

June 2024

Published by the Future Issues and Technology (FIT) Research Cluster, RSIS. This Bulletin comes as a series of articles on science and technology from the angle of national security.

(1) Fusion Energy Technologies: Safeguarding National Security | *Elias G. Carayannis*

In the face of escalating global energy demands and the ever-growing concern for energy security, the exploration of sustainable alternatives has become paramount. Fusion energy technologies, as outlined in recent breakthroughs in fusion energy research, offer a promising solution. This article delves into the transformative potential of fusion energy, emphasising its inherent safety, minimal environmental impact and economic advantages. Beyond addressing energy challenges, the focus here extends to the critical role that fusion energy plays in safeguarding national security. As nations strive for cleaner, safer energy solutions, fusion emerges not only as a technological breakthrough but as a linchpin for ensuring strategic and resilient national security.

Overview of Fusion Energy Technologies

Fusion energy, rooted in the principles of nuclear physics, involves the fusion of light atomic nuclei to release an immense amount of energy. In contrast to fission, where heavy nuclei split, fusion harnesses the process occurring in stars, generating clean and powerful energy. Recent strides in fusion energy research signify a pivotal transition in the field. Notably, breakthroughs in projects like the International Thermonuclear Experimental Reactor (ITER) showcase the feasibility of achieving a net energy gain, marking a significant milestone. Fusion energy's potential applications extend beyond electricity generation, encompassing diverse sectors such as desalination, space propulsion and industrial processes. These advancements underscore fusion's multifaceted role as a transformative energy source, heralding a new era in sustainable and versatile power generation.

Advantages of Fusion Energy for National Security

Fusion energy holds significant advantages for bolstering national security on multiple fronts. First and foremost, its inherent safety features make it meltdown-proof, presenting a stark contrast to fission technologies. The elimination of the risk of catastrophic accidents associated with meltdowns enhances the overall safety profile of fusion energy, mitigating potential threats to both the environment and human health.

From an environmental standpoint, fusion offers a compelling case. Unlike fission, fusion processes generate no long-lived radioactive waste. This characteristic not only minimises the environmental impact but also addresses concerns related to the storage and disposal of hazardous nuclear byproducts. Additionally, fusion's minimal carbon emissions align with global efforts to combat climate change, positioning it as a clean and sustainable energy alternative.

Beyond safety and environmental considerations, fusion energy enhances national security by providing an alternative to fossil fuels and other energy sources, thereby also mitigating dependence on energy imports from geopolitically sensitive regions for countries that lack their own energy sources. Fusion's versatility, extending to applications beyond electricity generation, further strengthens a nation's energy resilience and autonomy.

In summary, fusion energy's safety, environmental benefits, and capacity to diversify energy sources make it a crucial element in fortifying national security and fostering sustainable energy practices.

Economic and Technological Implications

Fusion energy emerges as a General-Purpose Technology (GPT) with profound economic implications, promising diverse applications across various sectors. Beyond its role in electricity generation, fusion's potential spans applications such as neutron sources, desalination, process heat and industrial manufacturing. This versatility positions fusion as a transformative force capable of driving economic growth and fostering innovation.

Moreover, the pursuit of fusion research has spurred technological advancements, with far-reaching consequences. The collaborative nature of fusion energy research, exemplified by projects like ITER, facilitates knowledge sharing among nations, contributing to a collective pool of expertise. This collaborative approach not only

accelerates scientific breakthroughs but also positions countries engaged in fusion research at the forefront of technological innovation.

Being at the forefront of fusion research translates into global leadership in innovation, with economic implications extending beyond the energy sector. The development of proprietary technologies, spurred by both public and private investments, creates opportunities for economic growth, job creation and technological leadership on the international stage. The economic and technological implications of fusion underscore its significance not only for national security but also for global competitiveness in the evolving landscape of advanced technologies.

International Collaboration and Security

International collaboration in fusion research, epitomised by projects like ITER, underscores the collective commitment to harnessing the potential of fusion energy. The collaborative nature of these endeavours fosters diplomatic ties and strengthens international relationships, transcending geopolitical boundaries. Shared participation in fusion projects not only facilitates knowledge exchange but also establishes a framework for cooperation on broader security interests. The interdependence forged through international collaboration in fusion enhances global security by promoting peaceful cooperation and fostering a shared commitment to addressing the challenges of the future.

In conclusion, fusion energy technologies offer a safe, sustainable and geopolitically advantageous solution for bolstering national security. Meltdown-proof and environmentally friendly, fusion has the potential to reshape global energy landscapes. Emphasising collaboration and innovation, continued investment in fusion research is paramount for a secure and sustainable future.

(2) Fusion Energy and AI: A Synergetic Overview | *Elias G. Carayannis*

In the rapidly evolving landscape of transformative technologies, fusion energy and artificial intelligence (AI) stand at the forefront, garnering increasing recognition for their pivotal roles in addressing pressing global challenges. Fusion, offering a clean and virtually limitless energy source, and AI, revolutionising the way we process information, are integral to our quest for sustainability and resilience. This rest of this article delves into the intersecting realms of fusion and AI, positioning them as public interest technologies with profound implications for national security. By exploring the symbiotic relationship between these innovations, we aim to underscore their collective potential in shaping a secure and sustainable future.

Fusion energy and AI converge in a synergetic partnership that holds promise for revolutionising our energy landscape and technological capabilities. Fusion, a process emulating the sun's power, offers a safe, meltdown-proof energy alternative with minimal environmental impact. Simultaneously, AI, renowned for its data-driven insights and adaptive learning, plays a transformative role in optimising fusion processes. AI enhances safety measures, accelerates research and refines control mechanisms critical for harnessing fusion's potential. Recent collaborations showcase AI's application in predicting and controlling plasma behaviour, underscoring the symbiotic relationship between fusion energy and AI. Together, they form a powerful alliance, driving innovation and efficiency in our pursuit of sustainable and secure energy solutions.

National Security Implications

The convergence of fusion energy and AI holds significant implications for national security. Fusion, as a clean and abundant energy source, contributes to energy security by reducing reliance on conventional fossil fuels. AI plays a pivotal role in enhancing the safety and efficiency of fusion reactors, minimising potential risks associated with nuclear energy. The integration of AI in monitoring and controlling fusion processes ensures precise and real-time adjustments, further enhancing safety measures.

This synergy between fusion and AI not only fortifies energy security but also addresses geopolitical tensions. By diversifying energy sources and minimising dependence on politically sensitive regions for fossil fuels, fusion and AI contribute to a more stable global energy landscape. The robustness of fusion as a sustainable energy solution, coupled with the intelligent adaptability of AI, creates a formidable foundation for securing nations against energy-related vulnerabilities and geopolitical conflicts. Together, fusion and AI emerge as crucial components in the arsenal of technologies safeguarding national security in the face of evolving global challenges.

Economic and Innovation Landscape

The convergence of fusion energy and AI extends beyond their immediate applications, positioning both as General-Purpose Technologies (GPTs) with far-reaching economic and innovative impacts. Fusion, as a GPT, offers a clean and abundant energy solution, driving economic growth by reducing reliance on

conventional energy sources. The integration of AI in fusion processes not only enhances safety but also expands the technological landscape.

This convergence fosters a dynamic innovation ecosystem, establishing global leadership in science and technology. Collaborations between fusion and AI researchers result in breakthroughs that extend beyond energy production, impacting diverse sectors. The economic potential of these GPTs lies not only in energy markets but also in the broader realm of technological applications, shaping industries and economies. As fusion and AI intertwine, they become catalysts for innovation, driving economic progress and solidifying nations at the forefront of the technological frontier.

Ethical Considerations and Public Support

The intersection of fusion energy and AI brings forth ethical considerations that demand careful examination. As these technologies advance, it is crucial to ensure responsible development, minimising potential risks and addressing societal concerns. Ethical considerations span various aspects, including safety, privacy and the equitable distribution of benefits.

Public support plays a pivotal role in shaping policies and regulations governing fusion and AI. Transparency and engagement with the public are essential to build trust and address apprehensions. Policies should reflect the values and concerns of the broader community, ensuring that the development and deployment of fusion and AI technologies align with societal expectations.

Moreover, fostering public awareness about the potential benefits and risks of these technologies is essential. Informed public discourse can guide ethical decision-making, helping policymakers strike a balance between innovation and societal well-being. As fusion and AI become integral components of public interest, their ethical implications must be actively considered, and public support should be cultivated to ensure the responsible and equitable development of these transformative technologies.

In conclusion, the synergy between fusion energy and AI represents a transformative force with profound implications for national security, sustainability and global cooperation. The intertwined roles of these technologies highlight their potential to address pressing challenges. As we navigate this frontier, it is imperative to prioritise ethical and responsible development, ensuring the alignment of innovation with societal values. Undertaking continued research and collaboration and actively

engaging the public are essential to harness the full potential of fusion and AI as public interest technologies. By doing so, we can pave the way for a future where these advancements contribute positively to humanity's well-being.

About the Author

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