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Fusion Energy for Peacebuilding: A Trinity Test-Level Critical Juncture

Abstract

Peacebuilding used to power humanity's quest for fusion; it still could. This article analyses the enormous implications of a burning plasma fusion breakthrough, for both worsening conflicts and peacebuilding, by applying the nonkilling global political science peacebuilding framework; the quintuple helix technology innovation ecosystem model; and recent path dependence theory. The first burning plasma will be an unprecedented historical event, with the closest parallel being the Trinity Test; we analyze the Test in path dependence terms to compare it with fusion. As with fission, fusion will be weaponized due to its intrinsic benefits. However, the innovations leading to fusion are not occurring unnoticed. Unlike Trinity, which was conducted in secret in wartime, fusion is being developed in peacetime, to assist a low-carbon transition. With fission, immediately following the Second World War, despite initial progress, the USSR rejected the US Baruch Plan to place atomic energy and weapons under the UN to stifle a nuclear arms race. The result was the Cold War. Similarly, we forecast a global critical juncture in which a new normative nuclear order can be created via a new Baruch Plan that could deliver a Universal Global Peace Treaty, with humanity re-prioritizing its goals for this century.

Keywords: *climate change, global nonkilling political science, nuclear fusion, peacebuilding, quintuple helix innovation ecosystem, railgun*

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Fusion Energy for Peacebuilding: A Trinity Test-Level Critical Juncture

Elias G. Carayannis, John Draper, and Balwant Bhaneja

We are here to make a choice between the quick and the dead. That is our business. Behind the black portent of the new atomic age lies a hope which, seized upon with faith, can work our salvation. If we fail, then we have damned every man to be the slave of fear. Let us not deceive ourselves; we must elect world peace or (elect) world destruction. (The Baruch Plan - United States, 1946).

Peacebuilding is, or at least was, at the heart of humanity's quest for nuclear fusion, the same process as occurs in the sun, as concretized in the International Thermonuclear Experimental Reactor, now simply ITER (Clery, 2014; Claessens, 2020). More recent high-level political discourse surrounding ITER has omitted the peace element (Carayannis & Draper, 2021). This article seeks to return peacebuilding to the forefront of fusion, considering the implications of fusion energy's arrival for conflicts and for peacebuilding. Adopting the quintuple helix innovation framework to emphasize the role of peacebuilding civil society in fusion energy (Carayannis et al., 2020a), together with recent path dependence theory for policy instruments (Capano & Lippi, 2017), including the critical juncture notion (Hogan, 2019), we note that fusion energy's arrival will create a global critical juncture of a scale not seen since the Trinity Test.

To contextualize fusion, we revisit the 1946 Baruch Plan, the United States' attempt to leverage atomic energy to ban atomic weapons and divert nuclear fission to exclusively peaceful energy. Little academic literature describes the Plan in path dependence terms, despite being a global critical juncture. Had the Plan succeeded, the "path less trodden" could have led to an international convention promising a future with no atomic weapons and a cooperative international regime for the development of all nuclear energy. In this light, we consider how the first fusion burning plasma, when a nuclear fusion reaction catches fire, will provide humanity with an opportunity to revisit this potential for perpetual peace (Kant, 2003) by removing energy insecurity, a major justification for war.

We explain how fusion energy could either contribute to a militarized future with the development and use of fusion-powered weapons like directed-energy weapons such as lasers or could be leveraged to attain a Universal Global Peace Treaty (UGPT), covering all forms of war and implemented by all countries. This is important because, while we live in a post-war era of U.N.-mediated international armed conflicts, *de facto* wars still occur, e.g., the Iraq War

(Weller, 2015), as do civil wars, e.g., the Yemen Civil War. Additionally, the threat of Atomic-Bacteriological-Chemical (ABC) warfare persists; new forms of war are emerging, like fifth generation warfare through misinformation and social engineering (Abbott, 2010); cyberwarfare (Green, 2015); and at least one major interstate war, the Korean War, is only on pause.

The exact timeframe for this impending critical juncture is solidifying. In 2022, the upgrade of the U.K.-based Joint European Torus (JET) donut-shaped tokamak scientific fusion reactor could attain Q=1 (energy breakeven) using a deuterium-tritium fuel mix (Gibney, 2021). However, what is important is the subsequent step, the first burning plasma, whereby a fusion plasma catches fire (National Academies, 2019). It is this milestone that is equivalent to a Trinity Test-level critical juncture because this stage concretizes the enormous potential for fusion energy to not just address grand challenges like energy inequality and climate change but also contributes to military applications like naval propulsion systems and to directed-energy weapons (Carayannis et al., 2020b).

This burning plasma would then be developed to provide electricity, through ITER consortium next generation DEMOnstration fusion reactor-phase fusion pilot plants (FPPs), as in the EUROfusion approach (EUROfusion, 2020). Alternatively, private-sector proponents claim that with fully funded technologies, this burning plasma stage might be achieved earlier, in the 2020s (Carayannis et al., 2020a; Nuttall et al., 2020). For instance, in 2019, the world's largest private sector fusion company, the U.S.-based TAE Technologies, with over 800M USD in venture capital and a market capitalization of approximately 3 billion USD, announced it seeks to develop a burning plasma and commercialize its compact fusion reactor in the megawatt rather than the gigawatt range in the 2020s (Wang, 2019). Presently, according to multiple projections and programs, in Canada, China, the U.K. and the U.S., fusion energy could be commercialized around 2040 (Carayannis et al., 2022; Clery, 2020; Li & Wan 2019; United States Department of Energy, 2021).

To analyze this emerging critical juncture, we combine three theoretical frameworks. Firstly, to underline both the promise for peace and the threat that fusion power represents, we introduce Paige's (2009) non killing global political science (NKGPS), a peace building science that advocates planetary demilitarization. NKGPS is promoted by the Center for Global Nonkilling, a Honolulu-based U.N.-accredited NGO and representative of peacebuilding civil society. Secondly, to bridge the gap between the fusion power development community and peacebuilding civil society, we introduce the quintuple helix, a technology innovation framework emphasizing combining the academic, public, private, and, crucially, civil society and socioecological aspects of fusion power. Carayannis, Draper, and Bhaneja first mooted the possibility of applying NKGPS and the quintuple helix to fusion energy in 2020 without going into substantial detail or providing theoretical rigor or examining the issue through the path dependence lens. Thirdly, we analyze the original Baruch Plan in terms of path dependence. Next, we outline the main danger of fusion energy to peacebuilding and its capacity for powering high-energy weapons like the railgun (see Mehlhorn, 2014). This results in our recommending a new Baruch Plan, formulated as the result of a high-level independent Global Commission for Urgent Action on Fusion Energy, a mechanism already supported by the International Energy Agency, for energy efficiency (Carayannis et al., 2020b). Finally, extending the Kantian concept of perpetual peace, we conclude by emphasizing that the first burning plasma introduces humanity's last opportunity to leverage a UGPT.

Literature Review

Nonkilling Global Political Science

In Glenn D. Paige's (2009) work *Nonkilling Global Political Science*, nonkilling denotes a paradigmatic shift in human society to the absence of killing, of threats to kill, and of conditions conducive to killing, strongly influencing nonviolent discourse. Paige emphasizes that if we can imagine a society free from killing, we can reverse the existing deleterious effects of killing and employ public monies saved from producing and using weapons to enable a benevolent, wealthier, and more socially just society. Here, we outline how NKGPS supports our leveraging a burning plasma breakthrough to attain a UGPT and so rejuvenate the United Nations System.

Since Paige introduced his framework, a substantial body of associated scholarship, guided by the Center for Global Nonkilling, has developed across a variety of disciplines (e.g., Evans Pim, 2010). The Center has associated NKGPS with previous nonviolent or problem-solving scholarship within different religious frameworks (e.g., Paige & Gilliat, 2001), providing it with a broad functional and moral inheritance (e.g., Chowdhury, 2010). NKGPS has been applied to a variety of regional and national conflicts, like the Korean peninsula (Paige & Ahn, 2012) and the Balkans (Bahtijaragić & Evans Pim, 2015). Within the NKGPS conceptual framework, the means of preventing violence involves applying it as a global political science together with advocacy of a paradigmatic shift from killing to nonkilling.

Paige stresses that a nonkilling society is not conflict-free; that its structure and processes do not derive from nor depend upon killing. Bhaneja (2006) emphasizes that NKGPS is suited for problem solving, while Motlagh (2012, pp.103-105) elaborates on Paige's framework via a fundamental objective hierarchy, including steps to transform social institutions contributing to nonkilling. Motlagh notes that this transformation requires social institutions within which symbolic images of perpetual peace and weapon-free zones matter, like the United Nations, as do actions like removing economic support for lethality, protecting human rights, and protecting the environment, where the ecological responsibility of humanity to the planet in the Anthropocene may serve as an inspiration (Ellis, 2018). Here, a UGPT requires both a powerful peacebuilding symbol like a sun in a box and would in and of itself be a powerful peacebuilding symbol.

Paige (2009, p.73) advocates a four-stage process in NKGPS, namely understanding the causes of killing; understanding the causes of nonkilling; understanding the causes of transition between killing and nonkilling; and understanding the characteristics of killing-free societies. Paige introduced a variety of concepts to support NKGPS, three of which we adopt in this article. The first is the societal adoption of the concepts of peace, namely the absence of war and conditions conducive to war; nonviolence, whether psychological, physical, or structural; and noninjury in thought, word, and deed (Evans Pim, 2012, 107). The second is a taxonomy to rate individuals and societies (Paige, 2009, p.77):

- prokilling—consider killing positively beneficial for self or civilization;
- killing-prone—inclined to kill or to support killing when advantageous;
- ambikilling—equally inclined to kill or not to kill, to support or oppose it;
- killing-avoiding—predisposed not to kill or to support it, prepared to do so;
- nonkilling—committed not to kill and to change conditions conducive to lethality.

The third is the funnel of killing. In this conceptualization of present society, people kill in an active killing zone, the actual place of bloodshed; learn to kill in a socialization zone; are taught to accept killing as unavoidable and legitimate in a cultural conditioning zone; are exposed to a structural reinforcement zone, where socioeconomic arguments, institutions, and material means predispose and support a discourse of killing; and experience a neurobiochemical capability zone where physical and neurological factors contribute to killing behaviors (Paige, 2009, p.76).

The nonkilling alternative is an “unfolding fan of nonkilling alternatives by purposive efforts within and across each zone” (Paige, 2009, p.76). Within this unfolding fan, the transformation from killing to nonkilling can be envisioned as involving changes in the killing zone along spiritual or nonlethal high technology interventions; changes in favor of nonkilling socialization and cultural conditioning in domains like education and the media; “restructuring socioeconomic conditions so that they neither produce nor require lethality for maintenance or change" (Paige, 2009, p.76); and clinical, pharmacological, physical, and spiritual/meditative interventions that liberate individuals like the traumatized from a bio-propensity to kill.

To conclude this section, in revisiting a version of the 1946 Baruch Plan for fusion, we focus on how leveraging a UGPT off a burning plasma would encourage the societal adoption of the concepts of peace by shifting the global community from killing-prone to nonkilling, by restructuring socioeconomic conditions regarding energy. As discussed later, the Baruch Plan was viewed as integral to the U.N. system: It was the focus of General Assembly Resolution 1 of Session 1. Furthermore, a UGPT is a powerful nonkilling symbol. It will not begin, and may never attain, unanimous consent from all countries; it is a majoritarian risk-management strategy for a fusion arms race that nonetheless may exert significant peer pressure on countries that might not initially sign it, like North Korea, and that would mitigate other risks, like the Artificial Intelligence (AI) arms race (Maas, 2019).

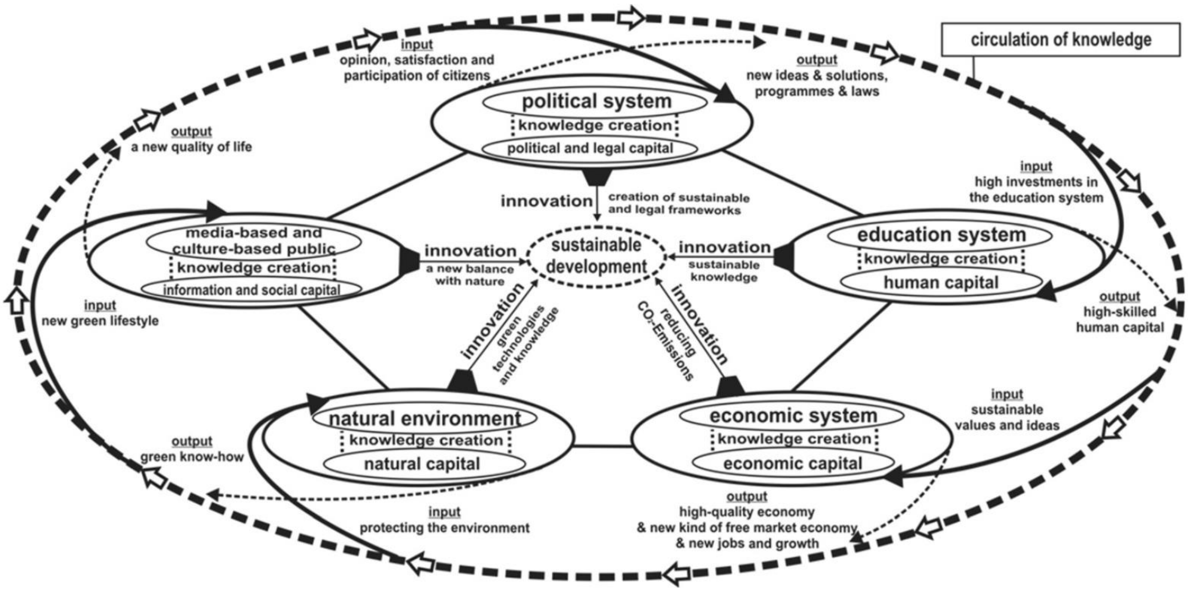
The Quintuple Helix Fusion Innovation Ecosystem (QHFIE)

The QHFIE applies the quintuple helix innovation model of innovation economics to fusion energy (Carayannis et al., 2020a; Carayannis et al., 2020b). Innovation economics is an emerging mainstream field of economics that emphasizes how entrepreneurship and innovation contribute to technological development (Freeman, 2009). The quintuple helix innovation model as applied to fusion advocates accelerating fusion energy's arrival through a global political, economic, sociological, technological, legal, and environmental (GEO-PESTLE) external independent review, simultaneously involving civil society, like the peacebuilding community, to address ongoing U.N. goals, particularly energy for all, climate change, and peacebuilding (Carayannis et al., 2020a).

The quintuple helix innovation model describes an inter- and trans-disciplinary analytical framework interrelating knowledge, scientific innovation, and quality of democracy via institutions like civil society and the media, with the socio-ecological environment, within a coherent ecosystem (Campbell et al., 2015). As such, it has already been applied to a green new deal and climate change (Carayannis et al., 2012). The quintuple helix innovation model emphasizes this synergetic relationship by extending previous models of knowledge production, notably the triple helix of university, public sector, and private sector (Etzkowitz & Leydesdorff, 2000). Crucially for this article, the quintuple helix innovation model adds the media- and culture-based public and civil society, key factors in the quality of democracy. In the quintuple helix innovation model, innovation operates to enhance sustainable development. This is achieved via the circulation of knowledge and innovation within a coherent socio-ecological ecosystem to address problems like climate change. Figure 1 illustrates the complex relationships between the helices, which possess their own forms of knowledge capital.

Figure 1

Circulation of knowledge within the QHFIE



Note. Sustainable development denotes a fusion power assisted low-carbon transition by 2100

The QHFIE model emphasizes sustainable development through managing climate change by accelerating knowledge flows leading to the burning plasma, within a holistic innovation ecosystem. Academia, the public sector, and industry all have a voice in fusion innovation (National Academies, 2019; 2021), as do the media and civil society, together with socio-ecological interests (Carayannis et al., 2020a). The QHFIE is therefore an ideal lens for examining how public policy, like a UGPT, can develop with regards to the fusion energy critical juncture. Additionally, applying fusion to the low-carbon transition problem is once again mainstream United States government thinking (National Academies, 2021), meaning fusion is operational at the socio-ecological level. This article adds the role of peacebuilding civil society through highlighting the importance of a burning plasma within a peace and conflict studies journal, by adopting NKGPS.

At the political level, a managed co-opetive (government-supervised quasi-cooperative and competitive) QHFIE solution enhances the global quality of democracy on issues like peacebuilding, to accelerate fusion's arrival to address climate change within this century (Carayannis et al., 2020a; Carayannis et al., 2022). In this approach, the Global South, perhaps via the U.N. Group of 77 (G77) bloc of 134 nations (Toye, 2014), is an active and informed co-developer of fusion technology. To sum up, accelerating the development of commercially viable fusion from around 2040 would offer another technology to provide electricity around the clock and address climate change (National Academies, 2021). With competition over fossil fuels causing wars (Colgan, 2013; Price-Smith, 2015), the QHFIE promotes peacebuilding via a cheap alternative primary energy source. Theoretically, NKGPS and more generally fusion for peacebuilding thus exist as a civil society discourse within the QHFIE ecosystem.

Methodology

We conducted a desk review of available literature on the Baruch Plan, including books, newspaper reports, and academic articles, as well as of literature on path dependence theory and the critical juncture. As part of a larger, related study, we also reviewed the literature on nonkilling global political science, the quintuple helix, and the development of fusion energy, the latter only being partially presented here. We used this to generate two basic research questions: What will be the historical importance of the fusion energy breakthrough and what should be the role of the peacebuilding community be?

Analysis

The Baruch Plan in Terms of Path Dependence Theory

To illustrate the importance of a fusion burning plasma to peacebuilding, we first revisit the Baruch Plan. In NKGPS terms, the 1946 U.S. Baruch Plan (United States, 1946; Mayers, 2016) attempted to minimize the socioeconomic conditions in the structural reinforcement zone that might make an atomic arms race and war more likely. It did so within a context seeking to create a form of perpetual peace (Kant, 2003) via the U.N., shifting a killing-prone world having experienced two world wars towards a nonkilling world. Within our overall combined NKGPS/QHFIE framework, this section applies path dependence theory as developed for policy document analysis by Capano and Lippi (2017) to the Plan. This adds an analytical layer to more recent conceptualizations of a critical juncture as a historical decision-making institutional process that is both significant, swift, and enduring (Hogan, 2006; 2019) and followed by a long period of stability and adoption (Capoccia, 2015).

Hogan (2019) notes that the main difference between the situation of a critical juncture and extant policy continuation in a crisis is that while the crisis causes extant ideational collapse in both cases, ideational change in a critical juncture is accompanied by new ideational consolidation. This is accompanied by a third order policy change, i.e., new policy developments reflecting the capacity of an institution to completely change its conceptual understanding as new events require (Bartunek & Moch, 1987). In contrast, with extant policy continuation, no new ideational consolidation follows, resulting in only first and second order policy changes, with first order ones being based on incremental changes and second order ones being modifications in institutional understanding.

Thus, the Baruch Plan was an attempted third order policy change responding to the splitting of the atom for use in warfare, and so a critical juncture. The Plan's collapse led to the pathway of an atomic arms race, the Cold War. Because the Plan's collapse resulted in the Cold War, it is well discussed in the literature (Gerber, 1982; Baratta, 1985), including in subsequent considerations of attempts to safeguard and internationalize nuclear energy (Nilsson & Abrahamson, 1991; Robinson, 2004; Scheinman, 2005), like the Comprehensive Nuclear-Test-Ban Treaty (Mackby, 2016) and the proposed Fissile Material Cutoff Treaty (Kearn, 2010).

In path dependence theory, Capano and Lippi (2017, p.269) note that imitation, layering, and ambiguity occur in tool choice selection and theoretically examine the logic by which decision makers choose specific policy instruments, with two main rationales being legitimacy (political acceptance) and instrumentality (effectiveness). Capano and Lippi (2017) maintain that legitimacy can be endogenous or exogenous to the specific policy field, while instrumentality may be dichotomous between specialized, i.e., highly selective and constraining; or generic, i.e., able to:

> include and cover an increasing number of actors, policy problems and situations, in order that they may be generally considered as fitting due to their ability to encompass a broad range of problems both within the same policy field and in different policy fields. (p.280)

Arranging these within a matrix results in four types of policy change: routinization (internal legitimacy, specialized instrumentality); contamination (internal legitimacy, generic instrumentality); hybridization (external legitimacy, specific instrumentality); and stratification (external legitimacy, generic instrumentality).

The bombing of industrial and civilian targets of Hiroshima and Nagasaki rather than uninhabited areas has already been described as a critical juncture (Feis, 1966, p.47), although not analyzed within path dependence. Here, we briefly describe this first critical juncture and its consequences in path dependence terms to illustrate what was subsequently at stake with the Baruch Plan. Persuaded that the Japanese would be unimpressed by the pre-advertised bombing of an uninhabited island, the U.S. instead bombed Hiroshima and Nagasaki (Hewlett & Anderson, 1961). In that this policy was internally legitimized and involved extending an existing technique, i.e., saturation bombing (Selden, 2007), it was an example of policy contamination.

Subsequently, the Russians developed their own bomb in 1949, and a path towards more, ever larger nuclear bombs resulted when the U.S. exploded its first fusion bomb in November 1952, followed by the Russians in August 1953. The U.K., France, and China then developed their own nuclear weapons, in 1952, 1960, and 1964, a form of path dependence self-reinforcement (Page, 2006). The resulting Cold War imposed a financial burden on the U.S. of over eight trillion dollars, with a similar burden on the U.S.S.R (Gaddis, 2005, p. 213; Lafeber, 2002, p. 1).

The Baruch Plan was a U.S. reaction to the geopolitical crisis that followed the development and use of the atomic bomb (A-bomb). Following the Trinity Test, a recognition arose among U.S. policy makers that the A-bomb was a new, devastating weapon; one that could result in an arms race and world-ending war. The A-bomb was not the first weapon of mass destruction (WMD). The development and deployment of chemical weapons in the First World War and the potential development of biological weapons were both seen as introducing new, also unacceptable, paradigms of war. They resulted in the 1925 Geneva Protocol, formally the Protocol for the Prohibition of the Use in War of Asphyxiating, Poisonous or other Gases, and of Bacteriological Methods of Warfare (see Brown 2005), a protocol to the *Convention for the Supervision of the International Trade in Arms and Ammunition and in Implements of War*. In path dependence terms, the Geneva Protocol was an example of stratification, being an additional layer of policy reliant upon the League of Nations for external legitimacy, with previous major strata comprising the First Hague Conference of 1899 and the Second Hague Conference of 1907, with substrata comprising the various conventions and declarations of these two conferences.

Like the Geneva Protocol, the Baruch Plan relied upon the external legitimacy of the nascent U.N., the League of Nations' successor. However, it incorporated entirely new concepts in response to the A-bomb's devastating power and the prospect of atomic energy, demonstrating hybridization. Firstly, the Plan proposed a ban on the use of A-bombs and decommission all existing (U.S.) A-bombs, a step not previously taken with other WMDs. Secondly, it proposed placing not just all fissile material production under the mutual control of the U.N., via a new global supervisor for atomic energy, the U.N. Atomic Energy

Commission, but also atomic energy itself. The proposal and discussion of the Plan at the U.N. was a key moment in global history: a critical juncture.

Fundamentally, developing the Baruch Plan involved a quest for an effective, legitimate policy instrument. The first task was developing a policy with internal legitimacy. On November 18, 1944, the Zay Jeffries committee issued the *Prospectus on Nucleonics*, detailing the industrial applications of fission. Even at this early stage, external legitimacy was married to a specific policy requirement, for the committee argued that "a world-wide organization was necessary to prevent the atom from becoming the destroyer of nations" (Hewlett & Anderson, 1961, p. 325). Thus, was born the novel concept of an internationally regulated energy industry.

In anticipation of the *Prospectus*, on September 19, 1944, Vannevar Bush, head of the Office of Scientific Research and Development, and James B. Conant, Chair of the National Defense Research Committee, addressed a letter to U.S. Secretary of War Henry L. Stimson which suggested the possibility of an international control agency for the atomic industry. To effect this policy, the U.S.S.R was to be incentivized to cooperate through access to U.S. technologies, furnishing it with atomic energy and preventing its own development of the A-bomb. Secretary Stimson championed this basic approach, relying solely on incentivizing the U.S.S.R, when he oversaw the production of the Baruch Plan's precursor, the *Report on the International Control of Atomic Energy* (the *Acheson-Lilienthal Report*). This was presented on March 16, 1946, to the State Department and published publicly on March 28.

The U.S. was initially optimistic in the quest for external legitimacy. In December 1945, the Moscow Conference of Foreign Ministers—including U.S., British, and U.S.S.R representatives—had all endorsed a plan to pass the responsibility for the control of atomic energy and weaponry, including the mining and production of fissile material, to the proposed U.N. Atomic Energy Commission. The U.S. viewed this as such a policy priority that the Commission established on January 24, 1946, by Resolution 1 of Session 1 of the U.N. General Assembly. The General Assembly (1946) asked the Commission to make specific proposals:

> (a) for extending between all nations the exchange of basic scientific information for peaceful ends; (b) for control of atomic energy to the extent necessary to ensure its use only for peaceful purposes; (c) for the elimination from national armaments of atomic weapons and of all other major weapons adaptable to mass destruction; (d) for effective safeguards by way of inspection and other means to protect complying States against the hazards of violations and evasions.

Subsequently, Under Secretary of State Dean Acheson chaired a committee that wrote the *Acheson-Lilienthal Report*, which was designed to implement Resolution 1. The *Report* argued that controlling atomic energy through inspections and policing was unlikely to succeed and that instead, all fissile material from all mines globally be owned by a new international agency to be called the Atomic Development Authority, which would allocate fissile material to individual nations to develop atomic energy for peace. Controversially, the *Report* recommended that the U.S. decommission its bombs and transfer its technology to the U.S.S.R, in return for an embargo on future bombs. While the approach was heavily criticized for utopianism, it also received considerable support (Hewlett & Anderson, 1961, pp. 558-559). However, following Stimson's resignation, the internal legitimacy of the policy's basic approach, specifically its weak enforcement mechanism, was increasingly challenged.

To implement the *Report*, U.S. Secretary of State James F. Byrnes recruited U.S. financier and statesman Bernard Baruch. Baruch became dubious of the Report, specifically that breaching the terms of the proposed agreement would result only in a warning period for the U.S. that a country was militarizing atomically. Baruch determined that a more forthright approach involving non-vetoable sanctions would win over U.S. domestic critics and result in a more effective treaty. However, from the Russian perspective, non-vetoable sanctions undermined the U.N. Security Council's role, as the U.S.S.R's participation in the U.N. relied on the Security Council's veto arrangement (Hewlett & Anderson, p.1961).

The policy climate was increasingly affected by growing distrust between the U.S. and U.S.S.R. Gerber (1982) cites Sherwin's (1975) influential study, which found the U.S. overplayed its hand and provoked the Cold War, in support of delivering the opinion that:

> America's failure to keep Russia informed during the war about the development of the atomic bomb, the implied threat to Russia entailed in America's use of the bomb against Japan, and the slowness with which the United States acted to initiate discussions after the war on the subject of international controls all lessened the chances for agreement on atomic energy by making the Soviets wary of American intentions. (p. 70)

However, the U.S.S.R's reliance on secrecy also meant it feared communism would face an existential threat if a key sector of its economy were opened to international scrutiny and engagement, an issue the U.S. side was, indeed, hoping to exploit via the Plan (Gerber 1982, pp. 87-91). Also, Stalin's determination that the balance of power had been destroyed rendered it unlikely he would have renounced developing the A-bomb whatever the proposition (Cochran et al., 2018).

Consequently, the U.S.S.R made a counterproposal to the Baruch Plan. This proposal also demonstrated path dependence hybridization, but with less specialization than the Baruch Plan in controlling fissile material and global energy development. Stalin's answer to the Plan, delivered on June 19, 1946, by Russian Ambassador to the U.N. Andrei Gromyko, five days after Baruch presented the U.S. plan, essentially ignored the regulatory aspects. It instead called simply for a treaty outlawing the use of atomic weapons. This aspect of the proposal embodied a stratification approach, adding a layer to similar treaties like the Geneva Protocol. However, in that it required the decommissioning of atomic stockpiles three months after its ratification, a position the U.S.S.R subsequently emphasized to the General Assembly, on October 29, 1946 (Hewlett & Anderson, 1961, pp. 583-584, 608), this was also a specialized instrument.

The negotiations that followed were, with the benefit of hindsight, doomed. Because Baruch had personally championed adding the sanctions mechanism to the basic ideas outlined in the *Acheson-Lilienthal Report* and then persuaded Truman to endorse it, little possibility of compromise existed on the U.S. side (Hewlett & Anderson, 1961, p. 574). The U.S. negotiators, inherently anxious over the threat posed by A-bombs wielded by a large, secretive, highly centralized state but buoyed by U.S. technological progress, wrongly judged the country would have the advantage for years and believed that this would benefit them in negotiations. Unable to conceive that the U.S.S.R could match pace, they insisted on the more comprehensive and specialized Baruch Plan, seeing its automatic, non-vetoable sanctions on transgressors as being the only effective policy guarantee. Their carrying most of the U.N. Atomic Energy Commission members with them buoyed their optimism. In fact, the U.S.S.R implemented a crash program to build its own bomb (Gerber, 1982).

The passing of U.N. General Assembly Session 1, Resolution 1, of December 14, on Principles Governing the General Regulation and Reduction of Armaments, which was designed to kick-start U.N. successor conventions to the Hague Conferences and to the work of the League of Nations on disarmament, appeared to indicate some progress in reconciling the U.S. and U.S.S.R proposals (Hewlett & Anderson, 1961, p. 611). However, this was illusory, and the impasse spiraled out of control and into the catastrophe of the Cold War.

To sum up, as reviewed in this section, the splitting of the atom offered, if only briefly, a new paradigm for peace via the Baruch Plan. In terms of Paige's funnel of killing, the Plan was designed to be effective at the structural reinforcement zone by decommissioning atomic weapons and putting the development of atomic energy under U.N. supervision, thereby curtailing an atomic arms race. Although the U.N. Atomic Energy Commission faded into obscurity, officially disbanded in 1952, the Plan's 14 measures eventually inspired many of the basic provisions incorporated into the independent International Atomic Energy Agency (IAEA), founded on July 29, 1957, which according to its Statute seeks to promote the peaceful use of nuclear energy and to prevent any military usage of nuclear weapons. By this time, however, the Cold War was fully underway.

Discussion

The Cost of the Not Acting—The Challenge of Weaponized Fusion

The above suggests that the historical importance of the fusion energy breakthrough will be enormous. To start, like nuclear fission, fusion can and likely will be weaponized. Firstly, theoretically, fusion reactors can be used to breed weapons-grade plutonium. Franceschini et al. (2010) note three main factors govern the likelihood of this possibility: "First, the technological trajectory of global energy policies; second, the management of a peaceful power transition between rising and declining powers; and third, the overall acceptance of the nuclear normative order" (p. 525). Secondly, fusion reactors' main use is as energy sources, which can then be weaponized via propulsion for naval vessels and energy for directed-energy weapons. In NKGPS terms, fusion makes new (or better) weapons available in the killing zone. It seems plausible that the extent to which this occurs is also governed by Franceschini at al.'s three factors, as discussed below. Fusion's attraction is that it possesses intrinsic benefits as compared to fission through lower levels of radiation and improved safety. Fusion reactors may also be cheaper due to a self-contained fuel cycle, e.g., a deuterium-tritium reaction involving tritium breeding. These factors would tend to proliferate fusion as an energy source over fission.

To begin with fusion's impact on the technological trajectory of global energy policies, many countries have made energy an existential security issue. This is mainly because most energy is still fossil fuel-based, which implies exploitation of finite and scarce resources for economic purposes, and potentially an unwelcome reliance on foreign sources (Christou & Adamides, 2013). Christou and Adamides (2013) define energy security as "the ability of states to maintain an uninterrupted supply of energy relative to demand at affordable and relatively stable prices without sudden and significant price increases" (p. 513). They argue that it is related to political, military, technical, economic, and environment sectors, and that energy security is both immanent and immediately severe in its effects. In other words, energy insecurity can affect a state quickly, and frequently with severe effects; ones that can threaten the state's existence.

Within this overall framework of energy securitization, which comprises actors and audiences negotiating discourses, it is also possible, in an extreme situation, for state actors to securitize another state actor's development of a specific type of energy for its own energy security as a military, even existential, threat to their own state in discourses involving both domestic and global audiences: The U.S. and Israel's securitization of Iran's nuclear fission energy industry is such a case (Adiong, 2009). China's development of fusion energy for weaponization potentially fits this situation of an extreme, yet plausible and consequential, example of an energy policy with global military consequences.

We now consider the management of a peaceful power transition between rising and declining powers, namely China and the U.S., both of which can develop and weaponize fusion. Recently, there were strong hints of a descent into a New Cold War mentality impacting trade, e.g., in the Korean Peninsula (Larson, 2020). The public debate over whether the U.S. and China are facing Graham Allison's Thucydides Trap (Allinson, 2017), in which China's rising aspirations pose a challenge to the global hegemonic power and could lead to interstate war, is being played out in the academic literature: The *Chinese Journal of International Politics* recently dedicated an issue to it. What is clear is that China is rapidly increasing its overall naval capability deliberately to overtake the U.S. (Larson, 2020; O'Rourke, 2020a). Here, we briefly outline how fusion can be weaponized for propulsion and energy for a novel first-strike weapon system utilizing magnetic acceleration, the railgun, in this New Cold War. Not previously well described in the academic literature, the fusion-powered railgun could, without a new nuclear normative order being established, result in another arms race.

Presently, many China studies scholars, while acknowledging a sustained New Cold War is possible (the "Churchill Trap"; Yuan, 2018), see a Sino-U.S. interstate war as highly unlikely. One basic argument is that Allison's historical examples are truly historical, and that the era of interstate conflict is over. Additionally, both powers are nuclear, and an escalating Sino-U.S. military conflict is thus theorized to be constrained by mutually assured destruction theory. However, there are credible reasons for a worst-case scenario perfect storm leading to a sub-nuclear interstate confrontation, most likely naval, in the South China Sea (Woodward, 2017; Larson, 2020). Moore (2017) provides seven:

> the bilateral strategic trust deficit, lack of agreement on the nature of the U.S. pivot, recent trends in China's maritime policies, disagreements over cyber security, security dynamics underlying China's Anti-Access/Area Denial and Washington's AirSea Battle strategies, recent trends in Sino-Russian strategic alignment, and Washington's concerns about China's increased defense spending. (p. 98)

In the South China Sea theater, China began militarizing (or defending) the Spratly (Nansha in Chinese) Islands it occupies from 2014, reinforcing its claims to all the Spratly Islands and concomitantly worsening the risk of a flash point (Boquet, 2017). The Spratly Islands are important because of the region's postulated fossil fuel reserves (Owen & Schofield, 2012) that, in an extended trade war, provide an incentive for China to securitize (or defend) the fossil fuel resources. China has now installed a runway on Fiery Cross Reef and a surface-to-air missile system on the contested Woody Island (Tomlinson & Frilling, 2017), threatening U.S. naval air superiority.

A fusion-powered railgun would threaten U.S. naval platforms themselves. Such a development could occur in the 2040s, or potentially earlier in the case of a fusion power race between the U.S. and China. Based on the development of fission, a fusion breakthrough will likely be commercialized and then weaponized around a decade later. The first proof-of-concept of an electricity-producing fission reactor, the X-10 Graphite Reactor at Oak Ridge National Laboratory (ORNL, n.d.), generated steam in 1946. This was followed by the first commercial fission power plant in 1954, at Obninsk (Josephson, 2005) and then in 1958 by the beginning of the construction of the world's first nuclear-powered aircraft carrier, the U.S.S. Enterprise, in service from 1961 to 2012 (Bureau of Naval Personnel, 2012). Especially for naval deployment, fusion reactors may well be preferred over fission ones because of safety and lower costs, meaning greater availability.

This greater availability has implications for the deployment of directed-energy weapons, as well as China's railgun. Both the Chinese and U.S. navies are developing railguns due to their potential to transform warfare tactically, impact theater operations, and affect overall military strategy. In 2018, U.S. concerns emerged over China's development of railguns, which are apparently being field tested (O'Rourke, 2020a). The railgun offers China a sub-nuclear long-range first-strike ship-killing capability, one that is potentially precise enough to disable or degrade an enemy weapons platform without necessarily destroying it, enabling new political options in a theater. Coupling railguns to a compact fusion reactor would provide a sufficient energy source for a railgun battery. Railgun batteries' strategic importance is that they could be used to secure China's long-term dominance over the politically and strategically important Spratly Islands.

Railguns are a cheaper and effective Naval Surface Fire Support long-range weapon which can deliver an undetectable precision first strike at Mach 5 or higher. There are presently no countermeasures, meaning that in terms of offense-defense theory (Glaser & Kauffman, 1998), the railgun contributes towards the likelihood of war. The U.S. Navy's railgun has yet to see sea trials, which are likely to be conducted around 2025 (O'Rourke, 2020b). In contrast, in 2017 China mounted a prototype railgun with speculated capabilities, according to U.S. intelligence, of a range of approximately 108 nautical miles, to the Type 072III landing ship

Haiyang Shan (936) and may have conducted sea trials in 2018 (O'Rourke, 2020a). These developments set the scene for naval railgun warfare from the 2020s onward.

In addition to railguns being mounted on naval platforms, shore-based railgun batteries can be used as defensive artillery against naval power or as a first-strike capability against an aircraft carrier group. This application is suggested by the U.S. Army awarding General Atomics a contract in 2018 to develop mobile railgun artillery, which would be on a smaller scale compared to naval railguns and have a range of approximately 60 miles (Harper, 2018). Ship and shore-based fusion-powered railgun batteries would pose a significant first-strike threat to elements of the U.S. Navy's 7th Fleet, especially when conducting freedom of navigation exercises in the South China Sea (see Freund, 2017). Such systems would transform the nature of the South China Sea theater, as well as other theaters, to the detriment of aircraft carriers, affecting overall U.S. military strategy and global geopolitics.

To conclude this section on the seriousness of a weaponized fusion energy breakthrough, we emphasize three points. The first is that only one major first-strike weapon system, the A-bomb/thermonuclear bomb has not been employed as such in a military theater. A real risk exists that a fusion-powered railgun system will be employed for a first strike because of its inexpensive nature, long range, precision, and ship disabling capability. The second point is that Chinese energy policy securitization introduces a key political dynamic that could lead to a political decision to use force in the South China Sea theater. The third point is that the U.S. is unlikely to accept Chinese superiority in the military applications of fusion. Especially given their major strategic rivalry (Walt, 2020) and the fact that many in the U.S. (45%) now view China as the country's worst enemy (Younis, 2021), a new Churchill Trap (Yuan, 2018) or Iron Curtain between the West's sphere of influence and China's, could then emerge, fueling the new arms race.

The NKGPS QHFIE—A New Baruch Plan for a New Nuclear Normative Order

Turning to the second research question, on how the global peacekeeping community should respond to the fusion energy breakthrough, the third of Franceschini et al.'s (2010) three main factors governing the weaponization of fusion is the overall acceptance of the nuclear normative order. Here, we apply both the NKGPS and QHFIE frames. The present nuclear normative order, governed by the IAEA, is based almost entirely on the governance of nuclear fission, particularly the safe operation of nuclear reactors, the trade in and applications of fissile material, and the treatment of nuclear waste (Fischer, 1997; Elbaradei, 2011). The development of fusion energy is generally viewed positively by actors such as the IAEA because its governance will be safer and simpler (Clery, 2014). However, replacing fossil fuels will be highly disruptive to the global economy, especially for fossil-fuel producing developing countries. As such, some researchers advocate for accelerating the arrival of fusion energy through Global North-South co-development during ITER's prototype-building DEMO phase (Carayannis et al., 2020a; Carayannis et al., 2020b; Carayannis et al., 2022).

Accelerating technology development and deployment in response to climate change is already occurring in initiatives like the International Energy Agency's Commission for Urgent Action on Energy Efficiency (IEA, 2019; Global Commission for Urgent Action on Energy Efficiency, 2020). Moreover, a critical juncture for climate change policy making has already occurred in the world's policy response to the ozone layer crisis. *The Montreal Protocol on Substances that Deplete the Ozone Layer* also governed technology development and transfer to address a global problem (Andersen et al., 2007). In path dependence terms, the Montreal Protocol was a hybridized, specialist protocol that relied on the external legitimacy of the U.N. via the *Vienna Convention for the Protection of the Ozone Layer*. The Montreal Protocol relied on the global ban of chlorofluorocarbons and the rapid development and deployment of a commercially viable new technology for its success (United Nations Environment Program, 2012).

Given these developments, as with the original Baruch Plan, the fusion burning plasma breakthrough creates the opportunity for a new nuclear normative order, a new Baruch Plan, this time based on fusion energy while likewise being oriented towards perpetual peace. Path dependence indicates, as with the Baruch Plan and the Montreal Protocol, this would be a hybridized approach, an innovative specialized policy framework relying upon the external legitimacy of the IAEA, followed by the U.N., and supported by the IAEA. It would be tasked with accelerating the development of fusion energy; ensuring co-development by the Global South in pursuit of a "Future Fusion Economy" that is both competitive with, and complementary to, renewables; and applying it to the grand challenges of climate change, energy for all, and peace, via its accelerated commercialization (Carayannis et al., 2020a; Carayannis et al., 2020b; Carayannis et al., 2022).

If such a framework can be designed and realized, developing fusion energy will mitigate against conflict. As with the original Baruch Plan, incentivization is critical. Beginning with the Global South, G77 co-development of fusion energy through funding around 6-10 competing public- and private-sector cost-sharing DEMO projects up to the sum of around 30 billion dollars over two decades via their sovereign wealth funds lessens the risk of fusion energy's accelerated arrival destabilizing their economies. It achieves this via the Global Commission to Accelerate Fusion Energy providing them with a stake in the new fusion-based

Future Fusion Economy through co-ownership of core fusion energy patents, insuring them against fusion competing with fossil fuels (see Suggested ToR for Global Commission to Accelerate Fusion Energy and Technical Annexes, available at the OSF Storage data repository: https://osf.io/hqzak).

For the West, several of their most advanced public- and private-sector fusion DEMO-phase projects, like the U.K. Atomic Energy Authority Culham Centre for Fusion Energy's Spherical Tokamak for Energy Production project, or TAE Technologies' project in the U.S., could be effectively funded to continuously innovate and engineer fusion reactors. Moreover, co-development grows the market more rapidly as Global South countries not only have a financial stake in sales but also have sufficient knowledge to build and operate their own fusion reactors. This agreement would benefit both the Global South and the mainly Western global fusion innovation ecosystem, like the U.K.'s South West Nuclear Hub. G77 co-ownership of patents would also benefit the global innovation ecosystem, as third-party countries would be less likely to reverse engineer and sell technology to Global South countries that those same countries co-owned.

Finally, in that the global commission would establish ownership of fusion IP and implement a robust sanctions mechanism for breaches of patents, a regime will be established whereby core patents held by Western companies could be securely licensed to China. Sino-U.S. relations should then improve as a new baseline for technological cooperation is developed and implemented, a return to the pathfinding element of fusion as a clean energy technology and basis for science diplomacy (Claessens, 2020). Revisiting the example of the Spratly Islands, the accelerated arrival and commercialization of fusion power in the 2030's-2040's to contribute to transitioning from fossil fuels (National Academies, 2021) would mean a railgun-powered military conflict over the islands would lack political utility. The most dangerous period between the deployment of railgun weapon systems in the 2020s and the burning plasma in the 2030s-2040s, when military planners begin contemplating a fusion-powered railgun arms race, would be governed by work towards the new nuclear order.

In situating NKGPS within the QHFIE framework, we have resurrected the U.S. goal, embodied in the U.N. and in the Baruch Plan, as well as in the Atoms for Peace program and in the ITER project, of a demilitarized world with access to inexpensive energy (Carayannis & Draper, 2021). The fusion energy critical juncture will introduce a genuine scientific paradigm shift (Kuhn, 1970), a term typically overused in the literature but appropriate here as conflict over fossil fuel resources could, within this century, subside. Given so much U.S. foreign policy is geared towards a culture of war in large part due to the securitization of fossil fuel energy

(Marsella, 2011), much U.S. domestic and foreign policy could then shift from a killing-prone nature to a killing-avoiding one within the unfolding fan of nonkilling alternatives. This could result in demilitarizing other societies. Demilitarizing would mean increased funding for public infrastructure and services, enabling the U.S. to revisit welfare reforms abandoned during the rise of its military industrial complex (Hooks & McQueen, 2010). Further, demilitarizing does not present an existential threat to the U.S. military-industrial-congressional complex (MICC) (LeLoup, 2008). The MICC can re-purpose itself for a post-fusion world, towards domestic and foreign aid to coordinate a global Fusion for Peace program to address energy for all and climate change, to ensure planetary defense (National Science and Technology Council, 2018), and to conduct space exploration (Dawson, 2017).

In terms of Paige's funnel of killing, preventing fusion-powered weaponry primarily requires action at the level of the structural reinforcement zone, where socioeconomic arguments, institutions, and material means predispose and support a discourse of killing (Evans Pim, 2012, p. 116, citing Paige, 2009, p. 76). Motlagh (2012, pp. 103–5) states that images of perpetual peace and weapon-free zones matter, as do actions like removing economic support for lethality and protecting human rights. In the U.S., the basic Kantian concept of perpetual peace (Kant, 2003; see Terminski, 2010) translated into President Roosevelt's human security paradigm, as embodied in the 1941 State of the Union address (the Four Freedoms Speech; see Kennedy, 1999) and then eventually into the *Universal Declaration of Human Rights*, adopted by the U.N. General Assembly on December 10, 1948 as Resolution 217, in its 183rd session. Following Motlagh, we emphasize protecting the environment and the ecological responsibility of humanity to manage the planet's climate responsibly in the Anthropocene Era. Consequently, addressing climate change via our hybridized specialist fusion governance instrument, the global commission, also serves as an inspiration for peacebuilding.

A strategic North-South partnership on developing fusion energy that re-engages the U.S. and China in science and energy diplomacy should also stimulate negotiations to use fusion energy for solely peaceful purposes. At the time of the original Baruch Plan, the U.S. and the U.S.S.R, divided by ideological differences, lacked a common language for negotiations. We suggest that negotiations via the Global Commission for Urgent Action on Fusion Energy would start to create that common language. They would lead to a new Baruch Plan via a technical report and business prospectus that employ the NKGPS peacebuilding, life-affirming paradigm of nonkilling, as a science-based philosophy of survival through cooperation that advocates pursuing mutually beneficial goals to overcome deadly antagonisms. This is possible because NKGPS specifically emphasizes that "science provides knowledge for liberation from lethality" and advocates humanity adopting multiple peace-bringing big science projects (Paige, 1996, p. 9).

In other regards, the North-South innovation diplomacy required to rapidly develop and direct fusion energy for peaceful ends would essentially revisit the same basic philosophical arguments regarding realizing perpetual peace that were triggered by the Trinity Test critical juncture, provoking the U.N. normative global governance regime. Once again, a completely novel nuclear energy source will emerge that could be militarized. Once again, there will be a momentous opportunity for peacebuilding, involving the U.S. and the West, the Global South, and China. And once again, the U.S. will be challenged to provide global leadership. Its incentive will be the possibility of revitalizing the flagging Washington consensus-based approach to global development (Löfflman, 2019), fueled by a Fusion for Peace program through a Universal Global Peace Treaty, a successor to the world's first Global Ceasefire, called as a response to Covid-19 (Gifkins & Docherty, 2020). A UGPT could rejuvenate the U.N. System in permitting humanity the opportunity to live without fear, or at least with less fear, while utilizing fusion power to help address climate change and achieve the U.N. Sustainable Development Goal of energy for all, whiling reaching for other goals, like the colonization of space, facilitated by fusion drives (United States Department of Energy, 2021).

Conclusion

This article has answered the kind of research questions that the peacebuilding community must plan for approximately once per century: What will be the historical importance of the fusion energy breakthrough and what should be the role of the peacebuilding community? We outlined, for the first time in the peacebuilding literature, a new Trinity Test-level critical juncture, the burning plasma breakthrough, as well as the massive symbolic and military significance of directed-energy weapons and railguns for their potential as power sources for a novel form of warfare.

The development of fusion energy risks a novel energy source being employed to power a new form of weaponry; threatening a New Cold War fusion-powered arms race; and potentially triggering a South China Sea theater flash point. Simultaneously, our analysis of the Baruch Plan suggests an enormous potential for peacebuilding. We propose an innovation on the 1946 Baruch Plan, a Global Commission for Urgent Action on Fusion Energy—a path dependent hybridized specialist instrument with external legitimacy, which could lead to a global Fusion for Peace program to address energy for all and climate change within this century, and result in a UGPT. In NKGPS terms, this proposed Treaty will promote the societal adoption of the concepts of peace, facilitated by an accelerated, global North-South fusion co-development for peaceful purposes. The Treaty operates in the structural reinforcement zone, creating a new international economic discourse whereby key actors would be less predisposed to condone a discourse of killing.

It is essential to create a new baseline for Sino-U.S. relations incorporating science diplomacy. The present situation, tending towards separate Chinese and U.S. scientific development, creates a bipolar world in which conflict over fossil fuel resources cannot readily be mediated. China now has pariah status in many U.S. circles over human rights, IPR, and trade. Importantly for NKGPS and fusion, the Sino-U.S. oppositional dynamic has also been cemented into science policy, where the development of fusion energy and railguns could harm or benefit humanity. Most notably, in 2011 the U.S. passed a spending bill which prohibited NASA from working with China, shutting China out of the International Space Station (Dawson, 2017, p. 18).

Continued exclusion of China from international high-technology and NASA space projects greatly inhibits humanity's technological development and reinforces an oppositional dynamic between China and other nations engaged in joint international science-based initiatives. Nonetheless, Chinese economic power and technology could assist in highly speculative, expensive ventures potentially involving fusion, like a manned mission to Mars and subsequent Mars colony (Dawson, 2017; NASA, 2018), or a planetary defense system to detect/deflect/destroy near-Earth objects (National Science and Technology Council, 2018). Moreover, a UGPT would mitigate against an AI arms race, as a majoritarian risk-management strategy towards artificial general intelligence could promote the development of a humanitarian, friendly AI (Yudkowsky, 2008; Carayannis & Draper, 2022). Leveraging the burning plasma breakthrough to create a global Fusion for Peace program would inculcate a more peaceful future.

To conclude, humanity is still demilitarizing from a hugely costly nuclear arms race. Another critical juncture involving innovative nuclear energy will arrive soon: It will not be a panacea but could, if anticipated, offer an opportunity to transition the planet's geopolitics towards nonkilling, saving countless lives at a critical time for humanity in a way that could assist with addressing climate change.

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