IGNITING AMERICA'S ENERGY FUTURE: THE PROMISE AND PROGRESS OF FUSION POWER

HEARING

BEFORE THE

SUBCOMMITTEE ON ENERGY

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

OF THE

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C O N T E N T S

September 18, 2025

IGNITING AMERICA'S ENERGY FUTURE: THE PROMISE AND PROGRESS OF FUSION POWER

THURSDAY, SEPTEMBER 18, 2025

House of Representatives,
Subcommittee on Energy,
Committee on Science, Space, and Technology,
Washington, D.C.

The Subcommittee met, pursuant to notice, at 10 a.m., in room 2318, Rayburn House Office Building, Hon. Randy Weber (chairman of the Subcommittee) presiding.

COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY
CHAIRMAN BRIAN BABIN

SUBCOMMITTEE ON ENERGY

HEARING CHARTER

Igniting America's Energy Future: The Promise and Progress of Fusion Power

Thursday, September 18, 2025
10:00 a.m.
2318 Rayburn House Office Building

Purpose
The purpose of this hearing is to explore the current fusion energy research and development landscape in the United States. This hearing will examine where the federal government still needs to play a role in filling key technical challenges that remain, and where fusion energy has the potential to transform the energy sector.

Witnesses
- **Dr. Stephanie Diem**, Assistant Professor, University of Wisconsin-Madison
- **Dr. Will Regan**, Founder & President, Pacific Fusion
- **Dr. Troy Carter**, Director of Fusion Energy Division, Oak Ridge National Laboratory
- **Dr. Bob Mumgaard**, Co-Founder and CEO, Commonwealth Fusion Systems

Overarching Questions
- What role should the Department of Energy (DOE) and the federal government as a whole play in the commercialization of fusion energy?
- What research areas should the DOE target to help facilitate the continued rapid development and discovery in fusion sciences?
- How are private-public partnerships addressing the hurdles facing the commercialization of fusion energy?
- How does the Chinese Communist Party's (CCP) fusion energy push fit into their broader strategy to challenge American global scientific leadership?

Background
The pursuit of a fusion-based reactor represents our attempt to replicate the power of a star on Earth. By definition, a star is plasma held together by its own gravity, and in its core, these gravitational forces create very high pressures and temperatures.[1] Our sun has an internal temperature of 27 million degrees Fahrenheit and a core pressure equal to approximately 340 billion times the Earth's atmospheric pressure.[2,3] Under these extreme conditions, hydrogen atoms in the sun's core are compressed and ultimately fused, a process that releases a large amount of energy in the form of gamma-ray photons and neutrinos.[4] This fusion energy travels to the sun's surface and is the source of its luminosity.[5]

For decades, scientists and engineers have pushed the boundaries of experimental physics to duplicate this reaction and harness it as an energy source. The potential benefits to society from a fusion reactor are beyond calculation: the fuel is abundant and widely accessible, the carbon footprint is negligible, and its associated nuclear waste and nonproliferation concerns are minimal.[6] Despite these incentives, and despite recent landmark achievements in the field, fusion energy science remains one of the most challenging areas of experimental physics today.

A key benchmark for the achievement of nuclear fusion in a terrestrial reactor is called "ignition." This is defined as the point at which the products of the fusion reaction are sufficient to maintain the temperature of the plasma and the reaction itself without external power input.[7] In other words, ignition is reached when the reaction generates more energy than it consumes.

Generally, these conditions required to sustain this reaction are described as: temperature (T), plasma density (n), and confinement time (t). Over the past 50 years, (n) and (T) have been reasonably well defined.[8] A central remaining challenge in fusion energy science is the third quantity: (t).[9] This refers to the residence time of the fusion products inside the plasma of reacting ions.[10] To generate a substantial amount of power, time is needed to allow fusion reactions to occur.[11] Inside our sun, gravitational confinement is sufficient to fulfill this requirement. On Earth, other mechanisms of confinement are required.

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[1] Sharp, Tim, and Ailsa Harvey. "What Is The Sun Made Of?" *Space*, 27 Jan. 2022, www.space.com/17170-what-is-the-sun-made-of.html.
[2] Hathaway, Dr. David H. "NASA/Marshall Solar Physics." *NASA*, 14 Jan. 2025, solarscience.msfc.nasa.gov/interior.shtml.
[3] Treybick, Marina. "Pressure at the Center of the Sun." *The Physics Factbook*, 1997, hypertextbook.com/facts/1997/MarinaTreybick.shtml.
[4] *Supra 1*
[5] "Fusion Energy Sciences." *U.S. Department of Energy*, 18 May 2019, www.energy.gov/science/fes/fusion-energy-sciences.
[6] Morgan, Daniel. "Fusion Energy." *Congressional Research Service*, 24 May 2023, www.congress.gov/crs-product/IF12411.
[7] "Fusion and Ignition." National Ignition Facility & Photon Science, 18 Sept. 2019, lasers.llnl.gov/science/ignition.
[8] "Lawson Criteria: Overview." *FENi*, 2023, www.fusion-energy-news.com/lawson-criteria-overview.
[9] Harack, Benjamin. "Derivation of Lawson Criterion for D-T." *Vision of Earth*, 14 Apr. 2010, www.visionofearth.org/wp-content/uploads/2010/11/LawsonCriterion.pdf.
[10] *Supra 8*
[11] *Id.*

The two mainstream mechanisms for confinement are inertial and magnetic. Inertial fusion applies a rapid pulse of energy to a small sample of fusion fuel, causing this fuel to implode, heating it to very high temperatures and compressing it to very high densities simultaneously.[12] Magnetic fusion reactors confine plasma with magnetic fields generated by running an electric current through the plasma itself. There are a variety of fusion reactor approaches, including combinations of these two mechanisms. For example, magnetic fusion reactors use several different architectures to approach adequate confinement: the tokamak, spherical torus, and stellarator are examples of geometries that are currently utilized by the fusion research community.[13]

Using these mechanisms, fusion power has been generated in a laboratory setting previously, but fusion ignition, or the production of more energy from the reaction than was required to initiate it, was not accomplished until December 5, 2022, when the United States became the first country to do so.[14] On June 22, 2025, a Los Alamos National Laboratory-led team at the National Ignition Facility (NIF) achieved burning plasma, a self-sustaining feedback loop for a fusion reaction, a feat that no other country or company has been able to accomplish.[15]

Due to the vast complexity of these experiments, fusion energy science is a heavily interdisciplinary endeavor. The push for the construction of a successful fusion reactor, while worthwhile in its own right, can also drive technological and scientific advances in several fields, including plasma science in astronomy, superconducting magnet research, complex cryogenic systems, vacuum technologies, artificial intelligence, robotics, and high-performance computing.[16]

Department of Energy Fusion Research Programs and Facilities

DOE supports fusion energy science research primarily through the Fusion Energy Sciences (FES) program within the Office of Science. The mission of the FES program is to expand the fundamental understanding of matter at very high temperatures and densities, build the scientific foundations needed to develop a fusion energy source, and promote the advancement of a competitive fusion power industry in the U.S.[17] To support this mission, FES is the largest federal sponsor of research aimed at addressing the remaining challenges in fusion energy research and development (R&D).[18]

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[12] "What Is Fusion?" *DIII-D National Fusion Facility*, 23 Sept. 2023, d3dfusion.org/what-is-fusion/.
[13] "Fusion Power." *Princeton Plasma Physics Laboratory*, 18 Oct. 2011, www.pppl.gov/sites/g/files/toruqf286/files/2021-04/FUS_PWR_FACTSHEET_0.pdf.
[14] Bishop, Breanna. "Lawrence Livermore National Laboratory Achieves Fusion Ignition." *Lawrence Livermore National Laboratory*, 14 Dec. 2022, www.llnl.gov/article/49306/lawrence-livermore-national-laboratory-achieves-fusion-ignition.
[15] "Achieving Fusion Ignition." *National Ignition Facility & Photon Science*, 27 Aug. 2025, lasers.llnl.gov/science/achieving-fusion-ignition.
[16] *Supra 7*
[17] "FES Building Bridges Vision." *U.S. Department of Energy*, 5 June 2024, www.energy.gov/sites/default/files/2024-12/fes-building-bridges-vision_0.pdf.
[18] *Supra 5*

In May 2023, the Office of Science released its fusion energy vision.[19] The vision identified three strategic actions to help bridge the interests of the private fusion energy sector and the public programs supported by the Office of Science: creating a U.S. Fusion Science & Technology Roadmap; establishing Fusion Innovation Research Engine Ecosystems; and developing a public-private consortium framework supporting fusion energy development.

In June 2024, DOE released its Fusion Energy Strategy for that year.[20] The strategy provided three high-level objectives for accelerating the viability of commercial fusion energy in partnership with the private sector: close the Science and Technology (S&T) gap to a commercially relevant fusion pilot plant; prepare the path to sustainable, equitable commercial fusion development; and build and leverage external partnerships.

Lawrence Livermore National Laboratory (LLNL)

After decades of work, NIF, located at Lawrence Livermore National Laboratory (LLNL), achieved fusion ignition on December 5, 2022. This was the first instance of net-positive fusion being achieved anywhere in the world. Since then, NIF has continued refining its ignition capability. Thus far, NIF has had nine successful fusion ignitions and has continued to set new records in energy yield and target gain. On April 7, 2025, NIF set its most recent record with a yield of 8.6 megajoules (MJ), as NIF's lasers delivered 2.08 MJ of energy to the target, producing a target gain of 4.13.[21] In partnership with Los Alamos National Laboratory (LANL), the ninth ignition experiment at NIF successfully created a self-sustaining feedback loop called burning plasma.[22]

Princeton Plasma Physics Laboratory (PPPL)

PPPL is a DOE National Laboratory that houses the National Spherical Torus Experiment – Upgrade (NSTX-U). NSTX-U is the world's most powerful spherical tokamak.[23] Unlike other tokamaks, which are shaped like a donut, the spherical torus confinement configuration is similar to a cored apple. Its compact design allows it to serve as a model for a fusion pilot plant.[24]

After undergoing a series of upgrades, NSTX-U is slated to be online at the beginning of 2026. These upgrades doubled the magnetic field, plasma current, and auxiliary heating power of the device while extending the plasma pulse length by nearly a factor of five.[25]

[19] "FES Building Bridges Vision." *U.S. Department of Energy*, 5 June 2024, www.energy.gov/sites/default/files/2024-12/fes-building-bridges-vision_0.pdf.
[20] "Fusion Energy Strategy 2024." *U.S. Department of Energy*, 6 June 2024, www.energy.gov/sites/default/files/2024-06/fusion-energy-strategy-2024.pdf.
[21] *Supra 16*
[22] *Id.*
[23] "National Spherical Torus Experiment – Upgrade (NSTX-U)." *U.S. Department of Energy*, 12 Nov. 2024, science.osti.gov/fes/Facilities/User-Facilities/NSTX-U.
[24] "National Spherical Torus Experiment-Upgrade (NSTX-U)." *Princeton Plasma Physics Laboratory*, 19 Nov. 2012, www.pppl.gov/nstx-u.
[25] *Supra 24*

General Atomics

The DIII-D National Fusion Facility is housed at General Atomics' San Diego, California, facility. This is the largest magnetic fusion user facility in the U.S., utilizing a tokamak confinement device with engineering flexibility to explore the optimization of the advanced tokamak approach to fusion energy production.[26]

The world-leading research at DIII-D provides a plethora of value across fusion science, including solutions to physics and operations issues critical to the success of the International Thermonuclear Experimental Reactor (ITER), developing the physics basis for steady-state tokamak operation required for efficient power production, contributing to the technical basis for a Fusion Nuclear Science Facility (FNSF), and advancing the fundamental understanding and predictive capability of fusion science.[27]

Other Facilities

The Department of Energy also has other facilities and projects that will play a critical role in the development of fusion energy. This includes the Linac Coherent Light Source-II (LCLS-II) facility at SLAC National Laboratory, a world leader in laser technology, allowing researchers to study atomic motions and how they interact to learn if they can be controlled.[28] Located at Oak Ridge National Laboratory, the Material Plasma Exposure eXperiment (MPEX) project will play a crucial role in the development of materials science for fusion energy.[29] Plasma Materials Interactions (PMI) are a critical junction within fusion research due to materials facing temperatures hotter than the center of the sun and magnetic fields thousands of times stronger than the Earth's. MPEX is a next-generation linear plasma device that will allow researchers to study, develop, and test materials that will interact with plasma and to create components that will last long-term in future fusion reactors.[30]

The International Thermonuclear Experimental Reactor (ITER)

The ITER project is a major international scientific collaboration between the European Union, Japan, South Korea, the CCP, India, the Russian Federation, and the United States to design, build, and operate a first-of-a-kind research facility to achieve and maintain burning plasma. Once complete, ITER will house the world's largest tokamak and will have five times the plasma volume of the largest machine operating today.[31]

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[26] "DIII-D National Fusion Facility (DIII-D)." *U.S. Department of Energy*, 30 Aug. 2024, science.osti.gov/fes/Facilities/User-Facilities/DIII-D.
[27] *Id.*
[28] "LCLS-II: A World-Class Discovery Machine." *SLAC National Accelerator Laboratory*, 21 Aug. 2023, lcls.slac.stanford.edu/lcls-ii.
[29] "MPEX." *Oak Ridge National Laboratory*, 26 June 2025, mpex.ornl.gov/.
[30] "The Device." *Oak Ridge National Laboratory*, 16 Dec. 2021, mpex.ornl.gov/the-device/.
[31] "In a Few Lines." *ITER*, 20 May 2025, www.iter.org/few-lines.

The ITER tokamak is a unique experimental tool. It has been designed specifically to: achieve a deuterium-tritium (DT) plasma in which fusion conditions are sustained mainly through internal fusion heating; generate 500 megawatts (MW) of fusion power in its plasma; contribute to the demonstration of the integrated operation of technologies for a fusion power plant; test tritium breeding; and demonstrate the safety characteristics of a fusion device.[32]

Role of Government

The federal government is uniquely positioned to address several R&D gaps in fusion energy development that private industry is unable to solve alone, particularly in the materials development and plasma physics space. For example, the federal government builds and operates testing facilities that no individual private company could maintain; can support decades-long basic research with no commercial application; and can develop specialized workforce training programs at the scale needed across universities and the national laboratories.

Public-Private Partnerships

In November 2024, DOE announced a $5 million public-private partnership program funded through the Innovation Network for Fusion Energy (INFUSE) to accelerate fusion research.[33] The goal of INFUSE is to accelerate fusion energy development in the private sector by reducing barriers to collaboration between the private sector and national laboratories or universities. In September 2025, DOE announced an additional $6.1 million to fund twenty more projects.[34]

Milestone-based Fusion Development Program

Modeled after the NASA Commercial Orbital Transportation Services (COTS) program, eight privately funded fusion companies were selected to pursue both S&T and business/commercialization milestones. Upon completion of each milestone, through an independent expert review process, the company receives its negotiated federal payment. The company is required to provide more than 50% of the cost to meet the milestone. Milestone awardees have collectively raised over $350 million of new private funding since their selection into the program, compared to the $46 million of federal funding initially committed for negotiated milestones, helping successfully de-risk multiple fusion-development paths.[35]

[32] *Id.*

[33] "Department of Energy Announces $5 Million for Fusion Research via Public-Private Partnerships*." U.S. Department of Energy*, 26 Nov. 2024, www.energy.gov/science/articles/department-energy-announces-5-million-fusion-research-public-private-partnerships.

[34] "Department of Energy Announces $6.1 Million to Fund Public Private Partnerships for Fusion Research." *U.S. Department of Energy*, 10 Sept. 2025, science.osti.gov/-/media/funding/pdf/Awards-Lists/2025/INFUSE_25_Awards-List-Spreadsheet_Draft.pdf.

[35] "U.S. Department of Energy Announces Selectees for $107 Million Fusion Innovation Research Engine Collaboratives, and Progress in Milestone Program Inspired by NASA." *U.S. Department of Energy*, 16 Jan. 2025, www.energy.gov/articles/us-department-energy-announces-selectees-107-million-fusion-innovation-research-engine.

Fusion Innovative Research Engine (FIRE) Collaboratives

The FIRE Collaboratives aim to create a fusion energy S&T innovation ecosystem by forming virtual, centrally managed teams called "Collaboratives" whose goal is to bridge FES's basic science programs with fusion industry needs. In January 2025, six projects were selected and awarded $43 million, with the total funding of FIRE collaboratives to reach $180 million over four years. These selected projects cover a diverse set of fusion concepts, from nuclear blanket testing capabilities, materials development, and fusion fuel-cycle testing capabilities.[36] In September 2025, the Department announced a further $128 million to seven teams.[37]

Innovative and Novel Computational Impact on Theory and Experiment (INCITE) Program

The DOE's Office of Science INCITE program provides access to a portfolio of high-performance computing facilities and supercomputers. INCITE aims to accelerate scientific discovery and technological innovation by granting access to time on supercomputers to researchers with large-scale, computationally intensive projects that address "grand challenges" in science and engineering.[38] The 2025 awardees contained fusion projects that are continuations of previous INCITE projects as well as novel project ideas.[39]

Advanced Research Projects Agency-Energy (ARPA-E)

ARPA-E, the DOE's high-risk, high-reward program, has funded 16 fusion projects spanning seven ARPA-E programs over the past 11 years. Over the last seven years, seven new companies have been formed because of ARPA-E research, and over $743 million of private funding has been raised as a result of ARPA-E fusion awards.[40]

Recent Developments

In July 2025, Helion Energy, a fusion power startup, announced the start of construction on its first planned power production reactor in Washington State.[41] The power plant is expected to

[36] ."Department of Energy Announces $43 Million for Fusion Innovation Research Engine Collaboratives." *U.S. Department of Energy*, 17 Jan. 2025, science.osti.gov/Funding-Opportunities/-/media/funding/pdf/Awards-Lists/2025/Awards-List-Spreadsheet-3361-FIRE-Collaboratives-v2.pdf.

[37] "Department of Energy Announces $128 Million for Research on Fusion Innovation Research Engine Collaboratives." *U.S. Department of Energy*, 9 Sept. 2025, science.osti.gov/-/media/funding/pdf/Awards-Lists/2025/Awards-List-Spreadsheet-FIRE-20-v3.pdf.

[38] "About INCITE." *U.S Department of Energy INCITE Leadership Computing*, Mar. 2024, doeleadershipcomputing.org/about/.

[39] "2025 INCITE Fact Sheets." *U.S Department of Energy INCITE Leadership Computing*, 17 Nov. 2024, doeleadershipcomputing.org/wp-content/uploads/sites/123/2024/11/2025INCITEFactSheets.pdf.

[40] "ARPA-E Fusion Overview 2025 Fusion Annual Meeting." *ARPA-E*, 5 Aug. 2025, arpa-e.energy.gov/sites/default/files/2024-08/Day1_01_Diallo_Staff.pdf.

[41] Behr, Peter, and Christa Marshall. "Startup Begins Work on US Fusion Power Plant. Yes, Fusion." *E&E News*, 1 Aug. 2025, www.eenews.net/articles/startup-begins-work-on-major-us-fusion-power-plant-yes-fusion/.

produce at least 50 MW of power and is on track to deliver electricity to Microsoft in three years under a purchase agreement.

In August 2025, Commonwealth Fusion Systems announced it had raised an additional $863 million in fundraising.[42] A long list of investors, including Nvidia, Google, and Breakthrough Energy Ventures, led this recent round of funding.[43] To date, the company has raised nearly $3 billion, the most of any fusion startup.[44]

CCP Challenge

Fusion energy has the potential to reshape global geopolitics, and the nation that leads in developing both fusion technology and its supply chains will dominate in a new energy era. While the United States and Europe have led in fusion research, the CCP has leveraged its industrial strengths, giving it an advantage in building critical infrastructure.[45] A recent $2.1 billion investment in China Fusion Energy Co. reflects the CCP's broader strategy to influence key future industries through civil-military fusion.

The CCP has several facilities and projects underway that have made significant investments to commercialize fusion energy. In January 2025, the CCP's Experimental Advanced Superconducting Tokamak (EAST) reactor set a global record by sustaining plasma at over 100 million degrees Celsius for more than 1,000 seconds.[46] The CCP is also on track to complete the Comprehensive Research Facility for Fusion Technology (CRAFT). This 40-hectare complex will develop the underlying engineering for future fusion machines by the end of 2025.[47] Results from EAST and CRAFT are expected to inform the design of the CCP's Fusion Engineering Test Reactor (CFETR), which is intended to bridge the gap between experimental and commercial fusion power.[48] Additionally, the CCP is slated to connect the world's first fusion-fission hybrid power plant to the grid by 2030.[49]

[42] "Commonwealth Fusion Systems Raises $863 Million Series B2 Round to Accelerate the Commercialization of Fusion Energy." *Commonwealth Fusion Systems*, 8 Aug. 2025, cfs.energy/news-and-media/commonwealth-fusion-systems-raises-863-million-series-b2-round-to-accelerate-the-commercialization-of-fusion-energy.
[43] De Chant, Tim. "Nvidia, Google, and Bill Gates Help Commonwealth Fusion Systems Raise $863M." *TechCrunch*, 28 Aug. 2025, techcrunch.com/2025/08/28/nvidia-google-and-bill-gates-help-commonwealth-fusion-systems-raise-863m/.
[44] De Chant, Tim. "Every Fusion Startup That Has Raised over $100m." *TechCrunch*, 1 Sept. 2025, techcrunch.com/2025/09/01/every-fusion-startup-that-has-raised-over-100m/.
[45] Brunner, Daniel F., et al. "Why the US and Europe Could Lose the Race for Fusion Energy." *MIT Technology Review*, 7 July 2025, www.technologyreview.com/2025/07/08/1119630/why-the-us-and-the-west-could-lose-the-race-for-fusion-energy/?mc_cid=3a1d9c48d9&mc_eid=156f84a18f.
[46] Pester, Patrick. "China's 'artificial Sun' Shatters Nuclear Fusion Record by Generating Steady Loop of Plasma for 1,000 Seconds." *LiveScience*, 21 Jan. 2025, www.livescience.com/planet-earth/nuclear-energy/chinas-artificial-sun-shatters-nuclear-fusion-record-by-generating-steady-loop-of-plasma-for-1-000-seconds.
[47] Dewan, Angela, and Ella Nilsen. "The US Led on Nuclear Fusion for Decades. Now China Is in Position to Win the Race." *CNN*, 19 Sept. 2024, www.cnn.com/2024/09/19/climate/nuclear-fusion-clean-energy-china-us.
[48] Clynes, Tom. "Is China Pulling Ahead in the Quest for Fusion Energy?" *IEEE Spectrum*, 29 Apr. 2025, spectrum.ieee.org/china-nuclear-fusion-reactor.
[49] Tischler, Karl. "China's Fusion-Fission Hybrid Ambition: A Different Path to Fusion Power." *Fusion Energy Insights*, 22 Apr. 2025, fusionenergyinsights.com/blog/post/china-s-fusion-fission-hybrid-ambition-a-different-path-to-fusion-power.

Further Reading

- Fusion Energy Strategy 2024
- Vision for the Office of Fusion Energy Sciences
- The Global Fusion Industry in 2025
- CRS Fusion Energy In Focus

Chairman WEBER. The Subcommittee on Energy will come to order.

Without objection, the Chair is authorized to declare recesses of the Subcommittee at any time.

Welcome to today's hearing, entitled "Igniting America's Energy Future: The Promise and Progress of Fusion Power."

I recognize myself for 5 minutes for an opening statement.

Well, good morning y'all. We've already had a chance to say good morning. We're glad y'all are here. Welcome to today's Energy Subcommittee hearing, entitled "Igniting America's Energy Future, the Promise and Progress of Fusion Power."

After a decade of stagnation, most of y'all—I think the young lady here was probably still in high school back then—after a decade of stagnation, U.S. energy demand is once again on the rise. This surge is driven by several factors, including the onshoring of supply chains crucial to our national security, and the rapid growth of commercial artificial intelligence (AI) technologies across the country.

At our last Subcommittee hearing, witnesses discussed nuclear energy's potential role in powering AI data centers. That conversation led us to focus on nuclear fission, which is commercially viable today. This hearing will spotlight nuclear fusion, a field that after decades of promise, has made remarkable progress across various technology readiness levels in recent years.

These advancements have highlighted a growing need for workforce development. The challenge is not simply producing more Ph.D.s, but building a robust, skilled, trained workforce. According to the Fusion Industry Association, only 23 percent of employees in the sector are scientists, and 44 percent are engineers, leaving a significant portion of the workforce without advanced degrees. The industry is expanding rapidly, growing by a staggering 50 percent in the last 2 years, while the supply chain has tripled in size in that same 2 years.

Many fusion companies project operational pilot plants by 2035, with workforce needs expected to increase sixfold at this stage, not including additional supply chain demand. To address these needs, our National Labs are considering apprenticeship programs to help prevent potential worker shortages. Such programs would complement the cutting-edge research conducted at DOE (Department of Energy) facilities, which house much of the specialized equipment necessary for fusion science.

Due to these unique capabilities, DOE's collaboration with the private sector is very vital for advancing commercialization. To foster these partnerships, DOE has launched several initiatives to connect, support, and indeed accelerate industry growth. These include a public-private partnership (PPP) program, a milestone-based fusion development program, and ongoing funding for fusion projects through the ARPA–E office. Public-private partnerships leverage DOE's expertise while encouraging private sector investment. Milestone programs tie Federal funding to demonstrated progress. And APRA–E's early fusion projects have already generated over $700 million in private investment. These efforts are prime examples of responsible use of taxpayer dollars.

For decades, fusion energy was seen as a dream always 20 or 30 years away. But recent successes at the National Ignition Facility, or NIF, have begun to change that perception. NIF became the first facility in the world to achieve a positive net energy output from a fusion reaction, as well as the first to achieve burning plasma.

It's important to note that critical basic science questions still exist before we can see operational fusion power plants connected to the grid. Fortunately, academia, along with DOE user facilities, is working closely with the private sector to both identify and solve these remaining challenges. Continued Federal investment is essential to ensuring these foundational science gaps are addressed in a very coordinated manner.

The progress we've seen is undeniable, and the fusion industry is steadily advancing toward delivering fusion power to the grid.

It can't get here quick enough, can it?

I want to thank our witnesses for their testimony, and I look forward to today's discussion on how the Federal Government can support academia, the National Labs, and private companies to ensure America leads in this critical race.

[The prepared statement of Mr. Weber follows:]

Good morning. Welcome to today's Energy Subcommittee hearing titled, "Igniting America's Energy Future: The Promise and Progress of Fusion Power." After a decade of stagnation, U.S. energy demand is once again on the rise. This surge is driven by several factors, including the onshoring of supply chains crucial to our national security and the rapid growth of commercial artificial intelligence technologies across the country.

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These advancements have highlighted a growing need for workforce development. The challenge is not simply producing more PhDs, but building a robust, skilled trades workforce. According to the Fusion Industry Association, only 23 percent of employees in the sector are scientists, and 44 percent are engineers, leaving a significant portion of the workforce without advanced degrees. The industry is expanding rapidly-growing by a staggering 50 percent in just the last two years—while the supply chain has tripled in size. Many fusion companies project operational pilot plants by 2035, with workforce needs expected to increase sixfold at this stage, not including additional supply chain demand.

To address these needs, our National Labs are considering apprenticeship programs to help prevent potential worker shortages.

Such programs would complement the cutting-edge research conducted at Department of Energy (DOE) facilities, which house much of the specialized equipment necessary for fusion science. Due to these unique capabilities, DOE's collaboration with the private sector is vital for advancing commercialization. To foster these partnerships, DOE has launched several initiatives to connect, support, and accelerate industry growth. These include a public-private partnership program, a milestone-based fusion development program, and ongoing funding for fusion projects through the ARPA–E office. Public-private partnerships leverage DOE's expertise while encouraging private sector investment. Milestone programs tie federal funding to demonstrated progress. And ARPA–E's early fusion projects have already generated over $700 million in private investment. These efforts are prime examples of responsible use of taxpayer dollars.

For decades, fusion energy was seen as a dream always 20 or 30 years away. But recent successes at the National Ignition Facility (NIF) have begun to change that perception. NIF became the first facility in the world to achieve a positive net energy output from a fusion reaction, as well as the first to achieve burning plasma.

It's important to note that critical basic science questions still exist before we can see operational fusion power plants connected to the grid. Fortunately, academia, along with DOE user facilities, is working closely with the private sector to both identify and solve these remaining challenges. Continued federal investment is essential to ensuring these foundational science gaps are addressed in a coordinated manner.

The progress we've seen is undeniable, and the fusion industry is steadily advancing toward delivering fusion power to the grid. I want to thank our witnesses for their testimony, and I look forward to today's discussion on how the federal government can support academia, the National Labs, and private companies to ensure America leads in this critical race. I yield back the balance of my time.

Chairman WEBER. I yield back the balance of my time and recognize the Ranking Member.

Ms. ROSS. Well, thank you very much, Chairman Weber, for convening today's important hearing on the current landscape of fusion energy—where we stand, what remains to be done, and how the Federal Government can play a pivotal role in ensuring United States leadership in a technology that could well revolutionize our entire energy sector.

I also want to thank our very impressive panel of witnesses for being here this morning. The United States is at a critical moment in the effort to develop fusion as a carbon-neutral, sustainable source of energy. Breakthroughs in plasma physics, technology, public-private partnerships, and private sector innovation are giving us reasons to believe that fusion can become a game-changer for clean power, climate resilience, energy security, and economic opportunity.

In my home district, North Carolina (NC) State University has just launched a new remote control room under its Future Fusion Research Initiative. In July, the Fusion Plasma Auxiliaries Characterization Lab at NC State successfully conducted their experiment remotely at the DIII–D fusion facility in San Diego. This marks a significant step toward enabling greater student and institutional access to national and international fusion research facilities. It demonstrates how Federal investment in infrastructure prepares students for the high-skilled jobs of tomorrow, fosters innovation and partnership, and positions the United States to lead globally.

Universities like NC State, our National Laboratories, and private innovators depend on steady investments. Many of the witnesses here today will discuss how our Nation's competitiveness in fusion is threatened by the absence of Federal investment in major new facilities, investments that would help address key gaps in materials science and technology development. Without that support, the United States will likely fall behind, both scientifically and economically in yet another critical new industry.

The Federal role remains essential. Challenges like ensuring the stability of burning plasma, materials resilience, and reactor system design require substantial Federal support, a trained workforce, and demonstration projects that can scale from experiments to net energy gain. These are the building blocks of a new clean energy future for all of us.

I look forward to hearing from our witnesses about the current hurdles on the path to a U.S.-based commercial fusion industry, and where Federal action could make the greatest difference.

I also ask for unanimous consent to permit Representative Don Beyer, co-chair of the congressional Fusion Caucus, to attend this hearing and ask questions of the witnesses.

Chairman WEBER. Without objection.

Ms. ROSS. Thank you, Mr. Chairman, and I yield back.

[The prepared statement of Ms. Ross follows:]

Thank you, Chairman Weber, for convening today's hearing on the current landscape of fusion energy—where we stand, what remains to be done, and how the federal government can play a pivotal role in ensuring U.S. leadership in a technology that could well revolutionize our entire energy sector.

I also want to thank this impressive panel of witnesses for being here this morning. The U.S. is at a critical moment in the effort to develop fusion as a carbon-neutral, sustainable source of energy. Breakthroughs in plasma physics, technology, public-private partnerships, and private sector innovation are giving us reasons to believe that fusion can become a game-changer for clean power, climate resilience, energy security, and economic opportunity.

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Universities like NC State, our national laboratories, and private innovators depend on steady investment. That said, as I know many of the witnesses here today will discuss further, our nation's competitiveness in fusion is also threatened by the absence of federal investment in major new facilities to address key gaps in materials science and technology development. Without that support, the U.S. will likely fall behind both scientifically and economically in yet another critical new industry.

The federal role remains essential. Challenges like ensuring the stability of a "burning plasma", materials resilience, and reactor system design require a substantial growth in federal support, a trained workforce, and demonstration projects that can scale from experiments to net energy gain. These are the building blocks of a new clean energy future for us all.

I look forward to hearing from our witnesses about the current hurdles on the path to a U.S.-based commercial fusion industry, and where federal action could make the greatest difference.

Thank you, and I yield back.

Chairman WEBER. Thank you, Ranking Member Ross. And I recognize the Chairman of the Full Committee, Dr. Babin.

Chairman BABIN. Thank you very much, Mr. Chairman.

This morning's hearing will examine the future of fusion energy and how the United States can maintain global leadership in fusion energy technologies.

And I also want to thank our illustrious witnesses here. We are looking forward to hearing what you all have to say.

But back to fusion has the potential to revolutionize electricity generation and reshape entire industries in our country. Beyond powering the grid, it holds significant promise for a variety of commercial applications, from providing medical radioisotopes for cancer treatment, to enabling advanced materials processing techniques, to propelling spacecraft in deep space missions.

The private sector has emerged as a dynamic force in the commercial fusion energy landscape, with global investments now exceeding $10 billion, driven largely by American companies. This reflects a transition from government-led research and development (R&D) to a market-driven, commercially viable fusion innovations that could transform energy production worldwide.

Even major tech companies such as Nvidia and Google are investing more in fusion power startups, viewing the technology as a promising way to meet their growing energy demands.

Despite substantial private sector investments, the Department of Energy plays a vital role in making fusion become a reality.

DOE's latest Fusion Energy Strategy aims to accelerate the path to commercial fusion in collaboration with industry, while coordinating fusion-related efforts across government, academia, and the public and private sectors.

For example, Oak Ridge National Laboratory (ORNL)—thank you for being here—is leveraging its deep expertise in fusion materials, plasma diagnostics, advanced modeling and simulation through three new research collaborations through the Innovation Network of Fusion Energy, or the INFUSE program. These partnerships focus on addressing practical engineering challenges essential to delivering fusion power to the grid by the 2040s.

Additionally, DOE serves as the central hub for bridging the science and technology gaps that are necessary to achieve commercial fusion power. Its role is critical, as the Federal Government is the only entity capable of undertaking the high-risk, high-reward, long-term research and development required to address these challenges. And although significant progress has been made, much more work remains to fully harness the potential of fusion technologies.

The rapid progress of the Chinese Communist Party or CCP in this sector poses a direct challenge to United States technological leadership.

Historically, the United States has led the way in fusion research. However, the CCP has effectively utilized its industrial base and civil-military integration to accelerate technological development and to rapidly scale critical infrastructure. It is also committed to connecting the first fusion-fission hybrid power plant to the electrical grid by 2030.

The nation that successfully commercializes fusion first will likely set the global standards, the supply chains, and technological frameworks that will shape this industry for decades to come. Moreover, the implications go well beyond merely achieving technological leadership. They also raise important questions about global governance and our values. Fusion energy technologies must be developed and deployed by nations that uphold democratic values, transparency, and international cooperation, not by authoritarian regimes that might exploit energy dominance as a weapon.

The United States must prioritize fusion energy development to outpace the CCP's aggressive timelines.

Achieving leadership in fusion technology is not only essential for energy independence but for ensuring that democratic values shape one of the most consequential breakthroughs of the entire century.

I want to thank our witnesses again for their testimony today, and I look forward to a very productive discussion.

And with that, I yield back the balance of my time, Mr. Chairman.

[The prepared statement of Mr. Babin follows:]

Thank you, Chairman Weber.

This morning's hearing will examine the future of fusion energy and how the United States can maintain global leadership in fusion energy technologies.

Fusion has the potential to revolutionize electricity generation and reshape entire industries.

Beyond powering the grid, it holds significant promise for a variety of commercial applications—from providing medical radioisotopes for cancer treatment, to enabling advanced materials processing techniques, to propelling spacecraft on deep space missions.

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Achieving leadership in fusion technology is not only essential for energy independence but also for ensuring that democratic values shape one of the most consequential breakthroughs of the century.

I want to thank our witnesses for their testimony today, and I look forward to a productive discussion.

Thank you, Chairman Weber. I yield back the balance of my time.

Chairman WEBER. Thank you, Mr. Chairman.

[The prepared statement of Ms. Lofgren follows:]

Good morning and thank you, Chairman Weber and Ranking Member Ross, for holding this very important hearing today. And thank you to this excellent panel of witnesses for being here this morning as well.

It is not exactly news around here that I am an enthusiastic supporter of fusion energy R&D. That said, there have been some significant developments since this Committee last held a hearing on fusion about two years ago.

The National Ignition Facility at Lawrence Livermore National Laboratory—still the only machine in the world to achieve fusion ignition—has now achieved it 9 times, with a big new record output of 8.6 megajoules reached in April.

Last year, the Department of Energy finalized agreements with the first 8 awardees of its milestone-based public-private partnership program. And DOE has made real strides over the last several months in pivoting its activities to better follow the recommendations of the fusion community in its most recent Long Range Plan, which was led by Dr. Carter.

Meanwhile, the global fusion industry has raised about $3.5 billion in private investment in the last 15 months alone, with the bulk of this money provided to companies that are currently headquartered in the U.S.

On the other hand, in an analysis released just this week, the Special Competitive Studies Project found that China has spent at least $6.5 billion on fusion commercialization efforts since 2023. I look forward to hearing from Dr. Regan and Dr. Mumgaard about this latest surge in investments at home and abroad—and what we in the public sector should really be doing to ensure U.S. leadership in this potentially transformational industry.

Now, I remain strongly opposed to the President's Budget Request overall, and the absolutely devastating impacts it would have on our nation's research enterprise if it were ever enacted.

But I can walk and chew gum at the same time, and when it comes to the specific request for fusion—while far more resources are certainly warranted—I believe that the Administration got it about right within the total funding for fusion that is being proposed.

This is why I introduced a bipartisan amendment to the Energy & Water Appropriations bill with Chairman Obernolte and my colleagues Mr. Beyer and Ms. Trahan. The amendment simply aimed to ensure that these important shifts proposed by the President to better support key commercialization-focused activities are fully funded, including a larger focus on fusion materials, fuel cycle R&D, and public-private partnerships. Unfortunately, for some reason the Majority on the Rules Committee did not choose to make this amendment to support President Trump's Budget Request for fusion in order, so it never got a vote. But I will continue to work with my colleagues on both sides of the aisle in the House and the Senate to make progress on this wherever I can.

Lastly, I'd like to again thank my colleague, Chairman Obernolte for joining me last month in introducing H.R. 4999, the bipartisan *STEM Education and Skilled Technical Workforce for Fusion Act,* to ensure that we are addressing the broad range of workforce needs for a growing, U.S.-based fusion industry. I'll look forward to discussing this topic in more detail with Dr.

Diem and our other witnesses as well, as this is truly a crosscutting issue for you all. With that, Mr. Chairman, I am excited to hear from our panel and I yield back.

Chairman WEBER. I now want to introduce our witnesses. Our first witness today is Dr. Stephanie Diem, Assistant Professor at University of Wisconsin (UW)—Madison. Welcome.

Our second witness is Dr. Will Regan, Co-Founder and President at Pacific Fusion. Welcome.

Our third witness is Dr. Troy Carter—you know, we have a Troy Carter in Congress, right? No relation, I guess. I gotcha. Director of the Fusion Energy Division at Oak Ridge National Laboratory. Welcome.

And our final witness is Dr. Bob Mumgaard, Co-Founder and CEO (Chief Executive Officer) at Commonwealth Fusion Systems (CFS). So we are glad you're here. Thank you.

I now recognize Dr. Diem for 5 minutes.

TESTIMONY OF DR. STEPHANIE DIEM, ASSISTANT PROFESSOR, UNIVERSITY OF WISCONSIN—MADISON

Dr. DIEM. Chairman Weber, Ranking Member Ross, and Members of the Committee, thank you for holding this important hearing and for inviting me to testify. My name is Stephanie Diem, and I am the principal investigator (PI) of a Department of Energy funded fusion experiment, and a professor at the University of Wisconsin—Madison. I also serve as the Vice President of the University Fusion Association and was appointed as the United States Science Envoy with the Department of State. My remarks today reflect my own views.

In a world facing urgent energy challenges and geopolitical tensions over access to energy and energy resources, fusion gives us hope. Fusion is a dense, virtually limitless source of power derived from hydrogen that could radically transform humanity. Fusion, the process that powers the Sun, occurs when light elements are forced together and combine under extreme conditions, releasing a vast amount of energy. On Earth, we use magnetic bottles or powerful lasers to create these fusion conditions. The resulting energy could provide large-scale baseload power and support applications such as hydrogen production, water desalination, process heat, and district heating.

American innovation has long driven global progress in fusion. The United States is at a pivotal moment, marked by the achievement of controlled fusion energy at the National Ignition Facility in 2022, the continued emergence of transformative technological and manufacturing advances, and the establishment of public-private partnerships to develop fusion systems capable of generating electricity. But our leadership is at risk.

Europe, Japan, and China are leveraging American innovation to advance their industries. History has shown us that when the United States invests boldly in research, it not only secures global leadership but also delivers transformative benefits to society. We cannot afford to fall behind. Universities are the foundation of the fusion energy industry, powering the breakthroughs that will radically transform how humanity sources and depends on energy.

I want to highlight three priorities for retaining United States leadership, continuing innovation to drive fusion science and technology forward, developing an agile workforce, and creating a robust fusion ecosystem.

First, university innovation drives economic growth. The field of fusion energy emerged from publicly funded research, and universities remain the engines of innovation that seed new industries. Today, over 45 fusion startups are driving commercialization, 60 percent spun out of universities, and 95 percent of private investment has gone into those university spinouts.

At UW-Madison alone, federally funded research led to three fusion companies, SHINE Technologies, Type One Energy, and Realta Fusion. SHINE has already commercialized fusion by domestically providing critical lifesaving medical isotopes, while Realta and Type One comprise a quarter of the DOE Milestone Program awardees who are designing first-of-a-kind fusion power plants. Together, they demonstrate how 20 percent of Federal support can attract 80 percent of private investment, create high-skilled jobs, and fuel economic growth.

Second, we need to build an agile workforce. Fusion energy is engineering at the extremes, required precision and advanced manufacturing. Federal funding has solved extraordinary challenges, but now we must scale those solutions into economically viable industry. The American fusion workforce faces personnel shortages, retention issues, education and training gaps, and limits in public engagement. To meet the demand, we must expand programs to include community colleges and launch apprenticeship programs. The recently introduced *Fusion Workforce Act* by Ranking Member Lofgren and Subcommittee Chair Obernolte lays out a coordinated response.

Fusion can also renew America's industrial base, driving local and regional growth by revitalizing industries, creating jobs, and strengthening wages.

Third, we need to grow a robust fusion ecosystem. Public-private partnerships like INFUSE and DOE Milestone and FIRE (Fusion Innovative Research Engine) collaboratives have laid strong foundations, showing how universities, National Labs, and companies can close these critical gaps together. To move swiftly from proving fusion science to developing commercial fusion energy, we need larger regional hubs supported by Federal and State funds that coordinate efforts and maximize efficiencies. Universities will be indispensable partners in the coordination of these hubs by fostering innovation, interdisciplinary research that anticipates and meets the future technological and workforce needs of the fusion industry.

Ongoing uncertainty in Federal fusion investments poses serious risk. Funding delays strain universities that lack capital to bridge these gaps. These jeopardize workforce stability, research continuity, and pace of innovation, while driving talent to other sectors or abroad, threatening the growth of private companies. Meanwhile, international collaborators and competitors are advancing with coordinated strategies, new infrastructure, and natural workforce initiatives, and major government support.

Without a stable Federal investment framework and coordinated effort, the United States risks ceding leadership in fusion energy. Continued public-private partnerships are essential to commercialization and sustained Federal funding will remain the catalyst that seeds innovation and drives the future of fusion energy. Thank you.

[The prepared statement of Dr. Diem follows:]

Written Testimony of Prof. Stephanie Diem
Principal Investigator, Pegasus-III Experiment
Assistant Professor, Department of Nuclear Engineering and Engineering Physics
University of Wisconsin-Madison
Vice President, University Fusion Association
U.S. Science Envoy, Department of State

Delivered to the
Committee on Science, Space, and Technology
Subcommittee on Energy
United States House of Representatives

Hearing on *Igniting America's Energy Future: The Promise and Progress of Fusion Power*
September 18, 2025

Chairman Weber, Ranking Member Ross, and Members of the Committee, thank you for holding this hearing on "Igniting America's Energy Future: The Promise and Progress of Fusion Power," and for inviting me and my colleagues to testify. My name is Stephanie Diem, and I am the Principal Investigator of a large university fusion energy experiment and a professor in the Department of Nuclear Engineering and Engineering Physics at the University of Wisconsin-Madison (UW-Madison). I am also the Vice President of the University Fusion Association and a U.S. Science Envoy with the Department of State, the first science envoy appointed for fusion energy. I am speaking today as an academic researcher.

Fusion is the process that powers the sun, and is the highest power density energy source known to humankind. Fusion only happens on Earth when you have light elements at such extreme conditions – temperatures at least ten times hotter than the sun – that they combine together and release enormous amounts of energy. One of the most commonly pursued approaches relies on fusing together heavy forms of hydrogen to form helium and release energy. The energy released from fusion has the potential to provide large-scale baseload power, as well as support applications such as industrial heat, hydrogen production, space propulsion, and water desalination. Achieving fusion requires confining matter under extreme conditions, demanding ingenuity at the intersection of advanced science and engineering to both create the necessary environment and harness the resulting energy. We use innovative techniques like building magnetic bottles (magnetic confinement fusion) or focusing some of the world's largest lasers onto a target the size of a peppercorn (inertial confinement fusion) to produce conditions extreme enough to safely fuse the fuel together and release energy.

American innovation has long driven global progress in fusion energy and has brought us to this pivotal moment: the achievement of controlled fusion energy at the National Ignition Facility (NIF) in 2022, the continued emergence of transformative technological and manufacturing advances, and the establishment of public-private partnerships to develop fusion systems capable of generating electricity.[1,2] Despite the historical dominance of the U.S. in this field, we are in danger of Europe, Japan, and China outperforming the U.S. by leveraging historical U.S. innovation to advance their fusion industries. However, it is not too late to reverse the trend – history shows that when the United States invests boldly in research and innovation, it not only secures global leadership but also delivers transformative benefits to society.

Innovation Seeds Economic Development

The field of fusion energy was born out of publicly funded research, much of which occurs at universities. Universities are recognized for their ability to seed innovation that will lead to robust industries. We stand at an extraordinary juncture, as more than 45 companies across the globe are driving efforts to commercialize fusion energy. Of these fusion startup companies, 60 percent originated from universities, and 95 percent of private investment in the sector has been specifically directed to university spinouts.[3] After beginning my career at a Department of Energy (DOE) national laboratory, I returned to my home state of Wisconsin to pursue fusion energy research at UW–Madison. As an undergraduate, I had learned firsthand that experimental fusion energy thrived at UW, in part because of the historic strength of Wisconsin's manufacturing industry. University experiments focus on early stage, transformative research that seeds new companies and later evolves into partnerships during their development. The experiment that my group built was historically focused on fusion science and has expanded to focus on developing advanced technology to make fusion more economically viable. The federally funded research at UW-Madison has led to the spinout of three fusion companies, each with a different approach to fusion: SHINE Technologies, Type One Energy, and Realta Fusion, all of which have provided significant economic growth to Wisconsin and beyond.

Founded in 2010, SHINE Technologies is unique in that it has successfully commercialized fusion today. They are combatting chronic shortages of critical, lifesaving isotopes such as Mo-99 (used in medicine) by producing them domestically with neutrons generated through fusion. Still headquartered in Wisconsin, SHINE Technologies has leveraged each federal dollar invested to generate nearly four dollars in private investment. As U.S. DOE Milestone awardees, Realta Fusion (est. 2022) and Type One Energy (est. 2019) still maintain close connections with the university. Realta Fusion collaborates with UW-Madison researchers to operate a ARPA-E-funded device that leverages university infrastructure and involves partnerships with other universities, national laboratories, and private companies. As a small business, Realta Fusion has amplified federal investments (20%) by securing significant private investments (80%). Type One Energy has been able to leverage federal investments (10%) to raise significant private funds (90%). As recently as last week, Type Energy and the University of Wisconsin won a DOE Innovation Network for Fusion Energy (INFUSE) award that will support work that will benefit the entire fusion community. These UW-spinout companies are just a few examples of the many fusion energy companies that have emerged from universities across the country, serving as vehicles for amplifying federal funding to attract private investments, creating high skilled jobs for Americans, and driving economic growth. The ties between these companies and universities do not end when a company is formed and in many cases, continue to grow. Academic institutions play a vital role in developing critical tools, enabling technologies, and talent that support private-sector companies in achieving key developmental milestones.

Fusion is unquestionably one of the biggest technological advances in energy production in the past century. While this new technology requires significant further investments, the potential payoffs are even greater and increasingly within reach. Continued public–private partnerships will be essential as the industry moves closer to commercialization, and sustained federal funding remains a critical catalyst–seeding the early phases of innovation that private companies will build upon in the years ahead. A representative from the Wisconsin Economic Development Corporation indicated that five elements are essential for any emerging technology to succeed: innovation, manufacturing, capital, government support, and public support. Fusion is beginning to align these elements – through university-driven innovation, growing manufacturing partnerships, leveraged public and private capital, federal and state investment, and efforts to build public trust – but sustained coordination across all five will be critical to secure U.S. leadership.

Emerging Technologies Thrive with an Agile Workforce

The technology required to achieve fusion is extremely advanced. Nearly all major components on existing and planned fusion devices are unique and purpose-designed. For example, cryogenic superconducting magnet coils are kept near absolute zero, and must safely operate a few feet away from conditions that are ten times hotter than the sun. Precision and advanced manufacturing techniques are required for complex components, such as magnets and laser fusion targets, that are essential for improving the efficiency of fusion energy production. Federal funding has allowed us to solve incredibly difficult engineering challenges to achieve the success we have attained so far, but now we need to scale these unique, one-off solutions into an economically viable industry. Several critical technology gaps remain, including the development of materials capable of withstanding harsh fusion conditions, closing the fusion fuel cycle, and effectively harnessing fusion energy.[2,4,5] Federal support will be essential to address these challenges.

The fusion industry is growing rapidly and current academic programs are struggling to keep up with the workforce demands. The American fusion workforce faces numerous challenges, including shortages and retention issues, gaps in education and training, limited support for workforce development, a lack of fusion-enabling technology programs, and relatively low public engagement compared to other emerging technology fields. While significant, these challenges are not insurmountable. With sufficient resources, the academic community is well positioned to collaborate with its private-sector partners to overcome them. Last year, the National Science Foundation-sponsored Fusion Workforce Accelerator conference convened key public and private stakeholders to identify partnerships and programmatic opportunities aimed at transforming the fusion workforce to meet the demands of an applied fusion energy mission.[6] And just last month, Ranking Member Lofgren and Subcommittee Chair Obernolte introduced H.R.4999, the "STEM Education and Skilled Technical Workforce for Fusion Act".[7]

Investment is necessary to mobilize a national strategy to develop fusion curricula, software, and learning materials that build on existing resources to close current education gaps. As the U.S. faces continued decline in science, math, and reading scores, infusing fusion into the K-12 curriculum can also serve to bring excitement into the classroom. This has already been demonstrated to work in the quantum space. The Quantum Information Science and Technology Workforce Development National Strategic Plan, has established a large-scale coordinated effort to address similar workforce shortages.[8] As we push the boundaries of fusion experiments and start construction on even more first-of-a-kind pilot fusion plants in the United States, we will require a larger percentage of the workforce with precision manufacturing and advanced manufacturing experience. Fusion offers the potential to renew and strengthen America's traditional industrial base. Investment in the development of fusion energy supports local, regional, and statewide economic growth by revitalizing industries, creating jobs, and strengthening wages and incomes.

Projections have suggested that a significant portion of the fusion workforce will be solely dedicated to manufacturing and building fusion power plants. Workforce shortages are already evident. When my group built our experiment four years ago, Midwest-based technicians and machine shops proved indispensable. Today, about 40 percent of our team are technical staff, and as fusion advances toward commercialization, the workforce will continue to shift toward technical and engineering expertise. Although developing curricula and building partnerships with universities, national laboratories, private companies, community colleges, and trade schools will take time, federal investments are needed for apprenticeship programs immediately.

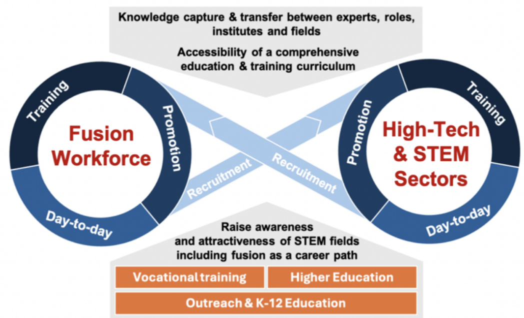

Fig. 1: Infographic detailing the interplay of the specific fusion workforce, the broader STEM workforce, and factors that improve the development and synergy of both. Figure from reference 5.

Building a Robust Fusion Ecosystem

Advancing an accelerated path to fusion energy in the United States will require a robust, integrated program–one that addresses fundamental scientific questions while driving the technical solutions needed for commercialization. The seeds of an American fusion energy ecosystem are being laid through initial funding from INFUSE and ARPA-E, targeted support for fusion pilot plant design points under the DOE Milestone program, and efforts to close critical S&T gaps through Fusion Innovation Research Engines (FIRE) Collaborations – all aimed at accelerating the economic viability of commercial fusion energy. We must act swiftly to pivot the field from its historic focus on creating the scientific conditions for fusion reactions to addressing the technical challenges of an applied fusion energy mission, while also supporting the critical growth of the fusion supply chain.[8] This transition can be achieved through federal investment in public-private regional hubs that coordinate and expand the broader fusion ecosystem, while engaging state governments to foster a supportive environment for emerging fusion companies. States such as California, Colorado, New Jersey, and Virginia are already mobilizing in the early phases of ecosystem formation. In May, Wisconsin announced the creation of the Great Lakes Fusion Energy Alliance to convene universities, national laboratories, private fusion companies, and the Midwest manufacturing industry in support of a robust fusion supply chain. Regional efforts such as these may prove transformative for states like Wisconsin, which are net energy importers and face challenges with energy supply reliability. A new baseload energy source such as fusion, combined with grid-scale storage for renewable energy, offers a robust and credible path forward.

However, ongoing uncertainty in federal fusion investments pose serious risk. Prolonged funding delays – often three to six months longer for universities than compared to funding slated for national laboratories – strain academic institutions that lack the capital to bridge funding gaps. These disruptions jeopardize workforce stability, research continuity and pace of innovation, drive talent to other sectors (or countries), and threaten the growth of private companies. At the same time, international competitors are moving ahead with coordinated national strategies and significantly expanded government support. The United Kingdom has launched a national strategy centered on building a spherical tokamak pilot plant, paired with significant funding and a coordinated workforce initiative; Germany has advanced a robust public–private partnership model; and Japan is investing heavily in new experimental facilities such as JT-60. Meanwhile, China is constructing several new fusion facilities and has made record breaking investments towards commercial fusion energy. Without a more stable federal investment framework and strategic coordinated effort,[10] the United States risks ceding leadership in fusion innovation, commercialization, and workforce development.

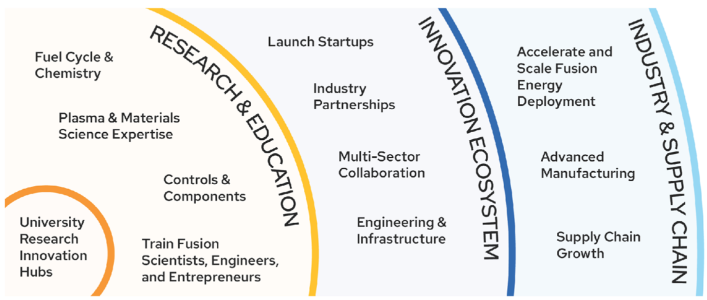

Fig. 2: Universities seed innovation that will lead to robust industries. The wide range of expertise on university campuses provides an agile framework to anticipate the needs of an emerging fusion industry.

Universities have been the engines of the fusion energy industry that has the potential to radically transform humanity's dependency and sourcing of energy. Due to the wide range of expertise on campuses, universities are flexible, nimble, and agile and this allows them to pivot and anticipate future needs of emerging technologies as they mature for deployment. For example, researchers at UW-Madison from the La Follette School of Public Affairs, the Nelson Institute for Environmental Studies, Nuclear Engineering, and Industrial & Systems Engineering are partnering to prepare a comprehensive assessment of the direct and indirect impacts of emerging fusion design concepts (life cycle assessment, environmental impacts, and byproduct materials) to support fusion energy deployment, while experts in risk communication develop strategies to build public understanding and trust. In this way, universities will continue to support and anticipate the future needs of the private fusion companies.

In a world where we are becoming increasingly concerned with how to address rapidly growing energy needs, as well as geopolitical tensions arising from access to energy and energy resources, fusion energy gives us hope. Fusion presents an extraordinary opportunity – a dense form of energy derived from hydrogen, an abundant resource, with the potential to radically transform the next phase of human progress. We have achieved remarkable scientific advances; now we need robust support to build a thriving fusion energy ecosystem. Realizing this vision will require substantial federal investments, together with highly skilled American manufacturers and technicians working alongside us to bring it to reality.

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3. Data gathered from: *The Global Fusion Industry in 2024*, a report by the Fusion Industry Association (2024)
4. U.S. Department of Energy, Fusion Energy Sciences Advisory Committee, *Powering the Future: Fusion and Plasmas* (2021). https://usfuionandplasmas.org
5. Report of the FESAC Facilities Construction Projects Subcommittee (2024)
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Stephanie Diem is an Assistant Professor of Nuclear Engineering and Engineering Physics at the University of Wisconsin-Madison. Prof. Diem is the Principal Investigator of the Pegasus-III experiment, a collaborative fusion energy experiment focused on developing enabling technology to reduce the cost and complexity of future magnetic confinement fusion energy machines supported by DOE Fusion Energy Sciences. She has also formed an interdisciplinary research team, funded by the Wisconsin Alumni Research Foundation, that convenes experts across campus to research direct and indirect impacts of fusion energy, risk and safety of these systems, and develop strategies that build public understanding and trust.

Prof. Diem is a U.S. Science Envoy for the Department of State, the first chosen for fusion energy, and the Vice President of the University Fusion Association, a nonprofit organization focused on the development of plasma science and technology for the long-term development of fusion energy. She was a member of the New Voices in Science, Engineering, and Medicine of the National Academies, a recipient of the 2023 Fusion Power Associates' David Rose Award for Excellence in Fusion Engineering and is a 2025 Kavli Fellow. Prof. Diem received BS degrees in Nuclear Engineering and Physics from the University of Wisconsin-Madison and a PhD in Astrophysical Sciences from Princeton University.

Chairman WEBER. You ended right on time. She's good, Dr. Regan. She speaks at about 400 words a minute with gusts up to about 650, so you've got a row to hoe. You're up next. Your testimony, please, sir.

TESTIMONY OF DR. WILL REGAN, FOUNDER & PRESIDENT, PACIFIC FUSION

Dr. REGAN. Thank you, Chairman Weber, Ranking Member Ross, also Chairman Babin and Ranking Member Lofgren of the Full Committee, Members of the Subcommittee, thank you for the opportunity to testify here today on the promise of fusion energy, and for your longstanding support of the field that has finally brought commercial fusion power within reach.

I am Will Regan, President and Co-Founder of Pacific Fusion. As Dr. Diem mentioned, fusion is what powers our Sun. It is where you squeeze hydrogen and helium and release vast amounts of energy.

The way we do it at Pacific Fusion is called pulser-driven inertial fusion. We run a fast pulse of electricity across a tiny can of fuel, which squishes the can, squeezes the fuel, and makes it hot and makes it fuse. We can make power by doing this over and over, kind of like a piston engine.

We are about 2 years old, have over 120 staff, and have raised over $900 million. We are on track to achieve net facility gain by 2030, so this is more fusion energy out than all of the energy we start with. This is something that no one has yet done. It is a critical milestone to get to power plants. And then we aim to generate net power by the mid–2030s.

We are all here today because fusion could be the ultimate power source, creating a new, multi-trillion dollar energy sector and providing abundant power for industry and AI. What makes fusion so great? Three things. First, fusion fuel is just extremely energy dense. You get millions of times more energy out per unit of fuel than in chemical reactions. The little speck of fuel in our tiny fuel cans can power your home for a week.

Fusion is compact. You can make lots of power on a little bit of land with a fairly small amount of materials, things like steel and cement.

And fusion is safe. It stops when you stop driving it and makes no high-level waste.

And the fusion industry, now on the cusp of commercialization, owes its existence to the visionary support provided by Congress. We founded our company in 2023 as a direct result of National Lab breakthroughs in 2022. First Lawrence Livermore's National Ignition Facility used lasers to drive controlled fusion ignition, for the first time in history releasing more fusion energy out than the laser energy they used to drive that. Around the same time, Sandia's Z Machine showed that electrical pulses offered a far more efficient path to achieve ignition, and that efficiency boost lets you take the next step beyond ignition and get net facility gain, net energy gain.

Also, a team at Lawrence Livermore in that same year demonstrated a compact, modular technology to make those electrical pulses, which opens up an exciting path to make commercial inertial fusion power.

So those three things gave us a great foundation to build on. And because our system is highly modular, made from widely available materials, things like steel, cement—steel, aluminum, plastic, oil, and water, we see a path forward to rapidly scale up affordable fusion power in America.

And what's even more exciting is we're not alone. Not just us, but multiple American fusion companies, like Dr. Mumgaard's, are poised to soon demonstrate fusion energy.

The problem is that China has noticed, and they are investing heavily to own this industry. Just since 2023, China has put upwards of $10 billion to $13 billion into fusion, including over $2 billion into a state-owned champion supported by one of their large power plant builders. And they have been rapidly constructing four major research facilities. They are aiming for fusion power by 2031, if not sooner.

This is an existential threat to American fusion leadership and energy dominance. Our industry and Congress need to work together to make sure that America wins.

How do we win? We need to grow our workforce, not just fusion scientists but mechanical and electrical engineers, technicians, welders, and many others. The Lofgren-Obernolte *Fusion Workforce Bill* is a great start.

We also need to start scaling our supply chain now. And I am thrilled to see the *Fusion Advanced Manufacturing Parity Act* that was introduced yesterday. So thank you very much, Representative Tenney and Representative Beyer for this bill.

We also need continued regulatory progress and certainty, building on the momentum of the recent NRC (Nuclear Regulatory Commission) decision and also Congress's *ADVANCE Act.*

But most critically, and why I'm here is America needs to build fusion power plants before China, with shovels in the ground as early as 2028. And fortunately, America has a great playbook for this. We have used public-private partnerships to reassert United States leadership in commercial space, just for one example. We can run that playbook again through an accountable, milestone-based fusion demonstration program to jumpstart construction of multiple United States fusion power plants. I don't ask for this just to benefit us, but because this is what is needed to move the whole United States fusion industry forward fast enough to win this race.

Thank you again for your time, Chairman Weber, Ranking Member Ross, also Chairman Babin and Ranking Member Lofgren, the Full Committee, and Members of the Subcommittee. Look forward to your questions.

[The prepared statement of Dr. Regan follows:]

Written Testimony of Will Regan, Ph.D.
Co-Founder and President, Pacific Fusion

Before the House Committee on Science, Space, and Technology; Energy Subcommittee
"Igniting America's Future: The Promise and Progress of Fusion Power"
Thursday, September 18, 2025

Chairman Weber, Ranking Member Ross, and Members of the Committee:

My name is Will Regan, and I am the Co-Founder and President of Pacific Fusion. Thank you for the opportunity to testify today on the potential of fusion energy, and for your longstanding support of fusion research that has put commercial power within reach. I am here to share our company's progress and to discuss how the government can help ensure that the U.S. leads in deploying low-cost, reliable, safe, and abundant fusion power.

I have spent nearly 20 years working on advanced energy technology, and have been fortunate to play a key role in the most exciting decade yet of fusion's century-long development. In 2015, while working at the Department of Energy's ARPA-E, I helped launch the fusion industry by building a program called ALPHA, which catalyzed several of the leading private fusion companies active today. I then joined Google X, where I spent eight years building ambitious energy projects (including fusion) that integrated advanced computation and hardware. And in 2023, I co-founded Pacific Fusion, now the world's leading inertial fusion company.

In just 10 years, fusion energy has transformed from a scientific dream into an imminent reality. Given the urgency of today's energy challenges and the central role that energy plays in both our economic and national security, this transformation could not come at a better time.

Electricity demand in the United States is rising at a pace not seen since World War II. Electrification of transport and buildings, new industrial loads, and the rapid growth of data centers to power AI are all driving skyrocketing demand for affordable, reliable power.

Fusion offers an ideal solution. It's the process that powers the sun and stars, and it can provide the same reliable, on-demand power as fossil fuels or nuclear fission but without carbon emissions or high-level waste. Today, thanks to recent advances that I discuss in detail below, it is no longer a distant aspiration but an emerging reality.

That is why my co-founders and I started Pacific Fusion: to transform recent fusion breakthroughs into practical power plants capable of powering cities, industries, and homes. The Federal government has played a pivotal role in supporting the research to get us to this point, and now has an opportunity to jumpstart this new energy industry and ensure long-term U.S. leadership in its deployment, especially as China ramps up its efforts to go all in and win.

Key takeaways from my testimony are below, and the following sections detail them further:

Where Fusion is Today and the Challenge Before Us

I. **Breakthroughs in 2022 proved that fusion can power the future.** Scientific breakthroughs in inertial fusion, paired with a major pulsed power engineering advancement, opened the path to build practical power plants. This motivated us to start Pacific Fusion in 2023 and raise $900+ million in tranched funding to bring inertial fusion to market. By 2030, we will demonstrate "net facility energy gain"—the critical milestone needed to unlock commercial fusion power generation.

II. **The U.S. fusion industry is on the cusp of commercialization.** We are not alone. According to the Fusion Industry Association, there are around 25 fusion ventures in the United States that have raised over $7.5 billion to achieve similar milestones this decade. America wrote the playbook on investing in fundamental scientific breakthroughs and then scaling their industrial application through the private sector. Fusion is no different, and today we're at the last mile of solving the key scientific challenges to enabling commercial deployment.

III. **China is moving fast to take the lead in commercial fusion.** Although behind the U.S. in scientific advancement, China is positioning itself to win at power plant deployment through heavy coordinated government investment.

In just the few years following the U.S. achievement of ignition at the National Ignition Facility (NIF), Chinese state-backed entities have by recent estimates put up to $10–13 billion into building new fusion facilities and funding state-owned fusion companies. A Chinese company has even recently set a goal to build the first power plant that uses fusion by 2031. Without a response, the U.S. risks inventing fusion energy but losing the industry to China, as it has too many times in other sectors.

IV. **We can leverage past successful U.S. playbooks to stay ahead.** Fortunately, this Committee has already helped pioneer the solution. We reasserted our leadership in the space industry through milestone-based public-private partnerships. The time is right to use that playbook again, including completing the Milestone-Based Fusion Development Program and launching a *Fusion Demonstration Program*.

If done right, we can accelerate the start of construction of multiple fusion power plants to 2028, pulling ahead schedules by multiple critical years. We believe this will keep the U.S. ahead of China in fusion power deployment. With targeted investments now—that are less than the up to $10–13 billion that China has invested since 2023—the U.S. can secure both energy dominance and the economic prosperity that will result from this new multi-trillion dollar sector.

I. Pacific Fusion Builds on a Foundation of U.S. National Laboratory Breakthroughs

2022 Breakthroughs at Lawrence Livermore National Laboratory & Sandia National Laboratories

Over the past decade, major fusion technology advances have led to a surge in investment and the establishment of a robust private fusion industry. And then in 2022, three pivotal advances created a new path to commercial power using inertial fusion:

1. The NIF at Lawrence Livermore National Laboratory (LLNL) became the first fusion machine to achieve fusion ignition using lasers — resulting in more fusion energy output than laser energy delivered to the fuel target — establishing the *scientific* feasibility of inertial fusion energy.[1]

2. Near the same time, the Z Machine at Sandia National Laboratories (SNL)[2] reported the highest *pulser-driven* inertial fusion performance ever, second only to laser-driven fusion. This showed that a more efficient path to inertial fusion was also possible.

3. A team at LLNL demonstrated an advanced modular, compact, affordable pulser technology that established the *economic* feasibility of pulser-driven inertial fusion.

Together, these advances opened a path to commercial fusion that simply did not exist before.

It was following these breakthroughs that my co-founders and I decided to launch Pacific Fusion in 2023, with the goal of translating those breakthroughs into a system that could produce low-cost commercial fusion energy.

About Pacific Fusion

We have assembled a world-class team of more than 120 staff, including fusion scientists from the national labs and leading talent from hard technology companies. And we have set clear milestones: (1) to build the world's first Demonstration System (DS) that achieves net facility gain by 2030 (releasing more energy from fusion than is initially stored in the machine), and (2) to deliver commercial power plants by no later than the mid-2030s. We have raised over $900 million in a milestone-based, tranched funding structure that ensures accountability and focus.

Pacific Fusion's approach is pulser-driven inertial fusion, building off the basic approach of the SNL Z Machine, but with improved scientific insight and capabilities developed at the NIF and using new, higher-performing pulser technology. We use fast-rising, high-current pulses to magnetically squeeze and heat small containers of deuterium-tritium fuel, driving the fuel to fusion conditions.

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[1] *Lawrence Livermore National Laboratory Achieves Fusion Ignition*, Lawrence Livermore National Laboratory (December 13, 2022).
[2] Matthew Weis & Whitney Lacy, *Z Machine – An Engine of Discovery*, Sandia National Laboratories (2020).

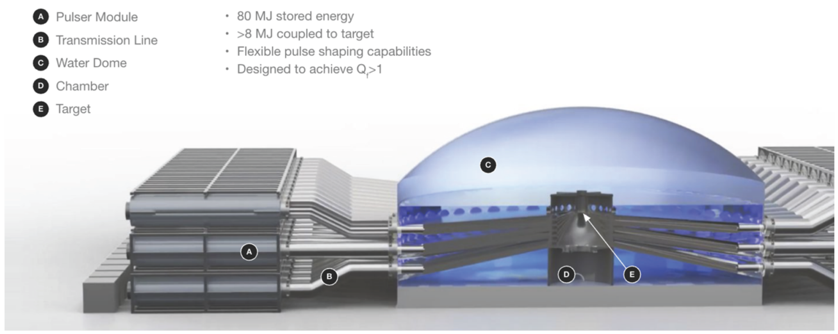

Figure 1: A rendering of Pacific Fusion's Demonstration System that will achieve net facility gain by 2030

At the core of the system is an advanced pulsed power driver known as the impedance matched Marx generator (IMG), which was co-invented by Pacific Fusion's Chief Technology Officer, Keith LeChien. The IMG delivers power far more efficiently (~90%) by synchronizing the discharge of capacitors with the speed of electromagnetic waves. This innovation cuts the size of pulsed power fusion systems in half while boosting performance.[3] It also enables the use of standard, lower-voltage components, making the system safer, easier to build, and more cost-effective. Recent peer-reviewed papers[4] in *Physics of Plasmas* discuss the robust evidence that underpins our path to achieve net facility gain by 2030 using this approach.

Our fusion driver is modular and mass-manufacturable. Each "brick"—made of two capacitors and a switch—is a building block for scalable power. These are assembled into modules that fit in shipping containers, enabling rapid deployment and low-cost maintenance. Our compact cylindrical fusion chamber further simplifies operations and maintenance.

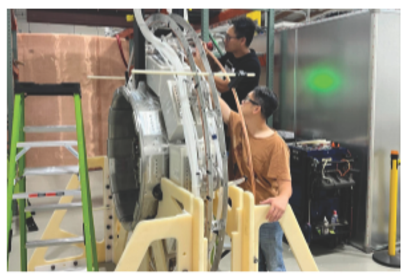

Figure 2: Progress on an IMG stage

The result is a fusion platform that is efficient, practical, and built for scale—a system that will be designed to achieve net facility gain in the near-term and commercial power soon afterwards. Our ultimate goal is to rapidly deploy fusion power plants at scale, delivering firm power at less than $0.05/kWh.

[3] Andrew Alexander et al., *Affordable, Manageable, Practical, and Scalable (AMPS) High-Yield and High-Gain Inertial Fusion*, Cornell University, arXiv (April 14, 2025).
[4] Leland Ellison, *Validating the Path to Fusion Ignition*, Pacific Fusion (September 3, 2025).

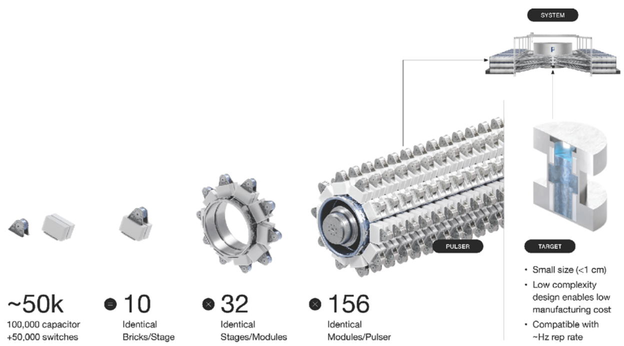

Figure 3: Pacific Fusion's modular design allows for mass-manufacturable fusion machines

Today, Pacific Fusion stands shoulder to shoulder with the leading fusion companies in the world. What distinguishes us further is that our approach is grounded directly in the highest-performing results from operating fusion machines at U.S. National Laboratories, and engineered from the start to be modular, manufacturable, and cost-competitive.

II. The U.S. Fusion Industry is on the Cusp of Commercialization

Fusion energy is arriving. Secretary of Energy Chris Wright recently stated, "fusion has hit that tipping point where things are going to happen fast," and we couldn't agree more.[5] While challenges remain, the fusion industry, working in partnership with the Federal government, National Labs, and academia, is advancing at an unprecedented pace to solve the remaining science challenges.

This is no surprise, as it is what America excels at—investing in fundamental scientific breakthroughs through our National Laboratories and universities, and then scaling their industrial application through the private sector. The current U.S. lead in fusion science is the result of decades of sustained investment and world-class research at our National Laboratories and academic institutions, supported by the U.S. Department of Energy (DOE) Office of Science and DOE National Nuclear Security Administration.

As Key Science Challenges Are Solved, a U.S. Fusion Industry is Forming

As the key fundamental science challenges that gate fusion deployment are being solved, an industry is rapidly arising. There are ~25 fusion ventures in the United States. According to the Fusion Industry Association, globally, private fusion investment into fusion companies has

[5] Special Competitive Studies Project, *Episode 25: A Conversation With the Secretary of Energy, Chris Wright,* YouTube at 11:05 (2025).

reached approximately $10 billion, with a recent slate of major investments over the last year.[6] Of that funding, one source estimates that $7.5 billion has been directed towards U.S. fusion companies.[7] Several fusion energy companies are now projecting that they will reach net facility gain or an equivalent milestone by 2030,[8] which would eliminate any doubt that fusion energy is viable and open the door to commercial deployment.

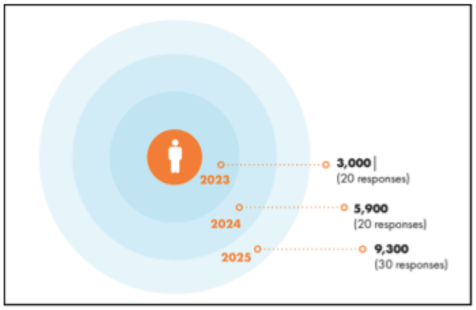

Figure 4: Supply chain jobs created (source: Fusion Industry Association)

And the fusion industry is far more than just the power plant developers. Key progress in fusion energy is being supercharged by advancements in enabling technologies such as superconductors, magnets, materials, and high-performance computing and machine learning. This, in turn, is fueling a thriving U.S. supply chain in those technology areas and others. While the Fusion Industry Association already estimates that there are nearly 5,000 employees at fusion companies, the number of jobs created in the supply chain is nearly double, at nearly 10,000—an over 200 percent increase since 2023.[9]

To that end, Ranking Member Lofgren and Representative Obernolte's ***STEM Education and Skilled Technical Workforce for Fusion Act*** is a great step in the right direction, which will further strengthen our workforce for demonstration and deployment.[10] I thank them for their foresight and long-standing dedication to seeing this industry grow.

Along with scientific innovation, we would be remiss to not call out the incredible role both the U.S. Nuclear Regulatory Commission (NRC) and Congress have played in clearing a regulatory pathway for deployment. The NRC's decision to establish a risk-informed regulatory framework for fusion energy, separate from traditional nuclear fission, has been pivotal for this nascent industry.[11] Congress's strong leadership in the ADVANCE Act cemented a clear and

[6] *The Global Fusion Industry in 2025*, Fusion Industry Association (July 22, 2025); *Commonwealth Fusion Systems Raises $863 Million Series B2 Round to Accelerate the Commercialization of Fusion Energy*, Commonwealth Fusion Systems (August 28, 2025).
[7] Sam Wurzel, *September 2025 Fusion Equity Investment Update*, Fusion Energy Base (September 1, 2025).
[8] *See, e.g.*, *Commonwealth Fusion Systems to Build World's First Commercial Fusion Power Plant in Virginia*, Commonwealth Fusion Systems (December 17, 2024).
[9] *The Global Fusion Industry in 2025*, Fusion Industry Association (July 22, 2025).
[10] Reps. Lofgren & Obernolte, *H.R.4999 - Fusion Workforce Act*, available at Congress.gov (introduced August 19, 2025).
[11] Scott Burnell, *NRC to Regulate Fusion Energy Systems Based on Existing Nuclear Materials Licensing*, NRC News (April 14, 2023).

risk-appropriate path forward.[12] It is quite possible that Pacific Fusion would not have been able to raise the funds it did—or launch at all—had the regulatory framework been different.

<u>The New Challenge is Commercial Deployment</u>

Solving the science opens up a new, exciting challenge—commercial deployment. The long-term fate of U.S. fusion leadership will depend on our ability to build and operate the first fusion power plants faster than our competitors abroad. This is because, among other reasons, the first country to realize fusion power generation will immediately become the global hub for fusion progress, and win the mantle to shape the future of this global trillion-dollar industry.

III. China is Moving Fast to Take the Lead in Commercial Fusion

Since 2023, following the NIF's announcement of ignition, China has moved aggressively into fusion, leveraging massive state investment and centralized coordination to accelerate its progress. The trend is obvious—China has seen the progress in the United States and knows that fusion is arriving. China has now overtaken the U.S. in investment into fusion companies.

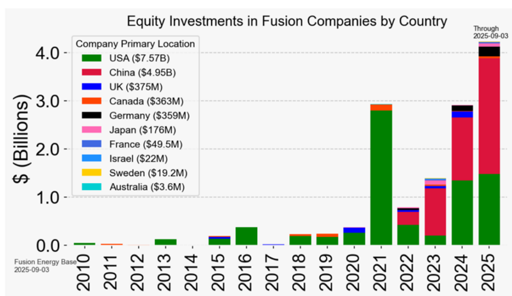

Figure 5: Investment in fusion companies: green is U.S., red is China (source: Fusion Energy Base[13])

Moreover, as laid forth in detail by the Strategic Competitive Studies Project (SCSP) in their recent analysis, China has deployed at least $6.5 billion and upwards of $10-13 billion since 2023 towards fusion facilities and standing up commercial companies.[14] The vast majority of this funding is provided through China's central and municipal governments, showcasing its willingness to use state resources to win the fusion race. Unfortunately, while the U.S. excels at innovation, the Chinese government has its own established playbook to capture industries at the critical cusp of commercialization through deep dedicated state investment. It has done this repeatedly in renewable energy, batteries, and critical minerals,[15] and could do so in fusion.

[12] About the ADVANCE Act, NRC (2024).
[13] Sam Wurzel, September 2025 Fusion Equity Investment Update, Fusion Energy Base (September 1, 2025).
[14] Cash, Scale, and Speed: Why China's $6.5 Billion Fusion Buildout Should Shock the World, SCSP (September 15, 2025).
[15] Hanming Fang, Ming Li, and Guangli Lu, Mapping Two Decades of China's Industrial Policies, Stanford Center on China's Economy and Institutions (July 1, 2025).

We list a few examples of recent Chinese investment:

- Earlier this year, China established its first state-owned fusion energy champion, China Fusion Energy Corp., with a registered capital of over $2 billion.[16] This corporation is supported by China's leading nuclear developer, China National Nuclear Corporation (CNNC), a large company with 25 nuclear fission reactors in operation and 18 in construction.[17] We expect CNNC has not invested in fusion to simply develop the science further, but to leverage its core competency and build fusion power plants.

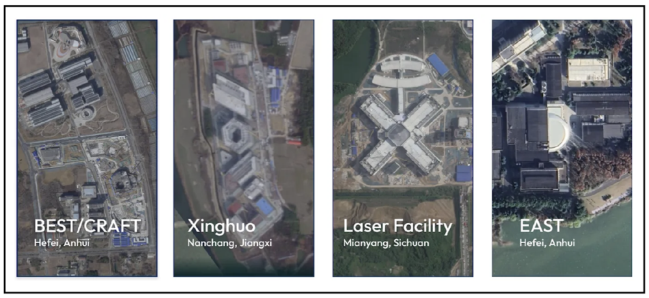

Figure 6: Primary centers of China's fusion infrastructure (source: SCSP[18])

- China has, in just a couple of years, progressed rapidly in building the world's largest inertial fusion facility in Mianyang, China.[19] Having tracked the results of U.S. leadership in inertial fusion science at the NIF, they are now close to operating a facility that could produce up to 10 times more yield, an enormous capability gap that—if unmatched—would wrest leadership from the U.S. This is just one of four major facilities that China has been rapidly constructing to accelerate fusion deployment, as seen above in Figure 6.

[16] ANS Nuclear Cafe, *China Launches Fusion-Focused Company*, Nuclear Newswire (July 30, 2025).
[17] *Major Chinese Operators Report Nuclear Output for 2024,* World Nuclear News (January 14, 2025).
[18] *Cash, Scale, and Speed: Why China's $6.5 Billion Fusion Buildout Should Shock the World*, SCSP (September 15, 2025).
[19] Gerry Doyle, *Exclusive: Images Show China Building Huge Fusion Research Facility, Analysts Say*, Reuters (January 28, 2025).

Figure 7: China is rapidly building an inertial fusion facility in Mianyang, China

- Jiangxi Electronics Group, a Chinese state-owned entity, has announced plans to build and start operations of a power plant that combines fusion and fission, aiming to generate 100 MWe by 2031, far in advance of prior Chinese projections of fusion deployment. It is currently raising the nearly $3 billion needed to make it happen.[20] Whether or not this date holds, it showcases that China is interested in deploying fusion at a commercial scale faster than most current U.S. company estimates.

IV. We Can Leverage Past Successful U.S. Playbooks to Stay Ahead

China's rise in fusion has created an existential threat to long-term U.S. energy leadership—and one we cannot afford to solve through the status quo. We need bold action, specifically to accelerate the timeline of U.S. fusion energy deployment to ensure we stay ahead of China.

Fortunately, just as we have a model for solving big science challenges, there are playbooks that have worked to keep the U.S. ahead of its peers on deployment too, and particularly ones this Committee has helped pioneer.

In particular, we find ourselves in a position not too different from the burgeoning private *space* industry in the mid-2000s and the *advanced fission* industry just five years ago—rapidly advancing up the technology curve, with substantial private sector growth, but approaching bottlenecks to commercialization. In both cases, the U.S. government set a clear market signal to rally the private sector and accelerate deployment against state-backed international competition.

[20] Jeff Pao, *China Aims for World's First Fusion-Fission Reactor by 2031*, Asia Times, (March 29, 2025); Tom Clynes, *Is China Pulling Ahead in the Quest for Fusion Energy? New Reactors Signal China's Plan to Lead the World in Fusion R&D*, IEEE Spectrum (April 29, 2025).

If done right for fusion, the same playbooks applied here can accelerate the construction timeline for fusion, and put shovels in the ground on multiple fusion power plants by 2028, pulling ahead deployment schedules by multiple critical years. We believe this would keep the U.S. ahead of China (and any other international competitors) in fusion power deployment, securing the U.S. as the leader of this multi-trillion dollar industry.

Past Successes We Can Build Off

In the space context, the NASA Commercial Orbital Transportation Services (COTS) program proved a transformative solution. This program was launched in 2006 to accelerate delivery of supplies to the International Space Station by a U.S. rocket, when at the time the only option was a Russian Soyuz rocket.[21]

The U.S. government eventually entered milestone-based contracts with multiple companies, including SpaceX, Rocketplane Kistler, and Orbital Sciences.[22] After Rocketplane Kistler failed to keep up, the U.S. government terminated its contract to save taxpayer dollars.[23] Six years later, thanks to this program, SpaceX was able to deliver to the International Space Station, and Orbital Sciences followed up in 2013.[24]

The success of this program has once again secured U.S. leadership in spaceflight. Today SpaceX has a market capitalization approaching $400B, far outweighing the ~$800 million price tag for the NASA COTS program.[25] It was so successful that it effectively pushed Russia—the former industry leader—out of much of the commercial space launch market.[26]

In the advanced fission context, to realize the promise of advanced fission reactors (which were struggling to commercialize relative to global competitors),[27] Congress drove forward the Advanced Reactor Demonstration Program (ARDP) in President Trump's first term.[28] It officially launched it in 2020 after receiving initial funding of $230 million.[29] This program has been vital

[21] *Commercial Orbital Transportation Services*, NASA (February 2024).
[22] Eli Dourado, *A 2006 NASA Program Shows How Government Can Move at the Speed of Startups*, The Center for Growth and Opportunity (March 15, 2021); *Veteran Space Company Orbital Sciences Ready for ISS*, WIRED (June 11, 2012); *NASA Partners With Orbital Sciences for Space Transport Services*, NASA (February 19, 2008).
[23] Loretta Hidalgo Whitesides, *NASA Terminates COTS Funds for Rocketplane Kistler*, WIRED (September 10, 2007).
[24] *First Commercial Resupply Mission Reaches International Space Station*, Office of Space Commerce (May 25, 2012); *NASA Partner Orbital Sciences Completes First Flight to Space Station as Astronauts Capture Cygnus Spacecraft*, NASA (September 29, 2013).
[25] Loren Grush, Katie Roof, & Edward Ludlow, *Musk's SpaceX Plans Share Sale That Would Value Company at About $400 Billion*, Bloomberg (July 15, 2025); *Commercial Orbital Transportation Services*, NASA (February 2024).
[26] Leonid Bershidsky, *How Elon Musk Beat Russia's Space Program*, Bloomberg (February 7, 2018); Eric Berger, *Russia Appears to Have Surrendered to SpaceX in the Global Launch Market*, Ars Technica (April 18, 2024).
[27] Colleen Howe, *China Starts up World's First Fourth-Generation Nuclear Reactor*, Reuters (December 8, 2023); Stephen Ezell, *How Innovative Is China in Nuclear Power?*, Information Technology & Innovation Foundation, (June 17, 2024).
[28] *DOE Launches Advanced Reactor Demo Program*, Nuclear News (February 17, 2020).
[29] *U.S. Department of Energy Launches $230 Million Advanced Reactor Demonstration Program*, DOE Office of Nuclear Energy (May 14, 2020).

to boosting advanced reactor deployment.[30] From being seen as second-class to Russia and China, the U.S. is back in the race and showing rapid progress.[31] According to the Nuclear Innovation Alliance, "[f]ederal funding of the ARDP is catalyzing billions of dollars in private investment in innovative nuclear technologies and creating a pathway for commercialization of new advanced nuclear reactors."[32]

Applying this Playbook to Fusion with a Fusion Demonstration Program

The lessons learned from these examples is that, when done right, milestone-based public-private partnerships can change the course of deployment for game-changing technologies, no matter the competition.

To apply this playbook to fusion, a first step would be completing the Milestone-Based Fusion Development Program, initially created in the first Trump Administration.[33] This program has accelerated preliminary design work towards the development of demonstration commercial fusion power plants.[34] Fully funding this program and allowing new entrants would enable U.S. fusion companies to complete their design work, setting the industry up to succeed in later deployment.

Simultaneously, this Committee should pioneer a ***Fusion Demonstration Program*** to accelerate the start of commercial fusion deployment to 2028, building off of and improving over past programs. The Fusion Demonstration Program would have three key characteristics:

- A clear and unequivocal goal to accelerate the deployment of at least three different fusion power plant approaches, with construction starting by the end of 2028 and entering operation by the early 2030s.
- Milestone-based, cost-shared funding that only awards those who show *substantial* progress towards the goal (e.g., achieving ignition or equivalent in a prior research system, and meeting the 2028 start of construction deadline). Those that do not meet their milestones will not get funded and would have their awards terminated.

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[30] Judi Greenwald & Erik Cothron, *The Case for Continued Investment in the Advanced Reactor Demonstration Program*, Nuclear Innovation Alliance (February 6, 2025).
[31] *The Global Race for Advanced Nuclear Is On*, Clean Air Task Force (October 24, 2024). For example, one of the two Advanced Reactor Demonstrations awardees, TerraPower, has already filed for a license with the NRC and broke ground on its power plant in June of 2024. *TerraPower Begins Construction on Advanced Nuclear Project in Wyoming*, TerraPower (June 10, 2024). The other, X-energy, has partnered with Dow Chemical Company to build four Xe-100 reactors in Seadrift, Texas. *X-energy, Dow Apply to Build an Advanced Reactor Project in Texas*, Nuclear News (March 31, 2025). One of the Risk Reduction awardees, Kairos Power, has received its construction permit and is well underway building its Hermes test reactor in Tennessee. *Kairos Power Receives DOE Funding to Support Development of Hermes Reactor*, Nuclear Engineering International (February 28, 2024).
[32] *The Case for Continued Investment in the Advanced Reactor Demonstration Program*, Nuclear Innovation Alliance (February 6, 2025).
[33] *Energy Act of 2020* (Sec. 2008), Committee on Science, Space, and Technology (2020).
[34] *DOE Opens Milestone Fusion Pilot Plant Program to New Companies and Teams* Nuclear News (June 12, 2025).

- Selection of participants based not just on scientific merit, but also by requiring a clear path to commercial and business success.

This program can be funded in stages to limit upfront costs and risks for the Federal government. For example, around the time Congress launched ARDP, it appropriated $230 million, which was enough to initiate work and send a clear market signal.[35] Additional funding arrived as the program progressed[36] and broad support increased. A similar path could be taken here. Here, a program costing a fraction of the roughly $10–13 billion China has invested just since 2023 would enable the U.S. to dominate the future of a trillion-dollar industry.

As the Fusion Demonstration Program develops, there is also still critical science and engineering work to be done to accelerate commercial deployment, such as engineering new systems to close the tritium fuel cycle and developing improved materials to withstand commercial fusion chamber environments. Such testbeds would support the broader industry and are critical for ensuring the U.S. commercial fusion industry can take off before China's.

The Fusion Demonstration Program may represent a new style of DOE fusion program. The DOE's Office of Science has brought fusion to the doorstep of commercialization and has started the shift towards applied research and commercialization through its Milestones program.[37] However, the Fusion Demonstration Program will require a much more applied focus, distinct and complementary to the Office of Science's science mission. To win the fusion race, DOE may need to bring on additional capabilities.[38]

* * *

Thank you for the opportunity to testify before this Subcommittee. I could not be more proud of the work that Pacific Fusion has done to date and inspired at the incredible progress the fusion community has made in just the last decade. The work this Subcommittee has done has transformed countless U.S. industries and lives. By leveraging playbooks that have proven successful in other industries, the U.S. can ensure energy dominance and economic prosperity by being the first nation to bring commercial fusion energy to scale.

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[35] *U.S. Department of Energy Launches $230 Million Advanced Reactor Demonstration Program*, DOE Office of Nuclear Energy (May 14, 2020).
[36] *The Case for Continued Investment in the Advanced Reactor Demonstration Program*, Nuclear Innovation Alliance (February 6, 2025).
[37] *Department of Energy Announces Milestone Public-Private Partnership Awards*, Fusion Industry Association (May 31, 2023).
[38] The SCSP *Commission on the Scaling of Fusion Energy* has evaluated how to establish this capability within DOE. *See, e.g.*, *Fusion Power, Enabling 21st Century American Dominance*, Commission on the Scaling of Fusion Energy (February 24, 2025).

PACIFIC FUSION

Will Regan, Co-Founder & President

Will Regan is the Co-Founder and President of Pacific Fusion, a company pursuing pulser-driven inertial fusion with the mission to produce the world's most affordable firm power. Years before, he helped catalyze the fusion industry, as co-developer of the ALPHA program at the U.S. Department of Energy's ARPA-E — which provided early support to several leading fusion startups active today — and as a founding advisor to Strong Atomics, a fusion-focused venture capital fund.

Prior to Pacific Fusion, he also built high-impact energy projects at Alphabet's X labs, including founding Mineral, a former Alphabet division focused on agriculture.

Will holds a Ph.D. in Physics from the University of California, Berkeley, and an AB in Physics from Cornell University.

Chairman WEBER. Thank you, Dr. Regan.
Dr. Carter, you're up.

TESTIMONY OF DR. TROY CARTER, DIRECTOR OF FUSION ENERGY DIVISION, OAK RIDGE NATIONAL LABORATORY

Dr. CARTER. All right, good morning. Chairman Weber, Ranking Member Ross, Members of the Committee, I'll add my thanks for having this hearing. Glad to be here.

I'm Troy Carter, Director of Fusion Energy Division at Oak Ridge National Laboratory. Before I was at Oak Ridge, I was a professor at UCLA (University of California, Los Angeles) for many years, where I led the Basic Plasma Science Facility and directed the Plasma Science and Technology Institute. Also a product of NC State. There you go. Big fan of the Wolf Pack. Degrees in physics and nuclear engineering from there.

The last time I appeared before this Committee was in 2021. That was after chairing the process that led to the FESAC (Fusion Energy Sciences Advisory Committee) long-range plan, "Powering the Future: Fusion and Plasmas."

So OK, let me start. First, I'll say it clearly, the investment that has been made by the Federal Government in fusion research has paid off tremendously. Over the decades, support from Congress, this Committee, thank you, has enabled the United States to make extraordinary progress. We've learned, as one example, learned how to heat and control plasmas, the superheated gases where fusion takes place, at conditions approaching those required for fusion power plants. Investments in facilities have been critical. Examples include the DIII–D tokamak at General Atomics in San Diego, several devices at Princeton, TFTR, NSTX, NSTX–U, Alcator C-Mod at MIT (Massachusetts Institute of Technology). This was central to this progress, absolutely important.

In addition, there have been investments by NNSA (National Nuclear Security Administration) that have been spoken about already, so the National Ignition Facility, the Z-Machine at Sandia. While these were built for stockpile stewardship, the breakthroughs that have been made there have direct impact, direct implications for fusion energy.

International collaboration is vital and remains vital. So there are a number of examples there. United States scientists contributed to record results at the Joint European Torus in the U.K., at the Wendelstein 7–X stellarator in Germany, United States partnership and involvement in ITER (International Thermonuclear Experimental Reactor), we're learning to build industrial-scale fusion while strengthening the supply chain for fusion.

Investments in fusion R&D have had broader impact. So Chairman Babin already spoke to this. There's a lot of spinoff technologies. These include semiconductor manufacturing techniques using plasmas, extreme ultraviolet lithography. There have been advances in high-temperature superconducting magnets that are now reshaping energy technology. And in developing tools for controlling, analyzing plasmas for fusion, our community has driven innovations in artificial intelligence. These methods are now being used in manufacturing, robotics, and even drug discovery.

All right, so a lot has happened. The opportunity before us now is to amplify that return on investment significantly by fostering the United States fusion industry. Thanks to this progress, we have a number of U.S. Space-based fusion startups that have raised significant capital and are targeting pilot plants on ambitious timelines. I will call out that these companies that spun out of the public program from universities and National Labs. The National Labs in the case of Dr. Regan, and MIT in the case of Dr. Mumgaard. So that investment has helped lead to this.

The ambition for doing this on a short timeline reflects the urgency of energy needs, as well as the confidence in the scientific foundation that has been laid by the program. However, we have significant challenges ahead. And they are shared by all of these companies, and we need to address them.

Without strong public-private partnerships, these companies will face unsustainable risk as they move forward. And the United States risks ceding leadership in this industry that it helped create. OK? Partnership is essential.

We need to pair the speed and the innovation of industry with the depth and specialized tools of the National Labs and the universities. We need to make these partnerships easier. It is challenging sometimes to set up SPPs (Strategic Partnership Projects) and CRADAs (cooperative research and development agreements) with the companies for National Labs to really do the work we need to do. We need to improve these processes, come up with more flexible ways to partner. And this will not only benefit fusion, it will benefit other fields, U.S. competitiveness in fields like AI, if we can get the National Labs lined up with industry and moving faster.

All right, so we know what we need to do to get there. We're excellent at planning in the United States. We've launched a lot of planning studies. The FESAC long-range plan is one of them. The plan is there, alongside national academy studies that have called for the goal of fusion power plant, industry led. We are starting to make progress on this.

I was before this Committee 4 years ago and said, "Now's the time for fusion." We have a plan, and we need to act. I still need to deliver that same message today as we still haven't fully acted yet. But we're starting. There are some programs that we've founded. So you look at the Milestone Program that's been mentioned, the INFUSE Partnership Program that's been mentioned, and new FIRE collaboratives that are just launched. These unite labs, universities, and companies on shared challenges. This is very important.

We need new facilities. These are called out in the planning documents. To close the gaps to the pilot plan, we need new facilities. ITER will give us access to burning plasmas and experience in building at industrial scale. Fusion Prototypic Neutron Source, we need that to develop and understand and qualify materials that can withstand the harsh neutron environment in a fusion device.

The Materials Plasma Exposure eXperiment (MPEX)—I choked up because it's my facility—now being built at Oak Ridge will study plasma-material interactions and develop solutions for fusion exhaust.

We need a blanket and fuel cycle facility to close the gaps to commercialization.

And I will end, because I see my time is up, by saying that we know these facilities are being built in China. Right? These facilities and more are happening right now. So we need to act quickly.

One more message, and if I have more time—I don't, I think I'm out. I'll just say we need to invest in the public sector because we need to continue to push innovation forward. We need workforce. I'll add my thanks on the *Fusion Workforce* bill, and just close to say the decisive moment is now. With deliberate action, supporting facilities, partnership, and innovation, we can ensure the United States leads in turning fusion from scientific promise into commercial reality. Thank you.

[The prepared statement of Dr. Carter follows:]

Written Testimony of Dr. Troy A. Carter
Director, Fusion Energy Division, Oak Ridge National Laboratory

Before the
Committee on Science, Space, and Technology
Subcommittee on Energy
U.S. House of Representatives

Hearing on *Igniting America's Energy Future: The Promise and Progress of Fusion Power*

September 18, 2025

Chairman Weber, Ranking Member Ross, and Members of the Committee, thank you for the opportunity to testify today on the promise of fusion energy. My name is Troy Carter, and I am Director of the Fusion Energy Division at Oak Ridge National Laboratory. Prior to joining ORNL, I was a Professor of Physics at UCLA, where I directed both the Basic Plasma Science Facility and the Plasma Science and Technology Institute. The last time I appeared before this Committee was in 2021, after chairing the Fusion Energy Sciences Advisory Committee (FESAC) long-range planning subcommittee, which produced the consensus report *Powering the Future: Fusion and Plasmas*.

Federal investment has led to significant scientific and technological progress

Long-term federal support for fusion energy research, thanks to the support of this Committee and Congress, has delivered extraordinary returns. We have advanced our fundamental understanding of the behavior of plasmas, the superheated gases that are at the heart of fusion devices, so we can create and control fusion fuel in conditions required for future power plants. DOE Fusion Energy Sciences investments in major user facilities, current and past--including the DIII-D tokamak at General Atomics; TFTR, NSTX, and NSTX-U at Princeton Plasma Physics Laboratory; and Alcator C-Mod at MIT—have been essential in enabling this progress. Facilities supported by the National Nuclear Security Administration, such as the National Ignition Facility at Lawrence Livermore National Laboratory and the Z-Machine at Sandia, while built for stockpile stewardship, have also generated breakthroughs with direct implications for fusion energy. International collaboration has been equally vital. For example, U.S. researchers have played central roles in recent record-setting results on the Joint European Torus in the UK and on the Wendelstein 7-X stellarator in Germany, and partnership in ITER is yielding experience in delivering industrial-scale fusion systems while building the U.S. fusion supply chain and workforce. These federal investments have also seeded important spin-off technologies – among them, plasma processing techniques that underpin the semiconductor industry, extreme-ultraviolet lithography for microelectronics, and the development of high-temperature superconducting magnets now being leveraged in fusion device design. Investment in fusion research has also led to progress in artificial intelligence – in developing the tools to analyze and control fusion plasmas, our community has helped drive innovations in artificial intelligence and machine learning methods that are now broadly used across fields like manufacturing, robotics, and even drug discovery.

Opportunity: Public–Private Partnerships to enable a US fusion industry

The opportunity before us is to significantly amplify this return on investment by fostering a robust and competitive U.S. fusion industry. Owing to the progress made in the fundamental science and technology relevant to fusion, around 30 U.S.-based fusion start-ups—most spun out by university and national laboratory researchers—are now pursuing electricity-producing fusion pilot plants on aggressive timelines. Their ambition reflects both the urgency of energy needs and confidence in the scientific foundation built through federal investment.

There are significant common technical challenges that need solutions for these efforts to succeed. Without strong public–private partnerships, these companies will bear unsustainable risks, and the U.S. risks ceding leadership in a sector it arguably founded. By coupling the innovative drive and risk tolerance of U.S. industry with the stability, depth of technical expertise, and specialized tools in the U.S. national lab–university system, we can de-risk the path to economical fusion power and ensure the United States fully captures the benefits of this emerging industry.

To succeed, we must also improve and streamline mechanisms for public and private partners to engage. Improving the process for and timeline to approval of Cooperative Research and Development Agreements (CRADAs) and Strategic Partnership Projects (SPPs), as well as exploring more flexible mechanisms for collaboration, would accelerate progress. These improvements would not only benefit fusion energy but are essential to strengthen U.S. competitiveness in other critical fields, such as artificial intelligence.

How to get there: Expert consensus path to fusion energy in the US

We are not starting from scratch. The technical challenges and strategic pathway for the U.S., targeting the goal of an electricity-producing fusion pilot plant, are clearly enumerated in consensus reports:

- The FESAC Long Range Plan, *Powering the Future: Fusion and Plasmas* (2021)
- The National Academies' *A Strategic Plan for U.S. Burning Plasma Research* (2019)

- The National Academies' *Bringing Fusion to the U.S. Grid* (2021)

Congress, and especially this Committee, has acted on recommendations from these reports through authorizing legislation and appropriations. DOE Fusion Energy Sciences is recently responding through the creation of new programs. This includes the Fusion Milestone program, which is supporting the private sector to develop technology roadmaps and preliminary designs for fusion pilot plants, as well as the popular and successful INFUSE program. INFUSE provides support for the private sector to access expertise and facilities at national labs and universities to make progress on their technology development. It also includes the recently announced Fusion Innovation Research Engine (FIRE) Collaboratives, which will unite labs, universities, and industry to tackle critical common challenges such as closing the fusion fuel cycle, identifying and qualifying robust materials for the extreme environment of a fusion system, and mitigating plasma instabilities that limit fusion performance.

New experimental facilities have been identified that are essential to de-risking the path to fusion pilot plants. The reports mentioned previously, along with a report released last year from the Fusion Energy Sciences Advisory Committee that recommended new facilities for public investment that "best serve fusion", identified priority facilities including:

- **ITER**: U.S. participation ensures access to a flexible and well-diagnosed platform for studies and optimization of the burning plasma that will be at the heart of a fusion reactor. It also provides valuable experience in designing, fabricating and assembling a fusion device at industrial scale. Investment in ITER has also benefited the private sector through developing a fusion technology supply chain.

- **Fusion Prototypic Neutron Source (FPNS)**: Will advance the science of materials under energetic fusion neutron bombardment and develop and qualify materials that can withstand the extreme neutron environment of a fusion reactor.

- **Materials Plasma Exposure eXperiment (MPEX)**: Now under construction at ORNL, this device will subject materials to intense heat and particle flows to enable the study of plasma–material interactions and the development of materials and components solutions for fusion exhaust systems.

- **Blanket and fuel-cycle test facilities**: Will demonstrate tritium breeding from fusion neutrons and tritium handling, demonstrating closing of the fusion fuel cycle—a critical hurdle for achieving economy and efficiency for commercialization.

The expert consensus view is that access to these facilities for U.S. public researchers and private sector developers is critically important to close science and technology gaps toward fusion pilot plants. I note that other countries, particularly China, are heavily investing in a number of similar fusion facilities that are under construction as we speak.

The importance of public sector innovation in the long-term success of the US fusion industry

Alongside increased efforts to partner with and enable the success of the private sector, we must also sustain and grow foundational fusion science and technology research programs at National Labs and Universities. Innovations from this research–and their translation to industry–will shape not just the first pilot plants, but the generations of fusion systems needed for a sustainable industry. This research ecosystem—spanning plasma physics, materials science and technology, and fusion enabling technology—has been the bedrock of U.S. progress.

Public sector programs will remain central to our long-term success by filling knowledge and technology gaps and serving as a rapid-response resource as technical challenges arise during demonstration and deployment of novel fusion systems. Foundational research and development at universities and national labs is also critical to sustain and grow the workforce needed for a successful fusion energy enterprise in the U.S.

A fusion workforce strategy should be developed for the U.S. and should include engagements across K-12 education, trade schools, community colleges, and higher education – with partnerships from national labs and industry providing, for example, internships and apprenticeships. I am very glad to see the Fusion Workforce Bill introduced by Representatives Lofgren and Obernolte – the provisions of this bill will set us on the right path to establishing the needed fusion workforce.

Closing: Now is the time to act

In short, Congress's consistent investment in fusion research has paid off in science, technology, and economic opportunity. But the decisive moment is upon us. Other nations are moving aggressively to invest in fusion energy development. With deliberate action now—by supporting new facilities, public–private partnerships, and sustained innovation—we can ensure that the U.S. leads in bringing fusion energy from scientific promise to commercial reality.

Thank you for your leadership and support. I look forward to your questions.

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Troy Carter, Ph.D.

Troy Carter is Director of the Fusion Energy Division at Oak Ridge National Laboratory (ORNL), where he leads programs in plasma physics, fusion materials, and enabling technologies. He oversees the development of the Materials Plasma Exposure eXperiment (MPEX), ORNL's research contributions toward ITER, and public–private partnerships that support the growing fusion energy industry.

Carter is on leave as a Professor of Physics at UCLA, where he was Director of the Basic Plasma Science Facility (BaPSF) and the Plasma Science and Technology Institute (PSTI). His research on waves, instabilities, turbulence, and transport in magnetically confined plasmas is motivated by both astrophysical processes and the development of fusion energy. He is a Fellow of the American Physical Society and the American Association for the Advancement of Science and a recipient of the APS John Dawson Award for Excellence in Plasma Physics Research and UCLA's Abelmann Award for Teaching Excellence.

Carter has served on a range of advisory committees for the plasma physics and fusion research communities, including the DOE Fusion Energy Sciences Advisory Committee, the Scientific Advisory Board (Fachbeirat) for the Max Planck Institute for Plasma Physics, and Program Advisory Committees for the DIII-D and Alcator C-Mod tokamaks and the NSF Frontier Center for Magnetic Self Organization. Carter served on the NASEM Committee for the 2020 Decadal Assessment of Plasma Science and led the DOE FESAC Long Range Planning process that resulted in the 2021 report "Powering the Future: Fusion and Plasmas." He was awarded the Fusion Power Associates Leadership Award in recognition of his fusion community leadership contributions.

Carter received BS degrees in Physics and Nuclear Engineering from North Carolina State University in 1995 and a PhD in Astrophysical Sciences from Princeton University in 2001.

September 2025

Chairman WEBER. Boy, you're a fast speaker, too, Dr. Carter. I thought—I could sit here and listen to you all day. And there for a minute, I thought I was going to have to.

[Laughter.]

Chairman WEBER. So, Dr. Mumgaard, you're recognized for 5 minutes.

TESTIMONY OF DR. BOB MUMGAARD, CO-FOUNDER AND CEO, COMMONWEALTH FUSION SYSTEMS

Dr. MUMGAARD. Chairman Weber, Ranking Member Ross, Members of the Committee, thank you for the opportunity to address you here today. I'm the CEO and co-founder of Commonwealth Fusion Systems. It's the largest fusion company in the United States and one of the largest fusion organizations in the world, second or third to the Chinese national program and the U.K. national program.

Since my last appearance here 4 years ago, the fusion landscape has continued to evolve. We see a surge of private investment. We see significant scientific milestones. And we in the United States face an increasing sharp competition from foreign rivals, particularly China. We are at a critical moment, transitioning from science to demonstration and the threshold of commercialization.

I want you to take away three things here, three things to know. First, a working fusion power plant is not a matter of if, it's a matter of when and where. NIF has shown it's possible. The window is now open.

At CFS, we are assembling our proof of concept machine, SPARC (as Soon as Possible Affordable, Robust, Compact). It's the largest next generation energy device in the United States. And in a couple of years, it will show commercially relevant net—not net electricity—net energy from fusion reactions.

You know, the entrepreneurs, they see this shift. In 2021, there were 23 fusion companies with about $2 billion. Now, there's 53 with $10 billion. Eighty-five percent of that is in the United States. And it's not just venture capital or billionaires. It's sovereign wealth funds, it's banks, it's energy companies, hyper-scalers. These are blue chip companies. The markets have seen that this window is open. Other countries see the window is open. We have significant policy shifts from Germany, the U.K., Japan, and most importantly from China.

The second thing to know is this is a very high stakes race. This is trillions of dollars. Fusion is a foundational tool to build an advanced society. It transfers energy from being about natural resources, consumption, who has it, how do you get it, to being about technology, what do you know, how do you innovate, how fast can you build.

AI makes this even more important, because AI needs the type of power that fusion can make, and fusion needs AI. It's a flywheel. And that's why you see AI companies investing in fusion.

And the race to fusion, that's the race to abundance. It's a hopeful message. We can't wait.

At CFS, we are simultaneously finishing SPARC while we're also designing ARC (Affordable, Robust, Compact), a commercial fusion power plant that we will build in Richmond, Virginia.

Now, the third thing to take away is the United States is not positioned to win. China is. The United States' leadership is under threat because we haven't made the investments, and we're not sufficiently organized. In China, we're witnessing a coordinated state-organized intention to win, with state-sponsored companies, with the buildouts of test stands at massive scale, with multiple shots on goal. Analysis released this week from the Special Competitive Studies Project, which I'm a part of, estimates that China has invested $6.5 billion in new fusion facilities since the NIF shot. That's three times more than what we have spent over the same period.

The United States has nothing like this. We are at serious risk of falling behind, unless it takes urgent action and soon. Our fusion program looks much like it did even 10 years ago. Its test stands are aging; its infrastructure is old. It's focused on science; it's not focused on moving to commercialization. The GAO (Government Accountability Office) report recently said that there's only about 2 percent ideally funding that's relevant to building a fusion industry.

OK. What do we do?

So the Fusion Industry Association and the SCSP (Special Competitive Studies Project) Fusion Commission and others are calling the U.S. Government to do a one-time $10 billion investment in fusion research and demonstration. That's the level that it would take to do this.

So like what would that do?

First, you would fund the commercialization programs that are already stood up. We've talked here about the Milestone Program. That program, it shares risks. The companies that have won it have real shots on goal. And they say they need about $2 billion to be able to see what those power plants would look like before they start to construct them. That's way more than what is currently going into that program, but it's also the level that is near the level that's authorized.

And then we would need another program on that Milestone framework that would actually go and build a few of these power plants. And that would be, you know, not unreasonable. It's very consistent with what we've done in other advanced technologies, if you think about commercial space or fission. And if we spend that money now, we won't have to spend 10x of that money later to catch up. And so that would amplify a key American strength, which is the competitive entrepreneurial ecosystem.

Second, we need to advance in commercially relevant R&D at National Labs and universities. No company can do this alone. There is still science and technology to be done, and that's where the crown jewel to really, really excel. But they need the material test stands, they need the programs that build the workforce, they need the mandate to go work on that. And this means shifting funding and adding funding. It means shifting priorities.

And all the roadmaps exist. The planning has been done. China is doing it. We just need to do it here. That's going to take like $4 billion.

Third, we've got to prime the pump for the future. Once we have the first power plant selling electricity, we're not done. We need workforce, we need supply chain, and we need a government program that can actually support that. That means an applied program. We should start planning that today.

So in closing, the moment is now. And thank you for having me testify. I'm happy to hear what the questions are.

[The prepared statement of Dr. Mumgaard follows:]

Written Testimony of Dr. Bob Mumgaard, Co-Founder and CEO, Commonwealth Fusion Systems

House Committee on Science, Space, and Technology, Subcommittee on Energy

"Igniting America's Energy Future: The Promise and Progress of Fusion Power"

September 18, 2025

Chairman Weber, Ranking Member Ross, and members of the Committee. Thank you for the opportunity to appear before you today. I am Bob Mumgaard, CEO of Commonwealth Fusion Systems (CFS), and I'm grateful to be back before this Committee, having last testified in November of 2021. Since that time, the landscape of the fusion industry has undergone a dramatic transformation. We have seen surging private capital investment, increasing linkages between fusion and artificial intelligence (AI), and significant scientific milestones on an accelerated path to commercialize this game-changing technology, all while facing increasingly sharp competition from foreign nations.

Commonwealth Fusion Systems: A Journey from Promise to Progress

When I last testified, CFS had just achieved a critical technological validation—the successful testing of the world's most powerful high-temperature superconducting (HTS) magnet. That breakthrough helped us raise $1.8 billion and it has since formed the foundation of our work.

In the past four years, we have translated that magnet technology breakthrough into tangible, real-world progress. We have progressed from a research and development phase to full-scale construction of the SPARC tokamak, our demonstration machine, in Devens, Massachusetts. CFS as a company has grown to over 1,000 employees, a 4 fold increase, building HTS magnets in our factory and assembling SPARC on a site that we had barely broken ground on the last time I spoke with you. Today, SPARC is actively being assembled, over 70% complete, with major components like the cryostat base already in place, subsystems in the commissioning phase, and our vacuum vessel - which serves as the heart of the machine - is scheduled to arrive shortly. We have a clear path to demonstrating net energy from fusion—what is known as Q > 1—and are aiming for 2027. Increasingly, the world is turning to SPARC to validate that fusion can be made at commercial scale.

Generating net energy with the first commercially relevant, grid-scale machine will be a civilization defining moment. It is our "Kitty Hawk" moment, ushering in a new era of virtually unlimited fusion power.

Beyond the SPARC machine, our focus has expanded to our commercial product for fusion power. This includes securing the site for our first 400MW ARC commercial power plant in

Chesterfield County, Virginia[1], and forging a landmark strategic partnership with Google, which has committed to purchase power from that plant once it is on the grid. We aim to commence construction on the ARC power plant in 2028, with the first fusion power on the grid by the early 2030s. This progress is a direct result of strong, consistent support from our investors, including our recent $863 million Series B2 funding round[2], leading our total private capital raise to just shy of $3 billion, from blue chip investors such as NVIDIA, Google, and the private arm of Fidelity. The funding and size makes CFS the largest dedicated fusion organization in the U.S. and one of the largest in the world, after the Chinese and U.K. national programs.

CFS isn't just the largest private fusion company, we are one of the largest privately funded “tough tech” startups in the world. That reflects the capital-intensive nature of our work, but it’s also a signal from discerning investors and market demand that commercial fusion is closer than many realize.

A Broader Fusion Industry Taking Shape

The momentum at CFS is a reflection of a wider trend in the global fusion ecosystem. Over the last four years, the private fusion sector has grown at an unprecedented rate, attracting billions of dollars in new capital. In 2021, there were 23 fusion companies that collectively raised $1.78 billion in private capital. Today, there are 53 private fusion companies that have raised $10.6 billion in private funding, 85% of which has been invested in American fusion companies, with the largest in CFS. This increased investment is a clear signal that the private market now sees fusion not as a distant dream, but as a viable commercial opportunity. The continued growth of AI, advanced manufacturing, electrification of things and resulting energy demands will accelerate these trends.

This shift in perception has been accelerated by key scientific breakthroughs, most notably the achievement of fusion ignition at the National Ignition Facility (NIF) in December 2022. For the first time, a fusion reaction produced more energy than was delivered by the lasers, proving the fundamental science of fusion energy gain. This landmark achievement has inspired confidence across the industry and started a global race to commercialize fusion power.

Artificial Intelligence and Fusion

The convergence of artificial intelligence and fusion is creating a powerful, mutually beneficial relationship that is fundamentally accelerating our progress. On one hand, AI is becoming an indispensable tool for solving the immense technical challenges of fusion. On the other, the soaring energy demands of the AI boom are creating a powerful new commercial imperative for fusion energy. We should embrace these connections.

The rapidly growing energy needs of data centers and AI training models are creating an urgent demand for a new kind of power source. The energy consumption of these centers is projected

[1] Commonwealth Fusion Systems to Build World’s First Commercial Fusion Power Plant in Virginia
[2] Commonwealth Fusion Systems Raises $863 Million Series B2 Round to Accelerate the Commercialization of Fusion Energy

to skyrocket in the coming years, placing immense stress on existing grids and demanding a firm, clean, and reliable source of electricity. This is where fusion comes in. A commercial fusion power plant can provide consistent, 24/7 power that can support a data center's continuous operation. Thanks to recent actions by the Nuclear Regulatory Commission[3] and Congress[4], we can license and build fusion power plants safely and quickly. And they can be built where the power is needed, like data centers, minimizing the need for building new transmission lines. This symbiotic relationship is driving strategic partnerships between tech companies and fusion developers. CFS and the rest of the fusion industry are getting closer to turning fusion into a business venture, and we need a lot of new energy at the moment this is happening. The recent $863 million funding round we received from investors, including new investments from Nvidia and increased investment from Google, is a clear signal that the AI industry sees fusion as an essential part of its future infrastructure. This capital, paired with Google's landmark power purchase agreement for 200 megawatts of power from our first commercial plant, highlights a new, powerful commercial pathway for fusion that goes beyond traditional climate arguments.

At the same time, advanced AI is being used across our industry to accelerate breakthroughs and reduce risk. At a fundamental level, AI-enhanced simulations are helping scientists at institutions like MIT to decode the turbulent behavior of plasma, a notoriously complex phenomenon. Using machine learning, researchers can create "surrogate models" that mimic complex physics simulations, but run in milliseconds instead of minutes. This is a game-changer for designing, optimizing, and controlling a fusion device. We've also leveraged cloud computing capabilities to model our machines, inform designs, reduce scientific risk and accelerate progress towards our commercial goals. CFS will announce some additional AI tools we have been utilizing in the near future.

Increasing Global Competition and the Case for U.S. Leadership

Despite the tremendous progress at home, the United States' leadership position in fusion is not guaranteed, and is eroding day by day. We are in a race to see which nation can first deploy a scalable, commercial fusion technology. Our competitors, particularly in China, are making significant strides backed by massive state-level investment and a coordinated national strategy. The Special Competitive Studies Project (SCSP) Commission on Scaling Fusion Energy, of which I am a member, just released an analysis of China's fusion efforts[5], including $6.5 billion of investment in commercial-relevant facilities since the 2022 NIF shot. That's 3 times what the US spent during the same period. Despite all the positive news coming out on the significant investments in the fusion industry, including our recent B2 raise, Chinese equity investments in their fusion companies have outpaced investment in US fusion companies for the last three years in a row[6].

China's national program, with its Experimental Advanced Superconducting Tokamak (EAST) "artificial sun," has set and re-broken world records for sustaining high-temperature plasma for

[3] NRC to Regulate Fusion Energy Systems Based on Existing Nuclear Materials Licensing
[4] FIA: US Senate Passes ADVANCE Act, Including Legislation to Codify US Fusion Regulations
[5] SCSP: "Cash, Scale, and Speed: Why China's $6.5 Billion Fusion Buildout Should Shock the World"
[6] Fusion Energy Base: September 2025 Fusion Equity Investment Update

over 1,000 seconds. This is a testament to their dedicated, long-term approach to fusion research. Beyond scientific milestones, China is also developing a robust industrial base and supply chain, which gives them a distinct advantage in the rapid deployment of large-scale projects. Their government's strategy is now fully entering the commercial race with the completion of the Comprehensive Research Facility for Fusion Technology (CRAFT), which serves as a national platform to explore and master critical enabling technologies. The 4 million square foot CRAFT facility will provide China with cutting edge research infrastructure and test stands to close many key science and technology gaps identified by the US' 2020 Long Range Plan[7], but that we have failed to act on them. China is also constructing a less sophisticated competitor to the SPARC demonstration machine, the Burning Plasma Experimental Superconducting Tokamak (BEST), a compact, high-field tokamak designed to achieve high-performance plasma. BEST and SPARC are both targeting 2027 for achieving a civilization-defining achievement of $Q > 1$. This coordinated effort is now being backed by direct state investment, including the recent formation of China Fusion Energy Co. (CFEC), a state-owned company with registered capital of approximately $2.1 billion, with the explicit goal of accelerating the industrialization of fusion energy. This is effectively a state-backed competitor to my company.

From my vantage point, it feels more and more like it is the U.S. fusion industry versus China in the race to deploy and scale fusion. China is building research facilities and proof of concept machines, organizing a whole of government effort in which it is hard to distinguish between their public and private efforts, and laying the groundwork for a supply chain and workforce with global dominance as an ambition. This is a coordinated, state organized intention to win the fusion race. The next decade of fusion breakthroughs and scientific discovery is going to happen in China, not in the US, with the investments I am seeing.

The United States has nothing like this and is at serious risk of falling behind unless urgent action is taken soon. The U.S. Government effort is fragmented, weighed down by underwater mortgages on antiquated facilities, underfunded, and ill-equipped to deliver the focused mission-driven programs needed to complement the private sector to effectively compete with the U.S.'s primary geostrategic rival in this important space. A recent report by the General Accounting Office[8] put it pretty bluntly: over the last few years, only 1.2% of DOE-funded fusion efforts on an annual basis are going towards commercialization through public-private partnerships (PPPs), like the Milestone program.

The decisions the federal government makes in the next year or two could have generational implications. Fusion is not like most technologies. Once commercial, it has the potential to forever change the direction of human development. China understands this. It does not take a stretch of the imagination to think what China could do with a Chinese fusion power plant as an extension of its ambitious "Belt and Road Initiative."

[7] FESAC: Powering the Future Fusion & Plasmas, 2020
[8] GAO: "Fusion Energy: Additional Planning Would Strengthen DOE's Efforts to Facilitate Commercialization" - January 2025

CFS and the other leading fusion companies are at the absolute edge of what venture capital is able to fund. I have no doubt we will work as hard as possible to achieve our commercialization goals. However, the US will lose a race to China if it does not mobilize to support this nascent industry. This would mean seriously investing in critical enabling fusion R&D at our National Labs and universities and can accelerate timelines for U.S. deployment by supporting the first commercial demonstration fusion power plants through cost-sharing programs, like it has for other critical technologies. It is for this reason that the Fusion Industry Association (FIA), the SCSP Commission on Scaling Fusion Energy[9], as well NGOs like Clean Air Task Force[10] are calling on the U.S. government to make a one-time, $10 billion dollar investment in fusion research and commercial demonstration efforts to ensure the US wins the race. I don't believe we can catch up at this point through the annual federal budget process alone.

Recommendations

With this context in mind and the critical moment we are in, I'd like to offer the following recommendations to inform your work.

1. **Fund public private partnerships at the level required to compete**. Thanks to this Committee's efforts in the form of the bipartisan Energy Act of 2020, signed into law by President Trump, many of the critical programs and authorities we need are already in place. We simply need to fund them.

   CFS is one of eight companies participating in the **Milestone-based Fusion Development program**[11]. Modeled on the highly innovative and successful NASA program that enabled SpaceX to pave the wave for a US dominated commercial space industry, the companies in the fusion milestone program are working towards finalizing the designs of our fusion power plants, like CFS' ARC powerplant. This program leverages the highly effective milestone-based approach, with the private industry taking on all the financial, scientific and project schedule risk. The federal government only provides a limited cost-share when we successfully achieve our milestones. The private industry, not the taxpayer, bears all the risk. I believe in this program. We fought hard for it. While I am grateful for the funding the program has received, it is not remotely at a scale to significantly attract meaningful new private capital to the field. We should fund the existing Milestone program at the federal cost-share levels the industry has asked for - on the order of $2 billion[12] - to accelerate fusion companies' efforts to complete their power plant designs.

   As this Committee thinks about new policies and funding mechanisms to accelerate commercialization and compete with other nations, I would strongly urge for the creation of a **Milestone-based Fusion Demonstration Program**. Think of it as a demonstration phase of the existing Milestone program. If funded at the scale of other demonstration

[9] SCSP Commission on Scaling Fusion Report - February 2025
[10] Clean Air Task Force: "Fusion on the Grid" - April 2025
[11] FIA: "Department of Energy Announces Milestone Public-Private Partnership Awards" - May 2023
[12] FIA Testimony: "From Theory to Reality: The Limitless Potential of Fusion Energy" - June 2023

programs, such as the Advanced Reactor Demonstration Program[13] for the advanced fission industry, of $2.7 - $3 billion it could help cost share the first 2-3 technologically diverse commercial demonstration fusion power plants, putting the first fusion power on the grid within just a few years from now. The FIA has drafted legislation to authorize this program and we stand ready to work with you and the Administration on this proposal.

2. **Build the critical fusion science & technology facilities and test stands.** Deploying and scaling fusion power requires closing some well known, long understood gaps in fusion materials and technologies. To do this, we need to build some critical facilities and test stands at National Laboratories and universities in the areas of materials science and fusion fuel cycles[14]. No single fusion company can take on these challenges, DOE funding and leadership is essential. The fusion community has been clear and consistent on the importance of these facilities for years. Yet, the federal government has done little to advance these essential projects beyond planning stages. China is building them all.

   Recent efforts by the FES (FIRE Collaboratives and BRIDGE) and ARPA-E are seeking to change this, though they simply are not a scale to close these gaps - we need the facilities. We simply have to change this dynamic and prioritize the necessary resources to move these facilities from planning to construction. PPPs and fixed-price, milestone-based approaches could be leveraged to manage costs and move them forward quickly.

3. **Transitioning DOE's fusion mission.** With each passing day, it becomes increasingly clear to me that commercial fusion is outgrowing its home within the Office of Science (SC). The staff within the Fusion Energy Sciences (FES) program are first rate. They are dedicated public servants who are a tremendous asset to our Nation. But a fusion commercialization effort within SC is already starting to stretch beyond the program's core mission, capabilities, and is often in competition with other scientific funding priorities. When we have the first fusion power on the grid, fusion research will rapidly need to transition to an applied focus, with new opportunities and challenges in workforce, supply chains, regulatory technical assistance, international cooperation and export markets. We should begin preparing for this transition now.

   I would point out that there used to be an Office of Fusion Energy. The Committee should consider restoring that office or moving commercially oriented fusion efforts to another home as part of a broader DOE reorganization. I avoid the temptation of rolling fusion energy into the Office of Nuclear Energy, as the technologies are fundamentally different. Regardless of which path we choose, I would urge this Committee to begin this organizational planning work. CFS and the FIA stand ready to work with you, the Administration, and our other partners in fusion research to effectuate this needed change.

[13] DOE Advance Reactor Demonstration Program
[14] FESAC: "Facilities that Best Serve Fusion" - April 2024

4. **Supporting the fusion workforce and supply chain.** Another theme I would like to touch on is the critical pipeline of talent coming out of our Nation's universities. CFS spun out of MIT and we understand the importance of nurturing a strong workforce. Investments in not only plasma physics but engineering across a broad spectrum (electrical, mechanical, civil, industrial, software, etc) as well as highly skilled technicians and welders needed to make our machines and building trades to build our factories and power plants are all paramount to maintaining the US leadership in this sector. I applaud Members of this Committee who introduced the "Fusion Workforce Act" to improve efforts by DOE and the National Science Foundation to support the fusion workforce.

   Likewise, there are steps Congress and the Administration can take to help ensure a robust and resilient fusion supply chain. Leveraging existing tools, like the DOE's Loan Program Office, as well as expanding the 45X Advanced Manufacturing Production Tax Credit, which currently excludes fusion as an eligible technology, would help significantly. The Defense Production Act could be used to expand certain minerals and metals that will be needed in our machines, from molten salt blankets, to hardened materials, like vanadium and tungsten, for our plasma-facing components. Supporting these investments in the fusion supply chain would not only create jobs and ensure resilience, it would help the US stay in the game with the dramatic moves China is making in this sector. For this Committee, I would focus on enabling R&D in the fusion supply chain in areas like fusion fuel cycles and radiation hardened robotics to develop the materials needed to withstand the extreme conditions of fusion. The DOE is starting to make progress here, but more prioritization and resources are needed, with additional focus on enabling these elements of the fusion supply chain.

5. **Cutting DOE red tape, aligning around first principles.** Fusion is incredibly technically challenging, requiring deep collaboration with DOE National Labs like Oak Ridge National Laboratory (ORNL). CFS has relationships and funds work with 13 of the 17 DOE National Labs. Yet the contracting negotiations on some of these awards can take a year or longer. In several instances, the value of the staffing resources required to negotiate these awards are on par with the value of the awards themselves. Further, each National Lab has its own processes and varying requirements from one lab to the next, causing an inconsistent set of requirements from one project to the next. As a frequent partner with our National Labs, these delays can often hinder progress and our shared deployment goals.

   I understand that many of these procedures and safeguards exist at the National Labs for good reason. But there has to be a better way, especially when resources are limited and we're in a race with other nations. For Milestone companies that have already been heavily vetted and scrutinized by the DOE, for example, we should consider expedited or prioritized contracting methods with National Labs. A simplified, expedited approach to facilitate research across the DOE National Lab system for previously vetted Milestone companies, who are at the leading edge of the US' efforts to commercialize fusion power, could improve efficiency, cut red tape, and make the highest and best use of limited resources.

More broadly, we need better alignment on first principles with pioneering programs, like the Milestone program. It took the eight fusion companies over a year to negotiate terms with DOE for a $46 million award that covers the first 18 months of the program. A challenge I noticed is that the DOE did not distinguish between how it traditionally conducts business versus the critical first principles of newly established programs, like Milestone. These misalignments on the actual principles behind the programs led to considerable time consumed negotiating IP terms with the fusion industry. DOE's Other Transaction Authority (OTA), which Congress required DOE to utilize in the Milestone program, gives DOE broad discretion and flexibility to negotiate these terms. But even with that Congressional direction, the lack of first principles alignment protracted these negotiations. The value of the Milestone program to the taxpayer is the creation of a new industry that powers the global economy, employs millions of people, strengthens energy security, and generates billions of dollars a year in economic activity. As the Committee entertains policy recommendations to improve PPPs with the DOE, I'd welcome the opportunity to explore these areas further and provide recommendations. We have developed legislative language with the FIA to that end.

Closing

The path to commercial fusion energy has been long and challenging, but it is a path that will define the future of global energy security, economic competitiveness, and human development for generations to come. American ingenuity has laid the groundwork, but increased support and a refocusing of the DOE's fusion efforts are essential to ensure that the United States remains the undisputed leader in this critical technology. We must move with a sense of urgency and purpose, recognizing that our competitors are not waiting for us to catch up.

Thank you for inviting me to testify, I am happy to answer any questions you may have.

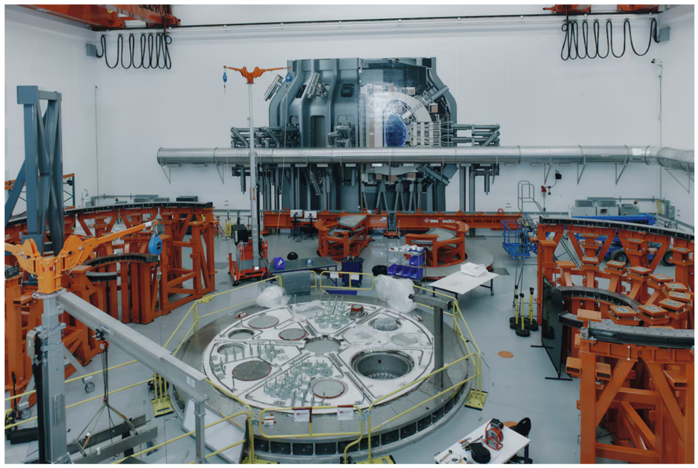
Appendix

SPARC in November 2021

SPARC and CFS Factory and HQ in 2025

SPARC Tokamak (foreground) and CFS HQ and factory (background)

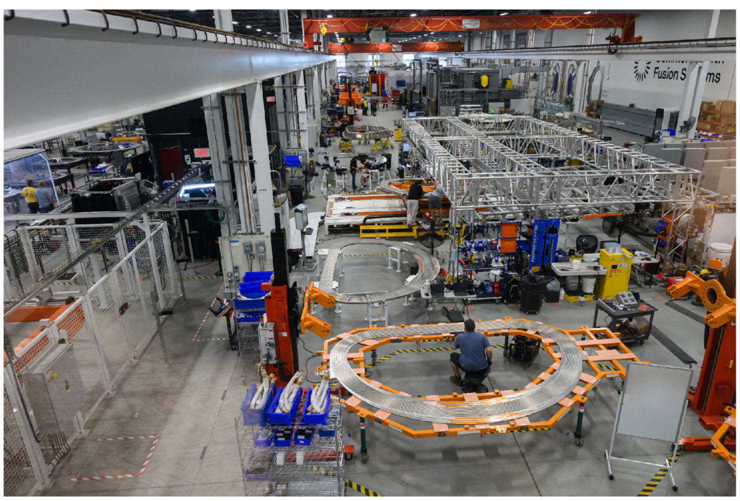
SPARC Tokamak Hall in 2025



SPARC vacuum vessel ready for shipment

TFMC Magnet Test, MIT - September 2021

CFS HTS magnet factory - 2025



China's Fusion Progress

Comprehensive Research Facility for Fusion Technology (CRAFT), Hefei, China

Satellite imagery of the existing CRAFT laboratory on the right and the BEST reactor on the left, Hefei, China. Source: Google Earth (satellite image provided by Maxar Images, Airbus) (December 19, 2024).

A satellite image from January 11, 2025 of Mianyang facility – Source Planet Labs PBC

Commonwealth Fusion Systems

Bob Mumgaard
CEO and Co-founder of Commonwealth Fusion Systems
Bob Mumgaard leads the strategic vision and direction of Commonwealth Fusion Systems, the world's leading, largest, and best capitalized fusion energy company. Under his leadership, Commonwealth Fusion Systems is paving the way for clean, abundant fusion energy to drive the energy transition.

Since co-founding Commonwealth Fusion Systems with a mission to commercialize the high-field approach to fusion, Mumgaard has grown the company to 800 employees and raised more than $2 billion from the world's leading climate investors including Bill Gates' Breakthrough Energy Ventures, Khosla Ventures, The Engine, oil majors including Eni and Equinor, and long-term strategic investors including Temasek and Tiger Global, among others.

Mumgaard performed his PhD work at the Massachusetts Institute of Technology (MIT), where he contributed to the design of several small superconducting tokamaks for a variety of physics missions using high temperature superconductors (HTS). Prior to co-founding Commonwealth Fusion Systems, as an MIT fellow, Mumgaard focused on how entrepreneurship, risk-retirement strategies, and partnerships could increase the speed of fusion from laboratory to market. He organized and led a team identifying strategies to utilize private finance and traditional academic resources to speed the path to fusion energy resulting in a collaboration model with MIT and the launch of Commonwealth Fusion Systems.

Mumgaard holds a PhD in Applied Plasma Physics and a MS in Nuclear Engineering from MIT, and a BS in Mechanical Engineering and BS in Engineering Physics from the University of Nebraska.

Chairman WEBER. Thank you, Dr. Mumgaard.

The Chair now recognizes the Ranking Member for at least 5 minutes.

Ms. LOFGREN. Well, thank you, Mr. Chairman. And my apologies for being late. I did want to thank you, Mr. Chairman, and Ranking Member Ross, for this hearing. As we all know, fusion has been a major focus of this Committee and myself for some time. And the National Ignition Facility at Lawrence, it's still the only machine in the world that's actually achieved fusion ignition, has now achieved it nine times, with a big new record output of 8.6 megajoules just in April.

So I agree that the milestone-based public-private partnership is excellent. It's made a big difference. DOE finalized agreements with the first eight awardees just last year. We've seen, as you've mentioned, an infusion of private sector investment in fusion, $3.5 billion in the last 15 months alone, most of that going to companies located in the United States. But as you point out, China is ahead of us. And I am very concerned that we are not making the investments necessary to be the winners in this.

I am very much opposed to President Trump's budget overall. But I would like to say that, when it comes to his specific request for fusion, it's moving in the right direction. And I am glad for that.

We introduced, Chairman Obernolte, Mr. Beyer who is here today, Ms. Trahan and myself, an amendment to the Rules Committee to basically support the President's budget. Unfortunately, for reasons I do not understand, that amendment that supported the President was not made an order. But I am hoping that we will continue to work on a bipartisan basis to get to where we need to go.

And I would like to mention that Chairman Obernolte joined me last month in introducing a bipartisan *STEM Education and Skilled Technical Workforce for Fusion Act,* because we need to get, like Wayne Gretzky said, you need to skate to where the hockey puck is going to be.

So I will just close with this, if I may just turn to questions, Mr. Chairman?

Dr. Mumgaard, you talked about the need for a $10 billion investment in fusion research and the demonstration effort. And I think that case has been made for some time. We've just never fulfilled it. Actually, we had the roadmap, and China took the roadmap and actually funded it. So that would be helpful, and you've outlined how it would be used.

But we're not going to catch up through the annual budget process alone. If we're able to do this $10 billion one-time investment, what is next to get us to where we need to be? I mean, maybe Dr. Carter and others have views on that as well.

Dr. MUMGAARD. Yes, so I think the idea of a kick, like a single program that can set the change in the trajectory, and that isn't just about the change in trajectory of like annual budgets, it's actually about the changing trajectory of the mandate. And if we have a goal to have a fusion power plant be built in the United States and we have a program that is sufficiently scaled to help propel that, not the whole cost, the cost share of it, what that will naturally do is mean that the programs that are already running, that are sort of going off and they're doing good work, but it's not directed, are naturally going to align to it. And we see that in other programs and other areas of science and technology at the transition to commercialization.

So I don't think it's a $10 billion one-time program and then suddenly we need to be at $5 billion a year of appropriations. We actually have a good pot of money. But we do need to see that shift and the level of commitment that's consistent with the ambition and commitment done in the private sector, frankly, and in other countries.

Ms. LOFGREN. Yes. Dr. Carter, you look eager to——

Dr. CARTER. Absolutely. No, I agree, a $10 billion injection would go a long way to setting us on the course, as Bob says—Dr. Mumgaard, sorry—in terms of getting facilities together, public-private partnerships. We'll need alongside of that the R&D programs to exploit these. Those should be PPP. We should be working together on trying to derisk and develop the technology.

We'll need foundational programs. We need to continue——

Ms. LOFGREN. Right.

Dr. CARTER [continuing]. We'll need workforce, we'll need to set up supply chains. There's all kinds of things that need to be done as part of that investment.

Ms. LOFGREN. I'd just like to say that the reduction in grant funding in research generally has not been helpful in advancing our quest to be No. 1 and to achieve fusion as an energy source, and we need to address that as well.

With that, Mr. Chairman, Ranking Member, thank you for letting me pop ahead of others, and I yield back.

Chairman WEBER. The gentlelady yields back.

The Chair now recognizes himself for 5 minutes of questions.

Dr. Diem, in your testimony, you mentioned that academic programs are struggling to meet workforce demand, which is resulting in shortages of technical staff and manufacturing expertise. I think we'd all agree on that.

So suggestions from you. What immediate steps do you think Congress can take to strengthen those apprenticeship programs and technical training so that we can ensure the workforce is ready before large-scale deployment? What do we need to do?

Dr. DIEM. Thank you so much for that question.

So in my research group, about 40 percent of the staff is technical staff, and when we had to fill an open position, we couldn't do it. So we have to depend on us finding someone with similar skills and upscale them in our lab. So an infusion of funds would allow us to build partnerships with community colleges and National Labs and other fusion facilities to provide hands-on training for this.

So a lot of the work that we do is very custom made. We're working in vacuum environments with strict materials requirements. And then we also have tolerances that you have to meet. We're working in a high magnetic field. So these are very unique things, along with working with exotic materials.

And so one example that you could look at is at Princeton Plasma Physics Laboratory. They actually started an apprenticeship program, where the only requirements is you're over the age of 18, high school or GED (General Educational Development) requirement. You take classes at a community college, and then you're full-time employed at the lab. So an apprenticeship for 4 years, and then you gain all these skills that you need, and then it's a benefit for the whole fusion facility, or whole fusion field. So expanding those programs, building that into regional efforts like Wisconsin that already has a large manufacturing base.

Chairman WEBER. Thank you. You said in your opening remarks, your testimony, that we should include those community colleges. What are you experiencing? Is that happening?

Dr. DIEM. So right now, I have—what I have is private donations to reach out to, to start these seed foundation programs. But we need more people dedicated to actually carry out the work. So part of it is the infrastructure we have on hand, but also the money to get people to help with the upscaling.

Chairman WEBER. OK. Dr. Mumgaard, I'm coming to you. In your testimony, you mentioned how several fusion energy stakeholders are calling on the U.S. Government to make a one-time, $10 billion investment in fusion research and commercial development. Have I got that right? Good.

What areas do you think should be prioritized to ensure that such an investment would deliver a long-lasting, competitive advantage for the United States? I know that's going to be a little tough because you don't know exactly what China is going to do. But what do you think?

Dr. MUMGAARD. Yes. We need to set—set out a course to get the first generation of fusion power plants built. So that is a demonstration program that actually puts steel in the ground on designs that we've reviewed and looked at and said they're likely to work. The Milestone Program is set up to do that. But when you look at the total bill that's going to be, the companies have raised $10 billion. So like the cost share there is billions of dollars.

But that's not alone. Because like those—those power plants, they're—with technology we have today, like if you forced it today, they'd be kind of not great. We have technology that's in the pipeline that's at the labs and universities. These are things like new materials, blankets, fuel cycles that—a lot of good ideas, but no way to really advance them or test them, because we don't have the test stands and we don't have the mandate.

And so directing money to build the test stands and set up those programs at places like Oak Ridge, places like Princeton, places like Pacific Northwest, that would be really, really important as part of the long-range plan. And that would naturally—you know, people vote with their feet on where things are going, scientists do, and that would create that outlet that people are looking for.

Chairman WEBER. Thank you. Then a follow up for you, Dr. Carter. In your testimony, you highlighted the need for new facilities like the Fusion Prototypic Neutron Source—say that ten times—and the Materials Plasma Exposure eXperiment, MPEX, to derisk the path to pilot plants. How would you see this $10 billion actually being distributed to those facilities?

Dr. CARTER. Part of the $10 billion is targeting the four facilities that I discussed before. We'd really like to have a blanket test stand that you can test in a nuclear space. You can actually generate tritium and do all the things you need to do to understand closing the fusion fuel cycle, which is a big hurdle to commercialization.

To do that, it might be in the billion dollar class. But I think we can find ways to do it in partnership with the private sector, as well as looking at, you know, out-of-the-box thinking on how to get this done that could bring it lower. But that's what you're talking about.

So you're looking at—$10 billion would go a long way to getting you to those facilities.

Chairman WEBER. I'm close to out of time, but there are often conflicting timelines regarding fusion energy which becomes commercially viable, with some projections going into the 2030s, while others extend into the future. And just think about this and I'll come back to you. Given these different timelines, how soon—I know this is a guess, a little bit of guesswork here, you all can think about this—can we realistically achieve fusion energy? No pressure, just give me month and day.

So I'm going to yield back and recognize the Ranking Member for at least 5 minutes.

Ms. ROSS. Thank you, Mr. Chairman.

I think we all can agree that fusion is, in addition to an energy issue, is a national security issue. And energy security is national security.

Recent analysis shows, as we've discussed, that China is moving fast. In fact, faster than we are. At the same time, we have allies, the U.K., Germany, Japan, South Korea, and others, that bring world-class facilities and industrial strengths.

This is a question for all of you, so if each of you wants to address it, I don't mind using all my time on it.

Do you support a tech agnostic, United States-led, trusted fusion partners initiative focused on commercialization, supply chain onshoring, so that we and our allies together can build first and keep Chinese tech and suppliers out of this critical ecosystem? And whoever wants to go first, raise your hand.

OK, Dr. Mumgaard.

Dr. MUMGAARD. In general, yes. So the fusion world and the future fusion industry will necessarily be global. The type of equipment you need to make is of high variety, and the designs will benefit from having a global market. And so it makes sense to the United States and allies working together.

We should also recognize though that an overly constricted program would be detrimental. We want to encourage ideas and competition as well. So like we don't want to end up in a situation that is, we're all going to the exact same place the exact same way. But that does mean that we can leverage each other's strengths. And I think when you look at the, you know, Japanese, the U.K., they have distinct strengths, and the United States has distinct strengths. And working together on the areas where strength reinforces strength is definitely what we should be doing.

How to carve in the China angle becomes a little bit difficult, because there are some in the middle. If you think about some of the places in Europe and some places, say India, who—which side are they on?

Ms. ROSS. Does anybody have anything to add to that?

Yes, Dr. Regan.

Dr. REGAN. Yes, thank you, Ranking Member Ross.

I totally agree, energy security is national security. And we want to incentivize as much benefit to the United States as we can. And that includes not just making fusion power in the United States but making fusion hardware in the United States. So I'm, you know, very excited by anything that helps do that. And again, thank you to Representative Tenney and Beyer for pushing for the *Fusion Advanced Manufacturing Parity Act.*

Ms. ROSS. Looks like Dr. Diem has something to add.

Dr. DIEM. Yes, I can just add pretty quickly, so as United States Science Envoy last year, I went with a United States delegation through Germany. And so we had a great opportunity to visit our allies and what they had and see onsite what they're doing to advance fusion energy, and how we can work together to not duplicate efforts but amplify what we're doing to accelerate the path forward.

So one example is like trading of codes or modeling tools and capabilities. They have fabulous public-private partnerships, which is large spaces with many labs next to each other, to foster innovation across that, so looking at those kind of models. And in the U.K., I'm working with my colleagues on how do we have companion efforts that support each other, looking at how do we advance heating of these plasmas. So those are kind of a couple of examples that helps both of us without duplicating efforts.

Ms. ROSS. OK. And then would there, if—if this is a good idea, what concrete steps in the next 12 to 24 months should the Federal Government take to emphasize this across DOE, the State Department, and the Department of Commerce? Any suggestions?

Dr. MUMGAARD. The U.K. is the closest. So they have facilities that are for tritium and blanket breeding that are very significant, multi-hundred-million-dollar facilities. We could get access to them, but it would require the U.S. Government having the agreement but also putting in some money to fund people to go do the work there, the same way that they are funding people to do work there, basically to compete for time. That's a concrete example of those facilities.

Ms. ROSS. Maybe we can tell the President before he comes home.

Does anybody else have any suggestions? Yes, Dr. Carter.

Dr. CARTER. I'll just amplify what Dr. Mumgaard said. I mean, we have strong relationships with U.K., Japan, and Germany and the like, we've been working for a long time. But we do need that mandate, that investment from the United States side, and agreements to clarify how we're working together, how that's going to work. Now we're getting into a space where IP (intellectual property) is being generated. How do we share that? So that's going to require some high-level discussions and agreements to get into place, plus the funding.

Ms. ROSS. OK. Thank you, and I yield back. I only have 4 seconds.

Chairman WEBER. The gentlelady yields back.

The gentleman from Tennessee is now recognized for 5 minutes.

Mr. FLEISCHMANN. Thank you, Mr. Chairman, appreciate your holding this, this Committee hearing.

To each of the four panelists, I know most of you all very well. Thank you so much. To our dear friends at ORNL, thank you for doing everything very well.

As most of you know, I am the Republican lead on the Fusion Caucus. My other day job is I am the Chairman of the Energy and Water Subcommittee of Appropriations, which funds all of the great work that our Department of Energy does, including fusion.

I have some questions, and I open it up, because I so appreciate the fact that we've got a great blend of academia and business. And I meet with so many great researchers, whether from ORNL or from Princeton. But the fact that there's been such a great infusion of capital into—from the private sector, so there's great balance out there between R&D and seeing all this great capital coming in, and the promise of us getting there.

So my question for you all is, with limited budgets, and we are going to continue to fund fusion, but with limited budgets and choices to make, where should our Federal dollars in fusion investment be going? And I'm solicitous of all four of your comments.

Dr. CARTER. Well, I'll lead off. I think, I mean, as I've said earlier and as you know, we have laid out this plan. We have a strategy on where we need to invest. I think that's been made clear in consensus documents. You know, as we push toward the goal of energy of a fusion power plant, there's clear things that we have not invested enough in that we need to put money into, the facilities I mentioned, the R&D programs to go with them. I'll end with that.

Mr. FLEISCHMANN. Thank you.

Dr. MUMGAARD. The program right now is not in line with the recommendations of the National Academies, the Fusion Industry Association, the long-range planning of the FESAC, because we haven't funded the programs that are needed to do the applied use of harnessing fusion power, so the materials, the test stands, Fusion Prototypic Neutron Source, the tritium, the blanket. That stuff has not seen significant funding.

We still have a program that's very much on operating plasma physics facilities that are very large, they're expensive, and some of them are a bit old. We can collaborate and get results from other nations on some of this. We need to shift toward that. That was laid out in the community-driven plan, that that shift needed to happen. It's laid out in the long-range plan for FESAC. We just need to do the shift.

Mr. FLEISCHMANN. Thank you.

Dr. DIEM. And to support that shift, universities are really critical in being—they're able to be agile and pivot pretty quickly to address needs not only currently that are being experienced by private companies but anticipate the needs down the line.

So one example was I had—we were building my experiment, we were running it for a while, and we had a failure. And I could just go to the building across the street and find experts in magnet technology and interfacing and just tell them about my problem. And they were like whoa, my expertise can help fusion? I didn't realize that.

And so that can be a catalyst, not only now but down the line.

Mr. FLEISCHMANN. Thank you.

Dr. REGAN. Thank you, Representative Fleischmann. And, you know, I think we all agree we need to win this race for America. And part of that is sustaining the great science we have. That is why the United States is the world leader in fusion, is because of the great universities and National Labs that have brought us to this point.

I just wanted to reiterate something I said in my testimony, which is I think one of the biggest returns—return on investment the government could see is from a fusion demonstration program, for a couple of reasons. One, to match the intensity of the reinvigorated Chinese effort, but also to send a strong signal to the market and bring more private money off the sidelines to invest in this industry.

Thank you.

Mr. FLEISCHMANN. Thank you. I really appreciate all four of your comments.

And if I may, just a suggestion. As my colleagues on the dais know, I chair eight energy-related caucuses, including the Fusion Caucus, but the National Labs Caucus, which is tremendous. And now, most recently, the American Dominance in Energy Caucus. The best thing about the caucus format is it's bipartisan. We have Republicans and Democrats. Every once in a while, senators come on in and visit, academia. So I welcome you. All of our caucuses that I run are free. I welcome you to come on in and speak with us. I know Mr. Weber, Chairman Weber and Chairman Beyer frequent our caucuses. They are convivial, but they're productive. So whenever we have these events, please check with us, and you're always welcome.

With that, I yield back.

Chairman WEBER. The gentleman yields back.

The Chair now recognizes the gentlelady from Oregon, Representative Salinas, for her at least 5 minutes.

Ms. SALINAS. Thank you, Mr. Chair, and thank you to our Ranking Member for the hearing. And thank you to our witnesses for being here.

Dr. Diem, you mentioned the Great Lakes Fusion Energy Alliance and suggested there would be value, all of you have, in public-private regional hubs to expand the fusion ecosystem. This sounds a lot like the hydrogen hub and direct air capture hub programs created by the *Bipartisan Infrastructure Law*. However, we also have the Department of Commerce Tech Hubs Program created by the *CHIPS and Science Act,* where several tech hubs already focus on areas relevant to the fusion industry from materials science to advanced manufacturing or, in Oregon's case, semiconductors.

Are you suggesting we need a dedicated regional fusion hub program of sorts? Or is there potential to expand coordination with existing efforts like the regional tech hubs?

Dr. DIEM. Thank you for your question.

So as I mentioned, fusion has really unique challenges that are different than the semiconductor industry. So these ultra-high vacuum environments, these exotic alloys and things like that. So I think a targeted effort that really focuses on that.

And the reason why we've worked a lot in the Midwest, specifically in Wisconsin, is because we've built so many experiments. We worked with a lot of small machine shops. And so we built through this relationship. They understand—understand our challenges. But to scale up to a large industry will take a coordinated, targeted effort to really understand the uniqueness of those.

So I could see some cross-collaboration, but really a hyper focus on the fusion aspects, too.

Ms. SALINAS. Thank you, that's helpful.

Would anyone else care to weigh in?

Dr. CARTER. Sure, I'll support what Dr. Diem said. I think these kind of regional hubs could serve many purposes for growing the ecosystem. We talked about these test stands that we need to grow. You know, it might be a model in a regional hub where you have investment from the industry, from the government, from philanthropy, from all over the place to try to buildup these—these hubs. You follow the model of other consortia, where you have companies buying in to get access to facilities, getting shared IP out of it.

In addition, there's a workforce angle. These hubs provide a focus point for drawing in. You want to coordinate the community colleges, the trade schools, and have them all be on the same page on what we're trying to do. And so that provides an opportunity to do that too. So I'm fully supportive of that idea.

Dr. MUMGAARD. On the idea of like how to blend fusion with other things, I think it's always important to start with the end in mind.

A working fusion industry is a very large industry. And so that means in the future, we are likely to have things like academic departments that just do fusion, the same way that we have academic departments that do aerospace or that do fission. And so in that framework, like when is the first time we see a fusion hub? Because eventually we would have to have them.

Ms. SALINAS. Thank you.

Dr. Regan, did you want to jump in?

Dr. REGAN. Yes, I'd like to just double down on Dr. Mumgaard's point. I think something that we need to see more of is cross-disciplinary programs that bring together folks from many different disciplines, mechanical engineering, electrical, thermal, nuclear systems engineering, all these things have to come together to not just do the fusion science but now build fusion power plants.

Ms. SALINAS. Thank you. So a few of you have mentioned this on the intellectual property side and cross-collaboration. As we get into this world, and I think I visited Helion a couple summers ago, this was a big concern, especially when it comes to protecting IP and China.

Do any of you have suggestions for how we move ahead and how the United States can be a player for the industry in protecting that intellectual property and making sure that it doesn't fall into the hands of adversaries?

To any of you. Sorry if this is a question you weren't anticipating. I'm sure my staff is like, where did that come from? It's not in my list of questions.

Dr. MUMGAARD. It's a very good question.

You know, the first thing is, IP is really only useful if you're able to make a large industrial return on it. And so we can oftentimes get too hung up on the IP versus like what is the pull that is going to pull the industry into existence. And the easiest areas of IP are areas that everyone needs, because that means the companies themselves have a reason to share.

Whether or not that falls into, you know, adversary hands, well, if we don't build something in the United States, it's not going to matter if the adversary has it or not. We have to actually do both.

Ms. SALINAS. Thank you. Does anyone else care to weigh in?

Dr. Regan.

Dr. REGAN. Yes, I think this brings up another important topic, too, which is the balance between what you publish and what you protect inside the company. So I think that's something that's come up a few times. I think it is important to publish and put out scientific, you know, work to stress test what your company is claiming against the thousands of brilliant researchers in the United States. And it's also critically important to have a robust portfolio of, you know, patents and trade secrets.

Just to add one more thing to what Dr. Mumgaard said, another big advantage in addition to IP is knowhow. You know, the expertise, the talent base, and capabilities. So the kind of machines that our companies are building and, you know, that can be built at National Labs do provide an edge that, you know, you need those to make progress.

Thank you.

Ms. SALINAS. Thank you. I'm just about out of time. I yield back.

Chairman WEBER. The gentlelady yields back.

The Chairman now recognizes the gentleman from Colorado for 5 minutes.

No?

Let's go with the gentlelady from South Carolina for 5—at least 5 minutes.

Ms. BIGGS. Thank you, Mr. Chairman. And thank you for holding this hearing today on fusion energy. And I would also like to thank our witnesses for being here.

The United States is at a critical point for our energy infrastructure. Our energy output has stagnated over the last 20 years, while the demand for energy is increasing rapidly across the board. Fusion energy, as part of an all-of-the-above solution, offers the United States the chance to maintain both energy and technological dominance, to keep rates low, and to build out our industry once more.

From industry suppliers to university research partners, the 3d District of South Carolina is proud to have a role to play in the future fusion energy landscape. Many of our constituents also work at the Savannah River National Lab, which has decades of expertise in working with tritium, an essential fuel for the nuclear fusion process.

As fusion becomes a viable energy source, expertise in handling, processing, and using tritium will be vital in establishing a safe and secure process to expand our energy infrastructure.

So I would like to open my question to the entire panel. What steps are the fusion energy sciences program and the fusion industry taking to build a robust safety culture around operations with tritium in the construction and operation of fusion plant—pilot plants?

Dr. MUMGAARD. This actually dovetails nicely with the IP question. So the industry has a pretty consensus view that in issues related to safety and public acceptance, we should be very open and collaborative with each other. So that means when we develop fuel cycles, when we have issues about safety cultures, we share.

And so there is actually a tritium working group that the Department of Energy convenes, it's international, that pulls in people from all the different users for tritium, and they share best practices. They tour each other's facilities. We actually just hosted them out in Devens at the SPARC facility. So that's an example. We have a strong culture already in this.

The other thing is that when we site these facilities. These are new and novel facilities. And that means you have to go into communities with an education mindset and a listening mindset, that we can't go and put fusion facilities, you know, black box facilities, you know, in places that people don't know they're there, or that they don't have consultation.

The good news is that when we do go and say, hey, would you like this, would you like to learn about it, we see broad engagement, and we see favorable attitudes.

So we've sited two facilities, one in Massachusetts and one in Virginia, and in both cases we were surprised at the level of questions, very, very educated, and also the excitement about a new thing in their community. And they asked questions around safety and tritium, and we were able to turn them to people like at Savannah River.

Dr. DIEM. So thank you so much for your question.

So Savannah River National Lab has great experience. And they're also leading a FIRE collaborative that's focused on the fuel cycle. And I think it's very important because you're leveraging their historical expertise in that. They're also engaging universities in that work as well. And I'm part of that, that FIRE collaborative.

And part of what we do is around tritium byproduct material and also engaging the public in that. So that provides an important space in the safety aspect, and also the siting, and going out into communities as well.

Ms. BIGGS. Thank you.

Dr. CARTER. Just quickly add, I think the National Labs provide—especially Savannah River on tritium provide a wealth of expertise. And I think that's essential to share that as we develop a stance on how we regulate and license fusion devices. So certainly Organization of Agreement States is leading the way on that with Tennessee taking a lead. And I think making good use of the knowledge and expertise at Savanna River and Oak Ridge and other places is going to be essential to doing that.

Ms. BIGGS. Thank you. My time is almost up, so I will yield back.

Chairman WEBER. The gentlelady yields back.

The Chair now recognizes the gentlelady from North Carolina for at least 5 minutes.

Ms. FOUSHEE. Thank you, Mr. Chair. And thank you to the witnesses for being here with us today.

I'm proud to represent North Carolina's 4th District, home to three research universities, including North Carolina Central University, one of the ten HBCUs (historically Black colleges and universities) in the State.

Dr. Carter, what are the most impactful actions Congress and the Federal Government can take to strengthen and expand partnerships between our National Laboratories and HBCUs to build the skilled workforce needed for the future maturation of fusion energy technology? One that comes to mind is Hampton University and their STAR—Lite Fusion Project, which demonstrates how direct investment in HBCU-led research can ignite broader participation and innovation in fusion science.

Dr. CARTER. Thank you for that question. I think it's an excellent question. I'll say a few things.

So first and foremost, Hampton, I'm going to visit there October 1 to tour the facilities and meet with Calvin Lowe, who I worked with on Fusion Workforce activity actually. So very glad to have connection and grow that connection with them.

Partnerships between universities and National Labs to me are absolutely essential. Universities, first and foremost, bring innovation. Of course, what comes along with that is students and workforce development, and that's a huge benefit to us.

So how do we make this a stronger connection? So Department of Energy has funded some activities under RENEW (Reaching a New Energy Sciences Workforce) program and Oak Ridge has led a couple of these that have been focused on getting regional universities, including HBCUs, involved in our programs. And so this has led to internships, a fusion energy boot camp that one of our programs is starting, modeled after the nuclear boot camp that has worked well in that industry, to try to get students at those institutions, and importantly the faculty. The way you maintain this relationship is not just picking up the students and bringing them in, you want to engage the faculty and have them be part of your programs, feel like they have a leadership role. So we need to have that happen with Calvin at Hampton and other institutions like that. Yes.

Ms. FOUSHEE. Following up to that, can you share your experience with international students at the National Labs and universities, and the role they play in pushing fusion research forward in our country?

Dr. CARTER. Yes, we've always got the best and brightest to come to this country, because of what this country represents and the opportunities. They want to be a part of this program, because they see what we're doing in fusion energy.

So in my role at UCLA, and in my role now at Oak Ridge, you know, international students have been key. They've come into our programs and they've made tremendous contributions. All the science that's been pushed forward, you can point to people coming from all over the world, coming to the United States.

I will point out the students that have come through my program at UCLA, all of them have remained within the United States as they go on their career. And they've made, you know, tremendous contributions in doing that.

At the National Labs, look at my division now, we have an amazing staff that come from all over the world that are there contributing their scientific talent, engineering talent, to pushing forward fusion. It's essential. We need to embrace getting the best and the brightest here to make this work. That's been how the United States has gotten where it is now, and we need to keep doing that.

Ms. FOUSHEE. Thank you for that.

Dr. Mumgaard or Dr. Regan, from a private sector perspective, how important is it that the United States has a sustainable international talent pipeline to pull into specified fields such as fusion research?

Dr. MUMGAARD. It's essential. Fusion is a global exercise. The fusion process is a universal thing. And so the investments made around the globe to create talent, that's what we thrive on. We pull people in from Japan, Korea, Germany. And we need to keep that pipeline going. You know, we use the O–1 visa for fusion expertise.

And that, if you look at just the tech industry overall, that's been a backbone of the tech industry. And so fusion is no different in the sense that a smart, single individual can make a society-level contribution at the birth of an industry. And they're essential.

Ms. FOUSHEE. Dr. Regan?

Dr. REGAN. Yes, thank you, I'll add to that a little bit. I fully agree with what Dr. Mumgaard and Dr. Carter said. I mean, we need the best and the brightest to come here. And specifically, we've talked about some of the capabilities that our allies have. Like the U.K. and Canada are—Canada is where most of our tritium comes from. So it is essential to bring in that talented workforce, especially when there's international capabilities that we want to benefit from here in the U.S.

Ms. FOUSHEE. Thank you. That's my time, Mr. Chairman. I yield back.

Chairman WEBER. The gentlelady yields back.

The gentleman from North Carolina is recognized for 5 minutes.

Mr. HARRIGAN. Thank you, Mr. Chairman. And thanks to our witnesses for your testimony today.

I'll be honest, though, I found it a little bit distressing. And I just want to have a quick conversation with you, and I want to gain some clarity on this.

We have talked—several of you talked about we're really falling behind China. And that's happening at a very rapid pace. And I really want to kind of understand why.

I know Dr. Mumgaard—excuse me—Dr. Mumgaard, you talked about how since 2022, China has spent $6 1/2 billion on investing in fusion research. And during that same period of time, the United States has barely done just over 30 percent of that investment.

But I really kind of want to wrap my mind around what's happened here? Because if we're falling behind, and we've made massive strategic investments, you all are here with your hands out for another $10 billion, right? Yet the testimony that I've heard today really can only be characterized as we're failing. And I'm genuinely not saying that as an attack on you. I'm saying that from the perspective of an American. This is a very bipartisan Committee. The work that we do is critically important for the future of our market economy and our national security.

But we've done something wrong here, because we've invested $40 billion over the last several decades in fusion research. And we're behind. How did that happen?

And is China stealing our research and development? Are they smarter than we are? Are their strategic investments better because they're doing a significant amount of investment in a very short period of time, when we are basically running a slow burn of investments across a long period of time?

And I say this only from the perspective of I hate losing. And I'm not willing to let this country lose to China in this space. How do we fix it?

Dr. MUMGAARD. Thank you for the question. I also hate losing.

The—what they—what they've done is they've done the same playbook they did in other areas. So they're not a leader in innovation. We are a long-term investment leader in innovation. But when the time comes to put something at risk at scale, they have the ability to mobilize to do that in a way that the United States doesn't. They have a centralized control system that allows them to pool large amounts of money, capital, and organizations to go and build things that need to be built.

And fusion needs things built. And so the fusion advances don't happen just in labs of single PIs of bright people that come here. They happen in coordinated fashion by building multi-billion-dollar facilities. And the Chinese have seen that those facilities will pay off. They saw it in NIF. And they immediately said, let's build one that's a little bit bigger. It's not as advanced. It's probably a generation behind in technology, but will make up for it in speed, scale, and coordination.

The reports are that there's people working 24 hours a day on building that. There are students on cots. Because that's the playbook, hard and fast, the minute the window opens.

We sort of are still debating whether the window is open. And that's to our detriment.

Dr. CARTER. Yes, just to follow up on what Dr. Mumgaard said, I mean, the investment that's been made, there's been tremendous payoff. I mean, the United States has innovated and got us to the point where we are. The world—you know, China is building things that were designed and developed and ideated in the United States.

So the moment that we have before us is to actually carry it forward. So we've set the stage, we've set the ball, right? We just need to spike it. And that's where we are. It's not that we failed. If we don't take action now, we will. So now is the time to move forward. And we have to change our approach and our mindset.

We're trying to get to a commercialized energy source. We've got a lot of R&D to do, but we have to change the way we're approaching it.

Dr. REGAN. Just a few comments, too. You know, I agree, we can't afford to lose this. And we wouldn't have started our company if we didn't think we could win this, our company could win this, and America could win this.

I want to reassure you I think we still do have the lead. But now is the time to act on that lead.

And I point to programs, the NASA (National Aeronautics and Space Administration) COTS (Commercial Orbital Transportation Services) program has come up as a great example. Like that is a great example where we were the ones that developed the technology, we got to space, we lost that industry to Russia, but then the NASA COTS program came in and, with the catalytic investment of, you know, that was around $800 million, that reasserted United States leadership. We now own that commercial space industry again, and that investment is worth, you know, 500, 1000x what the government put in that for an American industry.

Dr. DIEM. People really drive innovation here. And we see it time and time again. And universities spin that, right? And we also provide workforce.

But if we start contracting those governments—sorry, Federal investments in those sectors, we lose people. Right now, we're at risk of people leaving for other sectors, I mentioned, but also other countries.

The day my grant ended this year, in a, you know, Federal uncertainty level of funding, I actually coincidentally received a foreign talent recruitment email.

And so when you're under in stress of like how I'm going to fund these early career researchers to keep this innovation drive that will then, you know, impact private industry, that's really scary, right? And so you're looking at how you can keep supporting that innovation. So I think making that certainty continue with Federal funds is critically important.

Mr. HARRIGAN. Thank you for your responses, and I appreciate the commentary. The only thing I'd tell you is outcomes matter. They're everything. We've got to win.

Thank you, Chairman.

Chairman WEBER. The gentleman yields back.

The Chair now recognizes Dr. Foster for 5 minutes.

Mr. FOSTER. Thank you, Mr. Chairman, and to our witnesses.

Let's see, I guess I'll start with Dr. Mumgaard. You know the question was coming. What's the status of your testing of production coils, and how many of them have survived a full energy quench and so on?

Dr. MUMGAARD. Yes, so our—we use a machine called a tokamak. It's basically a magnetic bottle——

Mr. FOSTER. I understand the machine very well. OK? I'm old friends, I'm high school friends with Mike Zanrstorff, who is known to many of you.

Dr. MUMGAARD. We've produced about 95 percent of all the required magnet pancakes——

Mr. FOSTER. How many of them have survived a full energy quench?

Dr. MUMGAARD. We've quenched one, and it has survived. And we did it intentionally. Full energy, full——

Mr. FOSTER. Full energy? The full magnetic energy?

Dr. MUMGAARD. Full magnetic energy.

Mr. FOSTER. Of the full system? So this was running above nominal current?

Dr. MUMGAARD. You have to adjust for it's a single coil. But, yes, it was—it's not quite full energy. It's maybe—you have to do a geometry adjustment. But very, very significant. And with the quench protection system working, the same one that we developed after the previous coil which we intentionally quenched and intentionally destroyed to learn how it worked.

Mr. FOSTER. OK. And so then can you briefly say what is the quench detection and prevention? And, you know, quench-spreading mechanism?

Dr. MUMGAARD. Yes, it's a series of heaters.

Mr. FOSTER. OK.

Dr. MUMGAARD. It's very similar to what CERN uses to take down their——

Mr. FOSTER. Well, it's what we invented at Fermilab to make our magnets survive many years ago.

Dr. MUMGAARD. Yes, very similar.

Mr. FOSTER. OK, so this is good. I've been telling you for like a decade you're going to need a very serious quench spreading system, and I'm glad that——

Dr. MUMGAARD. It works.

Mr. FOSTER. It's worked once. Your lifetime—you've got to cycle this, I don't know, 30 times or something? I don't know what your—the lifetime number of quenches. All right, anyway, it's good to see that you're doing testing. But it's really, really important. You've raised a lot of money and if you have a problem with magnets—we've seen in high-energy physics, large accelerator projects canceled because they built everything, but the magnet didn't work. So keep your eyes focused on the magnets and I will continue asking that question.

The other thing is the energy density on the diverter. Do you have a design that actually, at least on paper, might work?

Dr. MUMGAARD. Yes, that's a good one. So actually we do. It's called an advanced diverter. And interestingly, the TCV (Tokamak à Configuration Variable) tokamak in a collaboration recently showed experimental results that looked really, really promising, that that actually spreads the heat out, and that validates modeling done at Oak Ridge and a couple other places that show that by basically magnetically extending the region of the plasma interaction, you can get a pretty good light bulb.

Mr. FOSTER. OK, all right. I look forward to seeing that being published in the whole simulation known.

Let's see, Mr. Regan, do you have a parameter set for something that would actually make energy, make energy economically? I mean, what is the cost per target, the cost per pulse, the efficiency? Just a high-level parameter? How much energy, fusion energy, do you expect per target?

Dr. REGAN. Yes, thank you for the question. So the scale of our—so right now, we're building what's called the demonstration system, that's intended to get net facility gain. That stores about 80 megajoules to produce 100-plus megajoules of output. In a commercial version of that where we're cycling it not once a day but once every few seconds, we're aiming for, you know, facility level gains of, say, like 5 or so, 5 or 6, so you're storing, say, in this case maybe it's 100, you're getting 500 to 600 megajoules of output.

Mr. FOSTER. Do you have a—do you have a published parameter set?

Dr. REGAN. Oh, yes.

Mr. FOSTER. OK, you have——

Dr. REGAN. Yes, I would refer you to—we published a paper called "AMPS," it's "Affordable, Manageable, Practical, Scalable." It was a set of criteria and a technical roadmap. We put it on the arXiv in April and it's published in *Physics of Plasmas* earlier this month.

Mr. FOSTER. OK. And so then the big difference between what's been proposed with normal Z-pinch devices is that you have a more efficient drive mechanism, which is basically—I think of it as an induction LINAK with a beam shorted with a piece of copper for a tapered impedance line. Is that pretty much what it is?

Dr. REGAN. It's—we use a technology called an impedance-match Marx generator (IMG), so it's an evolution of the old school Marx generator that gets pulse compressed on facilities like Z.

Mr. FOSTER. But it's got induction? It's got a bunch of ferrite or something equivalent in it?

Dr. REGAN. Oh, no, no, sorry. So the IMG is an improvement on the linear transformer driver, which is a Russian technology. So we improved and simplified a Russian technology to make the—or the National Labs did, and now we're building on that.

Mr. FOSTER. All right, and do you have worries about the lifetime of the switch, whatever you're using?

Dr. REGAN. Yes. Yes, so—so the switch and the capacitor are the two components we have to have long lifetimes for. And we're working on that, yes, yes. So with our demonstration system, we only need, you know, a few thousand, tens of thousands of shots. The switches we make today are plenty capable of that. And there are known pathways to extend those lifetimes to a rep-rated power plant.

Mr. FOSTER. It's good to see you're working on the important problems. OK.

Dr. REGAN. Oh, yes. Oh, no, no. This was very important to us at the very start of the company, to make sure that we have a path, practical path forward to make a power plant that lasts for decades.

Mr. FOSTER. OK, let's see, Chairman, can I have another 15 seconds, 20 seconds?

Chairman WEBER. If you'll do it in English.

[Laughter.]

Mr. FOSTER. OK, all right. All right, sorry.

All right, Ms. Diem, you should add to your list of spinouts from University of Wisconsin plasma physics a company called Electronic Theater Controls. Fifty years ago, I was working in the plasma physics lab there as a young student. And on the evenings after we completed our work, I kind of took advantage of a lot of that equipment to build our prototype. I took advantage of two computers at Oak Ridge, the PDP–10 that we could get access through that lab, and that was—we didn't have a CRADA (cooperative research and development agreement), but we had a very strong set of—we made a lot of use of the technical resources of the plasma physics lab on an informal basis, and that was necessary to get our company going. And that company now is $450 million a year, 1,500 employees, fully owned by the employees who owned it out in Middleton, Wisconsin. So claim credit for that one, too.

Dr. DIEM. Thank you, I will.

Chairman WEBER. The gentleman yields back.

The Chair now recognizes the gentleman from Indiana, Dr. Baird, for his 5 minutes.

Mr. BAIRD. Thank you, Mr. Chairman, and Ranking Member. And I always appreciate all of you witnesses taking the time to share with this Committee and us your insights into whatever the program is that we're discussing.

But you know, the thing that's of interest to me, I think there's a lot of sentiment to see that all sources of energy are available or on the table. We've got fossil fuels, we've got nuclear, we've got solar and wind, and there's been some concerns about that. And now we're talking about fusion.

And Dr. Regan, you mentioned the return on investment. So I guess here's my question. You know, Secretary Wright recently said that fusion energy was a source of limitless, reliable, American-made energy. And I think we want to take back that lead in the energy production.

So can you explain why this fusion energy is important as a potential future energy source? And what role and vision—you envision fusion energy can play in the future mix, and how fusion can contribute to the concept of energy abundance and energy security?

I guess what I'm really trying to get at, if we're going to invest in that, and I know it takes investment, sometimes, to get things moving, and I really appreciate what the National Labs do, I really appreciate what the private industry does, and I really appreciate what the land grant universities do. So I guess I'm trying to—so I guess my question is, tell me why I should invest in fusion energy and that kind of research? Am I going to get a return on—and that's to everyone.

Dr. REGAN. Thank you, Representative Baird. Yes, we fully agree. We need all of the above. Energy is prosperity. We want more of it. More is better. And just, you know, as has been discussed earlier, energy is a critical factor in the AI race. You know, we need 24/7 power-dense, sitable, low-cost energy. So I see what fusion offers is a new and, you know, revolutionary source of energy that, you know, can be low cost, the fuel will last us forever. And I think, yes, that's an important capability.

And like Dr. Mumgaard said, it's not a question of if it's going to happen, but it's going to be when and where. And we want that to be in America, as soon as possible.

Dr. MUMGAARD. Energy—energy is prosperity. Like we built this country on energy. You cannot have a rich country without energy. But, of course, energy comes, historically, with externalities. Right? There's a lot of people involved that are around an energy facility. And if the energy facility is very spread out, there's a lot of people involved in that. And, of course, if an energy facility consumes or emits things, there's a lot of people that are affected by that.

What fusion does is it gives you energy with very small externalities. So that means it's like not just energy sovereignty for the Nation, it's energy sovereignty for the community. It puts things into a plant that you build this plant, you put the parts there, and you have energy. You don't have pipelines coming in that can be shut off, and you don't have smokestacks of stuff coming out that can go places.

And so that, that's a different paradigm. It takes a bunch of tradeoffs out of the energy equation of like who's giving up something for someone to have energy. And it, you know, conceptually, it's a facility that you build like you build a power plant today, that hooks to the grid, like you build the grid today, that has operators that are like the people that are there today, that has fabricators that are like the people there today. And so it is a continuation. It's not a disruption of the energy system in terms of delivery. Those make it very, very, very attractive.

Dr. DIEM. And I think it's an important part of a broader portfolio, because a lot of different communities can rely on other different forms of energy. But what it brings you is this energy density that's just unfathomable. So get a million times more energy out when you burn—than when you burn oil. So as an example, your whole entire lifetime, if you want to power it by coal, you have to burn 280 tons of coal. The equivalent fuel would just be you take heavy hydrogen out of two bathtubs full of water and six laptop batteries. I mean, that could transform everything as far as how we power and how we enter the next phase of humanity.

Mr. BAIRD. Anyone else?

You know, the other thing that's interesting to me is our electric—the people in my district, we're talking about a significant increase in the need for energy because of these data centers. And so I guess I was kind of interested in how that might fit, how fusion might fit in that ballgame.

But anyway, my time's about up, and I really appreciate you being here. Thank you.

I yield back.

Chairman WEBER. The gentleman yields back.

The Chair now recognizes the gentleman from Arkansas for 5 minutes.

Mr. BEGICH. Alaska.

Chairman WEBER. Alaska, Arkansas. For Texas, they're all the same.

[Laughter.]

Mr. BEGICH. It is not the same. I am two and a half times the size of Texas——

Chairman WEBER. The gentleman's time has expired——

[Laughter.]

Mr. BEGICH. OK, start the clock. All right.

So we talked a lot about the sort of egalitarian motives of fusion power. And I am a big supporter of fusion power. You know, we talk about what a gift this would be to humanity, really. But where at the same time we're talking about how we need to beat China, right?

And so we talked earlier in the hearing about intellectual property, balancing that with collaboration, right? How do you maintain those aspects of intellectual property that really allow us to beat China and be sustainable in defeating our adversaries when it comes to this new power source.

And my question is to Dr. Regan. How do you think we should reconcile these two concepts? And what do we do about the capital investment that will be displaced, potentially pretty rapidly, by a fusion breakthrough.

Dr. REGAN. Thank you, Representative Begich.

you know, I think you could do both. You know, we can—we can win and beat China while at the same time deploying, first in America, a fantastic new power source that provides, you know, with reduced externalities to traditional sources, abundant, safe, reliable power. And then we can—we can power the world.

You know, like I grew up in New Jersey. I always—my mom and I would drive by this big, steel bridge in Trenton that says, "Trenton Makes, the World Takes." That's what I want for fusion. I want it to be made here, power our, you know, our grid and our manufacturing here, and then also be able to deploy it around the world, but it's an American technology we're deploying.

Mr. BEGICH. Dr. Mumgaard, fission technology is riddled with guarded state secrets. And I'm hearing a lot today about open and collaborative research. How much of what we're working on in the fusion space should be considered a state secret?

Dr. MUMGAARD. So fusion was declassified very early. Because it's really hard to do, and it's also because it's not directly related to weapons.

So in fusion, you don't have the chain reaction. You don't have the uranium, plutonium. It also means that you don't have the—what is the intent of having those things. Which is, when we look at a place like Iran, like you're separating out intent, energy versus weapons. Fusion doesn't have that, fundamentally, the reaction doesn't.

And so that was key to why it was declassified. And that, I think, is an important principle today. The reaction itself is universal, and the materials are universal. But the knowhow is the key part. And the knowhow coupled to the ability to build things is the economic engine of it.

And so if we really want that economic engine to work, there's not a lot of reason to have state secrets.

Mr. BEGICH. China is building a new coal plant every 2 to 3 days. They're also investing in fusion, but they're not placing all their bets on fusion. Why do you think they lack the confidence to place their bets on fusion, given their investment in traditional energy?

Dr. MUMGAARD. A very good question. I think it also—the answer, I think, dovetails with your previous thing about displacement of energy. The world just needs so much energy that you can't really close doors. Right? If you close doors to fossil fuels in China today and you bet it all on fusion, like there's a possibility that you don't have enough energy to run that country. They're not going to do that.

And what this is about is about building options, options that could expand. And every time we've built a new energy—new energy technology, it has not displaced huge amounts of energy instantaneously. It's allowed us to go faster and further by adding to it. And I think that's what the fusion story is and that's probably how they see it.

Mr. BEGICH. Thanks. One more question. This one to Dr. Carter.

In your experience, is there anything in recent history that indicates that China's fusion investments are motivated by a global egalitarian impulse?

Dr. CARTER. I think they are very fixated on their own needs and trying to spin up energy technologies and dominate them, right? I think that's the focus.

We have had interactions with China over the—over the years. They do have interactions with Europe. But I think the motivation is as I said.

Mr. BEGICH. Thank you. And I yield back to the gentleman from Arkansas.

Chairman WEBER. All right, my previous friend has yielded back.

[Laughter.]

Chairman WEBER. And the gentleman from Florida is recognized for 5 minutes.

Mr. HARIDOPOLOS. Thank you, Mr. Chairman. And I first want to—one of the things that a lot of us in the freshman class have been really looking at as this big AI issue comes to force is just the absolute need for energy. And I'm so glad we're having these discussions. The future is clearly at the table. And how we make these investments will be maybe if we win or lose. And it's a real challenge. And I'm glad to see that we've been listening to these type of things, making the decisions based on the experts' opinion, not a top down situation from Congress. And I think your testimony today is absolutely vital.

I will take it from a little different tack. I chair the Subcommittee on Space, and it's something that a lot of people are talking about, is the idea that will Helium-3 potentially move this ball forward? And a lot of people are, you know, as always, skeptical about this. But there is a lot of potential, given the reality of this being this really move from Moon to here in the States and around the world to try to reduce that radioactivity that comes traditionally with nuclear energy.

So the question, I'll ask Dr. Diem first, if you don't mind, do you think this could be that innovative tool beyond what we're talking about with the issue today, that could be a game changer, and do you think this technology can transfer itself in a short enough period of time to make a real impact in the energy needs we have in the future?

Dr. DIEM. Thank you so much for your question.

So a lot of our efforts have been traditionally focused on fusing deuterium and tritium. Right? Which as you point out creates another challenge, which is handling with materials. But it happens at lower temperatures. So it's more readily achievable.

So that's why a lot of work that we're doing has been focused on that fuel cycle. And that's, I think, where we'll get to first. And then as you're advancing that technology and bringing fusion to market, you can also be advancing the, you know, the scientific readiness of something that's based on helium-3 fuel cycle. So I think it's like a second generation to come.

But it is really exciting to see with the, you know, private investments that we're actually able to dig into that deeper, to make that closer to reality.

Mr. HARIDOPOLOS. Literally, you are correct.

So that idea, I think I'll just close with this, Mr. Chairman, because I know others want to speak, is I'm really glad, and I think it was Mr. Mumgaard that spoke about the idea that it's a very difficult challenge to move from traditional to these new fuels. Even when we make huge investments, we're still relying on traditional fossil fuels. And I think it's imperative that we also recognize that, no matter what we do here in the States, what they're doing in India and China are polluting the rest of the world at magnitudes versus the United States. As you know, the actual carbon production in the United States has gone down over the last few years.

And I've got to admit, it's incredibly frustrating as a policymaker when we see our own costs challenged because we're trying to diversify our fuel, and you see our competitors doing it at a much lower cost and impacting the world. It's not—the pollution is not just limited to China and India.

So I hope all of us policymakers will look at this as a reality that, yes, we want to make these innovative changes, but not at the expense of where we cannot be competitive around the world. And sometimes I think, sometimes in these buildings or even in academia, where I used to serve, we lose sight of the book version versus the harsh realities of a free market system, or at least a world competitive market.

And so I think each—I've been listening to your testimony today and I am really grateful that hopefully we can make this breakthrough. Because the last thing people want to spend money on is energy. And the thing we all are facing in these challenging times, the AI revolution, the only thing really holding us back, as Sam Altman talked with Congressman Begich and I and other freshmen. The only way we're really going to maximize AI is we have the energy production to fuel this, as we take on the challenges of China, who are using every fuel without regard for environmental concerns, despite some of their weak promises in places like the U.N.

So with that, Mr. Chairman, thank you very much for making the time for us. This is an important discussion, which I hope we can continue throughout this Congress. Thank you.

I yield back.

Chairman WEBER. The gentleman yields back.

The Chair now recognizes the gentleman from Virginia for 5 minutes.

Mr. BEYER. Mr. Chairman, thank you so much for allowing me to waive on.

And this is my third or fourth or fifth Science Committee fusion hearing, and by far the most exciting. We've come a long way in the last 4 years from talking about two hydrogen atoms hitting each other. And I just want to thank you for the progress that we made.

Dr. Mumgaard, I am very much looking forward to an invitation next year when you turn on SPARC, even without tritium. Congratulations on how far you've come.

Also, thank you for the announcement that you will build perhaps the first fusion energy plant in human history in Virginia, where it belongs, rather than Arkansas or Texas. And we are excited that Helion Energy broke ground on their new thing.

Dr. Regan, I'd never even heard of Pacific Fusion 2 years ago. So already you're here doing really great things. It's come a long, long way.

Thank you also for a number of times mentioning our 4-person bipartisan 45X bill that we have in Ways and Means. I'm very excited and I think can make really good progress.

We've had a chance to meet with Secretary Wright and make sure that he is as enthusiastic as we are, and that this is a bipartisan effort.

One of the things I'd love for us to do is, in every speech I give, I talk about fusion. But I find that most people are still like, what's that? And not only is it, what's that, just in terms of the science, but in terms of what the world will look like when you are successful in the near years to come.

What it will mean for—and what does energy abundance actually mean? What will it mean for those of us who believe in climate change? For example, one of the things we got done in recent bills was 45Q, which allowed us to do direct air capture. But right now, if you use fossil fuels, it's a wash. But driven by fusion energy, we could make an enormous difference on the amount of carbon dioxide that's in our atmosphere.

We think about it in terms of foreign policy. Most of the wars fought over the last couple thousand years have been about energy. What happens if energy is abundant? What will this do for peace in the world? What will it do for population? What will it do for just poverty. You figure you've got 2 billion people going to bed hungry every night. The scarce resource is not humanity, it's not land, it's energy.

So you are ushering in a dramatic new part of human history. I am so, so grateful. So it's very exciting.

On the $10 billion, I know the gentleman from North Carolina talked about $40 billion over the years. I don't know where that number came from. But let's just say it's right. Ten billion, when you figure we're at $930 million in the budget that's floating around right now, and only a small fraction of that is going for things like Milestones and FIRE, we would love to work really closely with you on exactly how that $10 billion is laid out, and go to the appropriators now, Democrat and Republican, get the Rosa DeLauros and Tom Coles and the like.

I did the quick math. Our overall budget is about $7 trillion. That means one $1 of every $700. Assuming that $10 billion is all spent in 1 year, which is probably not what you're trying to do anyway. So you're talking about one in every $2,000 dedicated to something that can make the hugest difference for mankind.

There's so much that I want to talk to you about, but one I just want to make sure that we want to work with you to define that $10 billion as best we can, knowing that it could change year to year based on our successes.

On the collaboration, I know it's great with the U.K. and China—and Japan. China's spending $6 billion. Is there any opportunity for collaboration with them? Especially when my good friend's fears about empowering China, already some of the most responsible fusion companies are doing peer reviewed articles. You're in the journals. They can read them. What's the—is there any possibility for productive collaboration that's not just about China stealing our IP?

Dr. MUMGAARD. Yes, it's a really, really good question. So there is today a collaboration with China in the U.S. program through ITER. And that's an example of ITER is for everyone. And so the Chinese are getting what they need out of it, we're getting what we need out of it. And our researchers interact through that project.

And that was really the model that we had in the last two decades, where we actually had a policy that we would collaborate with China. And we did learn things. They learned, I think, more.

I do think that going forward, the fundamentals of how plasmas work are so universal that like that is the stuff that should be in the peer reviewed literature, the same way the fundamentals of how the human body works and how genetics works, that's—that's, you know, something that everyone, everyone has access to and should.

The details of how do you design an actual facility, how do you manufacture it, how do you put it together, that's where the commercial interest is. That's the area that we don't collaborate on. And so I think the publication record of the company's labs, et cetera, is following those lines, which is very similar to what's happened when we wanted to buildup the drug industry or when we built the aerospace industry. So I think that's healthy.

Mr. BEYER. Great, great. Thank you.

I had so much more to ask, but my time is out. So, Mr. Chairman, thank you very much.

Chairman WEBER. The gentleman that criticized Texas has yielded back and has waived on for the last time.

[Laughter.]

Chairman WEBER. So we appreciate that.

I want to thank the witnesses for their valuable testimony, and the Members for their questions.

The record will remain open for 10 days for additional comments and written questions from the Members.

This hearing is adjourned.

[Whereupon, at 11:45 a.m., the Subcommittee was adjourned.]

Appendix

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by Dr. Stephanie Diem

U.S. HOUSE OF REPRESENTATIVE
COMMITTEE ON SCIENCE, SPACE AND TECHNOLOGY

Subcommittee on Energy
Igniting America's Energy Future: The Promise and Progress of Fusion Power

Dr. Stephanie Diem, Assistant Professor, University of Wisconsin-Madison

Questions submitted by Representative Zoe Lofgren, Committee on Science, Space, and Technology

Competition with China

As has already been highlighted this morning, a detailed analysis from the Special Competitive Studies Project found that China has invested at least $6.5 billion in fusion development since 2023, about 3 times the total funds appropriated for DOE's Fusion Energy Sciences program over the same period. And the authors note that largely due to China's lack of transparency, this is really a conservative estimate – the amount could be as high as $10 - $13 billion.

Dr. Mumgaard, you are a member of the SCSP Commission that produced this analysis. You're also the CEO of the largest private fusion company in the world. And yet in your written testimony, you actually state that "the next decade of fusion breakthroughs and scientific discovery is going to happen in China, not in the US, with the investments I am seeing."

- How confident are you in the findings of this analysis?
- Beyond total funding, how would you characterize China's scientific and technical capabilities in fusion energy development vs. the U.S.?

1. **Dr. Diem:** Any additional comments are welcome.

China's recent expenditures on fusion energy research, development, deployment, and infrastructure have far exceeded those of the United States and other countries around the world, as noted in the *Fusion Forward: Powering America's Future* report by the Special Competitive Studies Project's Commission on the Scaling of Fusion Energy. China is taking a highly strategic approach by investing heavily in the construction of major fusion energy research facilities and in developing a skilled domestic workforce to support them. For example, China is building a large laser-ignited fusion center in Mianyang estimated to cost on the order of $3 to 4 billion, and broader state investments in fusion infrastructure have exceeded $6.5 billion since 2023. Historically, Chinese researchers have collaborated with the United States directly on experiments conducted both domestically and abroad, as well as through international partnerships such as ITER and technical working groups within the International Energy Agency. China is already deeply engaged in global collaborations aimed at advancing fusion energy. Most recently, it hosted the International Atomic Energy Agency (IAEA) Fusion Energy Conference and the second ministerial meeting of the IAEA World Fusion Energy Group, underscoring its growing influence and leadership in the international fusion community. Any expertise China currently lacks, it is aggressively building up with the launch of their K visa program to attract foreign talent in science and technology.

A key challenge facing the United States is the uncertainty surrounding sustained federal investment in a long-term fusion energy mission. Without consistent and robust support, there is a growing risk that American scientists, engineers, and technologists—as well as other leading fusion energy experts worldwide—will pursue opportunities in China, contributing to the expansion of its capabilities. By contrast, with the launch of the DOE Fusion Science and Technology Roadmap and strategic investments in critical infrastructure such as a fusion prototypic neutron source and blanket test facility, the United States can secure its leadership on the path toward fusion energy commercialization and strengthen its globally competitive, American-led fusion energy industry.

Alternative approaches

Dr. Regan, while – as you noted in your testimony – your company has recently received an award from DOE to partner with Lawrence Livermore National Laboratory on an advanced measurement tool for fusion plasmas, I understand that you are working to advance a unique approach to fusion that doesn't appear to have an obvious, ongoing home in the DOE Office of Science's fusion portfolio.

2. **Dr. Diem**, is there anything you'd like to add on the value of establishing an ongoing alternative fusion energy concepts program, especially given the University of Wisconsin's pioneering work in this space?

The University of Wisconsin-Madison has a long and distinguished history of advancing experimental fusion energy research, particularly through pioneering alternative approaches to achieving fusion. This legacy has produced a uniquely synergistic ecosystem. By bringing together experts in experimental plasma physics, fusion technology, theory and computation, and close partnerships with the manufacturing sector, UW-Madison has directly contributed to the success of several leading U.S. private fusion companies. Notably, SHINE Technologies, Realta Fusion, and Type One Energy all originated at UW–Madison, demonstrating the university's proven ability to translate scientific innovation into commercial impact.

Fusion energy holds promise far beyond serving as a source of baseload power. It can potentially provide district heating, industrial process heat, desalination, and even propulsion for space exploration. Because energy needs vary by application and location—from large-scale baseload plants (500 MW–1 GW) to smaller distributed systems (hundreds of MW)—the pursuit of alternative fusion concepts offers pathways to tailor technologies to specific markets. UW–Madison spinouts exemplify this diversity: SHINE Technologies employs a beam–target approach to generate fusion neutrons for medical isotope production; Realta Fusion, a DOE Milestone company, is developing compact mirror-based systems for both energy generation and materials testing; and Type One Energy, also a DOE Milestone company, is designing a stellarator-based fusion pilot plant.

The renewed momentum behind these alternative approaches reflects two key drivers: growing private investment and technological breakthroughs that make concepts once deemed impractical increasingly viable. Early challenges, including plasma instabilities and low confinement, have the potential to be overcome through advances in computational modeling, AI and machine learning, high-temperature superconducting magnets, and improved physics understanding.

Establishing a fusion innovation ecosystem through a regional hub at UW–Madison would build on these strengths and this proven collaborative model—uniting expertise in plasma physics, fusion technology, theory, computation, and industry engagement under one coordinated national framework. This framework serves to advance all fusion concepts. Universities are recognized for their ability to seed innovation that will lead to robust industries. Of the 45 fusion startup companies, 60 percent originated from universities, and 95 percent of private investment in the sector has been specifically directed to university spinouts. The value of a regional fusion innovation ecosystem hub was underscored at the recent Fusion/AI Summit, where experts from across academia, government, and industry emphasized the need for a national demonstration hub to accelerate the translation of fusion science into deployable systems. However, a successful hub must be about more than workforce development; it must also integrate research, technology innovation, and industrial capability to create a full fusion ecosystem. Wisconsin is uniquely positioned to do so—not only because of its world-class research and S&T strengths, but also due to its deep manufacturing expertise and capacity that can directly support fusion component fabrication, materials development, and system integration. Robust public–private investment in a UW–Madison–based hub—the Midwest Collaborative Hub for Fusion Energy, Engineering, Science, and Experimentation (Midwest CHEESE)—would accelerate the maturation of multiple fusion pathways, generate cross-cutting innovations in heating and materials systems, and yield significant returns for the United States. Most importantly, it would reestablish U.S. leadership in the global fusion race by leveraging the uniquely fertile ecosystem that UW–Madison and Wisconsin industry have already created.

Lifetime of current fusion facilities and future needs

Dr. Mumgaard, in your testimony you state that "the U.S. Government effort is fragmented, weighed down by underwater mortgages on antiquated facilities, underfunded, and ill-equipped to deliver the focused mission-driven programs needed to complement the private sector to effectively compete with the U.S.'s primary geostrategic rival in this important space."

Relevant to this argument, Dr. Carter, you led development of the fusion community's most recent Long Range Plan, which made recommendations for the future of our nation's fusion efforts under several budget scenarios. And in the constrained budget scenarios, which certainly cover what we're living through right now, unfortunately, the report recommends reducing support for the current major tokamak facilities in the U.S. – that's DIII-D, NSTX-U, or both – to ensure sufficient room in the budget for increased support in higher priority activities.

Dr. Mumgaard and Dr. Carter:

- What are your views on the productive lifetimes of DIII-D and NSTX-U if we remain at roughly the current annual federal budget level for fusion over the next several years?

- Would those views change if our budget for fusion were somehow able to grow by, say, 10% annually over the next 5 years? 20%?

3. **Dr. Diem**, do you have any comments?

In a fiscally constrained environment, difficult choices must be made and priorities carefully balanced. Regardless of the budget, we must have a clear plan that aligns resources with mission needs. We are at a pivotal moment with the opportunity to leverage the entire U.S. fusion ecosystem to advance toward a commercial energy future. To do so, we must free up resources to pursue this mission rather than continue legacy experiments, such as DIII-D and NSTX-U, while intentionally transitioning the workforce to support the emerging fusion industry. If the Department's mission is to ensure a reliable energy supply, then our national facilities must evolve to directly support that goal. It is therefore critical to plan proactively for the impacts of such changes, ensuring that researchers and facilities can transition effectively to support emerging priorities and sustain progress toward commercial fusion energy.

Even if the federal budget for fusion were to grow by 10 or even 20 percent annually, several critical facilities are still waiting in the wings that would better position the U.S. public sector for long-term success. According to the Fusion Energy Sciences Advisory Committee (FESAC) Facilities Report, the Subcommittee reached a strong consensus on four facilities in the *"Best Serves Fusion"* category—each "absolutely central" to accelerating the fusion energy timeline and providing essential engineering and technology experience. These facilities include: (1) the Blanket Component Test Facility (BCTF), to qualify technologies that extract fusion power and breed fuel; (2) the Fuel Cycle Test Facility (FCTF), to develop systems that extract and recycle fusion fuel; (3) the Fusion Prototypic Neutron Source (FPNS), to qualify materials for use in the extreme nuclear environment of fusion power plants; and (4) ITER, which provides a world-class burning-plasma facility and an unparalleled opportunity for knowledge transfer in fusion systems integration, quality control, and precision engineering. The associated costs of these facilities are significant—ranging from approximately $125–500 million for the Fuel Cycle Test Facility (FCTF), $130–520 million for the Blanket Component Test Facility (BCTF), and $471 million to over $1 billion for the Fusion Prototypic Neutron Source (FPNS), with the U.S. contribution to ITER already totaling roughly $6.5 billion—and resources should therefore be focused on supporting the most forward-leaning aspects of fusion science and technology.

In addition to these cross-cutting facilities, FESAC identified several concept-specific plasma confinement facilities as "important and well-deserving of support," though not "absolutely central," because of their focus on individual confinement approaches. Progress in these areas can be accelerated through public-private partnerships with industry, which already plans to construct confinement facilities that explore high-performance plasma regimes and demonstrate integrated systems for future pilot plants. To fully capitalize on these opportunities, however, the United States needs a transformative shift in its approach to fusion energy commercialization—one that combines community-driven strategic planning, the DOE Fusion Science & Technology Roadmap, and the private sector's momentum to form a coordinated national effort.

The FESAC Long-Range Plan called for the United States to "move aggressively toward the deployment of fusion energy." Doing so requires a proactive, not reactive, approach. That means providing early and transparent communication about any facility transitions, decommissioning plans, and workforce implications. Researchers and technical staff affected by such changes should be given clear opportunities to reskill and upskill, ensuring that the nation's highly trained experts remain engaged in advancing the fusion mission rather than being lost to attrition. Proactive planning will minimize uncertainty and maintain the human capital needed to operate and design next-generation facilities.

Achieving this transition will require a coordinated national effort to design and deploy key infrastructure that closes enduring science and technology gaps. These include challenges in structural materials, plasma-facing components, confinement optimization, tritium processing and fuel-cycle technologies, blanket development, and full fusion plant engineering and systems integration. The United States has already identified the facilities necessary to address these gaps through FESAC's prioritization process—namely, the FPNS, BCTF, and FCTF—and must now provide the resources to build them. Investment in these facilities would not only advance the scientific and technical basis for fusion energy, but also strengthen the domestic fusion supply chain, supporting private companies as they define pilot-plant designs and prepare for procurement.

Smaller-scale facilities and specialized testbeds, such as those for plasma heating systems, materials testing, and diagnostic development, can also play a vital role in supporting supply-chain readiness and industrial engagement. But this transition must be clearly communicated to maintain continuity within the workforce and provide meaningful opportunities for professional advancement. Other nations, such as China and the United Kingdom, have already demonstrated this proactive model: the U.K. made the difficult but strategic decision to close JET while providing a clear transition plan and investing in new national infrastructure. The United States must now do the same—acting decisively, communicating early, and investing wisely—to ensure it remains a global leader in the race to realize commercial fusion energy.

ITER International Fusion Project

- Dr. Carter, given the many recent advancements in fusion science and technologies since ITER was first designed, do you believe that this project will continue to be of high value to the U.S. fusion research enterprise going forward? And if so, how?

4. Dr. Diem, do you have any comments?

ITER represents a landmark international collaboration uniting countries around the common goal of building a magnetic fusion energy device capable of studying the conditions required for sustained fusion reactions—a burning plasma. Throughout its conceptualization, design, and construction, ITER partners have accumulated invaluable expertise: developing advanced data structures and analysis codes to predict and interpret plasma behavior; modeling the phenomena expected in a burning plasma environment; designing diagnostics and infrastructure to withstand extreme fusion conditions; and establishing a global manufacturing base experienced in producing components for large-scale fusion devices. The collaboration has already yielded critical insights into fusion facility integration and engineering, and once operational, ITER will provide unprecedented scientific knowledge of large-scale burning plasmas. While the United States' path toward fusion energy commercialization is not dependent on ITER's timeline, it will undoubtedly benefit from the data and experience generated when the facility begins operation.

- As you know, there is now a wide array of promising fusion energy concepts being developed by the public and private sectors.

5. Dr. Diem, in your view, will ITER be relevant to fusion concepts that are not tokamaks?

There are several systems and research areas that span multiple magnetic fusion energy concepts and are central to ITER's current and future focus. These include advanced and additive manufacturing in ultrahigh-vacuum and nuclear environments, pulsed-power systems, and fusion facility integration. In addition, the development of materials capable of withstanding extreme heat loads and intense neutron fluxes, as well as evaluating the performance of proposed blanket materials, remains a shared challenge across nearly all fusion concepts.

<u>Questions submitted by Representative Sheri Biggs, Committee on Science, Space, and Technology</u>

- Tritium is one of the largest radiological isotope sources in a fusion plant.

1. What facilities and resources do you plan to use to train the US workforce to work with tritium at scale and to leverage the leadership in the US through our National Security programs that are performed at the Savannah River National Lab?
2. Where do you plan to demonstrate balance of plant (fuel cycle and tritium breeding) fusion technologies before they are deployed in a fusion pilot plant to ensure they are safe?

There is currently a limited workforce in the United States with hands-on expertise in tritium science, handling, and fuel-cycle technologies, all of which are essential to realizing a functioning fusion energy ecosystem. The Savannah River National Laboratory has long served as the nation's center of excellence for tritium R&D, providing critical infrastructure, data, and technical expertise. However, most of this work occurs in a highly controlled and classified environment, which, while necessary for safety and security for the site, also limits opportunities for broader scientific engagement, workforce development, and innovation. If the United States is serious about achieving fusion power on a decadal timescale, tritium research and training must be expanded beyond the walls of Savannah River to include industry and university partners operating in open-science environments.

Such an expansion would allow for shared access to tritium data, increased opportunities to validate models through experimentation, and a deliberate strategy to train, upskill, and retain the workforce needed to design and operate future fusion fuel-cycle systems. This broader approach would not only accelerate the development of safe and efficient tritium-handling technologies but also ensure that scientific knowledge and technical capabilities are distributed across the national innovation ecosystem.

International and domestic partnerships can play an important role in this effort. The United States should strengthen collaboration with the United Kingdom, Canada, and Germany, each of which maintains advanced tritium programs with strong safety and regulatory frameworks. Domestically, partnerships with private-sector leaders such as SHINE Technologies (which already operates with licensed tritium facilities) offer a unique opportunity to promote open science, workforce training, and applied R&D in coordination with the public sector.

The proposed Midwest Collaborative Hub for Fusion Energy, Engineering, Science, and Experimentation (Midwest CHEESE) would provide an ideal platform for such expansion. Anchored at UW–Madison, and leveraging Wisconsin's deep industrial manufacturing base and proximity to SHINE Technologies, the hub can create a regional nexus for open, collaborative tritium research, industrial-scale testbed development, and workforce training that directly supports the fusion fuel cycle. While Savannah River will continue to serve as the cornerstone of the nation's tritium capability, establishing complementary, open-access environments at universities and industrial facilities is critical to building the expertise and innovation capacity needed to bring fusion energy to the grid within the next decade.

Question from Representative Deborah Ross, Line 1032 in Transcript for "Igniting America's Energy Future: the Promise and Progress of Fusion Power, Committee on Science, Space, and Technology" Hearing

- What concrete steps in the next 12 to 24 months should the federal government take to emphasize this across DOE, the State Department, and the Department of Commerce? Any suggestions?

  As the United States intensifies its focus on fusion energy commercialization, our national expertise and partnership networks must evolve to support this mission and engage effectively with deployment and commercial-sector stakeholders. The establishment of a National Fusion Lead, as proposed in the *Fusion Forward: Powering America's Future* report by the SCSP's Commission on the Scaling of Fusion Energy, would provide the structure needed to coordinate this transition. An interagency task force, spanning the Departments of Energy, State, and Commerce, could align federal policy, international engagement, and industrial development efforts to ensure a unified national strategy for fusion energy.

To be effective, this coordination must draw directly on the expertise of active researchers, who are best positioned to identify emerging scientific and technical needs, recommend priority areas for international collaboration, and help shape partnerships that address shared challenges in critical minerals, infrastructure, supply chain resilience, and advanced research initiatives. Leveraging the U.S. Science Envoy program through the Department of State offers a mechanism to facilitate these collaborations. Now housed within the Office of Science and Technology Investment, Innovation, and Cooperation (STIIC), the Science Envoy program incorporates a new focus on commercial and emerging technology diplomacy, enabling early-stage engagement that accelerates international partnerships in fusion and related advanced technologies.

As fusion transitions from an era of open, foundational science to one driven by applied missions and commercialization, the field will also increasingly intersect with national security and economic competitiveness. Developing a clear framework for research security—crafted with input from active researchers, government agencies, private companies, and international partners—will be essential to balance openness and collaboration with the protection of critical technologies and intellectual property. Through deliberate coordination and informed leadership, the United States can position itself at the forefront of the global fusion energy enterprise while ensuring its scientific, technological, and strategic interests are protected.

Responses by Dr. Will Regan

QFRs

U.S. HOUSE OF REPRESENTATIVES

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

Subcommittee on Energy

Igniting America's Energy Future: The Promise and Progress of Fusion Power

Dr. Will Regan, Co-Founder & President, Pacific Fusion

Questions submitted by Chairman Brian Babin, Committee on Science, Space, and Technology

1. Both DOE and private investors have made major strides in fusion, with nearly $9 billion invested and companies planning commercial plants. As commercialization advances, how can DOE ensure the resources needed to fully deploy this technology?

a. Dr. Regan, what does private industry need from DOE and the National Labs as companies increasingly focus on commercializing their technologies rather than solely on basic research and development?

Thank you, Chairman Babin. What private industry needs most from the Department of Energy (DOE) and our National Laboratories today is a sustained partnership that bridges the gap between research and deployment. DOE and the Labs have done extraordinary work advancing the scientific frontier of fusion. However, the challenge before us is no longer whether fusion can work but how fast we can design, build, operate, and scale real power plants here in the United States before others do.

That means shifting part of DOE's fusion efforts from purely scientific discovery to applied engineering and commercialization. We need DOE to complete and expand the Milestone-Based Fusion Development Program and to launch a full Fusion Demonstration Program that supports multiple technologies through milestone-based, cost-shared partnerships.[1] Those programs, modeled on NASA's COTS and DOE's Advanced Reactor Demonstration Program, allow the government to set clear goals, back the most promising teams, and reward progress while leveraging private capital.

We also need the National Labs as close collaborators on the applied challenges of commercialization—helping develop materials that better can withstand the fusion environment, closing the tritium fuel cycle, and designing testbeds that companies can access for component validation. The Labs will always be the scientific bedrock of American energy innovation, but now they must also help industry build.

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[1] The Fusion Demonstration Program can also be created as a new "tier" to the existing Milestone-Based Fusion Development Program.

China has already mobilized billions of dollars to capture this industry. We don't need to match that dollar for dollar, but we need the same clarity of purpose. If DOE can help industry move from the lab to the field as efficiently as the NASA COTS program did for commercial space, we can ensure that fusion, and the prosperity it brings, remains an American achievement.

2. It's not often that we receive an entirely new source of energy. If the fusion industry successfully makes these breakthroughs, I want to ensure that America benefits first and foremost. We should be making these machines here, with components built in America.

a. Dr. Regan, what can Congress do to help ensure this industry supports American manufacturing jobs?

I completely agree, the promise of fusion is not just scientific; it is industrial. If we do this right, fusion can anchor an entirely new manufacturing base here in the United States that spans precision components, advanced materials, power electronics, and supply chains that touch nearly every state. However, to ensure those jobs are created here and not overseas, Congress has a critical role in shaping the environment for early deployment.

Most importantly, Congress should add fusion to already-existing programs that promote domestic manufacturing. Here I want to call out the great work done by Representatives Miller, DelBene, Tenney, and Beyer to introduce the *Fusion Advanced Manufacturing Parity Act*, which puts fusion on an equal playing field to other advanced energy technologies for tax incentives to promote domestic manufacturing.

As well, Congress can establish clear market signals through expanding funding for programs like the Milestone-Based Fusion Development Program, which are structured as milestone-based public-private partnerships. Just as NASA's COTS program ensured that rockets were built and launched in America, we can do the same for fusion systems.

Last, Congress can help DOE and the National Labs stand up programs to promote manufacturing and testing of fusion components. American companies can prototype key subsystems, qualify suppliers, and build the skilled workforce needed for high-precision energy manufacturing.

In short, if Congress combines targeted manufacturing incentives, milestone-based demonstration programs, and workforce investments, we can guarantee that fusion power — and the tens of thousands of jobs (or more) it will create—are made in America.

Questions submitted by Representative Zoe Lofgren, Committee on Science, Space, and Technology

Competition with China

As has already been highlighted this morning, a detailed analysis from the Special Competitive Studies Project found that China has invested at least $6.5 billion in fusion development since 2023, about 3 times the total funds appropriated for DOE's Fusion Energy Sciences program over the same period. And the authors note that largely due to China's lack of transparency, this is really a conservative estimate – the amount could be as high as $10 - $13 billion.

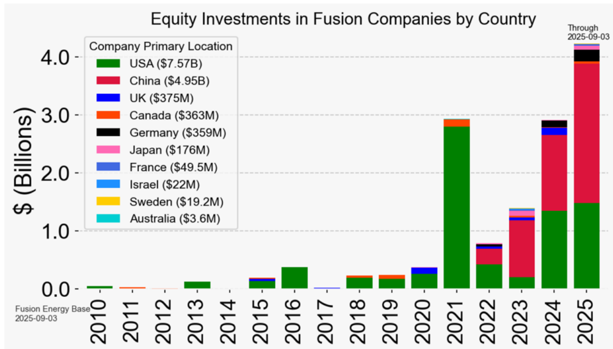
Dr. Mumgaard, you are a member of the SCSP Commission that produced this analysis. You're also the CEO of the largest private fusion company in the world. And yet in your written testimony, you actually state that "the next decade of fusion breakthroughs and scientific discovery is going to happen in China, not in the US, with the investments I am seeing."

- How confident are you in the findings of this analysis?
- Beyond total funding, how would you characterize China's scientific and technical capabilities in fusion energy development vs. the U.S.?

1. Dr. Regan, do you have any additional comments?

Thank you, Congresswoman. I do not want to sound alarmist, but we must be clear-eyed about where global competition stands. The Special Competitive Studies Project's (SCSP's) analysis is based on publicly available data and direct industry observation. And it is also conservative. A likely number, also acknowledged by SCSP, is that China has committed upwards of $10–13 billion since 2023 to build large-scale fusion facilities, stand up state-owned fusion companies, and integrate fusion into its national industrial policy – and these are new projects, beyond the research they are doing every day that is part of their annual budgets.

That level of *new* investment shows the Chinese are serious about commercializing fusion energy. It dwarfs what we've mobilized here so far on the applied, deployment side of fusion. As one analysis shows, China has now overtaken the U.S. in equity investment into commercial fusion companies, and this ignores China's edge in government-back infrastructure projects:



(source: Fusion Energy Base[2])

To your second question, China's *scientific* capabilities in fusion remain behind those of the United States. The breakthroughs that established that ignition and high gain inertial fusion are possible happened here at Lawrence Livermore and Sandia National Laboratories, and the world's leading fusi on scientists are still trained mainly in and collaborating with U.S. institutions. While the U.S. maintains the scientific lead, China is catching up faster in engineering and execution. They are rapidly building large-scale inertial and magnetic fusion facilities, creating vertically integrated supply chains, and aligning regulatory, industrial, and financial systems to move from science to deployment faster than us.

My broader point is that the next decade will be defined by who can *build* first. And right now, China is positioning itself to do that unless we act with the same urgency and coordination. The United States invented this technology. But without a comparable national effort to move from the lab to the field through milestone-based partnerships, demonstration programs, and industrial-scale investment, we risk repeating the pattern we saw with solar, batteries, and critical minerals: inventing the industry here, but watching the manufacturing and economic value migrate abroad.

The science and talent are ours, but leadership will go to the country that builds first. Congress now has an opportunity to make sure that's the United States.

Private investment

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[2] Sam Wurzel, *September 2025 Fusion Equity Investment Update*, Fusion Energy Base (September 1, 2025).

2. Dr. Regan, given the level of private investment that your companies and many others have been provided to date, why do you even need funds from the U.S. government to meet your goals?

a. Why can't we expect the privately funded U.S. fusion industry alone to fund and build the facilities that will be required to test materials and fuel cycle technologies that will be necessary for commercial fusion systems?

That's a very fair question, Congresswoman. The short answer is that private funding helps private fusion companies solve half the probem—proving the approach to fusion can work at a demonstration level. But we need a public program to catalyze the private investment needed to build the first power plants and scale the nascent fusion power industry, and to do so fast enough to win the global race to deploy fusion power.

There are two challenges fusion companies are trying to solve. The first is proving the core fusion technology—achieving facility-level energy gain from fusion reactions. Here private capital has risen to the challenge, and multiple companies (like ours) are funded to build these critical "fusion demonstration systems." The public sector has catalyzed this private investment through their decades of work on fusion science, including through decadal investments in major facilities like the National Ignition Facility.

The second is building a working power plant, which involves developing first-of-a-kind systems that convert that fusion power into useful electrical power that can be delivered 24/7/365, e.g., tritium-handling systems, blanket technologies, and systems to convert fusion energy to electricity.

Here there is, so far, limited private sector investment. If we want to move faster than China to deploy fusion in the 2030's, the industry needs the public sector to step in *now* — which will also help catalyze further private sector investment — to support the first commercial demonstration systems that will solve these challenges. A proven tool to make this happen is a dedicated, milestone-based program to design and build the first commercial demonstration fusion systems, taking the successful model used by NASA COTS and applying it to fusion. DOE already has authority for such a program, and can implement it by expanding FES's nascent Milestones-Based Fusion Deployment Program to cover commercial fusion demonstration.

Private capital is arriving in force to solve the core challenges around achieving high fusion gain. If we rely solely on private capital alone in this latter area of power plant development, the US will fall behind. Key capabilities will move offshore, and the United States could once again invent a technology that others commercialize first. But if we strategically align public and private resources, we can build the foundation for a trillion -dollar industry that delivers American energy security, manufacturing jobs, and technological leadership.

i. **Are you able to achieve your near -term goals to demonstrate net fusion energy production without these test facilities? And if so, then why would these facilities still be necessary?**

Yes, Congresswoman, we are confident that Pacific Fusion can achieve our near-term goal of demonstrating net facility energy gain, producing more fusion energy output than is initially stored in the system, without needing extensive federal test facilities. The private sector has raised enough capital to build and operate such demonstration -scale systems, validate our physics models, and show that fusion can be a practical power source. Those are challenges that companies like ours are built to solve efficiently and with high accountability.

However, once we achieve net gain, the mission shifts from *proof of concept* to power generation demonstrations and then *deployment at scale*. That's where shared infrastructure becomes important, and particularly for at -scale deployment. We will benefit from national facilities to qualify new structural materials in high fluence neutron environments, close the tritium fuel cycle for power plan ts, and test components that underpin commercial power plants. Those long-lead, high-cost capabilities benefit the entire industry but are difficult for any single company to build in isolation.

In sum, private capital can get fusion across the finish line scientifically. Still, we need the federal government's partnership to make the shared foundation to turn that breakthrough into a commercially-competitive energy industry.

Test facility needs

Dr. Carter, your testimony highlights a report released last year from the Fusion Energy Sciences Advisory Committee identifying the top 4 research facilities that will be necessary to accelerate the commercialization of fusion energy.

- **Can you describe these facilities in more detail?**
  - **Why aren't our current fusion research facilities, including the new materials experiment being built at Oak Ridge National Laboratory, sufficient to identify and test materials that can handle the heat and neutron impacts that are expected in the firs t wall of a commercial fusion reactor?**

- **Are there ways that we can potentially reduce the costs and schedule to build these facilities through public-private partnerships?**

3. Dr. Regan, is there anything you'd like to add?

Thank you, that is an excellent question, Congresswoman. The short answer is that our existing fusion research facilities, while world-class, were designed for science, not for industrial qualification.

Facilities like the new materials experiment at Oak Ridge are invaluable for studying radiation damage and materials behavior under fusion-relevant conditions. However, they operate at scales, duty cycles, and geometries that are different from what an actual commercial fusion machine will face. For years, a fusion power plant's "first wall" must withstand long periods of bombardment by high-energy neutrons, high thermal loads, and repetitive cycling. To validate materials for that environment, we'll need testbeds that integrate those conditions simultaneously, capabilities that existing facilities were not built to do.

We don't need to start from scratch or build billion-dollar facilities overnight. Public-private partnerships have a clear opportunity to accelerate and de-risk this work. For example, DOE could establish smaller facilities built through public-private partnerships and milestone-based funding. They could even co-locate with commercial fusion developers, using shared hardware and experimental platforms. This approach would shorten schedules and lower costs, turning these facilities into living test environments that evolve alongside private fusion systems.

In other words, current testing facilities are not designed to solve all the questions that need to be answered for deploying fusion at scale. Beyond just building government-led facilities, we can also create collaborative, scalable testbeds that directly serve deployment by delivering faster results, greater learning, and a stronger domestic supply chain.

Alternative approaches

Dr. Regan, while – as you noted in your testimony – your company has recently received an award from DOE to partner with Lawrence Livermore National Laboratory on an advanced measurement tool for fusion plasmas, I understand that you are working to advance a unique approach to fusion that doesn't appear to have an obvious, ongoing home in the DOE Office of Science's fusion portfolio.

4. Do you see value in establishing a program where academic and public sector researchers of innovative concepts like yours would be eligible to lead applications for federal funding?

Yes, Congresswoman, that would be valuable for the fusion ecosystem. As new private-sector concepts emerge, whether inertial confinement, magnetic confinement, or other innovative approaches, there is no clear consistent pathway for those approaches to access sustained public research collaborations.

Establishing a dedicated program where academic and public-sector researchers can lead or co-lead federal funding applications related to new fusion concepts would continue to drive innovation within the fusion sector. It is important that concepts that don't fit neatly within existing DOE frameworks have a chance to succeed.

Importance of peer review

Dr. Regan, your company has produced recent, peer-reviewed articles in respected scientific journals on your efforts to advance your respective fusion energy concepts. Frankly, that is not the case with all of your competitors in this field.

5. Given the extent of the private investments that you have received to date, why do you believe it is still important to submit your work to this kind of external review?

Thank you, Congresswoman. Peer review is essential, especially in a field like fusion, where the line between credible innovation and overstatement can make or break scientific integrity and public trust. Submitting our work – particularly key scientific claims – to rigorous, independent peer review makes our work better.

Peer review forces us to document our assumptions, quantify our evidence and uncertainties, and hold ourselves to the same standards of transparency that have always defined serious scientific progress. From an industry perspective, it's also the foundation for credibility and collaboration. When our findings are published, it allows the broader fusion community, at the national labs, in academia, and across industry, to challenge them and improve them.

That open scientific exchange drives the U.S. innovation ecosystem. The companies that take that process seriously are the ones that will ultimately succeed, not just in achieving fusion but in earning the trust of regulators, partners, and the American public.

6. Is there a balance that you've needed to strike between validating the credibility of your approaches through these publications and ensuring your company's international competitiveness, particularly with China, by maintaining some secrecy on your developments?

That's a great and timely question, Congresswoman. Yes, there's a balance, and we think about it daily. On one hand, peer-reviewed publication is vital for establishing scientific credibility and maintaining trust with the broader research community, policymakers, and investors. On the other hand, we are operating in a highly competitive and increasingly geopolitical environment. China, in particular, is investing billions of dollars and rapidly absorbing publicly available research to accelerate its fusion programs. So, we must be thoughtful about how much technical detail we disclose and when.

Our approach has been to separate scientific validation from engineering execution. We publish our scientific results and how we get that data (e.g., diagnostics) so the physics can be independently confirmed—but we retain proprietary information about our system architecture, manufacturing methods, and control algorithms. That allows us to advance the field responsibly without giving away the hard-won engineering breakthroughs that make our design commercially competitive. The United States benefits when private companies contribute credible, peer-reviewed science while protecting the innovations that will allow us, not our competitors, to build and commercialize first.

7. Dr. Mumgaard, in your testimony, you state that "the U.S. Government effort is fragmented, weighed down by underwater mortgages on antiquated facilities, underfunded, and ill-equipped to deliver the focused mission-driven programs needed to complement the private sector to effectively compete with the U.S.'s primary geostrategic rival in this important space."

Regarding this argument, Dr. Carter, you led the development of the fusion community's most recent Long Range Plan, which made recommendations for the future of our nation's fusion efforts under several budget scenarios. And in the constrained budget scenarios, which certainly cover what we're living through right now, unfortunately, the report recommends reducing support for the current major tokamak facilities in the U.S. – that's DIII-D, NSTX-U, or both – to ensure sufficient room in the budget for increased support in higher priority activities.

Dr. Mumgaard and Dr. Carter:

• What are your views on the productive lifetimes of DIII-D and NSTX-U if we remain at roughly the current annual federal budget level for fusion over the next several years?

• Would those views change if our budget for fusion were somehow able to grow by, say, 10% annually over the next 5 years? 20%?

7. Dr. Regan, do you have any comments?

As my company is focused on developing inertial fusion energy, I would defer to our peers in industry who are pursuing magnetic fusion energy to weigh in on the relative value of current major U.S. tokamak facilities compared to other funding priorities. What I can say is that such facilities do provide value to the U.S. fusion ecosystem, even to inertial fusion companies such as ours, both in training a robust scientific workforce and in expanding our scientific knowledge through advanced diagnostics and fusion-relevant materials. For example, our collaboration with General Atomics is made more effective thanks to the significant knowledge and capabilities they have generated through continued DIII-D operations. I do appreciate that hard choices must be made in constrained budget environments, and reiterate our recommendation that the key to maintaining U.S. fusion leadership in coming years is to support a milestone-based fusion demonstration program.

ITER International Fusion Project

Dr. Carter, given the many recent advancements in fusion science and technologies since ITER was first designed, do you believe that this project will continue to be of high value to the U.S. fusion research enterprise going forward? And if so, how?

8. Dr. Regan, do you have any comments?

The ITER project has delivered broad value to the U.S. fusion research enterprise, for instance through workforce development and development of cutting -edge diagnostics and fusion hardware by U.S. companies, National Laboratories, and universities. Given that private companies are now poised to be the first to achieve net energy gain, the way for ITER to continue making valuable contributions is by shifting more of its focus to developing critical enabling technologies (e.g. tritium handling) and sharing those technologies broadly with industry. I am encouraged that ITER has been taking steps in this direction and strengthening its relationship with the private fusion industry, such as at the recent ITER Private Sector Fusion Workshop in April 2025.

9. Dr. Regan, in your view, will ITER be relevant to fusion concepts that are not tokamaks?

ITER has potential to be relevant to fusion concepts that are not tokamaks, provided that they shift their focus more toward development of systems that are broadly -relevant to the fusion ecosystem, such as tritium handling systems.

Questions submitted by Representative Sheri Biggs, Committee on Science, Space, and Technology

Tritium is one of the largest radiological isotope sources in a fusion plant.

1. What facilities and resources do you plan to use to train the US workforce to work with tritium at scale and to leverage the leadership in the US through our National Security programs that are performed at the Savannah River National Lab?

Congresswoman, tritium management and availability is one of the defining challenges and opportunities for building a fusion workforce capable of operating at scale.

SRNL has critical capabilities to produce the gram-level quantities of tritium needed to operate research and demonstration fusion systems. Looking into the 2030s, fusion pilot plants will need larger quantities of tritium to start operations; here again, SRNL could provide a critical capability that the U.S. currently lacks, to help produce that tritium. However, given the lead time in standing up such a program, this issue needs more attention and we need to start now.

Tritium is not only a critical fuel isotope but also one of the largest radiological inventories in a commercial fusion power plant, and must be managed accordingly. The good news is that the U.S. has extensive expertise to meet this material management challenge through the Department of Energy's national security enterprise, centered at SRNL.

At SRNL, the U.S. has decades of experience handling, storing, and recycling tritium safely at industrial scale to support our nuclear deterrent and NNSA stockpile stewardship mission. That experience – which is critical for the fusion community – combined with the existing hot-cell facilities, isotope processing systems, and radiological safety protocols, forms the backbone of any future commercial tritium training program. What America needs to do now is connect that institutional leadership to the emerging U.S. fusion industry.

A formal partnership between DOE/NNSA and the private sector could create a national tritium training and qualification center at SRNL. That center could share the tritium expertise SRNL has developed and train operators, engineers, and safety officers using the same systems and best practices developed for the national security complex, while adapting for commercial fusion environments.

We would welcome the opportunity to explore such opportunities to work with SRNL, and would be excited to start conversations with the DOE Isotopes Office and SRNL on tritium supply and processing for research systems and the first pilot plants. Such collaborations can de-risk tritium operations and establish the U.S. as the global leader in tritium fuel cycle management, turning a potential challenge into a durable competitive advantage.

2. Where do you plan to demonstrate the balance of plant (fuel cycle and tritium breeding) fusion technologies before they are deployed in a fusion pilot plant to ensure they are safe?

We are developing plans to demonstrate the fuel cycle and related fusion technologies, and will work closely with the National Laboratories and industry partners to determine the best path forward. We would look forward to conversations with SRNL to explor e collaborations, and look forward to sharing our approach with you once finalized.

Responses by Dr. Troy Carter

Questions submitted by Chairman Brian Babin, Committee on Science, Space, and Technology

Dr. Carter, in your testimony, you note that the Chinese Communist Party and other nations are heavily investing in new fusion facilities, potentially outpacing the United States.

1. Where is the U.S. most at risk of falling behind, and what actions should be prioritized to ensure American leadership remains secure over the next decade?

The Fusion Energy Sciences Advisory Committee and National Academies have identified key priorities; the U.S. has the plan, we now need to execute on it. China is executing on our plan, building the key facilities it identified as being necessary to close remaining science and technology gaps to a fusion pilot plant. In my opinion, the U.S. should work with partners in the private sector and with governments of like-minded nations to build needed capabilities for the U.S. including a fusion prototypic neutron source and facilities at scale to develop tritium breeding and handling technologies for fusion. At the moment, the U.S. has an edge on expertise, experience and ideas, but China is not far behind. Without the needed facilities and associated R&D programs the U.S. risks falling behind rapidly.

Questions submitted by Representative Zoe Lofgren, Committee on Science, Space, and Technology

Competition with China

As has already been highlighted this morning, a detailed analysis from the Special Competitive Studies Project found that China has invested at least $6.5 billion in fusion development since 2023, about 3 times the total funds appropriated for DOE's Fusion Energy Sciences program over the same period. And the authors note that largely due to China's lack of transparency, this is really a conservative estimate – the amount could be as high as $10 - $13 billion.
Dr. Mumgaard, you are a member of the SCSP Commission that produced this analysis. You're also the CEO of the largest private fusion company in the world. And yet in your written testimony, you actually state that "the next decade of fusion breakthroughs and scientific discovery is going to happen in China, not in the US, with the investments I am seeing."
How confident are you in the findings of this analysis? Beyond total funding, how would you characterize China's scientific and technical capabilities in fusion energy development vs. the U.S.?

1. **Dr. Carter**: Any additional comments are welcome.

I agree with Dr. Mumgaard's assessment of the situation. The Chinese are building the experimental facilities the U.S. has identified as priorities and they are building them at speed. As I said earlier, the U.S. still has an edge on expertise, fusion experience and innovation. But China is mobilizing an army of talented fusion scientists and engineers and we won't have that edge for long if we don't act.

Test facility needs

Dr. Carter, your testimony highlights a report released last year from the Fusion Energy Sciences Advisory Committee identifying the top 4 research facilities that will be necessary to accelerate the commercialization of fusion energy.

2. Can you describe these facilities in more detail?

FESAC identified and prioritized the following four experimental facilitiues that are essential to de-risking the path to commercial fusion pilot plants:

Fusion Prototypic Neutron Source (FPNS): Developing and qualifying materials for the extreme environment of a fusion power plant is a critical task on the path to commercial fusion power. An FPNS will advance the science of materials under energetic fusion neutron bombardment and develop and qualify materials that can withstand the extreme neutron environment of a fusion reactor.

Blanket and fuel-cycle test facilities: Will demonstrate tritium breeding from fusion neutrons and tritium handling, with the goal of proving we can close the fusion fuel cycle—a critical hurdle for achieving economy and efficiency for commercialization.

ITER: U.S. participation ensures access to a flexible and well-diagnosed platform for studies and optimization of the burning plasma that will be at the heart of a fusion reactor. It also provides valuable experience in designing, fabricating and assembling a fusion device at industrial scale. Investment in ITER has also benefited the private sector through developing a fusion technology supply chain.

Materials Plasma Exposure eXperiment (MPEX): Now under construction at ORNL, this device will subject materials to intense heat and particle flows to enable the study of plasma–material interactions and the development of materials and components solutions for fusion exhaust systems.

a. Why aren't our current fusion research facilities, including the new materials experiment being built at Oak Ridge National Laboratory, sufficient to identify and test materials that can handle the heat and neutron impacts that are expected in the first wall of a commercial fusion reactor?

There are several important science and technology gaps in fusion materials that drive the need for the spectrum of new facilities that are called out in reports from FESAC and the National Academies. MPEX is an essential new facility that will advance our understanding of plasma–material interactions and enable the development of materials and components solutions for fusion exhaust systems. This facility will be capable of handling materials that have been subject to neutron

irradiation, but does not provide that irradiation capability. Irradiation in fission facilities, such as the High Flux Isotope Reactor (HFIR) at ORNL, can give us important information about material behavior under neutron bombardment and should continue, but it is essential to have an FPNS to provide the right energy spectrum of neutrons to study the unique material damage that is relevant to fusion systems. We also need to understand behavior of materials used for breeding of fusion fuel, in particular corrosion behavior and materials compatibility, including synergistic effects that occur with simultaneous fusion neutron irradiation. A blanket and fuel cycle facility will enable us to close those critical fusion material gaps in addition to advancing the science and technology of tritium breeding.

3. Are there ways that we can potentially reduce the costs and schedule to build these facilities through public-private partnerships?

My view is that partnerships, including with the private sector, philanthropic organizations, and state and local governments, should be explored as pathways to realize these facilities. These partnerships can only be effective if there is an appropriate value proposition for the other participants to justify co-investment. For example, while these facilities are critical to the success of fusion startups seeking to commercialize a fusion confinement concept, it is unlikely that any one startup in this space could make a substantial investment in a major test facility. However private-public consortia may be a route to attract participation from several players in the private sector, from startup companies to investment firms with stakes in many startups, toward realizing and exploiting these facilities with shared benefits (e.g. access to data and/or shared IP). Consortia could also leverage other investments from state and local governments with the aim of regional economic development, supply chain stimulation and workforce growth.

Lifetime of current fusion facilities and future needs

Dr. Mumgaard, in your testimony you state that “the U.S. Government effort is fragmented, weighed down by underwater mortgages on antiquated facilities, underfunded, and ill-equipped to deliver the focused mission-driven programs needed to complement the private sector to effectively compete with the U.S.’s primary geostrategic rival in this important space.” Relevant to this argument, **Dr. Carter,** you led development of the fusion community’s most recent Long Range Plan, which made recommendations for the future of our nation’s fusion efforts under several budget scenarios. And in the constrained budget scenarios, which certainly cover what we’re living through right now, unfortunately, the report recommends reducing support for the current major tokamak facilities in the U.S. – that’s DIII-D, NSTX-U, or both – to ensure sufficient room in the budget for increased support in higher priority activities.

Dr. Mumgaard and **Dr. Carter:**

4. What are your views on the productive lifetimes of DIII-D and NSTX-U if we remain at roughly the current annual federal budget level for fusion over the next several years?

I'll first reiterate my earlier point: investments in major user facilities—including the DIII-D tokamak and the NSTX-U facility—have been essential in enabling our progress in fusion. The private sector growth could not have happened without the scientific progress these facilities provided and continue to provide (alongside other important benefits such as workforce development).

As you have pointed out, the FESAC LRP addressed constrained budget scenarios, and made the hard choices to prioritize investments in fusion materials and technology including recommending reducing investments in tokamak user facilities in the most constrained scenarios. But importantly the LRP noted that this constrained scenario would significantly increase risk on our path to a fusion pilot plant and toward launching a U.S. fusion industry due to underinvestment across the board.

The LRP identified S&T gaps in the plasma physics of magnetic confinement fusion that should be closed and we either need to support facilities that allow us to close them (existing or new, public or through public-private partnerships) or accept the significant risk that comes along with not addressing these gaps. The U.S. must weigh all opportunities to close these gaps, and DIII-D and NSTX-U are assets that need to be considered in that decision making. NSTX-U will be a largely brand-new device and DIII-D, while aging, has been well maintained and remains an extremely productive facility – so it is hard to project lifetime based on status of the physical hardware. Both DIII-D and NSTX-U can help (and are currently helping) to address fusion materials and technology gaps and that also should be considered as the U.S. considers shifting investments to execute on our strategy.

Ultimately, I would recommend sticking to our U.S. fusion strategy and executing on our plan.

5. Would those views change if our budget for fusion were somehow able to grow by, say, 10% annually over the next 5 years? 20%?

I think my answer is the same: we can't consider these facilities in isolation in deciding how to execute the U.S. fusion program. Additional investments that are made must seek to address the highest priority science and technology gaps while carefully weighing risks that will arise in funding decisions.

ITER International Fusion Project

6. **Dr. Carter**, given the many recent advancements in fusion science and technologies since ITER was first designed, do you believe that this project will continue to be of high value to the U.S. fusion research enterprise going forward? And if so, how?

U.S. participation in ITER has already yielded tremendous value through providing experience in designing, fabricating and assembling a fusion device at industrial scale. Investment in ITER has also benefited the private sector through developing a fusion technology supply chain. Participation in ITER also ensures access to a flexible and well-diagnosed platform for studies and optimization of the burning plasma that will be at the heart of a fusion reactor, and this is essential to closing S&T gaps in our fusion strategy. The lowest risk path to an economical and competitive U.S. fusion power industry would have access to a facility like ITER even alongside facilities being developed in the private sector, including fusion pilot plants and first-of-a-kind power plants.

I understand that the lingering impacts of COVID-19 on the supply chain, as well as the discovery of corrosion in its thermal shield components several years ago, have led to significant changes and delays to ITER's construction schedule.

2. Dr. Carter, while I understand that a new baseline schedule is still being negotiated, do you have an estimate for the scale of these delays?

In 2024, the international project updated its timeline to research operations to reflect impacts due to first-of-a-kind manufacturing and pandemic delays. Civil construction is complete, and machine assembly has been underway since 2020. The ITER Organization has been working successfully to the updated schedule, with two sectors of the tokamak vacuum vessel already placed into the assembly pit and the next sector readied for insertion this fall. Multiple support systems are in commissioning, including the world's first power plant-scale cryoplant. All required magnet system components are on site in preparation for assembly. All ITER partners continue to fabricate and deliver hardware systems to support ITER assembly and operations. The US ITER project supporting ITER construction is over 50% complete.

Research operations will begin in 2034, with nuclear operations (deuterium-deuterium) starting in 2035 (the same as the prior schedule). Full power deuterium-tritium (DT) operations will begin in 2039, a delay of four years from the prior baseline schedule.

<u>Questions submitted by Representative Sheri Biggs, Committee on Science, Space, and Technology</u>

Tritium is one of the largest radiological isotope sources in a fusion plant.

1. What facilities and resources do you plan to use to train the US workforce to work with tritium at scale and to leverage the leadership in the US through our National Security programs that are performed at the Savannah River National Lab?

Advancing the science and technology of tritium breeding and handling is a priority in our U.S. Fusion strategy. Our planning processes and recent reports call out the need for new facilities including a fuel cycle test facility (or facilities) for advancing the science and technology of tritium processing and handling. These facilities and associated R&D programs are also essential to develop the needed skilled workforce. Savannah River National Lab is home to U.S. expertise in tritium and is well positioned to play a central role in tritium R&D and facilities for fusion energy.

2. Where do you plan to demonstrate balance of plant (fuel cycle and tritium breeding) fusion technologies before they are deployed in a fusion pilot plant to ensure they are safe?

As I mentioned, a facility for tritium breeding and handling is a high priority for the U.S. fusion program and this would play an important role in demonstrating needed technologies. Siting of such a facility (or set of facilities) is not yet determined but will be best realized as a partnership between national labs, academia and industry.

Responses by Dr. Bob Mumgaard

Questions submitted by Chairman Brian Babin, Committee on Science, Space, and Technology

1. Both DOE and private investors have made major strides in fusion, with nearly $9 billion invested and companies planning commercial plants. As commercialization advances, how can DOE ensure the resources needed to fully deploy this technology?
    a. Dr. Mumgaard, what does private industry need from DOE and the National Labs as companies increasingly focus on commercializing their technologies rather than solely on basic research and development?

A: First, we need a singular vision, an organizing National Goal to deploy the first block of commercial fusion pilot plants in the US. We think that National Goal should be to break ground on 2-3 commercial pilot plants by the late 2020s, which is also our goal for the ARC fusion power plant. Once we have this organizing deployment vision across government, the private sector, universities and National Labs, we must work together to prioritize appropriate funding for commercially relevant fusion research programs. While the U.S. has invested funds into fusion science, a large portion of this funding is not spent in critical commercialization areas. To truly compete with other nations, like the U.K., Germany, and China, and achieve this National Goal, CFS, along with the Fusion Industry Association and the Special Competitive Studies Project's Commission on the Scaling of Fusion Energy call on DOE to make a one time $10 billion investment in commercially relevant fusion research and demonstration efforts. First, $2 billion of this investment should go toward appropriately funding the existing Milestone-Based Fusion Development program ("Milestone") to complete the engineering designs for the first fusion power plants, this would flow to many different parties to get the designs ready. $3 billion should go toward a second, demonstration phase of the Milestone program. This Demonstration phase of the Milestone program would be dedicated to actually building the first pilot fusion power plants Both of these programs would attract additional private capital. We also recommend that DOE allocate $4.6 billion toward commercially relevant research and development activities at National Laboratories and universities, leveraging PPPs where possible. This funding can help close crucial gaps in the science and technology that underpins all the fusion concepts and will build the necessary test stand. This refreshes and updates existing DOE programs, like the Fusion Innovation Research Engine collaboratives program. The transition to fusion energy will happen, however, the leader is yet to be determined. If the U.S. wants to be at the forefront and lead this transition, the Government must help the industry build and scale. This $10 billion investment can position the U.S. to win the race.

2. It's not often that we receive an entirely new source of energy. If the fusion industry successfully makes these breakthroughs, I want to ensure that America benefits first and foremost. We should be making these machines here, with components built in America.
    a. Dr. Mumgaard, is your company currently building supply chains for these machines in the U.S.? How difficult was it to begin to onshore this supply?

A: Yes, CFS is a vertically integrated company and we build our magnets and plasma heating systems right here in the U.S. We leverage well over 1,000 vendors and suppliers here in the U.S. and around the world. Some of the components that we will need for fusion machines are bespoke and there are only a few places in the world to make them. Other components, such as fasteners, are already mass produced by hundreds of suppliers around the world at competitive pricing. Onshoring such mass produced components would not make as much economic sense. If the Government wants to ensure the American economy benefits first and foremost from a bolstered fusion industry and wants to ensure key components are built in the U.S., the single most important thing the Government can do is ensure we have policies in place that first attract the fusion industry. If fusion deploys and scales in America first, the supply chain will follow for the things the US can be best at making.

b. Dr. Mumgaard, what can Congress do to help ensure this industry supports American manufacturing jobs?

A: Supply chains and manufacturing jobs will vary by company, by the specific fusion technical approach and will also be based on each company's timelines. In building SPARC, we have created approximately 400 direct manufacturing jobs in the U.S. These jobs consist of production, quality, and supply chain operation roles. As we think about deploying our ARC power plant in the early 2030s and scaling after that, the number of U.S. manufacturing opportunities will also scale. However, how rapidly manufacturing jobs will scale is largely dependent on U.S. government support for fusion deployment through the Milestone program. U.S. government support in creating a fusion ecosystem and incentivizing domestic production will play a large role in scaling U.S. manufacturing jobs. Specifically, this means: Department of Energy supporting research and development in radiation hardened robotics, fusion fuel cycles, materials, etc. through public private partnerships like the Fusion Innovation Research Engine program; leveraging Department of Energy grants and Loan Program Office loans/loan guarantees for key elements of the supply chain, like high temperature superconducting tape, metal forgings, FLiBe production, etc; leveraging Defense Production Act for certain critical minerals, like beryllium and beryllium fluoride, which is needed for FLiBe; and expanding the 45X tax credit to include the fusion supply chain, by supporting the recently introduced "Fusion Advanced Manufacturing Parity Act." It must be emphasized, without U.S. government support, China will dominate this supply chain like they have in other areas, including solar, batteries, chips, etc.

Questions submitted by Representative Zoe Lofgren, Committee on Science, Space, and Technology

Competition With China

As has already been highlighted this morning, a detailed analysis from the Special Competitive Studies Project found that China has invested at least $6.5 billion in fusion development since 2023, about 3 times the total funds appropriated for DOE's Fusion Energy Sciences program over the same period. And the authors note that largely due to China's lack of transparency, this is really a conservative estimate – the amount could be as high as $10 - $13 billion.

Dr. Mumgaard, you are a member of the SCSP Commission that produced this analysis. You're also the CEO of the largest private fusion company in the world. And yet in your written testimony, you actually state that "the next decade of fusion breakthroughs and scientific discovery is going to happen in China, not in the US, with the investments I am seeing."

1. How confident are you in the findings of this analysis?

A: Based on everything I have seen and read thus far, I feel confident in SCSP's assessment. If anything, it is a conservative assessment based on open-sourced information. The authors of this SCPS report note that largely due to China's lack of transparency, the amount could be as high as $10 - $13 billion. Two state-backed fusion companies have raised $2 billion each. China is building out the necessary facilities and research infrastructure in a coordinated way, pursuing an intentional deployment strategy. The picture is consistent. You can see this progress in construction from space, they show pictures of what is in some of these buildings in open conferences, and we hear reports from colleagues who have been on the ground. China will soon have access to critical, cutting edge research facilities the U.S. has been talking about for years, but has not acted on. China will leverage these facilities to pull in the top research talent in the world to conduct research on these unique world-leading activities. China is building for the future, while the US fusion program continues to largely prioritize plasma physics and facilities that are not critical to commercializing fusion power, such as ITER, DIII-D, or NSTX-U, while underinvesting in priority facilities and research in materials and fuel cycles that have been called out as top priority by consensus scientific community reports or PPPs like the Milestone program that leverages the private capital and entrepreneurial advantages inherent in the U.S system.

2. Beyond total funding, how would you characterize China's scientific and technical capabilities in fusion energy development vs. the U.S.?

A: When it comes to scientific and technical capabilities, I believe the U.S. holds an edge, at least for now. For example, China has still not been able to maximize facilities they have already built, like their copy of DIII-D, and they are weaker in simulation tools. That being said, things are changing quickly. China is starting to draw talent from around the world, and access to their next-generation facilities has accelerated them. This next set of facilities will be able to close many gaps. They also are likely to benefit from their domestic AI strategy to close the simulation gaps. China is also bringing in partners from the E.U. to help them improve their domestic capabilities, and reaching out to aid setting up fusion research programs in the countries in their sphere. These trends are consistent with their stated ambitions to lead in fusion.

Private Investment

3. Dr. Mumgaard, given the level of private investment that your companies and many others have been provided to date, why do you even need funds from the U.S. government to meet your goals?

A: CFS, like the other fusion companies, has been almost entirely funded by private capital. At this stage of fusion development, the fusion industry is at the edge of private capital availability for research and development and first of a kind deployments. We are increasingly engaging foreign capital markets and governments for support, and it is clear that it will be slow to accumulate the capital needed to build a first of a kind fusion power plant. In addition, we receive questions from investors about why the U.S. government is not providing the same level of support as has been provided to other geo-strategic important early industries such as nuclear fission. A firm commitment from the U.S. government that commercial fusion is a priority could be catalytic to unlocking the next level of capital needed to propel the industry to deploy the first fusion power plants. Significant and appropriate investments in the DOE Milestone program will validate progress across participating companies, helping create transparency on the technology. This could unlock two to three times the amount of private capital currently invested in commercial fusion. The U.S. government has made strategic investments to help demonstrate other well capitalized game changing technologies, like advanced fission through the Advance Reactor Demonstration Program. The U.S. government has also made strategic investments to ensure U.S. leadership in well funded technology like semiconductors, AI, and quantum computing. Fusion should be added to this list, considering it too brings immense potential and opportunity for U.S. leadership.

a. Why can't we expect the privately funded U.S. fusion industry alone to fund and build the facilities that will be required to test materials and fuel cycle technologies that will be necessary for commercial fusion systems?

A: CFS and the other fusion companies are focused on making fusion power plants, not test stands. The test stands are needed and help all fusion concepts. They are the equivalent of the light sources, test reactors, and wind tunnels that other fields of science and technology use to advance the common good. It has always been understood that these test stands are the role of government, via support to National Labs and universities. If companies build these test stands on their own, it will be harder for the entire industry to be able to benefit, the results will unlikely be shared to the academic community or among the companies. Having them funded by the government will ensure they serve the entire industry in a pre-competitive manner. CFS and other fusion companies will pay to use these facilities once built, but the industry should not build them on their own.

i. Are you able to achieve your near-term goals to demonstrate net fusion energy production without these test facilities? And if so, then why would these facilities still be necessary?

A: CFS has and continues to innovate without industry-wide test stands. For instance, when it came to building and testing the magnets for our research machine, SPARC, we built our own test stands. However, building our power plant, ARC, would greatly benefit from new test stands, particularly in the areas of materials and fuel cycles. ARC has specific subsystems that are not present in SPARC, and these subsystems will require rigorous testing and innovation. Without these test stands, we could still build an ARC, however, it would be suboptimal with worse economics, more waste, and lower performance. Government support of industry wide test stands will help the fusion industry innovate, deploy and most importantly, scale fusion power more quickly. This data will feed back into the innovation ecosystem to create future generations of materials and technologies the same way that innovation happens in other areas of public-private cooperation to develop game changing technologies.

Subcommittee on Energy Igniting America's Energy Future: The Promise and Progress of Fusion Power

Test Facility Needs

4. Dr. Mumgaard, is there anything you'd like to add?

A: We still have some important, commercially-relevant science and technology to prioritize that will support fusion's deployment and scaling. The National Labs and universities are very well positioned to do some of this work, as well as leveraging public-private partnerships, but they need to be prioritized and sufficiently funded.

Importance of Peer Review

Dr. Mumgaard, your company has produced recent, peer-reviewed articles in respected scientific journals on your efforts to advance your respective fusion energy concepts. Frankly, that is not the case with all of your competitors in this field.

5. Given the extent of the private investments that you have received to date, why do you believe it is still important to submit your work to this kind of external review?

A: The private capital doesn't validate the science, in fact, it follows the science validated by the gold standard, peer-review. In 2024, I published an open letter explaining the importance of publishing research, plans and results in the fusion industry. It is no secret that while fusion has strong advocates, it also faces healthy skepticism. As the industry matures and we move closer toward commercialization, we believe it is crucial to deepen our credibility through validated publications. To date, CFS has published more than a hundred peer-reviewed papers and this transparency has been a key to our building of stakeholder support in the form of capital, but also advocates, employees, and partners. These publications provide us with the opportunity to hold one another accountable, reduce public uncertainty and confusion, identify areas of opportunity, and celebrate each other's successes. Therefore, CFS will continue to publish evidence of our technology and ensure it is available to peers, researchers, and the media.

> 6. Is there a balance that you've needed to strike between validating the credibility of your approaches through these publications and ensuring your company's international competitiveness, particularly with China, by maintaining some level of secrecy on your developments?

A: One can publish peer reviewed research and approaches and still ensure international competitiveness, even with China. For instance, we protect our high temperature superconducting magnet technology, one of our IP crown jewels, but we are also able to publish multiple peer reviewed papers on our magnet technology showing results without showing how to manufacture it. This balance is routinely struck in other fields, medical science is a great example. Breakthroughs would come much slower if everyone worked in silent silos, and drug companies have robust strategies to protect their competitive advantages. In short, protecting our intellectual property does not prevent us from publishing peer reviewed papers.

Lifetime of current fusion facilities and future needs

Dr. Mumgaard, in your testimony you state that "the U.S. Government effort is fragmented, weighed down by underwater mortgages on antiquated facilities, underfunded, and ill-equipped to deliver the focused mission-driven programs needed to complement the private sector to effectively compete with the U.S.'s primary geostrategic rival in this important space." Relevant to this argument, Dr. Carter, you led development of the fusion community's most recent Long Range Plan, which made recommendations for the future of our nation's fusion efforts under several budget scenarios. And in the constrained budget scenarios, which certainly cover what we're living through right now, unfortunately, the report recommends reducing support for the current major tokamak facilities in the U.S. – that's DIII-D, NSTX-U, or both – to ensure sufficient room in the budget for increased support in higher priority activities.

> 7. What are your views on the productive lifetimes of DIII-D and NSTX-U if we remain at roughly the current annual federal budget level for fusion over the next several years?

A: Neither DIII-D or NSTX-U are significantly additive for CFS' commercial deployment plans. Rather, it has been our assessment that closing the remaining gaps in the plasma physics for commercial fusion require a new facility that could reach conditions closer to a fusion power plant. This led directly to CFS investing more than $1 billion to construct SPARC and dictate its operation and mission space. If the commercial industry could have closed the gaps with existing facilities, like DIII-D or NSTX-U, then we would have preferred to do so.

The simple fact is that DIII-D is one of the oldest tokamaks still operating, and its ability to reach new operating conditions is only at the margins. It has been very successful at producing the current scientific basis but it is no longer at the cutting edge of performance, a victim of its success – and like all successful scientific facilities, learnings are implemented into the next generation machines. NSTX-U is not operating and has not made any significant operations in over 10 years since breaking despite approaching a $1 billion of continued funding. Since the repair and upgrade was approved years ago similar devices have been built internationally and utilizing them is a faster and lower cost path to accomplish the stated goals.

Importantly, this position is separate from the value of the people who participate in these programs. It is abundantly clear that the teams working on these facilities are highly valuable and capable. The value is not in the machines themselves, it's in the minds and relationships of the people, and we should strive to put them to use where they can do the most good. Through several fusion community planning efforts and DOE's recently completed roadmap, it is clear we need to be transitioning the US fusion program to commercially-relevant science and technology drivers, like materials and fuel cycles.

8. Would those views change if our budget for fusion were somehow able to grow by, say, 10% annually over the next 5 years? 20%?

A: Perhaps five years ago, when the Fusion Energy Sciences Advisory Committee Long Range Plan came out these budget changes would have made a difference. However, in today's reality, the U.S. is very behind other competitors, most notably, China. Now, we are at risk of losing this race. Therefore, I am not sure a 10% increase would change my views on the continued utility of existing facilities. We need to prioritize new facilities and programs. We need to be leveraging a new class of tools, including leveraging cutting edge privately built facilities, like SPARC, that will allow us to catch up.

ITER

Dr. Carter, given the many recent advancements in fusion science and technologies since ITER was first designed, do you believe that this project will continue to be of high value to the U.S. fusion research enterprise going forward? And if so how?

9. Dr. Mumgaard, would you like to comment?

A: ITER has been especially helpful in building precedent in the global supply chain for fusion. We have learned an enormous amount from designing it and preparing for its operation and building it. ITER is still many years from operating and when it operates, its results will flow to the entire world and is not a source of competitive advantage for the U.S. The facts are clear, SPARC will overtake ITER in level of completion and utilizes the same science basis. It is very likely to reach first plasma, DT operation, and scientific exploitation many years before ITER. and it presents a faster path to leadership. Importantly, whether ITER is deemed valuable on its own merits, we simply cannot let ITER pace the rest of the required fusion advances; building that faster track option by supporting the long-identified priorities of the power plant relevant technologies is very high value and deserving of significantly more funding than allocated. The U.S. government should begin thinking about what to do with ITER given these priorities, and trajectories.

Questions submitted by Representative Sheri Biggs, Committee on Science, Space, and Technology

Tritium

Tritium is one of the largest radiological isotope sources in a fusion plant.

1. What facilities and resources do you plan to use to train the US workforce to work with tritium at scale and to leverage the leadership in the US through our National Security programs that are performed at the Savannah River National Lab?

A: Currently, we plan to use our own facilities like SPARC as well as existing U.K. facilities, as they are the closest and most advanced. The U.K. has facilities for tritium and blanket breeding that are very significant, multi-hundred-million-dollar facilities. While CFS could access these facilities as we have bilateral private-public relationships with the U.K., the entire fusion industry could benefit from the facilities if the U.S. government had an agreement and designated funds toward researchers working there. The U.K. currently implements a similar model, funding people to research and work in the U.S. Moreover, it is important to note that the quantities of tritium needed for commercial fusion machines are much lower than those traditionally considered for ITER or DEMO like projects.

2. Where do you plan to demonstrate balance of plant (fuel cycle and tritium breeding) fusion technologies before they are deployed in a fusion pilot plant to ensure they are safe?

A: Currently, we expect to work on these issues by continuing to pursue ongoing research and development projects both at MIT and UKAEA as well as by constructing necessary facilities and experiments on our own campus. These are facilities that are identified as areas of public-private partnership but the requisite public funding mechanisms are not yet built or funded.