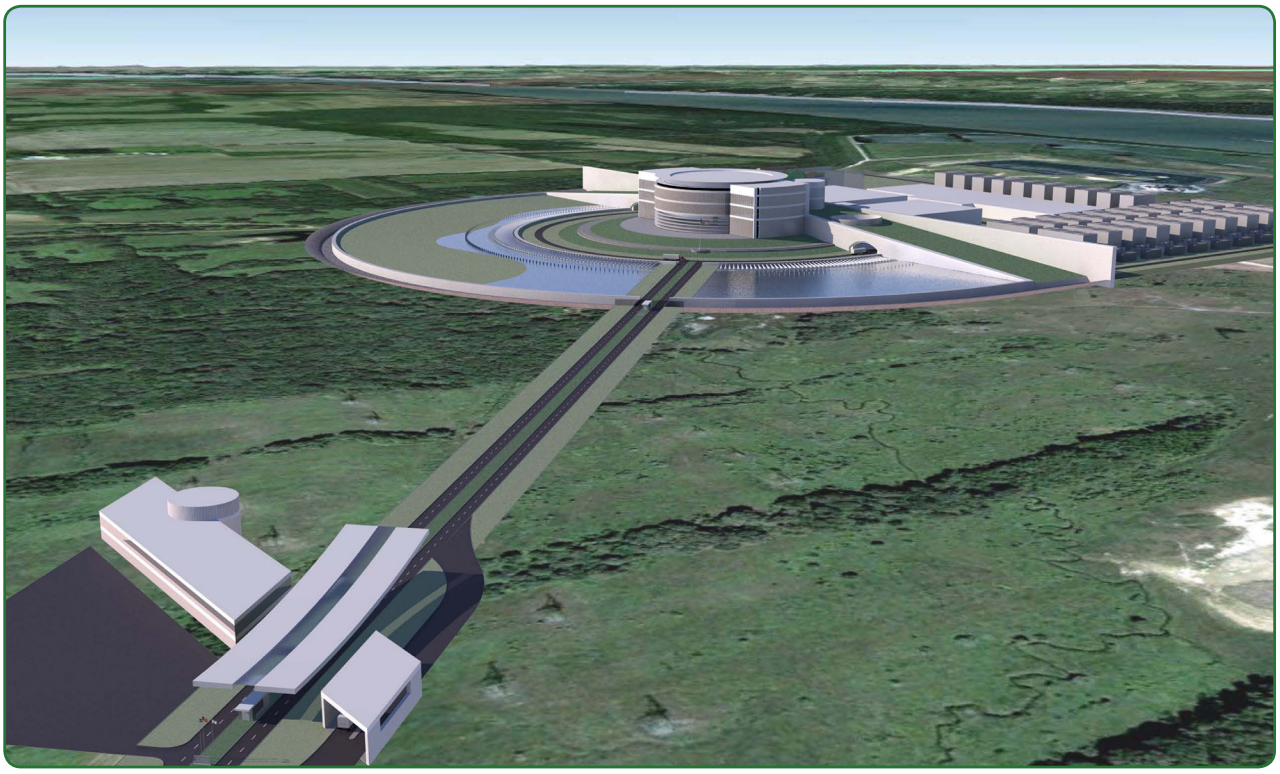
Laser Inertial Fusion Energy

Tackling the Global Energy Crisis

LIFE
is a holy cow game changer

Providing for the world's energy demands is one of the most urgent—and difficult—challenges facing our society. Even with likely improvements in efficiency and energy conservation, there is a critical need to rebalance electricity supply away from fossil fuels to ensure long-term sustainability of natural resources, reduce carbon emissions over the next half century, and stabilize greenhouse gas concentrations thereafter. The projected electrification of transport further increases this need, as does our increasing reliance on products fabricated from the very same natural resources that are currently being burned to create electricity.



Renewable sources such as solar, photovoltaic, wind, and hydro will play an essential role in meeting this challenge, but do not have the storage capacity or available land to meet the majority baseload power requirements of most countries. Nuclear energy offers many attractions, but requires addressing the safety and proliferation problems associated with enrichment, reprocessing, and high-level waste storage. While these solutions could and should be pursued within the United States, the need to replace the current fleet of power plants provides a clear window of opportunity to transform the energy landscape from 2030 onwards.

Fueling the future with LIFE

For 50 years, it has been recognized that fusion energy provides a highly attractive solution to society's demand for safe, secure, environmentally sustainable energy—at a scale that meets our long-term needs.

But despite fusion's tantalizing benefits, it has been largely ignored in energy policy discussions because it is viewed as a technology too immature to affect energy production over the next few decades, when it is most needed.

Drawing on huge prior investment by the Department of Energy, and linking in with recent innovations in the semiconductor industry, we are now at a stage to change this paradigm and offer a deliverable way forward.

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NIF IS THE PROOF *of principle for a inertial fusion power plant*

National Ignition Facility: Ready to Make History

The standard joke about fusion is that it is 30 years away and always will be. NIF is on the brink of changing this—with a plan to deliver net energy gain (more fusion energy out than the laser puts in) by the end of 2012. Begun in May 1997 and completed in March 2009, the $3.5 billion machine is the size of three football fields and has 192 laser beams. The now-operational facility is capable of directing nearly two million joules of ultraviolet laser energy in billionth-of-a-second pulses to the target chamber center.

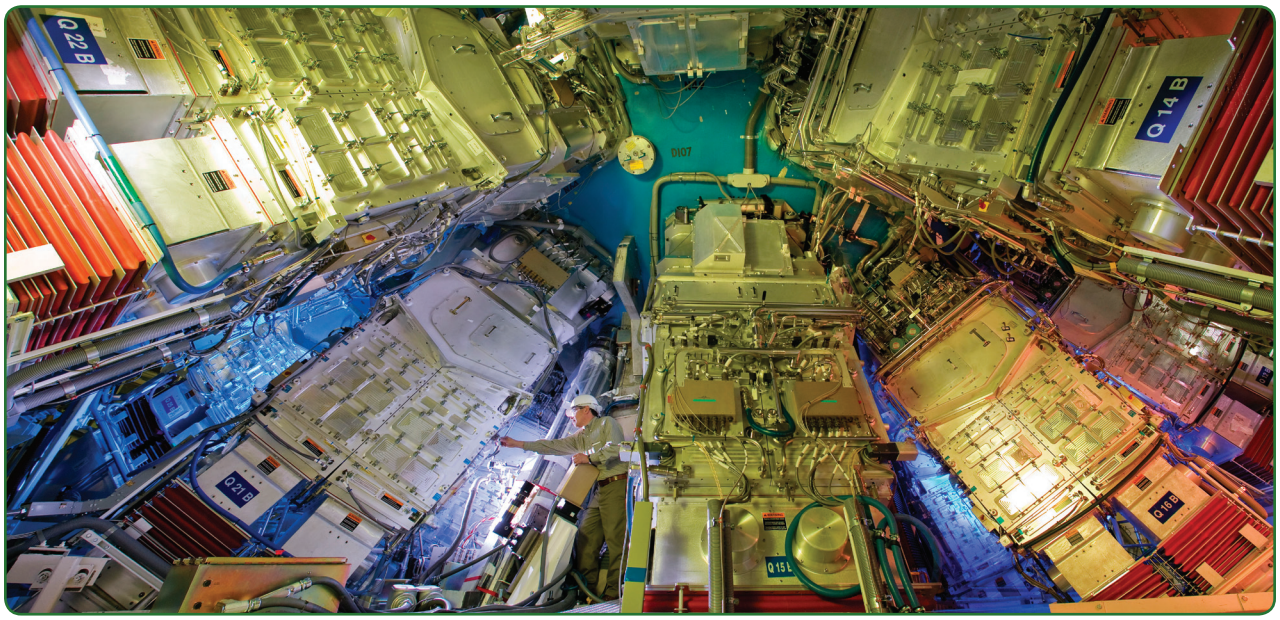
NIF's BB-sized targets will be filled with a deuterium and tritium (isotopes of hydrogen) fuel mixture. NIF's goal is to fuse the atoms to produce more energy than the laser energy required to spark the reaction. The 192 laser beams travel a long path, about 1,500 meters to the center of the target chamber. As they move through NIF's amplifiers, their energy increases exponentially from one-billionth of a joule to four million joules, a factor of more than a quadrillion—and it all happens in about five millionths of a second.

On the Path to Fusion Ignition

In September 2010, an experiment successfully demonstrated the integration of all the complex systems required for the laser to ignite the fusion fuel. This was the first in a series of shots that will lead up to conducting full-scale ignition experiments as part of the National Ignition Campaign. NIF will be the first fusion facility to demonstrate ignition and self-sustaining burn, as required for a power station.

For more information on NIF, visit

lasers.llnl.gov



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LIFE *builds on 50 years of international research*

Delivering Fusion Energy Soon Enough to Make a Difference

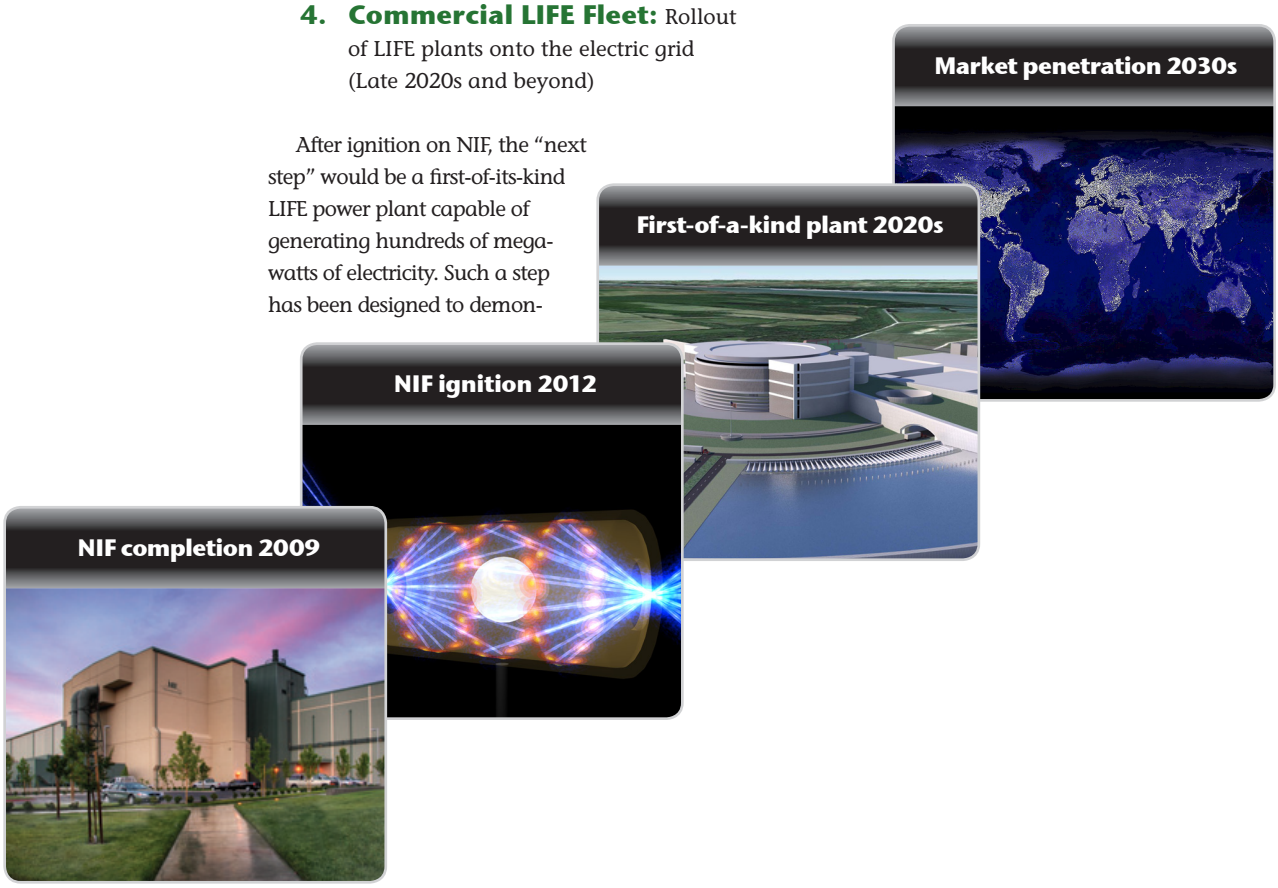
Despite fusion's potential benefits for a low-carbon energy economy, the long timescales typically associated with fusion development have excluded it from mainstream energy policy considerations. The United States is in a unique position to change this paradigm, and deliver laser fusion power stations on a timescale that matters—with LIFE.

The path to LIFE is a four-step process:

1. **NIF:** Construction and operation of a laser facility at the scale required for energy production (Achieved 2009)
2. **Ignition:** Demonstration of net energy gain from fusion fuel (On target, by end of 2012)
3. **LIFE Demonstration:** Integration of all the technologies required for a power station (Planned for mid-2020s)
4. **Commercial LIFE Fleet:** Rollout of LIFE plants onto the electric grid (Late 2020s and beyond)

After ignition on NIF, the "next step" would be a first-of-its-kind LIFE power plant capable of generating hundreds of megawatts of electricity. Such a step has been designed to demonstrate all the required technologies and materials certification needed for the subsequent rollout of electric power at commercial power plant levels from the late 2020s onwards.

This program plan builds on 50 years of international research and a multi-billion-dollar investment by the Department of Energy in NIF. Delivery of an integrated power plant on an acceptable timescale is possible only in the U.S. and benefits considerably from the distributed academic and industrial expertise arising from the nationwide NIF effort and the ongoing ignition campaign.



Laser Inertial Fusion Energy

PROVEN PHYSICS

demonstrated at the National Ignition Facility

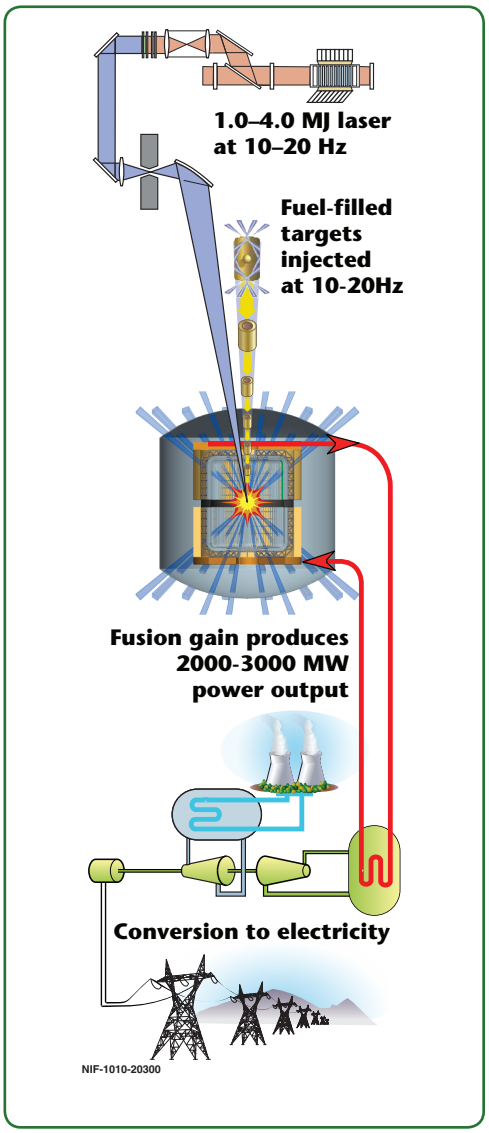
A Game-Changing Energy Solution

The LIFE approach offers:

1. A sustainable, carbon-free source of baseload electricity
2. Security of supply (reducing our reliance on foreign oil imports)
3. No enrichment, no reprocessing, and no high-level radioactive waste
4. Global commercial competitiveness from a U.S.-led solution
5. Compatibility with existing grid infrastructure
6. Intrinsic safety

How does it work?

In a laser fusion power plant, fuel pellets are rapidly injected into an interaction chamber, producing pulses of fusion energy that heat a blanket of material surrounding the chamber. The fusion heat is then transferred to a power conversion system to produce electricity.



The LIFE solution uses:

- Proven physics: demonstrated on the NIF
- Available materials: enabling construction of a demonstration plant in the near term
- Market-based technology: using the U.S. solid state (semiconductor) manufacturing base

Demonstration of fusion ignition on the National Ignition Facility (NIF) will provide the basis for a fleet of LIFE power plants that are being designed to deliver gigawatt-scale electricity—equivalent to the largest coal or nuclear power stations.

For more information on LIFE, visit

life.llnl.gov

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