International Journal of Scientific & Engineering Research, Volume 7, Issue 4, April-2016
ISSN 2229-5518

Bioenergy: The Current Energy Source

Thamer Altuwaijri

Abstract— This research paper discus the advantages and disadvantages of the current energy source, bioenergy.

Introduction

Though not typically mentioned as often as fossil fuels, bioenergy has its own advantages and disadvantages as a current energy source. Unlike many energies such as solar and water, bioenergy has been used and utilized by many groups on a regular basis. It is not a new form of technology, through processes to manufacture, refine, and burn bioenergy is always changing.

Bioenergy has a distinction from fossil fuels, in that it is derived from materials such as wood, straw, or animals wastes that were living relatively recently (Boyle, 106). However, fossil fuels, in contrast involve utilizing living things from sometimes millions of years ago. Though it may not seem to be the case, the significance of this distinction is large.

Bioenergy involves converting recently living things to fuel which are readily available. However, with fossil fuels, the rate at which they are being use relative to the supply is high. Therefore, we are using up fossil fuels way quicker than our ability to generate more, since they take so long to be useful.

Bioenergy uses recently living items, which can be cultivated and with proper planning, usage, and conservation efforts can make them beneficial and useful without any fear that there would become a short supply.

Though bioenergy has some significant advantages over fossil fuels, there are some distinct disadvantages to utilizing this energy source. There are many considerations to the overall effect that bioenergy has on the environment and the lifecycle of living organisms. Also, even if there is an advantage over fossil fuels, bioenergy does not always make sense when compared to other renewable and sustainable energy sources.

However, with around 2,000 billion tonnes of total mass in living matter, including moisture, 1,800 billion tonnes of total mass in land plants, and 1,600 billion tonnes of total mass in forests, there is certainly an opportunity to capitalize on bioenergy as a way to prevent the overuse and eventual extinction of current available fossil fuels that are not readily able to be recreated.

Science of the Energy

The science behind this energy involves the small chemical and physical processes that occur within plants, the soil, and living things. The bioenergy cycle begins when energy becomes stored in the carbohydrates in plants and dissipated in the plant, the soil and surrounding atmosphere and other living matter, until it is eventually radiated away from the earth as heat (Boyle, 106). For many living things, this biomass is lost within a year, but some biomass can accumulate and store in living things such as trees for decades (Boyle, 106).

When this biomass is captured when it is a chemical energy, you can use this energy as fuel. The benefit to this process is that as long as the consumption of this energy does not exceed the natural level of production, this process should generate no more heat and create no more carbon dioxide than would have been formed in any case by natural processes (Boyle, 106). As long as done through the right processes and in moderation, this makes the energy considered "sustainable".

Only some materials can burn to create biomass fuel. That is because only some materials can provide the chemical reaction of "combustion" which is necessary in order for there to be any form of fuel. In order for there to be combustion, there are three things that are necessary, all of which are needed to create energy (Boyle, 109):

It needs air – specifically oxygen

The fuel must undergo a significant change – where the fuel disappears

The energy must be released – this is where heat is produced

One reason that biomass energy is seen as sustainable is in the fact that it can be recreated. In the steps above, there is no outline of how this energy, once released, can once again become combustible. One very important key element in keeping the cycle continuing is through the sun. The solar element recreates fuel and oxygen (Boyle, 111). Plants take in carbon dioxide and water from their surroundings and use energy from sunlight to convert these into their "vegetable matter", which is sugars, starches, and cellulose (Boyle, 111). This process is called "photosynthesis" (Boyle, 111).

This energy can be converted and then transported into a secondary carrier (IEA Bioenergy, 4). There are many different routes to get the energy from its first state into a source that can be used for heat, electricity, or fuels (IEA Bioenergy, 4). The

International Journal of Scientific & Engineering Research, Volume 7, Issue 4, April-2016
ISSN 2229-5518

chart below shows the different methods in which energy can be transported from its original reaction to a final energy source (IEA Energy, 4):

History of the Energy

Initially, the main source for biomass was in the burning of firewood, rice husks, and other plant and animal residues (Boyle, 106). This is still utilized in developing countries and on a much smaller scale in the developed countries (Boyle, 106). This is considered "traditional biomass" as it has been utilized for thousands of years (Boyle, 106).

Though wood is seen as the first key component to have been burned, there is also evidence of coal-burning as early as 3,000 years ago (Boyle, 108). However, there was not a major contribution to the practice until about 200 years ago (Boyle, 108). This was when coal charcoal was produced and became the growing energy throughout the industrialized world, as the most used material (Boyle, 108). It was not until the twentieth century, that oil and natural gas began to rise, while coal was also increased five times in consumption between 1900 and 2000 (Boyle, 108).

Though fossil fuels have taken over the major consumption in industrialized countries, biomass has been used historically and still in present day for developing countries. Though hard to determine, there is about a third of energy consumption in developing countries that comes from biomass (Boyle, 108). However, this number can be up to 90% in some of the poorest countries in the world (Boyle, 108). This is in contrast to developed countries, which has seen a sharp decline since fossil fuels have become a primary source of energy.

There is a newer form of bioenergy that has evolved over the last couple of decades called "new biomass" (Boyle, 106). This new type of bioenergy comes from materials that are processed on a large or commercial scale and is utilized by industrialized countries (Boyle, 107). The hopeful end result of these activities is the output of heat or solid, liquid, or gaseous biofuels that come from purpose-grown energy crops or organic wastes.

Bioenergy Uses

As discussed and outlined above, there are many uses for bioenergy. The most common and easiest to understand involve the burning of materials for heat. However, by storing these processes, many other uses of bioenergy can be used for later consumption and creation of energy through new biomass. All of these processes, if done correctly can help to create sustainable energy.

The first major use of bioenergy comes from energy crops. Energy crops are grown specifically for use as fuel or conversion into biofuels (Boyle, 114). This includes the process of growing trees for wood for burning, but also for plants that can ferment to ethanol, as well as crops which have seeds that are rich in oils, not for consumption (Boyle, 114). The most widely grown crops for bioenergy purposes are sugar cane and maize, which have high yields that are needed for potential conversion into liquid fuels (Boyle, 116).

Another commonly forgotten bioenergy source comes from "wastes". This is the wastes that result from the cultivation of materials that can also be used as fuel sources if harvested appropriately (Boyle, 117). For instance, if there are operations that are taking down trees in order to produce biomass, there are "forestry residues" which retain nutrients that can be harvested for heat and/or power generation (Boyle, 117). This same method can be applied to residues from wheat and maize. There has been a new market for space heating which can use leftover crops that are overgrown to make a profit, rather than burning in fields and potentially causing air pollution. Animal wastes, such as animal manure, sewage sludge, and poultry litter have also been used in the same manner, with strict control being essential to the preservation of these fuels as a good source of energy without compromising the environment through overuse or bad management of the residue.

Current Bioenergy Practices

In order for bioenergy to be a preferred energy choice over fossil fuels, the methods or collecting, storing, and using the potential energy must be without significant loss or have greater output than the fossil fuels. That is why it is important to focus on how the combustion process is used for certain materials.

Some processes have not changed dramatically over time, as their system of combustion is very simple. For the combustion of wood and crop residues, as well as charcoals, the process is done through burning. However, for wood and crop residues, this is very inefficient. When burning wood or crop residues to make water boil, for example, much of the energy is lost through vapors that escape around the boiling water and creates a major loss in potential energy capture (Boyle, 124).

Charcoal is slightly better at retaining energy. Charcoal is produced in forests, where stacked wood covered with the earth smolders for a few days, and with the absence of air creates a piece of material that is almost pure carbon, and is twice as dense and the original wood (Boyle, 124). This burns at a much higher temperature and creates a

International Journal of Scientific & Engineering Research, Volume 7, Issue 4, April-2016
ISSN 2229-5518

fuel which is much more efficient than the prior processes of using wood and crop residues (Boyle, 124). However, this process releases vaporized tars and oils through incomplete combustion, and makes the most greenhouse gas intensive in the world (Boyle, 124).

Environmental Impacts

There are environmental impacts that must be considered for each of the types of bioenergy listed above which may make the type of bioenergy more or less sustainable than other types of fuel, as well as compared to fossil fuels. Since there are so many different ways to create energy, it becomes important to compare these pros and cons in order to make good decisions about where to take energy sources into the future.

The first is with energy crops. Though it may be seen as a very sustainable source, there can be a major problem with the deforestation of areas in order to gain the materials required for combustion. Though crops are capable of being regrown year after year, when it comes to the production of timber in order to generate combustion, trees must be brought down for wood. Trees cannot be regenerated at a rate that will keep this practice sustainable unless carefully controlled and regulated. Not only is timber being collected for biofuels, but also for the expansion of cities, and combined they could be detrimental to the goal of creating sustainable energy.

There has been an environmental impact for wastes as well. Though the actual uses of wastes are good for the environment, as all parts of a living crops material is being used for the benefit of something else, if wastes are not treated this way there can be problems. For instance, if there are leftover crop residues, many farmers have in the past resorted to the burning of these crops in order to make way for the next season of farming. This can be very harmful to the environment, because it can create air pollution. The concerns of air pollution even led to the ban of field burning in 1992 in the United Kingdom (Boyle, 117). Animal wastes can become an issues of not only pollution in a normal sense, but also of waterways which can be harmful to those living things who use the water sources (Boyle, 119). This means that it is extremely important for the animal wastes that naturally occur to be managed when they are created on a very large scale due to large farming efforts.

The Current State of Bioenergy

One of the primary goals in the research of bioenergy is to produce liquid biofuels as substitutes for fossil fuels. Currently there are three types of approaches which can be utilized in order to create liquid fuels (Boyle, 133):

Thermochemistry- This is the oldest method of producing liquid fuels from biomass. The aim with this method is to collect all of the volatile components of biomass and condense them to produce a liquid fuel (Boyle, 133). This is accomplished through the heating of bio-material with a controlled air supply (Boyle, 133). When not burned, the resulting reactions create oils, acids, water, solid char, and uncondensed gasses, which in total have about half of the energy of crude oil (Boyle, 133). This can be used as an oil substitute for heating or power generation (Boyle, 133).

Synthesis- Synthesis occurs through shift reaction, which adjusts the hydrogen and carbon monoxide (Boyle, 134). These molecules are passed over at high temperature and pressure and form a gas, which can be condensed and utilized into a form of energy that can be stored (Boyle, 134).

Fermentation- Ethanol can be produced through an anaerobic biological process when sugars are converted to alcohol through the actions of a micro-organism (Boyle, 134). This micro-organism, usually yeast, creates ethanol, which though not a direct substitute for petrol, can be used as a gasoline extender (Boyle, 134). This helps to extend the life of fossil fuels by supplementing the amount needed for gasoline, and with better technologies and improvement, this could become more than a simple supplement, and actually the main source of fuel for vehicles.

The Future of Bioenergy

In order for bioenergy to be a welcome successor of fossil fuels, more must be learned about how bioenergy works and how sustainable it has the potential to be. One thing that is worrisome about the energy is that there is no precise data that shows actual efforts to use bioenergy, as well as definitive statistics as to the effects that these may have on the environment. All information is merely guesswork based on average consumption and small-scale tests. What could be very detrimental to the energy would be if bioenergy, if adopted on a large scale to replace fossil fuels, ended up doing more harm to the environment then the depletion of fossil fuels has already. With very big concerns with air pollution and deforestation, these should not be taken lightly.

However, there are movements in the right direction to both develop knowledge as well innovate the processes. The United States Department of Energy has developed a Knowledge Discovery Framework to help map the future of bioenergy with GIS and other data and tools (US

International Journal of Scientific & Engineering Research, Volume 7, Issue 4, April-2016
ISSN 2229-5518

DOE, 1). They have created this framework with the vision of helping facilitate informed decision making and providing a means to synthesize, analyze, and visualize vast amounts of information (US DOE, 1). A GIS is a Geographic Information System, which creates data points for all locations and can be critical to planning and deploying renewable energy technologies, which includes larger biomass production capabilities (US DOE, 1). This can also help to improve efforts on better air quality, water resources, land conservation, and other environmental goals by having this data readily available (US DOE, 3).

In order to have bioenergy be a key player in finding a solution to the depleting fossil fuels, a roadmap has been set out by the International Energy Agency. The following must be observed in order to create a bioenergy framework that is sustainable (International Energy Agency, 6):

- Create a stable, long-term policy framework for bioenergy
- Introduce efficient support for mechanisms
- Increase research efforts on development of bioenergy feedstock and land sustainability mapping.
- Replace traditional biomass use through more efficient stoves and clean fuels
- Support the installation of more pilot and demonstration projects
- Set medium-term targets for bioenergy
- Implement internationally agreed sustainability criteria indicators and assessment methods
- Introduce international aligned technical standards for biomass and biomass intermediates
- Support international collaboration on capacity building and technology transfer

If these can be followed, the International Energy Agency believes that there can be a bright future for bioenergy. This will help set standards which, if followed by all countries, can help bring sustainable energy around the world with less reliance on fossil fuels.

References

[1] Boyle, Godfrey. Renewable energy: Power For Sustainable Future. Oxford. 2nd Edition. 2004. Print.
[2] IEA Energy. "Potential Contribution of Bioenergy to the World's Future Energy Demand." Implementing Agreement on Bioenergy. 2007. Print.
[3] International Energy Agency. "Technology Roadmap- Bioenergy for Heat and Power". IEA Publications. May 2012. Print.
[4] U.S. Department of Energy. "Bioenergy Knowledge Discovery Framework." U.S. Department of Energy – Energy Efficiency & Renewable Energy. July 2013. Print.