USING BIOMASS ENERGY TO SUPPLY THE REQIRED ENERGY IN RURAL AREA OF KHUZESTAN, IRAN

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REFERENCE NO

BIOG-02

Keywords:
Biogas, energy, biomass, Iran, Khuzestan

ABSTRACT

From renewable energy resources, the portion of biomass in total energy consumption in rural areas of Iran is significant. Animal waste, fuel wood and also industrial agricultural wastes are used for cooking and heating in these areas. It has been estimated that Iran has a high level energy potential originating from livestock, forest processing, wood, agricultural and breeding and municipality wastes. In this study biomass energy potential from Khuzestan, one of the south west provinces of Iran is studied. The idea is to use the mentioned energy to supply rural needs. To gather wastes, it is proposed to use small scale digesters near houses. The energy associated with amount of related wastes in Khuzestan has been calculated using Retscreen software. Results indicate that there is the potential of producing more than 3180 m^3 of biogas per person in each year in the area. About 2400 m^3 of this amount is additional to personal needs and can be used to supply new established industries and old ones.

1. INTRODUCTION

The first requirement in all categories of lives and in all parts of the world is energy. The existence of ecosystems, human civilizations and life itself are depending on energy. Energy consumption is increasing by about 1% each year in developed countries and about 5% in developing countries. A large share of the world's energy source is fossil-based fuels. As the standards of life accomplished in nations are often a function of energy-related factors, the sustainability of energy production is turning out to be a global issue. Renewable energy sources are sufficiently plentiful to supply all of the global energy needs. Therefore provision of adequate, affordable, efficient and reliable energy services with minimum effect on the environment is crucial. Many countries depend on fossil fuels for their energy needs. However, this is increasingly becoming unsustainable because fossil fuels cause ecological and environmental problems [1] and are depleting rapidly. Problems associated with non-sustainable use of fossil fuels have led to increased awareness and widespread research into the accessibility of new and renewable energy resources [2]. This increased word-wide awareness and concern about the environmental impacts of fossil fuels coupled with steep increases in oil prices have lent enormous weight to the argument for countries switching o renewable energy sources [3]. Renewable energy comes from natural resources and is naturally replenished. Major renewable energy sources are hydroelectric, solar energy, biomass, wind, geothermal heat and ocean. In its various forms, renewable energy comes directly from the sun, or from heat generated deep within the earth.

Biogas energy, a clean and renewable form of energy, could augment conventional energy sources. Produced through anaerobic fermentation, biogas consists of between 40% and 70% methane with the reminding being carbon dioxide, hydrogen sulphide and other trace gases [4]. Among the renewable energy sources, biogas is one of the most feasible and suitable options for thermal and electricity generation applications especially in rural regions.

Depending on the amount of CH_4 included in the biogas content, it can be used efficiently in many applications such as cooking, heating, cooling and electricity generation. Biogas energy has some advantages over other energy sources. Successful use of biogas technology can result not only in energy generation and bio-fertiliser production, but also other social and ecological benefits including sanitation, reforestation and reduction of imported fuel oil [5,6].

Besides, biogas plants could be reliable renewable energy supply source in residential areas from the points of both technology and practice. As a result, biogas can be delivered to nearby settlements, thus reducing the need for a large biogas pipe network, and fertilizer could be easily applied to the surrounding farmlands, without the need for transportation. Forestry, agricultural and other organic wastes will be enough to produce between 50 and 150 EJ/year [7].

One of the most important barriers to do this project is collecting all wastages during the year. This process needs high technology systems. Regarding to high temperature limits and presence of products like sugar cane and corn, Khuzestan province not only can support its rural area needs, but also can be used to establish other industries to make jobs for people and improve life quality of them and also to reduce the environmental effects and related pollutions of wastes and finally to increase sanitary level to achieve the standards.

One solution to gather maximum wastes is to use small scale digesters near houses. In this way people can save different wastages in digesters separately. For bigger industries like sugar cane and industrial livestock, daily waste may be collected and transferred to big scale digesters.

In rural regions it is possible to use of digesters in small scales to collect houses wastes. Figure 1 represents a small digester suitable to be used in rural areas.

Of the most important advantages of biomass usage in rural regions, the following can be mentioned as:

- Improving living level of low income persons.
- Being independent of fossil fuels during operation.
- Supporting required energy of rural population including heating, cooling and cooking energies.
- Improving health and farming levels.

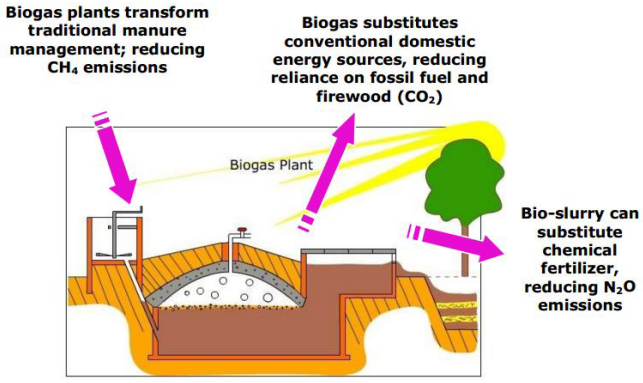

Figure 1.Digester in small scale [8]

Considering amount of the country's rural population and the dispersion of it and high cost of connecting country sides to the electricity grid and also lack of hygienic repulsion system for waste water and its environmental impacts and pollutions, using biomass and specially biogas technology has been of a great amount of importance in recent decades [9].

In this study biomass potential of Khuzestan province of Iran is studied and it is offered to be provided for rural uses.

2. CASE STUDY

The potential energy accessible from biomass is studied in the Khuzestan region of Iran. The Idea is to use this energy to supply rural in the area.

Khuzestan province with an area of 64057 km is located in the south of Iran. Khuzestan province has 27 cities, 144 rural districts and 6467 villages. As a result of the census of 2017 the population of rural areas is nearly about 1151596 persons. Figure 1 indicates geographical position of Khuzestan province.

Figure 2.Geographical position of Khuzestan province [10]

Khuzestan plain is one of the most fertile agricultural areas in Iran where agricultural products in this province have potential for biogas production. Wheat, maize and sugar cane are the most crops in this reign which has high potential for producing biogas, one of the most applicable forms of biomass energy. Production of biogas from putrefying materials and livestock wastes can help region economy and the outputs of Biogas power plant may be used as fertilizer in domestic agriculture.

According to the official statistics of the rural population of Khuzestan province, 2016 is 1301268 people living in villages. The number of villages with a population of over 1000 people is 275 and the number of villages with populations ranging from 500 to 999 people is 328 villages. The number of villages covered by the gas supply network is also 730 villages. The main occupation of people in villages is livestock and agriculture, where the agricultural wastes and livestock products, even wastages production of biogas can be a surplus on the needs of people [11].

Tables 1 and 2 present the total amount of yearly agricultural waste and table 3 and 4 present beast wastages per year. The energy associated with amount of related wastes is calculated using Retscreen software. [12].

Table 1. The biogas produced by agricultural wastages [13]

Agricultural products	Harvest (ton/year)	The amount of biogas produced per person($m^3/year$	Extraction coefficient
Wheat	128699	202.3	0.62
Barley	145597	23	0.62
Corn	491766	77.3	0.58
Sugar cane	6588757	1920	0.3
Sugar beet	110498	13	0.3

Table 2. The biogas produced by agricultural wastages [13]

Agricultural products	volume percentage of methane	Volume percentage of CO_2	Emission coefficient of CO_2 (Kg/GJ)	higher value heating(m^3/mJ)
Wheat	55%	45%	72.6	21.9
Barley	55%	45%	72.6	21.9
Corn	53%	47%	20.9	76.6
Sugar cane	73%	27%	53.3	28.9
Sugar beet	73%	27%	53.3	28.9

Table 3. The biogas produced by beast wastages [13]

Beast	number	The amount of biogas produced per person($m^3/year$)	Extraction coefficient
Goat	1183960	137.4	0.6
Sheep	2447230	519	1.02
Hen and rooster	15584496	290.95	0.54

Table 4. The biogas produced by beast wastages [13]

Beast	volume percentage of methane	Emission coefficient of CO_2(Kg/GJ)	Higher value heating (m^3/mJ)
Goat	70%	55.3	27.9
Sheep	64%	61	25.5
Hen and rooster	69%	56.1	27.5

Normally each person uses 619 m^3 of natural gas in each year, averagely. It is known that thermal value of biogas is 0.79 of natural gas. Consequently if someone wants to support the energy from biogas resource, he needs the following amount of it:

$$\frac{619}{0.79} = 783.5\ m^3/year \qquad (1)$$

226457 persons live in countries with population between 500 and 999 in Khuzestan province. Averagely 4 people live in each rural family in this district, So 56614 families live there.

The used gas during the year considering average of warm and cold seasons is 140176883 m^3 of natural gas and 177429059 m^3 of biogas. Consequently annual consumption of each family is 2476 m^3 of natural gas equal to 3134 m^3 of biogas.

According to Khuzestan climate, which is hot, cooling of the buildings is one of the most important needs in this province. Actually the required energy of a rural family in the district includes lightning, cooking, heating and cooling energies.

Based on statistics of Engineering Organizations of Iran, 40% of building's energy is used for cooling and heating in Khuzestan [14].

As indicated before, from the statistics data it is clear that each person needs 619 m^3 of natural gas and equally needs 783.5 m^3 of biogas in order to meet all energy requirements per year. For the chosen areas if the whole agricultural and livestock wastages be used to produce biogas it will lead to about 3180 m^3 biogas for each person per year in Khuzestan. More than 2400 m^3 of the mentioned produced biogas is more than required personal energy and can be used in other industries to improve life level, make new job opportunities and also reduce environmental impacts.

3. CONCLUSIONS

Biomass is one of the important renewable energy resources. According to high level potential of this energy in rural parts of Iran, it's feasible to plan to use it for essential requirements like heating, cooling, cooking and lights. This potential was estimated in Khuzestan province. One of the important steps in this project is to collect all wastages during the year. One solution to gather maximum wastes is to use small scale digesters near houses. For bigger cases like sugar cane and industrial livestock, daily waste may be collected and transferred to big scale digesters. If the whole agricultural and livestock wastages be used to produce biogas, there will be about 3180 m^3 produced biogas for each person per year in Khuzestan. About 2400 m^3 of the mentioned produced biogas is more than required personal energy and can be used in other industries to improve life level, make new job opportunities and also reduce environmental impacts.

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