CHAPTER I

INTRODUCTION

Power, in the forms of lighting, and in mechanical forms for agricultural irrigation, family manufacturing, small industries, etc., is an important input to rural development. Electrical distribution system networks belonging to the Provincial Electrical Authorities (PEA) are the main source of power throughout the country. In spite of that thirty thousand villages out of a total number of fifty-five thousand villages have at present still not been connected to the PEA distribution system. As a result, localized power generation has been found most practical for these remote villages for the time being. Power generating systems utilizing petroleum products as fuels have been found impractical for some villages due to the very low per-capita-income of the villagers. Although oil prices have decreased slightly in early 1986, it is still an uncertain situation in the long term.

In Thailand, there is still a large source of wood from forest lands which is distributed in many parts of the country and it is reported that with forest encroachment continuing at the present rate, there will be enough wood to last 26 years. In the southern part of Thailand where rubber tree wood is readily available, it has been estimated that 60 million kilograms of rubber tree charcoal are produced annually.

In addition, Thailand has been reported to have

produced 19.2 million tons of rice (milled) during the 1983-1984 harvesting season. The rice husk by-product generated from milling operation throughout the 40,000 or so existing rice mills amounted to some 7.72 million tons equivalent to 20.49 million barrels of oil based on bone dry husk. It has been estimated that only 30 percent of such rice husk are being utilized for energy purposes such as direct combustion for the production of steam and mechanical power in rice mills.

As a result, for reasons of savings of foreign currency at the national level and the saving of income at the rural community level, alternative sources of energy which may be suitable for Thailand's rural communities are biomass such as wood, charcoal, rice husk, and other crop residues. One thermo-chemical conversion of biomass which is potentially interesting is the process of "gasification". The carbon monoxide-hydrogen rich producer gas obtained from such a gasification process may be utilized to drive internal combustion engines for shaft power generation or other applications.

Studies on the gasification of biomass and the utilization of producer gas in both gasoline and diesel engines have been undertaken both in a technological point of view (Kaupp & Goss, 1981 ; Arthayukti, 1984 a, b ; Cruz, 1984 ; Stahl, 1984 ; Sagethong, 1984 ; Sitthiphong, 1984 ; Coovattanachai & Sthiarphan, 1984) and in an economic point of view (Foley & Barnard, 1983 ; Arthayukti, 1984 ; Stassen, unpublished data). These studies do not give sufficient details for engineers to make decisions whether gasification systems are suitable or not for a given application in a specific rural community and whether the system may be accepted by the villagers. There needs to be a generalized

technology introduction assesment system available to decision makers to help them make more meaningful judgement and decisions regarding introduction of technologies into rural communities.

The Rural Community Development Model (RCDM) was developed to simulate the economic results of a decision process for the development of rural communities with emphasis on rural energy development, taking into account the income, economic conditions, and occupations of people in typical Thai rural communities as well as the local resources. The income of the community is maximized in such a way that resources, labor, and technologies are used in an appropriate manner.

The objective of this study is to modify the RCDM to enable it to analyze gasification systems introduction to a rural community using local biomass as fuel with emphasis on increasing community income.

A simplified RCDM system is divided into the following components : end products/services goal, intermediate products/services, energy conversion, rural intermediate energy, internal and external resources.

A FINERG software is used in the RCDM and the model structure is composed of

1. Energy Flow Network

The Reference Energy System (RES) integrates a set of estimated energy demands, energy conversion technologies, fuel allocations and energy resources into an overall energy supply/demand balance.

RES is represented by a network through which energy flows from the supply node through the network links, to the demand nodes.

2. The Energy Sector Data Base

It contains a massive amount of both historical and projected data relating to subsystems and the specific activities represented within them. The parameters defined in it are classified into technological data, cost data, equipment data, environmental and social data.

3. The Simulation Model

For a given structure, SIMUL computes the energy and material flows through the network, from the final demands up to the primary resources. Subsequently, it calculates the associated cost flows from the primary resources down to the final demand. It also computes the amount of ancillaries required and the amount of by-products yielded by each process and sum up homologous ancillaries and by-products.

4. The Optimization Model

It is designed to evaluate systematically each of the possible alternatives and find the "most desirable" one according to the criterion selected for optimization, given a full set of data describing the various options open for the develoment of the energy sector, and their costs, yields and efficiencies, as well as any external constraints affecting their development. It enables estimate of the impact of changes on various components of the energy

impact of changes on various components of the energy development plan. Based on cost minimization of energy supply, conversion and use, it takes into account the technological, economical, political and environmental constraints as well as the whole set of possible fuel substitutions and capacity developments.

The model contains 3 programs of linear programming input matrix generator (ORESTE), standard linear programming software (MPSX), and report generator (ORACLE).

In general, RCDM would classify the community structure and activities into subsystems such as land, household, agriculture, animal, small industry, biogas/ fertilizer, energy supply and demand, forest, irrigation, transportation, and development subsystem.

For this study, the author chose Nongwang, a rural community in Sawang Daengdin District , Sakhon Nakhon Province, as a case study for gasification technology system introduction. Nongwang has about 1,500 people living in the area, or an average of 6 persons per household. The total area of Nongwang is about 9,000 Rai. Simulation of gasification systems introduction into Nongwang would be for a number of activities : electricity generation which would substitute mostly kerosene for lighting , operation of diesel engine-water pumps for irrigation to increase crops yield , shaft power production to be used in the only existing rice mill to reduce use of petroleum fuel.

Various gasification technology systems operated with diesel or gasoline engines in different capacities and diferent biomass resources (charcoal, wood, rice husk) will be introcuced and compared to conventional gasoline or

diesel systems.

RCDM will first be used as a tool to choose the system most economically acceptable to the villagers. This excercise will tell us how much investment and variable costs the remaining systems should be decreased by in order to be compatible with the one selected. Secondly for testing the influence of variations in baseline assumptions, a sensitivity analysis of biomass prices, diesel and gasoline prices will be performed. The model will indicate the optimum operating hours for economic operation of gasifier systems and also arrange some activities to maximize income of the Community. Finally, the model will tell us the total income of Nongwang and other impacts on the activities of the whole Community when the selected gasification systems have been introduced for specific applications.

All the results obtained from the analysis of the introduction of gasification systems to Nongwang using the RCDM should be used to list a general set of guidelines for gasification engineers and decision makers prior to the introduction of such systems to other local communities. Such an approach could then allow adjustments of some factors to be made for economic operation of such systems and for acceptability of the system by the villagers. In any other cases of energy technologies introduction in rural communities, RCDM may also be used as a generalized tool to test effects of various factors and to analyze parameter sensitivities in the same manner as the simulation of gasification system introduction which is based on the criteria of maximizing community income.