



## Model of Nuclear Energy Policy as An Alternative Energy in Supporting National Defence

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#### ABSTRACT

*This literature review article discusses the nuclear energy policy model as an alternative energy to support national defence. Nuclear energy has great potential as an energy source that can reduce dependence on fossil fuels whose availability is increasingly scarce. However, the use of nuclear energy also has risks that must be managed properly, such as nuclear accidents and the risk of terrorism. Several countries have developed their nuclear energy programs with the aim of meeting domestic energy needs and also as a national defence strategy. However, the development of this nuclear energy program also poses challenges in terms of security and safety. This article discusses the nuclear energy policy model that has been implemented in countries such as the United States, Russia, France, and Japan. In addition, this article also discusses the role of international institutions such as the International Atomic Energy Agency in overseeing nuclear energy programs and ensuring the security and safety of their use. This article also mentions several critical issues related to the use of nuclear energy, such as nuclear waste management, accident risks, and potential terrorism risks. Therefore, the development of a nuclear energy program must be carried out carefully and must pay attention to security, safety, and environmental aspects. In conclusion, the nuclear energy policy model must consider all related aspects, including technical, economic, social, political, and environmental aspects. In this case, the role of international institutions such as the IAEA is very important in ensuring the safe use of nuclear energy and in accordance with international standards.*

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### INTRODUCTION

Energy is a very important resource for every country. Without energy, production and consumption activities will be hampered and have an impact on the progress of a country. Therefore, every country needs to find a safe, reliable, and sustainable energy source. One of the alternative energy sources currently being developed by several countries is nuclear energy. Energy is very important to support daily life and to drive human and economic development. In 2019, globally, more than 26,000 TW/h of electricity was generated from various energy sources, - fossil

fuels, nuclear power, and renewable energy such as solar, water, and wind. Energy production and use are the largest sources of greenhouse gas emissions and causes of global warming worldwide. Global Warming, also called Climate Change, is one of the most difficult problems facing the world today. The Intergovernmental Panel on Climate Change (IPCC) has defined global warming as the combined increase in land, air, and sea surface temperatures, averaged over a 30-year period (Mathew, 2022) .

China's coastal areas are far from coal and gas producing areas, while the rapid economic development in these areas increases energy scarcity. Thus, there is a need and urgency to develop nuclear energy. In addition, these areas have rich and suitable manufacturing locations that make nuclear energy practical. The pace of nuclear power plant development to build the "three pillars" of hydroelectric power plants, nuclear power plants, and coal-fired power plants is beneficial in maintaining economic growth while reducing emissions (Peng et al., 2019) . The nuclear energy policy model as an alternative energy in supporting national defence needs to be considered by every country that wants to strengthen its national defence. This is because nuclear energy has several advantages compared to other conventional energy sources, such as fossil fuels and renewable energy.

One of the advantages of nuclear energy is its very high energy efficiency. In one nuclear reactor, it can produce the same energy as a hydroelectric power plant that requires a much larger land area. In addition, nuclear energy is also more environmentally friendly compared to fossil fuels, because it does not produce greenhouse gas emissions that are harmful to the environment. Nuclear energy is released from the nucleus, the core of an atom, which consists of protons and neutrons. Nuclear energy can be produced in two ways: nuclear fission when a heavy atomic nucleus splits into several parts, or nuclear fusion when two light nuclei from different atoms merge into one (Mathew, 2022) . Nuclear energy has received full attention from policymakers around the world, considering that it has a huge scope in reducing environmental degradation while maintaining a constant economic growth rate (Jahanger et al., 2023) . The results of previous studies showed that Based on an online questionnaire survey (valid sample of 933) conducted in China, the results showed that perspective taking was positively and significantly related to energy policy involvement. Energy policy involvement is positively and significantly related to trust in government and perceived benefits, while negatively and significantly related to perceived risks. Trust in government and perceived benefits are positively related, while perceived risks are negatively and significantly related to public acceptance of nuclear energy (Wang, Gu, & Wu, 2020) .

Nuclear energy also has the potential to increase a country's energy independence. In this case, the country can utilize its natural resources to build nuclear energy infrastructure, so that it does not depend on external energy sources. This will increase a country's energy security. However, the development of nuclear energy also has several challenges that need to be overcome. One of the biggest challenges is the issue of security and safety. The construction of nuclear reactors must meet high safety standards to prevent nuclear accidents that are dangerous to the environment and human health. The multilateral intergovernmental organization of the International Framework for Nuclear Energy Cooperation is expanding the peaceful uses of nuclear energy in a safe, efficient and reliable manner to ensure nuclear non-proliferation and nuclear security. The Permanent Working Group of IFNEC promotes the development of advanced nuclear energy and small modular reactors (SMRs), and actively promotes related seminars on the development and deployment of nuclear energy (Zhan, Bo, Lin, & Fan, 2021) .

In our current work, we expand on certain aspects of our project from 2013, which is the climate mitigation potential of various nuclear energy growth scenarios and estimate how much CO<sub>2</sub> emissions could be saved by the use of nuclear power in the near to medium future (up to 2040). We then look at the uranium resources needed and look at new nuclear technologies that promise better use of uranium (Muellner et al., 2021) .

In addition, the development of nuclear energy also has the potential to increase the risk of spreading nuclear weapons. Therefore, every country that wants to build nuclear energy infrastructure must comply with international regulations and standards set by the International Atomic Energy Agency (IAEA). The nuclear energy policy model must also consider economic aspects. The development of nuclear energy infrastructure requires large investments and high operating costs. Therefore, every country must ensure that the development of nuclear energy can provide significant economic benefits to the country. The current contribution of nuclear energy to climate change mitigation is small and, according to current planning, will remain at this level in the near to medium future. The nuclear expansion strategy is not feasible due to resource constraints. New nuclear technologies without such constraints will not be ready in the critical time frame of 2020 to 2050 due to the long research, licensing, planning and construction times of the nuclear industry (Muellner et al., 2021) . Previous research results showed that The results showed that CI decreased in the range of 43%-53% compared to 2005 considering five economic growth conditions in 2020. Furthermore, Fujian will achieve the national goal earlier because EC is controlled and the nuclear energy ratio increases to 16.4% (the proportion of non-fossil fuels in primary energy is 26.7%). Finally, the development of nuclear energy in China and the world is analyzed, and some policies for energy optimization and CI reduction are proposed (Peng et al., 2019) .

The phenomenon of global warming emerged from the issue of climate change that attracted the attention of intellectuals towards clean energy sources from dirty energy sources. However, the role of nuclear energy in reducing pollution emissions remains inconclusive and demands further investigation. Therefore, this study contributes to expanding the knowledge by investigating the relationship between nuclear energy, economic growth, and CO<sub>2</sub> emissions in the context of a developing country like Pakistan for the period between 1973 and 2017. The autoregressive distributive lag model summarizes that nuclear energy has a negative effect on environmental pollution because it releases carbon emissions into the environment. In addition, the Granger causality vector error correction provides evidence of bidirectional causality between nuclear energy and carbon emissions (Mahmood, Danish, Wang, & Zhang, 2020) . However, nuclear energy policy is not only related to the development of nuclear infrastructure and technology but also related to broader national energy policies. Previous studies have analyzed the theoretical relationship between nuclear energy and carbon dioxide emissions regarding territorial (or production-based) emissions (Danish, Ulucak, & Erdogan, 2022) .

## **METHOD**

The research method used is the literature review method on the nuclear energy policy model as an alternative energy in supporting national defence. The search was conducted on the Google Scholar site by entering the phrase "nuclear energy and nuclear energy" which is then assessed using critical appraisal analysis. There are 10 literature journals that discuss the nuclear energy policy model as an alternative energy in supporting national defence. All of these publications are international journals and national journals.

## RESULT AND DISCUSSION

### Results

By using the literature review method on the nuclear energy policy model as an alternative energy in supporting national defence. The search was conducted on the Google Scholar site by entering the phrase "nuclear energy and nuclear energy" which is then assessed using critical appraisal analysis. There are 10 literature journals that discuss the nuclear energy policy model as an alternative energy in supporting national defence. All of these publications are international journals and national journals. Below is a table of analysis of 5 journals, namely:

In a study by Bohuang Pan and colleagues in 2022, the effect of nuclear energy consumption on carbon emissions in major nuclear energy-using countries was analyzed. Through a quantile causality approach, the study found that in most quantiles, nuclear energy use contributed to reducing environmental degradation in countries such as the US, France, and Germany. However, in Spain and China, nuclear energy consumption was indicated to increase environmental degradation. The study also revealed a reciprocal relationship between nuclear energy and CO<sub>2</sub> emissions.

In a 2021 study by Cody Yu-Ling Hsiao and colleagues, it was found that the Fukushima nuclear accident had a significant impact on the global nuclear energy market. The study also looked at the impact of nuclear expansion in Korea, and found that nuclear phase-outs in Germany, Korea, and France had a smaller impact. The study emphasizes the importance of considering nonlinear, rather than linear, dependencies in nuclear energy market risk analysis, highlighting the importance of understanding asymmetric and extreme dependencies.

Neumann Anne and colleagues in a 2020 study explored the relationship between the quality of democracy and the adoption of nuclear power in 166 countries. The results showed that countries with nuclear weapons tended to continue using nuclear power. The study highlights an often-overlooked aspect of politics and democracy in public policy debates on nuclear energy, beyond energy and environmental issues.

In a study conducted by Sigit Santosa and colleagues in 2021, they developed a self-managed concept for nuclear energy development in West Kalimantan, Indonesia. This concept emphasizes the integration of accessibility and acceptability through cross-sectoral management coordination between the central and regional governments. This includes the involvement of local communities from the beginning of planning and affordability in the creation of technical designs by BATAN, using Small Modular Reactor (SMR) technology for the construction of commercial-scale nuclear power plants, considering local resources. Ahmad Saifudin Bukhari in his 2021 research revealed the dominance of Rosatom, a Russian state-owned company, in the global nuclear energy market. With the support of the Russian government, Rosatom has succeeded in strengthening Russia's economy and international political influence through nuclear energy exports.

Pami Aalto and team in 2017 examined Russia's nuclear energy diplomacy in Finland and Hungary. They identified three main interests: energy business, Russian economic modernization, and foreign policy, highlighting the interconnectedness of nuclear energy and foreign policy as well as Russia's adaptation to structural constraints in the target countries.

Diana Silva Siqueira and colleagues conducted a systematic review of nuclear energy as a climate change mitigation strategy in 2019. They analyzed the potential for CO<sub>2</sub> emission

reductions through the replacement of coal-fired power plants with nuclear power. Felix A. Ishola and team explored the potential for sustainable nuclear energy in Nigeria in 2019. Through a SWOT analysis, they found that nuclear energy could be utilized in Nigeria by adhering to global best practices.

Ruslan in 2020 analyzed the status of the use of new renewable energy and nuclear in the national energy mix. The findings showed that until 2019, the target for the use of new renewable energy and power plants had not been achieved. Policies and their implementation need to be improved to achieve the 2025 and 2050 goals. Nuclear energy is projected as a post-2030 solution for energy needs and reducing greenhouse gas emissions.

Ismawati Septiningsih and colleagues in 2021 studied the potential of smart electricity-based nuclear power in Indonesia. They found that the use of nuclear power is still limited, recommending strategies to increase its use in achieving energy sovereignty.

## **Discussion**

Nuclear energy as an alternative energy has become a hot topic in recent years. Many countries around the world are considering developing nuclear energy policies as part of their national defence strategies. However, the use of nuclear energy also has risks and challenges that must be overcome. Nuclear energy is an energy source that comes from nuclear reactions that occur in the atomic nucleus. Nuclear energy has advantages in terms of capacity and efficiency, making it an attractive alternative to increasingly scarce fossil energy sources. The nuclear energy policy model includes several aspects, such as regulation and supervision, radioactive waste management, and increased security in the use of nuclear energy. Strict regulation and supervision are needed to avoid potential accidents or terrorist attacks that could threaten national security. Nuclear power, as one of the alternative energies produced to meet electricity needs, is a real effort to minimize dependence on fossil energy which is the main energy source used to meet human electricity needs (Septiningsih, Kurniawan, & Pratama, 2020). The results of the study show that the results of the QQ estimator revealed that in most quantiles, nuclear energy contributed to environmental degradation in the US, France, Russia, South Korea, Canada, Ukraine, Germany, and Sweden. In contrast, feedback from Spain and China revealed that Nuclear Energy Consumption (NUC) contributed to environmental degradation. In addition, the results of the causality test revealed that nuclear energy and CO<sub>2</sub> emissions can predict each other in most quantiles (Pan, Adebayo, Ibrahim, & Al-Faryan, 2022). Another threat to the security and safety of Nuclear Energy in Nigeria may be from the nature of discord as evidenced by tribal, political, and religious differences. Some secret cabals have a tendency to engage in illegal activities that can compromise safety practices in line with the International Nuclear Energy Standards to make themselves stronger and/or to enrich themselves (Ishola et al., 2019).

Countries have different policies regarding access to nuclear technology and its use. Some countries have developed thriving nuclear programs, while others have chosen not to have a nuclear program at all. Nuclear programs can have multiple purposes, such as electricity generation, nuclear technology research and development, or nuclear weapons development. Countries that develop nuclear weapons must comply with regulations set by the International Atomic Energy Agency (IAEA) and the nuclear non-proliferation treaty (NPT) designed to prevent the spread of nuclear weapons to other countries. Safe and responsible use of nuclear technology is a major concern for countries with nuclear programs. Previous research results showed that empirical results show that the Fukushima nuclear accident had the most significant

impact on the global nuclear energy market, followed by Korea's nuclear expansion, while the nuclear phase-out policies of Germany, Korea, and France had the smallest contagion. The nonlinear dependence test detected more evidence of contagion than the linear dependence test, indicating that asymmetric and extreme dependence are important dimensions for measuring risk contagion in the nuclear energy market (Hsiao, Ou, Sheng, & Wei, 2021). Nuclear technology can provide great benefits in various fields, such as health, agriculture, and energy, but it also has significant risks if not managed properly. Therefore, it is important for countries to comply with international regulations and standards set for the use of nuclear technology.

According to Government Regulation 14 of 2015, the National Industrial Development Master Plan (RIPIN) 2015-2035, energy scarcity has begun to be felt, and to ensure the sustainability of industrial development, energy saving and diversification policies are needed, as well as greater attention to the development of renewable energy sources and cheap and safe nuclear energy (Ruslan, 2021). The nuclear energy policy as an alternative energy in supporting national defence in Indonesia must be considered carefully, considering the nature of nuclear which has the potential for major risks and impacts on the environment and humans if an accident or misuse occurs. However, if this policy is implemented properly and follows strict safety standards, nuclear energy can provide great benefits for Indonesia in facing national defence challenges. Some of the potential benefits of nuclear energy in Indonesia are as follows:

1. Energy independence, namely nuclear energy, can provide a more independent energy source for Indonesia, so that the country does not depend on importing energy sources from other countries which can be a risk in a crisis situation.
2. Reducing carbon emissions, namely nuclear energy can reduce greenhouse gas emissions resulting from the combustion of fossil fuels, which are the main source of air pollution and global warming.
3. Improving national security, namely nuclear energy can be used for national interests such as in the manufacture of nuclear weapons, and can help improve the country's defence system, such as border surveillance and weather and weather monitoring.

Previous research results indicate that the Republic of Indonesia has a lot of potential for new renewable energy, such as geothermal, water energy, wind energy, bioenergy (bioethanol, biodiesel, biomass), ocean current energy, nuclear energy, and solar energy, all of which can be applied or used in almost every country. region of the country. In order to be able to utilize this new renewable energy potential on a small scale, public awareness of the potential for this new renewable energy is needed, so that awareness of environmental protection can be increased and contributions to sustainable development can be made. support national energy (Hakim, 2020). Other research results also show that individuals and corporations can face criminal penalties in nuclear accidents involving the environment based on the PPLH Law. Due to the uncertainty of corporate criminality in the PPLH Law, the Regulation of the Supreme Court of the Republic of Indonesia Number 13 of 2016 concerning the Process of Handling Criminal Acts by Corporations regulates the handling of these corporations. In terms of punishing the use of nuclear weapons that have an impact on the environment, its nature is *ultimum remedium*, or as a last resort (Tolang, Jivisina Kotan, & Tety Nahak, 2020).

Several things need to be considered in nuclear energy policy in Indonesia. First, Indonesia must ensure that the infrastructure and technology needed to manage nuclear energy are available and well managed. Second, Indonesia must ensure that the workforce involved in the nuclear

industry is well trained and understands the risks and their responsibilities in maintaining safety and security. Third, Indonesia must collaborate with other countries to obtain technology and experience in managing nuclear energy. In making decisions about nuclear energy policy, Indonesia must consider all aspects related to security, environment, health, and long-term benefits for the country. The Indonesian government must also communicate openly and transparently with the public and educate them about the benefits and risks of nuclear energy so that the public can understand and support this policy. Our results show that countries with at least one nuclear warhead are more likely to continue using nuclear power than not using nuclear power at all. We discuss these results in the context of the public policy debate on nuclear power, but beyond energy and environmental issues that address the neglected political and democratic dimensions related to nuclear power (Neumann, Sorge, von Hirschhausen, & Wealer, 2020). According to Aalto, Nyysönen, Kojo, & Pal (2017) Russia has abundant energy resources that attract interest from various foreign governments and companies, allowing Russia to conduct active energy diplomacy. We use a structuration approach to examine in more detail how Russian actors seek to leverage their considerable assets in the nuclear energy sector. However, our analysis emphasizes that Russia's nuclear energy diplomacy must serve multiple interests simultaneously while accessing foreign markets in target countries.

Radioactive waste management is also an important aspect of nuclear energy policy. Radioactive waste must be managed in a safe and effective manner, so that it does not endanger human health and the environment. Improving safety in the use of nuclear energy must also be a focus of nuclear energy policy. This includes the development of safer technologies and the use of more stable fuels. The development of nuclear energy as an alternative energy source can provide several benefits for national security, such as reducing dependence on imported energy sources and reducing carbon emissions. The development of nuclear energy also faces several challenges, such as high costs, risk of accidents, and safety issues in the management of radioactive waste. Nuclear energy has great potential as an alternative energy source because it can produce large and stable amounts of energy. In addition, nuclear energy is also considered an environmentally friendly energy source and does not produce greenhouse gas emissions. The results of previous studies show that the concept of self-management is obtained by integrating aspects, namely (1) Accessibility and Acceptability in the form of priorities for improving the top-down and bottom-up cross-sectoral coordination management system, namely the central and regional governments in the construction of nuclear power plants with the involvement of local communities from the beginning of planning; (2) The affordability of BATAN's technical design with SMR (Small Modular Reactor) technology in the construction of commercial-scale nuclear power plants is reviewed from the availability of local resources as nuclear raw materials (Santosa, Khotimah, Andani, & Kumaraningrum, 2021).

Prävalie and Bandoc in Aalto et al., (2017) present a review of how nuclear energy can contribute energetically, climate-wise and environmentally to low-carbon energy generation. The article reinforces the strategic use of nuclear power in a number of countries and the importance of clean energy generation but focuses on the generation issues and risks associated with nuclear waste. The use of nuclear energy in supporting national defence is mainly related to the development of nuclear technology for military purposes. Nuclear energy is also used in other applications such as the development and testing of nuclear weapons. The safety of nuclear energy is an important factor in its development and use. The nuclear energy policy model must consider

this safety aspect and ensure that the use of nuclear energy is carried out in a safe and responsible manner. Nuclear energy also has risks that cannot be ignored such as nuclear accidents and disasters that can have a major impact on the environment and human health. The nuclear energy policy model must take these risks into account and take appropriate measures to prevent nuclear disasters. The government plays an important role in the development and use of nuclear energy. The nuclear energy policy model must ensure that the government is responsible for overseeing and regulating the use of nuclear energy. Previous research results show that the findings of this analysis indicate that Rosatom, with the influence and support of the Russian government, can dominate the world's nuclear energy market. Rosatom is a state-owned company founded by Russia with the aim of maximizing revenues from nuclear energy exports to improve the country's economy and international political power (Bukhari, 2021).

## CONCLUSION

Based on the description above, it can be concluded that the development of nuclear energy as an alternative energy source can support national defence. However, this development must be carried out carefully and pay attention to safety and security aspects, both in terms of technology and policy. In addition, there also needs to be an effort to educate the public about nuclear energy so that they understand the benefits and risks of its use. In the long term, the development of nuclear energy can provide a positive contribution to national defence and also national economic development.

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