International Journal of Scientific Engineering and Applied Science (IJSEAS) – Volume-3, Issue-2,February 2017
ISSN: 2395-3470
www.ijseas.com

The Use of Biomass as an Alternative Energy

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Abstract

The focus of the research is to investigate the advantages of biomass as an alternative energy source to prevent or reduce the additional emissions of greenhouse gases; that is released from the conventional fuels combustion. A study also put a spot of light on the potential of different sources which can produce good amount of biomass as fuel feed stock. It is clear that biomass can be used as an alternative source of energy if the mentioned recommendations are done.

Introduction

Biomass is the term used for all organic material originating from plants including trees and crops and is essentially the collection and storage of the sun's energy through photosynthesis. Biomass energy, or bioenergy, is the conversion of biomass into useful forms of energy such as heat, electricity and liquid fuels. It is organic, carbon-based, material that reacts with oxygen in combustion and natural metabolic processes to release heat. Such heat, especially if at temperatures >400 _C, may be used to generate work and electricity. The initial material may be transformed by chemical and biological processes to produce biofuels. The term bioenergy is sometimes used to cover biomass and biofuels together. Biomass is usually not considered a modern energy source, given the role that it has played, and continues to play, in most developing countries. Because it was the first energy source harnessed by humans and for nearly all of human history, wood has been our dominant energy source. Only during the last century, with the development of efficient techniques to extract and burn fossil fuels, replaced wood as the industrialized world's primary fuel. It considered as a renewable resource so far as its production is continued in a sustainable way.

1. Types of Biomass

Biomass feedstock come in a variety of forms and has different properties that impact their use for power generation. There is a wide range of biomass feedstock and these can be split into whether they are urban or rural.***(1)Rural Biomass feedstock***, ***(2) Urban Biomass feedstock***,

2. Biomass Conversion Methods

Bioenergy can be converted into power through two ways:

1. Thermo-chemical processes include combustion, gasification and pyrolysis.
2. Bio-chemical processes like anaerobic digestion.
3. Agro-chemical processes include fuel extraction and biodiesel.

Power generation from biomass can be achieved with a wide range of feedstock and power generation technologies that may or may not include an intermediate conversion process. In each case, the technologies available range from commercially proven solutions with a wide range of technology suppliers (e.g. solid fuel combustion) through to those that are only just being deployed at commercial scale [1].

3. Thermo-chemical Processes

3.1 Combustion

Direct combustion remains the most common technique for deriving energy from biomass for both heat and electricity production. In colder climates domestic biomass fired heating systems are widespread and recent developments have led to the application of improved heating systems which are automated, have catalytic gas cleaning and make use of standardized fuel (such as pellets). The efficiency benefit compared to open fireplaces is considerable with advanced domestic heaters obtaining efficiencies of over 70 percent with greatly reduced atmospheric emissions. The predominant technology in the world today for electricity generation from biomass, at scales above one megawatt, is the steam-Rankine cycle. This consists of direct combustion of biomass in a boiler to raise steam which is then expanded through a turbine. The steam-Rankine technology is a mature technology introduced into commercial use. Steam cycle plants are often located at industrial sites, where the waste heat from the steam turbine is recovered and used for meeting industrial process heat needs. Such combined heat and power (CHP), or cogeneration, systems provide greater levels of energy services per unit of biomass consumed than systems that only generate power. An alternative to the above-described direct-fired biomass combustion technologies, and considered the nearest term low-cost option, is biomass co-combustion with fossil fuels in existing boilers. Successful demonstrations using biomass as a supplementary energy source in large high efficiency boilers have been carried out showing that effective biomass fuel substitution can be made in the range of 10–15 percent of the total energy input with minimal plant modifications and no impact on the plant efficiency and operation. This strategy is economical when the biomass fuels are lower cost than the fossil fuels used. This can mean a substantial amount of biomass and related carbon savings and emissions reductions, particularly for coal substitution. Dry homogeneous input is preferred. There are two types of boilers:

Stoker boilers, burn fuel on a grate, producing hot flue gases that are then used to produce steam, the ash from the combusted fuel is removed continuously by the fixed or moving grate.

Fluidized bed boiler, suspending fuels on upward blowing jets of air during the combustion process.

Boilers also categorized as either atmospheric or pressurized units. ***Atmospheric fluidized bed boilers*** are further divided into bubbling-bed and circulating-bed units; the fundamental difference between bubbling-bed and circulating-bed boilers is the fluidization velocity (higher for circulating). Circulating fluidized bed boilers (CFB) separate and capture fuel solids entrained in the high velocity exhaust gas and return them to the bed for complete combustion.

Pressurize fluidized bed boilers, pressurized (CFB) are available, although atmospheric-bubbling fluidized bed boilers are more commonly used when the fuel is biomass [2, 3, 4].

A significant proportion of the world's population depends on fuel wood or other biomass for cooking, heating and other domestic uses. A large consumption arises from the widespread use of inefficient cooking methods, the most common of which is still an open fire. But a greater part of heat is lost by incomplete combustion of the wood, by wind and light breezes carrying heat away from the fire, and by radiation losses. Considerable energy is also wasted in evaporation from uncovered pots. Moreover, the smoke is a health hazard to the cook unless there is an efficient extraction chimney. However, Cooking efficiency and facilities can be improved by using dry fuel, Introducing alternative foods and cooking methods, e.g. steam cookers and decreasing heat losses using enclosed burners or stoves, and well-fitting pots with lids.

The combustion of firewood is a complex and varying process and much depends on the type of wood and its moisture content [5].

4. Gasification

Gasification is achieved by the partial combustion of the biomass in a low oxygen environment, leading to the release of a gaseous product (producer gas or syngas). Indirect gasification is also possible. The gasifier can either be of a “fixed bed”, “fluidized bed” or “entrained flow” configuration. The resulting gas is a mixture of carbon monoxide, vapour, CO_2, char, tar, nitrogen and hydrogen, and it can be used in combustion engines, micro-turbines, fuel cells or gas turbines. When used in turbines and fuel cells, higher electrical efficiencies can be achieved than those achieved in a steam turbine. It is possible to co-fire a power plant either directly such as; biomass and coal are gasified together or indirectly like gasifying coal and biomass separately for use in gas turbines.There are a wide range of possible configurations, and gasifiers can be classified according to four separate characteristics:

1) Oxidation agent: This can be air, oxygen, steam or a mixture of these gases.
2) Heat for the process: This can be either direct (i.e. within the reactor vessel by the combustion process) or indirect (i.e. provided from an external source to the reactor).
3) The pressure level: Gasification can occur at atmospheric pressure or at higher pressures.
4) Reactor types: these can be fixed bed, fluidized bed or entrained flow.

Gasification comprises a two-step process. The first step, paralysis, is the decomposition of the biomass feedstock by heat. This yields 75% to 90% volatile materials in the form of liquids and gases, with the remaining non-volatile products being referred to as char. The second step is the gasification process, where the volatile hydrocarbons and the char are gasified at higher temperatures in the presence of the reactive agent (air, oxygen, steam or a mixture of these gases) to produce CO and H_2, with some CO_2, methane, other higher hydrocarbons and compounds including tar and ash. These two steps are typically achieved in different zones of the reactor vessel and do not require separate equipment. A third step is sometimes included: gas clean-up to remove contaminants, such as tars or particulates. The gasification process is a predominantly endothermic process that requires significant amounts of heat. The producer gas, once produced, will contain a number of contaminants, some of which are undesirable, depending on the power generation technology used. Tars, for example, can clog engine valves and accumulate on turbine blades, leading to increased maintenance costs and decreased performance. Some producer gas cleanup will therefore usually be required. After cleaning, the producer gas can be used as a replacement for natural gas and injected in gas turbines or it can produce liquid biofuels, such as synthetic diesel, ethanol, gasoline or other liquid hydrocarbons [6].

4.1 Fixed Bed Gasifiers

Fixed bed gasifiers typically have a grate to support the gasifying biomass and maintain a stationary reaction bed. They are relatively easy to design and operate and generally experience minimum erosion of the reactor body.There are three types of fixed bed designs:

Updraft fixed bed gasifier, biomass enters at the top of the reactor and the reactive agent (i.e. air, steam and/or oxygen) below the grate. The producer gas, together with tars and volatiles, exits from the top while chars and ashes fall through the grate (at the bottom). These gasifiers are often used for direct heating, but gas clean-up can remove the relatively high levels of tar and other impurities to allow electricity generation. Slagging problems can also arise if high-ash biomass is used.

Downdraft fixed bed gasifier, the biomass and the reactive agent are introduced at the top of the reactor and the tars pass through the oxidation and charcoal reduction zones, meaning levels of tar in the gas are much lower than in updraft gasifiers. They tend to require a homogenous feedstock to achieve the best results [7,8].

Cross-draft fixed bed gasifiers are similar to downdraft gasifiers and are often used to gasify charcoal, but the reactive agent enters at the side, low down in the reactor vessel and parallel to the biomass movement. They respond rapidly to load changes, are relatively simple to construct and the gas produced is suitable for a number of applications. However, they are more complicated to operate and if a fuel high in volatiles and tars is used, very high amounts of tar and hydrocarbons will be present in the producer gas. Fixed bed gasifiers are the preferred solution for small- to medium-scale applications. Biomass gasification is successfully applied in India, and rice-husk gasification is a widely deployed technology. To produce electricity, piles of rice husks are fed into small biomass gasifiers, and the gas produced is used to fuel internal combustion engines. They can be an important part of off-grid electricity access in rural areas. The critical factors for these gasification systems are the reliability of the gasifier and the cost of the biomass supply [9].

4.2 Fluidized Bed Gasifiers

There are two main types of fluidized bed gasifiers: bubbling fluidized bed (BFB) and circulating fluidized bed (CFB), which can be either atmospheric or pressurized. In fluidized bed gasification, the gasification process occurs in a bed of hot inert materials (usually sand or alumina) suspended by an upward motion of oxygen-deprived gas. As the flow increases, the bed of these materials will rise and become fluidized.

Bubbling Fluidizing Bed gasifiers, the reactive gases pass through the reactor bed at the minimum velocity required to achieve a bubbling effect where the “bubbles” flow upwards through the bed material. At the top of the inert material, the bubbles burst and the bed material falls back into the bed.

Circulating Fluidized Bed gasifiers, the gas velocities are higher than the minimum fluidization point, resulting in the circulation of the inert bed materials in the gas stream. The bed particles thus exit the top of the reactor with the producer gas and must then be separated in a cyclone to be re-circulated to the reactor.The use of inert materials in the bed increases the rate of reaction of the biomass with the fluidized bed compared to fixed bed reactors, thereby improving performance. Also they can accept a wider range of feedstock, achieve larger scales and potentially yield a production gas with higher energy content. However, fluidized bed systems cost more and are significantly more complex [10].

4.3Gas Clean-up

The gasification process yields a producer gas that contains a range of contaminants, depending on the feedstock and the gasification process. These contaminants are not usually a major problem when the gas is combusted in a boiler or an internal combustion engine. However, when used in turbines to achieve higher electric efficiencies, some form of gas clean-up will be required to reduce gas contaminant concentrations to harmless levels. Different technologies have different tolerances to contaminants, so the correct design and selection of feedstock, gasifier and the generating technology can help minimize gas clean-up requirements [11].

4.3.1Producer Gas Contaminants

- *Particles,* includes ash, charcoal and fluid bed material. It causes erosion in gasifier and prime mover.
- *Alkali metals,* Includes Sodium and Potassium compounds. It causes hot corrosion.
- *Nitrogen compounds*, they are cause local pollutant emissions.
- *Tars,* are the name given to the mostly poly-nuclear hydrocarbons, such as pyrene and anthracene, that form as part of the gasification process, such as refractive aromatics, they cause clogging of filters and other fouling.
- *Sulphur and Chlorine,* cause corrosion and emissions.

Tars are a major problem, as they can build up on turbine blades and /or foul turbine systems. One solution to this problem is to “crack” the tars. Cracking can be either thermal or catalytic.

4.3.2 Biomass Integrated Combined Cycle Gasification

Biomass integrated combined cycle gasification (BIGCC), or biomass integrated gas turbine technology (BIG-GT), as it is sometimes referred to, has the potential to achieve much higher efficiencies than conventional biomass-powered generation using steam cycles by creating a high quality gas in a pressurized gasifier that can be used in a combined cycle gas turbine.

4.3.3 Pyrolysis

Pyrolysis is a subset of the gasification system. Essentially, pyrolysis uses the same process as gasification, but the process is limited to between 300°C and 600°C. Conventional pyrolysis involves heating the original material in a reactor vessel in the absence of air, typically at between 300°C and 500°C, until the volatile matter has been released from the biomass. At this point, a liquid bio-oil is produced, as well as gaseous products and a solid residue. The residue is char – more commonly known as charcoal – a fuel which has about twice the energy density of the original biomass feedstock and which burns at a much higher temperature. With more sophisticated pyrolysis techniques, the volatiles can be collected, and careful choice of the temperature at which the process takes place allows control of their composition. The liquid bio-oil produced has similar properties to crude oil but is contaminated with acids and must be treated before being used as fuel. Both the charcoal and the oil produced by this technology could be used to produce electricity (although this is not yet commercially viable) and heat. The output depends on temperature, type of input material and treatment process. In some processes the presence of water is necessary and therefore the material need not be dry.

Other thermo-chemical processes

A wide range of pre-treatment and process operations are possible. These normally involve sophisticated chemical control and industrial scale of manufacture; methanol production is such a process, e.g. for liquid fuel. Of particular importance are processes that break down cellulose and starches into sugars, for subsequent fermentation [12].

4.3.4Feed Stock

Biomass feedstock for thermo-chemical processes is the organic material of recently living plants from trees, grasses and agricultural crops. Biomass feedstock is very heterogeneous and the chemical composition is highly dependent on the plant species. This highly heterogeneous nature of biomass can be a problem since, although some combustion technologies can accept a wide range of biomass feedstock, others require much more homogenous feedstock in order to operate. Biomass' chemical composition is comprised of generally high (but variable) moisture content, a fibrous structure, which is comprised of lignin, carbohydrates or sugars and ash. Lingo-cellulose is the botanical term used to describe biomass from woody or fibrous plant materials. It is a combination of lignin, cellulose and hemicelluloses polymers interlinked in a heterogeneous matrix. This chemical composition of the biomass feedstock influences its energy density. The main characteristics that affect the quality of biomass feedstock are moisture content, ash content and particle size, and density.

4.3.5 Moisture Content

The moisture of biomass can vary from 10% to 60%, or even more in the case of some organic wastes. Stoker and CFB boilers can accept higher moisture content fuel than gasifiers. In anaerobic digestion, several options are available, including high solids-dry, high solids-wet or low solids-wet. In the case of a low solids-wet configuration, such as with manure slurry, the solids content can be 15% or less. The key problem with high moisture content, even when it is destined for anaerobic digestion, is that it reduces the energy value of the feedstock. This increases transportation costs and the fuel cost on an energy basis, as more wet material is required to be transported and provide the equivalent net energy content for combustion. Improving the energy density of the feedstock can improve combustion efficiency. The principal means of achieving this is through drying by natural or accelerated means.

4.3.6 Ash Content and Slogging

An important consideration for feedstock is the ash content, as ash can form deposits inside the combustion chamber and gasifier, called "slogging" and "fouling", which can impair performance and increase maintenance costs. Grasses, bark and field crop residues typically have higher amounts of ash than wood. Slogging occurs in the boiler sections that are directly exposed to flame irradiation. Slogging deposits consist of an inner powdery layer followed by deposits of silicate and alkali compounds. Fouling deposits form in the convective parts of the boiler, mainly due to condensation of volatile compounds that have been vaporized in previous boiler sections and are loosely bonded. Slogging and fouling can be minimized by keeping the combustion temperature low enough to prevent the ash from fusing.

4.3.7 Feedstock size

The size and density of the biomass is also important because they affect the rate of heating and drying during the process. Large particles heat up more slowly than smaller ones, resulting in larger particles producing more char and less tar. In fixed bed gasifiers, fine-grained or fluffy feedstock may cause flow problems in the bunker section, resulting in an unacceptable pressure drop in the reduction zone and a high proportion of dust particles in the gas. In downdraft gasifiers, the large pressure drop can also reduce the gas load, resulting in low temperatures and higher tar production. The type of handling equipment is also determined by the size, shape, density, moisture content and composition of the fuel. The wrong design will have an impact on the efficiency of the combustion or gasification process and may cause damage to the handling system [13].

5. Bio-Chemical Processes

5.1 Aerobic Digestion

In the presence of air, microbial aerobic metabolism of biomass generates heat with the emission of CO2, but not methane. This process is of great significance for the biological carbon cycle, e.g. decay of forest litter, but is not used significantly for commercial bio-energy [14].

5.2 Anaerobic Digestion

In the absence of free oxygen, certain microorganisms can obtain their own energy supply by reacting with carbon compounds of medium reduction level to produce both, carbon dioxide and methane (CH_4). The process may also be called 'fermentation', but is usually called 'digestion' because of the similar process that occurs in the digestive tracts of ruminant animals. The evolved mix of carbon dioxide (CO_2), methane (CH_4) and trace gases is called biogas as a general term, but may be named sewage gas or landfill-gas as appropriate, and it can be used for heat and stationary power without an emission problem [15,16].

5.3 Bio-Gas

Biomass that is high in moisture content such as animal manure partially decomposed green plants and food processing waste is suitable for producing biogas using anaerobic digester technology. The biogas process requires an input material (mostly agricultural waste) provided as partially composted liquid slurry with around 80 – 90 percent solid content. It is important to use materials which break down readily as highly fibrous materials like wood and straw are not easily digested by micro organism, but softer feed stocks like dung and leaves reacts well to the process. Also some feed stocks are more productive than others. For optimum performance the internal temperature of the digester needs to be maintained within the range of 25 – 37 degree centigrade and within a pH range of 6.7 to 9.4. For optimum gas generation, the pH must be maintained at a reasonable alkaline condition. Four basic types of microorganism are involved in the production of biogas from agricultural feed stock (Biomass); Hydrolytic bacteria break down complex organic waste into sugar and amino acids. Fermentative bacteria then convert those products into organic acids; Acidogenic microorganism converts the acids into hydrogen, carbon dioxide and acetate. Finally, the methanogenic bacteria produce biogas from acetic acid, hydrogen and carbon dioxide. This whole process takes place in air tight chamber called a biogas digester. Bio gas contains 55-70% methane and 30-45% carbon dioxide as well as small quantities of some gases. It is lighter than the air and has an ignition temperature of approximately 700 °C. The bio gas system is most suitable technology to solve the energy problems in rural areas, as it Produces Manure, clean fuel and improves rural sanitation. Its thermal energy per unit volume is sufficient to meet domestic energy needs [17].

6. Alcoholic Fermentation

Ethanol is a volatile liquid fuel that may be used in place of refined petroleum. It is manufactured by the action of micro-organisms and is therefore a fermentation process. Conventional fermentation has sugars as feedstock. In industrialized countries ethanol is most commonly produced from food crops like corn, while in the developing world it is produced from sugarcane. Its most prevalent use is as a gasoline fuel additive to boost octane levels or to reduce dependence on imported fossil fuels. Ethanol has a smaller heat value but a higher octane rate than gasoline, which enables higher of engine efficiency with a larger compression ratio. At present it is most advantageous in terms of energy ratio and cost to get it from sugar crops. In the temperate regions, ethanol is usually obtained from the fermentation of starch crops like corn. Ethanol is used for spark-ignition engines either in the form of a 20%–23% mixture with gasoline or in its pure form. While ethanol production from maize and sugarcane, both agricultural crops, has become widespread and occasionally successful it can suffer from commodity price fluctuation relative to the fuels market. Consequently, the production of ethanol from lignocelluloses biomass (such as wood, straw and grasses) is being given serious attention. In particular, it is thought that enzymatic hydrolysis of lignocelluloses biomass will open the way to low cost and efficient production of ethanol.

Methanol can be synthesized from biomass pyrolysis gas and can be used as an alternative fuel to gasoline. It is, however, more easily processed from natural gas. There are two methods of using hydrogen and carbon monoxide gas to produce synthetic methanol from natural gas: the catalytic steam reforming method and the partial oxidation method. At present, the catalytic steam reforming method is mainly used. In this method, the main components of the natural gas methane react with using hydrogen and carbon monoxide gas to produce synthetic methanol at high temperatures (250–400±C) and high pressures (5.07–30MPa) with the use of a catalyst of the Cu–Zn or Zn–Cr–Cu group. Then Crude methanol from a synthetic process is rectified in the prepurifying column. Ingredients with low boiling points, such as dimethyl ether and methyl formatted, are removed from the top of the column and an aqueous methanol solution is obtained from the bottom of the column. Next, the methanol–water solution is distilled in the rectifying column, and ingredients with higher boiling points, like higher alcohols, paraffin, ethanol, etc., and water come out from the bottom of the column. At this point, refined methanol is obtained from the top of the column [18].

7. Biophotolysis

Photolysis is the splitting of water into hydrogen and oxygen by the action of light. Recombination occurs when hydrogen is burnt or exploded as a fuel in air. Certain biological organisms produce, or can be made to produce, hydrogen in biophotolysis. Similar results can be obtained chemically, without living organisms, under laboratory conditions. Commercial exploitation of these effects has not yet occurred.

8. Agro-Chemical Processes

8.1 Fuel Extraction

Occasionally, liquid or solid fuels may be obtained directly from living or freshly cut plants. The materials are called exudates and are obtained by cutting into (tapping) the stems or trunks of the living plants or by crushing freshly harvested material. A well known similar process is the production of natural rubber latex. Related plants to the rubber plant Herea, such as species of Euphorbia, produce hydrocarbons of less molecular weight than rubber, which may be used as petroleum substitutes and turpentine [19].

8.2 Bio-Diesel and Etherification

Concentrated vegetable oils from plants may be used directly as fuel in diesel engines. Rudolph Diesel designed his original engine to run on a variety of fuels, including natural plant oils. However, difficulties arise with direct use of plant oil due to the high viscosity and combustion deposits as compared with standard diesel-fuel mineral oil, especially at low ambient temperature. Both difficulties are overcome by converting the vegetable oil to the corresponding ester, which is arguably a fuel better suited to diesel engines than petroleum-based diesel oil. Vegetable oils from rapeseed, soybean, sunflower, and others can be used for diesel engines. Raw vegetable oils are usually so viscous and their cetane numbers are so low for high-speed diesels that transesteification with methanol is performed. Emission from biodiesel is characterized with low sulphur oxides (SO_x) content. It is reported that in some cases nitrogen oxides (NO_x) increases, but with the adjustment of valve timing, nitrogen oxides (NO_x) could be kept on the same level as that of conventional diesel fuel. The etherification process is straightforward for those with basic chemical knowledge, and, with due regard for safety, can be undertaken as a small batch process. Biodiesel can also be made from waste (used) cooking oil and from animal fat [18].

9.1 Advantages of Biomass Energy

- Can supply on demand, base load power.
- Available year-round with storage.
- Carbon neutral.
- Can be processed into a syngas or liquid fuel.
- Can be used for power generation, space heating, and transportation applications.
- Biomass energy is an abundant, secure, environmental friendly and renewable source of energy. Biomass does not add carbon dioxide to the atmosphere as it absorbs the same amount of carbon in growing as it releases when consumed as a fuel.
- One of the major advantages of biomass is that it can be used to generate electricity with the same equipment or in the same power plants that are now burning fossil fuels.
- Biomass energy is not associated with environmental impacts such as acid rain, mine spoils, open pits, oil spills, radioactive waste disposal or the damming of rivers.
- Biomass fuels are sustainable. The green plants from which biomass fuels are derived fix carbon dioxide as they grow, so their use does not add to the levels of atmospheric carbon. In addition, using refuse as a fuel avoids polluting landfill disposal.
- Alcohols and other fuels produced by biomass are efficient, viable, and relatively clean burning.
- Biomass is easily available and can be grown with relative ease in all parts of the world [19].

9.2 Disadvantages of Biomass Energy

- Expensive to handle, low energy density.
- Must be utilized near its source.
- Labor intensive.
- Bulky - storage can be a challenge.
- Small scale technologies for power generation still emerging.
- Biomass is still an expensive source of energy, both in terms of producing biomass and converting it into alcohols, as a very large quantity of biomass is needed.
- On a small scale there is most likely a net loss of energy as a lot of energy must be used for growing the plant mass; biomass is difficult to store in the raw form.
- One of the disadvantages of biomass is that direct combustion of biomass can be harmful to the environment as burning biomass releases carbon dioxide, which contributes to the warming of the

atmosphere and possible climatic change. Burning also creates soot and other air pollutants.

- Over-collecting wood can destroy forests. Soils bared of trees erode easily and do not hold rainfall. Increased run-off can cause flooding downstream.
- When plant and animal wastes are used as fuel, they cannot be added to the soil as fertilizer. Soil without fertilizer is depleted of nutrients and produces fewer crops.
- Biomass has less energy than a similar volume of fossil fuels .

Conclusion

Now, the world is looking for new energy sources to replace the conventional sources because of its negative impact on climate and human health. But, no energy source is free of some type of environmental impact, though energy efficiency practices properly implemented are the most environmentally friendly. While renewable energy sources such as wind and solar have clear environmental benefits compared to conventional sources, they are not free of consequences and have a high costs. Renewable energies are generally having fewer disadvantages on the environment. Fossil fuel (oil, coal and natural gas) combustion release greenhouse gases which lead to the air pollution. This pollution causes acid rain that damage forests and cultivated crops, different diseases for human and animals. Fossil fuel mining, refining and transforming are cost high, and also nonrenewable source. From the extraction of uranium from rock formations, through the milling, refining, and enriching of uranium, to the operation of reactors, and the unsolved dilemma of what to do with spent fuel, there are major health effects at every stage of the nuclear fuel chain. Although it is widely accepted that there is no safe threshold for radiation exposure, low-level radiation emissions from nuclear facilities have not been considered a threat to human health. The link between radiation exposure and cancer is becoming increasingly clear, and the cellular mechanisms involved in this process are becoming better understood. There are enormous public health risks posed by the millions of tons of radioactive tailings from uranium mining, and the many thousands of tons of radioactive waste produced in reactors that will remain toxic for long time, an accident or meltdown causes a catastrophic release of radioactive particles into the air, water and soil. Biomass (forest residues and wastes, agriculture residues and wastes, and animal's wastes) is a renewable, sustainable and cheaper source. Animals waste depends on the density of livestock in a certain area to produce good amount of biogas fuel. Forest products constitute a significant foundation for both local and national economies in Sudan, in addition to environmental and social services provided by the forests. Wood constitutes the major source of energy in Sudan providing about 70-80% of the energy needs of the country for almost all segments of the population and institutions. Natural forests cover nearly 40.0 million hectare, the forest reserves area at present is 13.5 million hectare. Plantation forests are considered as an approach for addressing the recurrent problems of over exploitation of the natural forest resources, but the area of planted forests in Sudan is rather small. Agriculture residues and wastes can be used as biomass source. Agriculture contributes to about 46% of the gross national product in Sudan. The total area of cultivate land is about 120 million Fadden with annual agricultural production estimated as 15 million tones.

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