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Hearing on *Fostering a New Era of Fusion Energy Research and Technology Development*
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Chairman Bowman, Ranking Member Weber, and Members of the Committee, thank you for holding this hearing and providing me and my colleagues with the opportunity to testify. My name is Troy Carter, and I am the Director of the Plasma Science and Technology Institute and a Professor in the Department of Physics and Astronomy at UCLA. I serve on the DOE Office of Science's Fusion Energy Sciences Advisory Committee (FESAC). I am speaking today in my capacity as an academic researcher and am not here to formally represent FESAC or UCLA.

I recently chaired a FESAC subcommittee that was charged with developing a Long Range Plan for Fusion Energy and Plasma Science research for the Department of Energy Fusion Energy Sciences. The resulting consensus report, *Powering the Future: Fusion and Plasmas*[1], was the result of a two-year strategic planning process with strong engagement from the entire research community, including universities, national labs and industry. The report presents a 10-year strategy for both fusion energy development and for advancing plasma science and related technologies. Fusion and plasma research are inextricably intertwined. In fusion reactions, which power the stars, light nuclei (e.g. hydrogen isotopes) merge to form heavier nuclei (e.g. Helium) and energy is released. In a star, and in fusion reactors on Earth, the fusion fuel is in the plasma state: a super-heated, ionized gas. Advances in fundamental plasma physics are central to the progress that has been made toward realizing fusion energy on Earth. The link between fusion and plasmas is strong but does not fully define either one. Fusion energy requires research into and development of materials that can survive the extreme conditions of a fusion reactor, into technologies for breeding fusion fuel, and into enabling technologies such as magnets. The field of plasma science and engineering is intellectually diverse, is highly interdisciplinary, and has myriad applications beyond fusion energy. I will focus my brief comments here on the fusion energy strategy outlined in the report, but I would be happy to take questions on broader plasma science and engineering.

The main message of my remarks is that *now is the time* to move aggressively toward the development and deployment of fusion energy. Fusion energy will provide carbon-free, safe electricity generation that can substantially power society and mitigate climate change. Why are we confident that now is the right time? Important scientific and technological progress, coupled with a strongly growing private sector, positions us to realize a unique US vision for economical fusion energy with the goal of an electricity-producing fusion pilot plant. This unique US vision was first laid out in the 2019 National

[1] https://usfusionandplasmas.org

Academies of Sciences, Engineering, and Medicine (NASEM) report *A Strategic Plan for US Burning Plasma Research*[2] and is endorsed by our report and also by the 2021 NASEM report *Bringing Fusion to the US Grid*[3].

The strong and steady support for fusion energy research, including from this committee and Congress, has enabled important recent scientific progress and breakthroughs. Several examples of important progress, e.g. advances in our understanding of fusion plasmas and achievement of new performance records, are discussed in the report and will also be discussed in this hearing by Prof. Cowley. Here I'll offer two highlights that have occurred since the report was published. First is the recent breakthrough at the National Ignition Facility, just this past summer, where extremely high fusion gain was achieved, enabled by recently acquired scientific understanding. Dr. Ma will discuss this very important result. Second is the recent demonstration by Commonwealth Fusion Systems of a high-temperature superconducting (HTS) magnet, the largest in the world, operating at 20T (about 10x stronger than a typical MRI magnet). Dr. Mumgaard will discuss this breakthrough that is a game-changer for fusion.

Alongside this technical progress, we've seen rapid growth of private-sector investment in fusion energy. The ultimate goal of fusion energy research in the US is the development of a US commercial fusion power industry and that fusion energy industry is already taking root. At the time of the writing of our report about $2B had been invested worldwide in fusion energy development in the private sector, resulting in the launch of several start-up fusion energy companies. Significant new investment has occurred since, with $0.5B of new funding announced just in the last few weeks. This investment has enabled start-up companies to make impressive and rapid progress on the development of new fusion demonstration facilities and to create advanced enabling technologies for fusion such as the recent HTS magnet demonstration. The scientific progress and technical know-how developed through the federally-supported research program enabled the founding of these startup companies and we now have the opportunity to amplify federal investment through partnering with the private sector. Through partnership, we can accelerate the timeline to and reduce the cost of developing fusion electricity. Internationally, the United Kingdom and China have already established multi-hundred-million-dollar partnership programs and, through them, have successfully attracted private fusion energy companies. It is imperative that the US develops and implements new models, and strengthens existing ones, for partnerships between the public and private sectors to accelerate the development of fusion power in the US. This is critical to maintain a leadership position in the emerging fusion energy industry.

The consensus FESAC long range planning report makes recommendations for actions that DOE should take to re-orient the US fusion research program toward the rapid development of fusion energy. It enumerates and prioritizes urgently needed research programs and experimental facilities. The report recommends continued and strengthened partnership with the private sector and with our international colleagues, especially through the ITER project that Dr. McCarthy will discuss. This committee and Congress had implored our community to come together and create a new strategic plan for fusion. We

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[2] National Academies of Sciences, Engineering, and Medicine. 2019. Final Report of the Committee on a Strategic Plan for U.S. Burning Plasma Research. Washington, DC: The National Academies Press. https://doi.org/10.17226/25331.

[3] National Academies of Sciences, Engineering, and Medicine. 2021. Bringing Fusion to the U.S. Grid. Washington, DC: The National Academies Press. https://doi.org/10.17226/25991.

have now answered that charge and speak with one voice in support of the resulting strategic plan. Now is the time to act: *we need to implement the plan.* I want to thank this committee for authorization language in the "DOE Science for the Future Act" and language in the current reconciliation bill that is well aligned with the priorities expressed in our report. We're ready to get to work on making fusion power a reality and look forward to DOE implementing our plan. I look forward to answering your questions. Thank you.