Journal of Fusion Energy (2023) 42:23
https://doi.org/10.1007/s10894-023-00359-7

GUEST EDITORIAL

Expanding the Cross Section for the Fusion Industry: Regulation and International Coordination Critical to a Viable Global Fusion Energy Sector

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Global attention to climate change and the geopolitics of energy has heightened focus on fusion as a safe, carbon-free, and energy-dense technology.[1] Policymakers in governments around the world have also noticed this excitement, commencing the process of building a legal foundation for the commercialization and widespread deployment of fusion energy systems. Similar to the fission industry and other segments of the energy sector, regulation will have a direct, and possibly dispositive, impact on the likelihood that fusion migrates successfully from the laboratory to the commercial marketplace. This interest has been heightened by exciting experimental results demonstrating ignition in a laboratory setting at the National Ignition Facility in the United States.[2]

The United Kingdom and the United States are emerging as trendsetters for fusion policy. This piece offers a high-level overview of these early efforts.[3] Other jurisdictions are showing interest in fusion energy policy as well, but progress is ostensibly slower and perhaps less urgent, due to the concentration of privately funded fusion developers that have emerged in those two nations in particular. Policymakers are starting to appreciate the differences between fusion and fission; for example, that fusion: (1) presents no risk of criticality or meltdown (2) creates no high-level or long-lived waste stream; and (3) resolves proliferation concerns related to fission's reliance on fissile materials.

Wherever the early commercial fusion energy systems are developed, fusion companies want to export their technologies all over the world, which will subject their technologies to the laws and regulations imposed by local jurisdictions. As these regulations are finalized, stakeholders have an opportunity to shape policy and regulatory outcomes for fusion energy. Commercial deployment of fusion technologies will be most probable, fastest, and safest if countries adopting fusion technology coordinate and collaborate on regulating fusion energy.[4]

UK and US Blazing Regulatory Trail for Fusion

After consulting academia, industry, government agencies, and members of the public, the United Kingdom's Department for Business, Energy & Industrial Strategy (BEIS) published its policy direction for fusion energy on 20 June

[1] Fusion energy companies report an increase of 139% in investment compared to last year. *The Global Fusion Industry in 2022*, Fusion Indus. Ass'n at 6 (July 2022), https://www.fusionindustryassociation.org/about-fusion-industry.

[2] *NIF's Fusion Ignition Shot Hailed as Historic Scientific Feat*, Lawrence Livermore Nat'l Lab. (Dec. 14, 2022), https://lasers.llnl.gov/news/nif-fusion-ignition-shot-hailed-as-historic-scientific-feat.

[3] A decade ago, French authorities applied legacy nuclear fission rules to the ITER fusion experiment that is under construction in Saint-Paul-lez-Durance, France. ITER Licensing Procedure, ITER, http://www.iter.org/faq#Becoming_an_Installation_Nuclaire_de_Base_in_France. However, because no commercial entity is considering prototyping, let alone widespread installation of, a project approaching the size and scale of ITER, many stakeholders have argued that France's approach is not a relevant precedent for global deployment of commercial fusion energy projects.

[4] Beyond fusion, international bodies have recognized the benefits that international coordination has for regulatory development. *See, e.g.,* OECD, Recommendation of the Council on International Regulatory Co-operation to Tackle Global Challenges, OECD/LEGAL/0475, https://legalinstruments.oecd.org/en/instruments/OECD-LEGAL-0475 ("[I]nternational regulatory co-operation has become an essential building block to ensure the quality and effectiveness of regulation today").

This article belongs to the Topical Collection: The emergence of Private Fusion Enterprises article collection, editors Richard Pearson

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Published online: 27 May 2023

2022.[5] BEIS's overall decision is to continue regulation of fusion energy activities and facilities by the UK Environment Agency and the Health and Safety Executive, rejecting the suggestion to treat fusion energy projects as nuclear installations.[6] These two agencies have regulatory authority over fusion research activities in England[7] and will retain this authority over commercial fusion projects brought online in the 2030s-40s.[8] BEIS explains that the Government's own analysis, as well as the majority of the comments it received, support the view that fusion is distinct from fission and therefore the more prescriptive requirements imposed on fission systems are inapposite for fusion.[9] To clarify the legal basis for this decision, the UK Government has proposed legislation to formally exclude fusion energy facilities from the Nuclear Installations Act's full licensing requirements.[10]

Despite the overall decision on fusion policy, BEIS notes that related issues remain under review, including siting and permitting processes, liability regimes, cybersecurity, export control and safeguards.[11] Developing these supporting policies provides opportunities to continue engaging with BEIS and the rest of the UK Government to ensure that the policy outcomes reflect the risks that fusion energy presents, and that legal frameworks are harmonized with those risks in countries around the world.

The United States is arguably behind the UK in formalizing its regulatory strategy for fusion, although US policy development is ongoing. In 2009, the US Nuclear Regulatory Commission (NRC) asserted general jurisdiction over fusion energy activities pursuant to the Atomic Energy Act, although the NRC staff was directed to wait until a "successful testing of a fusion technology" before exerting substantial effort to address regulatory issues associated with fusion.[12] Prompted by Congress,[13] the NRC has initiated a process to establish a regulatory framework for fusion energy.[14] Consistent with the UK's trajectory, many commenters have urged the NRC to separate fusion from the regulation of fission energy systems and maintain the current regulatory approach that has covered fusion research facilities for decades.[15] Indeed it may be that the UK Government's decision to maintain the well-understood regulatory model for commercial fusion energy machines will attract fusion developers towards a more predictable regulatory environment.

Following a substantial public input process, [16] the NRC staff prepared a suite of regulatory options for fusion energy for the NRC Commissioners to consider. NRC staff's options include:[17]

1. regulate fusion energy systems under a "utilization facility" framework, i.e., regulating fusion machines as fission power plants;
2. regulate fusion energy systems under the "byproduct materials" framework, i.e., regulating fusion machines in a similar manner to existing fusion research machines and particle accelerators; or.
3. regulate fusion energy systems pursuant to a hybrid approach, blending the utilization facility and byproduct materials frameworks.

At a public meeting on September 23, 2022, NRC staff indicated that they intend to recommend that the NRC Commissioners adopt an approach in line with option 2. Under this proposed approach, NRC, and 39 of the 50 US states with delegated authority to regulate radioactive "byproduct" materials, would regulate commercial fusion energy machines in the same way that current fusion machines

[5] Towards Fusion Energy: The UK Government's Response to the Consultation on Its Proposal for a Regulatory Framework for Fusion Energy, BEIS (20 June 2022), https://www.gov.uk/government/consultations/towards-fusion-energy-proposals-for-a-regulatory-framework.

[6] *Id.* at 13.

[7] The Environment Agency is responsible for regulating major industry and waste, treatment of contaminated land, water resources, and conservation and ecology in England. About Us, Environment Agency, https://www.gov.uk/government/organisations/environment-agency/about. The Health and Safety Executive bears responsibility for regulating workplace health and safety, as well as supporting public assurance. Our Mission and Priorities, Health and Safety Executive, https://www.hse.gov.uk/aboutus/our-mission-and-priorities.htm.

[8] Id.

[9] Id.

[10] *Id.* at 14. *See also* Energy Bill, 2022-3, H.L. Bill [39] cl. 110 (providing that "fusion energy facilities" are exempt from the requirement to obtain a nuclear site license). As of this writing, the Energy Bill is pending before the UK House of Lords.

[11] Towards Fusion Energy at 16–20.

[12] Regulation of Fusion-Based Power Generation Devices, SECY-09-0064 (July 16, 2009), https://www.nrc.gov/docs/ML0922/ML092230198.pdf.

[13] Nuclear Energy Innovation and Modernization Act, Pub. L. No. 115–439, § 103(a)(4), 132 Stat. 5565, 5572 (2019).

[14] https://www.nrc.gov/reactors/new-reactors/advanced/policy-development/fusion-energy.html. To date, NRC has convened eight public meetings to take testimony on fusion energy.

[15] *See, e.g.*, *Igniting the Fusion Revolution in America*, Fusion Indus. Ass'n at 3 (June 2020), https://www.fusionindustryassociation.org/post/fusion-regulatory-white-paper (advocating for regulatory treatment of commercial fusion activities and related materials similar to that of other particle accelerators).

[16] NRC staff's public outreach process, including six public forums, a joint meeting with the US Department of Energy, and briefings of an NRC advisory committee, is summarized at https://www.nrc.gov/reactors/new-reactors/advanced/policy-development/fusion-energy.html.

[17] Licensing and Regulating Fusion Energy Systems, NRC Staff Prepared White Paper (Sept. 2022), https://www.nrc.gov/docs/ML2225/ML22252A192.pdf.

and more traditional particle accelerators are regulated. NRC staff also indicated that certain limited changes to the existing regulations, such as updated definitions, may be appropriate to clarify the applicability of this longstanding regulatory program to fusion energy. This preliminary approach is broadly aligned with the large majority of public comments offered to NRC staff over the last two and a half years, as well as the UK's approach described above, although further clarity is needed as to what the rulemaking exercise that NRC staff proposes would entail.

Following this extensive public input, NRC Commissioners convened a public meeting to discuss the regulatory framework for fusion on November 8, 2022.[18] NRC staff stated that they were still analyzing the issues around fusion regulation and did not offer a formal recommendation in this meeting, indicating that they expected to complete their analysis before the end of 2022. Despite the tenor of the commissioner briefing and the two-plus years of public meetings suggesting that stakeholders are broadly aligned that the byproduct material approach is appropriate for fusion, the NRC staff's options paper recommended a hybrid approach to combine aspects of both the byproduct material and utilization facility frameworks.[19] Commissioner Annie Caputo has rendered her decision first, deciding that regulating fusion energy via a byproduct materials framework implemented by 10 C.F.R. Part 30 is more appropriate than regulation via a utilization facility model or an undefined hybrid framework.[20] The other four commissioners released their votes on April 14, 2023, unanimously concluding that the materials framework was suited to regulate fusion energy systems and directing Commission staff to implement this decision via a limited update to the NRC's regulations and guidance material. **[[ADD REFERENCE: NRC Staff Requirements Memorandum, SRM-SECY-23-0001 (Apr. 14,2023), https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML23103A449.]]**

Implications for a Globalizing Fusion Industry

Beyond formal regulatory processes, both the United States and the United Kingdom are laying the groundwork for vibrant fusion industries. Building on the success of the Joint European Torus experiment,[21] the UK has established the Spherical Tokamak for Energy Production (STEP) project as a public program to demonstrate the ability to generate net electricity from fusion.[22] In the US, the Biden Administration is developing a decadal vision for commercializing fusion energy[23] and Congress has authorized the creation of at least two national teams to develop fusion power plant designs and technology roadmaps.[24] Both countries are attracting international interest from private fusion energy players.[25] Other countries like Japan,[26] the Republic of Korea,[27] Canada,[28] and the People's Republic of China[29] have all indicated interest in accelerating fusion's commercialization and deployment. The International Atomic Energy Agency (IAEA) notes that more than fifty IAEA member states are researching fusion and plasma physics.[30]

From expertise to capital investment to supply chains, all of these developments suggest that the fusion energy sector transcends national borders and increasingly will globalize

[18] NRC, Briefing on Regulatory Approaches for Fusion Energy Devices (Nov. 8, 2022), https://www.nrc.gov/docs/ML2230/ML22307A042.pdf.

[19] Daniel H. Dorman, *Options for Licensing and Regulating Fusion Energy Systems*, SECY-23-0001 (Jan. 3, 2023), https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML22273A163.

[20] Comm'r Annie Caputo, Response Sheet for SECY-23-0001 (Feb. 8, 2023), https://adamswebsearch2.nrc.gov/webSearch2/main.jsp?AccessionNumber=ML23039A061.

[21] Jonathan Amos, *Major Breakthrough on Nuclear Fusion Energy*, BBC (Feb. 9, 2022), https://www.bbc.com/news/science-environment-60312633.

[22] Spherical Tokamak for Energy Production, UK Atomic Energy Authority, https://step.ukaea.uk/.

[23] *Readout of the White House Summit on Developing a Bold Decadal Vision for Commercial Fusion Energy*, The White House (Apr. 19, 2022), https://www.whitehouse.gov/ostp/news-updates/2022/04/19/readout-of-the-white-house-summit-on-developing-a-bold-decadal-vision-for-commercial-fusion-energy/.

[24] CHIPS and Science Act of 2022, Sect. 10,105(a)(5) (Aug. 9, 2022).

[25] *See, e.g., UKAEA and Commonwealth Fusion Sys. Sign Agreement to Advance Fusion Energy*, UK Atomic Energy Auth. (July 25, 2022), https://www.gov.uk/government/news/ukaea-and-commonwealth-fusion-systems-sign-agreement-to-advance-fusion-energy (announcing a collaboration framework agreement between the UK's Atomic Energy Authority and US-based Commonwealth Fusion Systems to support joint efforts on a range of key fusion issues like fuel cycle technologies and plasma physics questions). *See also First Round 2022 Awards Announced by DOE*, Innovation Network for Fusion Energy (July 6, 2022), https://infuse.ornl.gov/news/first-round-2022-awards-announced-by-doe/ (describing fusion research awards to private firms including UK-based Tokamak Energy, Inc.).

[26] Natsumi Iwata, Japan Seeks Nuclear Fusion Reactor Prototype by Midcentury, Nikkei (Jan. 9, 2022), https://asia.nikkei.com/Business/Technology/Japan-seeks-nuclear-fusion-reactor-prototype-by-midcentury.

[27] MSIT to Present Policy Direction to Lead Fusion Energy Development, Ministry of Science and ICT (Dec. 30, 2021), https://www.msit.go.kr/eng/bbs/view.do?sCode=eng&mId=4&mPid=2&pageIndex=&bbsSeqNo=42&nttSeqNo=607&searchOpt=ALL&searchTxt.

[28] CNSC Regulatory Approach for Fusion Related Activities, Canadian Nuclear Safety Comm'n (Oct. 6, 2020), https://science.osti.gov/-/media/fes/pdf/2020/NRC-Public-Forum/AS1_B.pdf?la=en&hash=087484700439C8F09E23F4B409E88BBE9D6701DA.

[29] Compact Fusion Tech., ENN ENERGY RESEARCH INST., http://en.ennresearch.com/researchfield/Compactfusion/.

[30] Fusion, Int'l Atomic Energy Agency, https://www.iaea.org/topics/fusion.

as the sector matures. Appropriate regulation, calibrated to the risks fusion presents and harmonized across borders, will support adoption and broad acceptance of fusion technology and increase the chances that fusion energy will grow into a global, and world-changing, industry. The UK's regulatory framework and the current proposals in the US represent examples that all governments should consider as they develop their own regulatory strategies to support fusion energy. Much work remains to further clarify regulatory requirements for fusion and it is likely that these regulatory conversations will evolve dynamically over the coming years as fusion technology matures and all stakeholders gain more familiarity with commercial fusion energy systems. But there is no doubt that regulatory coordination and collaboration are necessary tools to ensure that the world reaps the benefits of its decades of substantial investment in fusion to mitigate climate change and create energy security and abundance for all of humanity.