Source : www.thehindu.com Date : 2022-12-14

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December 13, 2022 03:22 pm | Updated December 14, 2022 11:11 am IST

This undated image provided by the National Ignition Facility at the Lawrence Livermore National Laboratory shows the NIF Target Bay in Livermore, California. The system uses 192 laser beams converging at the centre of this giant sphere to make a tiny hydrogen fuel pellet implode. | Photo Credit: AP

U.S. researchers announced a historic nuclear fusion breakthrough on Tuesday that could pave the way for alternative clean energy sources.

The Lawrence Livermore National Laboratory (LLNL) said an experiment it conducted this month “produced more energy from fusion than the laser energy used to drive it”.

The U.S. Department of Energy described the achievement of fusion ignition as a “major scientific breakthrough” that will lead to “advancements in national defense and the future of clean power.”

LLNL director Dr. Kim Budil described it as “is one of the most significant scientific challenges ever tackled by humanity.”

Scientists have been working for decades to develop nuclear fusion - touted by its supporters as a clean, abundant and safe source of energy that could eventually allow humanity to break its dependence on the fossil fuels driving a global climate crisis.

Look up, and it's happening right above you — nuclear fusion reactions power the sun and other stars.

The reaction happens when two light nuclei merge to form a single heavier nucleus. Because the total mass of that single nucleus is less than the mass of the two original nuclei, the leftover mass is energy that is released in the process, according to the Department of Energy.

December 13, 2022, U.S. Energy secretary Jennifer Granholm and under-secretary for nuclear security Jill Hruby are due to announce a major scientific breakthrough in nuclear fusion after 50 years of research. Graphic shows how inertial confinement fusion works. nuclear clean energy |

Photo Credit: Graphic News Collective LLP

In the case of the sun, its intense heat — millions of degrees Celsius — and the pressure exerted by its gravity allow atoms that would otherwise repel each other to fuse.

Scientists have long understood how nuclear fusion has worked and have been trying to duplicate the process on Earth as far back as the 1930s. Current efforts focus on fusing a pair of hydrogen isotopes — deuterium and tritium — according to the Department of Energy, which says that particular combination releases “much more energy than most fusion reactions” and requires less heat to do so.

Daniel Kammen, a professor of energy and society at the University of California at Berkeley, said nuclear fusion offers the possibility of “basically unlimited” fuel if the technology can be made commercially viable. The elements needed are available in seawater.

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It's also a process that doesn't produce the radioactive waste of nuclear fission, Kammen said.

One way scientists have tried to recreate nuclear fusion involves what's called a tokamak — a doughnut-shaped vacuum chamber that uses powerful magnets to turn fuel into a superheated plasma (between 150 million and 300 million degrees Celsius) where fusion may occur.

The Livermore lab uses a different technique, with researchers firing a 192-beam laser at a small capsule filled with deuterium-tritium fuel. The lab reported that an August 2021 test produced 1.35 megajoules of fusion energy — about 70% of the energy fired at the target. The lab said several subsequent experiments showed declining results, but researchers believed they had identified ways to improve the quality of the fuel capsule and the lasers' symmetry.

“The most critical feature of moving fusion from theory to commercial reality is getting more energy out than in,” Kammen said.