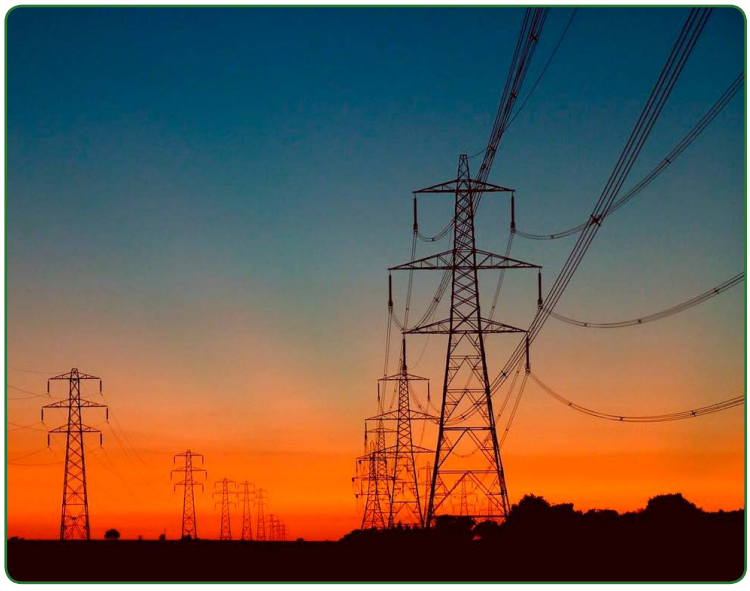
Laser Inertial Fusion Energy

LIFE: Safe and Sustainable Fusion Power

LIFE, an acronym for Laser Inertial Fusion Energy, is a practical, near-term approach to fusion power generation under development at Lawrence Livermore National Laboratory. Based on the physics and technology demonstrated on the National Ignition Facility (NIF), LIFE has the potential to meet future worldwide energy needs in a safe, sustainable manner without carbon dioxide emissions.

The Promise of Fusion Power

Ignition on NIF would serve as a springboard for LIFE, a clean, inherently safe, and virtually unlimited energy source. LIFE offers many compelling advantages. LIFE power plants could generate gigawatts of baseload power with no carbon dioxide emissions, no enrichment, no reprocessing, and no high-level radioactive waste. Besides offering energy independence and security, LIFE power plants could provide the United States with an enormous competitive edge in the energy sector in the coming years.



The LIFE engine will use an ICF laser system similar to the one now operating in NIF to ignite fusion targets. The laser will fire at targets that are sent into the target chamber at speeds close to that of a .22-caliber bullet. The resulting pulsed fusion reactions will produce high-energy neutrons, which bombard a spherical blanket containing a high-heat-capacity, lithium–lead coolant that surrounds the target chamber. The coolant converts the energy of the neutrons into heat to produce steam that will be used to generate electricity.

The Path to Fusion Energy

A LIFE development team consisting of physicists, materials scientists, engineers, and energy and national security experts from LLNL, the University of California at Berkeley, and other institutions has developed a "point design"—the target and laser features for specific ignition performance—and a path forward for LIFE. The LIFE plant design process began by examining end-user requirements rather than technical performance alone. Utility companies responsible for 75 percent of the electrical generating capacity of the United States were engaged to help develop a set of requirements for a fusion power plant. More than 30 major vendors from the semiconductor, optics, laser, construction, controls, nuclear, project delivery, and regulatory industries have since collaborated with the LIFE team to assess and detail technology readiness and cost and identify factory capacity requirements.

This design process has allowed trade-off decisions to be made on the wide array of possible development and risk reduction activities, and enabled selection of options most consistent with the final goal of robust, safe, and economically competitive electricity production.

To achieve high efficiency and high shot rates, LIFE will use diode-pumped solid-state lasers, cooled with liquid lithium. LIFE will capitalize on industry projections that the cost of pump diodes will continue to fall.

LIFE: CLEAN ENERGY

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Injection of fusion targets into the center of the target chamber at 10 to 15 times a second and then tracking their position for precise engagement with the laser beams are key technical challenges. Livermore scientists, working with General Atomics in San Diego, California, have shown that fully automated, low-cost, large-volume target manufacturing can be adapted from existing, well-understood mass-production industries. Also, codes used for modeling of NIF fusion targets are being used to design low-cost, mass-produced fusion targets for LIFE.

Given aggressive technological development and investment in this new technology, by the 2030s LIFE engines could be powering a substantial part of the U.S. and worldwide energy grid. Livermore team members are excited by the prospect that LIFE will offer a fusion pathway toward sustainable, safe, and carbon-free electric power. ■

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.

The Mercury Laser

Mercury is the world's highest-energy and power, nanosecond-pulse, diode-pumped laser. Experience with Mercury has informed the design for LIFE.