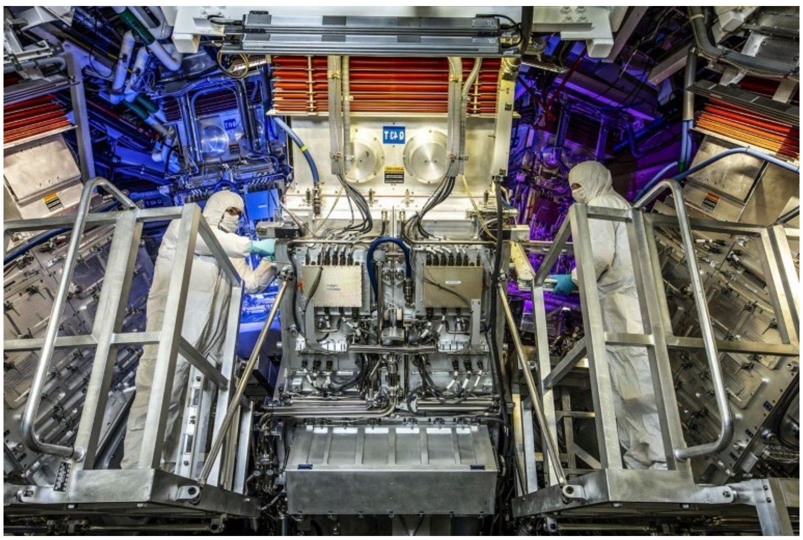
Kenneth Higashi
Per. 3

Unparalleled Carbon-free Energy but at what cost?

There are ongoing and evolving scientific tests every day to achieve a more thorough understanding of science and its technology. Nevertheless, this discovery regarding the National Ignition Facility will leave you quite surprised.



We will be discussing and describing how the NIF (National Ignition Facility) achieved the next stage of nuclear fusion, where the process is self-sustaining and is categorized as fusion ignition. Nuclear fusion does not require an external heat source to fuel the reaction. It is a similar phenomenon that powers the sun. The NIF is the National Ignition Facility and was designed to help atomic weapon scientists study the intense heat and pressure inside an explosion, and that is only possible if the laboratory produces high-yield fusion reactions. The NIF is not a fusion-energy device and is not considered efficient but exact. "It was designed to be the biggest laser we could possibly build to give us the data we need for the [nuclear] stockpile research program," says Mark Herrmann a scientist at the NIF.

Nuclear fusion emits an almost limitless, safe, clean source of carbon-free baseload energy. Fusion reactors do not emit toxins such as carbon dioxide (CO_2) or other greenhouse gases. The main byproduct of fusion reactors is helium; the inert, non-toxic gas has several uses in industry, which has suffered several shortages in recent years.

Why is it considered one of the major fusion breakthroughs of all time? Fusion is ultimately a carbon-free, renewable energy source. And it can produce 4 million times more energy than the chemical reaction of fossil fuels and has four times more fission energy. (Fission made atomic bombs in 1944, while fusion made the H-Bombs.) The process simultaneously forms nuclei while releasing a big burst of energy which is the chemical reaction. Which is far more powerful than fission will ever be. Fission energy is where the nucleus splits into 2 or more while releasing energy.

Using Fusion Ignition, we can receive more energy than we initially put into the reactor. (What scientists would call a breakeven) Nuclear fusion will not get more efficient until now. The Lawrence Livermore National Laboratory in California made one of the biggest breakthroughs in energy this time. It did not need as much energy to produce the same amount of power as before. Researchers have managed to release 2.5 MJ of energy after using just 2.1 MJ to heat the fuel with lasers.

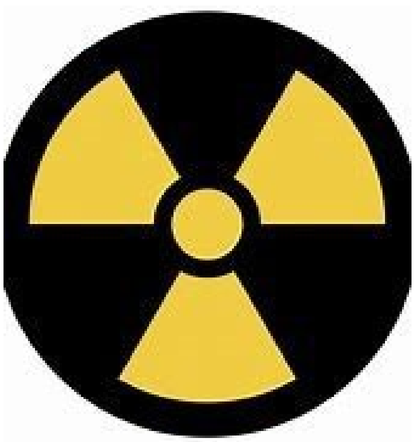
It is cost competitive. Even though the initial costs for power plants are very costly aside from this, other investments are to be made for enriching and processing the fuel, controlling, and getting rid of waste, and facility maintenance. But electric generation in reactors is cheaper than that of oil, gas, and coal plants.

What are the significant lengths that could be achieved? Even though experts say there is a long road ahead for even more fusion success there are still a lot of small goals to reach. One of these milestones is set to be reached - releasing more energy than is put into producing laser pulses - so energy release will need to grow by at least two orders of magnitude.

ITER (International Thermonuclear Experimental Reactor) plans to complete fusion ignition through a different technique which will potentially bring more energy, which is the same method as "inertial confinement" the same approach the NIF used to achieve ignition. ITER will keep the plasma of deuterium and tritium confined in a doughnut-shaped vacuum chamber, known as a tokamak, and heat it until the nuclei fuse. Once the reactor starts working towards fusion, currently planned for 2035, it will aim to reach the 'burning' stage, "where self-healing power is the dominant source of heating" stated Tim Luce an American physicist.

What are the real consequences of this newly obtained power? Even though there is a difference between fission and fusion, most people get the two mixed up. As in a fission reaction the radiation is alpha particles, beta particles, and gamma rays (which can penetrate your skin and break apart the bonds in your DNA structure, giving you all kinds of cancer) while in a nuclear fusion reactor, the only part that will be conducting the high energy neutrons will be the vessel walls (surrounding the reactor), and if in the most severe case, all the protective layers surrounding the main fusion vessel fail, the neutron radiation will stop as soon as the fusion reaction stops. As in a fission reactor, cancer-causing radiation still exists even in waste materials, which means that extreme measures are needed to be taken to bury the waste to keep it away from humans.

As in nuclear fusion, activated (used) materials can be stored safely for about 100 years, after which the radiation level becomes so low that they can be reused again. While the fusion reaction still produces radioactive waste, such as uranium mill tailings, spent (used) reactor fuel, and other dangerous substances. Although the radiation levels are low, they still must be disposed of. Typically, this must be either buried or put underneath the seabed and covered with materials to prevent the sealing barrier from perishing.



The more dangerous thing is the usage of irradiated, used nuclear reactor fuel which is used to power the reactors which generate energy. This is highly reactive after a prolonged amount of time. It then becomes unusable and is often stored in specially reinforced water pools, which cool the fuel and shield the radiation. It is now reported by the EIA (Energy Information Agency) that many reactors are moving their older nuclear waste, which is less reactive, to outdoor containers where heat can be dissipated only by on-air cooling. This method of cooling is less efficient than water cooling and does not supply additional insulation when compared to water cooling.

In fact, the EIA has also stated that “The United States does not currently have a permanent disposal facility for high-level nuclear waste.”

Kenneth Higashi
Per. 3

More importantly it is extremely difficult to accomplish and is required more brainpower than there was ever before; now imagine trying to contain plasma (a gaseous mixture of deuterium, tritium atoms and ions, and helium the fusion byproduct) at 150 million degrees Celsius (approximately 10 times hotter than the Sun's core) there is no material known to man that withstands that amount of heat. So, scientists try and suspend the plasma (since it is electrically charged and has a magnetic field of its own) in a magnetic field produced by superconducting magnets around the fusion vessel/chamber. This is like the same process as how bullet trains can ride on their tracks at ridiculous speeds.

Nuclear fusion has a lot of feedback and there are still a lot of unknowns. One thing is for sure, fusion is vigilantly more harmless than fission. But what is more significant is what measures will be taken to ensure that these reactions do not get out of hand?

Kenneth Higashi
Per. 3

Sites used:

https://en.as.com/latest_news/what-are-the-environmental-risks-of-nuclear-fusion-energy-n/#:~:text=Nuclear%20fusion%20brings%20other%20environmental%20risks&text=However%20some%20have%20suggested%20that,fuel%2C%20and%20other%20dangerous%20substances.

https://www.nature.com/articles/d41586-022-04440-7

https://newseu.cgtn.com/news/2020-07-29/What-is-nuclear-fusion-is-it-dangerous-and-is-it-likely-to-happen--Svej5vuBY4/index.html

https://www.linquip.com/blog/disadvantages-of-nuclear-fusion/

https://www.theguardian.com/environment/2022/dec/12/breakthrough-in-nuclear-fusion-could-mean-near-limitless-energy