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Exploring suitable utilization of waste tires in Chiang Mai

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Abstract

The study aims at utilizing waste tires in Chiang Mai municipal area. As there are approximately 27,000 waste tires per month, by which each contains up to 37 MJ/kg, there must be a better way than dumping. Therefore, the study explores the feasibilities of utilizing these waste tires by establishing (i) a rubber crumbing factory, (ii) a pyrolysis plant and (iii) a rubber power plant. Here, the site is firstly selected based on available supply, using basic optimization models. Then, the study focuses on the feasibility of demand, engineering, finance and social/ environment response of the three options. Finally, analytic hierarchy process is used to reflect the suitability of the options based on factors of interest. Within the options considered, a pyrolysis plant appears to be the most attractive.

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Keywords: Alternative energy; Analytic hierarchy process; Feasibility study; Site selection; Waste management.

1. Introduction

With a population of 1.6 million, a GPP of 6,137 USD and an area of 20,107 km², Chiang Mai is the second largest city of Thailand. Located 700 km north of Bangkok, Chiang Mai is the center of the northern economies linked other cities and neighboring countries, i.e., Myanmar, Lao PDR and South China [1].

According to Chiang Mai governmental office - self assessment report [1], waste is among Chiang Mai growth undesirable byproduct. Waste disposal, industrial and residential waste management and waste generation are among

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the main concerns in terms of policy and research [2-9]. Here, in this paper, the study focuses on disposal and potential utilization of waste tires.

2. Waste tire utilization alternatives

The study focuses on the feasibility of waste tire utilization in three alternatives, (i) a rubber crumbing factory, (ii) a pyrolysis plant and (iii) a power generation plant.

2.1. Rubber crumbing factory

Rubber crumbing factory can recycle automotive scrap tires. The process uses a granulator or cracker mill to reduce the size of the particles in either room or low temperature. The process is popular in recycling tire as it is simple and environmentally friendly. The crumb rubber can be used in many applications such as playground ground cover, athletic field surface, automotive parts and tires, molded and extruded products, rubber modified asphalt and sealants, rubber and plastic blends, etc. [10-13].

2.2. Pyrolysis plant

Pyrolysis plant performs a thermo-chemical decomposition of tires at elevated temperatures, in the absence of oxygen. The feed is changed to usable oil. It heats whole or shredded tires in a reactor vessel containing an oxygen-free atmosphere. The rubber is then softened and vaporizes and exits from the reactor. The vapor can then be burned directly to produce power or condensed into an oily liquid. The tire pyrolysis process is a clean process with low emissions or waste. However, incomplete combustion can create air pollution [14-18].

2.3. Power generation plant

Tire contains up to 37 MJ/kg. The power plant can use tire rubber in reburning and co-firing processes for the application in power station boilers. In addition to the electrical energy, byproducts can be re-used by other industries. The process is environmentally friendly as it can generate electricity with one-tenth the emissions of traditional coal fired power plants [19-21].

3. Waste tire supply in Chiang Mai

In Chiang Mai, there are more than 1.2 million vehicles registered. By which, more than 120,000 cars are newly registered each year [22]. As vehicles require tires and the life-time of the tire is recommended at 2-2.5 years or 40,000 km (personal use) or 6 month or 60,000 km (commercial use), there are a lot of tires used and disposed. As an approximation, there are more than 10 million tons of waste tires in Chiang Mai area. Majority is used for rubberized cement and landfilling. Some are used for recreational purposes and illegally burnt.

The data collection and survey is conducted to determine waste tire supply in Chiang Mai area. Per review, there are 56 tire shops, grouped into 12 commercial zones, in Chiang Mai municipal area (shown in Fig. 1). On average, there are about 27,000 waste tires disposed each month. The simple geographic information database, i.e., zone area (taken from shop location) and waste tire supply, is designed to determine the suitable location, should these waste tires be collected and processed.

Per data collection, it can be seen that about 50% of waste tires in Chiang Mai is disposed in the southern area, comprising five zones, namely, Mahidol, Nong Hoi, Hangdong, Don Jun and San Kampang. Investment-wise, the land is cheaper and traffic is less dense, in comparison to the central and northern areas. Therefore, the plant location is determined within the southern area. Using LINGO minimal spanning tree optimization, the total distance of link (five zones) is minimized and the suitable location is identified at Nong Hoi. The factory shall cover more than 50% of the inventory within a 10 km radius and 41.6 km single routing.

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