Nuclear Fusion, the Way of the Future?

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Outline

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   A. Fusion is the power source for the sun and stars. When you think of nuclear power, you probably think of death and destruction because of reactor meltdowns or nuclear bombs.
   B. If nuclear fusion is achieved, it can carry mankind into the next technological era. Nuclear fusion is safer than fission, but it still has radioactive waste.
   C. There are many positive sides to nuclear fusion as a power source to end the search for renewable energy. Is it possible, is it safe, and is it the power source of the future? If so, will it be available in time to save our planet?
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"Fusion is the power source of the sun and the stars" (Baird, 2005). When people think of nuclear energy, they probably think of the devastation caused by reactor meltdowns or nuclear bombs. The incidents themselves are not what make people weary of nuclear energy, but the radioactive fallout these incidents leave behind. Promising developments in fusion technology may be able to change the negative image of nuclear energy. Nuclear fusion produces an enormous amount of energy by fusing two hydrogen isotopes together. This method is more efficient and less dangerous than modern nuclear reactions. "Practical fusion would be a source of energy that is unlimited, safe, environmentally benign, available to all nations, and not dependent on climate or the whims of weather" (Baird, 2005). Fusion is the holy grail of green energy, but is it really possible? The disadvantage of nuclear fusion is just that: fusion is a new frontier of science and discovery. With that being said, it also costs an enormous amount of money and time. The latest project, International Tokamaks Experimental Reactor (ITER) is an experimental fusion reactor that is planned to be tested in 2028. The estimated price of this experiment is $12 billion (Baird, 2005). Until it is fully operational, the questions remains: is it possible, is it safe, and is it the energy source of the future? If so, will nuclear fusion be available in time to save our planet?

Scientists have viewed fusion as a potential energy source since the 1930's and have been quietly working on it since then. Fusion and fission are two very different ways of generating power through the manipulation of atoms. Fission is the process that is used presently and is the culprit behind nuclear energy's negative image. Nuclear fusion is the fusing of two atoms into one while fission is splitting atoms in half. Both emit energy, but fusion emits much more. Fusion is three to four times more efficient than nuclear fission, without risks

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of nuclear meltdown or dirty bombs ("What Is Fusion Energy?," 2016). Fusion reactors like the ITER are unable to have a meltdown because it has to be fed fuel, or it will burn out like a fire with no wood (Baird,2005). With fusion, there are no radioactive materials needed, such as uranium or plutonium, which are used in fission. Fusion uses deuterium, which is found in sea water and tritium, which is produced by a reaction between deuterium and lithium. "Researchers claim that the hydrogen isotopes in one gallon of water would yield the equivalent energy of three hundred gallons of gasoline" (Baird, 2005). Fusion is a very complex process were hydrogen isotopes have to be heated to temperatures up to 100 million degrees. In order to heat the atoms to such extreme temperatures, the atoms are suspended by magnetic containment fields. Once that the atoms are heated, they turn into a plasma, and the magnetic field pushes the atoms together, causing them to fuse together to form helium. As the atoms fuse, they produce an amazing amount of energy, but due to the enormous amount of power it takes to contain and heat the atoms, it has yet to yield a positive amount of energy. In 1997, the ITER's predecessor, JET, produced 16 megawatts of power but had an input of 24 megawatts. The ITER is a joint project between America, most of the European Union, Japan, China, Russia and South Korea that hopes to prove the potential of fusion. The program is being developed in France and is planned to be ready for its first test by 2028. The ITER is estimated to produce 500mw of power while only consuming 50mw (Ahlstrom,2016). If the test goes well, the fusion reactor could be commercially available as early as 2050 ("What Is Fusion Energy? ," 2016).

So, why should researchers be focusing on an unproven resource rather than focusing on proven renewable resources like wind, solar and hydro electrical? Although they are safe

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and have an unlimited fuel supply, they are both climate and geographically dependent and unable to meet the energy demands of an industrialized world. Fusion, however, is not dependent on climate or the whims of weather. A fusion reactor is fueled by deuterium and tritium, which are isotopes of hydrogen. “An isotope is a form of an atomic element that has a different mass from the normal element because of a different number of neutrons in the atomic nucleus“ (Baird,2005). Both isotopes are easy to extract and abundant in water. Deuterium is found in water, and tritium is created from a reaction between deuterium and lithium. The abundance of easily acquired fuel is why nuclear fusion remains a popular idea. The reason some still disagree with fusion reactors is because of the danger of an explosion or a meltdown. A meltdown could not occur in a nuclear fusion reactor, but if a fusion reactor were to explode, only the reactor site itself would be radioactive. Other than the ITER project, there are a few private companies pursuing nuclear fusion on a smaller scale. The Skunk Works team at Lockheed Martin is working on a compact fusion reactor that could yield results in under ten years. Skunk Works’ compact reactor is designed to fit on the back of a Simi truck and produces up to 100 MW of power. If the team succeeds in producing a compact fusion reactor, there could be unlimited applications. It could stabilize developing countries or be used to power future spacecraft. With the low fuel cost for the reactor, space travel could become much more frequent and allow mankind to travel farther into the cosmos (“Pursuing Compact Nuclear Reactor Concept,” 2014).

With all of the advantages fusion can bring, there are a few disadvantages. Nuclear fusion has been in development for over half a century and has yet to prove positive results. The cost of the ITER test reactor alone estimates around $12 billion. With that amount of

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money, would it be more beneficial to apply it toward expanding research of known renewable resources? Could more advanced research increase the energy production of solar panels or develop some kind of underwater wave turbine generator? The first test of the ITER is planned in 2028, but what if the test has negative results, and we find ourselves in an energy crisis that could have been avoid by simply buying $12 billion worth of solar panels or wind turbines? If the test is successful, how long would it take to replace fossil fuels? The ITER project does seem like a gamble, especially with its track record of expanding the timeline. "The original 2010 research plan foresaw the entire reactor being built by 2020, when ITER was also scheduled to produce its first plasma, using hydrogen as a test fuel" (Butler, 2013). To compensate for the time lost due to cash-flow problems, non-essential programs are being postponed until after the first test. The consequences for the postponements will cause the first test to only produce 100mw for a few seconds. The experiments related to steady-state ITER plasmas that are most likely to be delayed beyond 2028. After the test is complete, decades will be spent research how to produce continuous fusion. With that in mind, fusion is definitely not a viable option to our current energy crisis (Butler, 2013). If or when it becomes a prominent source of power, there is always the chance of it being weaponized. The compact reactors have the highest potential for this and could be used to power more devastating weapons. In today's world, we already have the means to destroy our planet using less powerful energy sources. Should we really risk creating a more powerful means to destroy ourselves?

There is no doubt that nuclear fusion is better than fission. Fusion can do much more with a lot less. It can produce three to four times as much energy, using water instead of uranium. Fusion has an unlimited fuel source and cannot have meltdowns. Fusion is the power

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source for the sun and the stars. It doesn't depend on the climate or geographical location. It has the potential to be fully mobile and take use farther into the stars. Fusion has great potential but at what cost? The billions of dollars spent on tests and research could yield results much sooner. Will it be available in time to save our planet or in time to destroy ourselves? The questions still remain: is it possible, is it safe, and is it the energy source of the future?

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References

Ahlstrom, D. (2016, February 6). Fusion is in fashion, and nuclear power is going green. *Irish Times.*

Baird, S. L. (2005, February 1). Creating a star: The science of fusion. *Technology Teacher*, (5), 17.

Butler, D. (2013). ITER keeps eye on prize. *Nature, 502*(7471), 282-3.

Pursuing compact nuclear fusion reactor concept. (2014, October 15). Lockheed Martin. *Transmission & Distribution World*.

What is fusion energy and how does it fare with environmentalists? (2016, August 15). EARTH TALK. *Charleston Gazette Mail*, p. 8A.

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