Nuclear reprocessing to re-use fuel

The reprocessing of spent fuels is a series of chemical operations that separates usable fuel from other nuclear wastes such as HLW in order to make more usable fuel. In nuclear fuel rods, only about 4% of the rod is high-level waste, whereas the rest is spent fuel, and can be recycled to be used again. The chemical processes used to refine the spent fuel rods are used to separate HLWs that have mixed in with the rest of the usable fuel. This technique can minimize the amount and toxicity of nuclear waste, but the recycling process transforms the unusable fuel into a component used in the creation a nuclear weapon. HLW produced from nuclear fission comes in a liquid form, which is both difficult and impractical for anybody to either steal it or use it in the construction of a nuclear weapon. However, the recycled fuel comes in a highly-concentrated powder-like substance which is easier to transport/steal and use in the construction of nuclear weapons. If the reprocessed fuels from the reprocessing technique can be used to create nuclear weapons, nuclear proliferation would spread exponentially; with easier means to create a nuclear weapon, countries or terrorist organizations will be able to easily increase the amount of nuclear weapons in the world, which may ensue in a nuclear war.

UN Involvement, Relevant Resolutions, Treaties and Events

The International Atomic Energy Agency (IAEA) drafted the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, which entered the force on June 18th, 2001. With 42 signatories as of July 2017, the joint convention seeks to set benchmarks for signatory nations regarding spent fuel, HLWs, and other radioactive wastes. The joint convention was also the first legal instrument to tackle the issue of spent fuels and HLWs on a global scale. The IAEA also drafted the Convention on Nuclear Safety, which entered the force on October 26th, 1996. With 83 signatories as of July 2017, the Convention on Nuclear Safety sets out to commit member states to set high safety standards in nuclear power plants by setting international benchmarks.

On the days of November 21-25, 2016, the International Atomic Energy Agency held an international conference regarding the safety or radioactive waste management. In the conference, member states recalled previous conferences regarding similar topics held in the years 1998, 2000, 2002, and 2005. The purpose of such conferences were to highlight long term solutions to the disposal of nuclear waste and promote the exchange of information in relationship to the disposal of nuclear waste.

Timeline of Events

Date	**Description of event**
December 17th, 1938	German physicists discover nuclear fission by splitting uranium atoms.
December 20th, 1951	The EBR-1 reactor in Arco, Idaho is the first reactor to generate electricity.
June 26th, 1954	The Obninsk nuclear power plant in Obninsk, Russia is the first commercial nuclear power plant.
July 29th, 1957	The International Atomic Energy Association (IAEA) is formed, promoting the safe and peaceful usage of nuclear energy. The Nuclear Fuel Cycle & Waste Technology (NEFW) is created as a subdivision and provides scientific, technical, and financial aid for means of disposal and storage.

January 7th, 1983	The USA adopts the Nuclear Waste Policy Act, acting to provide for the development of DGRs.
1988 (date unstated)	The first DGR is constructed in Forsmark, Sweden.
October 26th, 1996	The Convention on Nuclear Safety by the IAEA enters the force,
February, 2000	The IP-2 accidentally dumps 200 gallons of HLWs into the Hudson River, resulting in the wildlife being infected by radioactive toxins.
June 18th, 2001	The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management by the IAEA enters the force, regarding safety regulations relating to spent fuel and HLWs.
February 14th, 2014	The Waste Isolation Pilot Plant in New Mexico, USA leaks airborne radioactive materials, resulting in internal radioactive contamination.

Possible Solutions

The issue of nuclear waste is very important, because as of now, it stands as a requisite before becoming a renewable source and a dependable form of energy production. A possible solution to the current issue at hand is the increase of scientific development on the topic of nuclear waste as a whole. With enough funding and research, scientists, NGOs, and UNOs alike will be able to find an increase of methods in order to dispose of nuclear waste, and consequently discover methods which may prove more beneficial than the current method of disposal, storage in DGRs. When regarding research, it is critical that member states cooperate when sharing information in order to not only save time and money, but to prevent hazardous experiments that may result in more harm.

A further solution is the continuation or establishment of meetings such as but not limited to the IAEA's international conferences. The IAEA's conferences are a means to share information regarding methods of nuclear waste and highlighting the most reasonable method based on a country's geographic and economic position. As more and more ideas are proposed and evaluated accordingly, the end desired mean to deal with the issue of nuclear waste becomes more and more clear.

Another possible solution is the investment of time and resources into reprocessing spent nuclear fuels. The process of recycling fuels drastically decreases the amount of nuclear waste produced while increasing the amount of fuel that can be used. As uranium is an element that has to be obtained through mines, it is a limited resource. The fact that uranium is limited is what stands between where nuclear energy is right now, and nuclear energy becoming a renewable resource. By reprocessing spent fuels, the amount of that has to be mined in order to execute nuclear fission drops tenfold, benefitting the environment that is harmed through the mining of uranium. Though this technique of recycling fuel provides usable fuels which may be used in the creation of nuclear weapons, adequate resolutions, conventions, or agreements proposed by nations and the international community can prevent potential nuclear proliferation.

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