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Animal Manure as One of the Main Biogas Production Resources: Case of Turkey

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Abstract: Generating power from renewable energy resources has become increasingly important in the world. One of the main renewable energy resources is biogas. People have been using biogas for over 200 years. First of all, biogas is a resource of energy that is environment-friendly and manure. In many parts of the world, biogas is used to heat and light homes, cook and as manure in the fields and even as fuel for buses. It is collected from large-scale resources such as landfills and barns and through small domestic or community systems in many villages. Biogas contains agricultural waste such as manure and plant waste. In order to protect environment, the usage of biogas should be increased. There are several biogas plants in Turkey. The main aim of this study is to determine the potential of biogas production produced by livestock and poultry waste in Turkey. According to livestock and poultry population, agricultural sector has an important resource for biogas production. Biogas potential will be calculated in compliance with type of livestock and poultry.

Key words: Renewable energy, biogas, livestock, poultry, Turkey

INTRODUCTION

The importance of sustainable development has been increasing in last two decades depending upon global climate change. The years of 1995-2006 were the warmest years in the world considering the Intergovernmental Panel on Climate Change (IPCC) records (Anonymous, 2007). Sustainable development has three dimensions such as environmental, economic and social. Global climate change has threatened sustainable development. In order to mitigate and avoid global climate change, reducing carbon emission and the usage of renewable energy should be increased. Boosting investment in renewable energy, energy efficiency and new technologies contribute to the sustainable development and security of supply and helps for creating new jobs, economic growth, greater competitiveness and rural development (Anonymous, 2008).

GHG emission is one of the most important reasons for global climate change. When sector distribution of GHG emission is taken into consideration, energy sector has the biggest share (82%). Agriculture (8%), industry (7%) and waste management (3%) in the Fig. 1, respectively.

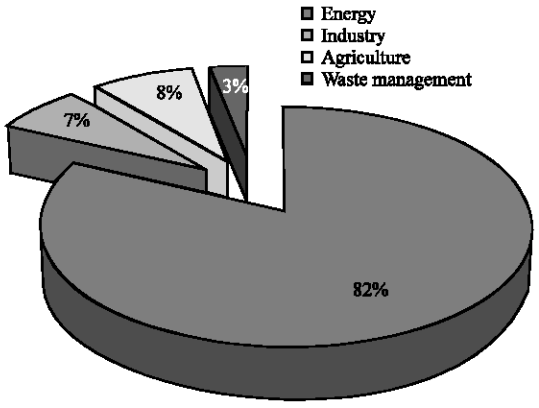

Fig. 1: Sector distribution of GHG emissions (Zanbak, 2009)

Biogas is a sustainable, renewable energy source, which is widely used to produce electricity today in the world. Biogas is a mixture of different gases produced as a result of organic material digestion by anaerobic microorganisms on domestic and agricultural wastes. It contains methane in bulk (50-86%) and other gases relatively in low proportions such as CO_2 (25-35%), H_2 (1-5%), N_2 (2-7%) and O_2 (0-01%).

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Table 1: Number of biogas plants in the world (Turker, 2008; Guttmann, 2009)

Countries	Plants
Austria	350
Belgium	10
Czech Republic	12
Denmark	70
Estonia	5
Finland	10
France	5
Germany	3,700
Greece	2
Hungary	2
Ireland	5
Italy	70
Lithunia	2
Luxemburg	15
Netherlands	70
China	20,000,000
Russia	70
Kazakhstan	30
India	2,500,000
Nepal	145,000
Vietnam	18,000
Turkey	48

Agricultural sector is a source and sink of both global climate change and biogas production. Mitigating former and swelling the latter, agriculture is likely to be much more sustainable. Some of the countries have biogas production facilities such as EU countries, China, India, Russia, Kazakhstan, Nepal, Vietnam and Turkey etc. and they consume biogas for cooking, heating, lighting and as fertilizer (Table 1).

Although, Turkey has a significant potential for producing biogas, there are a few biogas plants, which are generally operated in food industry and waste refinement. To create the awareness concerning the biogas production and its usage, research should be done by giving priority to renewable energy, some activities should be organized such as training, creating a focus group and holding stakeholders meetings etc. and incentives should be given for the construction of farmer/farmers organizations-based biogas plants and legal arrangements related to the renewable energy should be done.

MATERIALS AND METHODS

The material of this study includes the data, which are the number of cattle, sheep, goat and poultry in 2007. The following coefficients were used for the calculation of total animal manure.

- Cattle: 3.6 ton/unit/year
- Sheep/goat: 0.7 ton/unit/year
- Poultry: 0.022 ton/unit/year

In order to convert animal manure to biogas, the coefficients of 33 m^3/year/ton for cattle, 58 m^3/year/ton for sheep and goat, 78 m^3/year/ton for poultry were used as conversion coefficients.

The following coefficients were used for the calculation of biogas equivalents (Anonymous, 2009).

Gas oil: About 0.62 L, charcoal: 1.46 kg, wood: 3.47 kg, butane: 0.43 kg, dried cow dung: 12.3 kg, electricity: 4.7 kWh, diesel fuel: 0.66 L, fuel: 0.75 L, propane: 0.25 m^3.

RESULTS AND DISCUSSION

Admittedly, organic wastes are generally used in biogas production. Amid in these wastes, animal manure has the great importance. While, producing biogas from animal manure, not only biogas, but also highly enriched organic fertilizer is produced. Biogas provides many advantages from the aspect of energy sector, agriculture and environment. As it can be shown in the Table 2, agriculture has more advantages than the others.

Within the framework of a project initiated by the Ankara Village Service Research Institute in the 1980s, country-wide establishment of 1000 biogas facilities were targeted and many of them were opened to operation. However, none of these facilities are in working. One of the important reasons for the inoperative status of the facilities was that they gave insufficient training to managers of biogas facilities and they encountered operational difficulties in small facilities. Although, Ministry of Agriculture and Rural Affairs has been aware about the importance of biogas production for Turkey, any activities has not been organized in both Ministerial and local level (Ar, 2006).

Ecological structure of Turkey enables animal husbandry in all agricultural regions concerning the animal production. Specialized livestock production is performed on 2.36% of farm holdings in Turkey, while both crop production and livestock production are performed on the remaining 67.43% of them (Anonymous, 2003). The potential of total biogas production of Turkey is calculated as 3.079.066.211 m^3 (Table 3) in compliance with the number of livestock. As it may be shown in the Table 3, the equivalent of biogas for cattle manure has the biggest share in the potential of total biogas production. Sheep and goat and poultry excrements follow this, respectively.

The amount for the potential of biogas production is equal to 1.909.021.051 L gas oil or 4.495.436.668 kg charcoal or 10.899.422.096 kg wood or 1.323.998.471 kg butane or 37.872.514.397 kg dried cow dung or

Table 2: Advantages of biogas production for the energy sector, agriculture and environment (Birkmose, 2000)

Energy	Agriculture	Environment
Renewable energy	Improved utilisation of nitrogen from animal manure	Reduced nitrogen leaching
CO_2 neutral	Balanced phosphorus/	Reduced odour problems
	Potassium ratio in slurry	Reduced greenhouse gas emissions
	Homogeneous and light-fluid slurry	Controlled recycling of waste
	Reduced transportation of slurry	
	Possible to get large amounts of slurry with a full declaration of contents	
	Slurry free from weed seeds and disease germs	
	Common slurry separation	

Table 3: Number of livestock and biogas production potential

Livestock	No. of livestock	Manure (ton year^{-1})	Total manure (tons)	Coefficient of biogas (ton m^{-3})	Total biogas (m^3)
Cattle	11,121,458	3.600	40,037,249	33	1,321,229,210
Sheep and goat	31,761,651	0.700	22,233,156	58	1,289,523,031
Poultry	272,910,239	0.022	6,004,025	78	468,313,970
Total	315,793,348		68,274,430		3,079,066,211

Table 4: Biogas equivalents

Livestock	Biogas	Gas oil	Charcoal	Wood	Butane
Cattle	1,321,229,210	819,162,110	1,928,994,647	4,584,665,360	568,128,560
Sheep and goat	1,289,523,031	799,504,279	1,882,703,625	554,494,903	554,494,903
Poultry	468,313,970	290,354,661	683,738,396	5,760,261,833	201,375,007
Total	3,079,066,211	1,909,021,051	4,495,436,668	10,899,422,096	1,323,998,471

	Dried cow dung	Electricity	Diesel fuel	Fuel	Propane
Cattle	16,251,119,288	6,209,777,289	872,011,279	990,921,908	330,307,303
Sheep and goat	15,861,133,276	6,060,758,244	967,142,273	967,142,273	322,380,758
Poultry	5,760,261,833	2,201,075,660	117,078,493	351,235,478	117,078,493
Total	37,872,514,397	14,471,611,192	1,956,232,044	2,309,299,658	769,766,553

Table 5: Biogas production facilities due to number of livestock (Anonymous, 2009)

No.of livestock	Size of plants (m^3)	Manure needs (kg day^{-1})	Biogas production (m^3 day^{-1})
2500 poultry	15	200	17
10 cattles	10	150	5

14.471.611.192 kWh electricity or 1.956.232.044 L diesel fuel or 2.309.299.658 L fuel or 769.766.553 m^3 propane (Table 4).

It is possible:

- To lighten a lamb, which is 60-100 watt for 6 h
- To cook three meal for a family, which has 5-6 members
- To obtain calorie equal to 0.7 L fuel
- To start an engine for 2 h
- To generate 1.25 kWh electricity by using 1 m^3 biogas (Ozturk, 2005)

Table 5 gives an idea for determining of biogas facility's capacity according to the number of livestock.

CONCLUSION

Renewable energy has become an alternative of fossils fuel for quite some time. Although, Turkey has plenty number of renewable energy resources, it doesn't make use of it efficiently. The usage of renewable energy is promoted by Turkish legislation on the promotion of energy produced from renewable energy resources. Agricultural sector is a significant resource of biogas production. Unfortunately, generating energy from agricultural waste is not common in rural areas. So, as to increase the number of biogas facilities, public awareness should be created and the advantages of biogas to beneficiaries should be explained. Farmers, managers and staff of farmers organizations and local institutions should be trained concerning biogas production. Biogas facilities are an additional source of income on many farms besides crop production and animal husbandry. Through, producing biogas in farm holdings, energy costs of households are decreased. Briefly, the production of biogas has a lot of advantages in both environmental and economic aspect.

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