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INVESTMENT MANAGEMENT

Counterpoint Global Insights

Fusion

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Counterpoint Global's long-term ownership mindset emphasizes perspective and cross-disciplinary thinking, while our investment process focuses on identifying unique companies with sustainable competitive advantages. Through the EDGE, we share our framework for thinking about change and our process for recognizing patterns that may drastically alter the investment landscape over the long term.

This work complements our team's more traditional, fundamental research to create a framework for long-term investing that is grounded in intellectual curiosity and flexibility, perspective, self-awareness and partnership.

Many scientists and energy specialists regard nuclear fusion—the process that powers the sun—as a pivotal advancement in energy technology. Achieving economically viable fusion power would represent a significant milestone, offering virtually unlimited, clean, and safe energy. Nuclear fusion has the potential to serve as a sustainable alternative to fossil fuels, offering significantly higher energy density. Additionally, it presents several advantages over renewable energy sources: it can provide reliable electricity on demand, requires less land for infrastructure development, and allows for more flexibility in site selection. Commercializing nuclear fusion would revolutionize the energy sector, with a potential total addressable market of $40 trillion by 2050, according to analysis by Bloomberg Intelligence.[1] While nuclear fusion on earth has long been considered the stuff of science fiction, recent technological developments indicate that commercialization may be achievable within the next decade.

[1] Nuclear fusion market could achieve a $40 trillion valuation | Insights | Bloomberg Professional Services

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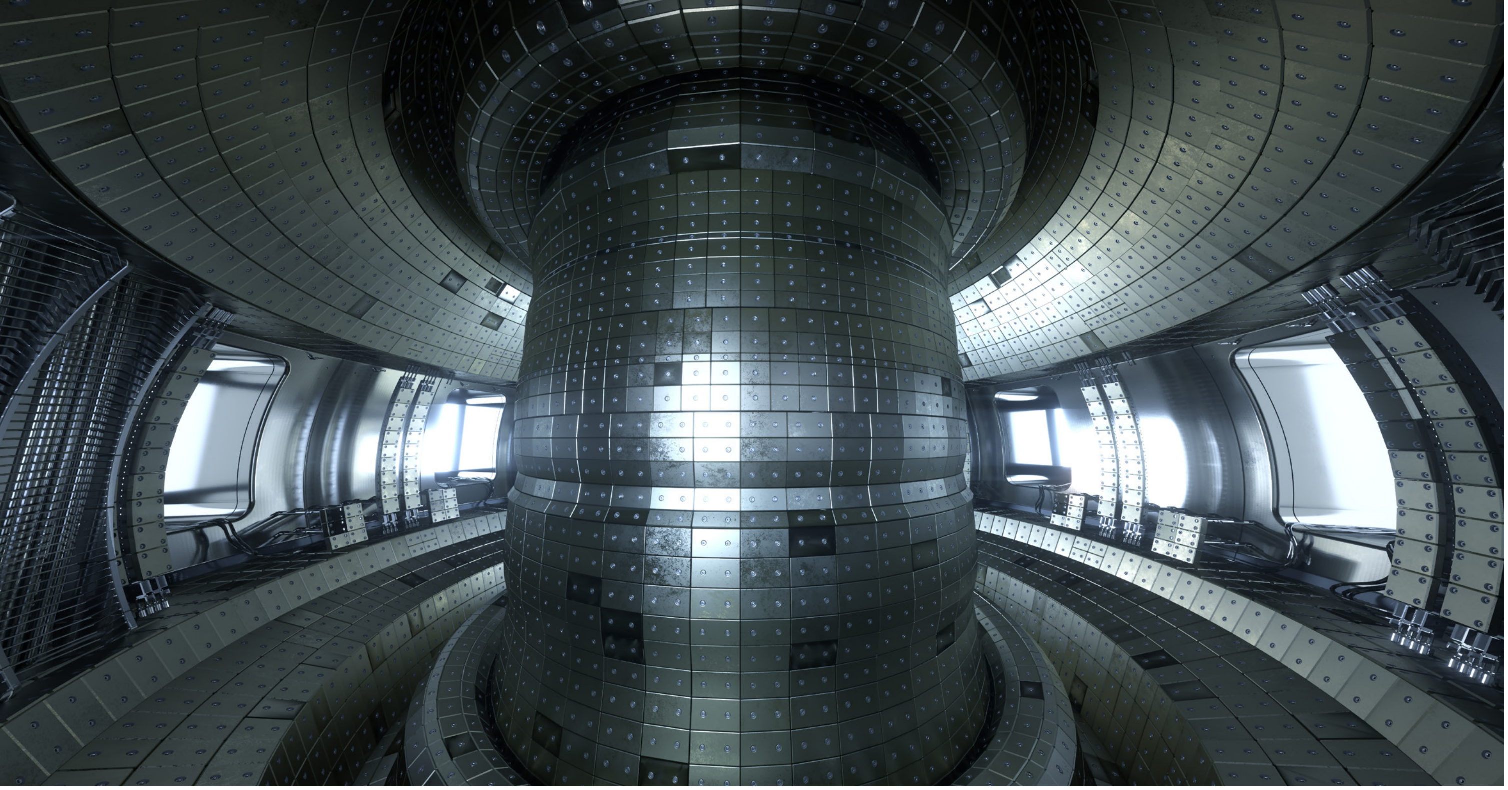

How it works

Fusion takes place when two lighter atomic nuclei combine under substantial heat and pressure, resulting in the formation of a helium nucleus and a neutron, while a small portion of mass is transformed into energy. The sun's significant gravitational force generates exceptionally high pressure and temperatures—reaching approximately 15 million degrees Celsius at its core—that naturally trigger fusion reactions. Replicating the pressure and temperature required to ignite fusion in a controlled way on Earth is extremely challenging.

Researchers have the option to utilize various elements as fuel; however, there is a particular emphasis on the use of two hydrogen isotopes, deuterium (D) and tritium (T). This focus stems from their ability to generate substantial amounts of energy and achieve fusion at comparatively lower temperatures than alternative elements. When a fully ionized gas-plasma is formed at approximately 100 million degrees Celsius, it can be ignited to initiate a fusion reaction. A plasma sustaining millions of these reactions per second can provide a huge amount of energy from minimal quantities of fuel.

Scientists have tried to replicate the fusion reactions that occur naturally in the sun since the 1930s. To do this in a reactor, the plasma must meet the Lawson Criterion, which is the minimum threshold for the triple product—a measure of temperature, density, and confinement time—to achieve sustained fusion reactions. The Lawson threshold varies widely depending on the specific reactor design, fuel type, and confinement dynamics.

There are several approaches to building nuclear fusion reactors, each with distinct tradeoffs in physics, engineering, complexity, scaling, and maturity. Magnetic confinement fusion (MCF) is based on low density, long confinement time, with relatively moderate temperature. Inertial confinement fusion (ICF) employs very high density, a very short confinement time at similar temperatures.

Reactor designs vary but almost all will need to breed tritium during the fusion reaction in order to provide a continued source of fuel. Because tritium's half-life is short, about 12.3 years, it does not occur in large quantities naturally. That means fusion reactors using D-T fusion must produce tritium on site, typically by breeding it from lithium using a breeding blanket, a structure placed around the reactor's core. Neutrons released by the fusion reaction interact with lithium in the blanket to breed tritium. This closes the fuel cycle and allows reactors to produce their own tritium.

Why now

In recent years, fusion has shifted from scientific experimentation to an increasingly likely energy solution with a rapidly-growing private sector.

Commercialization is nearing possibility as the result of a handful of advancements. These include:

- A major catalyst was the first demonstration ever of net energy gain (or Q-value) of 1.5 on December 5, 2022 at Lawrence Livermore National Labs' National Ignition Facility (NIF). The Q value is a measure of how much energy is produced by a fusion reaction. For example, Q = 1, also known as scientific breakeven, signifies that the energy being released by the fusion reaction is equal to the energy input. Immense progress has been made over the past 60 years, with fusion research increasing the triple product by a factor of 10,000, and currently within a factor of 10 from the performance needed for a fusion power plant.[2] With the science derisked, the focus is now on the execution of a viable nuclear fusion power plant capable of generating electricity for commercial use.

- Advances in enabling technologies, such as artificial intelligence (AI) and high-performance computing are helping control plasma, optimize reactor design, and accelerate simulations. Component-level advances including the development of high temperature superconducting (HTS) tape have also fundamentally accelerated the timeline for commercialization. HTS allows for a magnetic field twice as powerful as previously possible, allowing smaller and more economical reactors to achieve fusion reactions. Leveraging this technology, Commonwealth Fusion Systems, a fusion power company, is currently developing its demonstration machine, SPARC, which is expected to produce its first plasma in 2026 and demonstrate a Q > 1 in 2027.
- The ensuing AI race combined with the increased importance of energy security and independence has created unprecedented demand for large-scale electricity production. After two decades of stagnation, global electricity demand is now rising quickly, with consumption projected to grow 1.5 to 3 times by 2050 (an annual rate of 2-4%), up from less than 2% historically. This surge has sparked greater interest in nuclear fusion as a sustainable and long-term answer for powering AI infrastructure.
- Public policy is supporting nuclear fusion in several ways: 1) Christopher Wright, the current U.S. Secretary of Energy, expressed strong support for the technology in his first Secretarial Order; 2) Congress increased support for fusion, leading to a record total of $1.48 billion in funding from the U.S. government for fusion activities in 2025;[3] and 3) The Milestone-Based Fusion Development Program which provides financial support to private companies upon achieving specific, pre-agreed technical and engineering milestones.[4]
- Nuclear fusion will be regulated under Part 30, the same as for particle accelerators, which are substantially less stringent than those by which nuclear fission is governed. This is primarily because fusion does not rely on a self-sustaining chain reaction and produces minimal radioactive waste. Japan, Canada, and Germany have also taken measures toward regulating fusion separately from fission, following the lead of the U.S. and U.K.
- The last five years have seen significant investment across various reactor designs, including tokamaks, stellarators, laser ignition, z-pinch, among others. In total there are 53 companies working on nuclear fusion. Global funding for the fusion sector currently exceeds $9.76 billion.[5]
- In recent years, two private fusion companies have signed power purchase agreements with Google[6] and Microsoft[7] to buy a total of 250 megawatts of electricity. In addition, several utilities have partnered with fusion companies and are in the process of siting and permitting to build commercial-scale fusion reactors.[8] Historically, utilities have been slow in adopting new technologies, so these partnerships are a major vote of confidence that fusion can be a viable power source for the grid.

In the next few years, there are several important milestones to watch for: 1) the finalized regulatory framework anticipated in October 2026;[9] 2) Commonwealth Fusion System's ARC demonstration in 2027; and 3) the completion of Helion Energy's pilot plant in 2028.[10]

Why it's disruptive

Harnessing fusion power would rank among the most important technologies in history, alongside the steam engine. Nuclear fusion could revolutionize how we generate energy due to several significant advantages.

First is the abundance and low cost of fuel necessary to power fusion reactions. Deuterium is abundant in sea water and tritium can be bred from lithium within the fusion reactor during the fusion process. According to the International Atomic Energy Agency, the amount of deuterium present in one liter of water, combined with a small amount of lithium, can theoretically produce as much energy as the combustion of 300 liters of oil. This means that there is enough deuterium in the oceans to meet human energy needs for millions of years.

Second, only small amounts of fuel are needed to release the immense energy of a nuclear fusion reaction, making it the densest form of energy by orders of

[2] ITER: 60 years of progress

[3] Congress Increases U.S. Funding for Fusion Energy Sciences Research - Fusion Industry Association

[4] U.S. Department of Energy Announces Selectees for $107 Million Fusion Innovation Research Engine Collaboratives, and Progress in Milestone Program Inspired by NASA | Department of Energy

[5] Access to funding remains a major issue for fusion, says industry report - World Nuclear News

[6] Google and Commonwealth Fusion Systems Sign Strategic Partnership | Commonwealth Fusion Systems

[7] Announcing Helion's fusion power purchase agreement with Microsoft | Helion

[8] Fusion energy: Opportunities for federal action to support energy innovation and commercialization – Clean Air Task Force

[9] Building the fusion energy rulebook - Nuclear Engineering International

[10] Helion Secures Land and Begins Building on the Site of World's First Fusion Power Plant | Helion

magnitude. Fusion can generate 4 times more energy per kilogram than nuclear fission and roughly 4 million times more energy than burning oil or coal.[11] If successfully commercialized, the cost of electricity generated by fusion could be lower than any other power source.

Third, fusion reactors are safer than fission because their reactions are inherently self-limiting. Every aspect of the process, including magnetic fields, vacuum systems, and fuel ratios, have to be precisely controlled. The reaction stops if conditions are not perfect. Unlike nuclear fission which is self-perpetuating, a fusion reaction will cease almost immediately upon any change in environment. The exponential chain reaction in fission creates the risk of two catastrophic safety events, a runaway critical reaction and a nuclear meltdown. These differences are important and led to the unanimous ruling by the U.S. Nuclear Regulatory Commission (NRC) in 2023 that fusion will not be regulated under the same framework as fission. Their ruling was codified into law in the U.S. as the ADVANCE Act of 2024.

Waste is another important difference between fission and fusion. Nuclear fission produces high-level waste (HLW) in the form of spent fuel, which is dangerous to handle and store. Nuclear fusion produces only low-level waste (LLW), which requires less stringent management and disposal methods. LLW can be deposited in facilities near the earth's surface after minimal isolation. HLW is far more radioactive, requiring robust containment and long-term storage in deep geological repositories.

Risks and challenges

Replicating the conditions found in the sun's core on Earth involves achieving and maintaining extremely high temperatures and pressures. One major challenge in making fusion feasible is sustaining confinement, which means holding the plasma together for a sufficient period to allow particle collisions and fusion reactions to occur. To date, the longest fusion reaction has lasted just 22 minutes and 17 seconds at China's EAST (Experimental Advanced Superconducting Tokamak). For power production purposes, reactions must be maintained for extended periods with limited downtime.

The first challenge is designing a reactor with careful consideration of the tradeoffs between "physics risk" and "engineering risk." Understanding the difference is critical to evaluate whether a particular fusion approach is feasible scientifically and viable technologically. Physics risk is the uncertainty about whether the underlying physical principles will allow the system to achieve net energy gain under realistic conditions. Engineering risk refers to the difficulty of building a working, reliable, and economical fusion system.

Some startups intentionally accept more physics risk to reduce engineering complexity in the hope of moving faster and building a cheaper reactor. Traditional approaches such as the International Thermonuclear Experimental Reactor (ITER) reduce physics risk at the expense of massive engineering risk and cost. Each approach encounters distinct challenges in commercializing its technology.

Second is the dilemma of developing materials for the internal chamber of the reactor that can withstand the intense neutron bombardment from fusion reactions. As of now, this is a theoretical endeavor. The materials are subject to frequent damage, requiring systems that allow for maintenance without disrupting long-term power generation. It is unclear how long the materials will last and which materials the engineers should use.

A third challenge is effectively breeding tritium from the fusion reaction to ensure a continuous fuel source. The breeding process is complex, requiring stable temperatures, the ability to withstand intense neutron and heat loads, and efficient extraction of tritium and heat. Failure to effectively breed tritium stalls the entire fusion cycle.

Fourth, converting energy from nuclear fusion into electricity requires efficiently handling the intense heat and neutron flux generated by the fusion reaction. Traditional thermal power plants (fission, coal, or gas) need this process as well, but fusion introduces unique challenges due to the extreme conditions involved. Commercial fusion reactors will need a highly-efficient thermal path, using materials that can withstand harsh radiation and temperature loads.

Finally, economic viability will be crucial to scale commercial nuclear fusion power plants. The high cost of current research and development to build a first-of-a-kind reactor needs to materially decrease for fusion power to scale and replace alternative sources of energy.

Conclusion

Recent progress in material sciences, coupled with growing energy requirements and favorable funding and regulatory conditions, has positioned fusion as a potential commercially viable power source within the coming decade. If realized, fusion may help meet increasing global electricity demands and reduce reliance on carbon-intensive energy sources such as natural gas and coal.

[11] Making it work

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