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Energetic and economic feasibility of RDF to energy plant for a local Thai municipality

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Abstract

Management of waste is a main concern and one of the most crucial issues in modern society. Effective waste management considers prevention, recycling, and handling of waste in such a way that most effectively protects human health and the environment. Energy recovery is one of the accepted options in managing solid waste. In the present paper, a waste-to-energy conversion plant utilizing refuse derived fuel (RDF) with appropriate combustion technology was proposed for a local municipality in Lampang, Thailand. Realistic waste quantity and composition were estimated. Mass and energy analyses as well as an economic feasibility survey were carried out to evaluate performance and benefits of the proposal. With up to 220 tons of RDF available daily, it was suggested that a power plant project between 5 to 13 MW_e generation capacity may be developed. For a baseline case of 5 MW_e, the project is economically feasible with tolerance to ± 50% fluctuation in total capital cost, electricity sale price and tipping fee.

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Keywords: Biomass; Feasibility study; Renewable energy; Waste-to-energy

1. Introduction

Sustainable management of municipal solid waste (MSW) is vital due to growing MSW generation from rising population and urbanization. Annual worldwide urban waste is expected to exceed two billion tons by 2025. Proper

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collection and disposal of MSW are extremely important. Thailand has encountered an accumulating problem on waste generation and disposal. According to the Pollution Control Department [1], total solid waste throughout the country was 24.4 million tons in 2010 and increased to 26.8 million tons in 2015. The per capita generation of MSW in Thailand was approximately 0.5 – 1.0 kg/day. The increasing trend in quantity generated is expected at a rate about 1.0-2.0% per year. Currently, less than one fifth of collected waste in Thailand is utilized. Majority is not disposed of properly. Sustainable solid waste management is badly needed.

An effective waste management system considers prevention, recycling, and management of waste in such a way that most effectively protect human health and the environment. Waste-to-energy (WTE) technologies seem to be one of the most attractive options for managing waste. Modern WTE facilities with adequate and careful environmental monitoring have been shown to be a safe and cost effective technology [2, 3]. It can contribute to a positive cash flow in areas where tipping fees are high and landfill space is limited. It also extends landfill life through a reduction in volume and ameliorates the final waste disposal into landfills. Thailand Ministry of Energy has targeted to boost WTE production to 160 MW of power and 100 ktoe of thermal energy by 2021. There are a number of energy technologies available, but energy recovery from combustion is most widely adopted. Apart from conventional mass burn process, recycling and recovery of material as well as energy through production of a refuse derived fuel (RDF) is of great interest. RDF process utilizes separation and sorting of MSW to remove recyclable or hazardous materials. The remaining combustible material goes through then size reduction step. It may then be densified into pellets. RDF has several advantages over untreated MSW, including higher energy content, homogeneity, ease of storage, handling and transportation, and lower pollutant emissions [4].

In this work, feasibility of an energy recovery from waste project in Lampang, Thailand was investigated using RDF technology. Economic and financial risk of the project proposal was evaluated by carrying out a capacity analysis. Investment costs, net present value, benefit-cost ratio and internal rate of return were assessed and used for project evaluation. Sensitivity analysis of equipment costs, tipping fee and market price of produced goods such as recovered materials were also carried out.

2. Methodology

2.1. Proposed facility

A case study was conducted for Lampang. It is one of the major cities in northern Thailand. The amount of MSW collected in Lampang municipality and its surrounding areas is approximately 500 tons/day. The waste collection is normally carried out by the Municipality and local authorities. The composition of the Lampang MSW is shown in Table 1, according to the Pollution Control Department [1]. The location for the RDF/WTE station was designated to be on the existing dumping/landfill site not far from the main highway and Lampang city centre (shown in Fig. 1). The site occupies around 15 acres and is surrounded by uncultivated land. The site has already passed an environmental impact analysis as well as a public and stake holder debate concerning MSW disposal and management.

Table 1. Representative MSW component collected in Lampang in the year 2010.

Component	Fraction by weight (%)
Organic waste	34.95
Paper	12.33
Plastics	16.20
Glass	7.24
Metals	4.82
Leather, rubber	3.03
Textile	3.17
Wood	10.81
Ceramic, stones	3.56
Other	3.89

WTE facilities are based on RDF and incineration technology. The 490 tons of MSW goes through an RDF production line, consisting of screening, shredding, size reduction, classification, separation, drying, densification, and storage. Hand picking was extensively used as the method of separation rather than the more expensive automated methods mainly because of low labor cost. The approximately 220 tons of RDF can be produced. The RDF's mean