

The Surprising Benefit of Creating Stars on Earth

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1. Abstract

In the 1950's, scientists at several locations around the world and in the U.S. began a quest to reproduce the energy of the sun and stars here on earth. Since the 1950's, scientists and engineers in the U.S. and around the world have worked hard to make an elusive dream come true: the creation of a source of energy that is unlimited, safe, environmentally benign, available to all nations and not dependent on climate or the whims of the weather.

Initial optimism about the ease of creating a controlled fusion reaction on earth soon gave way to the realization that this was an unparalleled technological and scientific challenge. While meeting the scientific and technological challenges of creating practical fusion energy has taken much longer than anticipated by the early fusion pioneers, the difficult challenges that have been met and extraordinary progress to date have brought with them unanticipated benefits in a wide variety of fields.

Although fusion has now evolved from a dream to a laboratory reality, there are still major challenges, which must be met before it can become a practical energy source. Addressing these challenges has and will continue to yield rich benefits for other fields of science and technology. Areas of understanding and technology that must be improved include:

- The physics of high temperature plasmas (which have very complex behavior),
- Cutting edge computational capabilities,
- Sophisticated methods for heating fusion plasmas to 100s of millions of degrees,
- Innovations in materials, magnets and control mechanisms,
- Creation of new diagnostics and sensors (how do you measure temperatures and pressures in something that's 100,000,000 degrees?),
- Complex engineering innovations (heat removal, remote maintenance, impurity removal, etc),
- Micromachining and manufacturing,
- Extremely accurate tracking and targeting.

The great progress that has been made to date in fusion research has been the result of a long series of important breakthroughs in both science and technology. Meeting these challenges has resulted in and will continue to result in important spin-offs and contributions to other areas of science and technology. This paper describes some of these spin-offs and contributions in the areas of superconductivity, medical/health, material processing, and waste remediation.