Fusion Energy Could Supercharge the Economy

Energy powers the economy. Harnessing fusion—the same process the sun uses to create energy—could transform the U.S. economy by providing a reliable, low-risk, low-waste power source that is flexible enough to meet essentially all our electricity needs. This form of dispatchable, baseload power generation would address many of the limitations of existing clean energy sources while avoiding the harmful pollution and emissions from fossil fuel power plants.

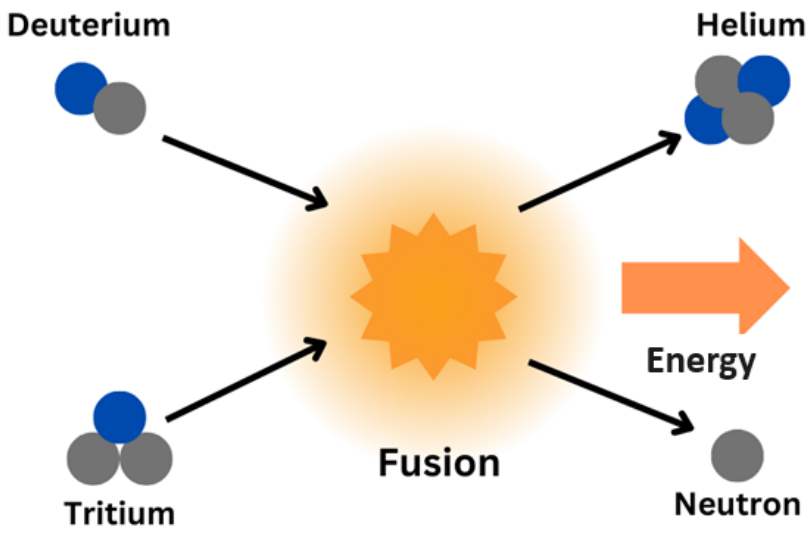
While still far from deployment, the technology advancement needed to make fusion energy a reality is no longer only a scientist's dream. Lawrence Livermore National Laboratory (LLNL) produced an important breakthrough in December 2022 that lays the groundwork for the next stages of fusion research and development. The urgency for clean energy sources is dire. To accelerate the jump from lab to commercial use, public-private sector collaboration is essential to address our significant energy, climate, and security needs and bring about fusion commercialization. Congressional fusion energy caucuses in both the House and Senate are building on recent legislation and regulatory clarity to drive support for this revolutionary technology.

Fusion is a long-term sustainable energy source with low risk and little waste

Fusion is the same process that stars use to generate energy

All stars, including the sun, release huge amounts of energy by combining two light atomic nuclei to form a single heavier one. Fusion energy systems here on Earth would not depend on external variables like whether the sun is shining or whether wind is blowing to maintain their energy production. Therefore, commercial-scale fusion could serve as important baseload power on a decarbonized energy grid. Producing fusion energy also creates no carbon pollution or long-lived nuclear waste from spent fuel.

The most promising fusion fuels (deuterium and tritium) are isotopes of hydrogen—the most abundant element in the universe. Deuterium is naturally abundant from seawater. While tritium is less common, it can be produced using the more common element lithium and could potentially be generated as part of self-sufficient fusion power plants. Fuel needs are minimal—for example, a bathtub of water and two laptop batteries are enough fuel to provide power for a person's entire lifetime. The graphic below shows how one of these reactions produces energy without the same harmful pollution from burning fossil fuels.



Fusion is far cleaner than fossil fuels and can provide potentially unlimited baseload energy across the economy

Commercial-scale fusion could supercharge the U.S. and global economies with unlimited, consistent power that won't harm our environment. As energy demand grows with the electrification of consumer goods, data centers, and manufacturing needs, fusion could fill an important need with a relatively small footprint in terms of land area.

Government funding and expertise has achieved fusion energy gain—but not yet at scale

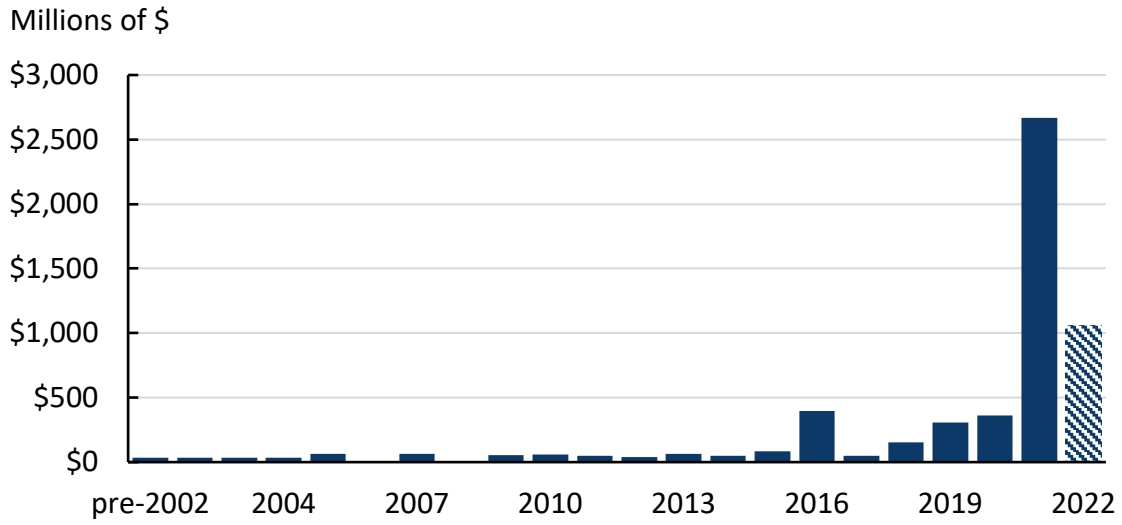
Building on a long history of government research and funding, Lawrence Livermore National Laboratory achieved energy gain in December 2022

Decades of funding for fusion energy research and development (R&D) from the federal government since the 1950s and 1960s led to LLNL achieving more fusion energy produced by a fusion fuel target than the energy it consumed in December 2022 and three subsequent times. While the experiments produced only a small amount of energy, this was a milestone scientific achievement and validation of the pursuit of these technologies as a potentially transformational energy source. This form of fusion is not yet efficient enough to economically generate electricity, but the result has generated significant excitement about the possibilities of fusion.

Strong bipartisan congressional support for fusion has brought about dozens of critical scientific discoveries, and continued support is integral for commercial fusion. For example, Congress appropriated $790 million for fusion science programs in FY2024—a significant amount but below the more than $1 billion authorized for this year in the landmark, bipartisan CHIPS and Science Act of 2022.

The Department of Energy (DOE) leads the distribution of government funding for fusion in the United States. DOE funds and helps to validate a variety of different possible fusion energy technologies since innovators are pursuing different options. In June 2024, DOE released the Fusion Energy Strategy 2024, which builds on the Biden-Harris administration's launch of the U.S. Bold Decadal Vision for Commercial Fusion Energy. In support of this, DOE also announced a $180 million funding opportunity for Fusion Innovative Research Engine (FIRE) Collaboratives. These Collaboratives aim to bridge foundational and applied science and support the growing fusion industry through public-private partnerships. This also builds on the more than $7.1 billion in total private sector fusion investment through early 2024.

Private Sector Investment in Nuclear Fusion Has Steadily Increased in Recent Years



Source: BloombergNEF, U.S. Global Investors
Note: Data for 2022 is partial.

Complementary public and private efforts aim to accelerate the transition from fusion research to commercialization

Public-private partnerships help maintain U.S. leadership and competitiveness in fusion

Commercial scale fusion requires building on the advances achieved at LLNL and elsewhere and on boosting public and private investment. Focusing on common pitfalls

in the path from lab to market will be essential to avoid the technology falling into what is known as the "valley of death." These challenges include: the need for large financial investments and specialized facilities to address outstanding fusion materials issues, issues navigating existing and possible future regulations, and the issue of how to standardize future fusion technologies. Fusion energy may also have trouble entering markets (in this case the power grid) that are currently structured around incumbent technologies (including wind, solar, and fossil fuels).

Cooperation across borders is also essential to foster innovation in fusion science, facilitate fusion's global market entry, coordinate regulatory frameworks, strengthen a global workforce pipeline, and improve public engagement. ITER in southern France is the hallmark fusion international collaboration with 35 countries participating in this experimental campaign. Investors across the world are also interested in creating and deploying commercial fusion, underscoring the financial promise of fusion energy. This can help motivate public-private partnerships that will bolster the public sector's fusion energy R&D resources. Additionally, the fate of fusion relies on public perception, so engaging the general public and local communities can accelerate commercialization and acceptance.

A regulatory framework for fusion is under development to provide clarity and accelerate deployment

Congress passed the Nuclear Energy Innovation and Modernization Act in January 2018 to require the Nuclear Regulatory Commission (NRC) to develop a clear and predictable regulatory framework for fusion. In April 2023, NRC announced that fusion would be regulated under the NRC's existing rules for the use of byproduct materials, separating it from the regulations on nuclear fission. This provides certainty for fusion developers to innovate and grow fusion energy while protecting public safety, security, and health. NRC staff are currently developing a regulatory framework for fusion. The proposed rule is expected to be sent for review by the Commissioners as soon as September 2024.

The bipartisan Fusion Energy Act codifies the NRC's decision to establish a regulatory framework for fusion energy under its byproduct materials framework, separate from nuclear fission, and passed the House in February 2024. In June 2024, the Senate passed the Fusion Energy Act as part of a broader nuclear energy and fire grants and safety package in a bipartisan 88-2 vote.

Congressional Fusion Caucuses in the House and Senate are guiding the way in Congress

Congressional Fusion Caucuses have been attracting lawmakers from both parties to ensure that fusion plays a critical role in the energy transition

Joint Economic Committee (JEC) Chairman Martin Heinrich (D-NM) was a founding member of the bipartisan Senate Caucus with Senators Angus King (I-ME), Tammy Baldwin (D-WI), Todd Young (R-IN), Brian Schatz (D-HI), and Kirsten Gillibrand (D-NY), while JEC Member Don Beyer (D-VA) founded the House Caucus. The bipartisan House Caucus now has over 110 members.

Given the importance of fusion for the U.S. economy and other climate, energy, and security goals, the Congressional Fusion Caucuses are launching a series of white papers to discuss pathways to commercialization and remaining needs, following onto this explainer. Possible topics to be covered include technology needs, artificial intelligence and fusion energy, and workforce development needs.