

Bringing Fusion to the U.S. Grid (2021)

R. J. Hawryluk¹

On behalf of the Committee on the Key Goals and Innovations Needed for a U.S. Fusion Pilot Plant

¹ Princeton Plasma Physics Laboratory, Princeton NJ

e-mail (speaker): rhawrylu@pppl.gov

The combination of scientific progress in fusion and the changing electrical landscape in the United States has motivated this study¹ to examine the key goals and innovations needed to build a fusion pilot plant. The 2019 National Academies of Sciences, Engineering, and Medicine report of the Committee on a Strategic Plan for U.S. Burning Plasma Research² described the progress in fusion and developed a strategic plan to guide implementation of its two main recommendations:

- First, the United States should remain an ITER partner as the most cost-effective way to gain experience with a burning plasma at the scale of a power plant.
- Second, the United States should start a national program of accompanying research and technology leading to the construction of a compact pilot plant that produces electricity from fusion at the lowest possible capital cost.

The second recommendation motivated, in part, this study. The other motivation is associated by the changes in the electrical industry due to the on-going transition to low-carbon and non-carbon emission technologies that has resulted in increased fusion funding from private investors. In a request from DOE, the National Academies' Committee on the Key Goals and Innovations Needed for a U.S. Fusion Pilot Plant was asked to build upon the work of the Burning Plasma report by identifying the key goals and innovations—independent of confinement concept—that are needed to support the development of a U.S. fusion pilot plant during each of its phases of operation. The committee obtained valuable input from a broad range of stakeholders.

Discussions with utility owners identified that utilities are planning on making major changes to the mix of electrical generation infrastructure to reduce carbon emission by 2050. The foreseen increased investment in modernizing their electrical production fleet provides an opportunity for fusion to contribute. This led to the committee's first recommendation.

Recommendation: For the United States to be a leader in fusion and to make an impact on

the transition to a low-carbon emission electrical system by 2050, the Department of Energy and the private sector should produce net electricity in a fusion pilot plant in the United States in the 2035-2040 timeframe.

An engineering design is the basis for determining costs and developing a schedule for a fusion pilot plant. The creation of national teams is imperative to begin the design work and to identify critical technology requirements. This led to the committee's second recommendation.

Recommendation: The Department of Energy should move forward now to foster the creation of national teams, including public-private partnerships, that will develop conceptual pilot plant designs and technology roadmaps and lead to an engineering design of a pilot plant that will bring fusion to commercial viability.

This plan is more aggressive, thus higher risk, than that in the Burning Plasma report, since it is motivated by the needs of the electrical marketplace to make significant investments in low-carbon and non-carbon emission electricity. This results in the following conclusion:

Conclusion: Successful operation of a pilot plant in the 2035-2040 timeframe requires urgent investments by DOE and private industry—both to resolve the remaining technical and scientific issues and to design, construct, and commission a pilot plant.

References

- [1] National Academies of Sciences, Engineering, and Medicine, 2021 Draft Report of the Committee on the Key Goals and Innovations Needed for a U.S. Fusion Pilot Plant
<https://www.nationalacademies.org/our-work/key-goals-and-innovations-needed-for-a-us-fusion-pilot-plant>
- [2] National Academies of Sciences, Engineering, and Medicine, 2019, Final Report of the Committee on a Strategic Plan for U.S. Burning Plasma Research, The National Academies Press, Washington, DC, doi: <https://doi.org/10.17226/25331>, p. 1.