Energy Production From Biomass, Case Study: Cow Farm

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Abstract

Recently the use of biomass for biogas production is very limited in Albania. According to data acquisition from the study, the highest share in the entire structure of urban solid waste is that of organic waste 41-61.2%.

A large part of these wastes is bio digestible and can used for production or utilized as potential substrate in anaerobic digestion to produce biogas, a renewable source of energy and environment friendly too.

Live stocks waste and especially cow manure farms are concerned in this study because there are a high number 11813 of them are spread all over Albania. In addition, the amount of cow manure exceeds 37,693.92 ton/year.

In this case study is presented a cow farm located near Tirana, capital city of Albania with 200 cow heads which in the future will become 700 cow heads. The

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total amount of cow manure produced in this farm is 1825 ton/year, a considerable quantity of manure available for biogas production.

This paper presents the type of digester, calculation of the biogas production yield, the obtained energy, the payback period of the initial investment and the net present value of this farm batcher digestor.

Key words: *Batch digester, biogas production, cow farms, cow manure, cost investment, energy.*

Introduction

After 1990s in Albania, the data indicate a significant increase in urban waste generation. In the total percentage of solid urban waste, organic waste component represents the highest percentage (41-66%) at the waste composition. Many livestock farms were developed. Recently the number of them is increase up to 23654 and approximately 50 % of them are cow farms, as shown in the Table I. In 2021 the waste forms the livestock sector is estimated to be 383,234.4 tons (INSTAT, 2022).

As is shown in the Table I the quantity of cow manure in 2021 in Albania is approximately 37,693.92 ton/year.

The reasons that are chosen cow manure farm are: the substrate quality for biogas production, the high quantity of available manure, the methane production yield up to 63% (Handbook 2005).

The results on biogas production in laboratory scale from cow manure (25 Nm^3/ton) are very optimistic to implement in the concrete cow farm with 200 cow's heads.

TABLE 1: The quantity of cow Manure in Albania

Region	Number of cow farms	Cow heads (+5)	Manure quantity (kg)
BERAT	542	5266	1 553 470
DIBER	593	5004	1 476 180
DURRES	529	5574	1 644 330
ELBASAN	488	4073	1 201 535
FIER	1687	16795	4 954 525
GJIROKASTER	455	9737	2 872 415
KORCE	1365	15253	4 499 635
KUKES	1749	13481	3 976 895
LEZHE	868	8347	2 462 365
SHKODER	1407	12816	3 780 720
TIRANE	1203	10791	3 183 345
VLORE	927	20639	6 088 505
Total	11813	127776	37 693 920

Materials and methods

As mentioned above, the study aimed to establish a biogas production plant with cow manure near the Cow Farm, located in Kashar village, approximately 15 km far away from Tirana, with a maximal capacity of 700 cow heads.

- Total surface area of the farm is 12,500 m^2
- Building surface + stalls are 5500 m^2 (Close system). Cow manure is collected within an open area in a natural dump.
- Actually, this farm has 200 cow heads.
- One head produces approximately 20 – 30 kg manure/day
- Average monthly consumption of electric energy is 3381 kWh/year.
- The price of electricity is 14 ALL/kWh without VAT. (0.14 $)
- Heating-cooling system for the building is assumed from heat pumps

Taking in consideration that one head produces 20–30 kg manure per day, 200 head of cows produce 5 tons of waste per day so 150 tons of waste in 30 days. Cow litter density is 500 kg/m3:

- The plant will be a batch digester type like what is shown in figure 2.
- The digester volume – 300 m^3
- Retention time – 30 days.

The samples of cow manure are analyzed in the biogas lab.

The method applied for the cow manure samples is the same as Mico and co (2013) for biogas production in laboratory scale.

Results and discussion

The biogas produced in the laboratory scale from cow manure is approximately 25 Nm^3 /ton.

- Five-ton manure produce 125 Nm3 /day biogas.
- The daily energy produced from the biogas quantity 125 Nm3 /day × 9.67 kWh = 1208.75 kWh.
- The monthly energy produced is 36262.5 kWh, which can be used to generate heat and electricity.

- The monthly energy produced by generator is 36262.5 kWh × 0.37 = 13417 kWhel (see Table I, Fig. 1)
- Annually energy produced is 161 MWhel.
- Demand for electricity based on bills paid for one year is approximately 42664 kWhel/year.

Annual gross profit taking in consideration the price of 14 ALL (0.14$) per 1 kWh is: Bt = 161 000 MWhel × 14 ALL/kWhel = 2 254 000 ALL (22 540 $)

Annual net profit is the difference between energy produced from the generator and the demand for electricity 161 000 – 42664 = 118 336kWhel, converted to monetary value 1 656 704 ALL (16 567 $).

TABLE 2: Monthly profits in (kWH) from production of Biogas

TABLE II: MONTHLY PROFITS IN (KWH) FROM PRODUCTION OF BIOGAS

Months	January	February	March	April
Demand	3849	3577	3672	3400
Incomes	13417	13417	13417	13417
Profits	9568	9840	9745	10017
	May	June	July	August
Demand	3256	3400	3900	3800
Incomes	13417	13417	13417	13417
Profits	10161	10017	9517	9617
	September	October	November	December
Demand	3361	3200	3462	3787
Incomes	13417	13417	13417	13417
Profits	10056	10217	9955	9630

FIGURE 1: Monthly profits in (kWH from biogas

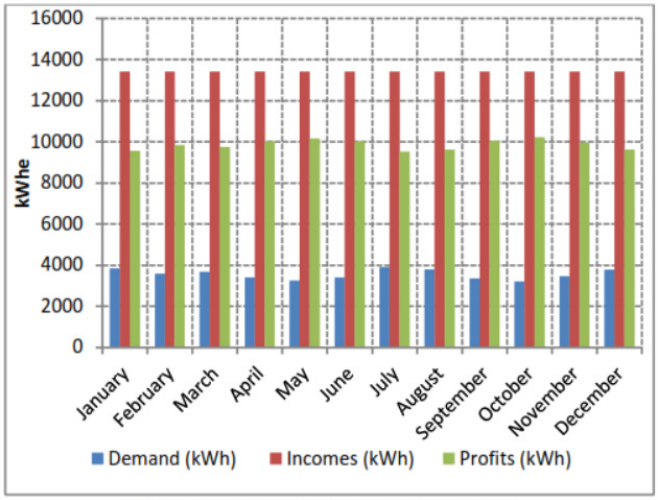
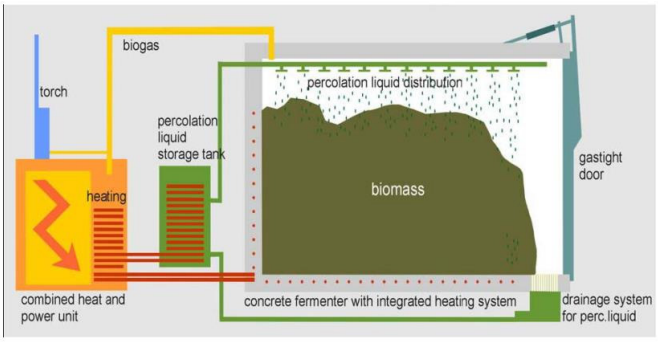


Fig. 1. Monthly profits in (kWh) from biogas.

Establishing a batch digester in Farm is profitable for the company because the handling and the storage of the feedstock is already available within the farm

territory; have low operation costs and low costs of the mechanical technologies; this process is also a contribution to the reduction of farm waste (Ricci & Confalonieri, 2016).

FIGURE 2: Batch digester



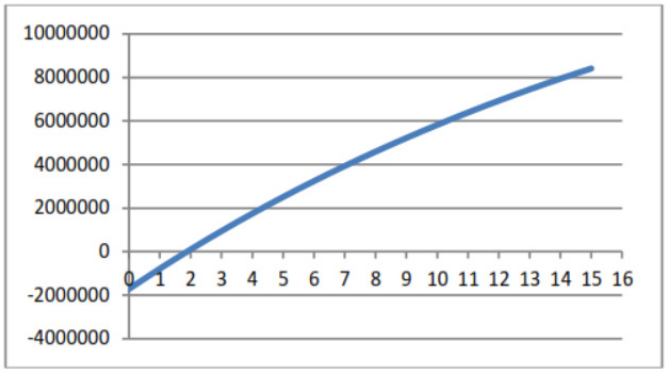
Total installed costs for an AD biogas plant can depend on the feedstock. Those based on manure and sewage are typically cheaper. This is because the handling and storage of the feedstock is already available (Kiely, 2019).

According to the literature review the total installed capital costs for an anaerobic digestion system vary from USD 7 310 to USD 5 050/Nm^3/hour. This is for systems with hourly output capacities of 100 Nm^3 and 500 Nm^3, respectively (IRENA, 2013).

Taking into consideration the biogas produced from experiments in the lab, the quantity of biogas produced is 25 Nm^3 /ton in a day. From 200 head cows, the quantity of biogas produced in a day is 125 Nm^3 /ton.

The biogas produced in an hour is 5.2 Nm^3/hour. Referring to the literature (IRENA, 2013) and to the quantity of biogas produced in an hour we calculated the initial cost of the investment that is 38 072.91 $.

FIGURE 3: The payback period of the investment cost.

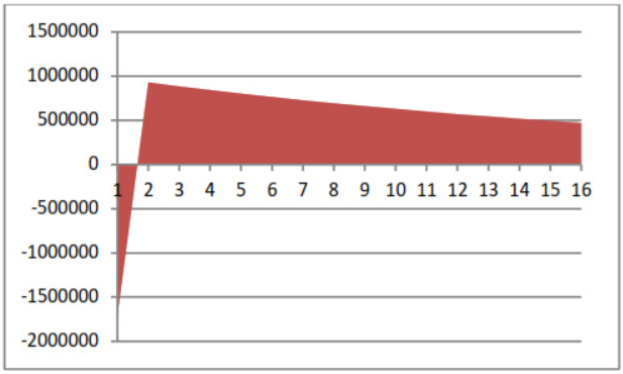


The electrical capacity of the biogas plant is 161 MWhel/year.

- Maintenance cost is 50,000 ALL (500 $).
- Interest rate is 5%.
- The cost per kWh electricity produced by biogas is 3.28 ALL (0.0328 $)/kWh without VAT, a low price comparing with electricity price by national grid (14ALL, 0.14$).

The payback period of the initial investment is 1 year and 6 months (see Fig. 3). The cash flow graphic of the investment is shown in figure 4.

FIGURE 4: Cash flow graphic of the investment.



The Net Present Value after 15 years is 14 527 088 ALL or 145 027.8 USD.

The batch digester to be implemented in the Farm is been studied as per real conditions.

Conclusions

- Different biomass samples of "Cow farm" cow manure analyzed in the biogas lab are easily biodegradable and as result was produced a considerable quantity of biogas.
- From the case – study, the payback period is assumed 1 year and 6 months.
- Net present value 145 027.8 $.
- The cost per kWh electricity produced by biogas is 0.0328 $/kWh, a low price comparing with electricity price by national grid (14 ALL, 0.14$) without VAT.
- The initial investment is economically profitable.

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