# Anaerobic Digestion of Biowastes- an Alternative Energy Source for Haiti

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## Abstract

Haiti is facing serious environmental degradation problems making its populace very vulnerable to natural disasters. Energy consumption patterns of the country are the most important drivers of this situation. Even today, firewood and charcoal provide around 66% of the energy consumption on a national scale. This situation is translated into deforestation, reducing the forest cover of the country to less than 2%. This study analyzed the current energetic situation of Haiti and estimated its biogas production potential in order to evaluate the eventual energetic contribution of anaerobic digestion technology. Amounts of biowastes generated from different activities were used to assume the biogas potential of the country. Wood, charcoal, and bagasse respectively represent 55%, 11%, and 4% of the total energy demands of the country. Hydro-energy contributes 5% while the remainder is provided by imported oil and its derivatives. However, anaerobic digestion of different kinds of agricultural wastes, human and animal wastes generated in the country can produce enough methane to meet around 17% of the total energy demand of the country. Two scenarios using 70 and 95% of available biowastes were evaluated, between 340 and 461 million $m^3$ of methane can be generated annually from manures, human wastes, and major crop residues. A typical Haitian farmer can produce enough gas to meet their energy needs for cooking purposes if all wastes generated on the farm are converted into biogas. In market places of big cities where large amounts of wastes are produced, every day, a substantial quantity of methane can be produced through anaerobic digestion. In conclusion, implementation of anaerobic digestion technology in Haitian rural sectors can provide sufficient energy to displace a substantial amount of firewood, thus reducing deforestation and improving air quality. Furthermore, this technology offers a sanitary solution to manage human and animal wastes, while producing a mineralized fertilizer for soil management and sustainable crop production.

## Introduction

- Biomass supplies around 70% of the total energy consumption in Haiti while the remainder is mostly provided by imported oil and derivatives.
- Deforestation accelerated by high energy demand makes the country vulnerable to natural disasters and drives environmental degradation including soil depletion.
- Biowastes are generated from agriculture and livestock, since agriculture is the primary economic activity of the country.
- About 9% and 30% of the population living in urban and rural areas, respectively, practice open defecation.
- Human wastes generated in cities with large populations are not properly managed and represent an critical threat to public health.
- Crop residues, animal manures, and human wastes, can be turned into biogas, which can be used for cooking or lighting.

## Objectives

- Analyze the current energetic situation of Haiti.
- Estimate the biogas production potential of agricultural wastes and manures generated in the country.
- Evaluate the potential contribution of anaerobic technology to the energetic patterns of Haiti.

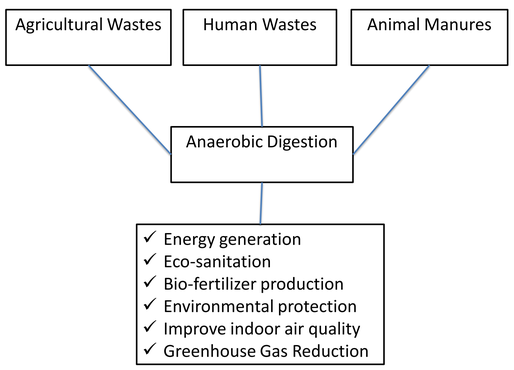


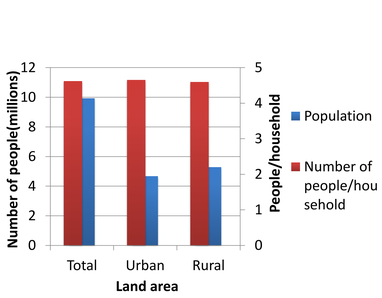

**Figure 1.** Benefits of anaerobic digestion of biowastes

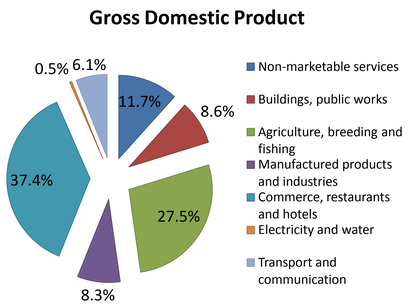
**Figure 2.** Anaerobic digester appropriate for Haitian rural areas

## Methodology

- Statistical data for the number of livestock animals and agricultural production was used to assess the amount of substrates available for anaerobic digestion.
- IPCC guidelines (2006) were used to obtain the amount of volatile solid (VS) produced per animal per day.
- Amount of crop residue was evaluated by using the range of straw grain ratio developed by Lal (2004).
- We assume that 70% of the total VS of all wastes is fed to the digester. Further, Methane production was estimated in a second scenario where 95% of all wastes is fed to the digester.
- Methane production potential was evaluated using values from IPCC (2006) and Deublein and Steinhauser (2008).
- Total methane was converted to thousand tons of oil equivalent (Ktoe) and compared to current energy consumption of the country.

## Haiti Overview




**Figures 3 and 4.** Socio-economic indicators of Haiti, adapted from IHSI (2009).

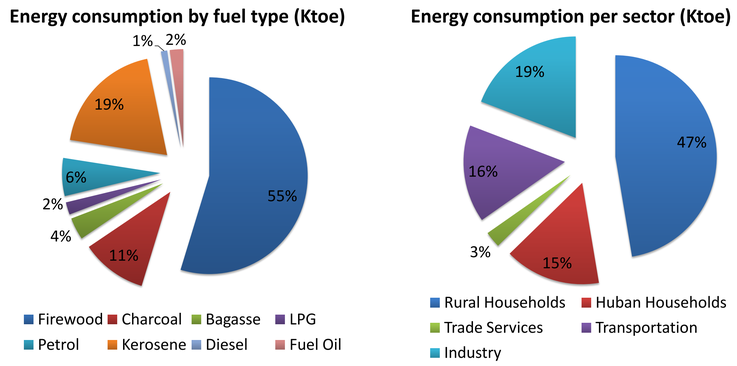



**Figure 4**. Energy consumption (Ktoe/year 2003). Adapted from IBRD/WB(2007). Energy imported include kerosene, diesel, liquid petroleum gas (LPG), and fuel oil .

## State of the Environment

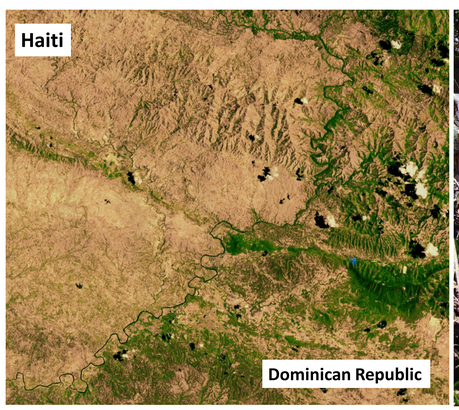



**Figure 5.** Satellite image of the border between Haiti (left) and the Dominican Republic (right), showing the intensity of deforestation within Haiti.
Image credit: NASA

**Figure 6**. Deforestation in Haiti. Every year between 15 and 20 millions trees are cut down for the production of charcoal, cooking and others purposes (UNEP, 2010).

## Results

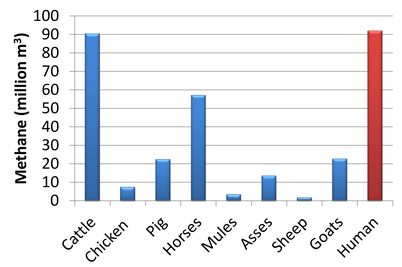



**Figure 7.** Methane potential from animal manure and human waste. Assumption of 70% of manure are collected for anaerobic digestion

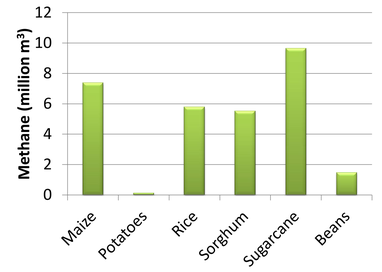



**Figure 8.** Methane potential from crop residues. Assumption of 70% of crop residues are collected for anaerobic digestion

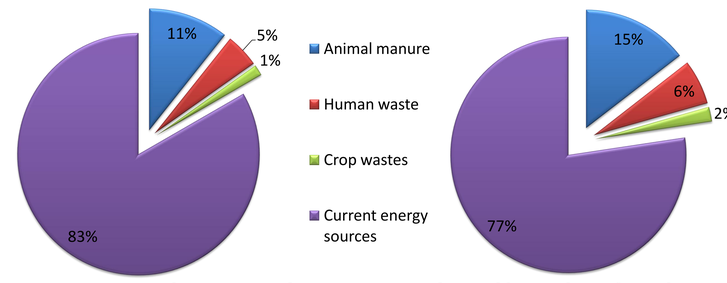



**Figure 9.** Percent contribution to total Haitian energy demand by methane from the anaerobic digestion of biowastes. Assumptions of 70% (left) and 95% (right) of all biowastes are collected.

## Discussion

- Based on our assumed 70 and 95% scenarios, 340 and 461 million $m^3$ of methane can be generated annually from biowastes, which corresponds to about 302 to 410 Ktoe, respectively.
- Potential biogas production from biowastes can contribute 17% to 23% of the all energy consumption in Haiti and over 65% of the energy consumption in rural areas.
- Animal manure and human wastes are the best candidates for anaerobic digestion in Haiti, examined in this study.
- Additional biogas can be obtained by increasing the mass of feedstock, particularly from crop residues.
- Anaerobic digestion can be used on small farms or on a larger scale to produce energy and low cost fertilizer.
- Other advantages of anaerobic digestion include prevention of waterborne diseases, reduction of indoor air pollution and environmental protection.

## Conclusions

- Anaerobic digestion of biowastes can be a sustainable source of energy for Haiti.
- Implementation of anaerobic digestion technology in Haiti can not only be considered a substantial energy source, but can help address issues related to sanitation, air quality, deforestation, soil depletion and agricultural production.

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