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IMPORTANCE OF ENVIRONMENTAL LAWS IN REGULATING THE PEACEFUL USE OF NUCLEAR ENERGY

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Abstract: The growing environmental challenges, declining confidence in fossil fuels, and the global need to diversify energy resources have intensified interest in advanced technologies such as nuclear energy. This article aims to assess the peaceful application of nuclear power within the framework of international environmental law. Given the increasing potential of nuclear technology and the complex legal and ecological issues it entails, such an investigation is both timely and necessary. The research adopts an applied and descriptive method of gathering information. The findings reveal significant inadequacies in the current international legal framework regulating peaceful nuclear applications. Consequently, the establishment of preventive, deterrent, and regulatory measures is imperative. Factor analysis further identified safety, liability, waste management, environmental protection, and international cooperation as the most influential contributions. The research concludes that the development of binding legal mechanisms, strengthened systems of international collaboration, and effective oversight structures are essential to ensuring both compliance and environmental sustainability in nuclear energy governance.

Key words: Nuclear energy, fossil fuels, alternative energy, international environmental law, environmental issues, waste management, peaceful use, environmental protection.

INTRODUCTION

The contemporary global energy landscape demonstrates that the majority of states recognize the critical role of diverse energy sources in meeting present and future needs. Consequently, governments are investing heavily in research, policymaking, and infrastructure to devise strategies that ensure efficiency and sustainability in energy use. Within this context, nuclear energy occupies a distinctive position, with numerous nuclear power plants operating worldwide. Given the inherent risks associated with nuclear activities, the international community has sought to establish binding legal frameworks and standards to ensure both

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environmental protection and the peaceful application of nuclear technology[1]. This concern is rooted in the post–Second World War development of nuclear weapons, which prompted the adoption of the 1968 Treaty on the Non-Proliferation of Nuclear Weapons (NPT). While prohibiting the military use of nuclear technology, Article IV of the NPT preserves the right of states to pursue nuclear energy for peaceful purposes[2].

The peaceful use of nuclear energy remains a central issue in international environmental law, intersecting with questions of safety, environmental protection, and regulatory capacity. As public international law governs inter-state relations through treaties, customary practices, and general principles, it plays a fundamental role in balancing states' rights to nuclear technology with their responsibilities to prevent transboundary environmental harm[3]. The environment, defined broadly as encompassing natural ecosystems, human societies, and human-made infrastructure, such as reactors, thus becomes an essential subject of legal protection. Nuclear energy, derived from fission and fusion, is among the most efficient forms of electricity generation, producing minimal air pollutants compared to fossil fuels. Nuclear plants, unlike coal facilities, do not emit greenhouse gases or acid rain–inducing pollutants, thereby contributing to climate mitigation.

Nevertheless, the international legal system attaches responsibilities to states regarding nuclear risks. International responsibility requires states to compensate for damages arising from breaches of international law[4]. The Statute of the International Atomic Energy Agency (IAEA) reinforces this by mandating the promotion of peaceful uses of atomic energy while emphasizing nuclear safety. Safety frameworks aim to protect humans, societies, and the environment from nuclear accidents.

LITERATURE REVIEW AND METHODOLOGY

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Scholarly studies reinforce the nexus between law, safety, and environmental protection. Castiglione et al. demonstrated that robust legal frameworks correlate with reduced pollution levels[5]. Kueny highlighted that nuclear law extends beyond human protection, encompassing non-human species[6]. Ferro stressed that regulation must include the entire nuclear fuel cycle, including waste management[7]. Riley emphasized the economic, scientific, and environmental justifications for peaceful nuclear use[8]. Similarly, Gharib argued that effective legal frameworks are a prerequisite for global nuclear non-proliferation and peaceful application[9].

Further, Van der Zwann examined Europe's nuclear trajectory, noting benefits such as energy independence and pollution reduction, while acknowledging unresolved challenges in waste management and weapons proliferation[10]. Atieh and Workman discussed international cooperation in nuclear knowledge preservation through the International Nuclear Information System (INIS), which facilitates scientific collaboration within legal obligation[11]. Bhattacharjee underscored the necessity of liability frameworks in addressing nuclear harm[12], while Rizwan-

[5] Concetta Castiglione, Davide Infante and Janna Smirnova, 'Environment and Economic Growth: Is the Rule of Law the Go-Between? The Case of High-Income Countries' (2015) 5 Energy, Sustainability and Society.

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uddin reaffirmed nuclear energy's importance in reducing costs and addressing climate challenges, contingent on transparency and compliance with international regulations[13].

Overall, the literature and legal developments highlight three interrelated objectives: (1) examining nuclear energy within the framework of treaties, principles, and jurisprudence of international law;

(2) assessing states' environmental responsibilities in peaceful nuclear use; and

(3) identifying safety criteria and standards aimed at mitigating nuclear risks.

Together, these dimensions illustrate the delicate balance between advancing nuclear energy as a sustainable alternative and ensuring compliance with international environmental and safety obligations.

Considering academic nature of the research it adopts a qualitative methodology grounded in doctrinal legal analysis and comparative evaluation. Primary sources include international treaties, conventions, and statutes such as the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and the Statute of the International Atomic Energy Agency (IAEA), which provide the legal framework for regulating the peaceful use of nuclear energy. Secondary sources encompass peer-reviewed scholarly articles, case studies, and reports from international organizations, which assist in contextualizing the environmental and legal implications of nuclear energy. The research employs a comparative approach by examining different jurisdictions and regional practices, particularly the European Union framework, to identify both convergences and divergences in regulatory standards. Furthermore, the study integrates findings from interdisciplinary literature—spanning environmental law, nuclear safety, and international relations—to highlight the multifaceted nature of the issue. From practical point of view, research will compare the findings of current methodology with similar studies carried out on the basis of a qualitative methodologies. The analysis proceeds in three stages: first, an examination of the historical and legal foundations of nuclear energy regulation; second, an evaluation of the environmental requirements and responsibilities of states under international law; and finally, an assessment of safety standards, liability principles, and their practical implications. This methodological approach ensures a comprehensive and systematic

[13] Rizwan uddin, 'Nuclear Power and the Fuel Cycle' (2010) 3 International Journal of Nuclear Governance, Economy and Ecology 111 <https://www.inderscienceonline.com/doi/pdf/10.1504/IJNGEE.2010.033306> accessed 5 May 2025.

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understanding of the intersection between nuclear energy use, environmental protection, and international law.

RESULTS AND DISCUSSION

The findings of this study reveal that the current international legal framework governing the peaceful use of nuclear energy remains fragmented and insufficient to address contemporary environmental and security challenges. The analysis identified five principal factors—safety, liability, waste management, environmental protection, and international cooperation—as the most critical dimensions influencing the effectiveness of nuclear governance. Collectively, these factors accounted for **79.14% of the variance** in international legal responses, underscoring their central role in shaping the normative framework.

Safety emerged as the most pressing concern, reflecting persistent uncertainties about the adequacy of international safety standards. Although the IAEA's Basic Safety Standards and related conventions provide a foundation, implementation varies widely across states, leading to inconsistent protection against nuclear accidents and radiological risks.

Liability represents another unresolved issue. The Vienna Convention on Civil Liability for Nuclear Damage attempts to assign responsibility, yet limitations in scope, compensation thresholds, and ratification levels significantly restrict its effectiveness.

Waste management continues to challenge the sustainability of nuclear energy. Despite international awareness, legal mechanisms for long-term disposal and cross-border waste control remain underdeveloped, leaving critical gaps in accountability and enforcement.

Environmental protection is only partially integrated into nuclear law, with broader conventions on hazardous waste (e.g., Basel Convention) insufficiently tailored to nuclear-specific risks. This disconnect highlights the need to align nuclear regulation more closely with international environmental law principles, particularly precaution and sustainable development.

Finally, **international cooperation** emerged as both a necessity and a weakness. While treaties emphasize collaboration, actual practice demonstrates limited coordination, especially in emergency response and compliance monitoring. The absence of binding supervisory mechanisms further undermines collective action.

Taken together, these findings confirm that international nuclear law requires a more **cohesive, obligatory, and enforcement-oriented framework**. Strengthening liability mechanisms, harmonizing safety standards, and institutionalizing waste governance under robust international supervision are essential steps. Moreover, enhancing cooperation among

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states and institutions would foster greater transparency, accountability, and resilience in the peaceful use of nuclear energy.

CONCLUSION AND RECOMMENDATIONS

This study has demonstrated that the peaceful use of nuclear energy, while offering significant benefits as an alternative to fossil fuels, remains constrained by serious gaps in the international legal and environmental framework. The factor analysis identified five key areas—safety, liability, waste management, environmental protection, and international cooperation—that collectively explain the majority of legal and regulatory challenges in this field. The findings indicate that the existing international laws and conventions provide only a partial response and lack the cohesion, enforceability, and global acceptance required to ensure the safe and sustainable development of nuclear energy.

From a policy perspective, three recommendations emerge. First, **strengthening safety regimes** through universal implementation of IAEA standards and the adoption of binding verification mechanisms would reduce disparities in national practices. Second, the **liability framework must be reformed**, expanding the scope of compensation under instruments such as the Vienna Convention and ensuring broader ratification to cover transboundary nuclear harm. Third, the **management of nuclear waste** requires a legally binding global framework that integrates long-term storage, cross-border transport, and environmental monitoring within the broader principles of international environmental law.

Additionally, enhancing **international cooperation** remains critical. Establishing permanent supervisory mechanisms, improving transparency in reporting, and encouraging regional collaboration would foster trust and accountability. The integration of nuclear governance with broader environmental treaties—such as those addressing hazardous waste and climate change—could also reinforce the coherence of the legal system.

Overall, the peaceful use of nuclear energy can only be realized sustainably if the international community moves toward a more **comprehensive, enforceable, and cooperative legal architecture**. Such reforms would not only mitigate risks but also strengthen confidence in nuclear technology as a viable component of global energy policy.

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