

Research on the Impact of Nuclear Energy on the Sustainability of the Global Environment and the Economic Independence

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Abstract: This paper will discuss the environmental and economic possibilities of nuclear energy. Under the great international tension created by Ukraine and the Russian War, energy dependence on Russia is becoming a major concern for the European Union. The dependence on energy sources from other countries is an underlying danger to one's own nation's political and Economic health. Nuclear energy, as one of the clean energy sources that can satisfy a nation's requirements both in quality and quantity, is an energy source full of controversy, due to its potential to cause devastating nuclear emissions. Through a literature search and reading, this paper would come to the conclusion that all countries that wish to operate nuclear power plants should operate them like France.

Keywords: nuclear energy, sustainability; economic independence

1. Introduction

Nuclear energy has been long debated on its possibility of being used. Until today, it is used in most developed countries in relatively small amounts. However, during the past few years, from 2020-2023, the deteriorating world economic situation has warned us of our dependence on Russia's natural gas and Middle Eastern oil. Most nations' economic systems have been negatively impacted, and some have even been pushed to the edge of falling apart. To seek a solution to this problem, and to prevent such events from reoccurring again, it is never more necessary to seek another kind of energy source that is not dependent on other nations and is capable of supplying a country's needs. This paper is going to discuss the possibility and ways in which nuclear power plants could be a possible solution to this problem.

1.1. Introduction to Nuclear Energy

A nuclear power plant is a form of clean energy that uses the energy released from nuclear fission to evaporate water into steam to generate electricity from spinning turbines [1]. Nuclear energy's current state of usage is not in a great amount. Until 2022, Nuclear power plants generate 11.2% of the world's electricity with 436 reactors [2]. However, the demand for this necessary, dependable, and greenhouse gas-free energy is rising [2]. Nuclear power reactors are in operation in 31 nations, and four nations without reactors are currently constructing new ones [2]. The reason that nuclear energy is not used

massively, is because it has extreme benefits and harm. The harm is so extreme that very few countries are willing to take this risk.

2. Nuclear Energy's Impacts on National Economic

It is important to admit that a Nuclear plant is not economically profitable on its own on most occasions. Historically speaking, a nuclear plant is not profitable for its high capital cost, unless it can operate for more than 40 years [3]. Unfortunately, a nuclear plant can hardly operate that long, due to Nuclear Regulatory Commission, natural disasters, and Government policies [3]. However, nuclear projects not being economically profitable on their own does not mean that it has no economic value. Nuclear power could be a very good primary source of energy if we consider the stability of energy prices. Unlike other energy sources like oil and natural gases, nuclear power ensures that a nation can supply its own country's energy source. Instead of finding oil and natural gas, which only appears in a certain amount of places, nuclear power is a more accessible energy source that is able to mass produce electricity. All eight top oil producers reached their production of crude oil peak when Mexico reach its peak in 2002 [4]. This leads to higher control of oil prices for OPEC countries. Being heavily dependent on importing other nations' cheap natural resources such as oil and natural gas may seem economically beneficial in the short term, but this would lead to a huge economic risk for a country's economic system. Energy sources are the fundamental needs for many products on the market, a rise in the price of energy sources would directly cause a rise in the price level to some degree [5]. When a country is handing its price control on energy sources to other countries it means that they are also handing their control price level. When a nation cannot control its price level, it cannot control its inflation rate, and a series of economic issues. An example of such a catastrophe could be Turkey. During the 1970s, a dramatic price change in oil causes cost-push inflation in Turkey [6]. Turkey is a very import-dependent country [6]. The rise in oil prices causes a rise in domestic product prices, an increase in the price level, a decrease in trade, and less production [6]. Under such an occasion, Turkey placed itself in what is called: stagflation. What is even worse, which makes them unable to fix this stagflation, is that they cannot control the price of the natural energy source. Even though the change in oil price is not the only or most important factor in the economic catastrophe, it is still an important contributor.

The change in oil price and natural gas prices would be a major concern that most countries need to consider because it will eventually come. Oil and natural gas are unrenowable energy sources, which means the more we use the less we have. The price of oil and natural gas would eventually increase due to a shortage of supply. Nuclear energy is less concerned about the resource shortage problem compared with other energy sources. Oil with a reserve of 270-300 billion tons and annual consumption of approximately 3.5 billion tons, is going to support humans for 30-50 years [7]. World natural gas reserves could support humans for 30-60 years, and the Coal reserve could support humans for 200 years [7]. Uranium 238 has the amount of reserve which would support humans for 700 years [7]. As the supply of oil and natural gas runs out, the price of it would rise dramatically.

Nuclear energy in such cases would show its advantage and its economic value. Nuclear energy is first capable of supplying a whole nation's electricity system. Compared with other renewable energy, nuclear energy is more efficient in producing electricity. The capacity factor for nuclear energy is 92.6% far more efficient than solar energy's 24.8%, wind energy's 36.1%, and hydroelectric energy's 37.4% [8]. Arguably, geothermal, gases, and wood, all have a capacity factor of around 70%, which is only a little bit less competitive with nuclear power plants [8]. However, all three of these energy sources lack the capacity to mass produce electricity. Wood would cause too much Carbon emission. Also, there are certainly not enough places that satisfy the condition required for geothermal, at least not enough for a whole nation. Compare with oil, one fingertip size of uranium can produce the same amount of energy produced by 150 gallons of oil [9]. However, even with the awareness of such

incredible productivity, most countries are still reluctant to use such technology massively due to its safety issues.

3. Environmental

From the perspective of the environment, the hugest debate is about harm from radiation, nuclear emission, and nuclear waste. Compared to nuclear emissions, the harm caused by wood burning, oil emissions, and natural gas emissions are far easier to control and treat. Radiation could cause cancer, animal mutation, or even death. The most burning wood and natural gas emissions could do is release massive amounts of CO₂. One of the most devastating nuclear emissions is the one that happened in Chernobyl in 1986. This emission caused an environmental impact across a large area of Northern Europe, 7,530 km² of land is severely polluted including 2,600 km² from modern Ukraine, and 2,130 km² from modern Belarus [10]. In fierce debate, this event caused 9,335 death, or approximately 4,000[11]. No matter which number is the correct number, both of it is a huge loss.

The report about Chernobyl frightens people which makes nuclear energy seem to be a far more dangerous energy source than other ones. However, the fact is the damage caused by other energy sources is far more severe. Annually, 24,000 people die from coal-fired power plant pollution, combined with 38,000 heart attacks, and 550,000 asthma attacks [12]. Also, a single accident of hydrogen sulfide-bearing natural gas happen in 2003 by China National Petroleum Corporation caused 243 death, 2142 people hospitalized, and 65,000 people evacuations [13]. Annually, 2.4 million people died because of air pollution [14]. With this comparison, Nuclear Energy is actually a relatively safer energy source for humans.

One of the other major concerns of nuclear power plants is their radiated waste. However, the nuclear waste problem could be solved if we didn't have to dispose of all the nuclear materials we used in the reaction. Instead of leaving behind dangerous waste, nuclear stations could reuse nuclear materials several times, and use up most of the material. France is a country that has succeeded in new spent nuclear fuel (SNF) [15]. France also has the second most number of nuclear power plants operating [7]. 75% of France's electricity comes from Nuclear power, and due to the low cost of its electricity, France is also the largest electricity exporter, with an annual profit of 3 billion euros [7]. PUREX is a mature technology that also recycles spent nuclear fuel (SNF), and, currently, is the only one that is commercially available [15]. The process of this could be simply described as separating the SNF into material that can be used and material that cannot be used. The material that can be used will be reused, and the ones that cannot be used will be packaged in a universal canister. This technology is incredible for the number of resources it saves, and the amount of waste it treated. This process has achieved significant success even today. France has been able to recover more than 96% of its used nuclear fuel thanks to the reprocessing of spent fuel [15]. France now only generates 4% of the nuclear waste it would generate if it did not reprocess its used fuel. And even for the 4% vitrified waste, it is stable and safe for long-term storage after vitrified processes [15].

4. Conclusion

In sum, nuclear energy is a clean yet unrenovable energy source that is capable of supplying a nation's power system. Beyond that, nuclear power is also important to form economic means where it could provide an energy independence base for an economic system, which would less likely to result in a financial crisis when the price of oil changes rapidly. The stability of a nation's economic system is essential to a nation's citizens' living standards and happiness. All other countries that are operating or want to operate nuclear power plants should use the same method as France, which is efficient and safe in production, environmentally friendly, and doesn't need to worry about the scarcity of material.

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