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A REVIEW ON BIO GAS

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ABSTRACT

The paper introduces biogas production and utilization methods that are suitable for providing continues operation of exiting biogas plants. Using biogas technologies the Eco-friendly Atmosphere can be built as it does not require any change or transformation of agriculture structure. Using biogas technologies energy-crisis in many rural areas can be solved. It is very cost effective also. This paper mainly focuses on generation of energy using waste disposal, animal dung, Marine Macro Algae, waste paper etc. we can create complex biogas production and utilization system by developing variants, so that both the energy and waste disposal goals can achieved together. Further research has to be done for better outcome.

KEYWORDS: Biogas Marine Macro Algae, Waste Paper, Anaerobic Digestion, Municipal Solid Waste.

INTRODUCTION

A major concern for most people these days is the use of availability of one excellent source of energy is bio-gas. [1, 19] Bio-gas typically refers to Methane rich gas produced from fermentation of organic matter under anaerobic environment. [1, 12] Bio-gas has about 60% Methane and 40% CO2 and trace of element. It is environmental friendly, economic and alternative means to fossils such as firewood fossils. [12, 13, 15] Anaerobic Digestion (AD) is historically is one of the oldest processing technologies used by the mankind [20]. Anaerobic Digestion (AD) is a biological process that happens naturally when bacteria breaks down organic matter in environment in the absence of oxygen. [7, 16] This process leads to the synthesis of bio-gas that can replace fossil-fuel and contribute to the mitigation of climate change. Often overlooked, but not less valuable, is the by-product of this process, the digester effluent or digested. This so-called bio slurry has the potential to improve soil fertility and soil structure, to act as pesticide and to stimulate algal growth in ponds for feeding fish and ducks. Small-scale farmers throughout the world use bio-gas digesters to treat on-farm bio waste such as manure, human excreta or plant residues. [14, 15, 16, 24] Bio-gas is substitute for firewood and cattle duck that can meet the energy needs of rural population. Bio-gas is a combustible gas consisting mainly methane (CH_4), carbon dioxide (CO_2) and small amount of other gases and trace elements. [7, 5].

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Methane(CH_4) from biomass is more famous for its greenhouse effect as it naturally arises from Forest fires, swamps and other wetland as well as land fields, rice paddies, animal guts. The methane in bio-gas is transferred into CO_2, a gas with lower greenhouse effect and from other side CO_2 emitted from burning bio-gas recycle into the vegetation within less than twenty years and therefore does not contribute to global warming. [1, 19] For climate change we can use Clean Development Mechanism (CDM), which include review of the materials presented and published the recent development in bio-gas technology. Some benefits of bio-gas are production of energy, transformation of organic waste into fertilizer, improvement in hygienic conditions and environment protection. It has effects on temperature, precipitations, firewood consumption, fire protection and greenhouse effect. [3, 9] It is a undeniable fact that alternative energy must replace fossil fuel in order to a upgrade the quality of life. Bio-fuels have become the subject of a "food versus fuel" debate. In anaerobic digestion 'both the nutrients and energy can be captured and recycled. The current research includes to access the potential for bio-gas production from food waste. [4, 10] Bio-gas production includes- hydrolysis, Acido-genesis, Methano-genesis. [5] Paper wastes is being considered as a potential feed stock for bio-gas production. Paper waste and cow dung in the ratio of 1:1 for bio-gas production. [8] The science and technology of anaerobic digestion (AD) is from agro-residues for bio-gas production. If it is carried out in modern bio-gas plants, it can meet the needs for sustainable development. [11] Production of algae as a 2^{nd} generation bio-fuel feed stock has been the subject of research of last decade. Life cycle assessment (LCA) is a method that applied in order to access the environment impacts that are essential with production bio-gas as an energy carrier. [16] Bio-gas used in internal combustion engines(IC Engines) and also in powering of generators. Bio-gas takes 35% less power compared to diesel and 40% less power compared to gasoline fuel. [17] The bio-gas digester residue can be utilized as nutrient, because of its high nutrient content. The performance of AD process is depend on characteristics of feed stock. [21] Bio-gas can be mainly processed from municipal waste, solid manure, sewage and landfills that contains organic wastes. [22] It is very important to find out the right process of anaerobic digestion and use the microbe economically in AD (Anaerobic Digestion). [23]

LITERATURE REVIEW

Bio-gas typically refers to the Methane rich gas produced from fermentation of organic matter under anaerobic environment. During last 50 years bio-gas production scheme turned from small units to large scale production plants. The first bio-gas production plant is thought to be built in INDIA in 1897. After purification bio-gas contains more than 95% of methane gas in it. [1]Gain of using bio-gas is the reduction in greenhouse gases. Bio-gas has not become a dominant energy source. Yet however its production is an effective way for waste management treatment. The most economically successful way to recover energy from bio-gas is Shill Direct Heating-application as in boilers and households. Soon bio fuel going to replace the fuel used in the present world, which will be very costly. [2] The natural generation of bio-gas is an important part of the bio- geo chemical carbon cycle. About 90% of the emitted methane in the atmosphere derives from the bio-genetic resources by the decomposition of bio mass. Only homo geneous and liquid substances can be considered for simple bio-gas plant . Bio-gas is a mixture of methane (40-70%), carbon dioxide (30-60%) and other gases (1-5%). Similar to many other pure natural gas, bio-gas properties also depends upon pressure and temperature. This is also affected by moisture and other major factors . Bio-gas can be sometime highly hazardous when it is mixed with air at the ratio of 1:20. [3] We can

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convert food waste bio-gas, it can also by same process of anaerobic digestion. As human population is increasing, fossil fuels are also depleting so we have to start depending on bio fuels. In anaerobic digestion both the energy and nutrients can be captured and recycled, providing a closed loop system that minimizes environmental impact and maximizes resource recovery. [4] People have known about the existence of naturally produced bio-gas since 17th century. During the mid 19th century several researches started about it. In 1890 the English man Donald Cameron first constructed a special septic tank which could be used to collect useful gases and further using it for street lighting. During 1920s construction of first bio-gas plant for waste water treatment started in Denmark. At the end of 1950s development of bio-gas nearly stopped due to cheap cost of fossil fuel. [5] Bio-gas production includes macro-algae as feed stock and poultry manure as substrate for algae growing and for digesters, local reduction of nitrogen and phosphate, which have seriously regarded the aquatic echo system through the use of local bio waste. [6] The use of microbial enzymes for the enhancement of degradation of waste activated sludge called the Enzyme Hydrolysis (EH). This process was first used for killing Pathogens. [7] Bio-gas has globally remained as renewable energy source derived from plants, from the solar energy which is used by them during the period of Photosynthesis. The study shows that paper wastes are abounded everywhere including the immediate environment. This waste is a very good feed stock for bio-gas production, which indirectly used for the utilization of energy generation. Instead of burning them up are having them littered around, we can use them for energy generation. [8] In case of bio-gas utilization in spark ignited internal combustion engines. We wish to present the connection between agriculture and energy. [9] The raw bio-gas splits into two streams during bio-gas upgrading:(i)Methane rich bio methane stream and(ii)Carbon dioxide rich off gas stream. [10] Anaerobic digestion and bio-gas plant technology has been evolved and partially deployed to meet sustainability criteria for over 9th century in India, largely in rural and agricultural sectors. The energies of the technology of bio mass based bio-gas plants along with potential for provide many lively-hood from it by product, to meet the larger goal of “Sustainable energy forever”. [11] Bio-gas originates from bacteria in the presence of bio degradation of organic material under anaerobic conditions . Methanogenesis are the last links in a chain which degrade organic material. Each year some 590-880 million tons of methane (CH_4) are released worldwide into the atmosphere. Bio-gas with methane (CH_4) content higher than 45% is flammable. In the rural areas of India bio-gas is called ‘Gobar Gas’, where the gas is produced using cow dung. Waste produced in this modern world is divided into 4 major types-(I)Municipal Waste, (ii)Individual Waste, (iii)Agricultural Waste and Residues, (iv)Hazardous Waste. [12] Using bio-gas technology we can create bio-gas which is more cheaper and echo-friendly. It contain 97% of methane both technical and financial performance. Production of bio-gas for vehicle fuel is at least possible as it is produced from renewable waste. [13] Anaerobic digestion (AD) is historically one of the oldest processing technologies used by mankind. Until 1970s it is commonly used in waste water treatment plants. Mainly 3 reactions occurs during entire bio-gas production process :(i)Hydrolysis, Acid forming, Methanogenesis. [14] The treatment of organic waste is necessary in order to keep clean the environment. Anaerobic digestion is the process of decomposition of organic matter by a microbial consortium in an O_2 free atmosphere. It is a process found in many naturally occurring processes including Arte resources Sediments. Bio-gas production from crop residues in economically farm scale level (50-500kw). [15] About 2. 5 millions of bio-gas plants operate in India, While China plans to build 200 million plants by 2020. Recently building of agricultural

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bio-gas plant has started in Northern America and in Latin America. Now a day's around 600 bio-gas plants exists in US, at which 100 are in agricultural sector and 500 at landfills. The United Kingdom is the second EU bio-gas producer. In 2010 in France, Bio-gas was produced 68 landfills. In 2011 there were 709 bio-gas plants in Italy. [16] Nowadays the fact that main resources of energy such as fossil oil, natural gas, coal are not the renewable energy sources, so we have to give importance to the other renewable sources like solar energy, hydro energy, energy of wind, bio-gas. [17] Small scale farmers throughout the world bio-gas digesters to treat on -farm bio waste. In the first stage of digestion, complex organic compounds broke down and in second stage the resulting compounds further converted to Acetic acid, Hydrogen, Carbon dioxide and other volatile Fatty acids. In third stage Methane (CH_4), bio-gas and other end products produced. [18]Bio-gas combustion temperature is about 700 degree C and the flame temperature is 870 degree C. Its heating value is 6 kWh/m^3. Heating value of 1m^3 of bio-gas is equals to 0. 4 litre of diesel, 0. 6 litre of Kerosene, 0. 8kg of coal. [19] Now a days anaerobic digestion plants are facing difficulties in obtaining fairly clean composts in city areas which cause technical difficulties to get right amount of bio-gas due to poor compost quality. [20] It can replace fossil fuel with renewable source such as bio-gas. It offers significant advantages over many other waste treatment process. It is preferable to utilize waste streams since in this way. The process addresses both Waste Reduction and Energy Production, as it offers other advantages such as Preventing of odour release and decrease of Pathogens. [21] Agricultural wastes are common in life stock and food production, which can be utilized for bio-gas production. AD has become well suited for organic waste of high moisture contained (about 80%). AD has great future amongst the different renewable energy resources, as well as waste management technology. In anaerobic digestion (AD), the process of Hydrolysis is the rest restricting step in which soluble organic materials are converted into bio-gas. [22] The advantage of bio-gas generation includes the replacement of bio-genetic materials into useful energy competent and flexible one, are used for the production of fertilizer. Cooking and agriculture activities in rural areas arises problem of energy requirement or soil fertility, Which can be solved using bio products. [23] Bio-gas can be composed and used in motor vehicles, the same way natural gas is composed in CNG. But natural gas and bio-gas have similar dangers. Bio-gas usually gets toxic by its own fraction of Hydrogen Sulphide. The negative pressure can lead to the exploitation in bio-gas plant. Bio-gas can be used for various purposes especially for cooking, fuel in vehicles etc. [24] In India initially cow dung was used as main fermentative material. Bio-gas plant consists of mainly two parts: (i)a digester or fermentative tank with an inlet into which the fermentative mixture is introduced in the form of slurry and (ii)a gas holder to collect bio-gas and helps to cut off-air to the digester with an overflow pipe to lead out spent digested slurry. [25]

WORKING PRINCIPLE&DISCUSSIONS

Bio-gas is generated when bacteria degrade biological material in the absence of oxygen, in a process known as Anaerobic Digestion (AD). Since bio-gas is a mixture of methane (CH4) and carbon dioxide ($C0_{2)}$ it is a renewable fuel produces from waste treatment. Anaerobic digestion is basically a simple process carrying out in a number of steps that can use almost any organic material as a substrate-it occurs in digestive systems, marshes, rubbish dumps septic tanks etc. Conventional anaerobic digestion has been a "liquid" process, where waste is mixed with water to facilitate digestion, but a "solid" process is also possible, as occurs in landfill sites. As methane is very hard to compress as its best use for stationary fuel, rather than mobile fuel. It takes a lot of energy to compress the gas, plus we

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have the headache of high pressure. A variable volume storage (flexible bag or floating drum are the two main variants) is much easier and cheaper to arrange than high pressure cylinders, regulators and compressors. There are many types of digesters such as Covered Lagoon, Plug Flow and Complete-mix digesters. Covered lagoons are actual man-made lagoon which are filled with slurry (manure with 0. 5-3%) where bio-gas is trapped under a cover. Because they are not heated, the bio-gas output flow reduced automatically in colder weather conditions. Plug Flow digesters are consist of long relatively narrow, heated tanks with a gas tight cover and they are generally used with dairy farms, because they can tolerate 11%-13% solids as well as some bedding which is collected by scraping. A bio-gas recovery system is composed of a manure source and collection system that provides manure to the digesters, where hydraulic and fermentative bacteria cooperate with acid-forming and methane-forming bacteria to produce bio-gas. The process is pushed by adding new manure to the plant. Passing the bio-gas through an iron sponge or catalytic oxidation of H_2S on activated carbon in the presence of oxygen are mean to reduce the H_2S content. Removal of CO_2 is only important when it is used in vehicles or in pipe line gas system. This whole anaerobic digestion process takes place in a sealed, water proof chamber known as an Anaerobic Digester. The digester is generally a cubical or cylindrical in shape and may be constructed of brick, concrete, steel or plastic. The liquid organic waste is fed into the digester chamber through a pipe line and exposed to the anaerobic bacteria that under require temperature between 95-140 degree Fahrenheit. Using anaerobic digestion for bio-gas generation is a clean, environment friendly way of energy production.

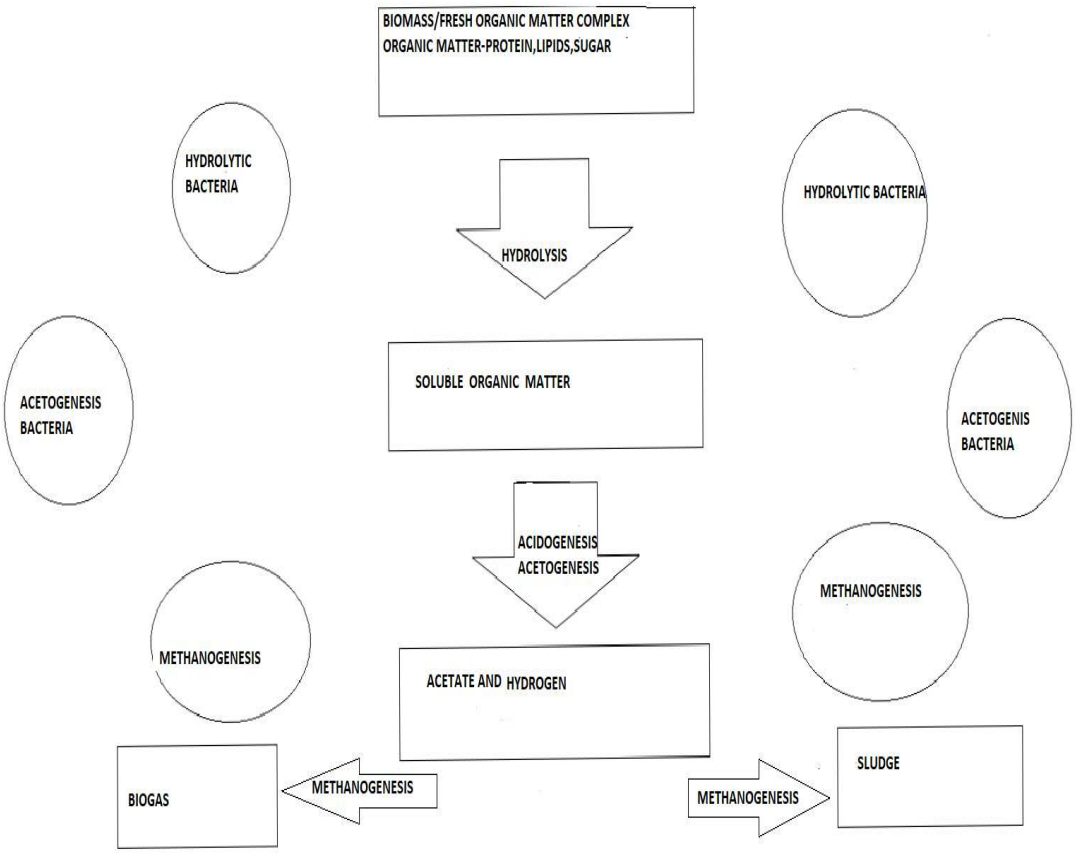

Figure 1.Stages of anaerobic digestion

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ADVANTAGES AND DISADVANTAGES

Bio-gas is echo-friendly: Bio-gas is a renewable as well as a clean source of energy. Bio-gas is generated through bio-digestion. It actually reduces greenhouse emission. No combustion takes in this process. Means there is zero emission of greenhouse gases through the atmosphere. Therefore using bio-gas from waste as a form of energy is actually. Bio-gas generation reduces soil and water pollution: overflowing landfills do not only spread foul smell, they also allow toxic liquids to drain into underground water sources. Consequently another advantage of bio-gas is that bio-gas generation may improve water quality. Moreover anaerobic digestion deactivates pathogens and parasites. Thus it's also quiet effective in reducing the incidence of water borne diseases. Similarly waste collection and management significantly improves the areas of bio-gas plant. Bio-gas generation process is enriched organic: Bio-gas generation produces organic fertilizers, the bi-product of bio-gas generation process is enriched organic, which is a perfect supplement for chemical fertilizer. It is a simple and low cast technology that encourages a circular economy. An unfortunate disadvantage of bio-gas today is that the systems used in the production of bio- gas are not efficient. There are no new technologies yet to simplify the process and make it abundant and low cost. This means large scale production to supply for a large population is still not possible. Like another renewable energy resources, bio-gas generation is also affected by the weather. The optimal temperature, bacteria needs to digest waste is around 37 degree C. In cold climates, digesters require that energy to maintain a constant bio-gas supply. Another disadvantage of bio- gas is that industrial bio-gas plants can only establish in places where raw materials are of constant supply. For this reason, bio-gas generation is less suitable for dense metropolitan areas.

APPLICATIONS

Bio-gas as fuel for combined heat and power applications: Burners and boilers used to produce heat and steam, can be fuelled by bio-gas, The normal burners will not work on direct bio-gas substitute, so there need some modification on normal burners to use with bio-gas. Direct use of bio-gas for on-farm heating: The on-farm heating application needs varies both seasonally and farm to farm in cold weather countries the farms needs to be kept hot in the cold season. So on-farm heating is directly done with help of bio-gas. Bio-gas as an engine fuel: Using bio-gas electricity generation on dairy farm is a proven and commercially available technology. Typical installation use spark-ignited natural gas or propane engines that have been modified to operate on bio-gas. Bio-gas fuel engines could also be used for other on-farm applications. Diesel and gasoline engines can be modified to use bio-gas. Bio-gas as fuel for agricultural pumps: The use of agricultural pumps varies widely from dairy to dairy depending on both on-site conditions and pumping needs. So we can operate agricultural pumps by bio-gas. Bio-gas to run refrigeration equipment: In dairy industry regular chilling of dairy products are very important. For this need, refrigeration equipment are used. Bio-gas can be used as power to run this refrigeration system. Bio-gas as vehicular fuel: In recent days the non- renewable fossil fuels are running out by day by day. So there should be an alternate energy source, which is also a renewable source of energy. Bio-gas is that alternative renewable energy source. Bio-gas can be used as vehicle fuel in modern days. Some engines have already modified to run by bio gas.

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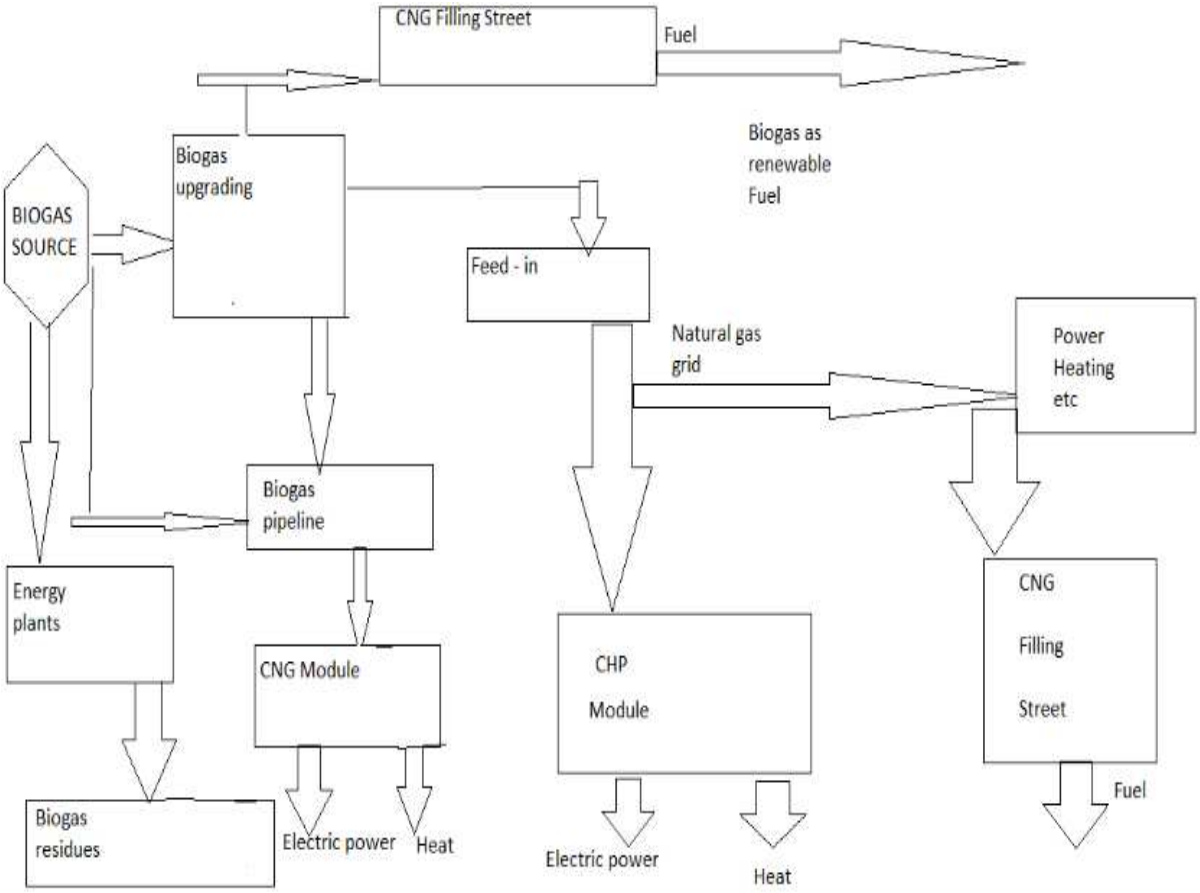

Figure 2.biogas utilization

PRESENT RESEARCH WORK

The current study is on the use of macro algae as feed-stock for bio-gas production. Three types of macro-algae Cladophora Glomerata (CG), Chara Fragilis (CF), and Spirogyra Neglecta (SN) were chosen for this research. The experimental studies on bio-gas production were carried out with these algae in a batch bio reactor. The bio reactor was maintained in 35+/-1 degree C temperature. the result showed that the appropriate macro algae for bio gas production is the Spirogyra Neglecta (SN) and Cladophora Glomerata (CG). The average bio-gas obtained from processing of SN, CG and CF is respectively 0. 23m^3/m^3d, 0. 20m^3/m^3d and 0. 12m^3/m^3d. It is also obtained that the concentration of methane during this process is exceeds up to 60%. So it can be easily claimed that the bio-gas produced from SN and CG algae is valuable. When processing CF, the concentration of methane reached the level of only 50%, which indicates that CF is less suitable for bio-gas production[6]

FUTURE SCOPE

Bio-gas is a mixture of methane, CO_2 produced when organic material decomposes. This renewable energy resource can be used to produce on-side heat and electricity, condition for injection into the natural gas delivery infrastructure or consumed as a transport fuel. since 2006, Southern California Gas has actively implemented a research, developed and demonstration program and also fostered commercial program to increase the use of renewable natural gas. Early work focused on studying feed stocks and setting guidelines for purifying bio-gas to pipeline quality. Looking ahead, So Cal Gas is working to develop algae as an energy crop and is exploring the use of solar thermo- chemical processes to create renewable

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natural gas. Full scale commercial demonstration of bio-gas Cleanup technology already implemented in operation at a waste water treatment facility in Escondido, Calif. So Cal Gas is also active in aiding regulatory in policy a force to advance bio-gas. We are currently working with other stakeholders in a California Public Utilities Commission proceeding to develop state wide standards and protocols for the Cleanup of bio-gas so it can be injected into a common carrier pipeline [16]. Today renewable natural gas can be produced from larger bio-gas sources such as waste water facility and landfills and prices competitive with other renewable resources. Bio-gas is plentiful and is available from sources such as landfills, waste-water treatment facility, animal waste and agricultural waste. If fully utilized, the yield from existing organic waste streams could satisfy about 20% of current gas use. Bio-gas feed stock may also soon be farmed economically. Work is already underway to develop low cast dedicated energy crops such as algae and other plant species that can be grown on marginal land to serve as a source of bio-gas production. Future energy crops could make the potential availability virtually unlimited. Ultimately technology and market advances will help determine the future of renewable natural gas, but its success also depends on a level playing field in energy policy. For the United States to fully realize the economic and environmental potential of renewable gas, it is imperative that public policymakers recognize the benefits of renewable natural gas.

CONCLUSION

In this high fossil fuel demanding modern century, the demands of non-renewable fossil fuels are increasing by an unexpectedly large scale. So it has become a global concern to the people that the future availability of non-renewable energy sources. To reduce this great headache of mankind, bio-gas can be a perfect alternative. It is renewable, can make very easily, low cost and echo-friendly. As the process of bio-gas making is echo-friendly so it does not give any bad effect on nature, which is the most significant side of using it. On the other hand day by day it becomes a great concern of waste management. Bio-gas produces from decomposition of organic parts, so organic waste can be used to produce a bio-gas and in another side waste treatment is also done at same time. So in modern society, bio-gas can is the best alternative of all non-renewable energy.

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