

PUBLIC OPINION AND SECURITY CHALLENGES OF NUCLEAR ENERGY: THE IMPACT OF AWARENESS, RISK PERCEPTION, AND POLICIES ON ACCEPTANCE IN SERBIA

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Abstract: Public opinion significantly shapes the development and acceptance of nuclear energy, particularly in countries like Serbia, where this technology is being reintroduced after a decades-long moratorium. This paper explores the interplay between public awareness, risk perception, and national policies in shaping the societal acceptance of nuclear energy. Drawing on theoretical frameworks from sociology, security studies, and communication science, the study investigates the factors influencing public attitudes and identifies key challenges to integrating nuclear energy into Serbia's energy strategy.

The research highlights the role of security concerns, including nuclear safety, nuclear security, and potential misuse of nuclear materials, as central to public perception. Furthermore, the level of public awareness about the benefits of nuclear energy—such as its potential to ensure energy security, reduce greenhouse gas emissions, and support sustainable development—is examined in relation to prevailing fears and misconceptions. The analysis reveals that low levels of trust in institutional frameworks, coupled with a lack of transparent communication, exacerbate public skepticism. The findings emphasize the importance of comprehensive national policies that balance security measures with public engagement and highlight the need for collaborative efforts between government, academia, and industry. By addressing public concerns and enhancing awareness, Serbia can build a more informed and supportive environment for the adoption of nuclear energy.

Key words: nuclear energy, security, public opinion, nuclear policies, awareness, security risks

1. INTRODUCTION

Nuclear energy is increasingly recognized as a vital component of sustainable energy strategies, offering significant benefits such as low greenhouse gas emissions, enhanced energy security, and economic development. In Serbia, the reintroduction of nuclear energy marks a transformative shift in the nation's energy policy, following a decades-long moratorium that was recently lifted with amendments to the Energy Law. This decision reflects a growing recognition of the potential role of nuclear energy in addressing global and local energy challenges, including climate change and the need for reliable energy sources.

However, the reintegration of nuclear energy into Serbia's energy strategy depends significantly on public acceptance. Globally, studies have shown that factors such as knowledge about nuclear inspections, trust in inspection authorities, and perceived benefits and risks play critical roles in shaping public acceptance of nuclear power [1]. Historically, public opinion has been shaped by major nuclear incidents such as Chernobyl and Fukushima, which heightened fears around safety, waste management, and the potential misuse of nuclear materials. The Fukushima disaster significantly altered public attitudes toward nuclear energy globally, underscoring the need to understand how these changes vary across countries before revising nuclear policies [2]. Additionally, the operational experience of nuclear power generation, which previously supported positive public opinion, became less impactful after such incidents, as evidenced by the rapid decline in support observed following Three Mile Island, Chernobyl, and Fukushima [3]. This highlights the necessity for policymakers to consider historical, environmental, and geographical factors specific to each country when addressing public acceptance in the context of nuclear energy policy.

In Serbia, where institutional trust remains relatively low and awareness of nuclear energy's benefits is limited, these challenges are particularly pronounced. This study seeks to explore the factors

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influencing public attitudes toward nuclear energy in Serbia, with a focus on three interrelated dimensions: public awareness, risk perception, and the role of national policies. Drawing on interdisciplinary theoretical frameworks from sociology, security studies, and communication science, the paper examines how these factors converge to shape societal acceptance or resistance.

By understanding the interplay of these dimensions, the study aims to identify the barriers to public support for nuclear energy and propose strategies to overcome them. In doing so, it highlights the critical importance of transparent communication, robust security policies, and collaborative efforts among government, academia, and industry. The findings of this study will contribute to the development of a more informed and supportive public environment, paving the way for the successful adoption of nuclear energy in Serbia's energy strategy.

2. PUBLIC ACCEPTANCE AND RISK PERCEPTION

Public acceptance and risk perception are critical factors influencing the integration of nuclear energy into a country's energy strategy. Risk perception shapes how individuals view the potential hazards of nuclear energy, including safety concerns, environmental risks, and waste management challenges. These perceptions are often amplified by historical nuclear incidents and media narratives, making them a central determinant of public attitudes. Meanwhile, awareness – encompassing knowledge about nuclear energy's benefits, technological advancements, and safety protocols – plays an equally vital role. Awareness can counterbalance fear-driven narratives and foster informed decision-making, creating an environment where nuclear energy is evaluated more objectively.

When addressing public acceptance, it is essential to recognize the spectrum of attitudes that exist between outright support and complete opposition. Between these poles lies a range of "reluctant acceptance," where individuals may tolerate nuclear energy under specific conditions or reservations. Understanding this nuanced landscape is crucial for policymakers aiming to tailor strategies that address public concerns while promoting nuclear energy's potential.

As highlighted in the reference, “public acceptance of nuclear power” can be defined as people's willingness or readiness to accept, within their governmental boundaries, the operation of nuclear power reactors for electricity generation and various applications of nuclear technologies. This concept hinges on two key elements: perception and sharing. Perception includes both objective evaluations of nuclear energy and the subjective views of individuals. Sharing, on the other hand, reflects the interplay of individual, social, cultural, and historical factors that collectively shape public acceptance. These dynamics underscore the complexity of fostering public support for nuclear energy and the need for a multifaceted approach in addressing both individual and collective concerns[1].

To apply the concepts of public acceptance and risk perception to Serbia, it is crucial to tailor the approach to the country's unique historical, cultural, and socio-political context. Given Serbia's past experiences with energy production and its relationship with nuclear technology, several steps can be taken to foster a balanced public discourse on nuclear energy.

First, increasing public awareness and education is essential. Serbia should focus on informing the public about modern nuclear energy technologies, particularly advancements in safety protocols and waste management. Public education campaigns can emphasize nuclear energy's role in reducing carbon emissions and enhancing energy independence. Knowledge is a significant psychological factor influencing public acceptance of nuclear energy. Research indicates that insufficient knowledge impedes the development of renewable energy sources, and that public knowledge can affect perceptions of risk and benefit associated with nuclear power. Therefore, it is valuable to consider public knowledge about nuclear energy in this context [4]. In Serbia, public education campaigns can play a pivotal role in enhancing understanding of nuclear energy's benefits, such as its capacity to reduce carbon emissions and contribute to energy independence. By providing accurate information and addressing misconceptions, these campaigns can foster a more informed public discourse, leading to increased acceptance of nuclear energy as a viable component of Serbia's energy strategy. A study conducted in 2019 found that the majority of respondents in Serbia were skeptical and did not support the construction of nuclear power stations, highlighting the need for improved risk-related information to influence public perception and decision-making[5].

Second, transparent and inclusive dialogue among stakeholders is key. The government, scientific institutions, and the public must engage in open conversations about nuclear energy. Institutions such as the „Vinča“ Institute of Nuclear Sciences, with its established reputation in nuclear science, can lead public forums and discussions. By involving local communities, environmental groups, and government officials, Serbia can ensure that different perspectives are considered and trust is built. The National Energy and Climate Plan (NECP) of Serbia, which includes the potential use of nuclear energy after 2040, emphasizes the importance of public acceptance in the decision-making process[6].

Third, understanding the historical and cultural context is important. Past nuclear incidents like Chernobyl and Fukushima have shaped public perceptions, and these concerns must be addressed head-on [7]. Serbia can position its nuclear energy strategy as one that learns from past mistakes, demonstrating a commitment to modern safety measures, international cooperation, and responsible energy production. Research suggests that events like Fukushima significantly altered public attitudes toward nuclear energy in many countries, and understanding these shifts can help Serbia better manage its own public relations efforts.

Fourth, Serbia should focus on developing tailored risk communication strategies. Understanding the varying risk perceptions among different demographic groups enables the creation of targeted messages that resonate with specific concerns. For instance, younger generations may be more open to new technologies, while older generations may require additional reassurance regarding safety. A study of China's recent efforts to improve nuclear power communication found that encouraging public participation was more effective than simply popularizing science. This approach not only allowed the public to influence policy but also helped people realize their value as citizens, further strengthening their acceptance of nuclear power[8]. Similarly, in Poland, a study identified that political ideology is the central factor in shaping public acceptance of nuclear energy. Environmental attitudes, risk perception, safety concerns, and economic variables also play substantial roles. The research advocates for policies that resonate with the diverse values, beliefs, and preferences of the population, emphasizing the importance of tailoring communication strategies to specific societal values[9]. By analyzing and adapting successful communication strategies from other countries, Serbia can develop an approach that effectively addresses its unique demographic and cultural context, fostering informed public discourse and enhancing acceptance of nuclear energy initiatives.

Finally, ongoing monitoring and response to shifts in public opinion are critical. Public attitudes toward nuclear energy can evolve, especially in response to government actions, media campaigns, or global events. Regular surveys and opinion polls can track these changes, providing valuable data to adjust strategies and address concerns in real-time.

By applying these strategies, Serbia can foster a more informed and balanced approach to nuclear energy, promoting a responsible reintegration of nuclear power into its energy mix. This will help build public confidence and ensure that the country can embrace nuclear energy in a way that aligns with both environmental goals and public interests. Also, through education on risks and their prevention, citizens will gain a better understanding of the safety measures in place, thereby strengthening their trust in nuclear energy initiatives.

3. POLICY AND INSTITUTIONAL TRUST

The successful reintegration of nuclear energy into Serbia's energy mix hinges on the interplay between national policies, institutional trust, and effective communication. National policies play a pivotal role in shaping public opinion by establishing robust nuclear safety standards, implementing effective waste disposal strategies, and ensuring transparent governance. These measures are essential for building public confidence and mitigating skepticism. However, in Serbia, low institutional trust has been identified as a significant factor amplifying public skepticism and resistance toward nuclear energy initiatives. This skepticism is further exacerbated by communication gaps, where insufficient or non-transparent communication impedes public engagement and erodes trust. Addressing these challenges requires a comprehensive approach that enhances policy effectiveness, rebuilds institutional trust, and fosters transparent communication to align nuclear energy initiatives with public interests and environmental goals.

National policies are instrumental in shaping public opinion on nuclear energy by establishing robust safety standards, implementing effective waste disposal strategies, and ensuring transparent governance. For instance, the International Atomic Energy Agency (IAEA) emphasizes that principles of openness and transparency are integral to nuclear law, both at the national and international levels, facilitating informed public discourse and trust in nuclear energy initiatives[10].

Developing a clear nuclear policy as an integral part of Serbia's energy strategy is a crucial step toward diversifying energy sources and ensuring energy stability. This policy must align with energy needs and all relevant sectors, including environmental protection, safety, and economic development, to ensure the sustainability and efficiency of the energy system. Given the growing energy needs and supply challenges, considering nuclear energy becomes increasingly relevant. Geopolitical dynamics, including changes in international relations and energy markets, also influence the country's energy strategy. The nuclear policy must be consistent with environmental and safety legislation. This includes implementing strict nuclear safety standards, effective strategies for managing radioactive waste, and transparent management of nuclear materials. These measures are essential for minimizing risks and protecting public health and the environment. Serbia has recently lifted its 35-year moratorium on nuclear power plant construction, signaling a commitment to developing a nuclear energy program. However, it is essential to establish comprehensive legislative frameworks to support this initiative.

Developing nuclear energy requires significant investment and long-term planning. It is important to develop a strategy that includes training skilled personnel, research and development, and building the necessary infrastructure. Institutional support, through appropriate regulatory frameworks and cooperation with international organizations, is key to the successful development of the nuclear program. A significant prerequisite for the acceptance of nuclear energy lies in the trust placed in institutions and their representatives to make the best possible decisions in this context. If there is a general erosion of trust in institutions, it will inevitably have a negative impact on the acceptance of nuclear energy as a viable option.

Trust in institutions depends on several key factors, including transparency, accountability, and integrity. Transparency involves providing clear and accessible information about decisions, policies, and operations, while accountability ensures that institutions and leaders are held responsible for their actions through robust oversight mechanisms. Integrity, demonstrated by ethical behavior and the absence of corruption, is equally critical. Competence in delivering services and addressing societal needs efficiently also builds trust, as does responsiveness to citizens' concerns and feedback. Inclusiveness and fairness are essential, ensuring that all groups are treated equitably, with non-discrimination in decision-making and consistent application of laws [11]. Communication plays a vital role, with clear, honest, and credible messaging fostering public confidence, particularly during crises. Opportunities for citizen participation and representation in governance enhance legitimacy, while an institution's historical performance significantly influences trust over time. Social and cultural contexts further shape perceptions, as alignment with societal values can bolster public confidence. Ultimately, trust emerges from the interplay of these factors, and the absence of one—such as accountability or fairness—can erode confidence, even when others are present[11],[12].

The repeal of the law banning the construction of nuclear power plants in Serbia through amendments to the Energy Law represents a precedent that has raised numerous questions about the transparency of the decision-making process. This approach, where a direct public debate on one of the most critical issues for the country's energy future was omitted, creates the perception that key decisions are being made behind closed doors. Such a lack of dialogue undermines public trust in institutions, as citizens were not given the opportunity to be informed, participate in discussions, or contribute to decisions on such an important matter. The absence of transparency further fuels skepticism toward institutions and opens the door to speculation about the true motives behind this change.

The consequences of this approach are far-reaching. In a country where general trust in institutions is already eroded, such actions can further hinder the acceptance of nuclear energy as a sustainable option. Citizens, who should be active participants in processes of national importance,

feel excluded, which further weakens their willingness to support future projects in this field. Transparency, public debate, and the inclusion of experts and the wider public are not only legal standards but also essential mechanisms for building trust and ensuring broad societal consensus on the direction of Serbia's energy policy.

To address the current situation and restore public trust, it is essential for institutions to initiate a transparent and inclusive process of informing and consulting the public. This would involve organizing public debates on nuclear energy, where experts, non-governmental organizations, the media, and citizens would have the opportunity to voice their opinions and receive answers to their questions. Additionally, it is necessary to publish all relevant analyses and strategic documents supporting this decision, along with a clear explanation of its significance for the energy sector and the broader community. Implementing mechanisms for ongoing communication, such as informational campaigns and regular progress reports, would also help strengthen trust and ensure that citizens are active partners in shaping energy policy.

4. CONCLUSION

The reintegration of nuclear energy into Serbia's energy strategy represents a complex endeavor requiring the careful alignment of technological, security, and societal dimensions. This study highlights that public opinion is predominantly influenced by risk perception, awareness of the benefits and challenges of nuclear energy, and the level of trust in institutions tasked with implementing this transformative change. In Serbia, low institutional transparency and insufficient public engagement further hinder the acceptance of nuclear energy as a viable option.

To overcome these challenges, it is essential to enhance public awareness through targeted educational initiatives, improve regulatory frameworks, and foster inclusive dialogue among stakeholders. Educational campaigns must address widespread misconceptions, emphasize advancements in nuclear safety, and highlight the environmental and economic benefits of this energy source. These efforts should not only inform but also empower citizens to actively participate in shaping the country's energy policies.

In parallel, Serbia must strengthen its regulatory frameworks to ensure the highest standards of nuclear safety, effective waste management, and transparency in decision-making processes. Robust regulations, aligned with international best practices and regularly reviewed, will provide a solid foundation for building public trust and ensuring accountability.

The Vinča Institute of Nuclear Sciences, with its distinguished history and expertise in nuclear research, can play a central role in these efforts. The Institute is well-suited to lead public education programs, organize workshops, and collaborate with schools, universities, and local communities. Additionally, it can contribute to enhancing regulatory frameworks by providing expert input and fostering partnerships with international organizations.

By combining comprehensive education, transparent dialogue, and robust regulatory measures, Serbia can create a more informed and supportive public environment for nuclear energy. This integrated approach will align nuclear energy initiatives with environmental objectives and public interests, paving the way for a sustainable and resilient energy future for the country.

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