CHAPTER I
INTRODUCTION

Nowadays, the energy demand is increasing around the world. The major energy source of the world is fossil fuels. The importances of fossil fuels come from the fact that they contain high energy density. Moreover, they are convenient to transport, easy to explore (exploration and production) and effective to process. In July 2008, crude oil price increased sharply at its peak to more than \$147 per barrel. Even today, the oil price is about \$110 per barrel but the oil price is expected to continue growing. Fossil fuels are not only expensive, but they are considered non-renewable and non-sustainable energy which is the major cause of global warming. This is due to CO_2 emission from combustion of fossil fuels which is the most abundant greenhouse gas (GHG). As transportation sector is the main causes of CO_2 emission, alternative and renewable energies have become more critical in recent years in terms of energy and environmental issues.

Biofuel is one of the alternative energies produced from biomass which is considered a renewable energy source as the energy it contains comes from the sun, thus making it cleaner fuel source than fossil fuels. At present, there are many kinds of biofuels such as bioalcohol, biodiesel, and biogas. Biofuels can be classified importantly into two generations which are first and second generation biofuels. First generation biofuels are mainly produced from agricultural resources (sugarcane, wheat, corn, beet for bioethanol and palm oil, sunflower oil, rapeseed oil for biodiesel). However, first generation biofuels have led to a competition with food which may result in higher food prices. Therefore, the second generation biofuels have been developed to solve this problem because they utilize lignocellulosic biomass as the feedstocks which mostly come from agricultural wastes such as forest residuals, straws and other agricultural by-products which are non-edible material.

Rice straw is an attractive lignocellulosic biomass for bioethanol production since it is one of the most abundant renewable resources. Thailand produces about 30 million tons of rice per year which ranks 3rd for rice producer in South-East Asia and 6th in the world. Furthermore, Thailand is the world's largest rice exporter which exports around 9 million tons of rice. As every kilogram of grain harvested is accompanied by production of 1-1.5 kg of the straw, this gives an estimation of about 30-45 million tons of rice straw produced per year. A large part (around 42.0 %) of rice straw is used as cattle feed and the rest is still unused (DEDE, 2009). Rice straw has several characteristics that make it a potential feedstock for fuel ethanol production. It has high cellulose and hemicelluloses content that can be readily hydrolyzed into fermentable sugars. Only disadvantage of rice straw for ethanol production are the high content of ash and silica (Binod *et al.*, 2010).

In order to thoroughly evaluate the efficiency of biofuels in terms of energy and environmental aspects, life cycle assessment (LCA) is recommended as an effective tool to assess potential impacts throughout the life cycle of the bioethanol process. This assessment consists of two main stages. The first is a collection of the data which involves making detailed measurements during the manufacturing of the product, from farming of raw materials used in its production and distribution, through to its use, possible reuse or recycling and finally disposal. The second is characterization of the collected data into environmental impact categories and interpretation of the results which can help manufactures analyze their process and improve their products.

This work focuses on bioethanol production from potential lignocellulosic biomass in Thailand. The purposes of this work consist of three main parts. Firstly, to develop the base case design for bioethanol conversion process derived from lignocellulosic biomass in Thailand. In this study, rice straw is used as a raw material. Secondly, to optimize the base case process by energy and waste management to reduce cost of production, reduce waste and minimize energy usage. And finally, to improve the base case process to be more sustainable based on life cycle assessment (LCA) by reducing the environment impacts from the process.