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Waste-To-Energy Technologies: an opportunity of energy recovery from Municipal Solid Waste, using Quito - Ecuador as case study

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Abstract

In this study, energy generation potential from municipal solid waste (MSW) in Quito, Ecuador was estimated for biochemical and thermochemical processes using generic models. Results showed that MSW of Quito contained 69.3% of biodegradable waste and 30.7% of non-biodegradable waste with putrescible waste accounting for 81.4% of biodegradable waste. The calculated energy potentials through thermochemical and biochemical routes were 5970 kWh/tMSW and 62 kWh/tMSW respectively. Similarly, the power generation potentials were estimated at 0.78 and 0.07 MW/tMSW for biochemical and thermochemical processes, respectively. This study thus illustrates that Quito´s MSW has high potential for producing biogas and heat energy.

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Keywords: Waste-to-energy technologies (WTE-T); municipal solid waste (MSW); biochemical processes; thermochemical processes.

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1. Introduction

The World Bank estimates that 1.3 billion tonnes of waste is generated annually worldwide and, by 2025, this amount will increase to 2.2 billion tonnes per year [1]. Thus, the need for treatment and disposal of municipal solid waste (MSW) around the globe will become increasingly important. Solid Waste Management (SWM) is a current paradigm between developing and developed countries. In industrialized countries, technologies to utilize MSW for the production of energy, heat, solid biofuel and compost were well established [2-4]. On the contrary, collection and transport of waste, and management of landfills in the developing countries is still by large a challenge [5, 6]. Unplanned management, cultural and socio-economic aspects, industrialization and low standard of living, policies and international influences have impeded an adequate SWM in developing countries [7, 8]. In this regard, waste to energy technologies (WTE-T) are vital for addressing sustainable SWM worldwide with special focus on developing nations.

MSW is a valuable renewable resource with capacity of biogas generation for combined heat and power (CHP) production by using the appropriate waste-to-energy technologies [9]. These technologies must be selected based on the waste composition assessment and economics [10]. Selection of the appropriate WTE-T is not an easy task due to generation of solid waste is influenced by seasonality and socioeconomic level of producers [11]. Policy instruments for sustainable waste management also have a significant impact in the selection of WTE-T [12]. Waste-to-energy technologies can be classified into biochemical and thermochemical processes while MSW can be classified as biodegradable and non-biodegradable, which are suitable for biochemical and thermochemical processes respectively [13, 14]. Biochemical processes are related to anaerobic digestion technologies to produce biogas [15] and thermochemical processes are related to pyrolysis [16], gasification [17] and incineration technologies [18]. Other authors also consider landfill gas utilization technologies [19] along with biorefineries as WTE-T [20, 21]. These technologies are potential to reduce greenhouse gas emissions in decentralized energy from waste systems [22].

In the Ecuadorian context, the Ministry of the Environment (MAE - Spanish acronym) has recently developed the National Program for the Integral Management of Solid Waste (PNGIDS - Spanish acronym) [23, 24]. There are 221 Decentralized Autonomous Governments (GADs – Municipalities) countrywide. Of which, only 24% of GADs have begun source separation of waste. MAE-PNGIDS estimates that 5.4 million metric tonnes of MSW per year will be generated by the end of 2017 at a per capita production of 300 kg per year. Furthermore, MAE-PNGIDS considers waste to energy technologies as part of the program. Some initiatives are being implemented in GADs. In the Pichacay Landfill, Cuenca, for example, 1,6 MWh of energy is estimated to be generated by biogas recovering and driving a thermal power plant [25]. Other examples of WTE-T projects are being studied in Quininde [26], and Quito [27]. However, the related literature has no addressed the methodology to estimate the potential of energy recovery from MSW neither in the country nor in GADs.

The aim of this study is to estimate the energy potential of Quito´s MSW by using biochemical and thermochemical processes by applying generic models.

Nomenclature

WTE-T	Waste to energy technologies
tMSW	tonnes of Municipal Solid Waste
SWM	Solid Waste Management
CHP	combined heat and power
MAE	Ministry of the Environment
PNGIDS	National Program for the Integral Management of Solid Waste
GADs	Decentralized Autonomous Governments
EMASEO-Q	Metropolitan Public Sanitation Company of Quito
EMGIRS-EP	Metropolitan Public Company of Integrated Management of Solid Waste
TS - NTS - STS	Transfer Stations - North Transfer Station - South Transfer Station
CELEC-EP	Electric Corporation of Ecuador, Public Company
EEQ	Electrical Company Quito