Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2016, 8(4):112-118

Review Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

The role of biogas to sustainable development (aspects environmental, security and economic)

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ABSTRACT

Achieving "Sustainable Development" is a formidable challenge in the present world. It concerns technologies that can help manage growth while considering economic, social, and environmental sustenance of the society. There is an urgent need to solve the present problems faced by the society without creating any long term negative impact, which could become a critical issue to resolve for the future generations. Energy need is an important ingredient in the modern economy, and must be evaluated in the context of the other aspects of development. In fact, modern energy services must be evolved and deployed in all aspects of the development process – e.g., energy and communications, energy and industry, energy and the environment, energy and agriculture, energy and education, and energy and public health and safety. Biomass can be used to provide sustainable supply of the required energy through biogas, vegetable oil, biodiesel, producer gas, and by directly burning the biomass.

Key words: Energy, biogas, renewable energy, Sustainable Development, Environment

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INTRODUCTION

Worldwide energy consumption and demand are growing up since past 50 years [1]. Renewable energy resources and significant opportunities for energy efficiency exist over wide geographical areas, in contrast to other energy sources, which are concentrated in a limited number of countries. Rapid deployment of renewable energy and energy efficiency, and technological diversification of energy sources, would result in significant energy security and economic benefits. [2] It would also reduce environmental pollution such as air pollution caused by burning of fossil fuels and improve public health, reduce premature mortality due to pollution and save associated health costs that amount to several 100 billion dollars annually only in the United States.[3]

Biomass can be converted to other usable forms of energy like methane gas or transportation fuels like ethanol and biodiesel. Rotting garbage, and agricultural and human waste, all release methane gas – also called landfill gas or biogas.

Sustainable development is an approach to development that takes the finite resources of the Earth into consideration. This can mean a lot of different things to different people, but it most commonly refers to the use of renewable energy resources and sustainable agriculture or forestry practices. It also entails the use of sustainable mineral use along with many other things. The idea is to create a system that is "sustainable", meaning one that can keep going indefinitely into the future. Sustainable development doesn't always refer to environmental sustainability or other green topics. Sustainable development also needs to take economic and social sustainability into account in order to fit within the parameters of sustainable development. Today's issues arise from the spread of deserts, the loss of forests, the erosion of soils, the growth of human populations and industrialized animal husbandry, the destruction of ecological balances, and the accumulation of wastes. As a result, the politics needed to meet present and future challenges require a new vision and new diplomacy, new leadership and new policies. In a world that is daily more complex and economically interdependent, the economic and security interests of the Developing Countries must be understood in a broader, global context. Necessary goals are to achieve economic and environmental benefits through sustainable projects for resource recovery and utilization, and programs for Developing Countries. The use of anaerobic digestion in an integrated resource recovery system in Developing Countries is important to solve both ecological and economic problems. Most countries became aware of biogas technology by the middle of the Twentieth Century. However, real interest in biogas was aroused from 1973 onwards, with the onset of the energy crisis, which drew general attention to the depletion of fossil fuel, energy resources and the need to develop renewable sources of energy, such as biogas. The importance of biogas as an efficient, non-polluting energy source is now well recognized

2. SUSTAINABLE DEVELOPMENT

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of needs, in particular the essential needs of the world's poor, to which overriding priority should be given; And second; the idea of limitations imposed by the state of technology and social organization of the environment's ability to meet present and future needs." All definitions of sustainable development require that we see the world as a system - a system that connects space; and a system that connects time. [4]

Sustainable development is the organizing principle for sustaining finite resources necessary to provide for the needs of future generations of life on the planet. It is a process that envisions a desirable future state for human societies in which living conditions and resource-use continue to meet human needs without undermining the "integrity, stability and beauty" of natural biotic systems. [5]

Sustainable energy is the sustainable provision of energy that is clean and lasts for a long period of time. Unlike the fossil fuel that most of the countries are using, renewable energy only produces little or even no pollution. [6]

3. BIOGAS

Biogas originates from bacteria during the process of bio-degradation of organic materials under anaerobic (without air) conditions. The natural generation of biogas is an important part of the biogeochemical carbon cycle. Methanogens (methane-producing bacteria) are the last link in the chain of micro-organisms that degrade organic materials and return the decomposed products to the environment. It is in this step of the biogeothermal carbon cycle that biogas, a source of renewable energy, is generated. It can be employed for generating electricity and also as automotive fuel. Biogas can be used as a substitute for compressed natural gas (CNG) [7].

The calorific power of biogas is about 6 kWh/m3 - this corresponds to about half a liter of diesel oil. The net calorific value depends on the efficiency of the burners or appliances. Methane is the most valuable component if the biogas is to be used as a fuel.

Table 1. Chemical composition of input materials and digested slurry out-put of the methanogenic fermentation system at a slaughterhouse (Average of 12-15 analyses; analysis was carried out regularly, once every 2 weeks). [8]

	Input material	Digested slurry
PH	6.32 + 0.38	7.40 + 0.21
Solids (%)	15.44 + 2.04	11.28 + 1.51
Ash (%)	1.96 + 0.53	1.79 + 0.27
Ammonia (g/l)	0.62 + 0.18	0.87 + 0.26
Nitrogen (g/l)	2.70 + 0.35	1.95 + 0.27
Phosphorus (g/l)	3.26 + 0.55	2.43 + 0.27
Volatile acids (g/l)	6.73 + 1.53	3.44 + 1.83

Biogas production and use is an integrated process and contributes to several sectors can be seen in fig1: [9]
- Energy
- Environment
- Agriculture
- Society

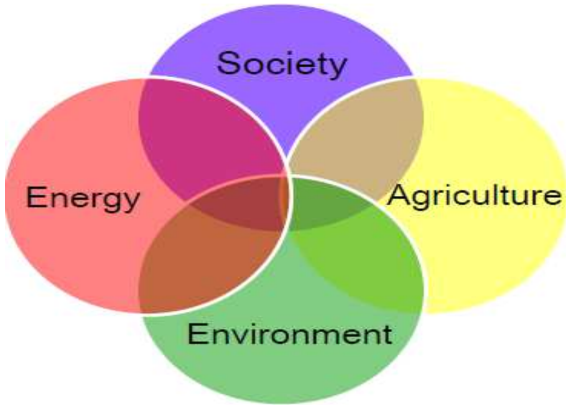

Figure 1.biogas production factors

Energy is an essential ingredient of socio-environmental development and economic growth Biogas can contribute in environmental sustainability. [10] It can play vital role for reduction of greenhouse gas emission, and forest conservation. It helps improve in health and sanitation through providing clean energy and smokeless kitchen that is directly associated with children and women's health and environment. Health and environment along with friendly surroundings contribute for better enterprise integration. [11]

The proportion of methane to carbon dioxide in biogas depends on the substrate. Factors such as temperature, pH and pressure can alter the gas composition slightly. Typical gas compositions for carbohydrate feeds are 55% methane and 45% carbon dioxide, while for fats the gas contains as much as 75% methane. Pure methane has a calorific value of 9,100 kcal/m3 at 15.5°C and 1 atmosphere; the calorific value of biogas varies from 4,800 - 6,900 kcal/m3. In terms of energy equivalents, 1.33 - 1.87, and 1.5 - 2.1 m3 of biogas are equivalent to one liter of gasoline and diesel fuel, respectively. Biogas has an approximate specific gravity of 0.86 (air = 1.0), and a flame speed factor of 11.1, which is low, and therefore the flame will "lift off" burners which are not properly designed, i.e. become unstable because of its distance from the burner. [12]

To summarize, biogas technology is receiving increased attention from officials in Developing Countries, due to its potential to bring an economically viable solution to the following problems:

a. Dependence on imported sources of energy;
b. Deforestation, which leads to soil erosion and therefore to a drop in agricultural productivity;
c. Providing inexpensive fertilizers to increase food production;
d. The disposal of sanitary wastes, which cause severe public health problems;
e. The disposal of industrial wastes, which cause water pollution.

5. BIOGAS AND THE GLOBAL CARBON CYCLE

Each year, some 590-880 million tons of methane are released worldwide into the atmosphere through microbial activity. About 90 percent of the emitted methane derives from biogenic sources, in the northern hemisphere, the present troposphere methane concentration amounts to about 1.65 ppm.

6. BENEFITS OF BIOGAS TECHNOLOGY

During the last years, anaerobic fermentation has developed from a comparatively simple technique of biomass conversion; Well-functioning biogas systems can yield a range of benefits for users, the society and the environment: [13]

a. Production of energy (heat, light, electricity);
b. Transformation of organic wastes into high-quality fertilizer;

c. Improvement of hygienic conditions through reduction of pathogens, worm eggs and flies;
d. Reduction of workload, mainly for women, in firewood collection and cooking;
e. Positive environmental externalities through protection of soil, water, air and woody vegetation;
b. Economic benefits through energy and fertilizer substitution, additional income sources and increasing yields of animal husbandry and agriculture;
c. Other economic and eco-benefit through decentralized energy generation, import substitution and environmental protection.
d. Reduces Greenhouse Effect

Biogas technology can substantially contribute to conservation and development, if the concrete conditions are favorable. However, the required high level of investment in capital and other limitations of biogas technology should also be thoroughly considered that can be seen in fig2 difference sustainable and non sustainable development.

7. REDUCTION OF THE GREENHOUSE EFFECT
Last but not least, biogas technology takes part in the global struggle against the greenhouse effect by reducing the release of CO2 from burning fossil fuels in two ways. First, biogas is a direct substitute for gas or coal for cooking, heating, electricity generation and lighting. Second, the reduction in the consumption of artificial fertilizer avoids carbon dioxide emissions that would otherwise come from the fertilizer-producing industries. By helping to counter deforestation and degradation caused by overusing ecosystems as sources of firewood and by amelioration of soil conditions, biogas technology reduces CO2 releases from these processes and sustains the capability of forests and woodlands to act as a carbon sink. Methane, the main component of biogas is itself a greenhouse gas with a much higher "greenhouse potential" than CO2. Burning biogas also releases CO2. Similar to the sustainable use of firewood, this returns carbon dioxide which has been assimilated from the atmosphere by growing plants. There is no net intake of carbon dioxide in the atmosphere from biogas burning, as is the case when burning fossil fuels. [14]

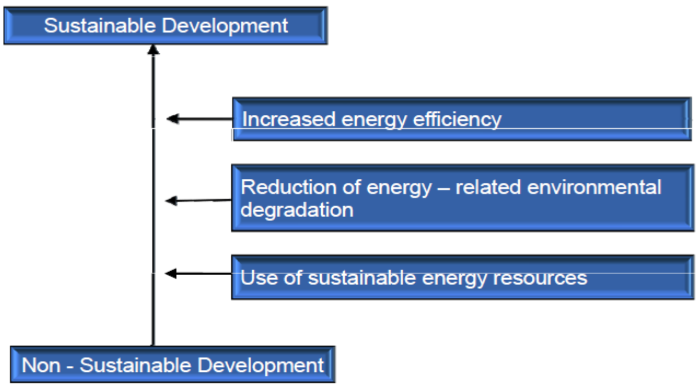

Figure2. Comparison sustainable and unsustainable development

8. BIOGAS FOR RURAL ENERGY; IMPROVING RURAL DVELOPMENT; ENVIRMENT AND ECOLOGY
When the methane content in the biogas reaches close to 50%, the gas becomes easily combustible and delivers a clear blue flame when burnt with sufficient supply of air. It can safely be used as fuel for cooking or for process heating.

Typical substrates, i.e. raw materials that can be used for biogas production in rural areas:
1) Agricultural waste: Maize, jawar, bajara, rice, sorghum, etc.
2) Food processing waste
3) Sugar factory: Molasses, spent wash, and press mud
4) Industrial waste: oilcakes and de-oiled cakes, maize husk, starch effluent, etc.
5) Other waste: Kitchen and hotel waste, organic waste in MSW
6) Cultivated substrate: Napier grass, Elephant grass, Safflower, etc.

After removing unwanted impurities, biogas can used as engine fuel to generate electricity. If purity of methane can be increased to over 90% then the gas can be compressed to high pressures of over 200 bar and stored in cylinders. It can then directly replace CNG, even for vehicular application. [8]

The effluent from the biogas plant is in the form of slurry, called as digestate. Liquid from the digestate can be separated by processes such as decantation or using simple techniques like a sand-bed filter. It could then be recycled into the biogas plant or can be used as nitrogen rich liquid fertilizer. The solids consists almost completely composted biomass. It can be used as manure. When minerals and micronutrients are mixed with the manure, it could be converted into fertilizer, which is a value added product. In China, anaerobic digestion is an important way of making use of biomass resources, achieving a number of benefits through biogas technology, in the production of energy, the protection of the environment and improvement of the ecology. China's use of biogas technology has attracted attention in many other countries. [15]

Table 2. Agricultural residues routs for development. [16]

Source	Process	Product	End use
Agricultural residues	Direct	Combustion	Rural poor Urban household Industrial use
	Processing	briquettes	Industrial use Limited household use
	Processing	Carbonization (small-scale)	Rural household (self-sufficiency) Urban fuel
	carbonization	Briquettes carbonized	Energy services
	Fermentation	biogas	Household industry
Agriculture and animal residues	Direct	Combustion	(save or less efficiency as wood) (similar end use devices or improved)
	Briquettes	Direct combustion Carbonized	Use Briquettes use
	carbonization	Briquettes	use
	carbonization	biogas	
	Fermentation		

9. COST

The cost of biogas plants varies greatly from country to country, because the costs of both materials (brick, concrete and plastic) and lab our can be very different. The economic viability of biogas depends on the cost of the fuel being replaced, and whether there are other financial benefits (for instance, avoided waste disposal costs, or income from selling compost).The potential of biogas plants to reduce greenhouse gases (including methane from uncontrolled dung and sewage management as well as carbon dioxide) means that carbon-offset finance has been a source of funding for some biogas programs.

10. ECONOMIC ANALYSIS

To assess the economic viability, we analyzed the balance sheet for biomass supply, biogas production and the use of the digestate, and we estimated the expense items, that is, the costs and loss of income, as well as the active items, namely the proceeds from sale and government incentives. In particular, the economic values examined for the biomass supply process were production cost, Sustainability 2014, 6 6706 purchase cost and loss of income estimated according to the market value of corn silage, triticale silage and cow manure. The values analyzed for the biogas production process were fixed costs associated with the investment, plant operating costs and earnings from feed-in-tariff proceeds, or in other words, the sale of electricity at special government incentive. The advantages of biogas are manifold. Biogas by itself can positively affect the economy of rural areas

11. ECONOMIC EVALUATIONS

A consensus on methodology should be developed to allow economic data to be compared among various applications, under varying circumstances, and to enable rigorous economic comparisons between biogas and other renewable energy technologies, or with conventional energy sources. The financial viability of biogas plants depends on whether output in the form of gas and slurry can substitute for fuels, fertilizers or feeds which were previously purchased with money. If so, the resulting cash savings can be used to repay the capital and maintenance costs, and the plant has a good chance of being financially viable. However, if the output does not generate a cash inflow, or reduce cash outflow, then plants lose financial viability. Finally, if broader social criteria are used to evaluate biogas, conclusions will be more favorable than a strictly financial analysis.

12. ANALYSIS OF ECONOMIC FEASIBILITY FOR BIOGAS CONSTRUCTION

Economic evaluation of small scale biogas plants requires measuring and valuing the fertilizer and fuel output, then comparing the gross value of output with the costs of plant construction and operation to arrive at a benefit-cost ratio or other index of value. It is also necessary to include in periodic costs for the maintenance of biogas equipment. The cost of lab our and material for managing and maintaining the biogas pits are also included here. Biogas production also has many indirect benefits, which sometimes play a very important role in biogas development. Furthermore, biogas development brings about social benefits in many respects. The increase in organic manure can result in using less chemical fertilizer, improving soil and increasing production. Environmental improvement in rural area reduces illness and build up people's health. Besides, in regions where biogas is used to generate electricity, cultural, recreation and spare time study conditions can also be improved.

13. THE FUTURE

Biogas plants have huge potential to produce clean fuel from unhygienic, wet organic waste. There are many more rural and peri-urban areas where traditional dung-based plants could be used. There may be even more potential in towns and cities, where waste disposal and sanitation is becoming an increasing challenge as more people move to urban areas. Interest is also growing in the use of larger plants for electricity generation and to supply gas grids.

RESULTS

With regard to the contents mentioned in this article, one of the effective methods for reducing pollution in the future will be more use biogas will be production from waste. Today, for various reasons, such as high cost of production, abundant fossil fuels and etc Less has been paid attention .But not far in the future will be the first position of renewable energy, because it can be produced in all parts as fuel becomes more devices

CONCLUSION

1) Biogas based energy could provide sustainable solution for rural areas
2) As the economics is attractive, it becomes a multipliable and scalable model
3) Supply of energy would assist rural businesses and enterprises to grow and prosper
4) Production and use of organic fertilizers would improve soil and increase yields
5) Considerable savings in subsidy bills and foreign exchange outflow could be achieved through such projects
6) The project would help employment generation by creating local job opportunities
7) Through availability of fuel and energy, the overall health and hygiene in the region will improve.

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