

# Biogas Energy in Buildings in Ghana – A Review

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**Abstract**— The use of biogas energy has been around for a long time. It has become an important topic for discussion of late due to the negative effects the use of fossil fuels has had on the world in recent times. It had become an imperative that a new and reliable renewable energy source to be used. This has brought about the discussion of how to use biogas on a large scale. The good thing about the production of biogas is the fact that it can be produced on a household basis. Utilising biogas energy in buildings helps to reduce the over reliance on fossil fuels and other conventional energy sources and helps to achieve low carbon emissions.

**Keywords:** Biogas Energy, Renewable Energy, Integration, Building, Energy Sources

## I. INTRODUCTION

Energy in the form of electricity is an important element in achieving national development goals. It is one of the basic inputs for all economic activities [1]. The world's energy crisis in 1973 and the inability of developing countries to guarantee the supply of energy have triggered studies into the sustainability of energy. Availability of electricity in terms of sufficient quality and quantity at affordable prices will enhance economic growth immensely. Energy is also an essential factor in development since it stimulates and supports economic growth and development [2]. As a result of increasing oil prices, provision of energy for cooking and lighting in our homes has become a very critical issue. Inadequate utilisation of energy has resulted in the deterioration of the environment.

Ghana has been fortunate to have had a head start with naturally clean generated energy from Akosombo but the load shedding exercises that persisted in the country and the current national electricity demands have outstripped Akosombo's output. Hence the need for an alternative energy source to supplement the one from Akosombo [3]. The quest for renewable and sustainable energy source, yet environmentally friendly has created the need to consider biogas as an alternative energy source. This has been necessitated by the environmental purification ability of biogas. Thus, reduces the greenhouse effect as well as the much disturbing waste of metropolitan Ghana.

The development of biogas energy will help to reduce the ever-increasing reliance on fossil fuels with its resulting pollution. Waste treatment is an effective way that can decrease the dependency on fossil fuels and minimize pollution [4]. Biogas energy is one of the many renewable energy sources. It has been one of the successful renewable energy technologies for the production of clean, environmentally friendly and cost-effective energy [1]. It can be found from sewage, liquid manure from hen, cattle, pigs, organic waste from the markets, food industry and so on [5].

Buildings are major consumers of electricity and as Ghana raises her pace to achieve its development aspirations, the impact on electricity is going to be

enormous and unsustainable [3]. The use of biogas energy has been around for a long time. Interest in the use of biogas technology in Ghana began in the late 1960s but it was not until the middle of 1980s that biogas technology received the much-needed attention from government [6]. It has become an important topic for discussion of late due to the negative effects the use of fossil fuels has had on the world in recent times. It had become an imperative that a new and reliable renewable energy source be used. This has brought about the discussion of how to use biogas on a large scale.

In the view of [1], a number of benefits are derived from the production of biogas energy. These are: it eliminates greenhouse gases, reduces the risk of contracting respiratory diseases such as bronchitis, leads to the betterment or improvement of fertilizer, assists in the production of heat and power and improves sanitation. Furthermore, it results in the reduction of workload of women and children, prevents deforestation and animal excrement from causing pollution, smell, flies and water pollution in the community and finally leads to visible improvement in rural hygiene.

## II. BIOGAS ENERGY AND ENERGY CONSUMPTION IN BUILDINGS

### A. Energy Consumption in Buildings

Buildings are mostly categorised into the residential sector and the commercial sector. More than 90% of our time is spent in buildings i.e. either in the office or at home. Energy used in buildings; both residential and commercial accounts for a significant percentage of a country's total energy consumption. It is known that buildings are the largest energy using sector in the world and over one-third of total final energy use and an equally important source carbon dioxide (CO<sub>2</sub>) emissions are imputable to existing buildings [7,8].

The present-day buildings have become the third largest consumer of fossil energy after industry and agriculture [9]. Today the world consumes about 13 TW of energy and approximately 80% of that comes from burning fossil fuels. The over dependence on the fossil fuels poses risks such as depletion of fossil fuel resources and global climatic changes caused by the net increase in the atmospheric CO<sub>2</sub> levels [10]. Other sources claim that in industrialised countries, energy usage in buildings is responsible for approximately 50% of carbon dioxide emissions [9].

According to [11], the net change in a buildings annual energy requirement is difficult to quantify and depends on the building characteristics, operating conditions and climate. With the rapid development of the global economy, energy demand is increasing and environmental pollution is intensifying. According to the International Energy Agency (IEA), buildings around the world share about 20 to 40% of the world's primary energy consumption, 30% of greenhouse gas emissions and 25 – 40% of solid

waste [12]. According to the IEA, buildings will account for some 41% of the global energy savings potential by 2035 compared with the industrial sector and the transportation sector [13].

Globally the building sector accounts for about 42% usage in electricity than any other sector and with increasing urbanisation higher in developing countries, the number and size of buildings in urban areas will increase resulting in an increased demand for electricity and other forms of energy commonly used in buildings. Global energy use in buildings is expected to grow as cities in developing countries continue to modernise and per capita income levels continue to increase [13]. The increasing demand for residential and commercial building spaces in developing countries will further push up energy consumption from buildings [14].

### B. Biogas Energy

Throughout history, buildings have changed to address social needs, Today's building industry appears to be entering another era of change with a view toward minimising the energy, carbon and environmental footprint of commercial and residential buildings [15].

Humanity is presently facing an extraordinary challenge; global warming. The building environment is one of the foremost points of carbon emissions related to global warming [16]. The global temperature has also increased due to the increase of CO<sub>2</sub> concentration in the atmosphere. Countries will have to make significant changes to use energy more wisely and also to change to using renewable energies as a result of the dangers and the repercussions of climate change and shortage of resources [17]. More than 40% of CO<sub>2</sub> emissions in developed countries come from heating, cooling and powering buildings [14].

According to [3], a country's growth is synonymous or directly proportional to the amount of buildings they have hence the need to find ways to effectively utilise the available energy at our disposal. In the current context of energy shortage and climate change, the development of renewable and sustainable energy has become an important global strategy [18].

Biogas fermentation also called biogas technology or anaerobic digestion is a promising waste treatment alternative because it results in the production of renewable energy sources such as methane while simultaneously removing organic pollutants [19]. Biogas is a gaseous fuel produced by the anaerobic digestion of biomass and waste, and biogas fermentation technology is considered a cost-effective way of renewable energy generation without increasing atmospheric CO<sub>2</sub> concentration [18].

Biogas, a methane rich gas produced by anaerobic fermentation of organic material is different from other renewable energy sources such as solar, wind, thermal and hydro because of its importance in controlling and collecting organic waste materials that if untreated could cause severe public health and environmental pollution problems [20]. Biogas can be produced from anything provided it is biodegradable. Biogas is a clean fuel because it burns without leaving soot and also less amount of carbon dioxide is released into the atmosphere during combustion [5].

### 1) Biogas Plant Sizes

Despite appearing in various sizes and shapes, biogas plants usually consist of a cylindrical tank for organic matter and a fixed, hemispherical dome for capturing the gas generated through the metabolic process by anaerobic bacteria or microorganisms [21]. According to [20], the other thing which distinguishes the use of biogas from the other renewable energy sources was the fact that biogas production systems are relatively simple and can operate at both small and large scales in urban as well as the remotest rural locations.

Different from large and community scale biogas plants that are primarily constructed in developed countries, small and domestic scale biogas digesters are generally used in rural households in developing countries such as China, India and Nepal [18].

## III. BIOGAS ENERGY UTILISATION

The benefits of biogas extend beyond energy production. Biogas digestate can be used as an organic fertilizer for agriculture, increasing independence from chemical fertilizers, pesticides and fossil fuels and resulting in mitigation of greenhouse gas emissions [19]. Various types of energy consumption in buildings such as cooling, heating, hot water, lighting as well as household appliance energy consumption can be supplied by renewable energy systems [22, 23, 24]. It can also be used as fuel for power generators and boilers [25].

### A. Benefits

Electricity demands can be affected by variations in pre-treatment demands and digestion technology among others and also depending on the raw materials used in constructing the biogas plant, the heat and electricity demands will vary [26]. The energy derived from biogas can be used for street lighting, water pumping and cooking in hospitals and schools [6]. For cooking, it is easier to use biogas stove since cooking with the gas takes less time than with wood or charcoal or any other commonly used fuel [1].

The byproduct of biogas production; bio slurry or bio residues are rich in plant nutrients and if properly treated can be used as a soil amendment to enhance crop yields [21]. Use of the digestates as fertilizers on arable land improves the utilisation of nutrients [26].

### B. Major Barriers

The research and practice of integration of biogas energy in buildings is not a lot in Ghana. There is also a lack of complete national and industrial standards. The economy of a biogas plant is characterised by large investment costs and some operation and maintenance costs [20]. The initial cost of biogas energy production as compared to the conventional energy sources is another significant barrier. Rural communities in Africa especially Ghana have various cultural beliefs as regards to the handling of waste. This has had an effect on the widespread use of biogas plants in the country.

#### IV. CONCLUSION

Biogas energy has a crucial part to play in meeting the increasing energy demands and to help in achieving low greenhouse gas emissions. The use of biogas energy in buildings is still in its infancy as compared to the developed countries. Lack of a comprehensive national and industrial standards are major barriers to the further development of biogas energy in buildings. A more detailed government policy is needed. Further research works are encouraged to facilitate the use of biogas energy in buildings.

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