

Possibilities for Capitalizing on Organic Matter from Livestock Farms

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Abstract

Today, as global energy demand continues to grow and global warming measures tighten, renewable energy has come to the fore. Governments' support for renewable energy has also increased, mainly due to efforts to reduce CO₂ emissions and diversify energy sources. These incentives, along with high fossil fuel prices, have persuaded many investors to turn to renewable energy. Biomass is the most abundant renewable resource on the planet, including absolutely all the organic matter produced by the metabolic processes of living organisms. This paper presents the possibilities for capitalizing on organic matter from livestock farms, with an emphasis on the production of biogas from biomass resulting from animal manure. An example of calculating the amount of biogas is also made.

Keywords: animal manure, biogas production, livestock farms

1. Introduction

Today, as global energy demand continues to grow and global warming measures tighten, renewable energy has come to the fore. Governments' support for renewable energy has also increased, mainly due to efforts to reduce CO₂ emissions and diversify energy sources.

Renewable energy is any energy resources that is generated from natural processes, and continuously replenished or naturally and constantly regenerated over a short time scale.

The renewable energy resources are sunlight, geothermal heat, wind, tides, water, biomass, but do not include energy resources derived from fossil fuels, waste products from fossil sources, or inorganic sources.

The renewable energy technologies range from solar energy; wind power; geothermal energy; biomass; hydropower (or hydroelectric power); ocean energy (tidal energy, wave energy); hydrogen fuel cell; fusion energy, etc. [1].

The general advantages of renewable energy are:

- provides low operating and maintaining costs;
- provides long life period;
- service cost is low;
- reliable source;
- induces technology development;
- fosters regional development;
- provides efficient energy production and safety ;
- generates revenue and tax;
- creates new employment opportunities ;
- protects environment and saves environmental protection costs;
- enhances living conditions;
- it is waste-free;
- improves air quality;
- preserves ecosystems;
- helps slow down climate change. [2]

The general disadvantages of renewable energy are:

- high up-front investment;
- entails long-term planning;
- entails long-term agreements;
- entails multidisciplinary involvement;
- entails new legal codes;
- could involve resettlement;

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- excessive competition [2].
The specific advantages and disadvantages of

renewable energy broken down by source are shown in Figure 1 [1].

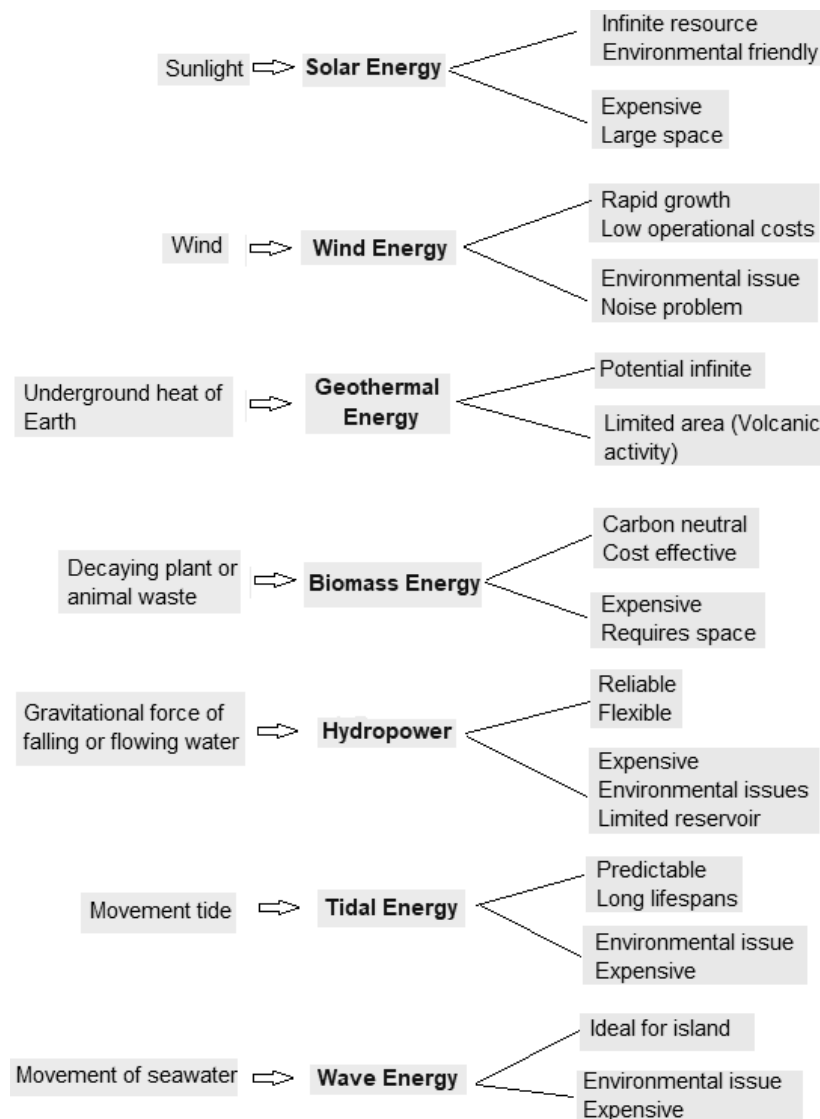


Figure 1. The specific advantages and disadvantages of renewable energy

The utilization of renewable energy sources which are derived from non-fossil sources, such as urban waste, animal manure, agricultural waste and other biomass sources are becoming increasingly important.

Biomass is the most abundant renewable resource on the planet, including absolutely all the organic matter produced by the metabolic processes of living organisms (scrap lumber, forest debris, agricultural harvest waste, animal manure, waste water and different industrial organic waste).

An important consequence of animal husbandry is the production of significant amounts of manure or organic waste.

In general, these organic residues in livestock farms can be used either as an important source of organic matter and mineral elements for agricultural soils (organic fertilizers) or for the production of biogas.

2. Materials and methods

The possibilities of capitalizing on organic matter from livestock farms can be:

- animal waste, which does not present special risks, may be subjected to industrial processing

and the production of meat, bone, blood or mixed flours, through various heat treatments;

- by-products and other organic waste, resulting from animals free of communicable diseases, can be neutralized by composting, mixed with other organic vegetable waste, resulting in compost for agricultural use;

- certain wastes can be subjected to methane fermentation, in association with other vegetable wastes, resulting in biogas and fermented sludge, free of infectious and parasitic risks;

- fertilization of agricultural land with manure. Manure is a mixture of bedding (straw, cochineal, sawdust, leaves, etc.), animal manure and urine. Manure from horses and sheep is richer in nutrients than that from cattle or pigs, its composition depending on the quality of the bedding, the quantity and quality of food consumed, and the digestive-metabolic characteristics of the animals considered. Manure is a complete organic fertilizer, containing all the nutrients needed by the plant: N, P, K, Ca, Mg, B, Mn, Zn, Cu, etc. Manure improves soil fertility by acting on their physical and chemical properties: increases water and air permeability, helps increase humus content, increases buffering capacity and nutrient retention power, enriches the soil with useful microorganisms and increases the amount of carbon dioxide in the soil that helps solubilize nutrients [3].

A special importance is currently given to biogas production. Biogas is a renewable energy and fuel used to replace fossil such as kerosene and natural gas. Biogas is a renewable energy source produced by anaerobic fermentation of organic

material. Biogas can be produced from animal manure, waste water and solid waste. Biogas is a mixture of gases. The main gases that make it up are methane and carbon dioxide, both in varying proportions. In very small quantities, hydrogen sulfide, nitrogen, carbon monoxide and oxygen are also found in biogas. The energy value of biogas is given by its methane content [4, 5].

The determining factors in biogas production are raw material, temperature, the pressure, shaking and pH.

The raw material must provide an environment conducive to the development and activity of microorganisms that contribute to the digestion of the substrate and, finally, to the production of biogas. This environment must meet the following conditions:

- contain biodegradable organic matter;
- to have a high humidity, over 90%;
- have a neutral or almost neutral reaction (pH=6.8-7.3);
- to contain carbon and nitrogen in a certain proportion (C/N=15-25);
- do not contain inhibitors for microorganisms: some heavy metals, detergents, antibiotics, high concentrations of sulfates, formalin, disinfectants, phenols and polyphenols, etc. [5].

In order to make the biogas production process more efficient, the raw material (biomass) must be prepared, taking into account the parameters necessary to obtain a maximum amount of biogas. The Table 1 lists for the main raw materials: Carbon content (C), Nitrogen content (N) and C/N ratio [5].

Table 1. Carbon content (C), Nitrogen content (N) and C / N ratio for raw materials

Name	Carbon content (%)	Nitrogen content (%)	C/N ratio
Green grass	15	0.6	25
Dried wheat straw	46	0.53	87
Dry rice straw	42	0.63	67
Dried oat straw	42	0.75	56
Corn cob	40	0.75	53
Alfalfa	48	2.60	18
Leaves	41	1.00	41
Potato spells	40	1.8	22
Soybeans	41	1.3	32
Fresh sheep manure	16	0.55	29
Fresh cattle manure	7.3	0.29	25
Fresh horse manure	10	0.42	24
Fresh pig manure	7.8	0.65	13
Fresh human feces	2.5	0.85	29
Chicken manure	45	3.00	15

In order to ensure a correct humidity of the raw materials, the humidity will be taken into account, as shown in Table 2 [5].

In Table 3 are presented the estimated quantities

of biogas that can be produced by anaerobic fermentation from different types of raw material and their content of organic matter and dry matter [6].

Table 2. The humidity for raw materials

Name	Average humidity (%)
Cattle manure	86.00
Pig manure	86.50
Sheep manure	75.00
Horse manure	77.50
Chicken manure	72.50
Human feces	73.50
Household waste	77.50
Wheat straw	13.50
Barley straw	15.50
Oat straw	16.00
Corn cobs	12.50
Potato, soybeans, beans seeds	82.50
Green leaves	87.50
Beet leaves	86.50
Green alfalfa	77.50
Weeds, green grass	84.00

Table 3. The estimated quantities of biogas

Name	Organic matter (% dry matter)	Dry matter content (%)	Biogas yield (m ³ /t organic matter)
Corn silage	86	34	350-390
Grass silage	67-68	26-82	300-500
Hay	83-93	86-93	500
Straw	85-89	85-90	180-600
Clover	80	20	300-500
Corn cobs	72	86	300-700
Molasses	95	80	300
Whey	80-92	4.3-6.5	330
Vegetable waste	76-90	5-20	350
Apple distillation scrap	94-95	2-3.7	330
Solid horse manure	75	28	200-400
Solid sheep manure	80	25-30	240-500
Liquid chicken manure	75-77	10-29	200-400
Solid chicken manure	70-80	32-32.5	400
Solid cattle manure	65-85	11-25	200-300
Liquid cattle manure	68-85	6-11	200-260
Liquid pig manure	60-85	2.5-9.7	260-450
Solid pig manure	75-90	20-25	450

After preparing the raw material for anaerobic fermentation, the estimated quantities of biogas

obtained from different types of animal manure are given in Table 4 [7].

Table 4. The estimated quantities of biogas

Name	Biogas volume (m ³ /t)
Cattle manure	15
Pig manure	15.6
Sheep manure	60

The Table 5 contain the amount of animal manure resulting in a day [7].

Table 5. The amount of animal manure resulting in a day

Name	Body weight (kg)	Manure (initial condition) (kg/day)
Cattle	200	10
Pig	60	6
Sheep	30	2

3. Results and discussion

The calculation of the daily volume of biogas produced following the anaerobic fermentation of animal manure for a pig, cattle and sheep farm is done as follows, taking into account the data presented above:

- Animal heads number: 500 cattle; 1200 pigs and 700 sheep;

- The amount of resulting manure in a day:

500 cattle x 10 kg/day=5000 kg/day=5 t/day

1200 pigs x 6 kg/day=7200 kg/day=7.2 t/day

700 sheep x 2 kg/day=1400 kg/day=1.4 t/day

- The daily volume of produced biogas is:

$5 \times 15 + 7.2 \times 15.6 + 1.4 \times 60 = 195.72 \text{ m}^3$

Knowing the amount of biogas produced by anaerobic fermentation of animal manure, the necessary facilities can be dimensioned and the consumption of the biogas produced can be planned.

The most effective are sheep manure.

4. Conclusions

Biogas production from animal manure is the best solution to realize clean farms that are environmentally friendly and is very profitable because it is able to turn waste and natural materials into valuable products without destroying it so that the ecological cycles are maintained. It is also possible to significantly reduce the gas expenses necessary for the

operation of the farm and the related household, respectively to increase the economic value of livestock farms.

For small localities, biogas can be a cost-effective alternative energy source.

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