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OUR FUTURE WITH FUSION

Forrest Fordham (fbf1@pitt.edu)

ONE OF THE MOST IMPORTANT ENGINEERING AMBITIONS

We Need to Find Alternatives

One of the greatest and most expansive projects that scientists and engineers have worked tirelessly on in the twenty-first century has been the pursuit of clean, alternative energy. The alternative energy initiative proves to be one of the most important projects we are working on in the modern day for a multitude of reasons.

Since the industrial age, we have relied heavily on the use of fossil fuels to power our factories, homes, and automobiles. One colossal problem we are going to face soon with our continuous and exhausting use of fossil fuels is a simple one- we are going to run out. The concept is not a difficult one to grasp, but many brush off just how significant it is. According to the website carboncounting.co.uk, we are estimated to deplete our natural gas reserves in about 50 years, we will run out of oil any time between the years 2025 and 2070, and other resources such as coal will not be too far behind as we exhaust them one by one [1]. The reality behind the longevity we have left in our traditional energy sources is frightening, and one of the most important things we can do today is to find newer forms of energy that will allow our society to grow and keep breaking new boundaries.

Running out of resources is a scary thought. An even scarier thought, however, is carbon emissions from fossil fuels and their effects on our planet, as well as our public health. Global warming is real, and the increase in Earth’s average temperature over the past 100 years cannot be neglected or brushed off as “just nature”. Climate change should not be taken lightly. As stated on NASA’s website, some of the issues that climate change will cause in the near-future include continually rising temperatures, changed precipitation trends, more droughts and heat waves, stronger and fiercer hurricanes, and an ice-less arctic, which goes hand and hand with rising ocean levels, just to name a few [2]. The National Institute of Environmental Health Sciences also adds that climate change is leading to lower air quality, migration of diseases, and changes in availability of water [3]. The consequences that arise from our use of fossil fuels should be enough to incentivize us to stop their use not when we eventually run out, but as soon as possible.

Our Current Progress

While the facts about fossil fuels can turn us weary about the future, the steps that scientists and engineers across the globe have taken towards alternative energy in recent years is reassuring. We have so far found ways to harness energy through solar power, wind power, biomass, tidal/hydroelectric power, geothermal energy, and nuclear energy, just to name some of the biggest ones. The one that may stand out to some is the mention of nuclear energy. When people hear “nuclear,” they assume catastrophe. They think about meltdowns and harmful radiation. Nuclear energy is often given a bad rap, when it could be the best form of alternative energy we have due to its power, efficiency, and virtually non-existent carbon footprint. The nuclear energy that most people are familiar with is fission, the process of splitting particles to produce energy. The danger with fission reactions is that once particles are split, the reactions sometimes cannot be stopped, resulting in “runaway” reactions. This is what caused nuclear meltdowns in the past. Many, however, are unfamiliar with the other, safer nuclear process that shows potential in alternative energy- fusion.

Fusion can almost be summed up as the opposite of fission. A fusion reaction occurs when the nuclei of light atoms, such as hydrogen and its isotopes (deuterium and tritium) combine to form heavier atoms, while releasing immense amounts of energy in the process. Fusion is much more controllable than fission because runaway reactions cannot occur, and the reaction can be manually halted if needed. However, fusion is a much more difficult reaction to replicate on Earth due to its extreme conditions needed to initiate. Our own sun burns through fusion, so it would be no surprise that replicating conditions on a star would be somewhat of a challenge to perform on Earth. Per eurofusion.org, some of the required conditions for fusion are that a temperature over 100 million degrees be reached, as well as a density of approximately one-millionth of the
Earth’s atmosphere [4]. These are just a couple of the barriers that separate us from harnessing the powers of fusion, but if overcome, we would be rewarded with the power of clean, limitless energy.

HOW WE’RE OVERCOMING THE BARRIERS

Complex Technology Leading the Way

As provided by lppfusion.com, the concept of fusion was discovered in the 1930s, and by the early 1940s, physicists began researching ways of harnessing it for practical use on Earth [5]. Soon after, designs for nuclear fusion reactors began to appear, but they were not without their many flaws. One of the leading problems was that the heated plasma inside the reactor was extremely difficult to contain, and collisions between atoms were nearly impossible to achieve since the heated substance would expand towards the edges of the reactor. As time went on, scientists attempted to utilize new inventions to fix the problems with these reactors. In the 1960s, following the invention of the laser, physicists sought to heat these substances with said lasers so fast that they would not have a chance to spread around the reactor. These attempts were largely unsuccessful. As time went on, physicist and engineers alike remained unsure of how to solve the problems with the reactor. The concept was there, but the route to get there remained hidden. But in the 1970s, researchers decided to appoint magnetic confinement duties to an earlier Soviet-devised machine- the tokamak [5].

The tokamak has been one of the best technologies available to engineers and physicists to begin replicating the process of fusion. As described by fusionforenergy.europa.eu, the tokamak design dawns the shape of a doughnut, and uses specialized coils within the machine to create magnetic fields that manipulate the path of the charged, heated plasma inside. The magnets keep the plasma circling the machine, instead of veering off into the sides of the vessel [6]. While the tokamak brings us a step closer to nuclear fusion, it is not the “perfect” machine. A Canadian Press article written by Frank Jordans states that the tokamak is fairly easy to build, but operating the machine proves to be extremely difficult [7]. Tokamaks have been migrating to alternate designs to make operation of the machine easier. A UPI Newstrack article mentions the development of spherical tokamaks, which would allow engineers to use weaker magnetic fields to operate the reaction, and lower the cost and difficulty of operating the machine [8]. New developments in the tokamak drive it further along every day.

TOKAMAKS IN THE WORLD TODAY

Competition in the Field

Another aspect that drives technological advances in nuclear fusion is competition. The tokamak’s main competitor, the stellarator has shown tons of promise for German engineers and physicists. “Stellarators are tokamaks with a set of twists and turns in their geometry that make it easier to keep the plasma under control,” writes Michael Brooks of the New Statesman [9]. A team of physicists and engineers in Greifswald, Germany have been working on a state-of-the-art stellarator called the WX-7. According to team leader Thomas Klinger, stellarators are much more difficult to construct but operation is much easier than that of a traditional tokamak. “The stellarator is much calmer,” states Klinger [7]. Developments in both the tokamak and the stellarator have brought into question which is the better of the two, with engineers advocating for both sides, but they provide the same result. Until future experiments provide a clear answer to which is better, both will continue to be utilized.

The ITER Project

The WX-7 is the largest stellarator project in the world today, but there is also a tokamak project in the works that is of much greater magnitude. As stated by iter.org, the International Thermonuclear Experimental Reactor, known as ITER, will be the largest tokamak ever built. It is “one of the most ambitious energy projects in the world today,” and possibly one of the most important. The members of ITER, China, The European Union, Russia, India, Japan, Korea, and The United States, are combining resources as 35 countries build the monster machine in southern France. ITER will aim to produce more energy than it uses, also known as “net energy”. ITER will also attempt to sustain a fusion reaction for long periods of time [10]. Both goals would be feats in nuclear research because neither have been accomplished before. ITER is a long-term project, with the first plasma not scheduled to be produced until 2025 [10]. If ITER can achieve its lofty goals, the energy industry will be changed forever. The possibilities are endless if we can successfully harness energy through fusion.

Where Nuclear Fusion Stands Today

Where we stand today, nuclear fusion is still decades away from being a practical energy source. Engineers still face many barriers on the path of being able to replicate fusion reactions. However, it should be in everyone’s best interest to invest time, energy, and money into a technology with so much potential. While resources such as wind, solar, biomass, geothermal, and hydroelectric have all shown promise, the best scientific minds in the world all agree that none are as powerful, efficient, or
economical as nuclear energy. Our society needs to do away with the negative light in which nuclear power is viewed, and understand that nuclear fusion is not only safe, but our best bet at long-term energy. Putting more research into tokamaks and tokamak-like technology is essential in achieving this goal. With the likes of WX-7 and ITER, engineers across the globe are getting us closer to a world where we can power our homes, automobiles, and entire society with clean and unlimited energy.

**SOURCES**


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