O 20. BIOGAS PRODUCTION STAGES AT CUMRA DISTRICT AND ITS CONTRIBUTION TO THE COUNTRY AND THE ENVIRONMENT

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ABSTRACT: This study examines the contribution that manufacture of biogas and biofertilizer from wastes issued from bovine animal producing facilities in the Central Anatolian region, which has become the center of agricultural and animal production over the last few years, has on the economy the region and the country. In our country as in the world, the use of renewable energy sources is on the rise in line with global warming. It is also significant in terms of the nation's economy that alternative energy resources are utilized for meeting the need for energy. Manufacture of biogas from animal wastes will not only provide the region with significant economic benefits, but also manifest numerous positive environmental and social effects. The manufacture of biogas in the agriculture and animal husbandry industry has been practiced successfully in developed countries for years. In order to contribute to the popularization of this practice in our country, and especially in the Central Anatolia Region, the quantities of biogas and biofertilizer that could be obtained as a function of different quantities of animals have been presented in this study in tabulated form a world long with the economic returns associated with them.

***Keywords**: Biogas, Organic wastes, Cumra District, Environment*

INTRODUCTION

One of the most essential requirements for a sustainable level of prosperity is energy. Researches are carried out to meet the increasing energy need when the energy is exhausted in the world. For such a long time, it is imperative that energy needs come from renewables. This stage; Studies in the field of biogas in Turkey and in the world have been discussed in general. It is quite possible to increase the biogas production under the conditions of Turkey. These sedans, vegetal and other wastes are found elsewhere here (Kumaş et al., 2018).

Within this scope, the sample animal manure of the Biogas Facility in Konya Province Çumra District will be biodegraded anaerobic inside. In Turkey, anaerobic culture biogas production is almost non-existent. There are a limited number of anaerobic treatment applications, especially in the food industry. With these systems; Fermented products with high energy and nutritional value are obtained from organic wastes.

Animal Wastes: Cattle, horse, sheep, chicken and pig animal manure, slaughterhouse residues, residues that occur during the processing of animal products.

Vegetable Wastes: Grain, stalk and straw, corn residues, sugar beet leaves, hazelnut capsules, wild herbs, residues generated during the processing of herbal products.

Organic Content City and Industrial Wastes: Sewage and bottom sludges, paper industry and food industry wastes, industrial and domestic wastewater with a high concentration of dissolved organic matter. These wastes are especially wastes used in biogas production centres established by municipalities and large industrial facilities using high technology. Biogas is a colourless, flammable gas that is released as a result of the fermentation of organic substances and is formed depending on the raw material produced by the way of production, and generally contains 60-70% methane, 30-40% CO_2 and a small amount of sulphureous hydrogen, nitrogen, hydrogen and carbon monoxide in its mixture (Alibaş & Soyupak, 1981).

Organic wastes are generally used as raw materials in the production of biogas. Animal fertilizers have an important place among these wastes. While biogas is produced from animal manure, both gas is obtained and the fertilizer matures within the fermentation period and is thrown into the field early. Thus, the waiting period of animal manure, which takes approximately one year before being thrown into the field, can be reduced to 15-20 days. This situation also prevents the loss of plant nutrients that occur during holding the fertilizer. Thus, this gas produced with biogas technology allows both energies to be obtained from organic wastes and recycling of wastes to the soil, thus increasing productivity in agricultural areas (URL-1).

Animal and herbal wastes not used in biogas production in our country are mostly either directly burned or given to agricultural lands as fertilizers. However, it is more common to use wastes in heat production by burning. In this way, the desired quality of heat cannot be produced, and it is not possible to use the wastes as fertilizers after heat generation. In many countries, biogas plants are built using different technologies according to the planned purpose. Biogas facilities can be handled as family type (6-12 m^3 capacity) farm type (50-100-150 m3 capacity), village type (100-200 m3 capacity), as well as Germany, USA, Denmark, Switzerland. Industrial biogas plants with a capacity of 1,000-10,000 m^3 are also operated in many countries (Okay et al., 1983.)

Although 50-65 Mtoe (million tons of oil equivalent) agricultural waste and 11.05 Mtoe of animal wastes are produced annually in Turkey, only 60% of these wastes are usable for energy production. is known to be equal to 22-27% of annual energy consumption. The energy potential that can be obtained from agricultural residues in our country every year is equivalent to 5.4 million tons of oil. In addition, our country has a potential equivalent to 5.9 million tons of wood, forestry and industrial waste, and 1.5 million tons of oil equivalent as animal waste. With this total energy equivalent to 12.8 million tons of oil, 40% of the country's energy use will be met. This energy is used as a versatile energy source for direct heating and lighting, as well as alternatives to electrical energy and mechanical energy.

In another approach, the amount of fertilizer obtained from animals varies according to the type of animals. According to this; 3.6 tons / year of wet fertilizer from 1 cattle, 0.7 tons / year of wet manure from 1 small cattle, 0.022 tons / year of wet manure is produced from 1 poultry.

Based on these values, 33 m^3 / year biogas from one ton of cattle manure, 58 m3 / year biogas from a ton of sheep manure. It has been determined that 78m^3 / year of biogas is produced from one ton of poultry manure. The amount of wet fertilizer that occurs in Turkey depending on the animal potential is calculated in tons / year and the biogas amounts that can be produced (m^3/year) have been determined according to these values and are given in Table 1.

Biogas in the World

Considering the situation that non-renewable energy sources will be depleted in an average of 100 years worldwide, where energy needs are increasing day by day, all developments and concerns about the future have started to direct the search for alternative energy in the world to renewable energy sources. Renewable energy source is defined as “the energy source that can be present the next day in its own cycle.” By definition, conventional energy sources are not considered as renewable energy sources. It is estimated that the average annual increase in world energy demand will be 1.6% in the period of 2008-2030. At the end of this period, the total energy demand increase by 2030 has started to accelerate, expected to reach.

Table 1. The Amount of biogas that can be produced for the animal waste potential of Turkey

Animal type	Animal numbers	Wet Animal Manure Amount (Ton / Year)	Biogas Amount (m^3/year)
Cattle	11.054.000	39.794.400	1.313.215.200
Sheep, Goat	38.030.000	26.621.000	1.544.018.000
Chicken, Turkey	243.511.000	5.357.242	417.864.876
Total	292.595.000	71.772.642	3.275.098.076

In line with the 2030 targets, countries are increasing their existing installed power capacity day by day. There are many examples from the public or private sector that focus on these areas. The development of biogas, one of the renewable energy sources, is gradually increasing in the world. Considering the facility rates of biogas obtained from animal manure, the facilities in the world; 80% are in China, 10% in India, Nepal and Thailand. Considering the number of biogas and facilities that Europe obtains with animal manure. Germany is the country with the highest production with 2,200 plants at this point. This

country is followed by Italy with 70 facilities. The construction of biogas plants in Germany has increased since 1993, and again from the same year to the 2000s, from 139 to 2,200 plants.
With residential biogas plants, approximately 2 billion m3 of biogas is produced throughout China, and with this production, 25 million people use it for cooking purposes most of the year. Inexpensive biogas stoves and lamps that can operate even at very low pressures have been developed and encouraged to find them in every home. In India, biogas plants, which started to develop in 1981, started to be used intensively, especially in large farms. However, approximately half of these facilities are idle and not used for various reasons as in Bangladesh. Most of them are used without a license. In accordance with the Kyoto Protocol signed in 1997, countries are required to gradually reduce their greenhouse gas emission values from year to year according to the protocol signed. Due to the ever-increasing energy need and this protocol, European countries have invested more in renewable energy and increased their production.

MATERIAL & METHOD

Research Area

Konya Biogas Electricity Production Company in Çumra Biogas Integrated Plant covers an area of approximately 17,203 m². The facility has a daily capacity of 12 MW and is the largest Biogas Power Plant in Turkey. It occurs with animal waste. When the facility went and toured, the necessary information was obtained from the facility manager and all the reactors of the facility were visited and the necessary information was obtained from both the facility manager and the employees. Data about the waste from the facility, the operation of the facility and the electricity production were obtained from the facility manager.

Amount and Characteristics of Waste

The total amount of poultry waste (70 tons / day) and bovine waste (7 tons / day) coming to the facility is 77 tons / day capacity.
Poultry Animal Waste = 70 tons / day Density1 = 0.96 tons / m^3
Poultry Animal Waste = (70 tons / day) / (0.96 tons / m^3) = 72.9 m^3 / day
Bovine Animal Waste = 7 tons / day Density1 = 0.99 tons / m^3
Bovine Animal Waste = (7 tons / day) / (0.99 tons / m^3) = 7.07 m^3 / day
Total = 79.97 m^3 / day

Domestic Solid Wastes, the number of personnel working in the facility, the amount of domestic solid waste consisting of personnel, the amount of solid waste produced per person per day is 1.16 kg. 17.4 kg of solid waste is generated per person per day. According to the characteristics of the solid waste (organics, glasses, plastics, papers, metals, etc.), it is collected in separate containers. It is protected in a closed way without polluting the environment in terms of its appearance, dust, odor, etc. Packaging Waste, on the other hand, consists of packaging waste originating from the personnel. The packaging wastes generated are collected regularly, given to licensed companies and disposed of. 15 kg of personnel-originated wastes per day are collected in the waste area separated from others and given to licensed companies for recycling. (Biogas Power Plant, Project file, 2020)

Average Amounts of Fertilizer and Biogas That Can Be Obtained from Animal Wastes for Konya, Çumra, Biogas Plant

When designing biogas facilities, it is necessary to determine the capacity first. For this, if only animal manure will be used in the facility; the amount of fertilizer released daily, the feeding patterns of the animals and the solids content of the fertilizers should be known. The amount of fertilizer produced daily can be in different amounts according to the fertilizer efficiency of the animals. In the calculation of the fertilizer amount; 10-20kg / day (wet) fertilizer yield can be accepted for bovine animals and 5-6% of live weight can be based on daily fertilizer amount. Likewise, 2 kg (wet) / day or 4-5% of live weight can be accepted as daily manure production for sheep and goats. Daily manure production for chicken is 0.08-0.1kg (wet) / day or 3-4% of live weight.

Flare (Biogas Burning Chimney)

In cases where biogas cannot be used, waste feeding is cut to minimize production and the produced biogas flare unit is burned to prevent its release to the atmosphere. In cases of maintenance and failure, when the biogas cannot be burned in the generators, the flare is installed in accordance with the facility capacity. In terms of emissions, it has a height of 8 meters. The flare is automatically ignited and extinguished.

Work Flow Chart

The organic wastes coming to the Biogas Plant are biodegraded in an anaerobic environment. The biogas that will be released during the biological decomposition of organic wastes is used in the cogeneration unit for electricity and heat generation. Solid and liquid fermented product is formed. Balancing the biological system, stabilizing the balance, taking into account the cost and ease of transportation of waste procurement; Bovine and poultry manure are taken to the facility. Work Flow Chart of the facility as shown in Figure 1.

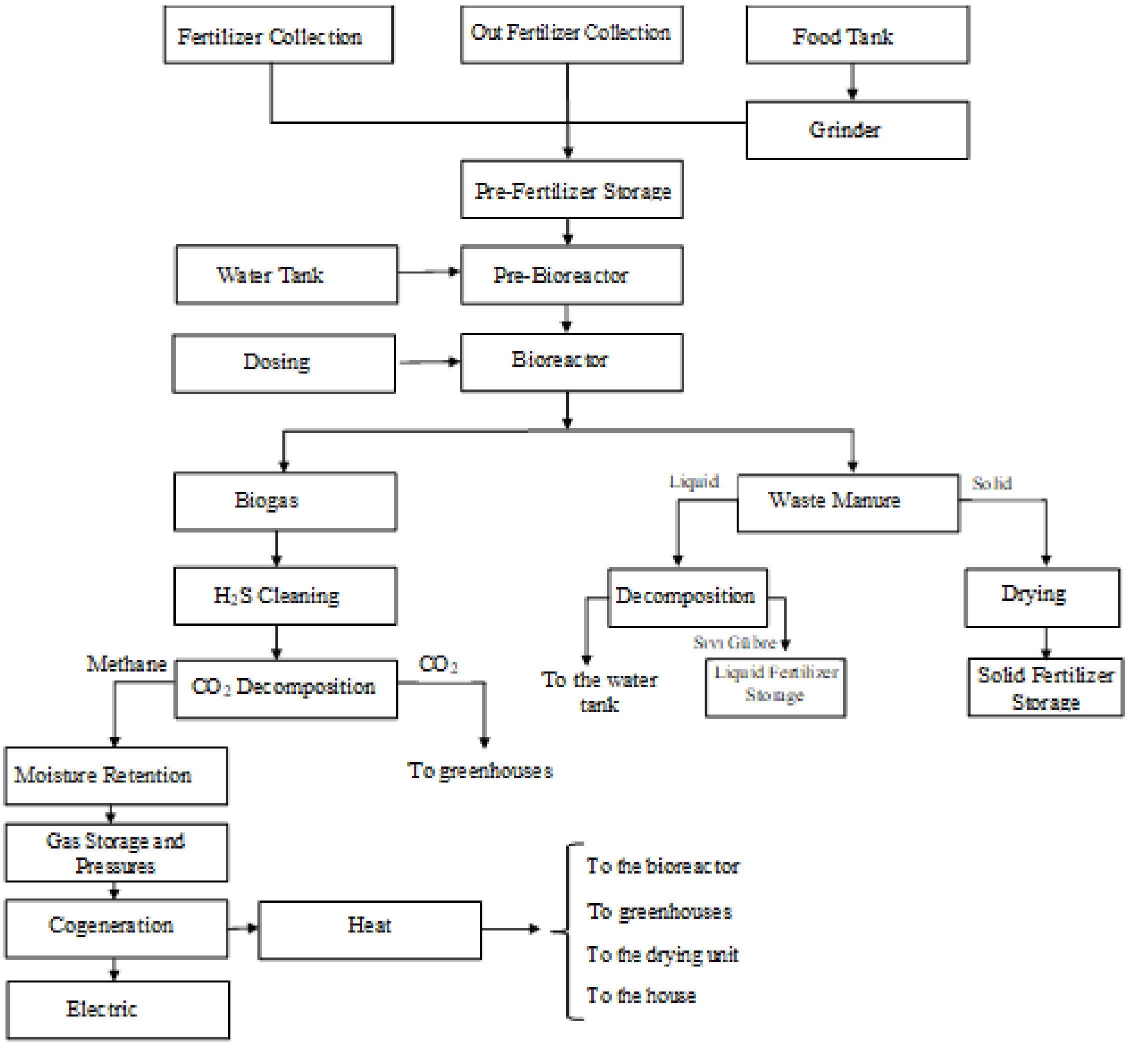

Figure 3. Work Flow Chart of the facility

Biogas Production

Biogas is produced by the decomposition of organic materials in the absence of oxygen, which is also known as oxygen-free fermentation. It is a mixture of organic wastes of animal and plant origin, released as a result of anaerobic fermentation, without colour and odour, lighter than air and flammable. It contains a large amount of methane gas. Energy provided by 1 m3 of biogas; 0.62 lt. gas oil, 3.47 kg wood, 4,70 kWh electricity, It is equivalent to the energy obtained from 1.46 kg of charcoal. Organic materials such as food residues, fertilizers, crop residues or water residues are fed into the fermenter. It is heated at 38 - 40 degrees Celsius in a fermenter (a cow with the same stomach temperature), mixed for 30 - 60 days, produced by mixing heavy CO2, methane and other gases. Afterwards, it can be used for energy production, cooling and heating. Or it can be connected to the network. When the production is finished, the waste that turns into fertilizer is removed from the digestate fermenter and the cycle continues. Biogas, which consists of methane gas, hydrogen sulphide, CO_2 and gas containing the required amount of hydrogen and nitrogen, which is formed anaerobically as a result of fermentation, is shown as a renewable energy source. There is a small amount of oxygen-free treatment processes, especially with the food industry. In these processes, fermented products with high energy and nutritional values are obtained for organic wastes. (Biogas Power Plant, Project file, 2019).

Table 2. Investment Cost Analysis

UNIT	Construction Procedures (TL)	Machine equipment and installation operations (TL)	Electrical equipment and installation procedures
Waste Receiving Unit	1.000.000	800.000	250.000
Waste Raw Material Preparation Pools	1.250.000	1.200.000	400.000
Reactor and Reactor Monitoring System Setup	3.200.000	5.000.000	650.000
Gas Cleaning, Gas Conditioning and Gas, Storage System setup	1.000.000	2.800.000	500.000
Cogeneration Facility (Energy Generation System) installation	2.000.000	4.700.000	700.000
Hygiene Unit and dewatering system	1.500.000	2.000.000	750.000
Storage Areas, Liquid and Solid Fermented Product Storage Area	1.500.000	3.500.000	300.000
Facility Control and Automation System	500.000	1.000.000	700.000
Other Units (Administrative building, laboratory, vehicle park etc.)	500.000	1.250.000	400.000
Landscaping	500.000	200.000	150.000
Project Works	250.000	150.000	200.000
TOTAL	13.200.000	22.600.000	5.000.000
Integrated Plant Investment Amount	**40.800.000 TL**		

Figure 2. Biogas Reactors View

Figure 3. Methane Gas Formation Tanks

Gas in landfills is a mixed mixture of different gases formed by microorganisms in the landfill. Approximately 40% - 60% of the gas in the landfill is methane gas, the remaining part is usually carbon dioxide gas. The proportions of organic compounds of the other extreme make up the rest. Some values in landfill gas are given below.

- **Gas Content in The Trash**
- CH_4 gas 45 - 70%
- CO_2 gas 30 - 55%
- •Nitrogen gas 2 - 5%
- Ammonia gas 0.1 - 1%
- O_2 gas 0.1 - 1%
- Water Vapors 1 - 3%
- Sulphur gas 0 - 1%
- Landfill gas field Landfill-gas Electricity 5,000 Daily Households
- 1 Mton / Year 500 m^3 / h meets 1 MW / Year Electricity Requirement. (URL2)

Hydrolysis and Fermentation

This stage converts the fermented into CO2, acetic acids and volatile soluble organic substances to break down carbohydrates, proteins (6C2NH3.3H2O), oils (C5OH90O6), which are the components of organic matter of bacteria called hydrolytic bacteria. The last group is called the formation of volatile fatty acids [CH3 (CH2) COOH] because the excess of volatile organic substances forms volatile fatty acids.

Acetic Acid Formation: In this stage, groups of aceto-genic bacteria (forming acids) that have emerged as a result of the first stage, converting volatile fatty acids into acetic acid come into play. Some setogenic bacteria convert volatile fatty acid into hydrogen and acetic acid.

$$CH_3(CH_2)_n COOH + H_2O \Rightarrow 2CH_3COOH + 2H_2$$

The other group of setogenic bacteria uses the hydrogen and carbon dioxide gas released and converts it into acetic acid. However, the amount of acetic acid formed in this second way is less than the first.

$$2 CO_2 + 4 H_2 \Rightarrow CH_3COOH + 2 H_2O$$

Methane (CH4) Gas Formation: For the last stage of anoxic fermentation, the bacteria that make up the methane come into play. Some methane-forming bacteria use H_2 and CO_2 and release methane gas and water, while other methane-producing bacteria use acetic acid to form CO_2 and methane.

$$CO_2 + 4H_2 \Rightarrow CH_4 + 2H_2O$$

$$CH_3COOH \Rightarrow CH_4 + CO_2$$

However, at this stage, the amount of methane formed in the first way is less than the amount of methane formed in the second way. This is done with 30% of all methane produced with the first, and 70% with the second. Three different bacteria act in all three stages. There are temperature zones according to the time to wait for oxygen-free fermentation, waste water, waste organic material types, pH ‘of the environment and the ions in it, and the structure of the microorganisms formed in a dependent manner.

1-Psychrophilic (Sacrophilic) Bacteria Optimum operating temperature: 5-25 ° C
2-Mesophilic (Mesophilic) Bacteria Optimum operating temperature: 25-38 ° C
3-Thermophilic (Thermophilic) Bacteria Optimum operating temperature: 50-60 ° C

If cattle manure is used in the biogas facility, mesophilic fermentation is applied. (Kahraman, 2013)

Factors Affecting Biogas Production:

It is known that many biogas plants established today are not used. The facility type should be selected according to the regions suitable for all conditions. It depends on some factors., The type and amount of the raw material, the temperature of the environment, the ambient acidity (pH), the large particle size, the duration of the fermentation, the ratio of carbon to nitrogen, the shape of the plant, the amount of dry matter.

Environmental Benefits of Biogas Production

It is known that the biogas system, which is cheap and a source of environmentally beneficial fertilizers, has many benefits for the environment and society. It causes the loss of the effects of most of the diseases that affect human health and underground water caused by animal fertilizers. Following the production of biogas, it turns into organic fertilizer. It is important in terms of recovery. Loss of germination of grass seeds in animal manure. The smell of animal manure is not felt. However, since it is used instead of fossil fuels, it also decreases greenhouse gas emissions. Thus, it is very important in terms of protecting the natural environment and natural resources. Biogas can be used for different reasons such as cooking, lighting, heating and cooling of fuels. 1 m3 of biogas per day = 4 people can cook the meals of a family. 2.43 m3 biogas = For a family of 6 people, the needs for daily cooking and lighting can be met .For a family, needs for daily cooking and lighting can be met. (Demir, 1993)

Fermentation Types in Biogas Production

Wet Fermentation: It is the biomass that turns into a slurry. Methane gas is produced by processes in the fermenter, which is called a slurry reactor. The amount of dry matter in the reactor is 5 - 12%.

Semi Dry System: It is in liquid form and in the form of mud. The amount of dry matter in the reactor is 10-20%.

Drying System: It is undiluted, tunnels are also fermented. Biomass is solid, the amount of dry matter in the reactor is 20-40%. (URL2)

RESULTS AND DISCUSSION

Biogas production calculation is given in Table 3.

Table 3. Biogas Production calculation Chart

Raw Material (Waste) Type	**Waste Value** (t/d)	**Dry Value** (kg/d)	**Dry** Mater rate (%)	**Dry** Mater (kg/d)	**Organic Dry** Mater Ratio (%)	**Organic Dry** Mater (kg/d)	**Biogas Yield** (L/kg	**Biogas Rate** (m^3/d)	**Rate** (%)	**Methane Amount** (m^3/d)
Chicken Stool Waste	70	70,000	77,4	54,2	67,05	36.341,8	620 x 620	22.531,9	60x60	13.519,1
Cattle Animal Waste	7	7,000	62,2	4.354	56,9	2.477,42	310 x 310	768	65x65	499,2
Total	**77**	**77000**		**58.555**		**38.819,2**		**23.299,9**		**14.018,3**

Biogas Production from Chicken Manure (m^3/d):

=Amount of Waste (kg/d) x Dry Matter Ratio (%) x Organic Matter Ratio (%) x biogas Efficiency (lt/kg OKM) /1000 kg/ton
= 70.000 x % 77,43 x % 67,05 x 620/1000= 22.531,89 m^3/d
Biogas Production from Bovine Manure (m^3/d):
=Amount of Waste (kg/d) x Dry Matter Ratio (%) x Organic Matter Ratio (%) x biogas Efficiency (lt/kg ODM) /1000 kg/ton
= 7.000 x % 62,2 x % 56,9 x 310/1000= 768 m^3/d
Total Biogas Production: 22.531,89 m^3/d + 768 m^3/d = 23.299,89 m^3/d = **23.299 m^3/d**

The amount of feces (waste) to be sourced from one poultry is 3% -4% of the live weight of the chicken.
The average weight of a chicken is in the range of 1.8-2 kg.
Waste between 0.054 - 0.08 kg / day is generated.
An average of 0.067 kg / day of waste is generated.
The amount of feces (waste) to be caused by one bovine animal is 5-6% of the bovine live weight.
Average weight of a cattle is 500-600 kg.
Waste between 25 - 36 kg / day is generated. (URL-3)

Electricity Production Account Spreadsheet
Methane Value (kWh/m^3) =10
Cogen Engine Efficiency (%) =42
Electrical Capacity from Cattle Feces (kWe) =87
Electrical Capacitance from Chicken Feces (kWe)=2365
Total Electrical Capacity(kWe)=2452
Electricity Generation from Chicken Feces(kWe):
=Biogas Production (m^3/d) x Methane Ratio (%) x Engine Efficiency x Methane Value x/24 h/d
= 22.531,89 m^3/d x % 60 x % 42 x 10 kWe/m^3/24 h/d = 2365 kWe
Bovine Feces Sourced Electricity Production (kWe):
=Biogas Production (m3/d) x Methane Ratio (%) x Engine Efficiency x Methane Value x/24 h/d
= 768 m3/d x % 65 x % 42 x 10 kWe/m^3/24 saat/d = 87 kWe
Total Electrical Capacity (kWe) = 2452 kWe =2,4 MWe
Electricity Generation Amount=2452 kWe x 8760 h/year = 21.479.520 kWh/year
are produced. The electricity produced is sold to the state.

RESULTS AND CONCLUSION

Today, biogas technology, which enables environmentally problematic wastes to be processed, rendered harmless and used for energy generation, is an important factor in renewable energy production. Although biogas, known as an energy production method in the society, has an organic waste potential that can be utilized in our country, it cannot be properly utilized. Our country has a potential of 12.5 million tons of organic waste. If these are evaluated, it is possible to provide a great economic input. Although the environmental and economic impacts of biogas are very important, organic wastes are considered as a standard issue applied in every country, but they are in the last place in our country.
It is clear that agricultural, animal and domestic wastes should be evaluated with anaerobic processes in meeting Turkey's energy needs and solving the energy problem. For this purpose, it is necessary to evaluate the production potential of wastes, to determine the anaerobic degradation conditions and the appropriate generator type, and to develop anaerobic treatment technologies by supporting studies on the subject. Using fossil fuels as long as possible in meeting the general energy demand of Turkey, turning to renewable energy sources as much as possible, obtaining biogas from biomass, which has a viable and useful quality and has an important potential, and its consumption especially in small settlements. It constitutes a good alternative, as demonstrated by the study. The use of this alternative is recommended because it is both economical and reduces environmental problems.
Turkey is foreign dependent in terms of non-renewable energy resources. This causes a significant portion of the resources that need to be allocated for development to be transferred to energy imports. Our country has an inestimable organic fertilizer, plant and urban waste potential. It cannot be said that this potential can be utilized sufficiently, most of the animal manure produced for many years is burned

as dung. As a result, organic matter, which is indispensable for our soils, also disappears, and the production and use of biogas should be encouraged in order to save energy and contribute to energy production. With the expansion of biogas facilities, organic materials can be utilized and energy can be produced, as well as the biofertilizer obtained can be used in soils and can also contribute positively to environmental health in rural areas.

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