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The Peaceful uses of Nuclear Energy as a Means for Human Welfare: a Legal Analytical Study

[1]Abdulrahman Ahmad N. Alhathi, [2]Khalid Ali Y. Alshahrani and [3]Ali Muhammad Muhammad Al-Darwbi
[1,2]Assistant Professor in Privet Law, Department of Law, College of Business Administrative, Najran University, Najran, Kingdom of Saudi Arabia
[3]Phd (Law) from the Islamic University of Medina
[1]aaalharthe@nu.edu.sa, [2]kaalshahrani@nu.edu.sa and [3]Addaroobi27@gmail.com
[1]https://orcid.org/0009-0002-7180-3452, [2]https://orcid.org/0009-0004-5925-4141 and
[3]https://orcid.org/0000-0002-2953-8846

Abstract: *Using a legal-analytical approach, this study explores the peaceful uses of nuclear energy as a means to promote human welfare. The study addresses both the primary and secondary applications of nuclear energy and their impact on the well-being and prosperity of humanity. It demonstrates that nuclear energy has emerged as a strategic alternative for electricity generation, especially amid growing concerns over oil depletion. Moreover, it offers a sustainable solution to the energy crisis and fluctuations in energy prices. The use of nuclear energy may also serve as a comprehensive solution to various energy- and water-related challenges at both local and international levels.*

The study recommends that access to nuclear technology should be granted to all countries on an equal footing without monopolization. It emphasizes the importance of adherence to relevant international treaties, the implementation of the highest standards of nuclear safety and security, the protection of nuclear facilities, and the safe management of radioactive waste. The study also underscores the necessity of restricting nuclear energy use to supporting clean energy goals within the framework of sustainable development, including investment in research reactors for medical and agricultural purposes.

Keywords: *Nuclear Energy, peaceful use, electricity, International Atomic Energy.*

INTRODUCTION

Nuclear energy is considered a double-edged sword, as it can be a highly beneficial tool if used properly and for peaceful purposes—such as electricity generation and the advancement of medical and industrial fields. In such cases, it becomes a major source of welfare, scientific progress, and technological development, contributing to improved quality of life and meeting humanity's needs. However, its misuse or conversion into weapons can lead to major disasters that threaten global security and stability. Therefore, the optimal use of nuclear energy solely in peaceful fields is what makes it an effective means to drive progress and prosperity across various domains.

The development of a peaceful nuclear energy program has become a kind of national priority, not only as a significant energy source but also as a form of national pride—not just in major powers but also in developing countries (Hassan Mohamed, 2009).

This study addresses the issue of peaceful uses of nuclear energy and the extent to which such uses can be considered a means of enhancing human welfare, given the delicate balance between the advantages of its use and the severity of its risks. The study aims to explore the peaceful applications of nuclear energy, outline its primary types and benefits, and highlight its secondary uses and advantages.

RESEARCH METHODOLOGY

The research methodology centers on examining the peaceful uses of nuclear energy as a means of promoting human welfare, by employing a deep and comprehensive analytical approach within a legal framework.

This methodology facilitates a thorough analysis of all aspects related to the peaceful applications of nuclear energy. It also includes a comprehensive assessment of the extent to which nuclear energy and its various uses can be considered tools for enhancing human welfare.

PRIMARY USES OF NUCLEAR ENERGY

Nuclear energy is a double-edged sword; when employed for peaceful purposes, it becomes a tool for the welfare and advancement of humanity. Accordingly, the primary uses of nuclear energy lie in three main fields:

1. Nuclear Energy for Electricity Generation

Research focused on utilizing nuclear energy for electricity generation has received considerable attention from scholars, primarily due to the severe threat posed by the global energy crisis. Nuclear energy has thus become an indispensable and essential source for electricity production. This focus has also drawn significant interest within the framework of international regulation, as the right to peaceful use of nuclear energy was one of the key motivations for establishing the International Atomic Energy Agency (IAEA) and drafting its foundational statute. The Agency's mission is to promote and facilitate the research and use of nuclear energy for peaceful purposes (Ibrahim, 2011; Abu Nazel, 2019; Al-Ajmi, 2005).

Currently, there are **435 nuclear reactors in operation worldwide**, producing a combined energy output of **369 gigawatts**. Approximately thirty countries, especially wealthy ones due to the high capital investment required, have chosen to pursue this energy source. Nuclear power contributes to over 25% of global electricity production. Within the European Union, it supplies around 35% of energy needs, with France relying on nuclear energy for about 78% of its electricity—similar patterns are observed in Belgium, Hungary, Japan, South Korea, and Switzerland. Many other countries, both within and outside Europe, are considering nuclear energy as a future solution (Moon, n.d.; Nouri, 2017).

Despite widespread opposition to nuclear power, global trends suggest otherwise. *Time Magazine* reported on August 17, 2009, projections for new reactor construction by 2020: China planned **115** new reactors, France **2**, and India **38** (Owais, 2011).

In **Saudi Arabia**, following the launch of **Vision 2030** in 2016, two major initiatives were introduced: the **King Salman Renewable Energy Initiative** and the **National Nuclear Energy Program**, which began mid-2017. These initiatives aim to incorporate nuclear energy into the national energy mix to support sustainable development (Mansouri, 2020).

Many experts foresee a significant future shortage in electricity production due to global warming caused by human activities. They view nuclear energy as the most viable solution to mitigate this shortfall (Shaaban, Dioub, & Deeb, 2009).

2. Nuclear Energy for Water Desalination

Peaceful applications of nuclear energy have also supported water security through seawater desalination, groundwater source development, water conservation, and reducing wastage. Leading countries in nuclear-powered desalination include **Japan, South Korea, Russia, China, India**, and **Argentina**. However, expertise and implementation in this field are significantly less developed than in electricity production. This is mainly because industrialized nations have a greater demand for electricity than freshwater.

The largest desalination plant, with a capacity of 10 million gallons per day, was built in **South Korea**. Notably, a single nuclear power plant can simultaneously produce both electricity and freshwater. A recent French study proposed a nuclear facility capable of producing **100 million gallons of water daily** alongside **300 million megawatts of electricity**, estimating the cost of producing 1,000 gallons of water at **$1.80 USD**. UN experts predict these costs will decrease by two-thirds as designs improve (Naaman, 2021; National Documentation Center).

Desalination using nuclear power presents a logical solution for **Saudi Arabia**, which falls below the United Nations-defined water poverty line of 2,000 cubic meters per person annually. The Kingdom is currently the largest market for water desalination globally. Thus, nuclear energy could offer a sustainable resolution to Saudi Arabia's water needs (Mansouri, 2020).

3. Nuclear Energy for Naval Propulsion

Nuclear energy is also utilized in **naval propulsion**, particularly for **warships and submarines**. Since 1954, nuclear-powered engines have enabled submarines to remain submerged for extended periods—up to several months—and undertake long global voyages without needing to refuel at ports. The thermal energy from nuclear engines provides sufficient power to operate vessels of any size (Ramadan; Media Documentation Center; Ismail, 2000).

In light of the above, the use of nuclear energy as a fundamental and primary alternative for electricity generation represents a **strategic choice** that aligns with growing concerns over the depletion of oil resources, which remain the primary source of electricity production in many countries around the world. Relying on nuclear energy can offer a **sustainable and long-term solution** to the energy crisis, particularly in the face of significant fluctuations in oil prices and supply instability.

Moreover, the shift toward utilizing nuclear energy in **water desalination processes** constitutes an important step toward addressing the issue of water scarcity, which affects many arid and semi-arid regions. This approach can significantly contribute to ensuring an adequate supply of potable and irrigation water, thereby reducing the **economic and social pressures** caused by water shortages.

Additionally, the adoption of nuclear energy in these two critical areas could help mitigate **global concerns** related to energy and water security, as it provides a **stable and reliable source** in comparison to conventional resources, which face considerable long-term challenges. Consequently, the expansion of nuclear energy use may serve as a **comprehensive solution** to many of the **local and international challenges** associated with energy and water.

Secondary Uses of Nuclear Energy

The use of nuclear energy is not limited to electricity generation, water desalination, or naval propulsion. Rather, its applications extend across various vital sectors, including industry, agriculture, medicine, the environment, and many other fields. This section briefly outlines the most significant **secondary uses** of nuclear energy, in line with the nature and scope of the study. These uses span the following areas:

1. Nuclear Energy in Industry

Nuclear energy plays a vital role in industrial development. Fission energy and its byproducts—radiation and nuclear particles—serve two main functions in industry. First, they help increase industrial production by generating thermal energy, which is then converted into electricity. Second, they aid in overcoming developmental obstacles and manufacturing defects, thus improving the production process (Abu Al-Hassan & Nasir Al-Sir, 2017).

The applications of radioactive isotopes in industry are diverse and numerous. They are widely used in **quality control**, **detecting industrial defects**, **identifying impurities and rare elements**, **detecting smoke in factories, shops, and homes**, **precision measurements on industrial production lines**, and **enhancing product quality and characteristics**. Furthermore, nuclear energy supports various industries such as **textile manufacturing**, **wood processing**, **construction materials**, and the **pharmaceutical and food industries** (Atiyah & Hafez, 2005; Mohamed, 2009; Naaman, 2021).

2. Nuclear Energy in Agriculture

Radioactive isotopes are also employed extensively in agricultural and livestock research. They are used to study **plant adaptation** to specific climatic and soil conditions, track the **absorption of nutrients**, and assess actual plant needs for **water, fertilizers**, and **chemical elements**. They also help in **inducing genetic mutations in seeds**, **controlling pests and diseases**, and **enhancing animal health and livestock**

productivity. Advanced nuclear techniques such as **radiotracer labeling** are used to detect radioactive residues in food products, among other applications in the agricultural sector (Mohamed, 2009; Naaman, 2021; Abu Nazel, 2019; IAEA, 2021).

3. Nuclear Energy in Medicine

Many assume that the primary use of radioactive isotopes in medicine is limited to cancer treatment. However, only about **5% of all isotopes** are used for treating tumors, while around **15%** are applied in treating or preventing other diseases. The remaining **80%** are dedicated to **medical diagnostics**.

Key applications in the medical field include **diagnostic imaging using radioactive tracers**, **elemental analysis in the body**, **treatment of thyroid disorders and cancer**, **sterilization of medical tools**, and **preventive medicine**. Modern nuclear technologies have significantly contributed to enhancing overall public health (Abu Al-Hassan & Nasir Al-Sir, 2017; Mohamed, 2009; Al-Nimr, 2013; *Science Magazine*, 2000; IAEA, 2017).

4. Other Uses of Nuclear Energy

Nuclear energy also finds applications in **scientific research**, **geology**, **environmental protection**, **urban development**, **space exploration**, **criminal investigations**, **archaeological dating**, **mineral and groundwater exploration**, **wastewater treatment**, and **oil and water resource prospecting** (Al-Jazzar & Saqr, 2011; Mohamed, 2009; Arjoun, 1996; Mehran, 2002).

CONCLUSION

From the above, it is evident that **nuclear energy has gained tremendous significance** across a wide array of disciplines, making its acquisition a top national priority in many countries. This trend aligns closely with the ongoing scientific and technological advancements globally, along with the peaceful applications of nuclear energy.

Undoubtedly, possessing nuclear capabilities has become a **decisive factor** in achieving progress and prosperity. Nuclear energy is now central to critical sectors such as **medicine**, **industry**, and **agriculture**, with reliance on it growing day by day due to its numerous benefits and its capacity to meet the increasing global demand for energy.

Consequently, nations are diligently working to develop their nuclear programs in a way that ensures both their **developmental goals** and the **safe, peaceful utilization** of this advanced technology.

RESULTS

The findings of the study titled *"The Peaceful Uses of Nuclear Energy as a Means for Human Welfare: A Legal Analytical Study"* are summarized as follows:

1. **Energy acquisition has become a top national priority** in the modern era, and possessing nuclear energy has emerged as a decisive factor in achieving progress and prosperity.
2. **Nations are actively striving to develop their nuclear programs** in a manner that ensures the achievement of developmental goals while maintaining the safe and peaceful use of this advanced technology.
3. **Nuclear energy represents a strategic alternative to electricity**, especially amid growing concerns over the depletion of oil reserves. It also offers a sustainable solution to the energy crisis and fluctuating energy prices.
4. **The use of nuclear energy can serve as a comprehensive solution** to many of the challenges associated with energy and water security, both locally and globally.

RECOMMENDATIONS

Based on the findings of the study on the peaceful uses of nuclear energy as a means for human welfare, the following recommendations are proposed:

1. **All nations should have equal access to the benefits of nuclear energy**, and its use should not be

restricted to a limited group of countries.

2. **Adherence to international treaties**—particularly the **Convention on Nuclear Safety**, the **Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management**, and **liability conventions**—is essential.
3. **Implementation of the highest standards of nuclear safety and security**, including the protection of nuclear facilities and the safe management of radioactive waste, must be prioritized.
4. **The use of nuclear energy should be restricted to supporting sustainable development goals**, especially clean energy initiatives, and investments should be directed toward **research reactors** for medical and agricultural advancements.

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REFERENCES

1- Ibrahim, Mujahidi. (2011). The Position of International Law on the Harmful Uses of Nuclear Energy. Journal of Arab Research and Studies, Egypt, Issue (54).

2- Abu Al-Hassan, Yasser & Nasir Al-Sir, Nasir Al-Sir. (2017). Possession of Nuclear Energy: Achieved Gains and Imminent Risks. Sudan Journal, Issue (9).

3- Abu Nazel, Hani Maher Anas. (2019). Legal Protection of Nuclear and Radioactive Materials (PhD Dissertation, Faculty of Law, Alexandria University).

4- Ismail, Nagwa Riyad. (2000). International Liability for Damage Caused by the Operation of Nuclear Ships in Peacetime (PhD Dissertation, Faculty of Law, Zagazig University, Egypt).

5- Al-Jazzar, Abdel Hamid Helmy & Saqr, Mohamed Abdel Moneim. (2011). Atomic Radiation and Its Peaceful Applications. World of Knowledge, Kuwait, Issue (379).

6- Elbyaly, M. Y. H., & Elfeky, A. I. M. (2023). FLIPPED CLASSROOM: ENHANCING FASHION DESIGN SKILLS FOR HOME ECONOMICS STUDENTS. *learning*, *4*, 7.

7- Elfeky, A. I. M., & Elbyaly, M. Y. H. (2023). The impact of augmented reality technology on developing hand embroidery skills among students of the college of education. *Annals of Forest Research*, *66*(1), 1584-1594.

8- Elbyaly, M. Y. H., & Elfeky, A. I. M. (2023). THE EFFECTIVENESS OF EMPLOYING MOTIVATIONAL DESIGNED E-LEARNING SITUATIONS ON DEVELOPING ACHIEVEMENT IN COMPUTER SCIENCE CURRICULA FOR OPTIMAL INVESTMENT STUDENTS. *European Chemical Bulletin*, *12*, 6595-6602.

9- Elfeky, A. I. M., & Elbyaly, M. Y. H. (2023). THE IMPACT OF MOBILE LEARNING ON DEVELOPING THE SKILLS OF INTEGRATED SCIENCE OPERATIONS AMONG STUDENTS OF THE OPTIMUM INVESTMENT DIPLOMA. *European Chemical Bulletin*, *12*, 6629-6635.

10- Elfeky, A. I. M., & Elbyaly, M. Y. H. (2023). The Effect of Simulation Programs On Enhancing Skills of Digital Applications. *European Chemical Bulletin*, *12*, 6588-6594.

11- Elbyaly, M. Y. H., & Elfeky, A. I. M. (2023). The Effect Of A Simulation Program On Students At The College Of Education's Acquisition Of Hand Embroidery Skills. *European Chemical Bulletin*, *12*, 6575-6580.

12- Ramadan, Mohamed. (2013). The Peaceful Use of Nuclear Energy within the Framework of Public

International Law. Egyptian Journal of International Law, Issue (69).

13- Shaaban, Ismail, Dioub, Mohamed Moan, & Deeb, Louay Bahjat. (2009). Nuclear Energy and Its Effects on National Economies. Tishreen University Journal for Research and Scientific Studies, Economic and Legal Sciences Series, Vol. (31), Issue (1).

14- Al-Ajmi, Thaqal Saad. (2004). The Peaceful Use of Nuclear Energy and Rules of Public International Law. Al-Huqooq Journal, 2004: 142.

15- Arjoun, Mohamed Bahi Al-Din. (1996). Outer Space and Its Peaceful Uses. World of Knowledge, Kuwait, Issue (214).

16- Atiyah, Mamdouh Hamed & Hafez, Sahar Mostafa. (2005). Radiation Hazards Between Environment and Legal Legislation. Dar Al-Fikr Al-Arabi, Cairo, Egypt.

17- Owais, Mohamed Zaki. (2011). The Future of Arab Nuclear Energy and Arab Security. Egyptian General Book Organization, Cairo.

18- Science Magazine. (2000). Nuclear Technology, Issue (286).

19- Mohamed, Mohamed Hassan. (2009). Nuclear Energy and Its Peaceful Prospects in the Arab World. Emirates Center for Strategic Studies, Social Affairs, Issue (102), Year (26).

20- Mohamed, Naemat Mohamed Safwat. (2009). Effectiveness of International Protection from the Damage of the Peaceful Uses of Nuclear Energy (PhD Dissertation, Faculty of Law, Ain Shams University, Egypt).

21- National Media Documentation Center. (n.d.). GCC States' Trends Toward the Peaceful Use of Nuclear Energy. Saudi Arabia.

22- Mansouri, Nora. (2020). Commentary on the Saudi Nuclear Energy Project. King Abdullah Petroleum Studies and Research Center.

23- Mehran, Abu Bakr Tawfiq. (2002). Current and Future Radiation. Al-Ahram Center for Publishing, Translation and Distribution, Cairo.

24- Moon, Ludovic. (n.d.). Oil and Nuclear Energy: Present and Future. Translated by: Marc Abboud, Dar Al-Mu'allif.

25- Naaman, Mohamed Abdullah Mohamed. (2001). Guarantees for the Peaceful Use of Nuclear Energy: A Legal Study in Light of International Rules and Documents, Unpublished.

26- Al-Nimr, Abdul Rahman. (2013). Nuclear Medicine and the Unity of Science. Al-Arabi Scientific Journal, Issue (3).

27- Nouri, Abdel Rahman. (2017). The Peaceful Use of Nuclear Energy Between Sustainable Development and Nuclear Security. Journal of Scientific Research in Environmental Legislation, Algeria, Issue (9).

28- International Atomic Energy Agency (IAEA). (2017). Nuclear Techniques in Human Health (Prevention, Diagnosis, and Treatment). IAEA Journal, September.

29- International Atomic Energy Agency (IAEA). (2021). Review of Nuclear Technology 2021. Austria, September.