Laser Inertial Fusion Energy

LIFE—safe, clean, and abundant energy

To make fusion happen, atoms of hydrogen must be heated to very high temperatures (100 million degrees) so they form a plasma and have sufficient energy to fuse, and then be held together long enough for fusion to occur. To heat and compress the fuel, Laser Inertial Fusion Energy, or LIFE, power plants will use lasers to deliver by an intense energy beam for a few nanoseconds to the outer layer of a tiny pellet of frozen hydrogen. This causes the heated outer layer to explode outward, producing a reaction force against the remainder of the target, accelerating the target material inward, and sending shock waves into the center. A sufficiently powerful set of shock waves can compress and heat the fuel at the center so much that fusion reactions occur. The energy released by these reactions will then heat the surrounding fuel, which may also begin to undergo fusion and ideally burn a significant portion of the fuel.

LIFE plants would deliver a successive stream of fuel-bearing targets to the fusion chamber and convert the released energy into heat. That heat would be carried from the chamber by a fluid to drive the turbine and generator to produce electricity.

LIFE power plants are intrinsically safe

While the temperatures and pressures involved in creating a controlled fusion reaction are extreme, inertial confinement fusion is an inherently safe process: each ignition "event" is very small—about the diameter of a human hair—and lasts for only a few trillionths of a second. The energy released is limited by the very small amount of fuel in the target capsule and is completely contained in the fusion chamber. When the laser stops firing, fusion reactions cease. Meltdowns and runaway reactions are impossible—and no cooling, external power, or active intervention is required in the event of a system shutdown (deliberate or otherwise).

Fusion energy is sustainable and environmentally friendly

Fusion energy offers the promise of abundant, truly sustainable energy. One out of every 6500 atoms of hydrogen in ordinary water is deuterium, giving a gallon of water the energy content of 300 gallons of gasoline. In addition, fusion would be environmentally friendly, producing no combustion products or greenhouse gases. While fusion is a nuclear process, the products of the fusion reaction (helium and a neutron) are not radioactive, and a fusion power plant would be passively safe and would produce no long-term radioactive waste. Fusion has high energy efficiency and so makes efficient use of land resources.

LIFE: SAFE AND SUSTAINABLE

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LIFE plants are designed to maintain a low tritium inventory

Many fusion plant designs require large quantities of tritium for start up and operations. In contrast, due to careful system design and adoption of fusion targets similar to those used at the National Ignition Facility (NIF), a LIFE facility will be able to maintain a very low and carefully controlled tritium inventory. A NIF target capsule is smaller than a peppercorn and contains less than 1 milligram of tritium. That amount of tritium corresponds to less than 10 Curies of radioactivity—about half the amount of radioactivity contained in a commercially available tritium-powered "Exit" sign. The tritium inventory is maintained at a level that would have no offsite consequences either during an accident or during normal operations.

Safety and environmental advantages of the LIFE approach:

- Abundant fuel supply.
- Inherent safety.
- No risk of meltdown or runaway reaction; reactions stop when system is off.
- No greenhouse gas emissions.
- Low environmental impact. Waste heat and the "ash" from burning the fuel (non-radioactive helium) could be collected and used.
- No spent fuel.
- Very low and segregated tritium (a radioactive isotope of hydrogen) inventory.
- No cooling, external power, or active intervention required in event of a system shutdown.

A LIFE Engine and Power Plant

LIFE power plants (an artist's rendition of a LIFE plant is shown here) could pave the way to a safe, sustainable, carbon-free energy future. Plant design is based on NIF-like fusion targets and a NIF-like laser.

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