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]

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[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]

[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]

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[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