

DON'T SHELVES THE QUESTION FOR ANOTHER DAY

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Almost from the beginning of time, mankind has made feeble attempts to preserve the planet, caring little for the future consequences. In the last century some began to notice the depletion of fossil fuel, the rain forests and the ozone layer. But, for lack of understanding or the knowledge of where to begin, the question had always been shelved for another day.

Now another day has come! It is time to understand how to care for this planet and to do something about it! Now is the time to begin! As a student of architectural, engineering and mechanical design, I choose to move toward newer answers, as well as narrowing my focus to an achievable end such as, the generation of renewable energy at the home level. The ultimate achievement would be a fully self-contained, renewable energy system that creates energy without using external resources, and which does not add to pollution of land and air.

The sources of renewable energy which are being explored at the moment include biofuels, geothermal, wind, solar, water, and hydrogen in Regenerative Fuel Cells and nuclear fusion. Each of these sources has its own challenges and advantages which vary according to the location.

Biofuels include waste products from city, industry, and farms, plus crops grown specifically for the purpose. Collection and processing are the biggest challenges as all types of waste need careful handling due to toxicity and potential health risks. The waste is either put into landfills, where the methane gas is piped off to burn, or it is directly burned to create energy. This solves two issues – condensing of waste and creation of energy, but in doing so, it adds to other problems such as greenhouse gas emissions, air pollution and the depletion of the ozone layer.

Animal and crop waste, and crops grown specifically for energy creation all abound in arable climates. In the United States, many of the major farms are rushing to replace food crops with bio-fuel crops in an effort to “cash in” on the “cash crop” and solve the energy crisis. However, an old adage rears its head and sagely says, “Haste makes waste.”

A current article from the Discovery website states: “Biofuel Farming Looks to Be an Environmental Disaster. Growing corn for ethanol may increase greenhouse gases for over a century.” Written by Jennifer Barone and Amber Fields, the article sites statistics from two studies:

The first study, “Land Clearing and the Carbon Biofuel Debt” was by Joseph Fargione, regional science director at the Nature Conservancy. In this study, Fargione and his team took a close look at the areas in North and South America that are being denuded for the new biofuel crops. The Discovery article states that Fargione reported, “biofuels would cause higher total emissions for tens to hundreds of years. Some ecosystems had

surprisingly high emissions—grasslands in the United States converted to corn farms would increase carbon dioxide for 93 years.”

The second study, “Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions From Land Use Change” was by Timothy Searchinger, a researcher at Princeton University.

According to Barone and Fields, “Searchinger looked at a future scenario in which the United States substantially increases its production of corn-based ethanol, a move that would decrease domestic crops for food and feedstock. To show the effect of such changes, Searchinger and his colleagues simulated the worldwide land-use changes necessary to offset the production of 56 billion liters of ethanol in the United States (the amount of ethanol projected to be processed in 2016, based on current tax credits and conservative estimates of oil prices). Using an economic model created at Iowa State University, the researchers projected how much land farmers around the world would have to convert to feed-crop production, and where they would do it.”

Both studies, according to the Discovery article, “found that changes in land use related to biofuel production would be a significant source of greenhouse gases in the future.”

The next three renewable energy sources, wind, sun and water, can be used successfully without contributing to greenhouse gas emissions, air pollution and the depletion of the ozone layer.

Wind power has been used for centuries, and windmills are an iconic feature in many countries in Europe. But wind can be fickle, blowing from this direction or that – or not at all, so the challenge becomes storing the energy for later use. Large wind farms have been created in just about every conceivable situation, including along the coastlines of Europe and the United States, and in the hills of California. However, these wind farms create controversy as people consider them unsightly, and unpredictable due to the inconsistency of the wind, and issues with storing the electricity for later use, once it is created.

Solar energy is created by the sun and reaches the earth in the form of heat and light. It is the basis from which all other forms of energy are created. Solar energy technologies harness the sun’s energy, and translate it into electricity. These technologies have been used by humans ever since they could create their own dwellings, and evidence of this can be seen in Greek, Chinese and even Native American history. Documentation shows how these cultures oriented their homes to take advantage of the warmth of the sun.

Currently, one of the major forms of harnessing the sun’s energy is called photovoltaics, which converts sunlight into electricity. Due to the growing need for different types of energy sources, many research facilities and universities are devoted to developing photovoltaic arrays, and their handiwork can be seen sprouting in some very unusual

places, such as town squares where “Solar Trees” sprout among oaks and sycamores, and people stroll among them as if they had an ancient heritage similar to their wooden cousins.

Other arrays may be integrated in farmlands, sweeping across the countryside among the cornfields integrated or grazing cattle. Arrays are beginning to appear installed on the roofs of tall buildings in the center of towns and cities. Still other arrays can be seen lighting our garden pathways, powering emergency telephones long the side of the road, operating parking meters, and on the roofs of our homes.

Water energy needs little discussion as its technology has been around for a very long time. Water powered grist mills, canals, irrigation ditches and dams, from small earthen to massive hydro-electric ones producing enough electricity to light entire cities, all are evidence of man's understanding of the hydro-technologies.

Geothermal energy is another source of energy that has been recorded in the history books, or is evidenced in archaeological digs as having been used, at least fitfully, by man for thousands of years. There is much more to learn about geothermal energy, and it is possible that, it could tie into the area of energy to which the rest of this paper is addressed.

There is a challenge facing all forms of energy production, whether it be fossil fuel or one of the many renewable energies already discussed. How is the energy just created, stored for later use? More importantly, is there a process which can *continuously* create energy so that storage is not an issue? And if such an energy process does exist, can it be reduced in size to be usable in a single home?

Yes! The answer is yes! Such energy processes do exist! Right now they are being researched by NASA and other institutes around the world. At least two of these processes, Regenerative Fuel Cells, and Focus Fusion Reactors use Hydrogen combined with different elements to achieve the end result of creating *continuous* energy.

From The Online Fuel Cell Information Resource: “Hydrogen, the simplest element and most plentiful gas in the universe, is colorless, odorless and tasteless. Each hydrogen molecule has two atoms of hydrogen, which accounts for the H₂ we often see. Hydrogen is the lightest element, with a density of 0.08988 grams per liter at standard pressure, yet it has the highest energy content per unit weight of all the fuels – 52,000 Btu/lb, or three times the energy of a pound of gasoline.

“Hydrogen is never found alone on earth — it is always combined with other elements such as oxygen and carbon. Hydrogen can be extracted from virtually any hydrogen compound and is the ultimate clean energy carrier. It is safe to manufacture. And hydrogen's chemical energy can be harnessed in *pollution-free* ways.

“Hydrogen generated from diverse domestic resources can reduce demand for oil by more than 11 million barrels per day by the year 2040.”

To better understand the Regenerative Fuel Cell, a brief explanation of a fuel cell is in order. The Online Fuel Cell Information Resource web page says that a fuel cell operates like a battery, but does not run down or require recharging. The fuel cell will produce energy in the form of electricity and heat as long as fuel is supplied.

Quoting from this website, “A fuel cell consists of two electrodes sandwiched around an electrolyte. Oxygen passes over one electrode and hydrogen over the other, generating electricity, water and heat. Hydrogen fuel is fed into the "anode" of the fuel cell. Oxygen (or air) enters the fuel cell through the cathode. Encouraged by a catalyst, the hydrogen atom splits into a proton and an electron, which take different paths to the cathode. The proton passes through the electrolyte. The electrons create a separate current that can be utilized before they return to the cathode, to be reunited with the hydrogen and oxygen in a molecule of water.”

A Regenerative Fuel Cell is a fuel cell with a closed-loop system in which water is separated into hydrogen and oxygen, generating electricity, heat and water, and the process begins again.

In a NASA article on line entitled “Lighting up the Lunar Night” Electrical Engineer David Bents and his team at NASA's Glenn Research Center in Cleveland demonstrated in the summer of 2005, “the first fully closed-loop Regenerative Fuel Cell ever operated. The cell completed five continuous day and night cycle. . . (and) at the end of the demonstration, it had not leaked and was capable of running at least one more cycle.”

“What makes our Regenerative Fuel Cell unique is that it's closed loop and completely sealed,” Bents is quoted in the article as having said. “Nothing goes in and nothing comes out, other than electrical power and waste heat. The hydrogen, oxygen and product water inside are simply recycled over and over again.”

This project was originally intended for use on a high-flying airplane, but NASA intends to develop the system for future lunar exploration. However, the application of such a system here on earth is surely a priority.

The Regenerative Fuel Cell, even in the closed loop system, must have an outside energy source to activate its process. There is one more possibility which may yet achieve our goal of being a fully, self-contained energy system that creates energy without using external resources, and which does not add to pollution of land and air: Focus Fusion. Immediately we back off of the subject as we think about the horrible accidents that have occurred with reactor melt downs, but fusion is not fission and does not need to create radioactive materials.

There is fusion that does create radioactive materials. It uses deuterium and tritium. From the Focus Fusion Society web site. "Deuterium has one proton and one neutron. Tritium has one proton and two neutrons. When they come together there are two protons and three neutrons. This unstable configuration then splits into a helium atom (two protons and two neutrons) and a high energy neutron. These neutrons create heat and radioactive materials just as in a fission reactor."

However, in the Hydrogen-Boron₁₁ process used in Focus Fusion, the result is three helium atoms and energy, no radioactive waste. Again from the Focus Fusion Society, "Boron₁₁ is a common element that exists in the earth's crust and seawater. You may even have some in your house if you own a box of Borax. Hydrogen is the most common element in the universe and is even part of water as demonstrated by the formula H₂O. Helium is the second most common element in the universe and is what makes children's balloons and blimps float. None of these materials is radioactive."

More about Boron₁₁: Boron₁₁ is an atom that contains five protons and six neutrons. Boron exists naturally as 19.9% ¹⁰B isotope and 80.1% ¹¹B isotope. Boron₁₁ can fuse with a hydrogen atom (one proton, no neutrons.) This makes six protons and six neutrons which are exactly enough for three helium atoms with no left over neutrons. The helium atoms then fly off at high speeds carrying the fusion energy."

From the Discovery Magazine, June, 2008 article, "FUSION ON TAP," the Plasma physicist Eric Lerner is quoted as saying that focus fusion is "a form of nuclear energy so clean it generates no radioactive waste, so safe it can be located in the heart of a city."

The article describes the focus fusion in layman's terms. "Focus fusion is initiated when a pulse of electricity is discharged through a hydrogen-boron gas across two nesting cylindrical electrodes, transforming the gas into a thin sheath of hot, electrically conducting plasma. This sheath travels to the end of the inner electrode, where the magnetic fields produced by the currents pinch and twist the plasma into a tiny, dense ball. As the magnetic fields start to decay, they cause a beam of electrons to flow in one direction and a beam of positive ions (atoms that have lost electrons) to flow in the opposite direction. The electron beam heats the plasma ball, igniting fusion reactions between the hydrogen and boron; these reactions pump more heat and charged particles into the plasma. The energy in the ion beam can be directly converted to electricity — no need for conventional turbines and generators. Part of this electricity powers the next pulse, and the rest is net output."

From all of this information gathered and reported, is it possible to say that we have found a fully, self-contained energy system that creates energy without using external recourse, which does not add to the pollution of land and air? And if so, can it, or has it been reduced in size to be usable in a single home?

The answer is, yes! There are ways of creating continuous energy and also of storing it, if needed. The Focus Fusion is an excellent idea, and, although it still faces many challenges with its process, and the stigma of its atomic relatives, it has great potential.

The Regenerative Fuel Cell with the closed loop system developed by the NASA team will not be far behind in being developed as a usable size system for home use. Its predecessors have paved the way, as, according to The Online Fuel Cell Information Resource, "More than 2500 fuel cell systems have been installed all over the world — in hospitals, nursing homes, hotels, office buildings, schools, utility power plants - either connected to the electric grid to provide supplemental power and backup assurance for critical areas, or installed as a grid-independent generator for on-site service in areas that are inaccessible by power lines. Fuel cells can replace batteries to provide power for 1kW to 5kW telecom sites without noise or emissions, and are durable, providing power in sites that are either hard to access or are subject to inclement weather. Such systems would be used to provide primary or backup power for telecom switch nodes, cell towers, and other electronic systems that would benefit from on-site, direct DC power supplies." Other places that have taken advantage of fuel cells are landfills, waste-water treatment plants and breweries. The auto industry, portable power tools, even laptops, all use fuel cells.

Another day has come, and the question is now being addressed.

Is it in time?
Will the planet survive?
Will mankind survive?
That remains to be seen.

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