The Future of Nuclear Energy

Thesis

Presented in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Science in Environmental Studies

By

Your Legal Name as it appears in the University records

California State University, Sacramento

2021

Thesis Committee

Name, Thesis Advisor

Copyrighted by

Your Legal Name

Choose an item.

**Abstract**

This paper examines scholarly knowledge and information about nuclear energy. It explores how nuclear energy became a consideration to find more sustainable and environmental-friendly replacements for nonrenewable fuels. It explores the reasons the proponents of nuclear energy advocate for its adoption soon. It also dwells on the many factors that slowed down and that continue to hamper widespread civilian usage of nuclear energy. Objectivity in nuclear energy analyses reveals both a positive and a negative outlook. The literature surrounding nuclear energy development features high polarization because of normative and ideological concerns. The paper takes note of the realities and proceeds to consider the next two or three decades regarding the adoption of nuclear energy. It presents the determinant factors that influence the adoption of nuclear energy. It also identifies key factors that could likely derail the investment in nuclear power by the leading global economies. Some of the factors considered include safety and security, climate change, economic competitiveness, and public perception. The paper seeks to draw a conclusion based on public perception and security concerns. It also considers the likelihood of adopting nuclear energy in the global economy. Finally, it concludes that nuclear power is likely to remain uneconomical and not viable for an extended period.

Table of Contents

Table of Contents

[Abstract ii](#_Toc69997187)

[Introduction 4](#_Toc69997188)

[The Emergence of Nuclear energy 7](#_Toc69997192)

[Factors determining the adoption of nuclear energy 8](#_Toc69997193)

[Economic competitiveness 8](#_Toc69997194)

[Nuclear Energy and its Impact on Climate Change 9](#_Toc69997195)

[Challenges involving Nuclear Energy 11](#_Toc69997196)

[Handling unique safety requirements for nuclear energy 11](#_Toc69997197)

[The danger of proliferation of Nuclear Weapons 11](#_Toc69997198)

[Public Opinion Towards Nuclear Industry 13](#_Toc69997199)

[Nuclear Energy Security 14](#_Toc69997200)

[Conclusion 15](#_Toc69997201)

[Bibliography 16](#_Toc69997202)

**Introduction**

Energy is a prerequisite for any economy to run. Like in previous centuries, energy continues to play a critical role in the global arena. Endowment and successful derivation of energy coupled with economic progress remain a primary goal of many nations with natural energy resources, including oil reserves, wind, and others. However, the scope of human history continues to depend on critical supply-side provisions. Energy sources continue to linger as the leading supply side that determines the operation of economic agents. The increase in globalization calls for the need to adopt a new power supply. The ideal power supply also entails minimizing the adverse effects resulting from energy production. Global energy reports note that fossil fuel accounts for 86% of energy demands (Blasio & Nephew, 2018). The revelation creates significant worry owing to the increasing costs of fuel sources.

The global oil reserve is at its peak, meaning that the future supply will reduce. Oil's super-cycle will end. The reduction in fossil fuel supply coupled with the detrimental impacts of gas, oil, and coal stimulates the need to venture into other energy sources (Helm, 2017, p. 4). Carbon dioxide continues to be destructive because it is associated with the increase in climate change. According to NASA, anthropogenic climate change impacts have increased in the last twenty years. Scientists and environmentalists attribute the earth's surface becoming warmer to methane, CO2, chloro-fluorocarbons, and nitrous oxide emission. CO2, a primary bi-product of fossil fuel, is a major global warming gas as it prevents heat radiated from the earth's surface from escaping back into space (NASA Global Climate Change, 2020). Burning fossil fuels increases the amount of carbon dioxide in the atmosphere leading to an increase in the amount of carbon dioxide available for oceans to absorb. Excess carbon dioxide acidifies oceans endangering marine life (Carr, 2018, p. 448). Such challenges posed by fossil fuels call for sustainable energy source solutions.

The need for cleaner energy prompted the generation of non-carbon fuel. Research and testing identify nuclear power as one of the leading sources of power free from greenhouse gases. Nuclear power continues to boast of a cleaner environment making it desirable for climate change. Despite its advantages, large-scale development, and adoption, nuclear power still faces contention from different stakeholders (Balkan-Sahin, 2019, p. 443). The views from the leading global nations support its adoption while others object. For instance, in the European Union, nuclear technology has produced a good percentage of the region's energy over the last few decades. This nuclear energy use capacity has seen the EU become one of the three top significant economies to make at least 50% of their electricity with low carbon emissions (Barnes & Barnes, 2018, p. 11). For nuclear energy to continue being relevant and essential to the EU's energy mix, public acceptance and political consensus are critical.

The thesis seeks to understand the future of nuclear energy utilization in the global arena. It considers nuclear energy as a potential future source of clean and sustainable energy. It also analyzes the role of different stakeholders, including policymakers who exhibit normative arguments regarding nuclear power. The projections of future needs also form an integral objective of the paper, highlighting the need to attain and sustain a balance among competing demands. Therefore, the report presents economic competitiveness, global security, climate changes, and safety issues as the leading factors for consideration while determining global energy security (Blasio & Nephew, 2018). Other factors for consideration include public perception of nuclear and proposed safety arising from the exploitation of nuclear energy. The paper seeks to identify the critical importance of the elements and draw a conclusion based on their interplay. It helps in making a decision relating to nuclear energy exploitation.

The thesis begins by covering an essential literature review regarding future projections of nuclear energy. It also discusses the economic perspective of adopting nuclear energy in the future. Under this capacity, the paper makes a critical comparison between nuclear power and another alternative energy source. The leading subjects under investigation include the influence of nuclear energy on climate change and safety measures resulting from nuclear power. The paper also considers literature that identifies proliferation risks and analyses matters about security and safety, including the public's perception regarding the utilization of nuclear energy. Finally, the paper draws recommendations from different literature reviews.

This paper's significance is educating the population on the benefits and economics of nuclear energy. It also includes factful information relating to the dangers of nuclear energy. Despite the many positive impacts attributed to nuclear power, the paper highlights public perception depicting the rejection of nuclear energy utilization. The paper attempts to portray the delicate balance between nuclear energy facts and needs by presenting research findings on the economics and perception of atomic energy. Finally, the study becomes significant in helping people understand the need to adopt clean energy for future decades. The adoption of clean energy has the impact of mitigating global warming and climate change.

**History of the Emergence and Development of Nuclear Technology and Energy**

The international quest for the exploitation of nuclear technology and research began with introducing the Atoms for Peace vision in 1953. The then-president of the United States, Dwight Eisenhower, initiated the project to increase East's and West's communication. More importantly, he believed nuclear technology would benefit societies' medical and energy production sectors (Copeland & Lamm, 1973, p. 607). The pronouncement resulted in a massive development and exploitation of nuclear energy. Indeed, the year 1970 witnessed the emergence of more than 90 nuclear power plants capable of generating 16,500 Megawatts of electricity. These power plants were scattered in 15 different countries. The number of power plants increased to 253 plants with a capacity of 135,000 MWe located in 22 other countries (Hore-Lacy, 2010). With the increase in the construction of nuclear energy plants, nuclear energy was set to increase. However, there was a strong nonproliferation campaign that saw nuclear energy demand decrease. Such impacts resulted in reduced activities of the existing power plants. The 1968 Nonproliferation Treaty cemented the reduction in nuclear plant constructions (Lavoy, 2020). Too many challenges, such as the higher rate of inefficiencies in these plants, the fear of nuclear energy weaponization, and the massive decline in demand for nuclear energy. The rising cases of accidents such as in the 1961 SL-1, 1979 Three Miles Island, and 1986 Chernobyl accidents demonstrated the devastating effects nuclear accidents had on humans and the environment. In the following decades, nuclear technology and research continued to cause controversies. The 1990s witnessed another surge in nuclear energy demand emerging from Asia, thereby leading to the construction of 19 power plants (Siqueira et al., 2018). However, the West continued to discourage building nuclear energy power plants (Lavoy, 2020).

The beginning of the century witnessed a renewed surge in nuclear energy demands by the leading global economies. Among others, China, the United States, and India renewed their focus on developing atomic energy. These nations have since floated plans to increase internal nuclear capacity. The surge follows the global projection of increased nuclear energy demand in the next decade. This predicted an increase in demand would depend on the exploitation of nuclear energy reserves. The current debates still offer no clear-cut picture of how this will proceed. However, as countries make nuclear energy projections, consider it an option and invest in nuclear technology, it is an indication that nuclear energy is still a considerable solution to a possible global energy crisis (Balkan-Sahin, 2018, p. 450).

Today, the number of nuclear energy plants has risen to 439, with a capacity of 373 GWe spread across 31 countries (Külahcı & Bilici, 2019). The construction of 36 more plants is underway, while the existing plan considers 93 more nuclear energy plants. Today, 16% of the global electric energy originates from atomic power. Current records also show increased optimism towards adopting nuclear energy by 2030 (Külahcı & Bilici, 2019). The table below provides an analysis relating to utilizing atomic energy and nuclear power projection for 2050. From the table, it becomes imperative that the exploitation of nuclear energy critically rises because of more electricity demand.

The leading global nations with the capacity to build and supply nuclear energy include the United States, Russia, Japan, India, China, and South Korea. These countries account for two-thirds of atomic capacity. China takes the lead because of its declaration to build 96GWe of more nuclear power. This capacity exceeds all the other nations. Indeed, such statistics indicate that there are still certain acceptance levels of nuclear technology despite its many challenges. Countries continue to invest enormous amounts of resources in sustaining old power plants, build new ones, and in the research and development of nuclear energy.

**Factors Determining the Adoption of Nuclear Energy**

Future adoption of nuclear energy critically depends on the correlation of determining factors. Striking a balance between these factors helps in determining the overall quest to attain nuclear energy power plants. These factors include concerns relating to global warming, economic competitiveness, security considerations relating to energy, and public perceptions. These factors become familiar to the available energy sources. Additionally, nuclear energy exploitation is characterized by high proliferation and safety risks that could spur its future growth trajectory. Prăvălie & Bandoc (2018) considers the projections to forecast an increase in energy needs by 55%. With the projected increase in electric consumption from 16930 to 38191 TWh by 2030, the existing electricity alternative must be capable of generating this massive power demand.

**Economic Competitiveness**

Analyzing the nuclear industry economically must consider the financial costs variations between nuclear energy and traditional alternatives generation. Natural gas and fossil fuel are the leading options in the traditional alternatives category. These fuels account for 60% of the energy market share (Cobos-Urbina, 2021). The future provisions depict a slight decline in the amount of power supplied by coal and gas because of their impact on the environment. Also, the exploitation of renewable energy sources, including solar and wind energy, does not presently highlight potential competition because they do not constitute the central global energy mix. However, it is critical to note that the renewable energy sector is growing fast, with a 100% increase in the US between 2000 – 2018 (C2ES, 2020). Thereby, despite the wind and solar power accounting for 2.1% in the energy mix now (Froggatt & Schneider, 2015), these figures could change. Massive investment in technology will enhance the increased absorption of more solar and wind energy channeled to the national grid. Then, it could be better positioned to be economical compared to nuclear energy, fossil fuels, and gas.

Therefore, the leading energy producers use fossil fuel and nuclear energy for comparisons. An analytical study conducted by the University of Massachusetts shows that the future of nuclear power shows great economic potential. It offers states, such as Texas and New England, cost-reduction benefits even in scenarios where carbon constraint is stringent. The latter state has little favourability for renewable sources (Buongiorno, Corradini, & Parsons, 2018, p.12). According to the study, nuclear technology has an opportunity because the already-installed capacities can meet the energy demand. Nuclear energy build-outs are dispatchable, allowing their operating capacity to remain higher than renewable sources (Buongiorno, Corradini, & Parsons, 2018, p.18).

It is disadvantaged because it does not attract a cost advantage over a long period. New facilities need expensive testing to be licensed. Most plants are constructed using inefficient designs, which add to their costs. Electricity, the primary product civilian nuclear power plants target to make, has a low-value addition nature. Also, most nuclear energy projects are large-scale with highly regulated research and development, making them costly. The report continues to state that nuclear energy plants have the potential to level their expenses in the long run. Economic values can be leveled with electricity generation from gas and coal (Balkan-Sahin, 2018). Upfront capital costs and the extended period for nuclear plant construction make them liable for rising interest rates. The increase in interest rates further prohibits more profitability because it attracts high overruns, extreme uncertainty, and substantial building delay.

Modern investors perceive investment in nuclear energy generation as a high-risk proposition more than fossil fuel with its risk-adjusted cost. The consideration of investment opportunities often favors the consideration of alternatives to nuclear energy such as renewable energy. The US government subsidies in the form of an investor guarantee to stimulate investment in nuclear by $2 billion (Balkan-Sahin, 2018). Despite the support, the nation failed to receive vital interest towards the establishment of nuclear power plants. The leading perspectives and provisions in the economy also attest to the failure of atomic energy plants in attaining practical energy strategy and credit quality.

Additionally, the expansion of nuclear power plants to further develop a nation results in investment uncertainty. An example relates to India, where ten reactors cost more than 300% of the estimated costs. The estimated cost for the project was $5.7 billion, but the overall cost for the project totaled $17.7 billion (Cobos-Urbina, 2021). Finally, both policy and political reversal express concern regarding the investment in nuclear reactors.

**Nuclear Energy and its Impact on Climate Change**

The 21st century has witnessed a critical rise in the level of climate change. The greenhouse effects are warming the earth's surface, interfering with ecosystems, and endangering biodiversity. It is also interfering with the air cycle, which ensures a balance between carbon dioxide and oxygen. Carr, 2018, notes that even when some people think that climate change is a hoax, scientists agree that temperatures have risen over time. It has attracted the international community's attention, with many treaties such as the Kyoto Protocol and the Paris Agreement being put in place seeking to curtail carbon emission.

Lobby groups and other concerned nations have raised issues regarding fossil fuel use because it is the leading contributor to global warming. The call for the adoption of nuclear energy has also increased due to the impacts of carbon dioxide. Scientists estimate a need to stabilizing the quantities of carbon dioxide by reducing 500 parts per million (Francis, 2014). Finally, it calls for a reduction in greenhouse gas emissions by 50% before the end of the century. Due to its high carbon levels, the toxic nature of fossil fuels calls for altering policies on greenhouse gas emissions. If the current policies remain unchanged, total emission will likely rise from 9.7 to 36.7 Gigatons of carbon dioxide between 2000 and 2030 (Cobos-Urbina, 2021). The realization signifies an enormous increase of carbon dioxide by 110%. Such increases undermine the goals treaties and agreements such as the Kyoto Protocol, and Paris Agreements sought to establish. These efforts had the incentive of helping different nations reduce their overall emission of carbon. Existing international responses to climate change could recognize nuclear energy as one source of reducing carbon dioxide concentration in the atmosphere instead of calling only for the adoption of renewable sources of energy. Climate change interlinks with politics on many fonts such as economic impacts, taxation, commands, and control, making it harder for international bodies to make viable contributions to nuclear energy debates (Masur & Posner, 2015, p. 138).

The relevance of utilizing nuclear energy towards reducing carbon concentration lies in its clean emitting ability. According to the global report, installing a nuclear plant with a capacity ranging from 1072 GWe instead of an efficient coal electric plant can reduce carbon emission by 1 billion tonnes of carbon (C) every year (Buongiorno, Corradini, & Parsons, 2018, p. 46). Other studies show that nuclear energy contributes to reducing carbon emissions by facilitating more than 600 million (C) annually (Barnes & Barnes, 2018). Indeed, the illustration above puts nuclear energy at the forefront of the reduction of carbon emission. Other measures like increasing the efficiency of fossil fuels reduce carbon emissions by 30%. The research results in the United States reveal that a collection of methods like conservation, $50 per surcharge, including increased efficiency, resulting in a 22.5% reduction in carbon emission (Barnes & Barnes, 2018). The above revelation leads to the consideration of the reliable measures of reducing carbon concentration. It raises the question of whether conservation is cheaper than nuclear energy. Energy efficiency is the perfect solution to energy crises. However, in an imperfect world, economic developments are likely to superseded conservation efforts as demand for energy is predicted to increase in the future. Finally, despite the enactment of the Kyoto protocol in 1990, few nations fully implemented the agreement. When the Paris Agreement came along, it brought controversies with global leaders such as the US withdrawing and then resigning the agreement. It has become hard for countries to sacrifice their economic goals to reduce carbon pollution. This demonstrates how hard it would be for conservation efforts to meet its target to become the better option. Such difficulties continue to jeopardize successful steps taken towards ensuring a carbon-free atmosphere.

The European Union continues to include nuclear energy in its energy mix. There are a hundred and six nuclear reactors across thirteen European Union states. Fifty-seven non-EU countries produce an estimated fifteen to twenty percent of electricity in the region. France has over half those in the EU region. This widespread usage of nuclear energy helps in reducing climate change (European Parliament, 2018). This follows the rise in uncertainties and ineffectiveness resulting from carbon consumption in the atmosphere. The European Union has instituted measures to ensure payment to the member states to reduce carbon dioxide emissions (Schmid, 2015).

For this reason, Europe continues to champion the adoption of nuclear energy. With the European Atomic Energy Community in place, European Union is a common market in which peaceful development of atomic energy occurs. It encourages upgrades consistent with international best practices to minimize the likelihood of accidents (European Parliament, 2018). The United States also renewed its technology relating to the extraction of energy from renewable sources. Therefore, a standstill exists between the United States and the European Union because they call for renewable energy sources and nuclear power (Bae & Lee, 2019). However, both factions consider the need to have efficient energy, minimal carbon emissions, and sequestration options. Finally, both entities have reached a consensus towards penalizing high carbon emitters.

**Nuclear energy and its impacts on the environment**

Fossil fuel exploitation and usage is a primary anthropogenic source of pollution. Pollution and climate change are of major concern to environmentalists and conservatism. Seeing that conservation intertwines with how we derive our energy, nuclear energy can be an option. It can help cut emissions as carbon monoxide is not a by-product. Hydroelectricity and other renewable energies are land-hungry, leading to space conflicts between habitats, agriculture, and energy generation. Nuclear plants are not land-intensive and can be based on lands with no other use. Nuclear energy is clean, safe, and can be sustained in the long run. These aspects make it good for the environment. However, nuclear waste is radioactive with long-live isolation needs. This is comparable to the large amounts of greenhouse gases produced over a nuclear's full life cycle. In this sense, nuclear energy seems more hazardous to the environment. There are increased concerns that the harmful effects witnessed in the history of nuclear energy will have long-lasting effects on the environment. The spilled radioactive materials pollute the air, water, and soil, ending species, including humans (Brook & Bradshaw, 2014, p. 703).

**Challenges Involving Nuclear Energy**

Handling Unique Safety Requirements For Nuclear Energy

Fossil fuels have myriad pollution and health issues. When combusted, fossil fuels produce harmful gases as by-products. These gases affect health and contribute to environmental injustices and inequalities. Air pollution from fossil gases contributes to climate change (Perera, 2017, p. 16). Nuclear technology features even more dire and unique safety concerns. These include the radioactive waste that contaminates soil, water, and air. Breach of safety measures has adverse measures on the environment and human beings. The development of nuclear power involves different stages that call for extreme care. Moreover, the reactor core functioning and waste disposal stages pose a significant threat to safety.

The damage to a reactor core can potentially cause catastrophic damage to people within a radius of up to 50 miles. Such people would need relocation, and if exposed to radiation, they would be highly vulnerable to a myriad of diseases, including different types of cancers. The deadliest global nuclear accidents related to nuclear include the Fukushima incident, Chernobyl disaster, and the Three-Mile Island incident. Chernobyl killed many people as its toxic fumes poisoned the air and contaminated vegetation and water in its surroundings. Fukushima suffered meltdowns after a tsunami and earthquake (Brook & Bradshaw, 2014, p. 706). Although no one died from the incident, estimates indicate that at least a thousand or more deaths occurred relating to stress triggered by the incident. Much of Fukushima's radiation went into the Pacific ocean, but some still radiated to the nearby area. The Three Miles Island incident resulted from partial meltdowns arising from system malfunctions. Although radiation was only within the facility, the incident still led to public tensions (Francis, 2014). Other nuclear energy accidents ranging from minor to moderate also feature global nuclear accidents during the 1990s. Despite the establishment of technological advancement claims, these nuclear accidents continue to rise, with the latest accidents being recorded in the last decade.

# The recent accident occurred in Japan due to uranium leakage that pushed atmospheric levels by a factor of more than 20,000 times (Balkan-Sahin, 2018). Nuclear energy generation poses greater danger arising from the possibility of mishaps. The rise in the number of atomic reactor tanks further intensifies the case of more accidents. Also, the enacted technologies of Light Water Reactor remain unproven. Light Water Reactors are designed to cool plant reactors more efficiently than heavy water reactors. They are designed to accommodate a protection system that acts as a safety feature if emergency cooling is required. Finally, Generation iv reactors are still on the verge of undergoing tests before reaching the final stage of maturity and testing. These reactors are designed to optimize electricity generation and minimize total annualization system function to reduce costs (Buongiorno, Corradini, & Parsons, 2018, p. 7).

Another potential danger arises from the spent fuel located at the back of the reactor. The nuclear cycle results in the discharge of wastes that continue to exhibit radio activities for thousands of years. Reprocessing plants would recycle these spent fuels to release the high-level waste that presents a hazardous proposition. The spillage of any radioactive materials poses a great danger to the air, water, and soil. It can also release fumes, thereby causing widespread environmental and human damage.

**The danger of Increased Proliferation** **of Nuclear Weapons**

In addition to the massive problems nuclear plants pose, there are imminent concerns that derail the adoption of nuclear energy attributed to exploiting this energy to develop weaponry. The fear of nuclear weapon technology proliferation stems from their ability to cause mass destruction that will leave long-lasting impacts, such as in Hiroshima and Nagasaki. Hundreds of thousands died in these areas from the heat of a nuclear bomb and the radiation effects it had (Loewe & Mendelsohn, 1981, 664). The atomic fuel originating from reprocessing plants through closed cycles provides a more accessible route through which weapons development can occur. Reprocessing technology takes the lead in separating plutonium from spent fuel. It is then subjected to recycling through mixed oxides to generate pure plutonium that aids the manufacture of weapons (Yavuzaslan & Cetin, 2017). The global regime has failed to identify the ideal method of disposing of plutonium because excess stockpile becomes visible in areas closer to nuclear energy tanks.

The disposal of nuclear waste continues to pose a significant threat because of the likelihood of diversion to weaponry. Fissile material wastes can be fissioned by thermal neutrons, making them possible means towards weapons development. The rise in the number of power plants results in a subsequent increase in waste materials. These wastes become transported in the water, on land, and through the air. The transporters can likely divert the waste transportation towards developing weapons of mass destruction (Gabbar, Abdussami, & Adham, 2020). The commercialization of fast reactors and the increased need for fabrication and reprocessing of the plutonium mixer in the Mixed Oxide Fuel (MOX) fuel can directly utilize weapons manufacture (Schmid, 2015). Indeed, nuclear proliferation has emerged as the leading complex challenge in the global energy sector (Barnes & Barnes, 2018). Various Nonproliferation Treaties (NPT) provision calls for the development of nuclear fuel cycles. The treaty grants them responsibilities that allow particular disposal of the plutonium proceeds. The challenge regarding the proliferation of nuclear weapons continues to adversely impact the adoption of nuclear energy because it presents security challenges. Waste from nuclear power has the potential of harming a more significant percentage of global economies.

**Public Opinion Towards Nuclear Industry**

Apart from concerns about plutonium proliferation, other problems hindering large-scale nuclear energy adoption describe public sentiments. The outcry arising from historic disastrous accidents in Fukushima, Chernobyl, and Mile island reduced nuclear power exploitation. More countries are considering investing heavily in renewable sources. These incidents justify the industry's slump (Francis, 2014). Public opinions differ from nation to nation, but the underlying factor pertains to the historical outcome of the nuclear sector. High costs of installing and maintaining nuclear plants and technology prevent many nations from exploring nuclear energy. Even those that can afford it are split on whether the investments are worth it in the short run and how to counteract waste management challenges.

Additionally, there is little public awareness of factful information about nuclear energy. Therefore, most opinions are based on information derived from political propaganda and unreliable sources. The general public's leading sentiments relate to the security and safety of nuclear energy. Future problems likely to arise through nuclear involve safety, the proliferation of nuclear weapons, security, and lack of support. Despite the adoption of modern technology and improved safety measures, the public opinion focuses on the adverse events in the past (Schmid, 2015). They fear the reoccurrence of similar events, thereby withhold their support for the development of nuclear energy. There is a dire lack of awareness of nuclear energy among the public in developing nations. This is despite signs of revival of nuclear energy among developed nations, including the United States. This support for atomic exploitation stems from the government's high spending to generate energy and increase nuclear energy's estimated benefits and outcome.

**The Security Nuclear Energy Offers**

Globalization coupled with increased development exerts pressure on the world's supply of finite energy sources. The global economy needs a predictable and abundant energy source to spur economic growth. An increase in global energy demands is likely to increase fossil fuel prices. These nonrenewable sources are bound to become scarce, and even when available, their exploitation and environmental impacts may become too costly. This will expose global economies to vulnerabilities and disruptions (Barnes & Barnes, 2018). Nuclear energy is favorable compared with fossil fuel on the subject of energy security. Nuclear energy can be made more abundant, and its distribution made even. Also, nuclear energy attains its benefit from the higher density than fossil and its close objectives. Critical advantages surround nuclear power; they include competitiveness, less burden on the state, reduced carbon emissions; thereby, it can help meet carbon restraints and higher density than competitors. However, nuclear energy poses massive threats should an accident occur, which is a primary reason hampering its enactment and exploitation even by the leading global economies.

**Conclusion**

Future adoption of nuclear energy continues to experience mixed reactions due to its numerous advantages and challenges. The main challenges include nuclear energy being a high resource burden. Every aspect of nuclear energy, including its inspection and licensing, is costly. Antiproliferation camps have also used historical accidents such as Chernobyl and Fukushima to argue that nuclear energy is unsafe. Not even the most stringent safety measures can contain the adverse effects such accidents pose. Environmentalists point out the devastating impacts radioactive waste would have on the air, soil, water, ecosystems, and biodiversity. There are also concerns about the weaponization of nuclear energy. The scope of proliferation, insecurity arising from nuclear energy, and negative public perception hinders adequate investment. However, notable European nations such as France and Russia have successfully used nuclear energy for decades. This success sets precedence for others to follow. Countries are increasingly perceiving energy security as a core pillar of economic development. Proponents of nuclear energy adoption argue that it reduces global warming by reducing carbon dioxide and other greenhouse gases. With the rise in global warming and increased carbon content in the atmosphere, there is a dire need to adopt measures to reduce pollution to the atmosphere. Nuclear energy comes in handy because it does not produce carbon content in any way. The contention continues to rage between adopting renewable energy sources or nuclear power as an alternative to fossil fuel. How this plays out will depend on technological advancement supporting each energy sector. Future energy needs will also shape and whether public awareness of nuclear energy can improve. Despite the advantages associated with acquisitions and utilization of atomic energy, there is a need for further examination regarding safety and security to make future projections possible.

**Bibliography**

Bae, S., & Lee, Y. (2019). Collaboration and Confucian Reflexivity in Local Energy Governance: The Case of Seoul's One Less Nuclear Power Plant Initiatives 1. *Journal of Contemporary Eastern Asia*, *18*(1), 153-174.

Balkan-Sahin, S. (2018). Nuclear energy as a hegemonic discourse in Turkey. *Journal of Balkan and Near Eastern Studies*, *21*(4), 443-461. doi:10.1080/19448953.2018.1506282

Barnes, P. M., & Barnes, I. (2018). *The politics of nuclear energy in the European Union: Framing the discourse: Actors, positions, and dynamics*. Toronto: Verlag Barbara Budrich.

Blasio, N., & Nephew, R. (2018). Renewing nuclear power and technology. *Geopolitics, History, and International Relations*, *10*(1), 119. doi:10.22381/ghir10120186

Brook, B. W., & Bradshaw, C. J. (2014). Key role for nuclear energy in global biodiversity conservation. *Conservation Biology*, *29*(3), 702-712. doi:10.1111/cobi.12433

Carr, P. H. (2018). The Wicked Problem of Climate Change. *Joint Publication Board of Zygon*, *53*(2), 443-461.

Cobos-Urbina, E. (2021). Social media: Useful for high-risk industries? A study of nuclear energy in Spain. *Communication & Society*, *34*(1), 143-154. doi:10.15581/003.34.1.143-154

Copeland, L., & Lamm, L. (1973). *The World's Great Speeches*. New York: Dover Publications.

C2ES. (2020, April 27). Renewable energy. Retrieved from https://www.c2es.org/content/renewable-energy/

European Parliament. (2018). Nuclear energy. Retrieved from https://www.europarl.europa.eu/factsheets/en/sheet/62/nuclear-energy

Francis, C. (2014). *Nuclear Energy, Facility Siting, and Waste Storage: Public Attitudes and Preferences* (1st ed.). New York: Nova Science Publishers.

Froggatt, A., & Schneider, M. (2015). Nuclear power versus renewable energy—A trend analysis [Point of view]. *Proceedings of the IEEE*, *103*(4), 487-490. doi:10.1109/jproc.2015.2414485

Gabbar, H., Abdussami, M. R., & Adham, M. I. (2020). Techno-economic evaluation of interconnected nuclear-renewable micro-hybrid energy systems with combined heat and power. *Energies*, *13*(7), 1642. doi:10.3390/en13071642

Hore-Lacy, I. (2010). *Nuclear energy in the 21st century: The world nuclear University primer* (1st ed.). Massachusetts: Academic Press.

Helm, D. (2017). *Burn out: The endgame for fossil fuels* (1st ed.). London: Yale University Press.

Külahcı, F., & Bilici, A. (2019). undefined. *Journal of Radioanalytical and Nuclear Chemistry*, *321*(1), 1-30. doi:10.1007/s10967-019-06559-w

Lavoy, P. (2020). The enduring effects of atoms for peace. Retrieved from https://www.armscontrol.org/act/2003\_12/Lavoy

Loewe, W. E., & Mendelsohn, E. (1981). Revised dose estimates at Hiroshima and Nagasaki. *Health physics*, *41*(4), 663-666.

Medhaug, I., Stolpe, M. B., Fischer, E. M., & Knutti, R. (2017). Reconciling controversies about the 'global warming hiatus.' *Nature*, *545*(7652), 41-47. doi:10.1038/nature22315

NASA Global Climate Change. (2020, 9). Global surface temperature | NASA global climate change. Retrieved from https://climate.nasa.gov/vital-signs/global-temperature/

Prăvălie, R., & Bandoc, G. (2018). Nuclear energy: Between global electricity demand, worldwide decarbonization imperativeness, and planetary environmental implications. *Journal of Environmental Management*, *209*, 81-92. DOI: 10.1016/j.jenvman.2017.12.043

Schmid, S. D. (2015). *Producing power: The Pre-Chernobyl history of the Soviet nuclear industry* (10th ed.). London: MIT Press.

Siqueira, D. S., De Almeida Meystre, J., Hilário, M. Q., Rocha, D. H., Menon, G. J., & Da Silva, R. J. (2018). Current perspectives on nuclear energy as a global climate change mitigation option. *Mitigation and Adaptation Strategies for Global Change*, *24*(5), 749-777. doi:10.1007/s11027-018-9829-5

Yavuzaslan, K., & Cetin, M. (2017). Is the Nuclear Unrivaled or Solution?: The Case of Turkey. *International Journal of Economic Perspectives*, *11*(1).