

Anaerobic Treatment of Municipal Wastewater to reduce pollution of South Africa's Water Resources while promoting Energy Efficiency at Municipal Treatment Work



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1 Background

Wastewater sludge from municipal waste treatment works has beneficial energy generation properties through the production of biogas. In turn, the production of biogas from the sludge reduces pollution water resources. Although anaerobic digestion has been a prevailing technology for biogas production for many years in other parts of the world, in South Africa (SA) this technology is still highly underdeveloped. Due to increased pollution of water resources in SA use of biogas technology may be beneficial by reducing wastewater pollution of water basins by deposition of faecal matter from municipal wastewater treatment plants. Sludge recovered may be converted to methane under a joint effort of several microbial groups in a reaction system.

This study discusses the possibility of reducing the pollution of SA's water resources if incorporation of biogas production plant into the municipal wastewater treatment plant is considered. Information and/or data on the impact of biogas production on pollution of water resources by faecal matter and pathogens as well as potential benefits on the bioconversion of the wastewater sludge for energy generation was gathered through literature review. Information gathered was then used as a basis to determine how the incorporation of biogas production in South Africa's wastewater treatment plants would contribute to the reduction of pollution in South Africa's water resources.

2 Current status of WWTW plants in SA

According to a report by the Department of Water Affairs (2009), in South Africa there are approximately 970 wastewater treatment plants treating an average of 7 589 ML of wastewater on a daily basis. Macro and large WWTWs account for about 17% of the number of plants - responsible for about 60% of the total volume of effluent discharged. Small and micro plants on the other hand were found to be responsible for 10% of the total daily effluent but account 40 - 46% of the number of WWTWs in the country (DWA 2010). Therefore, both large and macro works should be regarded as high risk facilities. However, a significant number of wastewater and sewage treatment works are not properly operated and maintained as a result of this they discharge poor quality effluent to streams and rivers (DWA 2009).

Application of biogas technology in the treatment of wastewater and sewage sludge has become one of highly recognized technologies in the developed world. Utilization of biogas technology can make an important contribution to the protection and improvement of natural resources and environment as a correctly run anaerobic digester plant will efficiently convert up to 95% of organic material into a low odour stabilized slurry, and produce a renewable energy resource in the form of biogas that can be flared or utilized on site. This eliminates the need for additional solid handling and large-scale pond systems, and may also limit reliance on non-renewable fuels. (0.1%).

3 Results

Lindeque and his team were able to produce biogas from municipal wastewater sludge using an automated system (table 1). In their study, from a known amount of municipal liquid waste about 70% of methane (CH₄) and 28% CO₂, were produced with trace amounts of N₂ (2%), O₂ (0.4%), CO (0.1%) and Ethane

Table 1: Biogas production from municipal wastewater sludge

Sample date	6 Sept. 2012	12 Sept. 2012	14 Sept. 2012	Average	Std. Dev.
Methane (CH ₄)	68,7	72,5	69,2	70,1	2.065
Carbone dioxide (CO ₂)	27,4	25,8	29,7	27,6	2.126
Nitrogen (N ₂)	2,9	1,2	0,6	1,5	1.196
Oxygen/argon (O ₂ /Ar)	0,7	0,3	0,2	0,4	0.265
Carbon Monoxide (CO)	<0,1	<0,1	<0,1	<0,1	0
Ethane	<0,1	<0,1	<0,1	<0,1	0

Using the Haridwar case study the result in table 2 were produced

Table 2: Potential production of biogas from municipal wastewater sludge in SA – informed by a case study from Haridwar (Uttarakhand) (Maliki and Bharti 2009)

Production of biogas seasonally	Amount of biogas produced (m ³)	Quantity of sludge (m ³)	Temperature (°C)
Winter	1 205 588.70	151 780	25-35
Summer	1 342 246.97	151 780	25-45

6 References

- DWA (2010). Wastewater services in South Africa, presentation (Presentation to the Portfolio Committee of Water & Environmental Affairs), 11 May 2010
- DWA (2009). Municipal Wastewater Treatment base information for targeted risk-based regulation- Western Cape Province
- Malik, DS and Bharti, U (2009). Biogas production from Sludge of Sewage Treatment Plant at Haridwar (Uttarakhand), Asian J. Exp. Sci., Vol. 23, No. 1, 95 – 98

5 Summary & Conclusions

After considering a number of case studies, theoretical results from this study showed that from 7 589 ML of wastewater produced on a daily basis South Africa has a potential of producing between 1 205 588.70 - 1 342 246.97 m³ of BIOGAS. A study of biogas production in Haridwar (Uttarakhand) (Maliki and Bharti 2009) was mainly considered in determine the potential of biogas production in South Africa. The following specific factors were used as determinants:

- By 2010 South Africa was producing 7 589 ML \approx 7 580 000 m³ of wastewater per day
- Generally, municipal wastewater has 2% sludge content therefore resulting in 151 780 m³ of sludge produced in South Africa per day
- From the study conducted in Haridwar 9600 m³ of sludge produced from municipal treatment plants produced 76252.81 m³ of biogas in winter and 84952.34 m³ of biogas in summer.
- It must be noted that in this study a number of condition such as climatic conditions, physical composition of the sludge that may differ between SA and Haridwar were not considered.
- Therefore, given the above assumption it can be estimated that in South Africa biogas production could be in the range of 1 205 588.70 - 1 342 246.97 m³ per day.

4 Materials and methods

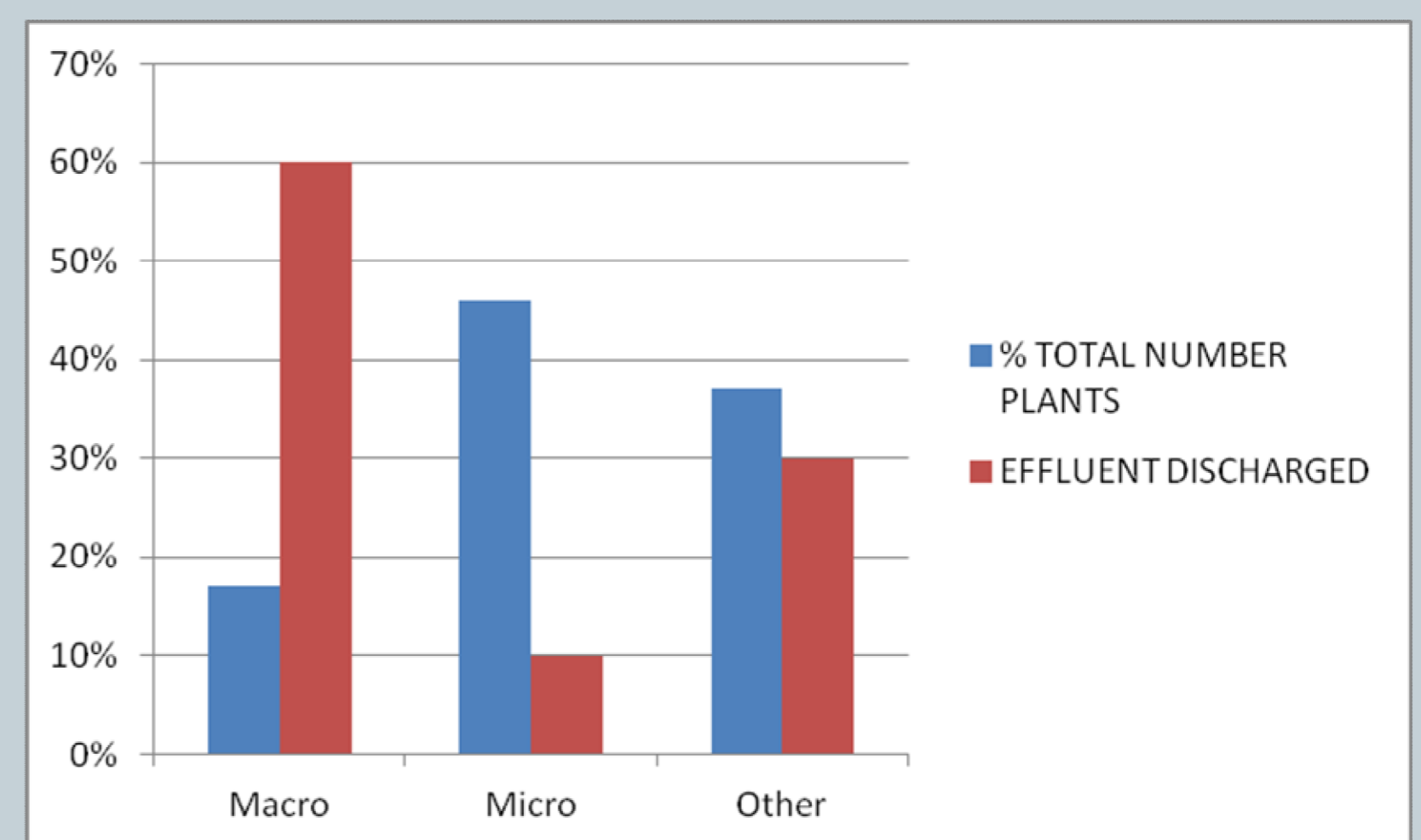


Figure 1: Graphical representation of effluent produced in South Africa (DWA 2010)

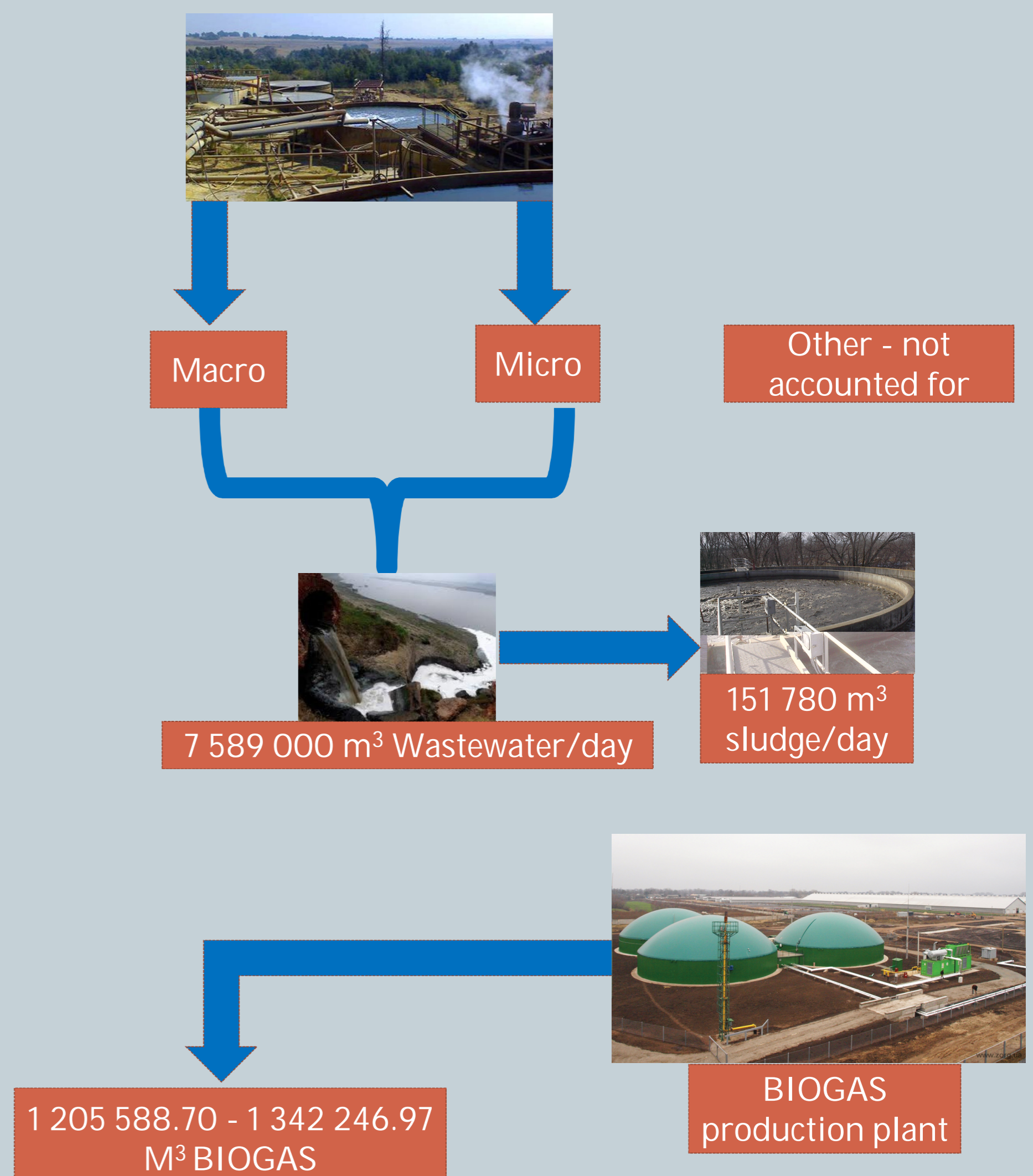


Figure 2: A flow diagram of a typical process of biogas production from municipal wastewater treatment plant