Study of Biogas as a Sustainable Energy Source in India

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ABSTRACT

India is a developing country comprising more than one-sixth of the world's population. Solely due to this reason there is a large dependence on energy resources for meeting the daily requirements particularly the fossil fuels which are generally regarded as undesirable for several reasons. Among the various other energy resources available, biogas has emerged as a promising fuel for the future with numerous advantages. This paper throws light upon the progress of biogas technology in India, suggesting how this valuable potent resource can be used for future sustainability. This study can be helpful in implementing biogas technology in many rural areas across India thereby establishing social and economic stability.

Keywords: *Biogas, Energy, Environment, Indian Scenario, Sustainable Fuel.*

1. INTRODUCTION

India is the fastest growing economy and is seventh largest in the world by nominal GDP. India had 17% of the world's population by 2011, March and was ranked first for a high population density of 371 people per Km^2 [11]. Still there are a large number of villages devoid of electricity due reasons like remote lands, rugged terrains and various other geographical reasons. The environment is also at stake as greenhouse gases, pollutants and other by-products critically impair the nature's wealth causing climate changes. Also due to population rise there is an increased demand for energy resources for national development needs. Ershad Ullah et.al, stated that biomass is still being depended upon as a solid fuel for cooking (thermal efficiency 5-15%) by about 30% of total Indian population [9].The strategy must target on the principal seven goals to fulfil the energy demand of the population in India which are minimization of cost, maximization of efficiency, employment generation, reliability of the system, minimization of petroleum product, maximize the usage of local resource and minimization of emissions [3].

Biogas has been found to be an eco-friendly fuel which can cater all the requirements of the present scenario in India. From being an easily producible fuel to an eco-friendly one, it can be used for cooking, heating, lighting and running small I.C engines. This is eligible in fulfilling the basic needs of an Indian household to managing waste from society.

Biogas is a gaseous fuel which is obtained from biomass by means of fermentation of wet organic matters. Biogas is clean as it does not release additional carbon into the atmosphere on burning and reduces greenhouse effect. Therefore it is eco-friendly and less polluting. All these factors effectively convey how biogas can become a sustainable source of energy in India.

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2. LITERATURE REVIEW

Biogas is primarily composed of methane (CH_4) and carbon dioxide (CO_2) with smaller amounts of hydrogen sulphide (H_2S). Biogas is one of the important renewable energy sources of the age and it offers the multiple benefits:

- It is environmentally friendly and its combustion does not increase the net amount of CO_2 in the atmosphere.
- It is produced from waste biomass materials and hence ensures the maximum availability.
- It facilitates a better way of waste disposal along with a provision of energy supplies.
- It possesses the potential to replace a substantial amount of fossil fuels throughout the world and thus the emissions.
- It provides a rich bio-fertilizer for agricultural lands, which can replace the use of chemical fertilizers for cultivation.
- It can prevent deforestation especially in developing countries [1].

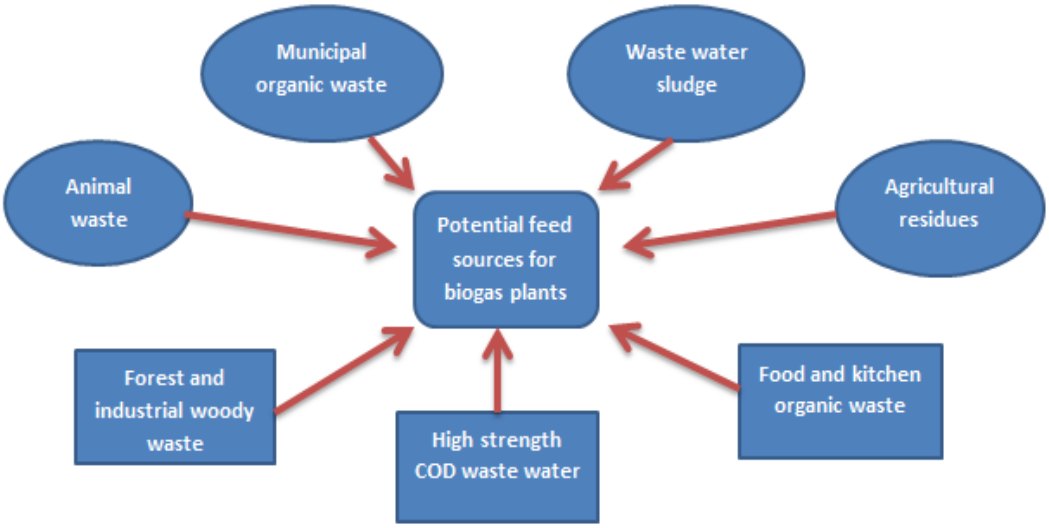

Fig 1: Diagram Showing Various Sources of Feed for Biogas Plants

From a resource-efficiency perspective it is very advantageous as the raw materials required for production of biogas include waste materials (agricultural crop residue, food waste, animal waste, aqua waste etc.), cultivated agricultural crops (rice, wheat, cereals etc.) and harvested materials (wheat straw, groundnut shells, coconut shells and rich husk). The various feed sources for biogas plants are given in the figure 1.

3. BIOGAS TECHNOLOGY IN INDIA

India is a major biogas producer, as of by 2009, with 4.5 million systems being installed totally [4]. In India, Development of biogas digesters began in 1939, with the first plants being constructed by the Khadi Village Industries Commission (KVIC) on a mass scale for dissemination in 1960 [18]. The National Programme on Biogas Development (NPBD) was implemented in 1982 with the intention that biogas could meet the needs of cooking energy requirements for rural households, and it is now one of the largest biogas programmes in the world [2]. Lohan SK et.al, reported that India has the potential of generation of $6.38x10^{88}$ m^3 per year of biogas with the annual production of 350 Mt of manure per year [10].Biogas became a well-established anddisseminated technology, under the programs with substantial subsidies, between 1985 and 1992 which continued on even after reductions in subsidies [5]. This also boosted the development of floating cover and fixed dome

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system variants, withapproval for at least seven different types by the Ministry of Non-Conventional Energy Sourcesfor the NPBD [5].Target-driven dissemination, however led to unhealthy competition between the implementing agencies by the early 2000's. This resulted in lower standards of construction and materials, eligibility and sustainability criteria being overlooked, disparities in the reporting of achievements, and a lack of follow up services and accountability for maintenance[2, 6]. In 2005, the government merged NPBD with the manure management initiative to address these issues to form the National Biogas and Manure Management Programme (NBMMP)[6].

Biogas has been successfully used as a vehicle fuel in transport busses in Delhi. The government has taken initiative in establishing a biogas plant in Mysore city to convert waste into fuel that can be used in vehicles.But the main barrier that stands before the use of biogas as fuel in I.C engine is that engine modifications are required over the existing ones, which is cost intensive.

4. BIOGAS AS A SUSTAINABLE ENERGY SOURCE

Secure supplies are not being delivered by the Indian government to meet the demands due to fuel subsidies, increasing import and inconsistent energy sector reform [12]. Over the years, the government development planning has been concerned with issues relating to human and inclusive developments with focus on poverty alleviation, generation of employment, health, education and development of skills [13].

Socio-economic benefits can be listed as:

- Illumination and safe drinking water availability for 2,500 households.
- Cooking fuel (biogas) supply to all the households.
- Irrigation to at least half an acre for each household.
- Establishment of agro-industry units withemployment and income generation.
- Empowerment
- Reduction in women and children drudgery[14].

Borjesson reported thatbiogas has the potential to combat environmental problems such as eutrophication, acidification and air pollution [7].Utilization and regularization of biogas technology will be beneficial in capacity building of rural economics, which includes advancement of village level institutions, capacity building of village communities, NGOs, entrepreneurs, researchers and evolution of appropriate bioenergy policy [14]. These factors point out the effectiveness of biogas being used as a sustainable energy source for the future in India.

5. COST FACTOR

Indian biomass power technology capacity demand is likely to be constrained by food security and the issue of high power generation cost, compared to the cheaper cost of generating electricity from coal. Therefore improved technologies for energy generation from biomass in feasible cost and methane capture from anaerobic wastewater treatment makes economic sense to follow the waste to energy prospect [8]. According to the Environment Protection Agency (EPA), it is possible to produce electricity for as little as ₹2.53 per kWh [15] assuming a 20 years capital repayment scope. This can be compared favourably to national electricity rates that range from ₹3.79 to ₹15.18 per kWh [16]. The community biogas plants (CBP) demand more capital and maintenance cost than smaller family biogas plants.Economically, biogas systems have been shown to be cost-effective. Despite the positive cost-benefit of biogas technology, the 'macro-environment', may discriminate against the uptake of biogas. The macro-environment which determines price structures of conventional fuels most likely acts as a disincentive to adopt renewable technologies. Subsidized conventional fuels, such as electricity, along

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with free connection to the grid for farmers, will continue to make non-renewable technology the cheapest option, unless subsidies for biogas can be brought into line, or prices of conventional fuels are raised [17]. Biogas will never be a charge-free fuel irrespective of the situations.

6. RECOMMENDATIONS FOR IMPROVING BIOGAS DISSEMINATION

The recommended strategies for improvement of biogas dissemination are given in table 1.

Table 1- Strategies for Improvising Biogas Dissemination

	Objective	Recommended Action	Responsible Body	Outcome
Social	Effective long term use and acceptance of biogas technology	Training and demonstration centres located in both urban and rural areas.	National, state, local governments. Biogas companies and NGO's	Increased awareness of benefits of biogas. Increased skills to effectively operate and maintain biogas systems.
Economic	Reduce biogas system installation cost barrier.	Provide soft loans, low cost credit. Apply for international funding e.g. CDM & JI programme. Direct and indirect subsidies. Introduce fee-for-service schemes.	Biogas companies, Banks/financial institutions, National and state governments, NGOs.	Increased uptake of biogas systems among low income earners.
Technical	Design biogas systems that are specific to user needs and local conditions.	Modify existing biogas system designs according to identified user needs and local conditions. Establish biogas technology knowledge sharing hub.	Universities and other research institutes. National, state, and local governments. Biogas companies and entrepreneurs. Non-governmental organisations (NGOs).	Increased uptake, efficient and productive use of biogas systems, reduced abandonment of systems.
Policy	Establish policy framework that is supportive of biogas technology.	Training and demonstration centres located in both urban and rural regions.	National, state, local governments. Biogas companies. NGOs	Increased awareness of the benefits of biogas. Increased skills to effectively operate and maintain biogas systems.

7. CONCLUSION

The paper reviews the status to biogas implementation in India. The renewable energy sources are one of the essential for the sustainability of the globe. India is the sixth largest fossil fuel consumer. The dependence of other countries for fossil fuels creates barriers in implementing unbiased political strategies. So biogas and other renewable energy sources have their relevance. The cost factor is one of the advantages of biogas. The government is in right direction for the implementation of biogas as

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fuels. But India has an infinitely extensible canvas synchronising with agricultural sector. The paper proposes the future strategies to be adopted by India for empowerment of biogas as a fuel.

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