CHAPTER I
INTRODUCTION

As the demand of energy increases continuously, there is the energy crisis while the discovery of new fossil energy resources and the generation of energy from other sources slowly increases. The lack of energy causes fluctuation of oil price. In addition, as environmental awareness of the fossil fuel usage increases, industries and businesses are assessing how their activities affect the environment. Society has become concerned about issues of natural resource depletion and environmental degradation. Especially, the increasing of carbon dioxide in the atmosphere leads to the greenhouse effect and climate changes. Thus, that is why the environmental issues become more mentioned stories of all people and organization around the world and there are a lot of alternative energy research and development at present.

Biofuels have been proposed as an ecologically benign alternative to fossil fuels. The potential environmental benefits that can be obtained from replacing fossil fuels with biofuels derived from renewable biomass sources are the main driving forces for promoting the production and usage of biofuels. The generic biofuels using at this moment such as biodiesel and bioethanol produced from agricultural products called—first generation biofuels. First generation biofuels are made from sugars and vegetable oils which can be easily extracted by using conventional technology. The potential of first generation biofuel production is limited by the problems such as the competition of the raw materials; they cannot produce enough biofuels without threatening food supplies and biodiversity, the environmental impacts taking place in cultivation and biofuel generation procedures. So there are a lot of attempts to investigate new suitable alternative fuels that have high economic and environmental potential in order to use as fuels for sustainable development. The important alternative fuels that the development countries are paying attention to are bio-hydrogen fuel, synthesis biofuels, bioethanol from lignocellulose, etc.

The developed biofuels from the first generation called—second generation biofuels are fuels that can be manufactured from various types of biomass. Second generation biofuels are made from lignocellulosic biomass, woody crops, agricultural residues or waste. Second generation biofuels gain an important advantage which is

the raw materials using for producing are not in the food chain. The challenges of this type of biofuel are to investigate the low cost process and to produce enough quantity of biofuel continuously. Most of the research and development of second generation biofuels in Thailand are only in lab-scale because of the technical and economic problems, the lack of basic information such as the raw materials acquisition, production and the usage.

Biogas produced from wastes is today considered one of the best biofuels available for vehicles from an environmental aspect. Millions of tons of wastes are generated each year from agricultural, municipal, and industrial sources. Agricultural wastes, including livestock manure, are another source of solid waste that can be used as the feedstock to produce biogas. The solid waste can be converted into usable biogas through anaerobic digestion. This can reduce the adverse impact on the environment and can be used on the farm to take care of a part, if not all, of its energy needs (Chen *et al.*, 2010). In addition, biogas can be cleaned and upgraded to biomethane, a gas indistinguishable from conventional natural gas that can be used as a transportation fuel (as compressed biomethane gas – CBG) or sold to utilities by injection into a natural gas pipeline.

Land use change (LUC) occurs as lands are shifted from one use to another, for example, for urbanization or expansion of agriculture. Depending on the location and type of land converted, significant GHG emissions may result. LUC caused by biofuels can occur both directly, as land use is shifted into biofuel crop production, or indirectly through market responses to supply and demand changes of biofuel crops and other related agricultural commodities. Resulting price fluctuations may incentivize these indirect land use changes elsewhere (Broch *et al.*, 2013). There is growing concern about the effects of LUC on biofuel carbon intensity, due to the difficulties in measuring its direct relationship to increased biofuel production and use, its potentially significant impacts, and the uncertainties surrounding modeling practices.

Therefore, the goal of this study is to evaluate the life cycle energy and environmental performance of the utilization of CBG as transportation fuel. The feedstocks used in the biogas production in this study are pig manure liquids and napier grass. All of the processes throughout the product's life are evaluated for

energy and environmental impacts associated with the production and utilization of CBG by life cycle assessment (LCA) technique which is a tool for quantitative assessment of materials, energy flows and environmental impacts of products and technologies. There is a broad agreement in the scientific community that LCA is one of the best methodologies for the evaluation of the environmental burdens associated with biofuel production, by identifying energy and materials used as well as waste and emissions released to the environment. It also allows an identification of opportunities for environmental improvement (Consoli *et al.*, 1993; Lindfors *et al.*, 1995). The results of the study are also compared with conventional fuels such as CNG and gasoline. Finally, suggestions for improvement are offered in order to make the production and utilization of CBG become more environmental friendly.