International Gas Union Research Conference 2011

THE USE OF BIOGAS GENERATED FROM SWINE MANURE AS A PRELIMINAR AGENT IN THE VIABILIZATION OF BIOGAS PIPELINE CONSTRUCTION

Main author

Antônio Rogério Machado Jr.

BRAZIL

ABSTRACT

Santa Catarina state has over 800 km of natural gas distributed along the coast line, however, has an area of 95.700km ². Due to mountainous relief, constructing pipeline that will supply natural gas to remote areas will prove difficult. Supplying gas to remote areas through biogas from pig manure is a feasible alternative to building a gas pipeline to these regions. Using data from the IBGE and by aid of computer programs it was found that Santa Catarina has a potential to generate biogas from 900.000 m³ / day which are located predominantly in the western region of state. Thus, through the provision of biogas in this region a market that uses natural gas as an energy source can stimulate. As result the pay-back time and the feasibility risk of a network gas project can be reduced. It was found that only in the west there is an energy potential to be shifted to natural gas equivalent of 389.583 m³ / day and as expected output is estimated to reach 16.728 m³ / day. This helps anticipate the building of a natural gas network that links the coast with outskirts of the state, while the environmental impact of swine as methane emissions and waste are reduced.

Key-words: Biogas; Swine Manure; Natural Gas Networks.

TABLE OF CONTENTS

1. INTRODUCTION

Santa Catarina is the largest pig producer state of Brazil, according to data from Santa Catarina Swine Breeders Association (ACCS) [(1)], with an amount of 6 million pigs. Brazilian's five largest agribusiness are installed in the state of Santa Catarina; cities such as Concórdia, located in the western region, have densities up to 287 pigs/km², an amount as high as those found in Europe (Prestes, 2010) [(2)]. According to the Merkel [(3)] research quoted in studies by Medri [(4)] , the daily estimated amount of manure digestion production per swine varies from 1 to 5 kg depending on the maturing stage.

The biogas produced by anaerobic digestion of animal waste, is a gaseous mixture, colorless and highly flammable. Methane (CH_4) represents 50 to 70% of the biogas volume, being the energy source of biogas, which allows it to be used as a thermal energy form, mechanical and electrical. Provide a source of renewable energy to remote areas through biogas produced from pig manure is an alternative to anticipating the natural gas pipe construction to these regions. On the other hand, this business model can certainly contribute with the reduction of the environmental impact, typical of swine industry, mainly on methane emissions which is 21 times more polluting than carbon dioxide and liquid effluents.

2.MATERIAL AND METHODS

2.1.Quantification of biogas

In order to quantify the potential biogas generation, SCGAS requested through the Federal University of Santa Catarina - UFSC, a report of the biogas potential in the state [(5)] . Through statistics obtained from IBGE [(6)] data by using the software *Biogás: Geração e Uso Energético*, *V. 1.0* (CETESB) [(7)] have been identified the regions which produce methane (CH4) in the form of biogas from pig waste.

The equation 1 introduces the methodology developed by CETESB in which estimates the potential of methane generated in the biogas form.

$$Q = \frac{PB * Conc * Qt * Mt}{VE} \quad (1)$$

where:

Q = methane flow (m³/day)
PB = biogas production (kg biogas/ kg.Mt)
Conc. = methane concentration in biogas (%)
Qt = effluent generating units (nº of animals)
Mt = total manure amount (kg manure/animal.day)
VE = specific volume of methane (kg/m³)

Were adopted in the calculation values as follows suggested by CETESB which considerate the effluents of the swine industry:

PB = 0,062 kg biogas/kg.Mt
Mt = 2,25 kg manure/animal.day
Conc = 66% methane
VE = 0,67 kg/m3

The parameter obtained through the suggested values and the equation (1) for the generation of methane per animal per day was 0,1374m³ CH_4/swine.day.

2.2. Market Potential Evaluation

To evaluate the market potential of biogas there have been done visits during the month of October 2009 in the western region of Santa Catarina state, where the largest swine production [8] are located. During this procedure there have been approached the largest companies in the region that used biomass (fuel wood), Liquefied Petroleum Gas – LPG and fuel oil as energy. For the purpose of comparison, the energy contents of the fuel used in the companies were converted to cubic meters equivalent to natural gas.

3. RESULTS

According to the collected data, Santa Catarina state owns 6.021.346 swines, while the potential methane in the biogas generated from biodigestion of swine manure is about 900.000 m³/day. Among the villages with largest potential, it can be cited the cities of Concórdia, Seara, Iomerê, Xavantina, Braço do Norte and Videira, which stand out for having a potential above 20.000 m³/day. As for the distribution of biogas production, 50% of generating potential is concentrated within 24 of the 193 villages, which represent only 8% of the total. Figure 1 illustrates the map of methane potential in the Santa Catarina state.

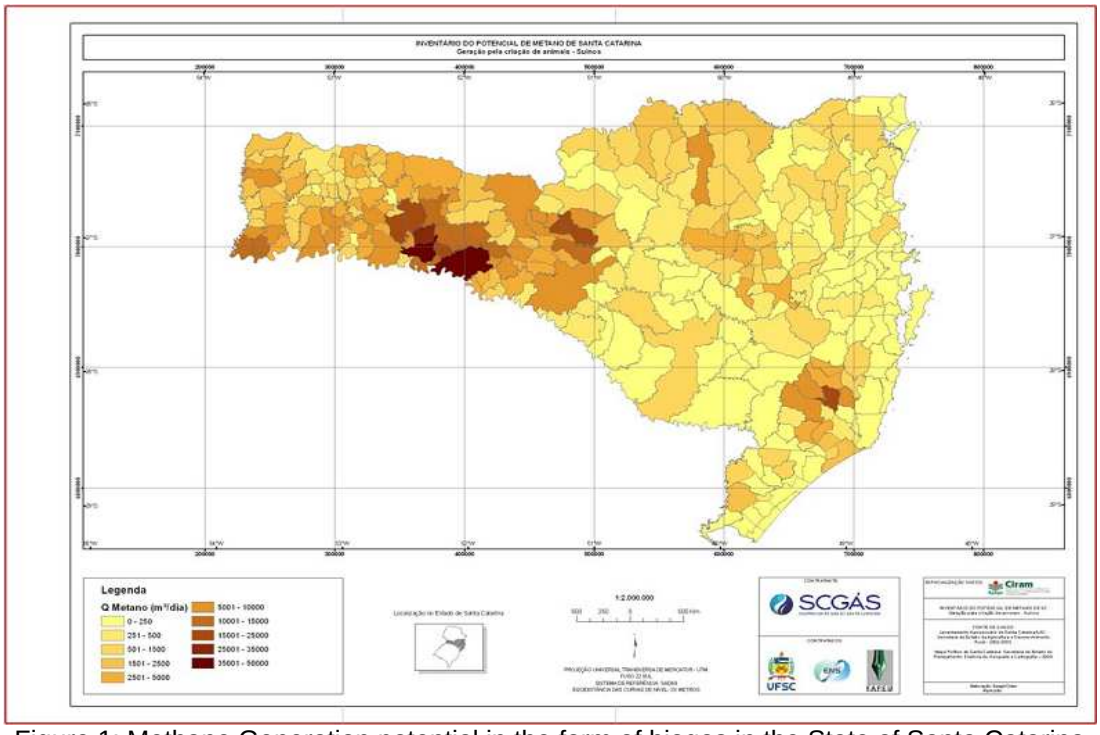

Figure 1: Methane Generation potential in the form of biogas in the State of Santa Catarina

As possible market, there are 389.586 m³/day equivalent to natural gas distributed in the 11 researched cities in west of Santa Catarina state. However, only 16.728 m³/day are able to be collected due to the use of LPG or fuel oils by the companies, which are energies that are easily moveable by biogas. Once the biomass (fuel wood) is easy to be purchased and has much reduced price this option does not seen to be a viable substitution by biogas. Table 1 shows, respectively, the natural gas market data and the methane (CH_4) market that can be captured in the form of biogas in the researched areas.

City	*Potential Market - GN eq. (m³/day)*	*Real Market (CH_4) – Biogas (m³/d)*
Concórdia	38.300	3.500
Seara	10.068	1.068
Xanxerê	8.600	50
Xaxim	7.350	750
Chapecó	40.100	4.200
Herval d'Oeste	11.100	1.100
Joaçaba	50	50
Vargem Bonita	230.167	167
Videira	17.956	1.500
Capinzal	24.682	4.333
Salto Veloso	1.210	10
Sub Total	***389.583***	***16.728***

Table 1: Potential market and reachable (real) methane market (CH_4) in biogas form in m³/day

4.DISCUSSION

The biogas may be upgraded into the natural gas category, therefore, in the raw stage provides low energetic value when compared to the first stage. According to Dublein and Stenhauser [(9)] the average energetic value of biogas in raw state lies between 5.160 a 5.590 kcal/m³, while the values for natural gas are at the order of 8.600 kcal/m³. The use of biogas with low calorific value narrows its applications to direct-burning, restricting its use for industrial burners or electric power generation units. After purified, the biogas may be used in other segments such as vehicular utilization or even injected into natural gas pipeline, amplifying significantly its application. In Laholm, a city in Sweden, the biogas produced through animals manure and by different types of organic waste has been injected into the natural gas pipeline since 2001. According to IEA Bioenergy [(10)] , after the biogas being purified it is introduced into the natural gas pipeline, reducing in 25% the consume of this fossil fuel, reducing consecutively about 3.700 t/year of CO2 emissions. The amount of biogas injected annually into pipelines is approximately 1.800.000 m³ and serves as for heat generation of the villages as well as for providing gas to vehicular market.

5.CONCLUSION

According to the present study, Santa Catarina state presents a considerable potential for the biogas generation from swine manure which was estimated in 900.000 m³/day. The identification of the biogas production areas allows the identification of the possible unit installation of production, processing or methane gas exploitation. Once biogas became available in these regions a stimulus on the development of a market that utilizes natural gas as energy source is produced. Furthermore, biogas can also be purified and injected into its own natural gas pipeline to be built. As a consequence, the reduction in turnaround time and risks regarding the viability of the works will be reduced. This allows the anticipation of natural gas pipelines construction to distant regions, while the environmental impacts inherent in the swine industry such as methane and liquid effluents emissions are mitigated.

ACKNOWLEDGMENTS

The authors would like to thank the Federal University of Santa Catarina – UFSC for the partnership in the present project and the visited companies that allowed the analysis of its productive process and data collection necessary to realize this study.

REFERENCES

1. ASSOCIAÇÃO CATARINENSE DE CRIADORES DE SUÍNOS. **Relatório Anual 2010**. Disponível em: <http://www.accs.org.br/. Acesso em 25 jan. 2011.
2. Prestes, Rosi Maria. **Análise da Sustentabilidade Ambiental da Suinocultura com Base no Balanço de N e P e na Percepção dos Agricultores do Município de Frederico Westphalen/RS.2010.** Chapecó: UCRC, 2010. 93 p.
3. MERKEL, J. A. **Managing livestock wastes**. Avic Publishing Company, Inc., 1981, 419p. MIDDLEBROOKS, E. J. Design equations for BOD removal in facultative ponds. **Wat. Sci. Tech**., v. 19, n. 12, p. 187-193, 1987.
4. MEDRI, Waldir. **Modelagem e otimização de sistemas de lagoas de estabilização para tratamento de dejetos suínos**. Tese (Doutorado) - Universidade Federal de Santa Catarina – UFSC, Florianópolis – SC,1997.
5. BELLI, P. CASTILHOS JR., A. B., GOSMANN, H., SALIM, K., SANTOS, H. Relatório: **Inventário do potencial de produção de metano por dejetos da criação de animais em Santa Catarina.** SCGÁS/UFSC. Florianópolis, 2008.
6. Instituto Brasileiro de Geografia de Estatística **-** IBGE**. Mapas.** Disponível em: < http://www.ibge.gov.br/7a12/mapas/ufs/santa_catarina.pdf> Acesso em 25 jan. 2011.
7. Companhia de Tecnologia de Saneamento Ambiental - CETESB. **Manual do usuário do programa de computador Biogás: geração e uso energético – efluente e resíduo rural** – Versão 1.0 / CETESB, Secretaria do Meio Ambiente, Ministério da Ciência e Tecnologia: SMA: CETESB: MCT, 2006.
8. COMPANHIA DE GÁS DE SANTA CATARINA - SCGÁS. **Projeto Conceitual da Rede de Distribuição de Biogás – Oeste Catarinense**. Florianópolis – SC, 2009.
9. DEUBLEIN, Dieter; STEINHAUSER, Angelika. **Biogas from waste and renewable sources**. 2nd Ed. Weinhein: Wiley –VCH Verlag GmbH & Co, 2011.
10. INTERNATIONAL ENERGY AGENCY - IEA BIOENERGY. **Injection of biogás into the natural gas grid in Lanholm, Sweden: Co-digestion of manure and industrial waste.** Disponível em: < http://www.ieabioenergy.com/OurWork.aspx. > Acesso em 2 maio 2010.

LIST OF TABLES

LIST OF FIGURES