An Overview Of Biomass And Biogas for Energy Generation: Recent Development And Perspectives

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ABSTRACT

Biogas from biomass appears to have potential as an alternative energy source, which is potentially rich in biomass resources. This is an overview of some salient points and perspectives of biogas technology. The current literature is reviewed regarding the ecological, social, cultural and economic impacts of biogas technology. This communication gives an overview of present and future use of biomass as an industrial feedstock for production of fuels, chemicals and other materials. However, to be truly competitive in an open market situation, higher value products are required. Results suggest that biogas technology must be encouraged, promoted, invested, implemented, and demonstrated, but especially in remote rural areas.

Keywords: Biomass resources, biogas application, sustainable development, environment

1 INTRODUCTION

Energy is an essential factor in development since it stimulates, and supports economic growth, and development. Fossil fuels, especially oil and natural gas, are finite in extent, and should be regards as depleting assets, and efforts are oriented to search for new sources of energy. The clamour all over the world for the need to conserve energy and the environment has intensified as traditional energy resources continue to dwindle whilst the environment becomes increasingly degraded. The basic form of biomass comes mainly from firewood, charcoal and crop residues. Out of the total fuel wood and charcoal supplies 92% was consumed in the household sector with most of firewood consumption in rural areas.

The term biomass is generally applied to plant materials grown for non-food use, including that grown as a source of fuel. However, the economics of production are such that purpose-grown crops are not competitive with fossil-fuel alternatives under many circumstances in industrial countries, unless subsidies and/or tax concessions are applied. For this reason, much of the plant materials used as a source of energy at present are in the form of crop and forest residues, animal manure, and the organic fraction of municipal solid waste and agro-industrial processing by-products, such as bagasse, oil-palm residues, sawdust and wood off-cuts. The economics of use of such materials are improved since they are collected in one place and often have associated disposal costs.

Combustion remains the method of choice for heat and power generation (using steam turbines) for dryer raw materials, while biogas production through anaerobic digestion or in landfills, is widely used for valorisation of wet residues and liquid effluents for heat and power generation (using gas engines or gas turbines). In addition, some liquid fuel is produced from purpose grown crops (ethanol from sugarcane, sugar beet, maize, sorghum and wheat or vegetable oil esters from rapeseed, sunflower, and palm trees). The use of wastes and residues has established these basic conversion technologies, although research, development and demonstration continues to try and improve the efficiency of thermal processing through gasification and pyrolysis, linked to combined cycle generation. At the same time considerable effort is being made to increase the range of plant-derived non-food materials. To achieve this several approaches are being taken. The first is to provide lower cost raw materials for production of bulk chemicals and ingredients that can be used in detergents, plastics, inks, paints and other surface coatings. To a large extent these are based on vegetable oils or starch hydrolysates used in fermentation to produced lactic acid (for polylactides) or polyhydroxbutyrate, as well as modified starches, cellulose and hemicellulose. The advantages are biodegradability, compatibility with biological systems (hence, less allergic reaction in use) and sparing of fossil carbon dioxide emissions (linked to climate change).

Associating an economic value to these environmental benefits, linked to consumer preferences has contributed to increased production in this area. The second expanding activity is the use of plant fibres, not only for non-tree paper, but also as a substitute for petroleum based plastic packing and components such as car parts. These may be derived from non-woven fibres, or be based on bio-composite materials (lingo-cellulose chips in a suitable plastic matrix). At the other end of the scale, new methods of gluing, strengthening, preserving and shaping wood have increased the building of large structures with predicted long-lifetimes. These include a wide range of natural products such as flavours, fragrances, hydrocolloids and biological control agents. In spite of decades of research and development, engineering (recombinant DNA technology) is being widely investigated to achieve this, as well as to introduce new routes to unusual fatty acids and other organic compounds. In addition such techniques are

TechConnect Briefs 2016, TechConnect.org, ISBN 978-0-9975-1171-0

being used to construct plants that produce novel proteins and metabolites that may be used as vaccines or for other therapeutic use. Processing of the crops for all these non-food uses will again generate residues and by-products that can serve as a source of energy, for internal use in processing, or export to other users, suggesting the future possibility of large multi-product biomass-based industrial complexes.

2 T TECHNICAL DESCRIPTION

Bacteria form biogas during anaerobic fermentation of organic matters. The degradation is very complex process and requires certain environmental conditions as well as different bacteria populations. The complete anaerobic fermentation process is briefly described below as shown in Table 1, and Figure 1. Biogas is a relatively high-value fuel that is formed during anaerobic degradation of organic matter. The process has been known, and put to work in a number of different applications during the past 30 years, for rural needs such as in [1]: food security, water supply, health cares, education and communications.

Biogas technology cannot only provide fuel, but is also important for comprehensive utilisation of biomass forestry, animal husbandry, fishery, agricultural economy, protecting the environment, and realising agricultural recycling, as well as improving the sanitary conditions, in rural areas. The introduction of biogas technology on wide scale has implications for macro planning such as the allocation of government investment and effects on the balance of payments. Factors that determine the rate of acceptance of biogas plants, such as credit facilities and technical backup services, are likely to have to be planned as part of general macro-policy, as do the allocation of research and development funds [2].

Biogas is a generic term for gases generated from the decomposition of organic material. As the material breaks down, methane (CH_4) is produced as shown in Figure 2. Sources that generate biogas are numerous and varied. These include landfill sites, wastewater treatment plants and anaerobic digesters. Landfills and wastewater treatment plants emit biogas from decaying waste. To date, the waste industry has focused on controlling these emissions to our environment and in some cases, tapping this potential source of fuel to power gas turbines, thus generating electricity. The primary components of landfill gas are methane (CH_4), carbon dioxide (CO_2), and nitrogen (N_2). The average concentration of methane is ~45%, CO_2 is ~36% and nitrogen is ~18%. Other components in the gas are oxygen (O_2), water vapour and trace amounts of a wide range of non-methane organic compounds (NMOCs) [4].

For hot water and heating, renewables contributions come from biomass power and heat, geothermal direct heat, ground source heat pumps, and rooftop solar hot water and space heating systems. Solar assisted cooling makes a very small but growing contribution. When it comes to the installation of large amounts of the PV, the cities have several important factors in common. These factors include:

- A strong local political commitment to the environment and sustainability.
- The presence of municipal departments or offices dedicated to the environment, and sustainability or renewable energy.
- Information provision about the possibilities of renewables.
- Obligations that some or all buildings include renewable energy.

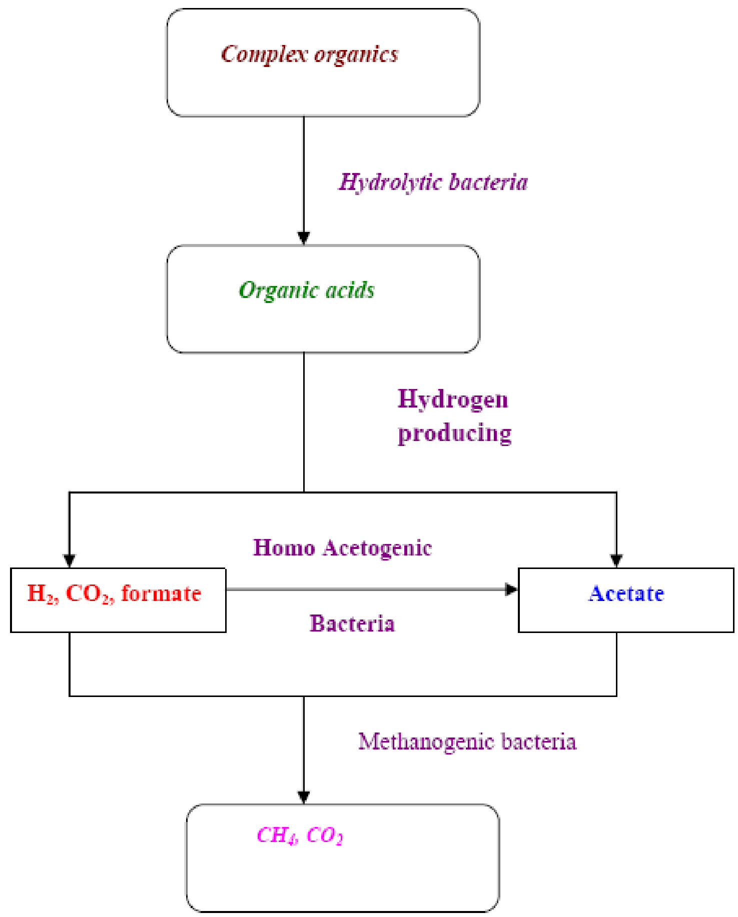

Figure 1: Biogas production process [3].

During the last decades thousands of biogas units were built all over the world, producing methane CH_4 for cooking, water pumping and electricity generation. In order not to repeat successes in depth on local conditions and conscientious planning urged [2]. The goals should be achieved through:

- Review and exchange of information on computer models and manuals useful for economic evaluation of biogas from biomass energy.

- Exchange of information on methodologies for economic analysis and results from case studies.
- Investigation of the constraints on the implementation of the commercial supply of biogas energy.
- Investigation of the relations between supplies and demand for the feedstock from different industries.
- Documentation of the methods and principles for evaluation of indirect consequences such as effects on growth, silvicultural treatment, and employment.

Level	Substance	Molecule	Bacteria
Initial	Manure, vegetable, wastes	Cellulose, proteins	Cellulolytic, proteolytic
Intermediate	Acids, gases, oxidized, inorganic salts	CH_3COOH, CHOOH, SO_4, CO_2, H_2, NO_3	Acidogenic, hydrogenic, sulfate reducing
Final	Biogas, reduced inorganic compounds	CH_4, CO_2, H_2S, NH_3, NH_4	Methane formers

Table 1: Anaerobic degradation of organic matter [3].

3 DISCUSSIONS

In the past two decades the world has become increasingly aware of the depletion of fossil fuel reserves and the indications of climatic changes based on carbon dioxide emissions. Therefore extending the use of renewable resources, efficient energy production and the reduction of energy consumption are the main goals to reach a sustainable energy supply. Renewable energy sources include water and wind power, solar and geothermal energy, as well as energy from biomass. The technical achievability and the actual usage of these energy sources are different around Europe, but biomass is seen to have a great potential in many of them. An efficient method for the conversion of biomass to energy, is the production of biogas by microbial degradation of organic matter under the absence of oxygen (anaerobic digestion). It is now possible to produce biogas at rural installation, upgrade it to bio-methane, feed it into the gas grid, use it in a heat demand-controlled CHP and to receive revenues.

An easier situation can be found when looking at the ecological effects of different biogas utilisation pathways. The key assumptions for the comparison of different biogas utilisation processes are:

- Biogas utilisation in heat demand controlled gas engine supplied out of the natural gas grid with 500 kWe - electrical efficiency of 37.5%, thermal efficiency of 42.5%, and a methane loss of 0.01.
- Biogas utilisation in a local gas engine, installed at the biogas plant with 500 kWe - electrical efficiency of 37.5%, thermal efficiency of 42.5%, and a methane loss of 0.5.
- Biogas production based on maize silage using a biogas plant with covered storage tank - methane losses were 1% of the biogas produced.
- Biogas upgrading with a power consumption 0.3 kWhe/m^3 biogas - methane losses of 0.5.

Due to the lack of knowledge and awareness, villagers cannot be expected to understand the benefits of solar stills, nutrient conservation, or health improvement [5]. A poor rural peasant is very hesitant to enter a new venture. The negative attitude towards the use of stills water varies from place to place, but when it occurs, it is a major obstacle to the implementation of solar still technology. In designing the solar still, the following points were considered: the unit has to cost as little as possible and materials should be readily available in rural areas. Technology should be simple, within the reach of a common village man. The unit should be usable in situations of emergency, e.g., during floods and after cyclones, etc. Energy efficiency brings health, productivity, safety, comfort and savings to the homeowner, as well as local and global environmental benefits. The use of renewable energy resources could play an important role in this context, especially with regard to responsible and sustainable development. It represents an excellent opportunity to offer a higher standard of living to the local people, and will save local and regional resources. Implementation of renewable energy technologies offers a chance for economic improvement by creating a market for producing companies, maintenance and repair services. Production of bio-fuels such as ethanol from sugarcane, takes advantages of year-round cultivation potential in a tropical countries. Benefits extend from local, national and international levels. Local rural economies benefit through new economic opportunities and employment in the agricultural sector. Urban regions benefit through cleaner air and health improvements. The nation benefits through substituting domestic resources for costly imported gasoline. The world benefits from reduced CO_2 emissions.

Climate change is a growing concern around the world, and stakeholders are aggressively seeking energy sources and technologies that can mitigate the impact of global warming. This global concern is manifest in the 1997 Kyoto Protocol, which imposes an imperative on developed nations to identify feasible options by the next Conference of the Parties to the Convention (COP) meeting later in 2001. Possible actions range from basic increases in energy efficiency and conservation, to sophisticated methods of carbon sequestration to capture the most common greenhouse gases (GHGs) emission (CO_2). On the other hand, renewable energies have always been identified as a prime source of clean energies that emit little or no net GHGs into the atmosphere. Forest ecosystems cause effects on the balance of carbon mainly by the assimilation of CO_2 by the aboveground biomass of the forest vegetation. The annual emissions of greenhouse gases from fossil fuel combustion and land use change are approximately 33 x 10^5 and 38 x 10^5 tones respectively. Vegetation and in particular forests, can be managed to sequester carbon. Management options have been identified to conserve and sequester up to 90 Pg C in the forest sector in the next century, through global afforestation [6-7]. This option may become a necessity (as recommended at the Framework Convention on Climate Change meeting held in Kyoto), but a preventative approach could be taken, reducing total GHGs emissions by substituting biomass for fossil fuels in electricity production.

4 CONCLUSIONS

(1) Biogas technology cannot only provide fuel, but is also important for comprehensive utilisation of biomass forestry, animal husbandry, fishery, evoluting the agricultural economy, protecting the environment, and realising agricultural recycling, as well as improving the sanitary conditions, in rural areas.
(2) The biomass energy, one of the important options, which might gradually replace the oil in facing the increased demand for oil and may be an advanced period in this century. Any county can depend on the biomass energy to satisfy part of local consumption.
(3) Development of biogas technology is a vital component of alternative rural energy programme, whose potential is yet to be exploited. A concerted effect is required by all if this is to be realised. The technology will find ready use in domestic, farming, and small-scale industrial applications.
(4) Support biomass research and exchange experiences with countries that are advanced in this field. In the meantime, the biomass energy can help to save exhausting the oil wealth.
(5) The diminishing agricultural land may hamper biogas energy development but appropriate technological and resource management techniques will offset the effects.

5 RECOMMONDATIONS

1. The introduction of biogas technology on wide scale has implications for macro planning such as the allocation of government investment and effects on the balance of payments. Factors that determine the rate of acceptance of biogas plants, such as credit facilities and technical backup services, are likely to have to be planned as part of general macro-policy, as do the allocation of research and development funds.
2. In some rural communities, cultural beliefs regarding handling animal dung are prevalent and will influence the acceptability of biogas technology.
3. Co-ordination of production and use of biogas, fertiliser and pollution control can optimise the promotion and development of agricultural and animal husbandry in rural areas.
4. Determine the energy rate bio-pellet eligible to stimulate biomass-based energy industry that is sustainable with fixed price provisions to ensure business certainty approved banks and financial institutions. It advised the Minister of Energy and Mineral Resources Regulation and mandated to state own electricity company.
5. Facilitating access to financial institutions / banks in financing biomass-based energy industry by involving Non-Bank Financial Institutions such as Venture Capital scheme. Banking and Financial Institutions are expected to fund the Green Energy with incentives; i.e., lending rate is 2 % below the central bank rate. Establish the rules of green banking in Banking and Financial Institutions sectors, this incentive for developers of renewable energy with a more attractive landing rate and below market rate so business people can obtain reliable funding sources for renewable energy projects.
6. Local Government should issue a Spatial Planning and Regional Governance and People's obvious that employers have a legal framework in the area of forest plantation use, in addition to the Ministry of Forestry should be able to issue permits use of social forestry with a short-time and in the candy should be included at least 20 % social forestry for gardens Energy. Local government should provide education about social forestry for energy.
7. This study can be continued for any type of renewable energy technology based on the amount of power, the power plant site and the technology used.

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