Journal of Energy Research and Reviews

3(4): 1-6, 2019; Article no.JENRR.48652
ISSN: 2581-8368

Feasibility Study for a Biogas Plant in Jordan

Zainab Alhammad[1*]

[1]*Department of Animal Production, Agricultural Zarqa Governorate, Jordan's Ministry of Agriculture, Jordan.*

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/JENRR/2019/v3i430104
Editor(s):
(1) Dr. Hen Friman, Lecturer, Faculty of Engineering, H.I.T - Holon Institute of Technology, Holon, Israel.
Reviewers:
(1) Haruna Ibrahim, Umaru Musa Yar'Adua University, Nigeria.
(2) Yuwalee Unpaprom, Maejo University, Thailand.
(3) Juvy G. Mojares, Batangas State University, Philippines.
Complete Peer review History: http://www.sdiarticle4.com/review-history/48652

Short Research Article

Received 12 May 2019
Accepted 14 July 2019
Published 09 October 2019

ABSTRACT

This research was conducted to estimate the economic feasibility of establishing biogas plant from dairy farms manure in Al-Dlail district (Zarqa governorate). Biogas is a mixture of gas consisting of 50-70% of methane and carbon dioxide 30-45%, and other gases and water that resulted from the digestion of the biomass process with the absence of oxygen. It is used as a fuel source in many countries for the purposes of lighting and cooking. Biogas is a clean and renewable form of energy that can be sustainable solutions of large organic waste produced in animal farms and reduces the harmful environmental pollution. Also, it can be an opportunity to invest and make profits. Data for this research was collected by desk research, survey and interviews. The respondents were 31 dairy farmers; the interview included the Jordan Biogas plant manager, owners of manure plants, heads of cattle breeders associations and stakeholders in government organization. The collected data were analyzed by using SPSS, 5P's analysis, PESTEC Analysis and Canvas model to come up with a clear picture about the feasibility of biogas utilization in Zarqa governorate. The study showed the tremendous environmental pollution that happened in Al-Dlail and Al-Khaldiah areas due to the poor management of cattle farms manure, causing air, soil ground and surface water pollution. As a solution to this problem, the study showed that the most appropriate solution to this problem is to exploit these manure in the production of energy from biogas as a sustainable, and environment-friendly project. The research also included the size of the feedstock of the manure produced from cattle farms, the availability of the necessary technology to build a project of this plant, the availability of markets for its products and the legislative framework governing the renewable energy

**Corresponding author: E-mail: Zainab.alhammad.za@gmail.com;*

projects represented by the Ministry of Energy. The study concluded that it is possible to establish a medium-sized biogas plant. The recommendation is to facilitate government procedures for investors in renewable energy and the promotion of environmental awareness between farmers and pay more attention to the management of livestock waste by creation waste management departments in government institutions.

Keywords: Biogas; Jordan; animal farms; PESTEC analysis; feedstock.

1. INTRODUCTION

Population growth, high standards of living, industrial and agricultural progress, and lack of proper methods of collecting, transporting and processing organic wastes increase the amount of waste dramatically, leading to environmental pollution. The progress of human civilization and its mission in preserving the environment from pollution led to the return of organic agriculture and the exploitation of natural resources [1]. Global competitive energy through the use of advanced, clean and cheap technologies for agricultural products that achieve the ambitions of farmers to exploit secondary agricultural products in an economically and environmentally safe manner and to generate additional income from the agricultural unit area. Agricultural organic wastes from cow breeding and rearing farms in the regions of Al-Dlayl and Khaledeyah in Jordan are estimated to be more than 140,000 tons per year [2]. Potential of biogas production is the solid waste collected from the Malvar Public Market and urban barangays going to the Materials Recovery Facility (MRF) [3].

These systems and technologies are characterized by fermenting all organic materials inside the reactor and are therefore approximately 800 times faster than fermentation compared to the gas generated within the landfill (drag system). All organic waste entering the reactor is fully converted into organic fertilizers and biogas [4]. There is a need for the presence of landfill and means of transportation. Biogas production technology is compatible with local resources within the study area. After the production of the gas, the good fertilizer (compost) lags which are rich in an organic matter suitable for quantities of plants. Furthermore, it contains elements, plant hormones, vitamins and growth regulators. It is free from pathogenic bacteria, larvae and weed seeds that are completely destroyed during the process of fermentation of organic waste [5]. This results in a pure clean fertilizer that does not pollute the environment and has no risk when used as fertilizer in all crops. Hence, the construction of biogas production projects contributes to the decentralization of waste management policy and to reduction, if not total elimination, of landfill sand incinerators.

The recent increase in oil and gas prices in Jordan has shown the need to seek alternative sources of conventional energy [6]. It was found that livestock waste (cow manure and dung) contained a large proportion of organic substances that could be used to produce energy; it was found to contain 65% of methane.

The justification for the project can be summarized as follows:

1. There is an increasing demand for local energy sources because of rising fuel prices.
2. There is also an increasing demand for manure.
3. Investment in this sector continues to attract many investors.
4. Improving the economic situation for owners of projects.
5. Solve the problem of pollution resulting from the wastes of farms.
6. The project is sustainable and environmentally friendly.

The proposed project aims to construct a medium-sized project for the production of biogas for heating, cooking and eventually generating electricity [3]. It is also possible to build small-scale brewing and anaerobic units serving agricultural and remote areas. In addition, the anaerobic fermentation process eliminates some pathogenic bacteria and many parasites and thus improving the health and environmental level. Biogas from the exploitation of air fermentation has many benefits to the environment in terms of climate change and methane. Methane has a multiplier effect on the environment, 21-times greater than that of carbon dioxide effect [7]. The proposed project contributes to solving the problem of solid waste, making it a source of wealth contributed to the national income of Jordan, securing employment

opportunities and reducing the import of some raw materials, especially energy sources from abroad. Due to the high value of manure, after processing, it can be an important source of wealth that helps raise soil efficiency, increase agricultural and forestry production as well as saving costs by reducing the use and consumption of chemical fertilizers [8]. The objective of this short research article is to estimate the economic feasibility of establishing biogas plant from dairy farms waste in order to produce energy and decrease the environmental impact of manure in Al-Dlail and Al-Khaldiah district.

2. MATERIALS AND METHODS

The proposed model for the feasibility study was as follows.

2.1 The Project Site

It is proposed to establish the project in Zarqa and in the Al-Dlayl area within dairy farms that provide all services in addition to animal waste. It is worth mentioning that there are more than 220 cow farms in both Al-Dlayl and Khaledeyah with about 40,000 cows [2].

2.2 Market Study

2.2.1 Expected demand

In view of the natural increase in the population and the natural increase in the amount of consumption of meat and different dairy products, as well as the increase in the number of canned and processed meat factories that use many meat products resulting from slaughter in various manufacturing processes, it is expected that there be a significant growth in the number of farms for cattle and cows as well as in the quality of these farms and therefore there will be a healthy effort to get rid of this waste and convert it to energy and fertilizers. The project will also help to promote the use of biogas technology in neighboring farms and increase the spread because of the renewable and cheap energy of these systems, as well as the production of organic fertilizer free of chemicals.

2.2.2 Project production capacity and market share

Since the project is a factory to produce energy and fertilizer from cows waste using anaerobic fermentation technology, the economic and investment costs of generating biogas (measured by electrical power) are linked to several factors, including the estimated project needs of raw materials, and energy dynamics. They can be summarized as follows:

Quality of materials to be fermented.

Dry matter of organic matter.

A quantity of gas product (electrical and thermal energy) of organic materials.

Skills of project workers.

3. RESULTS AND DISCUSSION

Table 1 shows the method of calculating the expected production capacity of the project of different products based on Banks, Energy equivalents [9]; AECOM [10], and Al-Rousan A. [11].

It has assumed an increase in the production volume of 10% annually. So, there is a good chance for a project to create additional fermentation units and get electricity and thermal energy for water heating. Also, the production of organic fertilizers may contribute to increasing the performance of livestock farms and improving environmental and health standards.

Table 1. Method of calculating the expected production capacity of the project

Description	Unit	Quantity
The number of cows	Head	2000
The amount of manure produced for one cow	Kg	10
The total amount of annual manure production	tons	7300
Cow production of biogas	m^3/year	547.5
Farm's total production of biogas	m^3/year	1095000
Electrical energy produced from1m^3 of biogas	kWh	2.14
Farm electrical energy produced	kWh	2343300
Annual production of organic fertilizer for one cow	tons	4
Annual production of organic fertilizer for 2000 cows	tons	8000
Dioxide emissions annual saving	tons	26400

3.1 Competition, Marketing and Selling Prices

The sale of the project's products prices will be adopted either in the petroleum refinery for diesel or manure, as well as global prices for carbon dioxide as shown in the Table 2. The method of calculating the expected revenue for the project is in Euros (€).

3.2 Expected Revenues

Expected revenues of the project were displayed in Table 2.

3.3 Technical Study

3.3.1 Project site

The project is proposed to be established on dairy farms in the Al-Dlayl region, which has more than 2,500 cows. These farms provide all services in addition to the fact that there are animal waste and wastewater rich in organic matter.

3.3.2 Implementation of the project program

Estimated time to implement the project is about one year. Construction can be carried out in a short time as most of the appliances and equipment will be imported.

3.4 Financial Study

The following Table shows the annual operating costs for the first year of production (Table 3).

3.5 Project Costs

The project's working capital requirements are estimated at € 198,778 based on the rental duration for six months and three months for the remaining operating expenses (Table 4).

3.6 Financial Assumptions

A financial analysis of the project was carried out for 5 years, based on the assumptions shown in Table 5:

Suppose the project owner covers the remaining cost of his own resources.

The assumption that the procurement project, including raw materials and production inputs will be in cash.

Assuming that all outputs of the project will be in cash.

The assumption that annual wages increase by 5% for each month.

Taking into account that the project is subject to an income tax rate of 15%.

Table 2. Expected revenues for the project in Euros (€)

Description	Unit	Quantity	Price (€)	Total Price (€)
The electrical energy produced per cubic meter	kWh	2343300	0.077	179965
Annual production of organic fertilizer for 2000 cows	tons	8000	30	240000
Savings in the cost of wastewater *	m^3	7300	3.5	25550
Carbon dioxide **	tons	26400	0.0	0.0
Total revenue	445515			

**The farm will use the wastewater in anaerobic digestion; ** For carbon dioxide, the availability of this product is difficult in the current days, can be sold after 10 years*

Table 3. Variable costs in Euros

Item	Amount	Price (€)	Total Price (€)
Cow manure (ton)	7300	2.56	18688
Packaging materials			45000
Chemical substances and additives			25600
Water			15360
Electricity			5120
Fuel			46080
Sub-total variable costs per year			155848
Interest on variable cost 10%			15585
Total variable costs per year			171433

Table 4. Project capital costs

Description	Total Costs (€)
Land rents	8320
Site preparation for construction	10000
Biogas plant	1861000
Building office equipment	5600
Transportation	60000
Cow manure	4672
Packaging materials	11250
Chemical substances and additives	6400
Water	3840
Electricity	1280
Fuel	11520
Interest on variable cost10%	3896
Total investment cost	1987778

Table 5. Project financial analysis for 5 years

Project Years		Year 1	Year 2	Year 3	Year 4	Year 5
Cash inflow	Electrical Energy	179965	197962	217758	239534	263487
	Savings in the cost of wastewater	25550	25550	25550	25550	25550
	Organic fertilizers	240000	264000	290400	319440	351384
Total revenue		445515	487512	533708	584524	614871
Cash out flow	Cow manure	18688	20557	22612	24874	27359
	Packaging materials	45000	49500	54450	59895	65885
	Chemical substances and additives	25600	26600	27500	29000	30500
	Water	15360	16128	16934	17781	18670
	Electricity	5120	5376	5645	5927	6223
	Fuel	46080	49306	52757	56450	60401
	Subtotal variable cost	155848	167466	179899	193927	209039
	Interest 10%	15585	16747	17990	19393	20904
	Total variable cost	171433	184213	197889	213320	229943
	Total fixed cost	173111	175561	178134	180835	183671
	Total cost (fixed and variables)	344544	359774	376022	394154	413614
	Net income before tax	100971	127738	157686	190370	201258
	Tax 15%	15146	19161	23653	28555	30189
	Net income before tax	85826	108577	134033	161814	171069

Suppose the project owner covers the cost of his own resources.

4. CONCLUSION

The summary of the results of the financial indicators of the basic situation and the accompanying sensitivity analysis shows that the project aims to achieve a net profit for the next five years. In addition, cash flows indicate that the project is able to meet its financial obligations and that the financial recovery is good. This study also includes profit and loss account, cash flow, and estimated budget. The project is expected to generate a net profit of € 85826 in the first year of operation. The return on investment is between 10.0% in the first year and 19% in the fifth year. Recovery project is seven years.

ACKNOWLEDGEMENT

Major thanks to funding parties (Van Haul University of Applied Sciences, Netherlands) and their professors for their support. The technical assistance provided by Norman Borlaug fellow of the US Department of Agriculture, Florida A & M University, Mohunnad Massimi, and the extension services of the Jordanian Ministry of Agriculture is highly recognized.

COMPETING INTERESTS

Author has declared that no competing interests exist.

REFERENCES

1. Hassan MAM, Haddad M. The feasibility of family biogas production from mixed

organic wastes in Palestinian rural areas. In Faculty of Graduated Studies, An-Najah National University; 2004.
2. MoA. Annual report. Jordan: Ministry of Agriculture; 2015.
3. Mojares JG. Implementing biogas technology project in Malvar, Batangas, Philippines. Asia Pacific Journal of Multidisciplinary Research. 2015;3(4):158-164.
4. Kanchikere J, Kumar JA, Reddy MVK, Kumar JP. Feasibility study of 6m3 biogas plant in Dhoolapally, Hyderabad. International Journal of Mechanical Engineering and Technology. 2018;9(6):334–342.
5. Baccioli A, Ferrari L, Guiller R, Yousfi O, Vizza F, Desideri U. Feasibility analysis of bio-methane production in a biogas plant: A case study. Energies. 2019;12(3):473.
6. Abu-Hamatteh ZSH, Al-Jufout S, Abbassi B, Besieso MS. Biogas energy: Unexplored source of a renewable energy in Jordan. Renewable Energy and Power Quality Journal. 2010;8:202.
7. Extension. Economics of anaerobic digesters for processing animal manure; 2015.
Available:http://articles.extension.org/pages/19461/economics-of-anaerobic-digesters-for-processing-animal-manure
(Accessed: 10 September 2016)
8. Ismail AL-Masalha, Mutaz Elayyan, Husam Aldean Bani Issa. Use of biogas energy in poultry farming heating. The International Journal of Engineering and Science (IJES). 2017;6(3):58-63.
9. Banks C. Energy equivalents. Optimising anaerobic20; 2009.
10. AECOM. Amount and characterization of dairy cattle manure and poultry litter in Jordan. Amman; 2014.
11. Al-Rousan A. A technical experiment on biogas production from small-scale dairy farm. A Technical Experiment on Biogas Production from Small-Scale Dairy Farm, 11_14; 2014.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/48652