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Biogas Upgrade to Biomethane from Landfill Wastes: A Review

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Abstract

Wastes from landfills originate from many spheres of life. These wastes are produced as a result of human activities either domestically or industrially. Wastes are generally regarded as by-products nevertheless; they could be useful resources in wrong hands or location. Due to the fact that biogas could be produced from two main sources such as landfills and digesters chambers [1]. It is important to critically look into the biodegradable materials that ends up as wastes on our landfills because they could be converted into biogas as a result of the high concentration of carbon and hydrogen contained in such wastes and majority of which are from agricultural and domestic locations. Recently, producing biogas is not good enough for some applications therefore the need to upgrade it for usage as a vehicular fuel [2]. This paper reviews landfill waste categorization, biogas production processes, biogas to biomethane upgrade, and biomethane utilization.

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1. Introduction

Due to the ever growing demand for energy globally and the rate of depletion in the quantity of world oil reserve annually which stands at 2.1%, there is an urgent need to look into other sources of energy than solely depending on fossil fuels which is currently the main supplier of about 88% of global energy [3]. Fossil fuels have contributed to the development of the world in an immense way nevertheless man has also not been spared from its dangers and harm as a result of the exploration activities. It is also one of the world most consumed natural resources and it is forecasted that OPEC will reach its production peak by 2026 at a rate of 53MMSTB/D [3]. The world at large has

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benefitted from the exploration of fossil fuels in all sectors such as transportation, energy (electricity), industrial, labour amongst many others nevertheless the world has also been affected by oil spillage, global warming, acid rain, Greenhouse gases emission (GHGs) and many more. Due to the unpleasant and non-environmental issues associated with the use of fossil fuels various countries in the world are beginning to explore alternative sources for energy and the most predominant option being renewable energy. According to the American Energy Information Administration (EIA) and the International Energy Agency (IEA), the world-wide energy consumption will on the average continue to increase by 2% per year [4]. Although, fossil fuel may not be totally replaced by biofuels for the short and medium term in fact the largest increase in world energy consumption is predicted to be from fossil fuels as shown in Fig I. Nevertheless, due to energy security reasons, environmental benefit, foreign exchange savings and socio-economic gains relating to renewable energy it will continue to receive tremendous attention in South Africa and the world at large.

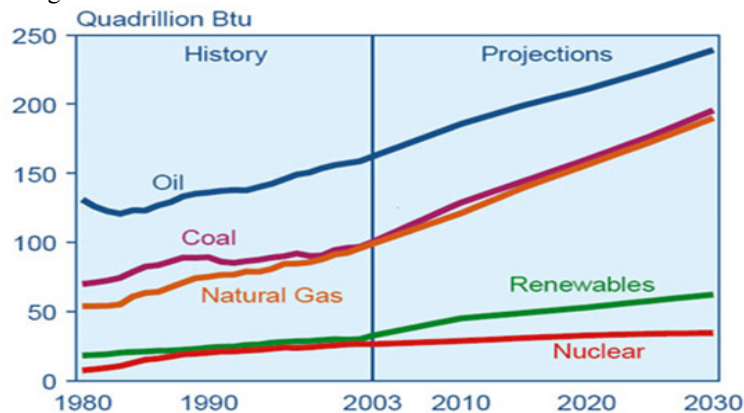


Fig.1: World Marketed Energy use by Fuel Type, 1980-2030 [4]

2. Landfill Wastes Categorization

The act of dumping wastes on landfill sites is the oldest, cheapest and most common form of waste management [5]. A landfill which is also known as dumping ground or rubbish dump is a site where waste materials are disposed and buried. Landfills are allocated by the municipality of a state or province and it is the only designated place where disposal of wastes is environmentally acceptable. Some countries of the world such as: South Africa, United States of America, Germany amongst others have waste classification and management regulations which are enforced into law by the country's Waste Act. In USA, the Environmental Protection Agency (EPA) uses the Resource Conversation and Recovery Act (RCRA) Section 4001, Subtitle D to regulate Garbage, Refuse, Sludges, Non-hazardous industrial wastes and other discarded materials [6]. Waste Act is often revised due to the complexity of waste generated by various sectors especially from the industrial sector and as soon as various tests are carried out on certain class of waste to determining risk posed by the waste on the environment and human life Waste Acts are amended to accommodate the risk and classify such waste accordingly. Generally, landfills can be broadly categorized into two namely: (i) Sanitary Landfills and (ii) Secure Landfills.

2.1. Sanitary Landfills

Sanitary landfills are sites designated for the disposal of non-hazardous wastes where it could be spread in layers, compacted and covered with earth (soil) at the end of each day the landfill is in operation. Non-hazardous wastes are often regarded as general waste because if properly managed they tend not to pose any significant threat to the health of the public and the environment [7]. This category of waste is mostly generated from four major areas namely: Residences, Institutions, Industries and Construction/Demolition as shown in Table 1.

Table 1. Non- hazardous wastes and their sources. [8]

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