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Innovation in Solid Waste Management through Clean Development Mechanism in Developing Countries

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Abstract

Municipal Solid Waste (MSW) has emerged as a core issue, which needs to be tackled effectively in developing countries. The burgeoning population indicates increased MSW generation rates indirectly posing challenge to the final disposal. The final disposal is of critical importance as it largely impacts the environment and public health. A number of technologies are available for management and treatment of MSW but choosing the appropriate one depends on the nature of MSW and local conditions. Selecting the appropriate technology also helps to reduce the greenhouse gas (GHG) emissions, thereby mitigating climate change. The opportunity to reduce GHG emissions is offered by the Clean Development Mechanism (CDM). This paper reports how MSW can be managed effectively through CDM. 350 MSW projects have been registered under CDM across 56 developing countries. 51,292,568 metric tons of CO2e are estimated to be reduced through these 350 projects. China registered the maximum number of projects (102), followed by Brazil and Mexico registering 45 and 28 projects, respectively. Overall, 175 projects from China, Brazil, and Mexico account for about 51.63% of the total estimated emissions reductions. Asian region reported the highest number of projects (191) followed by South American region (123). 16 methodologies have been used as stand-alone as well as in combination for management of MSW through CDM and cover several areas through which the potential of MSW can be trapped. China and India used the maximum methodologies (9) followed by Brazil (7). Registering for CDM offers financial benefits as well as technology transfer and ultimately sustainable development. Source reduction and technology development to suit local needs are the areas where developing countries can focus. An integrated system for solid waste management is perfectly suitable for developing countries.

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1.0 Introduction

Millions of tons of solid waste are generated daily in the world needing collection, sorting, treatment, and final adequate destination. In developing countries, most of the solid waste generated is disposed in landfills and open air sites causing serious risks to public health and the environment (Lino and Ismail, 2013). Solid waste has emerged as a significant pressure on the environment, mostly due to the population growth, the changes in consumption habits and of the patterns of the communities' developments. Municipal Solid Waste (MSW) is the largest volume of residues produced worldwide; at the same time, the citizens' demands for an environmentally sound management of MSW have significantly increased during the last decades (Leme *et al*., 2014). Selecting the appropriate processing mode can not only reduce the impact of MSW on local environment, but also reduce greenhouse gas (GHG) emissions and save fossil fuels and mitigate of global climate warming (Wang *et al.*, 2015). In highly populated countries such as China and India and others such as Turkey, Mexico, and Brazil, almost 90% of the solid waste (whose major part is organic) considered as the principal source for producing methane is usually destined to landfills and dumps freely liberating huge quantities of carbon dioxide and methane to the atmosphere. Globally, landfills are the third largest anthropogenic source of methane, responsible for approximately 14% of estimated global methane emissions (Lino and Ismail, 2011).

Solid waste, including municipal waste and its management, is a major challenge for most cities and among the key contributors to climate change. GHG emissions can be reduced through recovery and recycling of resources from the MSW stream (King and Gutberlet, 2013). Due to initiatives such as the Clean Development Mechanism (CDM), reducing GHG emissions for a developing country can offer an important route to attracting investment in a variety of qualifying project areas, including waste management (Barton *et al.*, 2008). CDM can play a major role in managing MSW by motivating municipalities to go in for energy recovery projects, as it will bring in carbon credits, which makes the projects financially more attractive (Unnikrishnan and Singh, 2010).

2.0 Technologies used for MSW management

The technologies to treat MSW and further reduce emissions include landfilling with biogas recovery, composting of selected waste fractions, anaerobic digestion and thermal processes including incineration, gasification and pyrolysis. The applications of these technologies depend on local, regional, and national drivers for both waste management and GHG reduction (Lino and Ismail, 2013). Direct landfill and composting, due to their disadvantages, are gradually replaced by other technologies. In spite of the advantages derived from incineration of MSW, such as heat recovery, there are numerous disadvantages including production of large flue gas volumes, hazardous waste streams associated with the fly ash and a poor public image (Luo *et al.*, 2010). Vermicomposting of MSW was also suggested in some countries (Sim and Wu, 2010; Lim *et al.*, 2015). A more recent trend for the treatment of solid waste is the combination of incineration and energy recovery in the so called "waste-to-energy (WtE)" plants. This combination helps to solve two problems: one is the energy involved and the other is the environment (Byun *et al.*, 2011). Biomethanation or anaerobic digestion may be perceived as a potential alternative to treat MSW as it not only provides renewable source of energy but also utilizes recycling potential of degradable organic portion of solid waste generated by numerous activities (Ambulkar and Shekdar, 2004). MSW pyrolysis and gasification technology is an attractive way to treat MSW with less pollution emissions than other methods of treatment. Especially, it offers a potential of higher efficiency in energy production (Luo *et al.*, 2010).

3.0 Methodology

The project search tab for CDM on the United Nations Framework Convention on Climate Change (UNFCCC) website was used to shortlist registered CDM projects, which focussed on MSW treatment and management. These shortlisted projects mainly belonged to three CDM sectoral scopes: waste handling and disposal, agriculture, energy industries (Renewable/non- renewable sources) and transport. The details of the CDM projects *viz*. number of projects per country, the estimated emission reductions per country, the number of methodologies used per country were obtained and compiled.