The Sustainability of Green Energy in Today's Society And the Effects it has on the Economy

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ABSTRACT

There exist many problems today with the society. These problems range from environmental problems to economical problems. One of the leading problems at this present time is high gas prices. This project will analyze various forms of green energy and the effect that they will have on the economy. Green energy is power produced from renewable energy sources coupled with improvements and energy efficiency. This type of energy is also commonly referred to as renewable energy. Green energy is also described as any type of energy that is not harmful to the environment. Many different types of green energy exist right now and many types are being experimented in society today. The type of green energy that will be the basis for my research is fuel cells. Fuel cells are energy conversion devices that chemically transform the energy stored in a fuel into electricity and heat. The fuel is not burned, but oxidized electrochemically. Like a battery, these cells convert chemical energy directly into electricity. Numerous types of fuel cells exist such as: solid oxide fuel cells, molten carbonate fuel cells, solid polymer fuel cells, hydrogen fuel cells, phosphoric acid fuel cells, alkaline fuel cells, and direct methanol fuel cells. The two leading fuels cells in the automotive industry are hydrogen fuel cells and direct methanol fuel cells. Toshiba, Toyota, General Motors, and Mercedes Benz are some of the automotive vendors that are adding fuel cells to their cars for power. This research project will be completed in order to find the effect that green energy, fuel cells in particular , have on the economy, as well as which type would be a better power alternative for the automotive industry. This research will be done on how frequently these two types of fuel cells are used in the automotive industry. Calculations and comparisons of the total costs and savings from using these fuel cells will also be done. This research will be completed under the guidance of my mentor.

Introduction

Ninety-eight percent of the electricity produced in he United States comes from non-renewable sources such as polluting fossil fuels and nuclear power. These resources are used every time we turn on a light, vacuum the house, and even iron our clothes. Along with electricity, coal burning, gasoline fueled vehicles and propane come many environmental and economical issues. The issue that caught my attention was the issue of gasoline fueled vehicles in relation to the economy and environmental safety. Gasoline fueled vehicles are one of the leading causes of air pollution. 135 billions of gallons of gasoline are lost each year through the exhaust and coolants of passenger vehicles alone. Heavy duty trucks waste 32 billion gallons of diesel each year. When the hurricanes came through this year and damaged the coast, they put a damper on our nation's source of gasoline. Since the hurricanes hit, gas prices have been on the rise and there has been a shortage of gas all over the country. This brought about my concern for a cheaper, more environmentally safe gas alternative. This research is being conducted in order to find the best alternative for environmentally unsafe electricity and power and the best alternative for the economy.

The History of Green (Renewable) Energy

The larger portion of the population's electricity is generated by burning coal, which creates the greenhouse gas pollution that contributes to global warming and climate change.[3] This was a great problem in the United States until green energy came into the picture. Green energy captures its energy from existing energy produced by natural processes. Some of these natural processes include sunshine, wind, flowing water, biological processes, and geothermal heat flows. These energies are also energies that are not harmful to the environment. That is why this energy is called green energy. The majority of renewable energy comes from the sun. The power from this green energy is electricity generated from clean, renewable sources of power.

Throughout history, various forms of renewable energies and non-renewable energies have been used. The earliest manipulated source of energy by a human was wood. Wood was used as a thermal energy source and can still be found being used today as a thermal energy source in fireplaces across the country. Wood was burned for both cooking and heating up the family's home. Special types of wood cooking and smoke curing enabled the family to safely store perishable food items throughout the year. It was later discovered that wood caused partial combustion when being burned in the presence of oxygen and could produce charcoal. This provided a hotter and more portable energy source. However, this was not a more efficient energy source, because it required a larger input of wood in order to make the charcoal.

Another form of a historical energy source was animal power. Animal power was used for vehicles and mechanical devices. This was originally produced through animal traction. Animals such as horses and oxen provided transportation and powered mills. The oils from animals, especially whales, were used for oil for a long burning light.

Hydroelectric Power-Green Energy Source

Water power eventually took the place of green energy. Archaeologists have discovered descriptions of water wheels used for grinding grain that date back to more than 3,000 years ago. Today, the energy of falling water is used mainly to drive electrical generators at hydroelectric dams. The figure below (Figure 1.) is a picture of a homemade hydroelectric generator. These can be made using wire, magnets, a plastic jug, vinyl tubing, and other household materials.

Figure 1. Homemade Hydroelectric Generator

As long as snow and rainfall can fill the streams and rivers, moving water can be a renewable source of energy. Water power uses hydroelectricity and continues to be the least expensive when storing and generating dispatchable energy. Hydroelectricity provides more renewable energy than any other renewable source throughout the world. The energy in the water can be used in the form of thermo electro motive energy or temperature differences.

Figure 2. Conventional Water Mill

The oldest machines for capturing the energy of moving water were waterwheels. In the days before electricity, it was common to use water wheels (mills) to provide the power for mills that ground grain or cut lumber. To start the mill, the miller simply opened a gate to let the water flow over the top of the wheel. The water wheel was connected to a massive millstone or metal saw blade through a system of gears. Water for the wheel usually came from a small dam and reservoir, called the Millpond (Figure. 2). Since water is about a thousand times heavier than air, even a slow flowing stream can yield a large amount of energy. Water power comes in many forms, such as tidal power, tidal stream power, wave power, ocean thermo-electric energy conversion, and deep lake water cooling. Tidal power captures energy from the tides flowing in the horizontal direction. Tides come in and raise the water levels in a basin, and tides roll out. The water passes through a turbine to get out of the basin. Tidal stream power acts the same as tidal power, except for it is done vertically. It captures the stream of the water as it is moved around the world by tides. Wave power uses the energy in the waves. Ocean thermo-electric conservation (OTEC) uses the temperature difference between the warmer surface of the ocean and the cool lower recesses. It employs a cyclic heat engine. Deep lake water cooling is not technically an energy generation method, but it saves a lot of energy in the summer season. It uses submerged pipes as a heat sink for climate control systems.

Geothermal Energy

Geothermal energy is also related to the renewable energy family. It can be used as geothermal electricity, geothermal heating (through deep earth pipes), and geothermal heating (through a heat pump). Geothermal energy comes from very hot (about 600◦) material in the earth's core, which heats the earth from inside out. Geothermal energy is found in different places on earth because it the energy is closer to the core of the earth and closer to the surface in some areas. To receive geothermal energy, one must simply pump a fluid whether it is oil or water, from the earth and allow it to evaporate. Once the liquid begins evaporating, the hot gases vented from the earth's crust can run turbines linked to electrical generators. Geothermal energy from the surface of the earth can be used on most of the globe directly to heat and cool buildings.

Energy from Wind Power

Currently, wind is the fastest growing source of electricity in the world.[7] Wind power has been used for several hundred years. As the sun heats up, the earth forms uneven winds. From these winds, kinetic energy is used to run wind turbines (Figure.3) at approximately 5 miles per hour.

Figure 3. Modern Windmills

It was originally used by a large sail-blade windmill with slow moving blades. The windmills either pumped water or powered smaller mills. New wind farms and offshore wind parks are being planned and built all over the world.

Solar Energy

Solar power was and still is being used as a direct energy source. It was not used by mechanical systems until recently. Solar power has many different uses as do most renewable energy sources. Solar power can be used to generate electricity using solar cells, generate electricity using thermal power plants, generate electricity using solar towers, and heat buildings directly, through heat pumps, and through solar ovens. Solar cells are often used to power batteries, as most other applications would require a secondary energy source, to cope with outages.

Renewable Energy in the Form of Biomass

Biofuel is any fuel that is derived from biomass, which is recently living organisms or their metabolic byproducts. An example of this is manure from cows. Plants use photosynthesis to store solar energy in the form of chemical energy. Biofuel is typically burned to release its stored chemical energy. Liquid biofuel is usually bioalcohol such as methanol, ethanol, and biodiesel. Biodiesel can be used in modern diesel vehicles with little or no modification and can be obtained from waste and crude vegetable and animal oils and lipids. In some areas, corn, sugar beets, cane, and grasses are grown specifically to produce ethanol to be used in internal combustion engines and fuel cells. Direct use is usually in the form of combustible solids, either firewood or combustible field crops. Field crops may be grown specifically for combustion or may be used for other purposes and the processed plant waste then used for combustion.

Many organic materials can release gases due to metabolisation of organic matter by bacteria. Landfills need to release biogas in order to prevent dangerous explosions. Biogas can be produced from current waste streams, such as: paper production, sewage, and animal waste. These various waste streams have to be slurred together and allowed to naturally ferment and produce methane gas. Biogas production has the capacity to provide us with about half of our energy needs, either burned for electrical productions or piped into current gas lines for use.

Fuel Cells

A fuel cell is an electrochemical energy conversion device. A fuel cell converts the chemicals hydrogen and oxygen into water, and in the process it produces electricity.[13] With a fuel cell, chemicals constantly flow into the cell so it never goes dead. As long as there is a flow of chemicals into the cell, the electricity flows out of the cell. Most fuel cells in use today use hydrogen and oxygen as the chemicals. A fuel cell provides a DC (direct current) voltage that can be used to power motors, lights or any number of electrical appliances. These fuel cells work like batteries but do not run down or need recharging. These fuel cells consist of two electrodes, a negative electrode (or anode) and a positive electrode (or cathode). These electrodes are sandwiched around an electrolyte. Hydrogen is fed to the anode, and oxygen is fed to the cathode. Activated by a Platinum catalyst, hydrogen atoms separate into protons and electrons, which take different paths to the cathode. The electrons go through an external circuit, creating a flow of electricity. The protons migrate through the electrolyte to the cathode, where they reunite with oxygen and the electrons to produce water and heat. Fuel cells can be used to power vehicles or to provide electricity and heat to buildings. Fuel cell technology is extremely interesting to people in all walks of life because it offers a means of making power more efficiently and with less pollution. The fuel cell will compete with many other types of energy conversion devices, including the gas turbine in your city's power plant, the gasoline engine in your car and the battery in your laptop. Combustion engines like the turbine and the gasoline engine burn fuels and use the pressure created by the expansion of the gases to do mechanical work. Batteries converted chemical energy back into electrical energy when needed. Fuel cells should do both tasks more efficiently. There are several different types of fuel cells, each using a different chemistry. Fuel cells are usually classified by the type of electrolyte they use. Some types of fuel cells work well for use in stationary power generation plants. Others may be useful for small portable applications or for powering cars. Pollution reduction is one of the primary goals of the fuel cell. By comparing a fuel cell powered car to a gasoline engine powered car and a battery powered car, you can see how fuel cells might improve the efficiency of cars today. These three types of cars have many of the same components; nevertheless the cars' efficiencies can be compared up to the point where the mechanical power is generated. The Fuel-Cell-Powered Electric Car is powered with pure hydrogen. It has the potential to be up to 80-percent efficient. That means it converts 80 percent of the energy content of the hydrogen into electrical energy. The efficiency of a gasoline-powered car is very low. All of the heat that comes out as exhaust or goes into the radiator is considered to be wasted energy. The engine also uses a lot of energy turning the various pumps, fans, and generators that keep it going. Thus, the overall efficiency of an automotive gas engine is about 20 percent. That means that only about 20 percent of the thermal-energy content of the gasoline is converted into mechanical work. The battery-powered electric car has a fairly high efficiency. The battery is about 90-percent efficient, and the electric motor/inverter is about 80-percent efficient. This gives an overall efficiency of about 72 percent. While the fuel cell is a very helpful solution to global warming, it does have some disadvantages. These disadvantages include finding safe ways to store hydrogen, reducing the cost of electric vehicles, creating durable vehicles, and developing filling stations that offer hydrogen.[9]

Proton Exchange Membrane Fuel Cell (PEMFC)

The proton exchange membrane fuel cell (PEMFC) uses one of the simplest reactions of any fuel cell. The electrolyte is the proton exchange membrane. This specially treated material, which looks something like ordinary kitchen plastic wrap, only conducts positively charged ions. The membrane blocks electrons. Proton Exchange Membrane Fuel Cells operate at fairly low temperatures, which mean they warm up quickly and don't require expensive containment structures. Improvements in the engineering and materials used in these cells have increased the power density to a level where a device about the size of a small piece of luggage can power a car.[10]

Direct Methanol Fuel Cells (DMFC)

Direct methanol fuel cell is developed to tackle the fuel storage problem of hydrogen, and also eliminate the need of a reformer to convert methanol to hydrogen for a hydrogen fuel cell to work. The technology behind Direct Methanol Fuel Cells (DMFC) is still in the early stages of development, but it has been successfully demonstrated powering mobile phones and laptop computers. These two devices are the potential target end uses in future years. Direct Methanol Fuel Cells are similar to the PEMFCs in that the electrolyte is a polymer and the charge carrier is the hydrogen ion (proton). However, the liquid methanol (CH_3OH) is oxidized in the presence of water at the anode generating CO_2, hydrogen ions and the electrons that travel through the external circuit as the electric output of the fuel cell. The hydrogen ions travel through the electrolyte and react with oxygen from the air and the electrons from the external circuit to form water at the anode completing the circuit. These fuel cells were initially developed in the early 1990s, but they were not employed because of their low efficiency and power density, as well as other problems. Improvements in catalysts and other recent developments have increased power density twenty fold and the efficiency may eventually reach 40%. These cells have been tested in a temperature range from about 50ºC-120ºC. This low operating temperature and no requirement for a fuel reformer make the DMFC a model candidate for very small to mid-sized applications, such as cellular phones and other consumer products, up to automobile power plants. One of the drawbacks of the DMFC is that the low-temperature oxidation of methanol to hydrogen ions and carbon dioxide requires a more active catalyst, which typically means a larger quantity of expensive platinum catalyst is required than in conventional PEMFCs. This increased cost is, however, expected to be more than outweighed by the convenience of using a liquid fuel and the ability to function without a reforming unit. Direct Methanol Fuel Cell was developed to eliminate the fuel storage problem of hydrogen, and also eliminate the need of a reformer to convert methanol to hydrogen for a hydrogen fuel cell to work.[13]

Today many companies have begun to convert to fuel cells for their source of energy, and many companies are experimenting with the idea. One of the companies experimenting with fuels cells is NASA. Currently they are testing Proton-Exchange-Membrane fuel cells in order to see if they can be a main part of space missions in the near future. NASA has a fuel cell testing facility called the NASA Glenn Research Center, which can test fuel cells up to 125 kW. After testing is complete with the PEMFC at the fuel cell research center, the engineering model will undergo tests at the Johnson Space Center in Houston, Texas. After all tests have been completed and simulated, the technology will be applied to future space missions.[7] Mark Jacobson of Stanford University conducted a study on diesel fueled vehicles. When these gasoline-fueled vehicles were switched over to diesel fuels there was an increase in surface ozone over 75% of the southeastern portion of the United States. There was a slight decrease over the remaining surface. It has been promoted that diesel fueled vehicles obtain 20 to 30% better mileage than equivalent gasoline vehicles. This improved fuel efficiency should result in lower emission of compounds that lead to the production of carbon dioxide.[2] The Navy is working to bring diesel fuel cell technology onboard (R) to power its ships. It is looking at a method to extract hydrogen from diesel fuel. A diesel reforming system would take advantage of the relative low cost of the fuel. The navy's shipboard gas-turbine engines typically operate at 16% to 18% efficiency. The fuel cell system that the Office of Naval Research is developing will be capable of between 37% and 52% efficiency. In July of 2004 Toshiba announced its new development in fuel cell. This particular fuel cell was a fuel cell that weighs 8.5 g (0.3 oz) and can produce up to 100 mW of power.[11]

Conclusion

From a review of the recent technologies it appears to be difficult to choose one method of power generation over the other. However, if the focus of the industry or mankind is to preserve the environment there are not many sources of green energy available. Most of them have been described above in a basic manner, though more researches are continuously pouring in to advance the technology. The new fuel cells will take over the economy and improve the environment by producing pure water as a byproduct. Other green power methods will always compete, but they would need a lot of subsidy in many different forms.

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