



Biogas Production from Anaerobic Digestion of Manure Waste: Moroccan Case

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Résumé - Le biogaz issu de la fermentation anaérobie des substrats organiques animaux ou végétaux est une énergie renouvelable qui suscite un intérêt croissant. L'exploitation de cette ressource énergétique présente en effet de nombreux avantages au niveau économique et environnemental.

En revanche cette technologie reste très peu connue au Maroc par les institutions, les décideurs et les acteurs privés (gérants, bureau d'études, personnel);

Dans cette étude nous dressons une présentation cartographique de la densité en déchets d'élevages au niveau des différentes régions du Maroc, nous présentons également une estimation du potentiel énergétique pouvant être produit par fermentation méthanique.

Notre étude montre qu'à l'échelle des différentes régions du Maroc, nous avons la possibilité de récupérer plus de 87 millions de tonnes de déchets et résidus organiques fermentescibles de fumier de bétail et de volailles ceci est équivalent à plus de 4,5 MTep/an.

Keywords : biomasse, énergie, méthanisation, carto-graphie, déchets organiques.

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Les avantages de cette technologie et ces applications seront discutés en perspective d'une large diffusion dans le monde rural.

Motclés : biomasse, énergie, méthanisation, cartographie, déchets organiques.

Summary - Biogas from the anaerobic fermentation of organic substrates, animals or vegetal, is a renewable energy that requires a growing interest. The exploitation of this energy has indeed many advantages in economic and environmental terms.

However this technology is still very little known in Morocco by the institutions, policy makers and private actors (managers, engineering, personnel);

In this study we make a cartographic presentation of the density of livestock waste in the various regions of Morocco, we also present an estimation of the potential energy that can be produced by methane fermentation.

Our study shows that across the different regions of Morocco, we are able to recover more than 87 million tons of fermentable organic waste and residues of livestock manure and poultry this is equivalent to more than 4.5 MTep / year. An integrated energy policy taking into account this factor is necessary for optimal use of this renewable energy source.

The advantages of this technology and applications will be discussed in view of the wide dissemination in rural areas.

Keywords : biomass, energy, methanation, cartography, organic waste.

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I. INTRODUCTION

Morocco as a developing country, and not a producer of fossil fuels, is subjected to a strong energy constraint illustrated by an energy deficit that has worsened over time; it was about 73% in 1970 rising to 83% in 1980 and is currently at 97% [1, 2].

Against this backdrop, Morocco seeks other energy resources more cleaner, such as renewable energies. Among these sources, biogas technology, that is renewable, non-polluting and can be applied on the farm as well as in the food industry or in municipal landfills

Currently, a considerable number of biogas installations of different types and sizes are operational in several countries.

In this context, our study aims to cite the advantages and applications of biogas technology, to give an assessment of national potential for the development of this technology, and to enhance energy performance of manure waste in particular.

II. THE BIOGAS

Biogas is a mixture containing mainly methane (50-70%), carbon dioxide, water of the hydrogen sulfide. Due to a high concentration of methane, biogas is very rich in energy ($> 7 \text{ kWh / m}^3$).

Biogas is produced by methanation (also called "anaerobic digestion") is the transformation of the organic matter into biogas by microbial consortium operating in the absence of oxygen [3].

The composition of biogas and its quality depend on the nature of the organic matter used and the fermentation conditions. In general, the total fermentation time varies between 35 and 60 days [4].

The exploitation of this energy resource indeed presents many advantages:

- **Energetically:** biogas is an energy resource that can be exploited in various ways:
 - As fuel for heating or hot water
 - As fuel to generate electricity
 - As an alternative fuel in vehicles.
- **Environmentally:** Biogas production is a way to valorise organic waste, thus avoiding pollution and nuisances with a significant reduction of CO₂ and CH₄ emissions (GHG), in addition, the residual

products from this fermentation may be used for the production of compost fertilizer in agriculture.

- **Economically:** Biogas presents advantages at local level as additional activity for the farmers who can develop economically and energetically their agricultural waste (vegetal or animal source) and the introduction of this technology will contribute to sustainable development and economic autonomy for biogas producers.
- **Technically:** biogas technology seems simple and can be easily installed on a small scale for a better adaptation to the national context, as is the case in several countries (China, India, Senegal) especially during the last thirty years.

III. THE ENERGETIC POTENTIAL OF LIVESTOCK WASTES IN MOROCCO

The study of potential biogas will contribute to the awareness of the public concerned and would draw attention to this very promising new energy, at both economically and ecologically level.

It is noteworthy that a detailed cartography of solar and wind potentials is available. However, few studies on the potential of biomass have been developed. In this context, we focus on agricultural biomass, urban biomass and agribusiness. Our goal is to estimate the amount of this resource in Morocco and its energy potential of biogas and translate the results into a mapping on the scale of Morocco.

IV. MATERIALS AND METHODS

The general method for estimating the biomass potential involves estimating the maximum quantity or theoretical and adjust it to reflect the performance of recoveries. [2].

The available potential is expressed, in general, according to the formula below,

$$aB \text{ (t / year)} = tB \text{ (t / year)} \cdot f$$

aB = potential in organic waste (available biomass)

tB = the set of organic waste produced (theoretical biomass)

f = percent recovery (rate available for methane fermentation), varies depending on the substrate and the site.

a) *Livestock waste potential*

The potential production in manure is estimated according to official figures published in the Statistical Yearbook and the journal of the poultry sector concerning the number of head in different herds and the yield per year for each waste type [5, 6].

$$tB = N_h \times Y_w$$

N_t = number of heads

Y_w = waste in ton / head / year

b) *Slaughterhouse Waste*

$$Q_{sw} = a_w \times f_a \times N_h$$

Q_{sw}: quantity of slaughterhouse waste (t / year)

N_h = number of heads

a_w: average weight of the animal

f_a: fraction of waste (liquid and solid) depending on the type of animal (14% cattle, sheep, goats, poultry 35%.

c) *Estimation of the energetic potential*

The total energetic potential, by type of waste, is given by:

$$Pe_a = P_d \times P_b \times P_{CI} \times R_t$$

Pe_a = energy potential of waste "a" in kWh / year

P_d = potential in available waste "a" tons / year

P_b = potential in biogas waste "a" m³/ton of fresh matter for each type of waste [7, 8, 9, 10]

P_{CI} = based on methane % of the biogas considered in this study as 60% [1m³ of Biogas = 6 kWh
1Tep = 11628KWh

R_t = for electrical conversion = 1.7 kWh / m³ biogas and 2 kWh / m³ biogas in the case of thermal combustion

V. RESULTS

a) *Livestock Waste*

Our study shows that in 2007 on the scale of different regions of Morocco, we were able to recover more than 87 million tons per year, which could generate biogas with an energy value more than 4.5 Mtep / year.

It should be noted that this potential has been estimated by assuming that the animals spend 24 hours in the breeding local and this is equivalent to a coefficient of manure recovery of 100%. In our study of northern Morocco [2] we considered the time spent outside the local livestock at 12 hours. The recovery coefficient is therefore adjusted to 50% except in the case of poultry, this factor is maintained at 100% [2].

The map below illustrates the geographical distribution of biomass potential and its potential energy in Tep, at the different regions of Morocco, by making use of software Arc Gis (9 .3) to edit the versions map 1: 100 000.

VI. CONCLUSION

The management of these resources must be part of an integrated energy policy taking into account the energy needs for rural development.

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