Fusion Power: 'We Could Have A Reactor in Ten Years'

by Natalie Lovegren

The American Security Project (ASP) hosted an event on Capitol Hill Jan. 29, 2014, entitled: "Fusion: Update on the International ITER Project."

This is politically significant, at a time when the obstacles to thermonuclear fusion development are no longer a matter of science, but of policy. The engineering breakthroughs needed to bring fusion energy online for commercial electricity generation are a function of political will,[1] at a point when our current inclination is toward thermonuclear war,[2] rather than controlled thermonuclear fusion for abundant energy. This political will must be part of an evolution in identity among American policymakers, to recognize and recommit to that which created this nation—the pursuit of scientific progress toward the common aims of all mankind.

Brig. Gen. Stephen Cheney, CEO of ASP, introduced the event by disabusing the audience of the myth that fusion "will always be 30 years away," and that investment into it is therefore a Sisyphean task, a futile drain on the American taxpayer. The issue is a lack of funding, Cheney said, rather than lack of science, adding that, "Were the necessary resources applied, we could have a demo reactor in ten years."

The mythology of the non-feasibility of fusion is perpetuated to mask the sabotage of the U.S. fusion program, inflicted by budget cuts, since the 1980 McCormack bill[3] was denied funding.

At the 1985 Geneva Superpowers Summit, Soviet President Mikhail Gorbachov and U.S. President Ronald Reagan agreed to initiate a joint project for developing fusion energy, which had been under discussion since the late 1970s. In 1988, Europe and Japan joined the U.S. and USSR, and in subsequent years, China, India, and South Korea joined the project, culminating in an agreement in 2007 to build the International Thermonuclear Experimental Reactor (ITER), in Cadarache, France.

These nations are not simply donating money to a French project, but are each performing research, contributing technologies, and building parts domestically, for shipment to, and assembly at, the construction site in the South of France. Because each of these high-tech industries must be developed domestically to meet various scientific and engineering challenges, there are local effects on each national economy. The fusion research required for this project and the construction of the various ITER parts contribute to local economies in virtually every U.S. state. This approach strengthens the individual fusion programs of each nation, and also fuels spinoff industries which are generated as a lawful result of investment in technologies that push the limits of current scientific understanding.

Parallel efforts invested in both domestic and international programs simultaneously provide an effective means for achieving rapid progress, as well as facilitating a sound basis for diplomatic relations.

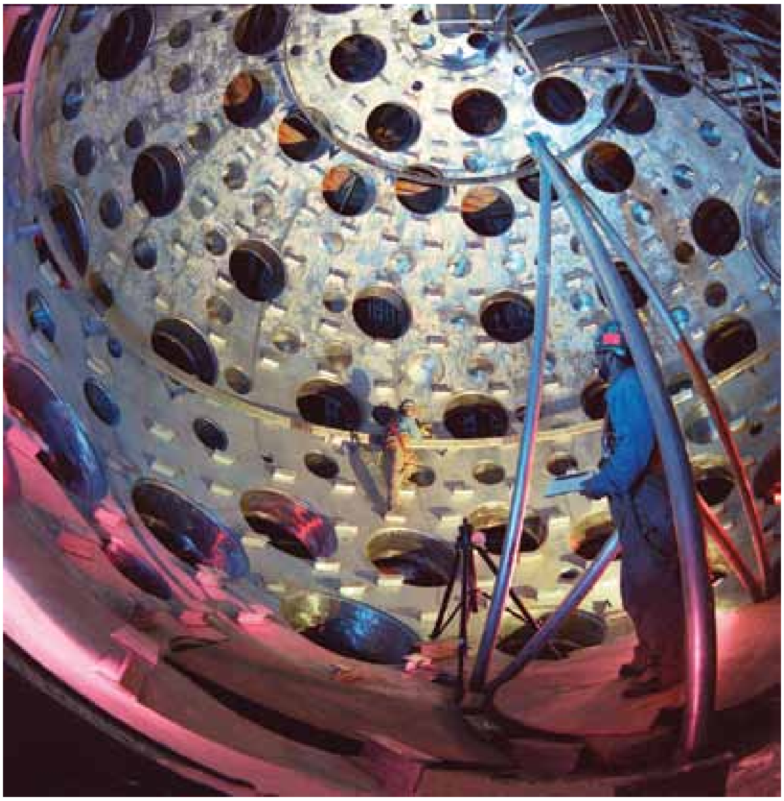
De-Fund 'Green Technologies'

The desperate and misguided suggestion from some U.S. fusion scientists to pull out of ITER in order to

1. A 2013 Harvard study on the cost of the Iraq and Afghanistan wars estimates a final total of between $4 and $6 trillion. The current U.S. annual magnetic fusion energy budget is approximately $400 million, four orders of magnitude lower. Linda J. Bilmes, "The Financial Legacy of Iraq and Afghanistan: How Wartime Spending Decisions Will Constrain Future National Security Budgets." HKS Faculty Research Working Paper Series RWP13-006, March 2013.

2. Lyndon H. LaRouche, Jr., "Twenty-Six Days to Hell, or Not: Count-Down," *EIR*, Feb. 14, 2014.

3. "The Magnetic Fusion Energy Engineering Act of 1980" declared to be the policy of the United States and the purpose of this act "to accelerate the national effort in research, development, and demonstration activities related to magnetic fusion energy systems.... Acceleration of the current magnetic fusion program will require a doubling within seven years of the present funding level without consideration of inflation, and a 25 per centum increase in funding each of fiscal years 1982 and 1983." This funding was never provided.



Lawrence Livermore Laboratory

The United States is one of a number of nations participating in the international ITER fusion program, based in France. Here, the Lawrence Livermore Labs National Ignition Facility target chamber under construction. The holes in the chamber provide access for the laser beams, and view ports of NIF diagnostic equipment.

divert scant resources into the domestic program, will not only defeat the purpose of this dynamic boon to the economy, but it will not work. Resources diverted will not be redirected at all. A more useful suggestion for those interested in actual economic growth, would be to divert all funding away from net-energy-loss "green" technologies such as wind and solar, and into advanced nuclear fission and controlled thermonuclear fusion research and development.[4]

Dr. Ned Sauthoff, Director of the U.S. ITER Project, who had recently toured the facilities under construction in France, presented an update of the progress that has been made by ITER in recent months. He gave a lively overview of the current theory of magnetic confinement fusion, and detailed the various contributions of partner nations to the project. The following are examples of the contributions, and do not constitute a comprehensive list:

France, as the host for the site, is responsible for making the structure completely impervious to earthquakes. A system of "seismic isolator pillars," made of alternate layers of rubber and metal, has the resilience to absorb the shock of an earthquake without disturbing the fusion reaction.[5]

India is responsible for the 30 meter by 30 meter cryostat—a type of giant vacuum-sealed stainless steel thermos bottle. It requires 3,800 tons of steel and will be the world's largest high-vacuum pressure chamber. The cryostat forms the vacuum-tight container surrounding the ITER vacuum vessel and acts like a very large refrigerator, to maintain the temperature of the super-cold superconducting magnets that create the tokamak's enormous magnetic field. It is so large that it must be shipped from India to France in 54 separate pieces.

Japan and Russia: In order for the gas in the vacuum chamber to reach the plasma state and temperature of 150 million degrees centigrade—ten times the temperature at the core of the Sun—three methods of generating and controlling heat will be used. One of the methods is called "Electron Cyclotron Resonance Heating." A high-intensity beam of electromagnetic radiation is tuned to 170 GHz, the frequency of the electrons. The tuning of this beam to match the natural frequency of the electrons allows the electrons to communicate with the radiation, absorbing that energy. These high-energy electrons then transfer that energy to the ions (the deuterium and tritium nuclei) by collision. Japan and Russia are building 170-GHz gyrotrons for this purpose. A gyrotron accelerates beams of electrons toward a cavity where a strong magnetic field is applied. The interaction between the rotating motion of the electrons and the magnetic field generate high-frequency radio waves that are then used to heat the electrons in the plasma.

South Korea, in conjunction with the EU, is build-

4. This energy-intensive project is being built in France, where adequate electricity is available from the high energy-density of nuclear power, which constitutes 75% of electricity production—the highest in the world.

5. It should be noted, though, that fusion cannot generate chain reactions like fission that could run away and create meltdowns. If the reaction is disrupted, it will simply stop reacting.

ing the vacuum vessel that will hold the fusion plasma. 633 massive stainless steel forgings—360 tons of material—were manufactured in Germany and shipped to Hyundai Heavy Industries, for this purpose This vacuum vessel acts as the first safety containment barrier, inside which the plasma is to be suspended by the magnetic field. The ITER vacuum vessel will be twice the size of any other tokamak ever built, and will weigh over 8,000 tons—slightly more than the Eiffel Tower. South Korea is also building the thermal shield which is positioned between the vacuum vessel/cryostat and the magnets to protect them from radiation damage. South Korea and China are the only two countries in the world that operate superconducting tokamaks for fusion development, while Japan is soon to be the third.

South Korea is unique in developing a domestic demonstration reactor alongside ITER, called K-DEMO, which intends to produce double the power of ITER for a longer period of time. It is designed to be a small step away from a commercial fusion plant, and is planned to come online seven years after ITER.

China: In addition to constructing a share of the toroidal field superconductor, China will build the protective thermal blanket and blanket-shield, and power supply. The ITER power supply test facility, which was built for the project at China's Institute of Plasma Physics, set a new record in both AC and DC current generation this past December. China's domestic fusion program is taken very seriously, considering its growing population and current dependence on coal. China also intends to develop a parallel demonstration reactor to maximize participation in the ITER.

The **United States** is responsible for the central solenoid, and a portion of the superconducting components. The U.S. has taken responsibility for the control and measurement of the plasma, which will play a key role in the advancement of fusion. One of the big challenges is to prevent major disruptions of the plasma, which will stop the reaction.

Imagine the surface of the Sun as the outer edge of the tokamak. Like the Sun, these edges have a tendency to become a tempestuous sea of plasma, which

Livermore's Laser Fusion Progress Widely Covered

Feb. 13—Exciting results from laser fusion experiments that were carried out last Summer and Fall at the Lawrence Livermore National Laboratory in California are attracting worldwide attention, as the results were reported in this week's issue of *Nature* magazine. The Reuters and other wire service reports, including comments by the scientists, were picked up extensively around the world.

In a series of experiments on the 192-beam National Ignition Facility (NIF), for the first time, a laser fusion experiment produced more fusion energy than the amount of energy deposited by the laser on the fuel target, described as a positive fuel-energy balance. Overall, the lasers deposit less than 1% of their total energy onto the fusion fuel, so this is not yet energy "breakeven." The Lab ran a series of experiments, changing various experimental parameters, such as the shape, energy level, and timing of the laser pulse, to try to get closer to eventually achieving a sustained fusion reaction, described as "ignition."

The importance of these results is not the amount of energy, per se, explained two top inertial fusion scientists, but that there was a self-heating of the fusion fuel. Although that heating did not lead to a sustained ignition of the rest of the fuel, they estimate that it produced about half of the total number of fusion reactions that took place. To achieve the recent result, Ed Moses, Associate Director of NIF, explained in October, that in August, the scientists had lowered the energy of the lasers "a tiny bit—about 5 percent—but more important, we changed the shape of the energy pulse.... We got three times the energy out," compared with previous experiments, Moses said.

Talking with the press yesterday, the principal author of the *Nature* article, Omar Hurricane, described the results, as "quite unique. And that's kind of a major turning point, in a lot of our minds.... We are closer than anyone has gotten before."

—*Marsha Freeman*

can leap out and splash against the walls of the reactor. This must be minimized, to keep the plasma calm, so that it does not flare out, bypass its magnetic containment wall, and melt the metal surfaces of the reactor wall. Even a small amount of melting will cause pieces of the metal—such as beryllium or tungsten—to contaminate the plasma, thus reducing its energy and performance.

One trick that was developed by General Atomics in California, and Oak Ridge National Laboratory in Tennessee, is to inject cold hydrogen into the plasma at key points, to turn a large disturbance into a small one. Tickling the edge of the plasma disturbs it slightly, thereby entertaining its propensity for disturbance, but on a small scale that can be controlled. The problem with shooting a gas at a plasma, though, is that it's too diffuse, and it just bounces off. The trick to overcoming this problem is to concentrate it into solid bullets. By freezing deuterium into small (1.3 mm) BB-like pellets, and shooting them very quickly (60 times per second), the plasma's wall of resistance can be overcome, and it can be tamed.

Chinese and Japanese representatives agreed with LaRouchePAC associates in discussion following the event, that this type of collaboration around the frontiers of science is preferable to territorial tensions, such as what have been stirred up in the East China Sea. Why not build a thermonuclear desalination demonstration plant on those islands, to jointly develop fusion energy, create freshwater, and mine the valuable minerals of the surrounding sea? Scientific representatives of the various ITER-member nations were receptive to further discussion of fusion as a driver for world economic development, as outlined in the "Nuclear NAWAPA XXI: Gateway to a Fusion Economy" report,[6] which was made available to attendees.

LaRouchePAC Scientific Research Team member Creighton Jones, who attended the event, posed the following question to Dr. Sauthoff at the conclusion of his presentation:

"In light of the recent Chinese lunar landing, there has been some discussion of mining the Moon for helium-3, to use as an efficient fusion fuel. Achieving helium-3 reactions is an engineering challenge due to the greater requirements for temperature, pressure, and plasma density, but one of the ways to possibly mitigate that would be with polarized fuel. So I was wondering if, as part of the ITER, there is any investigation of polarized fuel?"

Sauthoff responded: "No, I'm not aware of any. The basic strategy is to find the easiest way to produce a self-sustaining fusion reaction, and deuterium and tritium are by far the most reactive. I spent 35 years at Princeton, and we had various collaborations with NASA about mining the Moon. There's an astronaut named Harrison Schmitt as you know, and Gerry Kulcinski from the University of Wisconsin, and a few others who are very strong advocates of this, and I believe that it is very important that we have a vision that we're going to be producing fusion reactors that will get better and better.

"But, quite frankly, we have to get ourselves up off the ground with something like the Wright Brothers, as opposed to a 747 as the first step. So, ITER is a good first step. It produces the heat, it demonstrates much of the technology, it doesn't produce electricity, it's just trying to study the physics of the technology for producing a fusion reaction. I'm sure there will be very many and better fusion reactors in the future, and polarized fuels give us one opportunity."

6. http://larouchepac.com/nawapaxxi