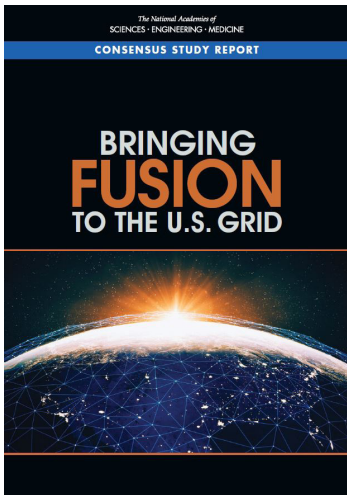




February 2021

Bringing Fusion to the U.S. Grid



Fusion energy could provide a future source of non-carbon emitting electricity generation for the United States and play a role in the nation's transition to a net-zero emissions electricity infrastructure. With the international fusion experiment known as ITER scheduled to begin operations within the next decade, many partner countries are already undertaking large efforts to capitalize on their involvement and develop their own nuclear fusion capabilities to generate electricity. Results from U.S. investments in ITER, coupled with a strong foundation of research funded by the Department of Energy (DOE), position the United States to begin planning for its first fusion pilot plant.

ITER is an experiment designed to show that fusion can (a) produce a burning plasma in which the reaction is sustained by internal heating, (b) study the underlying physics, and (c) test important technologies for a fusion power plant. A

U.S.-based fusion pilot plant would aim to produce net electricity from fusion over longer periods of time, test integration with the U.S. electric grid, and provide the technical and economic information for a future “first-of-a-kind” commercial power plant. Strong interest from the private sector motivates development of a fusion pilot plant, as companies seek to lead the way towards decarbonizing and modernizing the nation's energy system. Discussions with utility operators also indicate that a pilot plant operating during this timeframe by 2050 creates an opportunity to support the transition to low-carbon energy systems.

At the request of DOE, the National Academies of Sciences, Engineering, and Medicine were asked to identify the key goals and innovations needed to support the development of a U.S. fusion pilot plant. This report presents a strategic plan for the design, construction, and operation of a fusion pilot plant with the objective of producing electricity in the 2035-2040 timeframe. Although there are multiple possible approaches for achieving fusion, this plan is meant to be broadly applicable for whichever design emerges as the most technologically and economically feasible.

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.*

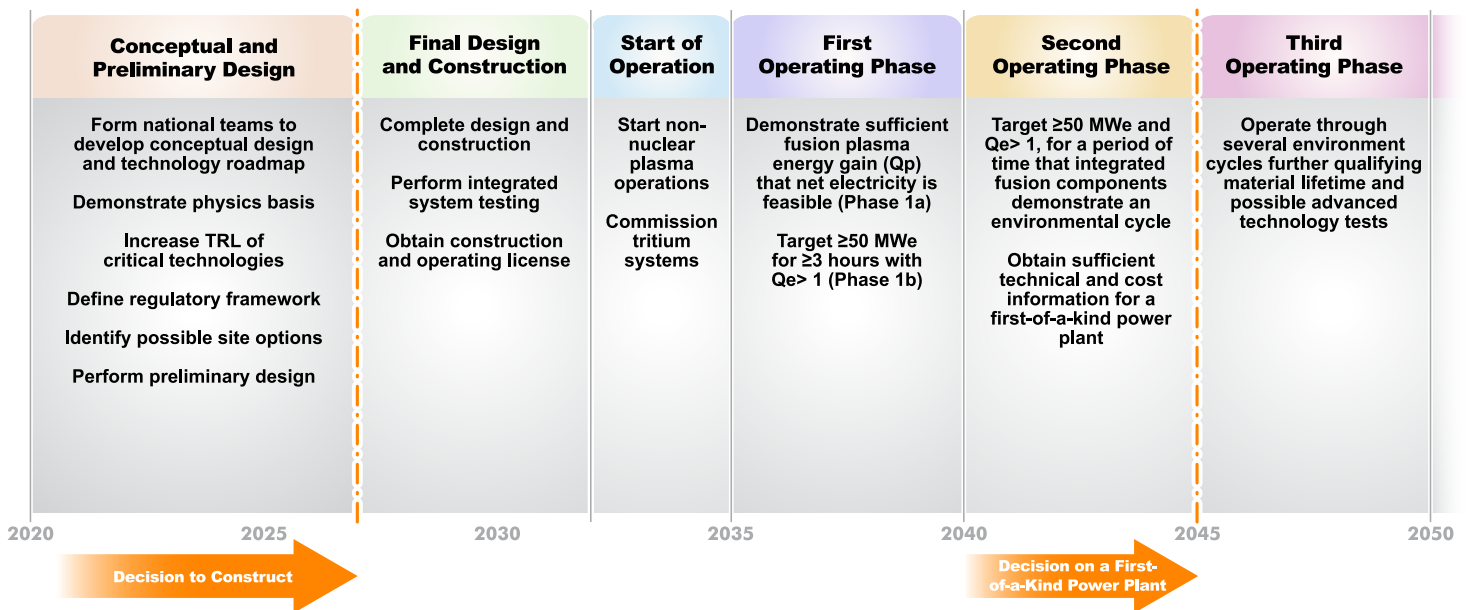
Developing a fusion pilot plant will require a wide range of cutting-edge skills from researchers and engineers in industry, national laboratories, and universities. The creation of interdisciplinary teams is imperative to begin the design work and to identify critical technology requirements.

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.

The U.S. fusion community has been a pioneer in fusion research since its inception and now has the opportunity to bring fusion to the marketplace. However, utilizing fusion as an energy source will require the resolution of significant technical, scientific, and economic risks. The United States can be a global leader in the face of strong competition around the world if the nation can overcome these risks and provide the resources for a fusion pilot plant as outlined in this report.

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.

The phases, major goals, and approximate timeline for developing the first U.S. fusion pilot plant.



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