EFFECTIVENESS OF SMALL BIOMASS POWER PLANTS IN THAILAND: FROM RESOURCE-BASED VIEW AND RESOURCE DEPENDENCE THEORY

Kwunjai Chotsuwan

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Kwunjai Chotsuwan
School of Public Administration

Associate Professor...Major Advisor
(Tippawan Lorsuwanrat, Ph.D.)

Instructor...Co-Advisor
(Sawat Wanarat, Ph.D.)

The Examining Committee Approved This Dissertation Submitted in Partial Fulfillment of the Requirements for the Degree of Doctor of Public Administration.

Associate Professor...Committee Chairperson
(Vichit Lorsherashunkul, Ph.D.)

Associate Professor...Committee
(Tippawan Lorsuwanrat, Ph.D.)

Instructor ....Committee
(Sawat Wanarat, Ph.D.)

Assistant Professor...Dean
(Pairote Pathranarakul, Ph.D.)

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ABSTRACT

Title of Dissertation	Effectiveness of Small Biomass Power Plants in Thailand: From Resource-Based View and Resource Dependence Theory
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This research explores the important factors affecting the effectiveness and the effectiveness of small biomass power plants all over Thailand. The objectives of the study include 1) to study and establish a model of the relationship between the factors that influence the effectiveness and the effectiveness of small biomass power plants. 2) to test and analyze the relationships between key factors affecting the effectiveness and effectiveness of small biomass power plants. This study uses the Mixed Method with Qualitative and Quantitative Method by the Sequential Mixed Method Designed as the Exploratory Design. This method is well known as The Sequential Exploratory Mixed Method. The qualitative research data, collected by in-depth interviews of experts of small biomass power plants from both government and private sectors as well as focus groups with the community surrounding the plants and field studies. The qualitative research results of the important factors affecting the effectiveness of small biomass power plants consist of Biomass fuels, Technology of producing the electricity, the knowledge, skills, and abilities of employees, The government subsidy, Location of power plant, The community acceptance, The initial project design, The management of biomass power plant, Biomass fuel management, The dependence on the biomass fuel from outside, Regulations and laws, The organizational culture, The executive vision, The potential of the grid lines, The accessory of connecting the electricity, The distance of biomass sources, Knowledge development, The supply chain management, The purchase agreement, The local politics and crude oil prices.

. The effectiveness of small biomass power plant are 1) The financial effectiveness 2) The environmental effectiveness and 3) The community effectiveness. The research uses all important issues from qualitative research to design the instrument of the quantitative research. The questionnaires are the instruments for collecting the data from the small biomass power plants all over Thailand, totaling 343 power plants. 211 (61.51%) returned completed questionnaires. The researcher analyzed the data by using the Exploratory Factor Analysis to classify all variables from a large number of variables resulting from qualitative research to group and to create new variables applicable to the conceptual frameworks and hypotheses of the quantitative research. The results of Exploratory Factor Analysis are the 8 factors of the important factors affecting the effectiveness of small biomass power plants as the following 1) The power network and the transmission lines 2) The skills and capabilities of employees 3) Regulations and laws 4) The community acceptance 5) The dependence on the biomass fuel resources 6) The values of working 7) The location of the power plants 8) The supply chain management. The effectiveness of small biomass power plants are 1) The financial effectiveness 2) The environmental effectiveness and 3) The community effectiveness. The researcher used all 11 latent variables to create the model of the relationship between the factors that influence the effectiveness and effectiveness of small biomass power plants and analyze the model with the Structured Equation Model Statistical method. The statistical results found that the model of the relationship between the factors that influence the effectiveness and effectiveness of small biomass power plants is a very good fit. The results of the hypothesis testing are that the power network and the transmission lines, the skills and capabilities of employees, the dependence of the biomass fuel resources and the supply chain management are positively correlated with the financial effectiveness of small biomass power plants. The regulations and laws, the dependence of the biomass fuel resources, the location of the power plants and the supply chain management are likely to positively correlate with the environmental effectiveness of small biomass power plants. The community acceptance, the dependence of the biomass fuel resources, the values of work, and the supply chain management are likely to positively correlate with the community effectiveness of small biomass power plants.

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ABBREVIATION AND SYMBOLS

Abbreviations	Equivalence
N	indictors variable number of the latent variable
δ_i	Standard Variation indicator variable
P –Value	Level of statistical significant In case the variable has significant level used ***
Composite Reliability : CR	The confidential level of the variables
Average Variance Extracted : AVE	The test value of the square root of standard variation is more than the relation of each variables
Average Shared Square Variance : AVS	The average of co variance of the variables
Maximum Shared Square Variance : MSV	The square of the maximum of co variance of the variables
Factor loading	The relation value of the variables
$\bar{x}$	Average
***	Level of significant at 0.05
AGFI	Adjust Goodness of Fit Index
CFI	Comparative Fit Index
CMIN/DF	Chi-square Statistic Comparing the Tested Model and the Independent Model with the Saturated Mode
GFI	Goodness of Fit Index
IFI	Incremental fit index
NFI	Normal Fit Index
RFI	Relative fit index

RMSEA	Root Mean Square Error of Approximation
RMSR	Root Mean Square Residual
S.D	Standard Variation
TLI	Lewis Index

CHAPTER 1

INTRODUCTION

1.1 The Industry Problems, and the Significance of the Study

Electricity is fundamental to all aspects of national development and is essential to all sectors, both public and private. The government has attempted to allocate power to the people in both areas as much as possible in order for people to use at their facilities. The electricity used in the production of both agricultural and industrial sectors shows that energy is essential for national development at all levels. Therefore, electricity must be planned and implemented in accordance with the increase in the demand for electricity by the expansion of the population and the economy.

Statistics from the Department of Alternative Energy Development and Efficiency, 2016, the final stage of power demand in the country, the demand of coal (8,655 thousand tons), petroleum products and raw petroleum (49,741 million liters), and electricity (190,504 million kilowatt hours). However, with limited domestic energy resources, governments will need to import fuel and electricity from abroad for many years to come. (Department of Alternative Energy Development and Efficiency, 2016a) From the statistics of The Imports of Electrical and Fuel Energy Survey by the Department of Energy (2017), the imports volume in 2016, imported 21,775 thousand tons of coal, 3,494 million liters of petroleum products and petroleum, and 19,825 million kilowatt hours of electricity. (Energy Policy and Planning Policy and Planning, 2017a) The amount of fuel and electricity imported shows that the country lost huge sums of foreign currency. The huge value of fuel and energy imports every year have enormous impacts on the economy and the stability of the nation’s fuel supply. The government needs to supply renewable sources to lessen this financial burden. A very practical and sustainable approach to solving the energy sector’s problems is to support the production of electricity from biomass. Common agricultural residues such as corncobs, residues from sugar cane bagasse, rice husks, rice straw and wood chips that grow very quickly and can easily be used as fuel to generate electricity. The Department of Alternative Energy Development and Efficiency, Ministry of Energy, have an action plan to develop renewable and alternative energy construction by 25% in 10 years (2012-2021). They are promoting and supporting small power plants as sources of renewable energy in the country. Therefore, there is a need to adjust incentives for private investment to match the council's situation of a 25% increase. The measures of development are as follows: To support the additional power units (adder) schedule for power units in the Feed-in Tariff: FiT and Renewable Heat Incentive, modifying laws and regulations that are favorable for the development of renewable energy. Accelerate the improvement and expansion of infrastructures such as transmission lines and distribution lines for electricity assigned to the electricity production and the expansion of the regional electricity grid. Electrical distribution lines need to be supportive of the development of small power plants. (Department of Alternative Energy Development and Efficiency, 2015a)

Small biomass power plants are an important source to produce electricity as they can use biomass fuel for recycling and adding value to common waste. Although, the government's new policies do promote and develop the production of electricity from biomass in many aspects such as The National Economic and Social Plan and The Energy Department's Energy Plan does comply with the policy to support and promote small biomass power plants in Thailand, the operation of biomass power plants today still suffers from several problems. The Department of Alternative Energy Development and Efficiency (2015b) claimed the problems of biomass power plants in Thailand as the following:

1) The problem of increasing prices of biomass fuel. The creation of biomass fuel is the idea of salvaging agricultural waste as fuel, which adds value to the farmers’ products. When the price of biomass fuel increases that affects the cost of production of energy. When the biomass fuel prices rise too high, the investment is not competitive to fossil fuel power plants.

2) The problem of shortage of biomass fuel. Because of the increasing numbers of biomass power plants, many industries have switched from traditional

fossil fuels to biomass fuel but the amount of biomass fuel is not increasing as fast as necessary. This is due to the limitation of farmlands, farmer’s activities and their cultivation methods, as well as natural disaster issues.

3) The problem of people opposed to biomass power plants within the community surrounding the power plant. The reasons for people being against the biomass industry are a lack of positive public relations, the shortage of knowledge or awareness, the ambiguity of the information about biomass power plants from the developers to the community.

4) The problems of the technology. The lack of operational experience and technology. The main problem stemming from the complicated operational systems are, the requirement of specialists with good techniques, problem-solving skills and experience working with biomass systems to continue the energy production at the biomass power plant. Currently, operational management teams face a shortage of skilled, knowledgeable, and experienced technicians to continue operation.

5) The problems of the management of biomass power plant. The production of biomass energy is faced with problems such as legal procedures and regulations, the electrical connections to the grid for distribution, incentives on the current purchase price. There are difficulties finding operators of the machines, equipment, and systems for energy production because of a limited number of skilled professionals in the country. The potential of biomass sources because of limits to the power grid and the problem of the project as a financial investment.

6) The problems of the biomass investment projects. The investment in biomass power projects has a longer payback period than other types of plants. Thus, the promotion of the production of biomass energy development plan is aimed at promoting renewable energy power plants in the next 10 years at the community level. The investments need to be partnerships due to the high capital necessary to start a biomass power plant.

Understanding the numerous problems stated, the researcher found the study of the factors affecting the effectiveness of the operations of biomass power plants and the effectiveness of the power plants to be an important study. The results of the study are useful to strengthen the power security of the country and self-sustainability, supporting the government’s renewable policy and so on.

1.2 The Objectives of the Study

The objectives of the study are the following

1) To study and establish a model of the relationship between the factors that influence the effectiveness and general effectiveness of small biomass power plants.

2) To test and analyze the relationships between key factors affecting the effectiveness and general effectiveness of small biomass power plants.

1.3 The Scope of the Study

The scope of the effectiveness of the small power plants are as follows:

1.3.1 Scope of Content

1) On the study of qualitative research, the researcher uses in-depth interviews to identify key factors that influence the effectiveness of biomass power plants and the effectiveness of biomass power plants from the perspective, experience and opinions of the professionals of biomass power plants of the public and private sector.

2) On the study of quantitative research, the researcher creates the variables of effectiveness of a small biomass power plant by studying the effectiveness of the operation of small-scale biomass power plants in three aspects: financial, environmental and community-based, from the conceptual model of effectiveness. Moreover, creates the variables of key factors that influence the effectiveness of biomass power plants, the external factors from the resource dependency theory and the internal factors from the resource-based view. Integrating the supply chain management and resource dependency theory into the resource-based view.

1.3.2 Scope of Study Area

1) On the study of qualitative research, the researcher specifies the samplings by technology used in power generation and capacity of production across Thailand.

2) On the study of quantitative research, the researcher sets the samples to cover a total of 343 power plants all of which are small biomass power plants licensed for a capacity to produce 10 megawatts of electricity.

1.4 Contributions of the Study

The contributions of this research are at the theoretical and practical level.

1) The findings are beneficial to biomass power plants and other types of businesses to guide the development of the organization to manage the performance more effectively. For the purpose of the study, establish, test and analyze a model of the relationship between the factors that influence the effectiveness and effectiveness of small biomass power plants. The study results indicate which factors affect the effectiveness of small biomass power plants, what the relation between each factors is the final effectiveness of small biomass power plants. The results benefit other small power plants and other related businesses, which can use, apply or implement the study results with their own business as to improve the administration of the business, to develop the working processes and so on. When the small biomass power plants are growing, they can then fuel the economic circle for strengthening both the economic and electrical power in Thailand.

2) The findings are useful to government policies regarding the production of electricity from biomass. The study results are collections of primary data from the professionals of biomass power plants consisting of public and private sectors. The government can use the results to both factor the influence of effectiveness and general effectiveness of small biomass power plants as well as to develop the small biomass power plants problem solving skills related to the biomass fuel for small biomass power plants. These results can also bring together the key elements of biomass fuels to promote the cultivation of energy crops. Lastly, these results are key in promoting crop rotation that can be used to recycle biomass as a fuel for biomass power plants, along with the development of biomass power plants, in order to prevent future biomass fuel shortages.

3) Research results are beneficial to the economy and society. A study of the factors influencing the effectiveness and general effectiveness of small biomass

power plants in Thailand. The results can be useful for small biomass power plants, the continuing business with small biomass power plants, and other businesses as well. The results can be used to develop the strengths in the production of electricity from biomass and strengthen the security of national income and the energy strength.

4) Theoretical Contributions, The purpose of the study are to create the variables of effectiveness of a small biomass power plant by studying the variables of key factors that influence the effectiveness of biomass power plants, the external factors from the resource dependency theory and the internal factors from the resource-based view. The supply chain management integrated with the resource dependency theory and the resource-based view. The study covers all resources both external and internal. Moreover, the effectiveness of the operation of small-scale biomass power plants in three aspects: financial, environmental and community-based, from the conceptual model of effectiveness. There are 3 types of effectiveness covered.

1.5 Terms and Definitions

To facilitate a better understanding of this study, some of the terms used are defined as follows:

Small biomass power plant means power plants which produce electricity from biomass fuel. For example, the thermo, gasification and fermentation power plants, such as the sugar mill, which uses sugar cane as fuel. The rice mill, which uses rice husks as fuel. The palm mill, which uses the residues of palms as fuel. The cassava mill, which uses cassava residues and waste water as fuel. Finally, the independent biomass power plants with a license to produce 10 megawatts of electricity.

Biomass means Compounds of organic matter that act as reservoirs of natural energy which can be converted into energy. Such compounds are agricultural wastes, such as rice husks, bagasse, wood pulp, palm fiber, cassava, cornhusks, coconut shells, yeast, etc. (The Department of alternative Energy Development and Efficiency, 2008).

Watt means a unit of measurement of electrical power and Kilowatt-hours (kWh) means the power unit is equal to 1,000 watts per hour.

Effective means implementing the goals of an organization. The use of company resources efficiently to produce maximum benefits to the organization's stakeholders. The three indicators measured to calculate effectiveness in this research are the successful implementation of a biomass power plant including the financing, environmental and community impacts.

Community means a group of people living around a small biomass power plant.

Environment means the physical environment around a small biomass power plant.

1.6 Organization of the Study

This study of the effectiveness of Small biomass power plants in Thailand is organized into 7 Chapters as follows:

Chapter 1: Introduces the topic and the significance, the objectives, the scope of the Study, the Contributions of the study, and the definitions of terms and the organization of the study.

Chapter 2: Provides details about the background of the biomass power plants in Thailand, The Renewable Energy Government policy as The national Economic and Social Development Plan 1-12, Renewable Power Plan, Law and regulations related, The Government Subsidy Policy Supporting Biomass Power Plants, The Electricity System in Thailand, The Electricity Distribution in Thailand, The Purchase Agreement, Biomass power plant operation situation in Thailand, The community acceptance, The result of the biomass power plant operations, and finally the chapter summary.

Chapter 3: The Literature Review consists of The Resource Dependence Theory, The Resource Based-View, Organization Effectiveness, The integration between The Resource Dependence Theory, The Resource Based-View, Research related and chapter summary.

Chapter 4: The Research methodology, The design of qualitative research, The qualitative and quantitative methodology, the population and the samplings of the study, the instruments of the research study, the tests of the instruments, data collection procedures, the methods of the data analysis and chapter summary.

Chapter 5: Qualitative research and concept development, qualitative research results, the concept development of conceptual frameworks, research hypotheses and chapter summary.

Chapter 6: The results of the Quantitative Method, The Mixed Method results and chapter summary.

Chapter 7: The final chapter, contains the conclusion and a discussion of the results, suggestion of the study, the limitation of the study and chapter summary.

CHAPTER 2

SMALL BIOMASS POWER PLANTS IN THAILAND

The small power plants in Thailand consist of policies, plans, and laws related to biomass-based power plants, Key components in operating a small biomass power plant, Acceptance of community biomass power plant operation, Results from the operation of small biomass power plants, and chapter summary.

2.1 Government Policies, Plans, Regulations, and Laws Relating to the Production of Electricity from Biomass.

The renewable energy government policy for biomass power plants is divided into 3 parts: 1) The National Economic and Social Development Plan 1-12 2) Renewable power plan of the ministry of energy, and 3) The government subsidy policy for biomass power plants.

2.1.1 The National Economic and Social Development Plan

2.1.1.1 The National Economic and Social Development Plan 1 (1961-1966)

The principle of The National Economic and Social Development Plan 1 focused on the development of infrastructure: for example, roads, water systems, electric utilities, for developing the economy in the country. NESD1 accelerates the development of the resources that affect the economy including agriculture and industry in order to support the transition to becoming a more developed country.

There are many important aspects of energy-related topics in NESD1, for example, the development of the power system, infrastructure, sources of electric power, coal power, lignite power plants, Nam Phong and fountain projects, transmission and grid electricity lines, the improvement of the distribution of electricity to promote the use of electricity in industry and utilities, the establishment of private small power plants in different districts, and increasing the capacity of electricity production to meet the electricity demand in the country.

2.1.1.2 The National Economic and Social Development Plan 2 (1967-1971)

The principle of The National Economic and Social Development Plan 2 focused on the development of society in parallel with economic development, the development of infrastructure in the country, the development of agriculture and industry, the development of rural areas to the distribution of income and the stability of revenue distribution as well as a development of manpower.

The most important energy-related topics within NESD2 are, the development of the electrical supply system of the Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA), the production systems for generating electricity from dams by developing The Ubolrat Dam, the electricity production from hydropower, the electricity production technical team, the survey measurements of the electrical safety system, and the transmission and distribution of the electricity system.

2.1.1.3 The National Economic and Social Development Plan 3 (1972-1976)

The principle of The National Economic and Social Development Plan 3 focused on restructuring the economy in the country in order to increase its productivity and national incomes, to expand the industrial and manufacturing sectors, to promote the private sectors, to encourage government subsidies for further investment from the private sectors, and lastly, to accelerate the development of the country by emphasizing family planning.

The most notable energy related topics in NESD 3 are the planning for economic and social development by forecasting and constructing energy generation to meet the demand of the country, the production of hydropower plants, the restructuring of the transmission system in 51 provinces, to expand the distribution system to more districts and outside of previously unconnected remote districts, the establishment of industrial estates, the establishment of the rate of electricity units sold in the metropolitan areas and around the country, the promotion of research surveys on electricity sources, and the development of research in the field of natural energy and renewable as an energy source being produced in the country.

2.1.1.4 The National Economic and Social Development Plan 4 (1977-1981)

The principle of The National Economic and Social Development Plan 4 focused on restoring the country's economy, the acceleration of the development of society to coincide with its economic development, to further reduce and bridge the gap between the social and economic development, the improvement of the quality of life, the increasing number of employed persons in the country, the improvement of the state enterprise's performance, the integration of resource management to achieve proper energy security in the country.

There are many important energy-related topics in NESD 4, for example, the problem-solving and energy solutions issues, the solution to power shortages in the country, the development of energy and fuel sources to produce electricity, the setting-up of manufacturing as a supplier of electricity to the PEA, and the development of water resources to produce electricity.

2.1.1.5 The National Economic and Social Development Plan 5 (1982-1986)

The principle of The National Economic and Social Development Plan 5 focused on improving methods of solving problems and finding solutions to the economic and financial stability in the country, to accelerate the improvement of the administration within the government sectors to comply with the development of the national economy and society, to accelerate the development and degradation of resources, water resources, aquatic life resources, and degradation of the environment and land in Bangkok.

The important energy-related topics listed in NESD 5 are: the solutions to the national energy shortage, the solutions of taxation issues that affected the energy sectors, the solutions to the high fuel costs of producing electricity, the development of electricity resources in rural areas, the adaptation of energy pricing, the development of new and existing energy sources, the investment in power of both public and private sectors, future planning development of energy resources, the development of the energy and the development of renewable energy.

2.1.1.6 The National Economic and Social Development Plan 6 (1987-1991)

The principle of The National Economic and Social Development Plan 6 focused on the improvement of solving problems and finding the solution to the social and economic cumulative problems from plans 1-5, the acceleration of the optimization of human resources, science and technology development, the acceleration of the development of production, marketing, distribution, and the production of distributing income and personal prosperity to the regions and country overall.

NESD 6 mainly focused on: the energy restructuring, the promotion of using energy efficiently, the improvement of electricity resources in rural areas, the promotion of private investment in electrical power to reduce the government's burden, the development of the domestic energy exploration, the exploration of coal and lignite fuel for electricity, the development of water resources for power generation, the development of biomass fuel for producing electricity in rural areas, and providing a forecasting system to evaluate the electricity demand in the country to achieve appropriate and more accurate production.

2.1.1.7 The National Economic and Social Development Plan 7 (1992-1996)

The principle of The National Economic and Social Development Plan 7 focused on sustainability development, the development of economic growth, the development of human resources, the development of the 'quality of life', the development of the environment, the improvement of the law, the improvement of the bureaucratic system, the development of state enterprises, the improvement of the environmental degradation.

There are many important energy-related concerns in NESD 7, for example, the speed and rate of energy production and electricity to meet domestic demand, the exploration of energy resources back-up, the development of fuel resources to generate electricity, the encouragement of private sectors to participate in the power-sharing government plan to reduce the burden of the state, the negotiation with neighboring countries to explore energy sources, the support of research projects to develop renewable energy systems, the encouragement of the private sector to invest in small power plants, the adaptation of the government regulations, the development of the purchase of electricity from small power producers, the support of the community to grow the energy crops and the devolvement of laws and regulations to promote the use of efficient and economical energy consumption.

2.1.1.8 The National Economic and Social Development Plan 8 (1997-2001)

The principle of The National Economic and Social Development Plan 8 focused on the development of economic activity, the increase in the national income and the real income, the increase in the standard of living, the distribution of the national income level, the development of the social environment to be strengthened, the adjustment of the management system to allow the private sector and communities to participate in government activities, and the development of geologic resources to use mineral resources for electricity production.

2.1.1.9 The National Economic and Social Development Plan 9 (2002-2006)

The principle of The National Economic and Social Development Plan 9 focused on the sufficiency economy of King Rama 9's philosophy to build a foundation of sustainable development in the country, the use of the middle way to administrate the balance of both economic and social interests, and the promotion of the governance administration to build sustainability in the country.

2.1.1.10 The National Economic and Social Development Plan 10 (2007-2011)

The principle of The National Economic and Social Development Plan 10 focused on the building of knowledge and morality within families, the empowerment of community networks to be the foundation of economic development and quality of life, the creation of a competition and investment system, the strengthening of the abundance of resources in the country, and the promotion of a good governance administration in the country.

2.1.1.11 The National Economic and Social Development Plan 11 (2012-2016)

The principle of The National Economic and Social Development Plan 11 focused on the creation of a fair and peaceful society, the development a successful economy, the development of a growing economy for sustainable growth, the development of natural and environmental resources management. There are many important contents of energy-related topics in NESD 11, for example, the development and promotion of the use of energy from biomass instead of fossil fuels, the adoption of agricultural and industrial residues to produce electricity, the promotion of electricity production within the community, the development of technology for producing renewable energy, the promotion of biomass fuel to produce electricity, the improvement of renewable energy development to the community, the restructuring of the energy form, increased awareness of bioenergy's efficiency. (Office of The National Economic and Social Development Board, 2016)

2.1.1.12 The National Economic and Social Development Plan 12 (2017-2021)

The principle of The National Economic and Social Development Plan 12 focused on the nation’s strategies for strengthening sustainability, the increase of the potential economic benefits by reforming the price of fuel types to be more appropriate with costs and accompany a reasonable tax burden, the encouragement of the consumers awareness to be cautious with their use of dissipated energy, the support of power plants within both public and private sectors, the replacement of using fossil fuels with fair, transparent, environmentally friendly fuels, and the cooperation between neighboring countries to develop energy sources. (Office of The National Economic and Social Development Board, 2017)

2.1.2 Renewable Energy Development Plan of the Ministry of Energy

2.1.2.1 15 Year Renewable Energy Development Plan from 2008-2022

The Renewable Energy Development Plan focuses on the production, the usage, and the encouragement of public awareness of biomass renewable energy. REDP has guidelines for biomass renewable energy production as the following, the creation of a positive condition of investing in biomass projects, risk reduction of biomass investment projects to achieve the goal of using biomass, to promote a multi-sector coordination center, the development of a prototype project research center, an extension of original, outdated technology, the improvement of the efficiency of technology to improve environmental cleanliness, the adaptation of biomass investment projects, the support of finance plans for developing renewable projects, the encouragement of Thai people and public sectors to understand the circumstances and benefits of using biomass.

There are many important contents of energy-related topics in REDP, for example, the promotion of fast-growing trees as biomass fuel for electricity production, the development of small technology for generating electricity, the development of the knowledge for the production of electricity from biomass, and the promotion of finance and investment in the production of biomass electricity production. (Ministry of Energy, 2015a)

2.1.2.2 Energy Efficiency Plan; EEP 2015 (2015-2036)

Energy Efficiency Plan: EEP uses strategic forces with regulations and financial incentives, provisions of technical assistance of renewable energy, the awareness of changes to energy consumers behavior, the changes within the energy market transformation, the promotion of the campaign of energy conservation, environmental protection, the reduction of greenhouse effects, the promotion of energy conservation measures, the distribution of energy conservation activities within both government and private sectors, the establishment of the professional consultation team for consulting and implementing energy conservation techniques, the development of technology reliance to reduce costs and create efficient technology, and the strengthening of efficient energy within business units. (Ministry of Energy, 2015b)

2.1.2.3 Alternative Energy Development Plan; AEDP 2012 (2012-2021)

Alternative Energy Development Plan: AEDP 2012 focuses on the development of renewable and alternative energy as the following, 1) The encouragement of community members to get involved in renewable energy production, small power plants setting to be the community power stations majority, the community encouragement to be part of the investment program, the social enterprise setting to manage and administrate community power stations, the promotion of farmers in communities to plant fast growing trees to supply fuel to local power plants. 2) The incentive adjustment of private sectors power plant investment in appropriate ways, the adaptation of electricity unit sales incentives, for example, the adders, Feed in Tariff: FiT, and renewable heat incentive scheme as special support to community power stations. 3) The amendment of acts, rules, and regulations to develop the renewable energy sector, infrastructure improvement, electricity grid development, power distribution lines expansion, the regional electricity grid, the electrical distribution lines to support the development of biomass power plants, and the area of farmland available for biomass fuel as an energy source. 4) Public awareness and education promotion, the development process of establishing biomass power plants, the campaign of children and young people's education for the preparation of biomass for energy production, the promotion of biomass electricity generation establishment. 5) The production of electricity from biomass research projects and renewable energy solutions development. 6) The biomass manufacturing processes development for biomass as a fuel to produce electricity in the future. 7) The gasification and gas engine technology development in order to produce liquid fuels from biomass. (Ministry of Energy, 2015c)

2.1.2.4 The Energy Strategy 2014 (2014-2018)

The Energy Strategy 2014 includes the essential topics as follows: 1) to provide a sufficient supply of power to meet economic growth and enhance the quality of citizens' lives, push energy projects especially the renewal and alternation plan and the supply power plan respectively, participation from the private sectors to be part of the sustainable development project, and distribute knowledge of energy development projects. 2) to stabilize and enhance the value added to energy, accelerate the development and diversification of sources and the type of fuel used to produce electricity, improve regulations and measures to improve standards of fuel used to generate electricity. 3) to incorporate the energy sectors and energy prices, drive and support the safety environment of enterprises in manufacturing power generation, restructuring the price form to reflect the actual cost of electricity production. 4) to develop the sustainable energy market while creating a friendly environment, accelerating research projects and technology innovation in energy conservation, increase the efficiency of electricity production in the industry sectors such as the potential manufacturing electricity power plants in sugar mills, oil palm, and cassava, drive and amend the related laws and regulations that hinder the development of renewable energy, increase the amount of participation from private sectors and people in the energy field, as well as develop the knowledge of renewable energy. (Ministry of Energy, 2015d)

2.1.2.5 Power Development Plan: PDP 2015-2036

Energy Policy and Planning Policy and Planning. (2015a) defines the Power Development Plan: PDP 2015 as a master plan for the country of electrical power supply in 15-20 years to set up the long-term stability and adequacy of electricity capacity. The Power Development Plan details concerns of all the factors of economic, social and environmental, such as economic growth, the distribution of fuel to produce electricity, the electricity reserves, increases in the energy efficiency, the power back-up resources, and the renewable policy and so on.

Power Development Plan: PDP 2015-2036 focused on energy security and the following: The government must provide enough electricity to power demand. Increase the variety of fuel to produce electricity in order to reduce the risk of shortage. Reduce the use of energy from natural gas, promote the proportion of electricity generated from coal with clean technologies, limiting energy imports and electricity from abroad not to exceed 20 percent of total capacity within the system, promoting renewable energy electricity production, promoting the development of renewable energy to its full potential in each area, supporting electricity generation from waste, biomass and biogas, solar, wind and so on, accelerate the expansion of transmission and distribution systems to support renewable energy generation, develop the power grid and the transmission system, grid to grid, and the development of the electricity grid lines and Smart-Grid, realize the actual cost of electricity, use electricity more efficiently, reduce the environmental impact from electricity generation, abolish subsidies for energy prices to be based on market mechanisms, and promote the peoples' awareness on energy facts in order for the citizens to be more conscious electricity consumers.

2.1.3 The Government Subsidy Policy of Producing the Electricity from Biomass

2.1.3.1 Definition of Subsidy

A public subsidy is defined as a transfer payment; a payment other than one made in consideration of services rendered or factors or goods supplied at the order of a drawee, to a firm, factory owner, or household that is conditioned on some actions by the recipient and is designed to induce a change in relative price as market price, price to seller or to buyer of a good, service, or a factor, or a group of goods or service factors. The subsidy is distinguished from a 7welfare payment which is not conditioned on the desired action by the recipient household, firm, or owner of a factor of production. A subsidy may be provided in different ways, as cash, tax subsidy, credit subsidy, lump sum, or subsidy depending on its financial supportive form. The subsidy is provided to producers or to customers depending on the policy objective. (Kang, 1987)

Shim (2006) said a subsidy can be any government action that keeps the price of a commodity below or above what the market level would normally determine. The World Trade Organization (WTO) narrowly defines a subsidy as a financial contribution by a government or any public body within a territory of a member which confers a benefit because that organization is focusing on trade rather than on the environmental aspect. The OECD study defined a subsidy in general terms as any measure that keeps prices for consumers below market levels, or for products above market levels, or that reduces costs for consumers and producers (Organization for Economic Co-Operation and Development, 2010).

2.1.3.2 The form of Subsidy

A subsidy can include some government activities which involve insurance or reduce the risk of doing business as the following; On-budget subsidies with 1) Budgetary subsidies is direct subsidies to consumers or producers, such as, grants, deficiency payments, sales premiums. 2) Tax subsidies which are supported through tax policies, such as, tax credits, tax exemptions, e.g. accelerated depreciation allowance. 3) Public provision below cost is Provision of infrastructure and complementary services below long-run marginal cost, Research and development expenditures 4) Capital subsidies as preferential loans, debt write-off, and liability guarantees. Off-budget subsidy with 1) Capital cost subsidies as Liability guarantees, low rate of return requirements. 2) Support to other factor inputs as Royalty concessions. 3) Subsidies through the market mechanism being domestic-oriented, such as, price regulation, quantity controls, market access restrictions, procurements policies. 4) Departure from the principle of causation is exemptions from environmental standards, liability limits, allowing insufficient provision for future liabilities. (Beers & Moore, 2001). The details of subsidy form shown in Table 2.1.

Table 2.1 The Subsidy Type

Subsidy	Subsidy Type	Examples
Narrow	**On-budget subsidy**	
	Budgetary subsidies	Direct subsidies to consumers or producers, e.g. grants, deficiency payments, sales premiums
	Tax subsidies	Support through tax policies, e.g. tax credits, tax exemptions, e.g. accelerated depreciation allowance.
	Public provision below cost	Provision of infrastructure and complementary services below long-run marginal cost, Research and development expenditures
	Capital subsidies	Preferential loans, debt write-off, liability guarantees
	Off-budget subsidy	
	Capital cost subsidies	Liability guarantees, low rate of return requirements
	Support to other factor inputs	Royalty concessions
	Subsidies through the market mechanism	Domestic-oriented, e.g. price regulation, quantity controls, market access restrictions, procurements policies (e.g. government brokered sales contracts) Trade-oriented, e.g. import and export tariffs, nontariff barriers (e.g. quantitative import controls)
Broad		
	Departure from the principle of causation ("polluter-pays principle")	Exemptions from environmental standards, liability limits, allowing insufficient provision for future liabilities.

Source: Beers and Moor, 2001.

2.1.3.3 The Additional Costs Added to the Electricity units for Small Biomass Power Plants.

The adder is the additional price of purchase of the electricity unit costs from renewable electricity generation. The adder is set for motivating the manufacturers to use renewable energy and biomass fuel to generate electricity. (Energy Regulatory Commission, 2015a)

Table 2.2 The Additional Costs Added to the Electricity units for Small Biomass Power Plants.

Fuel	Adder per unit	New Adder per unit	Special Adder price per units	Special Adder price per units in 3 border province	Subsidy Period
Biomass					
Production capacity less than 1 Megawatt	0.30	0.50	1.0	1.0	7
Production capacity more than 1 Megawatt	0.30	0.30	1.0	1.0	7
Biogas					
Production capacity less than 1 Megawatt	0.30	0.50	1.0	1.0	7
Production capacity more than 1 Megawatt	0.30	0.30	1.0	1.0	7
Garbage					
Fermentation	2.50	2.50	1.00	1.00	7
Thermo	2.50	3.50	1.00	1.00	7
Production capacity less than 50 Kilowatt	3.50	4.50	1.50	1.50	10
Production capacity more than 50 Kilowatt	3.50	3.50	1.50	1.50	10

Table 2.2 (Continued)

Fuel	Adder per unit	New Adder per unit	Special Adder price per units	Special Adder price per units in 3 border province	Subsidy Period
Water Power					
Production capacity 50-200 Kilowatt	0.40	0.80	1.00	1.00	7
Production capacity more than 50 Kilowatt	0.80	1.50	1.00	1.00	7
Solar	8.00	8.00	1.50	1.50	10

Source: Energy Regulatory Commission, 2015a.

2.1.3.4 The Financial Support from the Government to Promote the use of Renewable Energy

Government supports financially by loaning money through financial institutions to encourage the investment of conservation and renewable energy. The financial support from the government is funded through two different sectors, The Energy for Environment Foundation and The Energy Foundation of Thailand. This fund is to encourage investment from renewable energy ventures, to joint ventures in energy management companies, to invest in developing and trading carbon credits, to lease renewable energy generation equipment, to support credit loans, and to provide technical assistance to renewable and biomass power generation developments. (Department of Alternative Energy Development and Efficiency, 2015c)

2.1.3.5 The Support of Investment to Promote the use of Renewable Energy.

Board of Investment of Thailand (2015) BOI collaborates with the Department of Alternative Energy Development and Energy Conservation to promote investment from manufacturing companies of machinery or equipment, to exempt machinery from heavy import taxes, to support the parts of production of renewable energy, to exempt the import duties for raw materials, and to exempt the corporate tax as shown in the following table.

Table 2.3 The Support of Investment to Promote the use of Renewable Energy

Area	Provinces	Within the industrial zone	Outside the industrial zone
1.	Consists of 6 provinces: Bangkok, Nakhon Pathom, Nonthaburi, Pathum Thani, Samut Prakan, and Samut Sakhon	1) Machinery import duty exemption at 50% 2) 3-year corporate tax exemption 3) 1-year raw materials import duty exemption	1) Machinery import duty exemption at 50% 2) 1-year raw materials import duty exemption
2.	Consists of 12 provinces: Kanchanaburi, Chachoengsao, Chon Buri, Nakhon Nayok, Pha Nakhon Sri Ayuthaya, Phuket, Rayong, Ratchburi, Samut Songkhram, Saraburi, Suphan Buri and Ang Thong	1) Machinery import duty exemption at 50% 2) 3-year corporate tax exemptions 3) 1-year raw materials import duty exemption	1) Machinery import duty exemption at 50% 2) 3-year corporate tax exemptions 3) 1-year raw materials import duty exemption
3.	Group 1 consist of 36 provinces: Krabi, Khampenag Pet, Khon Kaen, Chanthaburi, Chai Nat, Chumphon, Chiang Rai, Chiang Mai, Trang, Trat, Tak, Nakhon Si Thammarat, Nakhon	1) Machinery import duty exemption 2) 8-year corporate tax exemptions 3) 5-year raw materials import duty exemption 4) Income tax exemption on profits at the investment rate	1) Machinery import duty exemption 2) 8-year corporate tax exemptions 3) 5-year raw materials import duty exemption 4) The installation and setting of cost from

Table 2.3 (Continued)

Area	Provinces	Within the industrial zone	Outside the industrial zone
	Sawan, Prachuap Khiri Khan, Prachinburi, Phang-nga, Pattulung, Phisanulok, Petchaburi, Phetchabun, Mukdahan, Mae Hong Son, Ranong, Lopuri, Lampang, Lumphun, Loei, Songkhla, Sa Kaeo, Singburi, Sukhothai, Surat Thani, Uttaradit, and Uthai Thani	of 50% of the normal rate for five years 5) Transportation, electricity, and water bills deduction 2 times for 10 years 6) The installation and setting of cost from the profit at 25% of the investing cost	profits at 25% of the initial investment 5) Income tax exemption on profits at the investment rate of 50% of the normal rate for five years 6) Transportation, electricity, and water bills deduction 2 times for 10 years 7) The installation and setting the accommodation costs from the profit at 25% of the investing cost 8) Income tax exemption on profits at the investment rate of 50% of the normal rate for five years 9) Transportation, electricity, and water bills deduction 2 times for 10 years 10) The installation and setting of costs from the profit at 25% of the investing cost

Table 2.3 (Continued)

Area	Provinces	Within the industrial zone	Outside the industrial zone
	Group 2 consists of 22 provinces: Kalasin, Nakhon Phanom, Narathiwate, Nan,BuriRam, Pattathni, Phayai,Phrae, Maha Sarakham, Yasothon, Yala, RoiEt, SiSaket, Sathonnakhon,Satun, Surin, NongBua Lamphu, Chaiyaphum, NongKai, Ubonratchathani, Udonthani, and Amnat charoen	1) Machinery import duty exemption 2) 8-year corporate tax exemptions 3) 5-year raw materials import duty exemption 4) Income tax exemption on profits at the investment rate of 50% of the normal rate for five years 5) Transportation, electricity, and water bills deduction 2 times for 10 years 6) The installation and setting of costs from the profit at 25% of the investing cost	1) Machinery import duty exemption 2) 8-year corporate tax exemptions 3) 5-year raw materials import duty exemption 4) Income tax exemption on profits at the investment rate of 50% of the normal rate for five years 5) Transportation, electricity, and water bills deduction 2 times for 10 years 6) The installation and setting of costs from the profit at 25% of the investing cost

Source: Board of Investment of Thailand 2015 BOI collaborates with the Department of Alternative Energy Development and Energy Conservation.

2.1.3.6 Feed-in Tariff (FiT)

Energy Policy and Planning Policy. (2015b) circulated the purchased power units of biomass power generation by using the Feed-in Tariff system. Feed-in Tariff is a measurement to promote the purchase of electricity from renewable energy. The purchase rate is fixed over the duration of the operation program. FiT is set for purchasing the electricity units with clarity and fairness. The rate of electricity purchased in the Feed-in Tariff system can be divided into three parts: 1) FiT fixed:

FiTF, FiTF is calculated using the unit of electricity and investing costs for setting up the power plant, such as the operational costs and maintenance costs over the project's duration. 2) FiT variable: FiTV, FiTV is calculated with the cost of the raw material for producing electricity. This rate is adjusted according to the time of operation in the process. 3) FiT Premium rates, FiT premium is a special rate for incentives for investment projects from government policies, such as the investment of electricity generation from waste, biomass, biogas, and the investment projects of electricity in the southern provinces three southern border provinces of Thailand in order to strengthen energy security there.

Table 2.4 Feed-in Tariff (FiT)

Feed-in Tariff (FiT) rate pronounced in year 2015

Capacity (MW)	**FiT (Bath/unit)**			**Support period (year)**	**Fit Premium**	
					Bio fuel (First 8 years)	**Projects in 3 boarders provinces**
	FiTF	**FiTV, 2017**	**FiT(1)**			
Biomass						
Production Capacity $\leq$ 1 MW	3.13	2.21	5.34	20	0.50	0.50
Production Capacity > 1-3 MW	2.61	2.21	4.82	20	0.40	0.50
Production Capacity > 3 MW	2.39	1.85	4.24	20	0.30	0.50

Source: Energy Policy and Planning Policy, 2015b.

2.1.4 Regulations and Laws Related to Small Biomass Power Plants

The regulations and laws related to small biomass power plants consist of 4 main parts, as follows: 1) the allowance process for establishing biomass power plants. 2) The allowance of biomass power plants for operating and controlling power. 3) The regulations involved with purchasing electricity units from very small power plants and small power plants. 4) The environmental regulations.

2.1.4.1 The Allowance Process for Establishing Biomass Power Plants.

The first step in setting up a power plant involves the operators submitting the documents for allowance at the Sub-district Administrative Organization (SAO) and Provincial Industrial Officer (PIO). PIO will review all submitted documents and survey the location before construction of the power plant. They will announce the allowance of the power plant within 45 days and issue the allowance documents to the Department of Industrial Works. When the Department of Industrial Works receives the allowance documents, they will survey the local community acceptance by sending requests to the community to ask for their opinion about the power plant in the area. When the community around the setting area accepts the local power plant the Department of Industrial Works grants permission for the power plant to start their construction.

2.1.4.2 The Allowance of Biomass Power Plants for Operating and Controlling the Power Generation.

The Energy Industry Act 2550 Volume 124, Section 48 is an important principle to control the operation and energy production. 1) The Energy Industry, whether they pay or not, they must obtain a license from the Energy Regulatory Commission as stated in Article 47. 2) The operators who need to set up a building or factory to operate a power generation facility need to comply with the laws such as the controlled building laws, and the city planning laws. The power generation needs to be permitted by the Energy Regulatory Commission. The Energy Regulatory Commission needs to ask the opinion of the related public organizations. However, the public organizations need to report their opinion to the Energy Regulatory Commission.

2.1.4.3 The Permission Process and the Related Documents for Operating Power Plants.

The permission process includes: 1) The prior permission process 2) The permission process 3) Building and factory construction and licensing procedures.

1) The prior permission process, The very small biomass power plant and small operators must follow the reporting procedures, study the measures to prevent and correct the impact on the environment and safety. The

operators need to submit the all related documents to the local authority units to approve all document details. Once the documents are approved by the local authority units, the operators submit all documents to the expert committee for all document approvals. In case the operators of small power plants have a production capacity of more than 10 megawatts, they need to report the environmental impact analysis to the committee along with all the aforementioned documents.

2) The permission process, The Building permission, Application for Factory License are applied through the Department of Industrial Works Office. Energy Regulatory Commission approve the Energy Licenses. In case the land of small power plants are in Industrial Estates operated by The Authority of Thailand area, the operators need to have the allowance from The Industrial Estate Authority of Thailand. After The Energy Regulatory Commission approve the alliance, the operators need to pay all fees. The Energy Regulatory Commission will announce the allowance on their website.

3) Building and factory construction and licensing procedures. After the operators of small power plants built the power plant and the building, they need to submit the allowance to the Sub district Administrative Organization (SAO). When SAO approves the documents, the operators can set up the machinery, test the operation process and submit the allowance of the energy control production from The Energy Regulation Commission. When the ERC approves the allowance the operators for producing the electricity then the operators can produce the electricity units. In case the ERC does not approve allowance the operators can appeal the matter at The Energy Regulatory Commission Office. (Energy Regulatory Commission, 2015b) The details are shown on picture number 2.1

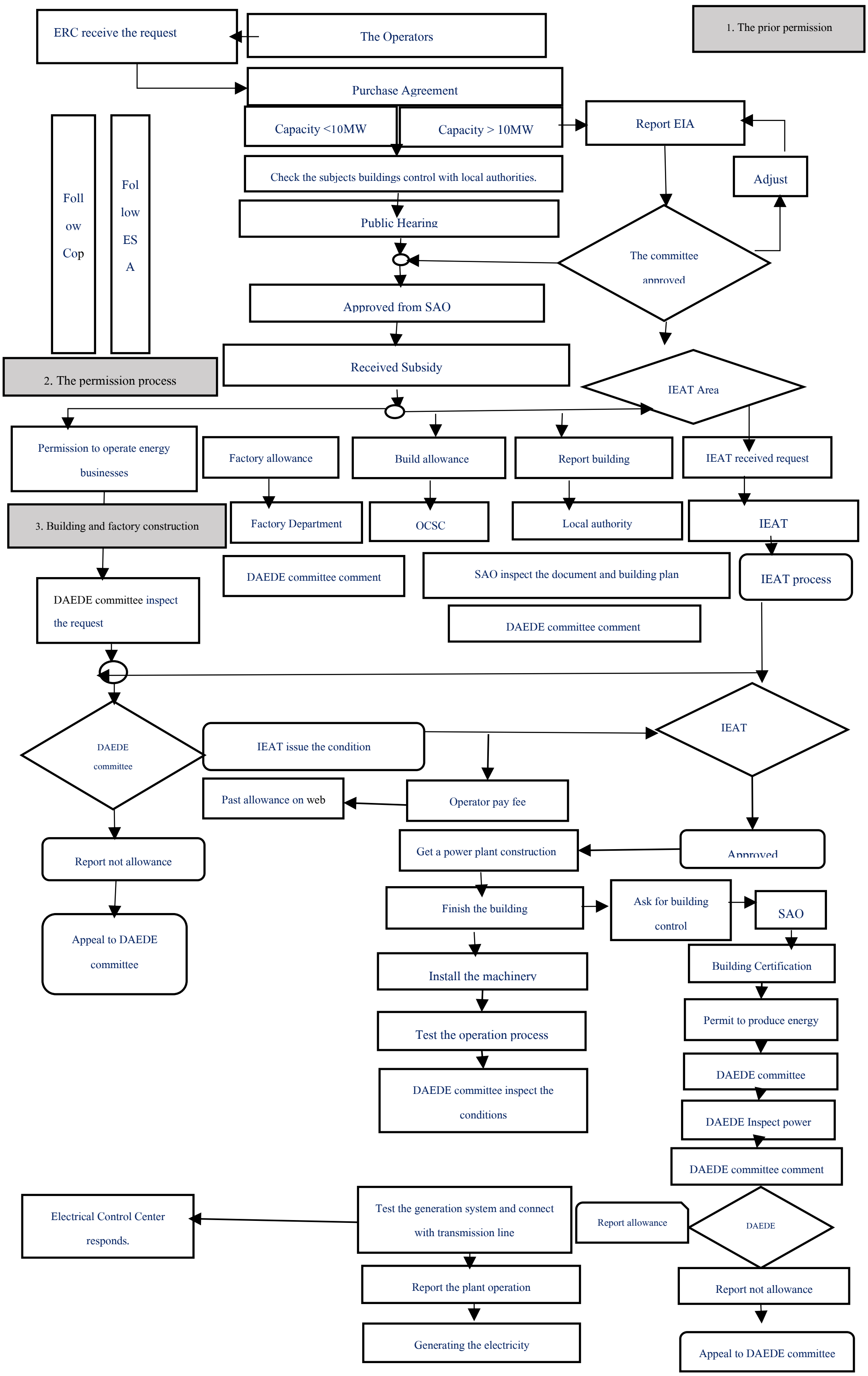

Figure 2.1 The Regulations of Power Plant Setting in Thailand

Source: Energy Regulatory Commission, 2015b.

2.1.4.4 The Regulation of Purchasing Electricity units from very Small Power Plant and Small Power Plants

The regulations of purchasing electricity from Very Small Power Plants (VSPP) and Small Power Plants. SPP means an electricity producer both public or private using biomass fuel with the capacity of production within 10-90 Megawatts, the fuel used in the electricity production being solar, wind, water, biomass, or biogas (not including diesel, natural gas, coal, or nuclear). SPPs need to sell the electricity to the Electricity Generating Authority of Thailand: EGAT. VSPP means, producing electricity by either public or private means using biomass fuel with the capacity of production within 10 Megawatts, the fuel used in the electricity production could be solar, wind, water, biomass, and biogas (not including diesel, natural gas, coal, or nuclear). VSPPs need to sell the electricity to The Provincial Electricity Authority (PEA) and Metropolitan Electricity Authority (MEA) (Electricity Generating Authority of Thailand. 2015)

Provincial Electricity Authority PEA (2015) defined the rules and regulations for purchasing power from small and very small power producers with the details as the following: 1) Production Standard SPPs and VSPPs that produce and sell electricity units need to follow the regulations of safety standards and the electricity system connection standards, the rules of the energy network systems, and the rules of the connection systems. 2) The approval principal and process of purchasing electricity units, The approval principal and process of purchasing electricity units consists of VSPPs needing to submit the purchase and connection forms to the office of PEA. PEA will then approve the details on the purchase and connection forms of the VSPP. PEA reports the results to the VSPP within 45 days and invoices the expenses within 15 days after approving the purchase agreement. The VSPP needs to sign the purchase agreement within 60 days after approval. The VSPP can sell the electricity units to the grid lines after signing the purchase agreement and inspecting the connection equipment that follows the standards and regulations. The VSPP needs to sign the purchase agreement before selling the electricity to the grid lines. The electricity Purchase Agreement The PEA and MEA are the purchasing organizations from the producers with a maximum capacity of 10 megawatts at the connection station. In the event that a connection needs to be inspected because of doubts of the ability and stability of electricity in the system following the regulation of the PEA. The PEA has the authority to inspect, to correct, and or to amend the producer's equipment within the conditions needed. SPP's need to submit the purchase form with completed documents and the Juristic Person Certification, the location map of power plants, the electricity generator location map, information of the production process, the quality of heat usage, the equipment details, the electricity system circulation, the electricity reservation system, the beginning date to sell the electricity, the reserve supply resource, and the guarantee certification to the office of EGAT. EGAT will approve the details on the purchase and documents then report the results to the SPP within 90 days. The SPP needs to sign the purchase power agreement within 2 years after approval.

2.1.4.5 The Power Development Fund for Small Biomass Power Plants

On the energy industry act 2550 section 93, a fund shell was set up in the office, under the name of The Power Development Fund with the objectives to provide financial support from the energy service extension to various localities, to decentralize development to localities, to enhance the development of local communities which have been affected by power plant operations, to promote the use of renewable energy and to promote the technology which renders minimal impact on the environment with due consideration of the balance of natural resource and fairness to energy consumers. The fund came from the fines that were collected from the contribution of the electricity industry licensees, the money donated, the assets donated, the interests, and other benefits incurred from money or assets held by the fund.

The Department of Alternative Energy Development and Efficiency (2015c), DAEDE has guidelines for using the power development fund to develop the communities within 11 different sectors, to increasing the quality of life, health and wellbeing, to develop professional careers, to develop the economy, to develop the national religion, to retain Thai customs and local traditions, to develop the communities, to conserve the environment, to spend for emergency cases, and to develop certain community projects.

2.1.4.6 Power Purchase Agreement-PPA

Power Purchase Agreement-PPA is the contract between independent power producers with the Electricity Generating Authority of Thailand: EGAT. The PPA has 2 forms, firm agreement and non-firm agreement. 1) Firm agreement: A firm agreement is a power purchase agreement with the duration of more than five years. The pricing of the electricity unit consists of 3 important parts, 1) The capacity payment 2) The energy payment 3) Fuel savings. The capacity payment is determined from the amount of investment of power plants by EGAT. There is the long running cost of capacity cost of EGAT from purchasing the electricity units from the producers. The energy payment is determined from the amount of fuel costs of power plants by EGAT. There is the long running cost of capacity costs of EGAT from purchasing the electricity units from the producer. The fuel savings is the amount of savings that the electricity producer can save from costs over the standard expenses. The firm agreement stipulates that the producers need to produce the electricity at the quality as stated in the PPA. If producers cannot produce the electricity at the quality level stated in the agreement, the producers need to pay a fine to EGAT. 2) A non–firm agreement is a contract less than five years. The pricing of the electricity units consists of 2 important parts, the energy payments and the fuel savings. The capacity payment is determined by the amount of investments of power plants by EGAT. There is the long running cost of capacity costs of EGAT from purchasing the electricity units from the producers. Normally, the electricity units purchasing average from non-firm agreements is lower than that of firm agreements. However, renewable energy power plants have additional price support-an adder for the electric costs or Feed-in Tariffs. (Energy Regulatory Commission, 2015c)

2.2 The Electricity System in Thailand

The Electricity System in Thailand is the single electricity buyer or Enhanced Single Buyer (ESB). Electricity Generating Authority of Thailand (EGAT) operate the production, transmission system, purchase the electricity units, and coordinate transmission of electricity to the distribution of Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA). The structure of the electricity system consists of four systems, such as a production system, transmission system, distribution system, and retailing system 1) The production system is Electricity Generating Authority of Thailand (EGAT). EGAT is responsible for foreign power generation, Thai power generation with independent power producers (IPP) and small power Producers (SPP) 2) Transmission systems are run by the Electricity Generating Authority of Thailand (EGAT). EGAT is responsible for the transmission of the whole system. 3) The distribution system is run by the Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA) 4) Retailing systems are Very Small Power Producers (VSPP) and the end users. (Energy for Environment Foundation, 2005)

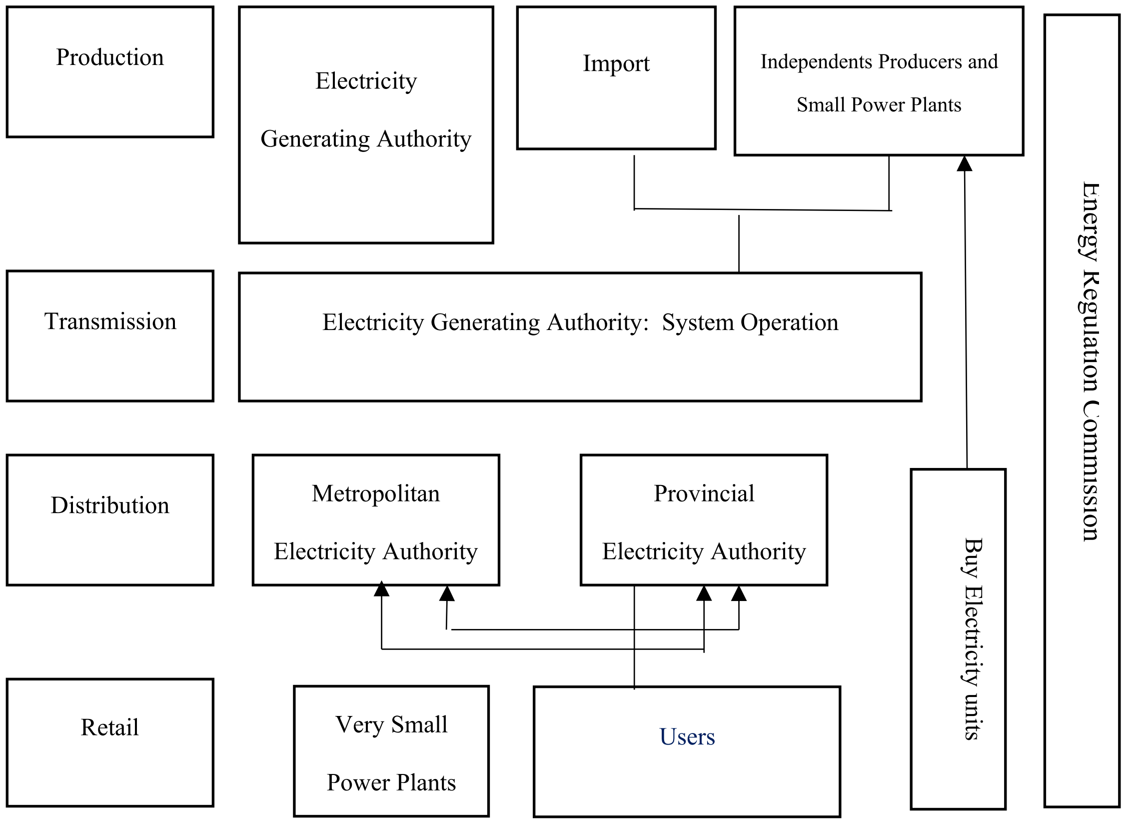

Figure 2.2 Enhanced Single Buyer: ESB Electricity System in Thailand
Source: Energy for Environment Foundation, 2005.

Nattawut Pongsiri (2007, p. 55) mentioned The Electricity System in Thailand is an important Public Utility System that is operated and controlled by the government. The electricity units are supplied by the Electricity Generating Authority of Thailand (EGAT), Metropolitan Electricity Authority (MEA) and Provincial Electricity Authority (PEA). EGAT's duty is the production and transmission of the electricity to MEA and PEA. MEA's duty is the transmission of the electricity to end users in Bangkok, Nonthaburi, and Samutprakarn. PEA's duty is the transmission of the electricity to other end users. In 1992, the government of Anand Panyarachun issued laws that allowed the private sectors to invest in electricity producing public utility systems. On 12 September, 1992, the cabinet resolved the private sectors to invest in electricity systems with 3 forms, as follows, 1) Independent Power Producers: IPP, IPP produce the electricity units and sell them to the Electricity Generating Authority of Thailand (EGAT) 2) Small Power Producers: SPP, SPP produce the electricity units and sell them to the Electricity Generating Authority of Thailand (EGAT) and industry end users. 3) Very Small Power Producers: VSPP, VSPP produce the electricity units and sell them to Provincial Electricity Authority (PEA) and the end users. The principle objectives of increasing the role of private sectors in the electricity industry are to increase competition in the electricity industry, to increase the efficiency of the electricity system, to reduce the burden of the government, to reduce the burden of public debt, to encourage more efficient electricity usage of the end users, to increase the electricity quality for users, to encourage the public to participate in the development of the country's energy systems. The private sector's participation in the electricity system is a model for the construction, ownership, and operation (Build-Own-Operate) program. Private sectors build the power generation plants, own the generation plants and sell the electricity to EGAT and PEA under the Power Purchase Agreement (PPA). PPA is a key component to creating collaboration between the private and public sectors to be a successful, harmonious partnership.

2.2.1 The Electricity Distribution in Thailand

2.2.1.1 The Power Distribution System Consists of Four Systems.

1) Generation system, Generation system is the transformation of power generation such as water, coal, nuclear power generation to become electricity units. The power generation function is to produce electricity units to meet the demand of the country.

2) Transmission system, Transmission system is the method of sending electricity from the production process to the distribution system in order to supply electricity units to consumers. The transmission will be sent using a high-voltage power transmission system. In order to have effective transmission, electricity pressure needs to at a high voltage to supply electricity to remote sources. Before the power is supplied to the end user, the electricity pressure needs to be reduced to fit transmission lines and equipment used at the 220-volt level. The power transmission includes the electricity transmission lines and the equipment of the transmission system. The characteristics of the transmission lines need to be strong enough to resist the high force and pressure of the electricity units.

3) Distribution system, Distribution system consists of the electricity transmission lines to the end users. Before transmission of the electricity units to the end users, the electricity units' force and pressure need to be reduced in order to work with the equipment. The electricity reduction is passed through a substation known as feeder lines. The feeder lines function is to transmit the electricity units from the grid lines to end users.

4) The line service system, the line service system is the service systems including 4 function lines as follows: 1) Single phase lines with 2 lines, the two lines link the grid line and the end users 2) Single phase line with 3 lines, the three lines link the grid lines and the end users 3) Three phase 3 lines 4) the Three phase 4 lines are the lines to distribute the high force and high pressure to the industrial users as 380-400 volts. (Electricity Generating Authority of Thailand: EGAT, 2015)

2.2.2.2 The Transmission and Distribution Equipment

The electricity production consists of the transmission and distribution systems. Both systems link the power generation to supply electricity to both the public and industrial users. The transmission and distribution equipment consists of 1) The generator or power plant, the function of the generator is to produce the electrical power. 2) The voltage stations, the function of the voltage stations is to change the electricity force and pressure to be high enough for transmitting it to the remote areas**.** 3) The transmission lines, The function of the transmission lines are power lines that serve the pressure of electricity 4) Electricity Station, the function of an electricity station is to change the voltage of electricity in the lines 5) Sub-transmission lines, the function of the sub-transmission lines is to link the electricity stations and the substations. 6) Electricity Sub-station, the function of the electricity substation is to change the force and pressure of the electricity before distributing the electricity units. 7) The primary or high voltage distribution lines, the function of the primary or high voltage distribution lines is to feed the electricity from the substation to the distribution transformers. 8) Distribution transformers, the function of the distribution transformers is to reduce the force and pressure of electricity before transmitting it to end users. 9) The low voltage distribution lines, the function of the low voltage distribution lines is to link the distribution transformer to the end users. (Rajamangala University of Technology, 2013)

2.2.2.3 The Potential of Grid Lines

The grid lines are high voltage transmission lines that transmit electricity. In order to effectively transmit electricity from the generators to the load centers and finally to the end users, the grid lines need to be designed with effective resistance to withstand the electrical force and pressure, serve the power with stable load, stability, and reliability. (Rajamangala University of Technology, 2013)

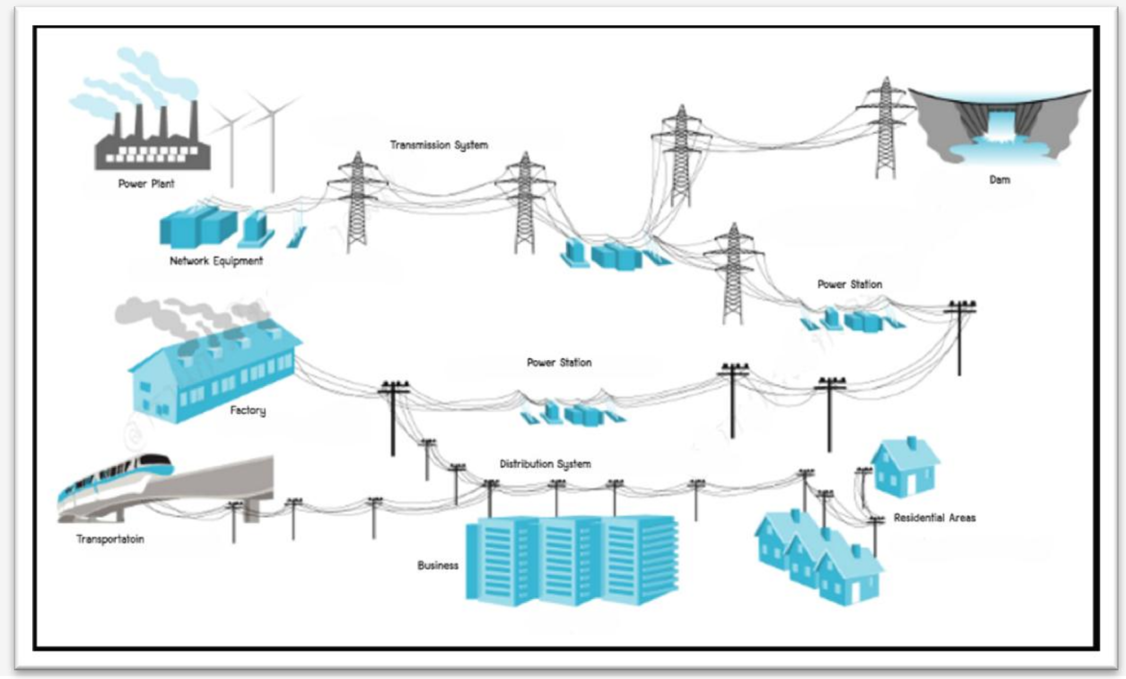

Figure 2.3 The Electricity Distribution in Thailand

Source: Telecommunication, 2016.

2.3 Key Components of a Small Biomass Power Plant Operation

The operation of a small biomass power plant consists of several factors, such as, the analysis of the start-up biomass, choosing the right technology for producing the electricity, the management of the biomass fuels and so on.

2.3.1 The Analysis of Investment in the Initial Biomass Power Plant Project

In general, the analysis of investment in the initial biomass power plant project is the Cost-Benefit Analysis. The method evaluates the money value of the investment to ensure that there are no financial problems throughout the project and the return on investment is enough to motivate stakeholders to invest.

Cost-Benefit Analysis uses two parts, 1) The revenues of the project, the revenues are the income from selling the electricity units and the ash from the production 2) the expenses, expenses are investment lumps, the management and staff salaries, interests, fuel costs, electricity and water bills, and other operational costs. The operators need to use the actual numbers of both revenues and expenses in the investment of the biomass power plant project for the actual operations cost and returns.

Cost-Benefit Analysis method consists of: 1) the analysis of Net Present Value: NPV, Net Present Value is to estimate the financial net present value, to consider the value of money in comparison to the value of the current discount rate at 7% compared to lending rates of commercial banks 2) The analysis of Benefit-Cost Ratio BCR. Benefit-Cost Ratio is to assess the proportion of compensation costs 3) The internal rate of return IRR. The internal rate of return is a rate of interest received from the investment costs of the initial investment, and 4) The payback period PB. The payback period is a term of capital return based on the investment period. (Department of Alternative Energy Development and Efficiency, 2015d)

Table 2.5 The Analysis of Investment in the Initial Biomass Power Plant Project (1 megawatt)

Details	**Value**
Present Value	91,485,296.63
Investment	56,000,000.00
Net Present Value: NPV	35,485,296.63
Internal Rate of Return: IRR	22.22%
Payback Period: PB	5.47 years
Production cost per unit	3.28-4.10 (bath/kWh)

Source: Supreme Renewable, 2015.

2.3.2 Biomass Electricity Production Technology

The technology used to generate electricity from biomass fuel consists of thermo technology. Physical and chemical conversion (Physic-chemical) and (Biological Conversion). Thermo technologies are combustion, pyrolysis and gasification. Physico-chemical is a Physical and chemical conversion process as

Fermentation and Anaerobic Digestion. The details shown on picture 2.4. (Bauen, Woods, & Hailes, 2004)

2.3.2.1 Direct combustion technology: This technology is the process of converting biomass energy into electricity units by heating. The heat quality depends on the type of biomass fuel used. The heat energy can be used to boil water into steam and steam is used to spin a turbine to power a generator to produce electricity. The cogeneration is the production of electricity from biomass using a heating process. Thus providing electric power and thermal energy from the same fuel source. The heat created from power generation is transferred to other forms by working two systems together combining the usable heat energy and the generation of electricity. The principle direction of combustion technology is burning fuel within the combustion chamber of a gas turbine. The air is compressed by high pressure while the fuel is burning. Hot gas pressures and high temperatures drive a gas turbine to drive a generator for producing electricity.

2.3.2.2 Gasification, gasification is the process of changing gas without a combustion process, instead of burning the biomass fuel in specially designed stoves known as gasification stoves. Gasification is the process of transforming biomass with carbon and hydrogen elements from solids to a gaseous fuel by a chemical reaction with air, oxygen or steam locally producing a fuel gas. The gasification process contains the sub-4 process, including drying, pyrolysis, combustion, and reduction. The process produces carbon monoxide (CO), hydrogen (H2), methane (CH4), oxygen (O2), carbon dioxide (CO2), nitrogen (N2), dust, ash, and tar. Synthetic fuels can be used as fuel for the combustion process and engines can produce the electricity. (National Innovation Agency, 2012)

2.3.2.3 Fermentation Technology, The fumigation technology is the process used to produce a gas or biogas that has a component of methane known as Biogas. Many factories in the various industries can use biogas by producing Anaerobic Digestion. In the anaerobic digestion process, bacteria will digest the biomass or waste of production process into the biogas. They will use biogas to burn and use the vapor to produce the electricity units, for example, cassava factories, palm oil factories, fruits, sugar mills, and so on. The Fermentation technology includes 1) Slowing fermentation tank, the process is combining many fermentation tanks linked together to a biogas tank. 2) Stable fermentation tank, the process is to bury the fermentation tank. 3) Flocculation tank, this process develops the flocculation inside the fermentation tank to increase the capacity of the fluid inside the tank. 4) Oxygen-less fermentation tank, this process aims to control oxygen inside the tank, which increases the capacity of bacteria. The biogas from the fumigation technology can be used to produce heat from burning and using the vapor to produce electricity, to use biogas as a physical link with the engine, to produce the electricity units as biogas fuel. (Energy for Environment Foundation, 2012)

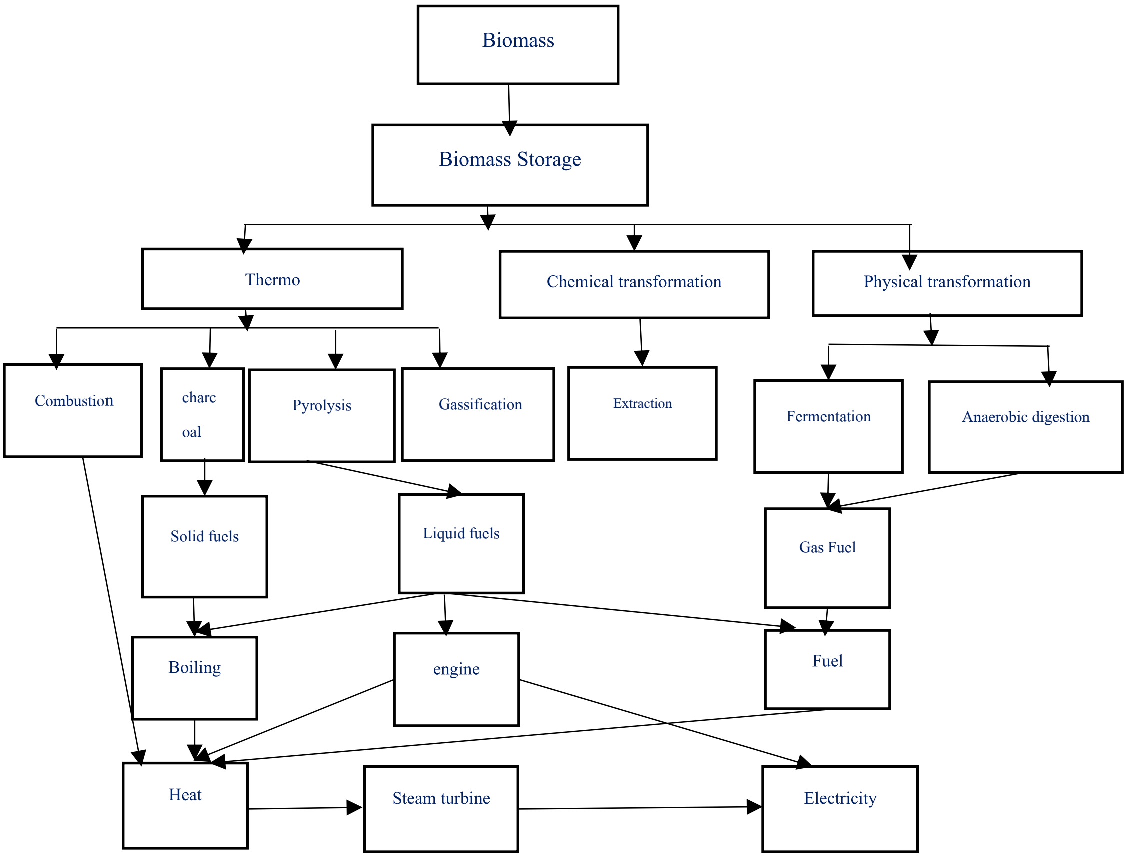

Figure 2.4 Biomass Electricity Production Technology

Source: Bauen, Woods, and Hailes, 2004.

2.3.3 Biomass Fuel and Biomass Fuel Management

2.3.3.1 Biomass is compounds of organic matter that are stores of natural energy converted into potential energy such as; agricultural waste, such as, rice husks, bagasse, wood pulp, palm fiber, cassava, corn husks, coconut shells, yeast, and so on. Sources of biomass, Biomass comes from many sources as the following 1) Biomass comes from yield forests, plantations, gardens, trees, and weeds, for example, hardwoods, softwoods, lumber, leaves, twigs, grasses, fast-growing trees, grains, crop residues, bark and so on. 2) Biomass also comes from agricultural crops, for example, sugar cane, cassava, corn, palm oil and so on. 3) Biomasses can be derived from agricultural waste, for example rice, cassava, maize, palm oil, sugar cane, bagasse, rice straw, sugarcane stalks, leaves, corn cobs, soybeans and so on. 4) Biomasses can be made from residues and waste from the business sectors, such as wood chips, sawdust, yeast, molasses and bagasse. FFB chips, cobs, husks, coconuts, or coconut shells. 5) Biomasses can finally be taken from communities' waste or garbage. (Department of Alternative Energy Development and Efficiency, 2008)

Table 2.6 Biomass Quantity to Generate Electricity in Thailand (Units in megawatts)

Parts of Thailand	**Biomass Quantity to Generate Electricity in Thailand (Units in megawatts)**
Northern	1, 433.35
North East	1,158.79
East	225.72
West	441.53
Central	348.26
South	446.50
Total	4, 044.15

Source: Department of Alternative Energy Development and Efficiency, 2015e.

Table 2.7 Types of Biomass that can be used to Generate Electricity

Plants	**Parts**	**Low Heat (kJ/Kg)**	**Moisture (%)**	**Density (kg/m)**
Rice	Rick Husks	14,230	10.00	125
	Straw	12,330	8.20	150
Sugar Cane	Bagasse	7,360	9.20	100
	Shoots and leaves	15,479	50.73	120
cassava	Cassava roots	5,494	59.40	250
	Stalks	7,560	48.40	N/A
	Leaves	1,760	78.40	N/A
Corn	Corncobs	16,220	7.00	N/A
	Stalks	9,830	41.7	N/A
Palm oil	Palm bunches	7,240	58.60	380
	Palm fibers	11,880	31.80	250
	Palm shells	18,267	12.00	400
	Stalks	7,540	48.40	N/A
Rubber Wood	Stalks	8,600	45.00	450
Eucalyptus	Eucalyptus shells	6,745	50.00	N/A
Coconut	Coconut fibers	6,272	51.00	270

Source: Department of Alternative Energy Development and Efficiency, 2015f.

2.3.3.2 The Biomass Quantity for Producing Electricity in Thailand

Department of Alternative Energy Development and Efficiency (2015e) explores the potential of biomass quantity to generate electricity units in Thailand from multiple regions in the year 2558. The quantity of biomass in the Northern part is at 1,433.35 MW, in the Northeast part at 1,158.79 MW, in the Eastern part at 225.72 MW, in the Western part at 441.53 MW, the Central part at 348.26 MW, the Southern part at 446.50 MW which sets the total quantity in Thailand at 4,044.15 MW. According to the data survey, it is found that the amount of biomass in Thailand is sufficient to support biomass power plants.

2.3.3.3 The Biomass Fuel Management

Biomass Fuel management is a very important factor in the sustainability for biomass power plants. Fuel management in general and the balance of quantity to quality are crucial steps to take when managing biomass energy production. It is critical to maintain the proper volume and price of fuel over the more than 20-year operating terms. The choice of fuel that adds value to farmer's crops and minimizes risks of both low quality and low quantity to the operation of the plant becomes a very important decision. Fuel management practices: 1) Survey fuel sources by exploring the area around becoming familiar with which plants can be used as a biomass fuel source for electricity production, then to select the primary fuel and explore biomass fuel sources for backup operations. 2) Maintain price standards, quality levels, main sources and reserve sources month-to-month from year-to-year without allowing the supply of electricity production to deteriorate. 3) Manage the scheduling of transportation involved in moving all the fuel material without affecting the surrounding communities. 4) Prepare the fuel for transportation, supplying a sufficient area to allow the fuel to dry, providing proper storage areas and finally preparing the fuel for electricity production processing. (Department of Alternative Energy Development and Efficiency, 2013)

2.4 The Community Acceptance of Small Biomass Power Plants

The development of small power plants in Thailand has many problems, for example, the ignorance of the operators, the general misunderstanding of biomass power plant projects, the lack of information, the ambiguous information, the political problems, the local conflict problems, and the regulations and the laws. A particular case study is the ViengSa Power plant project in Nan Province. The project has problems with community acceptance; people surrounding the power plant reject the setting of small biomass power plants and other local political problems. The problems have caused the power plant to be removed. (Suwaporn Sirikhun, 2010)

The community acceptance One problem with the biomass power plant project is the community surrounding the power plants not accepting it being built in the area. The problem stems from the negative opinion about the administration of the biomass power plant, such as air and environmental pollution and so on. Department of Alternative Energy Development and Efficiency. (2015g) claimed that the acceptance of the community in establishing biomass power plants is an important factor to influence the biomass power plant success. If the community resists the biomass power plant project, the operators cannot set up and operate the projects. The solution to problems are to promote the project's information to the community, to promote the transparency of the information, to follow the regulations and laws, to make the effects of the project aware within the community, to pressure the community to participate in the project, to allow the community to visit the factory, to take care of the stakeholders, to return the profit to the community.

The acceptance and participation of the community of a power plant project are as follows. 1) The community participation is a survey of communities' methods of communication with the power plant. A method of participation is organizing a community forum. The community forum is a Participatory Learning Process open to everyone participating in the process to express their feelings or opinions with equality. The process of public participation has several methods, such as a community forum, network cooperation, discussion of topics, and so on. 2) The process of participation and survey of the community. 2.1) Before the community forum, plant operators need to prepare background information of the group which is participating, such as gender, age, education, and etc. The information is used in the preparation of meetings as tools and methods to comply with the participants. The preparation stage is used to prepare the equipment, tools, the questions of the discussions, the processes of community participation to achieve necessary goals. 2.2) The aims of community forums 1) to help participants get to know plant team management 2) to identify the purpose of the forums 3) to discuss issues or problems of the projects such as, the process of establishing a biomass power plant, the potential of biomass fuels, the technology used, the environmental impacts, the benefits to the community and clear open discussions for better understanding 4) the results of the community forum, the results of the processes need to be recorded and separated by which ones are problems, and which ones are the solutions. The results and recommendations from respondents are then followed up at the next appointment to discuss further progress and information. (Department of Alternative Energy Development and Efficiency, 2015g)

Community Acceptance of Biomass Power Plant Operations, The study of Wustenhagen found that Community Acceptance of Biomass Power Plant Operations from Bio fuel consists of 3 dimensions, Distributional Justice, Procedural Justice, and trust. The community acceptance of biomass power plants as the Justice in the field of distribution as the fairness in terms of the burden and the benefits of equality. The justice of the process is the production process and the maintenance. The trust is the trust of the community members, the fairness that has taken place, and the community's experience gained from the operation of the biomass power plant.
(Ganzevles, Asveld, & Osseweijer, 2015).

2.5 The Results of the Biomass Power Plant Operations

The result of the biomass power plants as the economic result, the environment result and the community result.

2.5.1 The Economic Results

Biomass Power Plants generate economic benefits including the use of biomass from agriculture as a fuel for electricity generation, reducing the fossil fuel imports from abroad, reducing the import currency valuation, increasing the revenue of local farmers, creating many jobs, increasing the economic income surrounding the biomass power plants. The local economy gains more stability with the production of more electricity from biomass power plants. (Pimanong Rimsinthu. 2013).

Baten (2014) referred the economic results of the operation of biomass power plants, such as, to create jobs in the area of biomass power plants construction. When comparing the biomass power plants and fossil fuel power plants, the biomass power has more befits of job creations than fossil fuel power plants. The economic benefits of using biomass fuels as a primary fuel for power generation, such as, the creation of various occupations, the harvest of the plants, the fuel transportation system to the factory, and the process of storing biomass fuels. (Gavrilescu, 2008, p. 262)

2.5.2 The Environmental Results

Thailand Greenhouse Gas Management Organization (2015) defined the meaning of carbon trading as a country needing to reduce emissions but the cost of reducing the emission is high, then a country needs other countries to reduce emissions instead. The concept is created as a mechanism under the Kyoto Protocol's "Clean Development Mechanism" or CDM: Clean Development Mechanism. The objective is to hire other countries to reduce emissions instead. The market mechanism is called "Carbon market" it is a major driving force to bring the value of carbon offsets when trading with each other known as "Carbon Credits".

Clean Development Mechanism or CDM: Clean Development Mechanism is the incentive tools for developing countries to use clean technologies. Thailand has promoted the biomass electricity production to reduce greenhouse gas emissions. The implementation of the Clean Development Mechanism is there for sustainable development tools, such as benefits to both the local and national level, reducing the amount of waste in the area, increasing the economic turnover in communities, improving good quality of communities. (Department of Alternative Energy Development and Efficiency, 2015k)

Table 2.8 The Proportion of Carbon Credits and Prices from Biomass-Based Biomass Power Plants.

Technology	Production Cost (US/Kw)	Material Cost (US/tonne)	Production Capacity (Mkw)	Lower carbon credits (Tonne/year)	Tone Lower carbon per megawatt (credits/year)	Carbon credits and prices (US/tonne Carbon Credit)
Gasification (Small)	311	29	45	305,000	6,780	29
Gasification (Large)	211	34.91	225	1,550,000	6,800	32

Source: Cameron, 2004.

The gasification biomass power plants being able to reduce the amount of carbon monoxide gas that pollutes the environment. He cites the many benefits of reducing the amount of carbon monoxide gas by carbon trading. Pricing carbon per ton at US $29-39. Moreover, biomass power plants reduce the amount of nitrogen oxide (NOx) that pollutes the environment. Biomass Power Plants support importing residuals used as fuel to generate electricity, reducing the burning of agricultural residues on farmland or open spaces causing air pollution (Cameron, 2004) and from the operating experience of biomass power plants in America. San Joaquin Valley Energy Partners, Chowchilla, El Nido, and Madera, California, USA. There are 3 power plants as Chowchilla II power plant with production capacity 10 megawatt, El Nido power plant with production capacity 10 megawatt and Madera power plant with production capacity 25 megawatt. Three of these power plants use Variety of 35 varieties such as shell, cotton, corncob, and other agricultural residues and so on. The performance of these power plants are stable and well environment performance. The ration of release gas as Sulfur dioxide (SO2), nitrogen oxide (NOx), carbon monoxide (CO) and small particulates into the environment. The results of various emissions to the environment of a 10 MW biomass power plant are shown in Table 2.9

Table 2.9 Various Emissions to the Environment of Biomass Power Plants. (10 megawatts)

Plants	Volume	SO_2	NO_x	CO	PM
Chowchilla	Control	10.4	10.4	22.9	6.2
	Emissions	2.6	8.0	14.7	5.4
El Nido	Control	8.0	10.4	22.9	6.2
	Emissions	1.9	8.9	12.2	0.9

Source: Wiltsee, 2000.

The benefits of biomass power plants with wood chip fuel are beneficial to the environment, especially the environment in terms of the carbon monoxide gas that aids the Greenhouse Effect. The study found that biomass power plants reduce the greenhouse effect on the reaction, reduce the impact of soil erosion, plants in the forest become fuel for biomass power plants improving the cycle of life in the forest and greater environmental benefits. (Baten, 2014)

2.5.3 The Social Results

Department of Alternative Energy Development and Efficiency (2016b) claimed the direct results from Biomass Power plant operations to the local communities are the money from The Power Development Funds to develop the communities within 11 sectors, to increasing the quality of life, health and wellbeing, to develop the careers, to develop the economy, to develop the local religion, customs and local traditions, to develop the communities, to conserve the environment, to spend on emergency cases, to develop local community projects.

Sivaporn Sirikhun (2011) citing the benefits of the small of biomass power plant to the community, increasing the economic turn over in communities, increasing the forest area, increasing the amount of fast-growing trees, expanding the logistics systems in the operation process, adding value to agricultural residues as fuel, reducing the unemployment rate, increasing job creation, reduce the labor migration, and adding to the money circulation in the community.

Baten (2014) discusses the benefits of biomass power plants that use wood chips fuel are, increasing the economic development in the community, increasing job creation, increasing the value of marketing and production involving the process of biomass power plants, increasing the transport process, trading, increasing the money circulation in the community surrounding the power plants.

Orasa Suksawang (2015) claimed the benefits of Nakhon Phanom Provincial Administration power plants in BEBC. The NPPA hired Roseland Group Company Limited to survey and analyze the power plant project before beginning construction of the power plants. They investigated the return on the project as follows. In case setting up the power plants with a capacity of 350 kilowatts, producing electricity unit at 2,160,000 kWh per year can substitute 576,000 liters of diesel per year for electricity, the residuals of agriculture at 4,000 tons for the fuel of the power plant. The returns impact the society and environment when the small power plants use the gasification technology or production has the biochar as the residuals. The characteristic of biochar has many positive characteristics, high carbon, ventilated, absorbant, reduces the dirt acidity, can be used as a fertilizer to improve land quality. When farmers in the community have quality land, they have plentiful crops and a lot of residual biomass for fueling the biomass power plants.

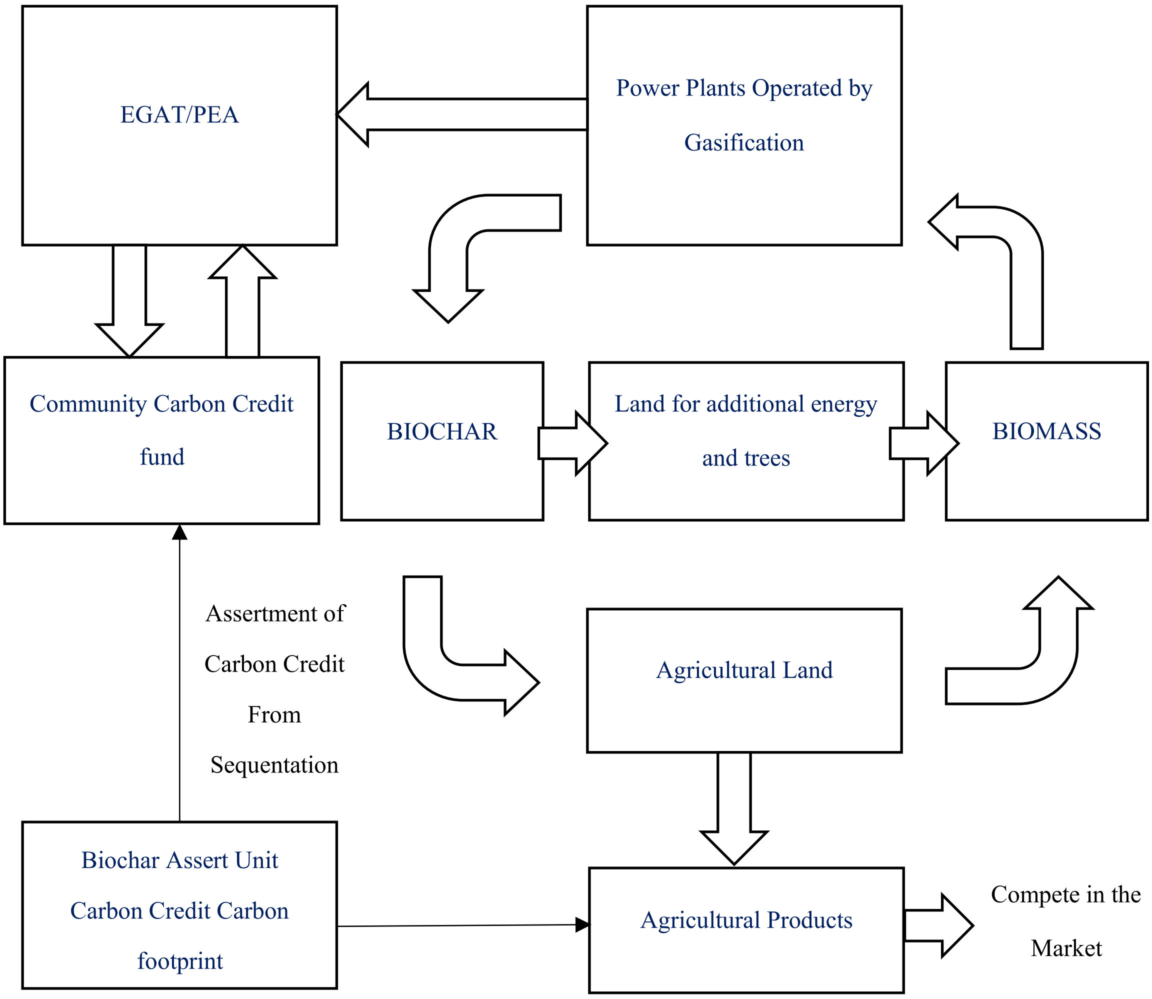

Figure 2.5 Sustainable Utilization of Biomass at Community Level.
Source: Orasa Suksawang, 2015.

2.6 Chapter Summary

The government sectors emphasize many parts of small biomass power plants operation, for example, The Renewable Government Policy, The national Economic and Social Development Plan 1-12, Renewable Power Plan of the Ministry of Energy, The Government Supporting Policy to Biomass Power Plants. The Electricity System in Thailand consists of the Electricity Generating Authority of Thailand, Provincial Electricity Authority: PEA, Metropolitan Electricity Authority: MEA, and private sectors , Very Small Power Plants: VSPP, Small Power Plants: SPP. The private sectors need to follow the laws, regulations and purchase agreements very seriously for high standard performance, safety standards, and quality of both distributors and users. On the operation process of biomass power plants need to be concerned with the quality of biomass fuels, the types of biomass fuels, operations technology, the management of the fuel for the sufficiency of the production, the analysis of the investment of Biomass power plants, the acceptance and the participation of communities. The positive results of the biomass power plant operations are the benefits to economy, environment, and communities.

CHAPTER 3

LITERATURE REVIEW

This chapter consists of The Resource Dependence Theory, Resource-Based View, The Integration Theory, The related research and the chapter summary.

3.1 Resource Dependency Theory

The organizations survive to the extent that they are effective. The effectiveness derives from the management of demands, particularly the demands of the interest group upon which the organizations depend on resources and support. The key to organizational survival is the ability to acquire and maintain resources. This problem would be simplified if organizations were in complete control of all the components necessary for their operation. No Organization is completely self-contained. Organizations are embedded in an environment comprised of other organizations. The organizations depend on other organizations for many resources they require. Organizations are linked to environments by federations, associations, customer-supplier relationships, competitive relationships, and asocial-legal apparatus defining and controlling the nature and limits of these relationships. Organizations need transactions with other elements in their environment to acquire needed resources, The organization's means, public organization, a private organization, small or large organizations, and organizations which are bureaucratic or organic. (Pfeffer & Salancik, 1978, p. 2)

Johnson (1995, p. 3) claimed The Resource-dependence theory is the theory of organizations that seeks to explain organizational and inter-organizational behavior in terms of those critical resources that an organization must have in order to survive and function. The theory focuses on the following Resource; the flow of exchange of resources between organizations; those dependencies and power differentials created because of unequal resource exchange; the constraining effects such dependence has on an organization's action and the effects by the organizational leader to manage dependence.

As an open-system theory, the resource dependence argument suggests that a given organization will respond to and become dependent on those organizations or entities in its environment that control resources which are both within its operations and over which it has limited control. Resource-dependence theory has its focus 1) Resources 2) The flow or exchange of resources between organizations 3) The dependencies and power differentials created as a result of unequal resource exchange 4) The constraining effects dependence has on organizational action 5) The effort by organizational leaders to manage dependence.

1) Organization resources (Galskiewicz & Marsden, 1978 cited in Johnson, 1995) Organization resources take a variety of forms, such as, raw materials, capital, personnel, information, technology and technological innovations, social support, various services and production operations and so on.

2) The necessity of organizational negotiation and exchange. As there is no organization which is entirely self-sufficient, inter-organizational exchange is necessary. (Pfeffer & Salancik, 1978, p. 2) The organizations seek requisite resources, engage in transactions with various organizations in their specific and general environment. The exchange relationships, which exist between organizations, can be assumed a variety of forms: dependent, reciprocal or dominant. (Silver, 1993 cited in Johnson, 1995)

3) The emergence of organization dependence. The organization needs to acquire resource leads to the development of exchange relationships between organizations. The unequal distribution of needed resources results in an inter-dependent organizational relationship. For any given organization, the need for resource acquisition creates dependencies between the organization and other organizations in the environment. Several factors would appear to exacerbate the character of this dependence, such as, the importance of the resource and the degree to which the resource is concentrated in the environment. (Johnson,1995, p. 5)

4) The presence of external organization constraints. As a result of these external dependencies, the choices and actions of the local organizations are somewhat constrained as its managers seek to attend to the demands made by those

environmental entities which provide resources critical to organizational survival and success. The individuals in an organization are subject to pressures from those with whom they interact, so the organization is subject to pressures from organizations with whom it is inter-dependent.

5) The managing of dependence. If the formal organization is conceived of as a purposive social form, the imposition of external constraints brought on by dependence represents a formidable organization challenge. The organizational leaders seek to manage and strategically adapt to external dependencies. (Johnson, 1995)

Resource dependency theory is a matter of the organization in the open system. The organization needs to rely on other organizations. The reliance on resources from other organizations raises the risk and uncertainty over the performance of the organization. An organization or company needs to establish relationships or link to critical resources that rely on resources to reduce risk. The relationship of organizations is a buffer against potential environmental change. The exchange of potential of resource dependencies helps in reducing the cost of operating an organization and exchanging the scarce resource to help the organization survive. (Hillman, 2005)

Paulraj and Chen (2007, p. 29) claimed Resource Dependence theory asserts that firms facing substantial environmental uncertainty will attempt to stabilize by imposing inter-organizational ties. Resource dependence theory proposes that organizations engage in exchanges with their environment to obtain the resource. (Pfeffer & Salancik, 1978) The underlying assumptions of the resource dependence theory perspective are as follows 1) Very few organizations are internally self-sufficient with respect to strategic and critical resources thereby leading to dependence on another firm 2) firms seek to reduce uncertainty and manage dependence by purposefully structuring their exchange their relationship, establishing formal and semi-formal links with other firm The establishment of inter-firm relationships is viewed as dealing with problems of uncertainty and dependence by increasing the extent of coordination with exchange partners

Tippawan Lorsuwannarat (2013, p. 248) discussed the key assumptions of Resource Dependency Theory as: 1) Organizations have insufficient resources, They must seek outside resources, the necessary resources, including: physical resources, finance, and information. 2) Organizations have a relationship. The relationship is commonly a social relationship. The relationship between organizations and the environment is a loose relationship. A loose relationship means the environment has no control altogether. 3) Organizations have the ability to adapt in response to external pressures. 4) Organizations must seek certainty and predictability. 5) Organizations focus on environmentally sensitive work-related resources that mean the environmental impact on operations of organizations is a direct dependent.

Gerald and Adam (2015) discussed The Resource Dependence Theory consists of three important ideas: the context of society, Organizational management strategies for organizational autonomy and survival, and empowerment. Empower is the heart of The Resource Dependency Theory, and power makes the theory different from other theories. Moreover, power refers to power in the organization itself and power derived from the exchange of power between organizations.

The Resource Dependency Theory relates to organizational management in terms of organizational relationship management to get the resources to exchange from outside the organization. The key organizational management styles, such as, collaborative, formation of relationships in the organizational alliances form, Joint Venture and Merger and Acquisition. The purposes are to acquire the required resources, to reduce the risk of reliance on resources between organizations and to gain access to the required resources. (Drees & Heugens, 2013)

3.1.1 Resource Dependence

Tippawan Lorsuwannarat (2013, p. 262) referred to the organization dependence the resources depend on with 2 important issues including 1) Organizations are demanding scarce resources from other organizations, the dependence between organizations, suppliers and the importance of the resources that affect the organization. Organizations find it necessary to limit their dependence on resources. The limited dependence by limited power. Tippawan Lorsuwannarat, (2013), referred to the importance of dependence on resources based on the level of an organization of power to control resources from other organizations. Organizations deem it necessary to use different strategies to reduce resource dependency and increase control over resources within the organizations The degree of resource dependence is based on factors including 1) Resource Importance refers to the importance and the degree of importance that organization needs to use resources in a manufacturing or service organization for achieving the organization's goals. 2) Resource control, means the power to manage resources, the ability to access resources, the ability to control the use of resources, and the regulations and rules of the resources. 3) The ability to seek resources from other organization's resources. The importance of Resource Control, Resource Importance, and the ability to seek resources from other organizations are the conditions that organizations rely on other organizations for their resources.

Ketchen and Hult (2007) Resource dependency theory centers on how firms become reliant on others for needed inputs such as goods and materials, and how firms can manage such relations. The asymmetric interdependence that exists in these inter-firm relationships is critical to reducing environment uncertainty for some firms. The relationship causes to cost reductions, information exchanges, and building of new relationships in the supply chain among organizations.

The Resource Dependence Theory relies on the importance of the interdependence between organizations. The organizations need to depend on other organizations to acquire the resources needed and agree between the organizations to depend on each other. The Theory is explained in terms of interdependence between organizations managed under various organizational forms for the autonomy and legitimacy of the organization. The theory is an important theory that explains the relationship between organizations and the environment and describes the use of strategies in environmental management and organizational performance.

3.2 Resource Based View

Rugman and Verbeke (2002) refer to Edith Penrose's book relate the theory of the growth of the firm that is considered by many scholars in the strategy field for the resource- based theory of the firm. The main contribution of the resource-based view is the ability to bring together several standards of research in economics, industrial organization, and organization science and organization strategy. The exact definitions of key concepts, such as resources, competencies, core competencies, capabilities, and dynamic capabilities. The resource-based view can be seen as an excellent starting point for analysis of the strengths and weaknesses of firms whereas a strategic positioning approach is probably the cornerstone of the opportunities and threats analysis. (Wernerfelt, 1984; Barney, 1991). In a post of 1980, the academic work on the resource-based approach to strategic management shares the four characteristics. 1) The firm’s ultimate objective in a resource-based approach is to achieve sustainment, above normal return as compared to rivals. 2) A set of resources, not equally available to all firms and their combination into competence and capabilities. 3) Competencies and capabilities lead to sustained superior return, to the extent that they are firm specific, valuable to customers, non-substitutable and difficult to imitate. 4) From a dynamic perspective, innovation, especially in terms of new resource combinations, which can substantially contribute to sustainable superior returns.

3.2.1 Definition of Organizational Resources

The importance of resources in the organization is made of 2 key points, which are the organization-meaning in the sense of a combination of resources that can be replaced, and the pattern of organizational growth that comes from internal resources and external resources. The availability of resources is a key factor in the organization's ability to produce goods and services that the resources can produce the most for the organization from its organization’s strategy. The organization-strategy is used to position the resource in the organization to post the organization’s strengths or weaknesses. Moreover, to post the meaning of the organization’s resource that is tangible or intangible, such as, trademarked, knowledge of technology, skilled of workers, contract, machinery trade, management approach, cost or investment lump in business, and so on. The resources are important to the performance of the organization. It is the source of the question that is, ‘What circumstances does the resource affect the performance of high-yielding organizations in the long run?’ (Rugman & Verbeke, 2002)

Barney (1991) suggested the firm obtained sustained competitive advantages by implementing the strategies that exploit their strengths, through responding to the environmental opportunities, while neutralizing external threats and avoiding internal weaknesses. The sources of sustained competitive advantages focus the firm on opportunities and threats. Firm Resources include all assets, capabilities, organizational processes, firm attributes, information, knowledge, etc; controlled by the firms that enable it to conceive of implementation strategies that improve its efficiency and effectiveness. There are numerous firm resources, all of which can be classified into three categories, physical capital resources, human capital resources, and organization capital resources. Physical capital resources include the physical technology used in a firm, a firm's plant and equipment, its geographic location, and its access to raw materials. Human capital resources include the training, experience, judgment, intelligence, relationships and insight of individual managers and workers within a firm. Organization capital resources include a firm's formal reporting structure, it's formal and informal planning, controlling, and coordinating system, and the relations among groups in a firm and between the firms in their environment.

3.2.2 The Nature of Organizational Resources in the Resource View

Holley, Broderick, and Moller (1998) defined a typology of organizational resources as Assets, Tangible and Intangible, and Capabilities. Tangible assets can be touched, smelt, heard, tasted and seen, for example, Land, Cash in hand, Plant & Machines, The people, customer database, copyright & patents, database & MIS. Intangible assets do not assume physical shapes and often exist in the heads and minds of people, for example, credit worthiness, procedure & system, human abilities, brand & reputation, reputation in litigation, knowledge, capabilities, and the term organizational capabilities referring to the abilities of an enterprise to organize, manage, coordinate, or undertake specific sets of activities, for example, customer care, individual learning, self-management, internal & external focus, coordinating skills, individual tasks, customer orientation, group learning, interpersonal skills, marketing, operation, new product development, group task, market orientation, organization learning, portfolio management, marketing sensing, resource utilization, innovation and planning processes.

Galbreath (2005) referred to the Resource-Based View theory's focus as the exploitation of firm resources to gain a sustainable competitive advantage that affords the accrual of superior performance. The resource constructs are conceptualized as 1)

Tangible resources which include financial assets and physical assets. 2) Intangible resources that are assets which include intellectual property assets, organizational assets, reputational assets, and intangible resource that are skills which include capabilities.

3.2.3 Firm Resources and Sustained Competitive Advantage

Barney (1991) defined the definition of a sustained competitive advantage as one that depends upon the possibility of competitive duplication. A competitive advantage is sustained only if it continues to exist after efforts to duplicate that advantage have ceased. In this sense, this definition of sustained competitive advantage is an equilibrium definition. The attributes of the organizational resources that lead to the sustained competitive advantage for the firm are the following four attributes:

1) Valuable Resource, the Firm resource can be a source of competitive advantage or sustainable competitive advantage when they are valuable. The resources are valuable when they enable a firm to conceive of or implement strategies that improve its efficiency and effectiveness. The firms are able to improve their performance when their strategies exploit opportunities or threats.

2) Rare Resources, A firm pleases a competitive advantage when it is implementing a value creating strategy not simultaneously implemented by a large number of other firms. If a valuable firm resource is possessed by a large number of firms, then each of these firms has the capability of exploiting that resource, in the same way, the implementation of this strategy gives no one firm a competitive advantage.

3) Imperfectly Imitable Resources, Firm resource can be imperfectly imitable for one or a combination of three reasons: 1) The ability of a firm to obtain a resource is dependent upon unique historical condition, 2) the link between the resource possessed by a firm and a firm’s sustained competitive advantage is causally ambiguous 3) The resource generating a firm’s advantage is social complex.

4) Substitutability, The last requirement for a firm’s resources to be a source of sustained competitive advantage is that there must be no strategically equivalent valuable resource that is them either not rare or imitable. Substitutability

can take at least 2 forms, First it may not be possible for a firm to imitate another firm's resources exactly, Second, the different firm resources can be strategic substitutes.

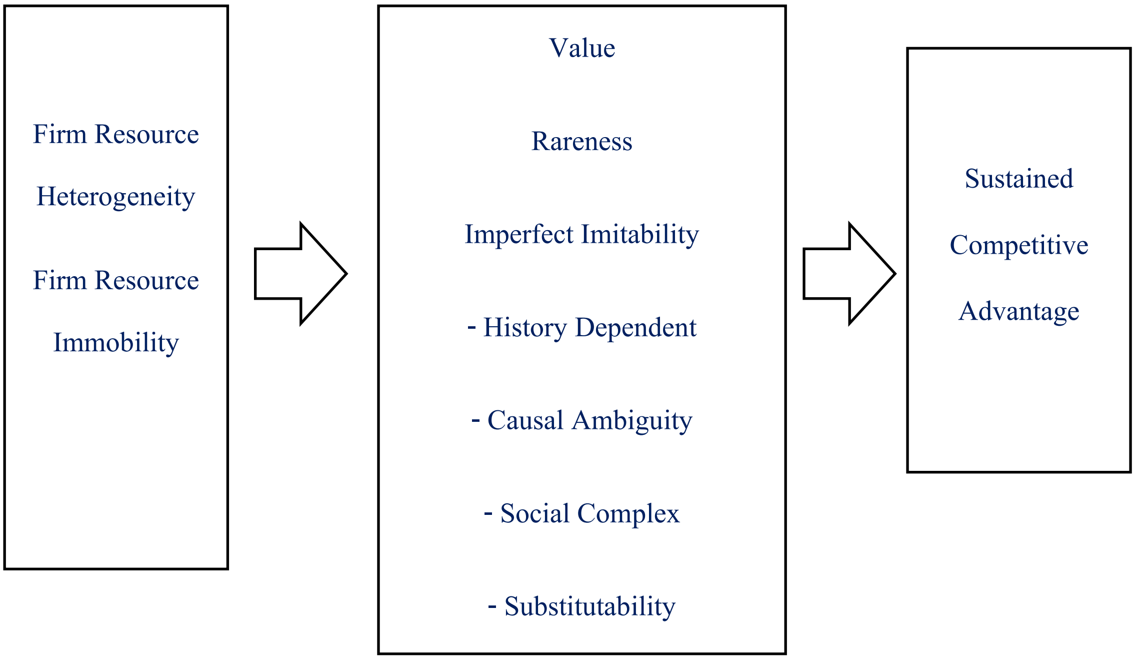

Figure 3.1 The Relationship of Firm Resources and Sustained Competitive Advantage

Source: Barney, 1991, p. 112.

3.2.4 The Importance of Tangible Resources and Organizational Performance

Resource Based view theory focuses on the internal resources of the organization. Resources of organizations include Tangible Assets and Intangible Assets, and both are important and have a role in creating value for the organization's performance. Tangible assets are special features of machines, materials used, appliances and (Galbreath, 2005) the tangible assets of the organization are the subjects of finance or valuable assets on the balance sheet of an organization. (Carmeli & Tishler, 2004) Examples of tangible resource factors in the woodworking industry are, geographic location, raw materials, employment, Plant, machinery, and financial capital. (Lahtien, 2007)

Table 3.1 Tangible Assets

Source	Definition
Barney (1991)	Tangible Assets include Physical Technology, Plants, Equipment Processes, Location, and Access to Raw Materials.
Carmeli and Tishler (2004)	Tangible Assets include Facilities, Raw Materials, and Equipment.
Galbreath (2005)	Tangible Assets include Physical Assets, Financial Assets, Assets Value shown in the Organization's Balance Sheet.
Kapelko, (2009)	Tangible Assets include Physical Technology, Plants, Equipment Process, Location, Access to Raw Materials and Financial Assets.

Source: Barney,1991; Carmeli and Tishler, 2004; Galbreath, 2005; Kapelko, 2009.

3.2.5 Supply Chain Management

Supply Management concern with the flow of goods and services through the organization with the aim of marking the firm more competitive, the goal is to contribute to the end user customers satisfaction, such as, the raw material management, cost reduction techniques, Quality Improvement, Lead Time Reduction, Increasing Profile of Profile, Outsourcing, Supply Base Delegation, Co-design, and the capability of the organizations in relationship to gain the competitive advantage. (Cousins & Spekman, 2003)

Mentzer, et al. (2001) defined Supply Chain as a set of firms that pass materials forward. Several independent firms are involved in manufacturing a product and placing it in the hands of the end user in a supply chain. The another definition notes a supply chain is the network of an organization that is involved through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services delivered to the consumer.

Types of Channel Relationships**:** 1) Direct Supply Chain, consists of a company, a supplier, a customer involved in the upstream and downstream flows of products, service, finances and information from a source to customers. 2) Extended Supply Chain, includes suppliers of the immediate supplier and customers of the immediate customers in the upstream and downstream flow of products, service, finances and information from a source to customers. 3) Ultimate Supply Chain, all the organizations involved in the upstream and downstream flows of products, service, finances and information from ultimate supplier to the ultimate customer. (Mentzer, et al., 2001, p. 4)

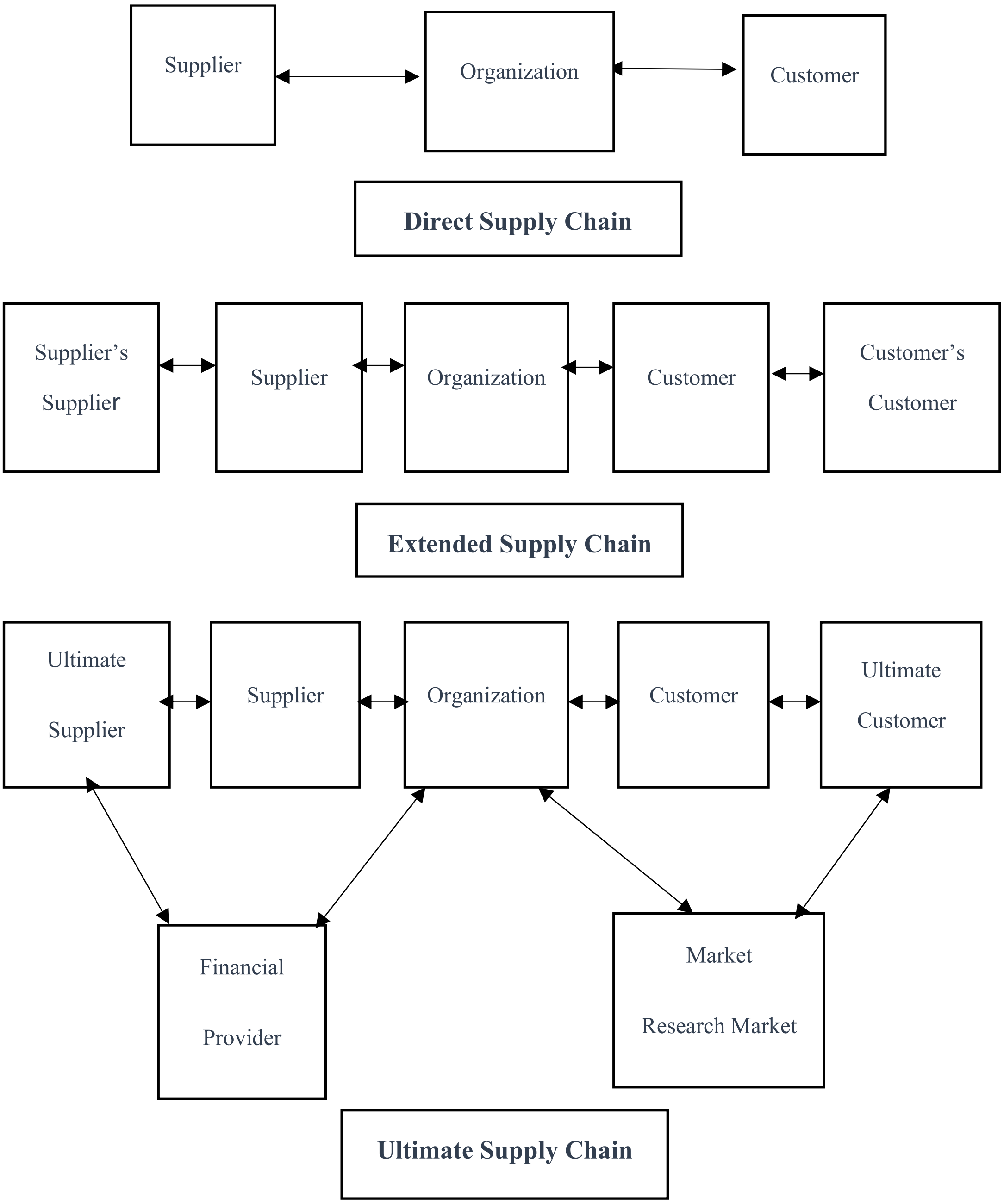

Figure 3.2 Types of Channel Relationships

Source: Mentzer, et al., 2001, p 5.

Many scholars study the supply chain from the critical role of The Resource dependency Theory and The Resource-Based View. The scholars import the supply chain in the Resource Dependency theory, which depends on the reliance on scarce resources from other organizations and the superior performance. Relying on the dependence of scarce resources, supply chain members need to be interrelated. Therefore, to achieve a superior performance over competitors, the members of the supply chain need to manage the relationships between each other. The supply chain management from The Resource-Based View is further described as: chain management is an important resource in an organization's ability to manage. Supply chain management is an important organizational strategy for competitive advantage. The detailed study of the importance of supply chain management in the theory of resource dependency and resource perspective is detailed in Table 3.2.

The summary of supply chain management is critical on The Resource Dependency theory from the operations of the organization, it is necessary to rely on resources that are lacking from other organizations in order to outperform the competitors. Moreover, supply chain management is important in The Resource Based-View concepts in terms of the organization's ability to manage resources.

Table 3.2 The Study of Supply Chain Management on The Resource Dependency Theory and The Resource-Based View

The role of Resource Dependency Theory			The role of Resource Based View		
Scholar	**Issue**	**The importance of the study**	**Scholar**	**Issue**	**The importance of the study**
Hult, Ketchen, and Nichols, (2003)	To integrate the resource dependence theory and the importance of Supply chain Management,	Resource Dependency Theory focuses on the interdependence between the organizations on reducing the uncertainty that occurs. Members in organizations in Supply Chain Management concept need to work together closely and to rely on each other.	Wu, Kim, and Cavusgil (2006)	Supply chain capabilities and firm performance	IT alignment and IT advancement as a strategic resource that impacts four dimensions of supply chain capabilities: Information exchange, coordination, activity integration, and SC responsiveness.
Craig and Roger (2008)	Applied Resource Dependence Theory to Organization Management, Supply Chain Management, the	Organizations need to survive and gain effectiveness from dependence on the other organization's resources.	Hult et al., (2006)	Knowledge as a strategic resource in supply chains	Effective fit between the eight knowledge elements and a particular strategy type is valuable, rare and

Table 3.2 (Continued)

The role of Resource Dependency Theory			The role of Resource Based View		
Scholar	**Issue**	**The importance of the study**	**Scholar**	**Issue**	**The importance of the study**
	usefulness of Supply Chain Management and Integration of the theory.	The important of the relationship between organizations. The more resource scarcity, the more dependence on the resources of other organizations.			inimitable as a strategic resource
Chirstope et al. (2011)	Resource Dependence Theory to Organization management, Supply Chain Management, the usefulness of Supply Chain Management and Integration of the theory.	Resource dependence theory focuses on uncertain environmental principles and exchanges among relations of scarce resources without the need to rely on resources from other organizations.	Rungtusanatham, Salvador, and Choi (2003)	The link of Supply Chain management and the organization's effectiveness.	The link of Supply Chain management in the organization on the chain is the organization's strategy.

Table 3.2 (Continued)

The role of Resource Dependency Theory			The role of Resource Based View		
Scholar	**Issue**	**The importance of the study**	**Scholar**	**Issue**	**The importance of the study**
Paulraj and Chen (2007)	The strategies of supply chain management and uncertainty in the environment based on the Resource dependence theory and organizational performance	Supply chain management is the concept of interdependence between the various organizations. The need for the organizations to rely on external resources and to achieve the superior performance of the organizations	Cousins and Menguc (2006)	Supply chain and its impact on supplier communication and operational performance	Supply chain socialization as a strategic resource that is valuable, rare, inimitable and non-substitutable and also intangible
Belaya and Hanf (2014)	The role of the power on the relationship between customers and suppliers in the Food Industry	Applied the resource dependency theory to the supply chain between the customers and suppliers. The role of the power on the relationship between customers and suppliers to survive and empower the organizations	Holldorson et al. (2007)	Contemporary theories of SCM	From RBV supply chain management seen as coordinated relational assets

3.3 Organization Effectiveness

The concept of organizational effectiveness (sometimes called organization “success” or organization “worth”) is ordinarily used to refer to goal-attainment. In a study of the industry, organizational effectiveness has been viewed in terms of productivity, net profit, the extent to which the organization accomplishes its various missions and the success of the organization in maintaining or expanding itself. The definition of Organizational Effectiveness must take account two aspects: the objectives of the organization and the means through which they sustain themselves as well as attain their objectives. The most important objectives of organizations are the high output of achieving the end results for which the organization was designed whether quantitatively or qualitatively, the ability to absorb and assimilate reverent endogenous and exogenous factors, and the preservation of organizational resources both human and material types of resources. (Georgopoulos & Tannenbaum, 1957)

The effectiveness of an organization is its ability to create acceptable outcomes and actions. It is important to avoid confusing organization effectiveness with organization efficiency. The difference between the two concepts is the heart of the external versus internal perspective on the organization. The most important part of organization effectiveness is the acceptability of an organization and its activities are ultimately judged from outside of the organization. The organization can manipulate, influence, and create acceptability of itself and its activities. The organization efficiency is an internal standard of performance, measured by the ratio of resources utilized to output production. (Pfeffer & Salancik, 1978, p. 11)

Jean-Franqois, (2004, p. 98) claimed Organizational effectiveness models are a various conceptualization of organization that yields different models of effectiveness. 1) Goal Model, The traditional model relies on a vision of the organization as a rational set of arrangements oriented towards the achievement of goals. Effectiveness is measured in terms of accomplishment of outcomes. The focus is exclusively on the ends: achievement of goals, objectives, targets, etc. 2) System Model, the system model emphasizes the means needed for the achievement of specific ends in terms of inputs, acquisition of resource and processes. 3) Strategic Constituencies Model, The model is the expectations of internal and external constituencies, as the owners, employees, customers, suppliers, creditors, community and government. The group must be satisfied in order to ensure the effectiveness and survival of the organization. 4) Competing Value Model, The model is using organization values as the 4 models of effectiveness as rational goals, internal process, open system and human relations 5) Ineffectiveness Model, the model focuses on the factors that inhibit successful organizational performance; this model evinces a different perspective by conceiving the organization as a set of problems and faults.

Table 3.3 The Effectiveness Model

Model	Conceptualization of the Organization	Focus	Advocates
Goal Model	Organization as a rational set of arrangement oriented toward achieving goals.	The accomplishment of outcomes.	Etzioni, 1960
System Model	Organization as an open system, input, transformation, output.	Inputs, acquisition of resource and internal process(means)	Yuchtman and Seashore, 1967
Strategic Constituencies Model	Organization as internal and external constitutes that a complex set of constraints, goals, and referents.	Response to the expectations of a powerful interest group that gravitates around the organization.	Connolly et al.. 1980
Competing Value Model	Organization as a set of competing values which create multiple conflicting goals.	Three dimensions of competing values: Internal vs external focus.	Quinn and Rohrbaugh, 1983

Table 3.3 (Continued)

Model	Conceptualization of the Organization	Focus	Advocates
		Control vs flexibility concern Ends vs means concern.	
Ineffectiveness Model	Organization as of problems and faults,	Factors that inhibit successful organization performance	Cameron, 1984

Source: Jean-Franqois, 2004, p. 99.

Cameron and Whetten (1996) discussed organizational effectiveness where multiple models of organizational effectiveness are products of multiples and arbitrary models of organization, the conceptual boundaries of effectiveness are not clear and the best of criteria for assessing organizational effectiveness are held by different constituency groups. The models of organizational effectiveness are goal models, System Resources, Internal resources, Strategic constituencies, Competing value, Legitimacy, and Fault-driven.

Tipawan Lorsuwanalat (2013, p. 145) Effectiveness is the working process to meet the objectives of an organization or the outputs comply with the objectives of the organization. The important modes of effectiveness of an organization as 5 important models, as following, 1) Goal Attainment Models, The effectiveness of the model is to accomplish the organization’s goals, for example, The goal of the company is to maximize the profit and for a non-profit organization is an acceptance from communities. 2) Systems Model, this model focuses on the sub-sectors in an organization that complies with the system theory. The effectiveness focuses on the survival of the organization in long term. The organization needs to maintain, adaptation, and survival. 3) Strategic constituencies Model, the effectiveness of this model are the competency, the capacity of response to the constituencies, and survival. 4) Competing-value Framework-CVF, the organizations have different objectives, the evaluation of the organization performance based on the evaluation criteria to assess whether there is any important or which are the most appropriate methods. 5) Balance Scorecard, The measure of the balanced scorecard is the organization performance that depends on the vision, organization's strategy, and results of operations. The Balance scorecard including 4 critical perspectives, such as financial perspective, customer perspective, internal processes perspective, and learning and growth perspective are to achieve a balanced measure of an organization's performance inside and outside of the organization.

Amporn Tamronglak (2008, p. 87) referred to the measure of organizational effectiveness, consisting of financial returns, Worker satisfaction, product and service quality, the trust, benefit to the community, satisfactory operation, respect for compliance with laws and regulations. Stakeholders include owners, employees, customers, creditors, community, suppliers, raw materials, and the government agencies, respectively. The details of the effectiveness of the organization shown in Table 3.3.

Table 3.4 The measure of organizational effectiveness

Stakeholders	Organizational Performance Indicators
Owners	financial returns
Employees	Worker satisfaction
Customers	product and service quality
Creditors	the trust
Communities	benefit to the community
Suppliers	satisfactory operation
Government agencies	respect for compliance with laws and regulations

Source: Amporn Tamronglak, 2008, p. 87.

Summary of the organization effectiveness refers to the performance of an organization that accomplishes the goals it targets. It is the efficient use of the resources of the business to maximize the benefits to both the organization and the stakeholders. Taking into consideration organizational benefits is the process of organizational development, progression, and growth. For the owner, is it worth the investment, for customers is to provide efficient products or services at customer satisfaction, for suppliers is the payment of raw materials on time, for the government agencies is respect to the regulations, for the community is to create benefit to the community and environment. In this study, the effectiveness of the small biomass power plant using the measure of effectiveness of financial performance, benefits the environment and community.

3.4 Integration Resource Dependence Theory and Resource-Based View

Resource dependency theory is a strong foundation that organizations do not have the resources needed to operate completely. The organization needs to seek external resources in order for the organization to survive. The theory discussed the importance of external resources that the organization needs. Organizations need to build relationships with other organizations to obtain the resources needed. The acquisition of resources from the others and keep reserves of the resources are important keys of the theory. (Pfeffer & Salancik, 1978). Resource models on The Resource Dependency Theory are resources from the environment and resources from other organizations. The strengths of the theory is that the theory focuses on getting external resources and acquires scarce resources. The limitations of the theory is the importance of the reliance on resources from other organizations, power and legitimacy but the theory does not focus on the key factors on the resource in the organization that drives the organization's success.

Resource Based View focuses on the internal organization’s resources, the variety of resources, the benefit of resources for the organization’s activity, the efficiency of the resource usage, the value of the resource, the relation of the resource and the organization ability. Barney (1991) The RBV distinguishes between a resource that can be acquired in factories or markets and those developed inside the firm. To confer competitive advantage, all competing firms must not possess the resource, they must be difficult to imitate or duplicate through other means, and contribute positively to performance. Resource Base Theory focuses on the internal organization's resources, however, not a priority to resources outside the organization to influence the organization's performance. Fraczkiewicz-Wronka & Karolina. (2012) claimed both Resource-based view and Resource Dependency Theory on their research as the researcher interested in RBV are usually focused on examining different resources in relation to performance. These who do research in the stream of RDT stress the efforts of organizations to reduce dependencies on external sources. In our research, we focused on the importance of internal and external resources for making strategic decisions that are based on stakeholders approach. In our research, we discovered that public hospitals use both resource dependence and resource based approaches in their decision making. These approaches are positively correlated, which means that managers who understand the importance of resources for decision making usually try to use both the external and internal view. First of all, they understand the importance of setting the goals on the basis of their own resources and resources that are owned by stakeholders. These organizations who do not recognize the role of their own resources also are not interested in resources that are in their environment, and vice versa.

Resource-based View and Resource Dependent Theory focus on the effectiveness of the organization. Tippawan Lorsuwanarat (2013, p. 280) comment on both resource-based view organizations and resource dependence theory. The concept of resource base view involves internal resources and internal factors of the organization. However, the resource dependence theory needs to compete to seek outside resources and maintain the resources. The integration of both theories makes perfect concepts and can be described in terms of resources, both within and outside of the organization resource.

Table 3.5 Integration Resource-Based View and Resource Dependence Theory

Topic	Resource Dependence Theory	Resource-Based View
Outcome	1) Effectiveness 2) Prior Performance 3) Organization Survival	1) Effectiveness 2) Prior Performance 3) The competitive Advantage
Resource	Resource from Environment or resource from an outside organization	Resource in Organization
Strength	The theory focuses on resources from the environment or outside the organization. The organization needs to seek and maintain for its survival.	The theory focuses on resources in the organization both tangible and intangible resource for the organization strategy.
Limitation	The Theory focus is on resource dependence from another organization, the power and legitimacy. However, the theory does not focus on the key factors as the resources within the organization and human resource management.	The theory focuses on the resource within the organization. However, in the market, Organization is one in the open system, including the sale of goods or provision of services to customers. The organization needs outside resources to use as raw materials in manufacturing, and also need to deal with other organizations for the important resource needed.

In this research, the research establishes the relationship between the factors that influence the effectiveness of small biomass power plants, and the effectiveness of small biomass power plants. The study of key factors in the operation of a biomass power plant consists of resources within the organization, such as the location of the plant, technology for electricity generation, the importance of biomass, biomass fuel management, employee skills, organizational culture or work values, community acceptance, and the internal resources of the business that are a part of the competitive advantage. However, in addition to the company's internal resources, biomass power plants need to use external resources, such as waste materials, biomass, and agricultural residues. Therefore, the reliance on the resources of biomass power plants with other organizations is an important factor in the operation of biomass power plants. The researcher integrates The Resource Dependency Theory and the Resource-Based view into a comprehensive study of both internal and external resources to describe the performance of an organization better than using one theoretical theory alone, because it gives a whole view of the resources within the organization and external resources that rely on interdependent resources.

3.5 The Related Research

Boasson (2001) studied the Location, Strategy and firm performance of the pharmaceutical manufacturing business. The purpose of this study is the importance of the physiological location of the pharmaceutical manufacturing industry in terms of its innovative effects on drug production and the financial performance of the pharmaceutical industry. The sample sets are the publicly traded companies in the United States pharmaceutical industry. By using quantitative research methodology to study the relationship between physical locations influencing innovativeness and financial performance of the business. The hypothesis focuses on the firm location, strategy, and firm performance. The study found that firm location in clusters exhibits stronger financial and stronger innovation than firms located outside clusters. The main finding indicates that geographic variable plays a significant role in company performance across the financial performance indicators. The firm performance indicators by the accounting standard indicators such as return on assets return on investment and the innovation based on patent counts.

Kakali (2004) studied the evaluation of the socio-economic and environmental impacts of the biomass Gasification-based power plants in Chottomollakhali island, India. It is a study by quantitative research methodology. The samplings is the population in Chottomollakhali island of Sunderbans with a total of 225 samples. The study uses the cost-benefit analysis to evaluate the benefits and cost return, internal rate of return, and payback period. The findings of the study indicate that Biomass Power plants based on the gasification made a very positive impact on the life of the villagers of Chottomollakhali island. The results led to increased economic activities and more profitable turnover for commercial consumers and improved quality of life for the household sector.

Chan, Lismen, Margaret (2004) studied In search of sustained competitive advantage: the impact of organizational culture, competitive strategy and human resource management practices on firm performance. It is a study using the quantitative research methodology. The samplings are from multiple industries in Hong Kong in the late 1990’s totally 1,422 samplings. Using matched data from senior executives and human resource managers. The study indicated that human resources management were not an important influence on firm performance. However, organizational culture can be a valued resource and influence the organization performance.

Fischer (2005) studied "Health and Social Impacts of Biomass Gasification for Household Energy in Rural China: Assessment from Three Perspectives and Emergent Insights from their Synthesis. The purpose of the study was to study the health and social outcomes and impacts of using biogas-based gasification technology. The methodology of this research is qualitative methodology. The samplings are the village in Jilin Province, China. The finding is using a Gasification technology and biomass as a fuel to generate electricity, proves useful to the economy, community and the environment, such as the economic benefits are useful as entrepreneurs emerge from the Biomass Power Plant setting. The community benefits from the generation of employment in the setting area, this creates new jobs in the community and helps develop the biomass in the community to use as fuel. The environment sees the setting of the factory as useful because there is a reduction of wildfires by a collection of waste in agriculture to reduce the burning by farmers and ultimately helps keep the environment clean from the reduced amount of wildfires.

Hysong (2008) studied “The Role of Technical Skill in Perceptions of Managerial Performance.” The purpose of the study is to determine whether technical skill provides incremental value over managerial performance. Using the quantitative methodology. The samplings is the Petrochemicals business in the United States with a total of 107 samples. The results of the study found that the technical skill included managerial skills, technical skills, power, and influence on the tactical habits, the managerial performance indicators as production output, subordinate job satisfaction, and subordinate rate. The finding is the technical skill rose incrementally with the perception of managerial performance.

Katila, Rosenberger, and Eisenhardt (2008) "Swimming with Sharks: Technology Ventures Defense Mechanisms and Corporate Relationships. The purpose of this study is to study the tensions of the business faced by reliance on other organizational resources and the mistakes made, the use of resources by choosing the wrong partner from the perspective of the new entity. The study focuses on the tension that firms face with the need of resources from a partner. The study uses the quantitative methodology. The finding is that entrepreneurs take a risk when they need a resource that established firms uniquely provide. Overall, findings show a tie between how information is negotiated on that depends on resource needs, defense mechanisms and alternative partners.

Feeman, and Styles (2013) study the firm location and performance in "Does Firm Location Influence the Export Performance of Australian SMEs?" The purpose of this study is to identify and analyze how location factors impact a firms' export performance. The sample of the study is Australian SMEs. The study found the firm location lead to the firm advantage on the competitors, such as the acquisition of resources to be used, to liaise with relevant government agencies, to ease of use of utility services, to manage skilled labor, to build business network opportunities and gain marketing advantages, to develop firm production and firm performance.

Nattapong Phuensaen (2011) studied " Public and Private Partnership and the Effectiveness of Policy to Promote the Generation of Electricity from Renewable Energy" The objective of this dissertation is to study the effect of Public and Private Partnerships and the effectiveness of policies to promote the generation of electricity from renewable energy. The literature reviews on public and private partnerships and to promote the use of renewable energy implementation in Thailand and Foreign Countries were conducted to create a framework for relations between the various factors to the effectiveness of the policy. The methodology of this research is mixed method research. The finding of the study is the regression analysis from sampling groups that can officially sell electricity to the public showed that Resources, Social Impacts, Structure/Regulations/Legal Issues, Capability, Coordination, Grid, Goals, and Incentives affected the effectiveness of policy significantly. Nonetheless, support from the government leaders has not affected the effectiveness of policy because most of the electricity generating equipment has already been installed. Therefore, only factors of concern are the continuous operation of electricity generation, which will alter the effectiveness of the policy.

3.6 Chapter Summary

Resource dependence theory focuses on external resources for the survival of the organization. The key to the survival of the organization is the ability to acquire and maintain the resources. The organization needs to control resources.

Resource-based View focuses on the resources within the organization consists of tangible assets and intangible assets. Tangible assets are critical to the operation of the organization, such as the plant, property, equipment, raw materials and financial position. Intangible assets, such as brands, patents, copyrights, registered in the contract in terms of trade, customer loyalty, distribution channels, network of organizations, the ability of employees in the organization, organizational culture, Information, the reputation of the organization, the coordination of the business, and human resources.

The Resource Dependency Theory and resource based-view, both focus on the organization effectiveness, the organization effectiveness refers to the performance of an organization that accomplishes the goals it targets. It is the efficient use of the resources of the business to maximize the benefits to both the organization and the stakeholders. Taking into consideration organizational benefits is the process of organizational development, progression, and growth. For the owner, it is worth the investment, for the customer it is to provide efficient products or services at customer satisfaction, for suppliers it is the payment of raw materials on time, for the government agencies it is respect to the regulations, for the community it is to create benefit to the community and environment.

The researcher integrated The Resource Dependency Theory and resource based-view to study the organization resource to maximize the use of resources in the organization's resources, internal, external and between resources to benefits that can create success in the implementation of the goals of the biomass power plants in Thailand. In this study, the effectiveness of the small biomass power plant using the measure of effectiveness of Financial performance, benefit to the environment and to the community.

CHAPTER 4

METHODOLOGY

This chapter contains the mixed method research design methodology, the methodology of the study, population and samplings, the instrument of the study, testing the instrument of the study, data collection, data analysis, and chapter summary.

4.1 Mixed Method Research Design

This study is designed with the mixed method methodology by integration of quantitative and qualitative research methods together in order to answer the research questions extensively, deeply, and completely. The Mixed Method is designed by using a combination of quantitative method with using the strengths of quantitative method to support the weaknesses of qualitative method and using the strength of qualitative method to support the weakness of the quantitative method. Quantitative research is often confirmatory in nature and driven by theory and the current state of knowledge about the phenomenon under study. A theory is generally understood to refer to a unified, systematic explanation of a diverse range of social phenomena. Quantitative research generate hypotheses that can be tested using statistical techniques. Quantitative research employ deductive or reasoning, which involves arguing from the general to the particular. (Teddie & Tashakkori, 2009, p. 23) The ultimate goal of the Mixed Method is superior to the single approach as following, The Mixed Method can simultaneous address a range of confirmatory and exploratory questions with both the qualitative and the quantitative approaches, The Mixed Method provide better inferences, and the Mixed Method provides the opportunity for a greater assortment of divergent views. (Teddie & Tashakkori, 2009, p. 33) This study is using the Mixed Method with Qualitative method and Quantitative Method by the Sequential Mixed Method, designed as the Exploratory Design. This method is well known as The Sequential Exploratory Mixed Method. (Creswell, 2003)

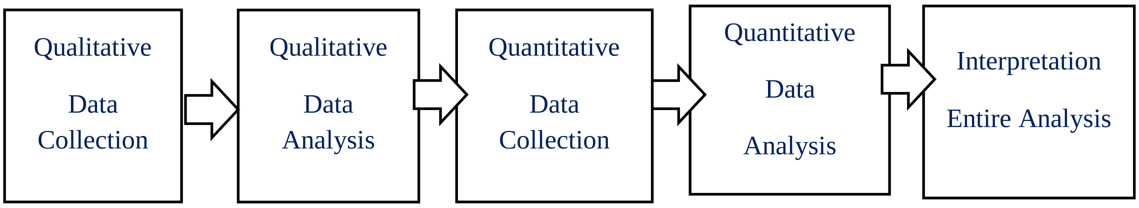

Figure 4.1 The Sequential Explanatory Design

Source: Creswell, 2003.

The research use The Sequential Mixed Method with Sequential exploratory, with Sequential Exploratory Qualitative $\longrightarrow$ Quantitative (Creswell, 2009, p. 212) claimed with Sequential Exploratory Mixed Method, separated into 3 important phases, phase I is the qualitative methodology, data collection and data analysis. Phase II, the developing the instrument, create the questionnaire to use with sampling in Quantitative method. Phase III, the quantitative methodology. On Phase I, The researcher used qualitative with in-depth interviews with the sampling to seek the important issues of the key success factors to operate in the small power plants and the effectiveness of the small power plants and used the important issues to develop the questionnaire for collection of the quantitation method, and analysis data of the quantitative method to confirm and disconfirm the qualitative methodology and compare the findings of both methodologies.

Teddlie and Tashakkori (2009, p. 275) claimed the conclusion and discussion on The Sequential Mixed Method with Sequential exploratory as the use of the qualitative research to explore the situation, events, issues, and the findings as well as to use the quantitative research with the exploratory factor analysis or the Structural Equation Method to evaluate the latent variables with the construct identification and construct validation. The final interference should conclude separately on the qualitative and quantitative method and use the findings of the quantitative data to confirm or disconfirm the qualitative findings. The researcher may compare the findings between the qualitative and quantitative methodology.

4.2 The Research Methodology

For this study, the researcher used a combination study from Qualitative and Quantitative study. The methodology consists of qualitative and quantitative methods as follows:

4.2.1 The Qualitative Methodology

Phase I, The qualitative study focuses on the findings of the key factors of success influencing the success of the operation of Small Biomass Power Plants, and effectiveness of the operations of small biomass power plants in Thailand. The qualitative study consists of 4 sections as the following:

The first sections, The document research with study paper of the effectiveness of the organization, the key factor of success of biomass power plants and other industries, the process of small power plants in Thailand, the regulations and laws of the operation of small power plants.

The second section is the in-depth interviews with the professional on public units related to the small power plants, and the executives of the small biomass power plants with the interview forms. The main issues of the interview forms are the key factor of success on the operations and the effectiveness of small biomass power plants.

The third section, is the discussion with the community surrounding the power plants with the discussion form. The main issues on the form are the relationships between the community and the power plants and the results of the power plant to the community.

The forth section is the fieldwork and interviews of the executives of the small power plants. This section is very useful to understand the working process on the small biomass power plants, the factors of the operation and the effectiveness of the biomass power plants.

The qualitative method used clear parameters, finding the variables to define the concept, and to clarify the measurement of the variables to be used in the questionnaire for the quantitative research to collect data from small biomass power plants in Thailand. The data analysis from the qualitative method may differ from the literature review and may have more information from the literature review. The important issues from the qualitative method can be clear or unclear variables on the quantitative method especially the measurement of the variables. The research used the important qualitative methods to create the questionnaires for collecting data from the quantitative method. The samplings on the quantitative method is the biomass power plant that has a 10 megawatt purchase contract.

4.2.2 The Quantitative Research Design

This quantitative methodology is phase II of this research study. This methodology study is the continuous study from the qualitative methodology as the researcher developed the important issues from interviewing and holding group meetings with 24 items. There are 3 issues of effectiveness of Small Biomass Power plant as, the effectiveness of the Environment, the effectiveness of the community and the effectiveness of the finance. There are 21 issues of The key factors of success on the effectiveness of Small biomass power plants, as the following: Biomass fuel, Technology producing the electricity units, The knowledge, skill and abilities of employees, The government subsidy, The location of Small power plants, The community acceptance, The initial project design, The management, The dependence on the biomass fuel from outside, Rules and orders of government for setting and operation of Small biomass power plants, The organizational culture, The executive vision, The potential of grid lines, The accessory of connecting the electricity, The distance of biomass source, Knowledge development, The supply chain management, The purchase agreement of electricity selling, local politics, and The crude oil price. The researcher used all mentioned issues to design the questionnaire to be the instrument of Quantitative method for the small biomass power plants in Thailand totaling 342 factories. The sample set is small biomass power plants that have contracts for the sale of electricity to the power maximum of 10 MW, using biomass as fuel, Thermal technology, Gasification and fermentation technology with the questionnaire for collecting the data. After the research has been collected adequately, the researcher used Exploratory Factor Analysis, Conceptual Framework, The assumption, Confirmatory Factory Analysis, and Statistic in the quantitative Methodology. The study is a Non-experimental design as Suchitra Boonyaruttapunth

(2012, p. 66) claimed to define a research experiment that the study phenomena occur in nature are really not trying to force the variables. The study of variables for the impact occurred on the dependent variable and there are Cross-Sectional Studies that study the data from the data collected over a long period of time. The data collection in late September-November 2016 and additional collecting in the half of November 2016 by using a questionnaire sent to the organizations with the registered mail. The researcher followed up the results from questionnaires every two weeks. Then the researcher sent the questionnaires using Express Mail Service again for executives who did not answer the questionnaire. When the researcher obtained the information from the questionnaire as required, checked the completeness of the questionnaire, sorted the data from the questionnaire with SPSS, and used the SPPP program to analyze the data of the respondents' basic information. Exploratory Factors Analysis was used to extract variables and group variables. When analyzing the survey elements with the SPSS program, the researcher introduced the variables from the grouping. To create a conceptual framework hypothesis and analysis of Confirmatory Factor Analysis with SPSS AMOS version 24 program to analyze key factors influencing the effectiveness of small biomass power plants. Effectiveness of small biomass power plants and analysis of structural equations to investigate hypotheses, research and quantitative research reports, respectively. Details of the procedure are shown in Figure 4.2.

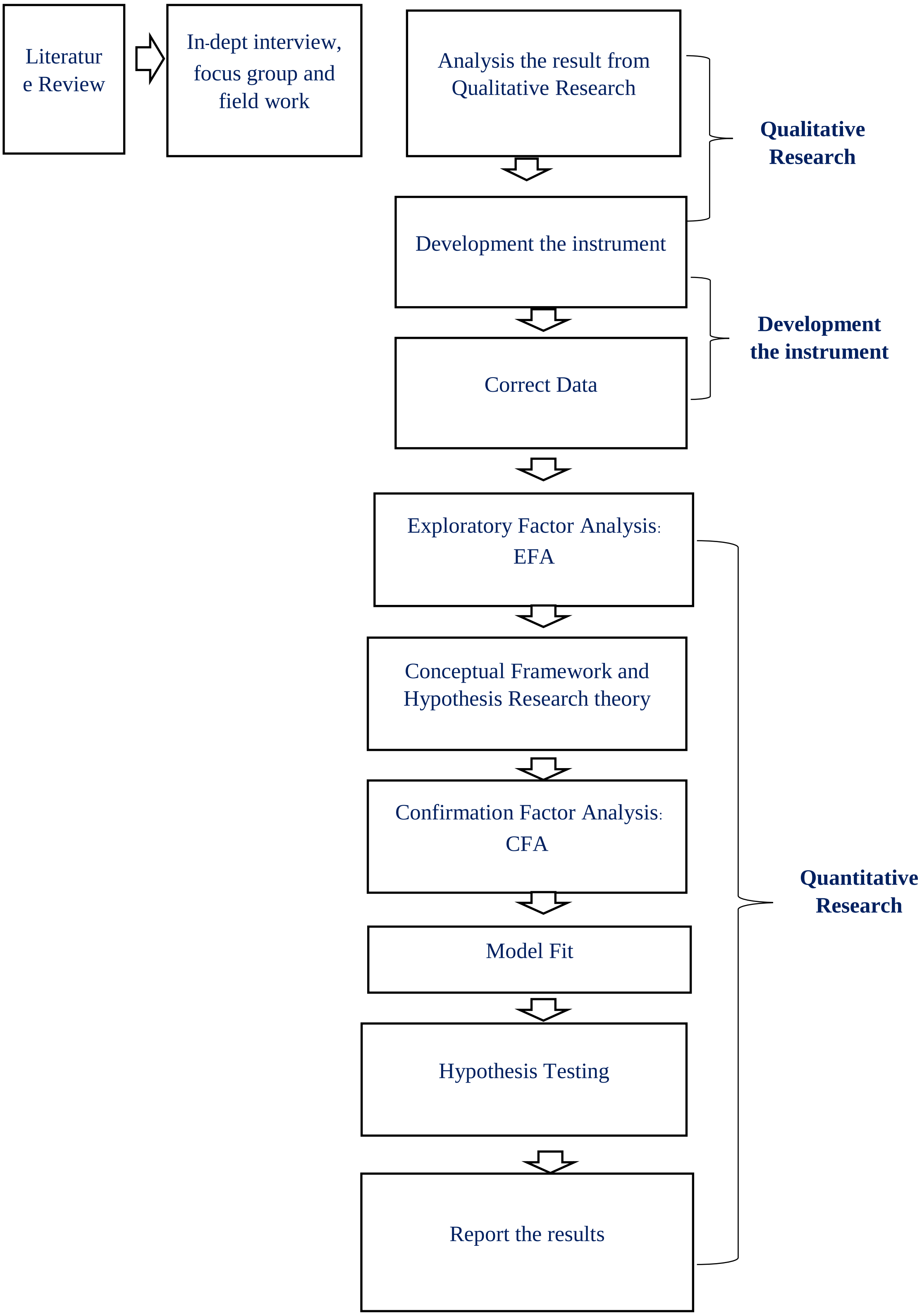

Figure 4.2 The Quantitative Research Sequent from the Qualitative Research

4.3 The Scope of the Study

The scope of this study as following:

4.3.1 Phase 1: The Qualitative Methodology

Stage 1: Documentation, Literature Review, Data, Samplings, and instrument of Qualitative methodology, from September 2015 to April 2016.

Stage 2: Collecting the data by interviewing the samplings from May to July 2016.

Stage 3: Report the Qualitative Methodology in July 2016.

4.3.2 Phase 2: Design and Development of the instrument

Stage 4: Design the instrument of The Quantitative research in August 2016.

Stage 5: Test the Questionnaires from 30 of the first samplings in August 2016.

Stage 6: Develop the Questionnaires in August 2016.

4.3.3 Phase 3: The Quantitative Methodology

Stage 7: Data collection from samplings from September - December 2016.

Stage 8: Data analysis, report, and discussion from December 2016 to March 2017.

4.4 The Population and the Sampling of the Study

In this study, the researcher studied small-scale power plants that use biomass as a primary fuel for power generation from thermo, gasification, and fermentation technology with a capacity of electricity not exceeding 10 megawatts all over Thailand. In the qualitative research, the research use specific samples and on the quantitative research use simple of samplings.

4.4.1 The Population

The population of the study is the Small Power plants, using biomass fuel for producing electricity units, and sell the electricity units to PEA, with thermo, gasification and fermentation technology. The power plants have the licensing and allowance for producing the electricity from the Energy Regulatory Commission until December 2015. These biomass power plants have the contract for selling the electricity units within 10-megawatts for a total of 343 plants.

4.4.2 The Samplings of the Qualitative Research

Qualitative sample selection in qualitative research is done to set the samples for good knowledge and experience in biomass power plants in Thailand and to provide the most complete data collection. By specifying a sample from government agencies as an executive who specializes in small biomass power plants, and specify the samples from the private sectors as an executive or experienced management representative in the biomass power plant as the primary fuel for the thermo, Gasification, and fermentation technology, according to a different capacity. Collection of data from a community meeting in the area around a small biomass power plant and the field study has also been done.

The sampling of the qualitative method is the selection of 3 groups as: 1) The executives with expertise of Small Biomass Power Plants from the government sector 6 samples. 2) The executives of Small Biomass Power Plants from the private sector 13 samples. 3) The community surrounding Small Biomass Power Plant 2 groups, and the field study from 2 power plants.

The details of the samplings are as follows:

1) The first sampling group is the executive and expertise of Small Biomass Power plants from government agencies with 6 samples.

(1) Dr. Prasert SinsukPrasert, Deputy of Energy Policy and Planning office, and Mr. Reakrit Khenharach, Director of Renewable Department, the executive from Energy Policy and Planning office, Ministry of Energy, Thailand

The importance of Energy Policy and Planning office, Ministry of Energy is the key organization of the Ministry of Energy. The functions of the organizations are to create and to manage the Energy Policy and Planning of energy for the sustainability of Energy in Thailand.

(2) Ms. Pitsamai Satheanyanon, Renewable expert, the executive from the Department of Alternative Energy Development and Efficiency.

The importance of the Department of Alternative Energy Development and Efficiency is an agency of the government that oversees the development of renewable energy, such as, biomass bioenergy, solar, wind, and water in Thailand.

(3) Dr. Prasit Siritipratsami, Director of Engineering and the technical Department as well as an executive from the Energy Regulatory Commission.

The importance of the Energy Regulatory Commission is being the sole agency of the government that has functions to manage an energy management system, provides the stable, reliable and efficient system of the firms that operate the energy systems to be fair to all users and the operation of firms in the energy industry.

(4) Mr. Monthon Vasuvaranich, The executive from the Energy for Environment Foundation

The importance of Energy for the Environment Foundation is the agency supported by the government's energy policy. The functions of the foundations are to promote the use of renewable energy, the knowledge, the concepts, the science of producing electricity from renewables in the country widespread, such as, to promote of the use of biomass as an energy source that exists in the country, to establish the promotion of the biomass energy center for promotion, and finally, the adoption of biomass to produce the electricity.

(5) Dr. Nutthapong Peangseang, Assistance of the project manager of renewables, Thasakea Project. The executive from Electricity Generating Authority of Thailand.

The importance of Electricity Generating Authority of Thailand is the state enterprise under the Ministry of Energy which serves and produces the power generation use in Thailand. The functions are to impose the conditions on power quality, the condition of engineering and the security of the power system. The agency controls the private firms that produce, sell the electricity units to Electricity Generating Authority of Thailand, Metropolitan Electricity Authority and Provincial Electricity Authority by connecting the electrical systems.

2) The second set of samplings are the executives from Small Biomass Power Plants in the private sectors totaling 13 plants. The samples are set specific by the technology used to produce the electricity units and the sale of units to PEA. The samplings are 5 plants producing electricity from Gasification, 5 plants producing electricity from thermo, and 3 plants using fermentation technology.

(1) The sampling from Small Power Plants that use biomass fuel with Gasification technology to produce the electricity totals 5 plants. The power plants are assorted by their capacity as follows.

(1.1) Mr.Yai Saithai, The president of Supreme Renewable Energy Company Limited. The prototype plants in Chiang-rai province. Supreme Renewable Energy Company Limited operate a Very Small Power Producer using corncobs as fuel and gasification technology for producing the electricity. The power plant is located in the Northern part of Thailand. The electricity producing capacity is 150 Kilowatts. The company won The Asian Award in 2010.

(1.2) Mr. Atichart Raksajit and Dr. Nared Chininmanu, The project manager and the consultant of Rice Mill of The Chaipattana Fundation. The project manager of Rice Mill of The Chaipattana Foundation, Aumpur Ladboulung, Pranakornsri Ayuttaya province. The rice mill of The Chaipattana Fundation is The Demonstration and The Energy Development Center. The center for developing technology from rice agriculture for use as a biomass from the rice husks to be fuel in small power plants with the zero waste, management project. The rice mill and small power plants are located in the central part of Thailand. The small power plants use gasification technology to produce electricity. The capacity they are producing is at 200 kilowatts. The purpose of the Zero Waste Management is to use the products from upstream to downstream, for example, the rice products, by-products from rice, and biomass or residuals from rice husks to be the fuel in the small power plants.

(1.3) Mr. Siripong Seangsuk, Deputy Chief Executive of Nakhornpanom Provincial Administration Organization. Nakhornpanom Provincial Administration Organization has a small biomass power plant located in amphur Papak, Northeastern part of Thailand. The power plant uses wood chips as fuel and gasification technology for producing the electricity units. Nakhornpanom Provincial Administration Organization’s objective of building the small biomass power plant is for the prototype of plants with gasification technology, the development of the fast growing trees to support the plants as fuel, and to develop the prototype power plant for the private and government sectors.

(1.4) Mr. Phamin Sawetsira, an executive from Asia Green Power Company Limited. Amphur Hanka, Chai Nat Province. Asia Green Power Company Limited operates a Very Small Power Plant using woodchips as fuel with gasification technology for producing the electricity. The power plants are located in the Central part of Thailand. The capability of producing electricity is at 1 megawatt. The company has their own area for producing the fast growing trees.

(1.5) Mr. Thanet Masanthi, The factory manager of Plan Eco Energy Company Limited, Yan Ta Khun, Trang. Plan Eco Energy Company Limited operates a small biomass power that is located in the Southern part of Thailand. The factory uses roots of rubber trees as fuel and gasification technology for producing the electricity units. The power plant's is at a capacity of 5 megawatts. The government subsidises some part of their financial plan to the Eco Energy Company Limited.

(2) The samplings from Small Power Plants that use biomass fuel with thermo technology to produce electricity totals 5 plants. The power plants are assorted by the capacity as the following:

(2.1) Mr. Vasan Vongraj, an executive representative from The MITR small power plant Group is The Vice President of the Power plant. MTR Phol Bio-Power (Dan Chang) Company limited. Dan Chang district. Suphanburi Province. MTR Phol Grop operates a Sugar Mill and small biomass power plants. In part of the small power plants they use the residuals from the sugar mill as fuel and thermo technology to produce electricity units. The small power plant of MTR Phol group has a capacity from 10-90 megawatts. The plants are located in the Central and Northeastern part of Thailand.

(2.2) Mr. Aphipong Vitchuvetkamine, an executive representative from The Sahacogen Group is an executive from Sahacogen Green Company limited, Amphur Meaung, Lumpun Province. The Sahacogen operates a small power plant and the related energy company to produce electricity units. The small power plants are in the Central and Northern parts of Thailand.

(2.3) Ms. Jaruwan Khansonkit, a secretary of the executive of Evergreen Plus Company Limited. The executive from Evergreen Plus Company Limited, Amphur Pattatnanikhum, Lopburi Province. Evergreen Plus Company Limited operates small biomass power plants with thermo technology. The capacity is 10 megawatts. The power plant is located in the Central part of Thailand.

(2.4) Mr. Somnuk Jindasab, The executive from Rachaburi Holding Company Limited, Bangkok.

Rachaburi Holding Company Limited is the investors and owners of the small power plants and the power plants as well as relegated energy companies in Thailand. There are many renewable power plants using both biomass and solar in Thailand and international locations.

(2.5) Mr. Navaphon Disatheian, an executive from Songkhla Biomass Company Limited, Aumpur Jana, SongKhla Province. Songkhla Biomass Company Limited operates a Small Biomass Power plant. The plant is located in the Southern part of Thailand. The power plant uses roots from rubber trees for fuel and thermos technology to produce electricity units. The capacity is 10 Megawatts. The power plant has a special subsidy from PEA as the power plant is one of the 3 special area border provinces in Southern Thailand.

(3) The sampling from Small Power Plants that use biomass fuel with fermentation technology or biogas to produce the electricity totals 3 plants. The power plants are assorted by the capacity as follows.

(3.1) Mr. Jadsada Chotivattna, The factory manager of Asain Palm Oil Company Limited with thermo and fermentation Technology, Amphur Auluk, Krabi Province. Asain Palm Oil Company Limited operate the palm oil production and produce the electric units. The factory uses the residuals from palm oil and the waste from the factory to produce the electricity units. The factory uses thermo technology to produce electricity units for energy in the palm oil production process and uses the fermentation technology to produce biogas in order to produce electricity, which they sell to the Provincial Electricity Authority, PEA. The electricity producing capacity is 3.6 megawatts. The factory is located in the Southern part of Thailand.

(3.2) Mr. Phudit Maneechot an executive from Maxwell Company Limited and BanHun Group, Amphur Srikeaw, Nakhonrachasima Province. Maxwell Company Limited and BanHun Group operate a Very Small Power Plant using residuals from cassava and wastewater from the cassava production industry. The factory is located in the Northeastern part of Thailand. The power plants use fermentation technology to produce electricity units. The capacity of the group is at 2 megawatts.

(3.3) Mr. Sothana Pheamchart, an executive from Khunpat Peang Power plant, Amphur Authong, Supanburi Province. Khunpat Peang Power plant operates a Very Small Power Plant with fermentation technology from residues and wastewater to produce the electricity units. The capacity is 1 megawatt and located in the Central part of Thailand.

3) The third sampling is from the community surrounding the Power plants.

(1) The leaders and the members of community surrounding Asain Palm Oil power plant in Aumpir Auluk, Krabi Province.

(2) The leader of the members of the community surrounding Nakhornpanom Provincial Administration Organization power plant, Parkpak, Nakhornpanom Province.

4) Study Field, the research studies the following fields: 1) The project manager of Rice Mill of The Chaipattana Foundation. Aumpur Ladboulung, Pranakornsri Ayuttaya province. The rice mill of The Chaipattana Fundation is The Demonstration and The Energy Development Center. The center for development of energy from rice agriculture to use as biomass from rice husks as fuel in small power plants with the zero waste management project. The small power plant has 0.20 megawatts capacity. 2) Asain Palm Oil Company Limited operates a palm oil production facility and produces electricity units. The factory uses the residuals from palm oil and the waste from the factory to produce electricity units. The factory uses thermo technology to produce electricity units for energy in the palm oil production process and uses fermentation technology to produce biogas as well as produce electricity which is sold to the Provincial Electricity Authority, PEA. The electricity producing capacity is at 3.6 megawatts. These two small biomass power plants allow research to be done for studies inside the power plants with useful suggestions.

Table 4.1 The Professionals of Small Biomass Power Plants from Government sectors

Sampling	Organization	Address
Dr. Prasert SinsukPrasert Deputy of the Energy Policy and Planning office	Energy Policy and Planning office, Ministry of Energy, Thailand	121/1-2 Petchaburi 7, Thung Phayathai, Ratchathevi, Bangkok, 10400
Mr. Reakrit Khenharach Director of Renewables Department	Energy Policy and Planning office, Ministry of Energy, Thailand	121/1-2 Petchaburi 7, Thung Phayathai, Ratchathevi, Bangkok, 10400
Ms. Pitsamai Satheanyanon Renewable expert	Department of Alternative, Energy Development and Efficiency	17 Rama1 Road, Phathumvan, Bangkok,10330
Dr. Prasit Siritipratsami Director of Engineering and Technical Department	Energy Regulatory Commission	319 Jaturatjamchuri Building, 19 floor, Phayathai Road, Phathumvan, Bangkok,10330
Mr. Monthon Vasuvaranich An executive of the foundation	Energy for the Environment Foundation	99/305 TashabansoungKoal, Ladyao, Jatujak, Bankkok 10900
Dr. Nutthapong Peangseang Assistant of the project management of renewables, Thasakea Project	Electricity Generating Authority of Thailand	53 Moo2, Jaransanitvong, Aumphur Bangkrew, Nonthaburi Province,11130

Table 4.2 The Executives of Small Biomass Power Plants, which Produce Electricity

Name	**Address**	**Capability Megawatt**	**Experience**
Gasification Technology			
Mr. Yai Saithai The president of Supreme Renewable Energy Company Limited	101 Moo5, Banpangka-Banpharea Road, Tamboon Rayhow, Aumpur Veiwkan, Cheangrai Province, 57310	0.15	2553 (5 years)
Mr. Atichart Raksajit and Dr. Nared Chininmanu The project manager and the consultant of Rice Mill of The Chaipattana Foundation	99 Tamboon Ladbuoroung, Aumpur Ladbuoroung, Phanakhonsri Ayutaya Province	0.20	2555 (4 years)
Mr. Siripong Seangsuk The Deputy Chief Executive of Nakhornpanom Provincial Administration Organization	Nakhornpanom Provincial Administration Organization 151/1 Nakhonphanom-Thautan Road, Taboom Papak,Aumpur Meang, Nakhornpanom Province, 48000 256 Moo 2, Taboon Nonghee, Aumpur Meang, Nakhornpanom Province,48000	0.35	2556 (3 years)
Mr. Phamin Sawetsira The executive of Asia Green Power Company Limited	15/1 Taboon Deangha, Aumpur Hanka, Chai Nat Province	1.00	2558 (2 years)

Table 4.2 (Continued)

Name	Address	Capability Megawatt	Experience
Gasification Technology			
Mr.Thanet Masanthi The factory manager of Plan Econergy Company Limited	124/1 Moo 2, Taboon Naikhoan, Aumpur Yantakhaw, Trang, 92140	8.00	2555 (4 years)
Thermo Technology			
Mr. Vasan Vongraj The executive representative from The MITR small power plant Group is The Vice President of Power plant	1) MTR Phol Bio Power Company Limited, Aumpur Phukaew, Chaiyaphum Province	10 (Chaiyaphum)	2547 (12 years)
	2) MTR Phol Bio-Power (Dan Chang) Company limited. Dan Chang district, Suphanburi Province	25 (Suphanburi)	2547 (12 years)
	3) MTR Phol Karasin Bio Energy Compnay Limited Kuchinarai, Kalasin Province	28 (Kalasin)	2555 (4 years)
	4) MTR Phol Bio Power Phuleaw, Wangsapung, Lea Province	42 (Lea)	2556 (2 years)
Mr. Aphipong Vitchuvetkamine The executive representative from The Sahacogen Group	Head office: 636 Moo11 Sukhapiban 8, Tamboon Nongkham, Aumpur Sriracha, Chonburi Province 20230 Power plants in Khamphangpet and Lumpun	7.5 (Khamphangpet) 9.6 (Lumpon)	2549 (11 years)

Table 4.2 (Continued)

Name	Address	Capability Megawatt	Experience
Ms. Jaruwan Khansonkit The secretary of the executive of Evergreen Plus Company Limited	180 Moo 11, Soi 29, Nikhum Wang Moung Road, Taboon Nong Meaung, Amphur Pattatnanikhum, Lopburi Province	9	2556 (2 years)
Mr. Somnuk Jindasab Rachaburi Holding Company Limited	8/8 Moo 2, Ngamvongvan, Bangkhen, Aumpur Mueang, Nonthaburi, 11100	9.9	2557 (2 years)
Mr. Navaphon Disatheian An executive of Songkhla Biomass Company Limited	56 Moo 3, taboon Khuntadvai, Aumphur Jana, Songkha Province 90130	9.9	2557 (2 years)
Fermentation Technology			
Mr. Jadsada Chotivattna The factory manager of Asain Palm Oil Company Limited with thermo and fermentation Technology	99 Moo 2, Taboon Auluktai, Aumpur Auluk, Krabi Province 81110	3.6	2540(19 years)
Mr. Phudit Maneechot an executive from Maxwell Company Limited and BanHun Group,	Taboon Banhun, Aumpur Srikeaw, Nakornrachasima Province	2	2555(3 years)
Mr. Sothana Pheamchart An executive from Khunpat Peang Power plant	333 Moo 6, Taboon Saiyaysom, Aumpur Authong, Supanburi Province	1	2549 (10 years)

Table 4.3 The Third Samplings are from the Community Surrounding the Power Plants

Community	Address	Power Plant
The leader of members of the community surrounding Nakhornpanom Provincial Administration Organization	Taboom Papak, Aumpur Meang, Nakhornpanom Province, 48000	Biomass power plant of Nakhornpanom Provincial Administration Organization
The leader of the members of the community surrounding Asain Palm Oil power plant in Amhpur Auluk, Krabi Province	Taboon Auluktai, Amphur Auluk, Krabi Province 81110	Asain Palm Oil power plant with thermo and fermentation Technology

4.4.3 The Sampling on the Quantitative Research

The sampling of this study is from the power plants that use biomass as the fuel all over Thailand. There are 33 samplings of power plants from the Northern region, Northeastern 98, central 72, Western 34, Eastern 28, Southern 77, for a total of 343 samplings.

Table 4.4 The Number of Small Biomass Power Plants in Thailand

Part of Thailand	Total
Northern	33
Northeastern	98
Central	73
Western	34
Eastern	28
Southern	77
Total	343

Sources: Energy Regulatory Commission, 2016.

4.5 The Instruments of the Research

The instruments used in this research consist of two main components: qualitative research and quantitative research instruments. In this qualitative research, the tools used in the research were Semi-structured interviews and questions for group meetings. The quantitative research used a questionnaire developed from key issues of qualitative research.

4.5.1 The Instrument of Qualitative Methodology

In the qualitative research, the research uses an instrument for interviewing and focus groups with 3 forms.

1) The interview forms for in-depth interviews of the experts of Small Biomass Power Plants in government agencies with 5 parts as follows:

Part 1: General, personal Information

Part 2: The current situation of the Small Power Plants in Thailand

Part 3: The key factors of success of the effectiveness of Small Power Plants

Part 4: The general effectiveness of Small Power Plants

Part 5: The suggestions from the experts

2) The interview form for in-depth interviews of experts of Small Biomass Power Plants in the private sectors with 5 parts as follows:

Part 1: General, personal Information

Part 2: The general information of the Small Power Plants operation

Part 3: The key factor to the success of the effectiveness of the Small Power Plants

Part 4: The effectiveness of the Small Power Plants

Part 5: The suggestions from the executives

3) The interview form for focus groups for discussions with the leaders and the members of the community surrounding the Small Biomass Power Plants with 3 parts as follows:

Part 1: The relationship between the community and the Small power plant

Part 2: The benefit of the operation of Small Power Plants to the community

Part 3: The suggestions from the community

4.5.2 The Instruments of Quantitative Methodology

The instrument of Quantitative Methodology is Phase 2 of the research. The instrument or questionnaires were developed from the key issues from the qualitative research. The researcher uses the key factors from the important factors which effect the effectiveness of small biomass power plants and the effectiveness of small biomass power plants that consists of: 1) The Independent variables, The independent variables on questionnaires are the key factors of success and issues of small biomass power plants sorted in descending order as follows, Biomass fuel, Technology producing the electricity units, The knowledge, Skills and abilities of employees, The government subsidies, The location of the Small power plant, The community acceptance, The biomass fuel management, The initial project design, The administration of small biomass power plants, The dependence on the biomass fuel from outside, The regulations and laws for setting up and operating the small biomass power plant, The organizational culture, The executive vision, The potential of the grid lines, The accessories of connection to the electricity system, The distance of biomass sources, Knowledge development, The supply chain management, The purchase agreement of electricity selling, local politics and The crude oil price. 2) The dependent variables, The dependent variables are the effectiveness of small biomass power plants as following the effectiveness of finance, the effectiveness of the environment, and the effectiveness of the community.

4.5.3 Variables and References of Source Variables in Quantitative Research

1) The government subsidy, the important of the government subsidy affects the effectiveness of small biomass power plants. (Ms. Pitsamai Satheanyanon, Dr. Prasert SinsukPrasert, Mr. Monthon Vasuvaranich, Ms. Jaruwan Khansonkit, Mr. Atichart Raksajit and Dr. Nared Chininmanu, Mr. Reakrit Khenharach, Mr. Yai Saithai, Mr. Somnuk JindaSab, Mr. Siripong Seangsuk, Mr. Aphipong Vitchuvetkamine, personal communication, May-June, 2016)

2) The regulations and laws of operating small biomass power plants, the importance of the government subsidy affects the effectiveness of small biomass power plants. (Dr. Nutthapong Peangseang, Mr. Monthon Vasuvaranich, Mr. Phamin Sawetsira, Mr. Jadsada Chotivattna, personal communication, May-June, 2016)

3) The initial project design, the importance of the initial project design affects the effectiveness of small biomass power plants. (Mr. Phamin Sawetsira, Mr. Navaphon Disatheian, Mr. Vasan Vongraj, Mr.Thanet Masanthi, Dr. Nutthapong Peangseang, Mr. Reakrit Khenharach,personal communication, May-June, 2016)

4) Biomass fuel, the importance of biomass fuel affects the effectiveness of small biomass power plants. (Ms. Pitsamai Satheanyanon, Dr. Prasert SinsukPrasert, Mr. Phamin Sawetsira, Mr. Somnuk JindaSab, Mr. Jadsada Chotivattna, Ms. Jaruwan Khansonkit, Mr. Siripong Seangsuk, Mr. Monthon Vasuvaranich, Mr. Yai Saithai, Mr. Reakrit Khenharach, Mr. Navaphon Disatheian, Mr.Thanet Masanthi, Mr. Aphipong Vitchuvetkamine, personal communication, May-June, 2016)

5) The biomass fuel management, the importance of biomass fuel management affects the effectiveness of small biomass power plants. (Mr. Monthon Vasuvaranich, Mr. Navaphon Disatheian, Mr. Aphipong Vitchuvetkamine, Dr. Nutthapong Peangseang, Mr.Thanet Masanthi, Mr. Reakrit Khenharach, Mr. Yai Saithai ,personal communication, May-June, 2016)

6) The dependece of biomass fuel from others, the importance of the dependence on biomass fuel from other organizations affects the effectiveness of small biomass power plants. (Dr. Prasert SinsukPrasert, Dr. Nutthapong Peangseang, Ms. Pitsamai Satheanyanon, Mr. Reakrit Khenharach ,personal communication, May-June, 2016)

7) The distance of biomass transportation, the importance of the distance of biomass transportation (Dr. Nutthapong Peangseang, personal communication, June 11, 2016).

8) The technology to produce the electricity units, the important of the technology to produce the electricity units affects the effectiveness of small biomass power plants. (Mr. Phamin Sawetsira, Dr. Nutthapong Peangseang, Mr. Yai Saithai, Mr. Atichart Raksajit and Dr. Nared Chininmanu, Ms. Pitsamai Satheanyanon, Mr.

Jadsada Chotivattna, Mr. Vasan Vongraj, Mr. Aphipong Vitchuvetkamine ,personal communication, May-June, 2016)

9) The administration of small biomass power plants, the importance of the administration of small biomass power plants affects the effectiveness of small biomass power plants. (Dr. Prasit Siritipratsami, Mr. Atichart Raksajit and Dr. Nared Chininmanu, Mr. Yai Saithai ,personal communication, May-June, 2016)

10) The knowledge, skill and abilities of employees, the importance of the knowledge, skills and abilities of employees affects the effectiveness of small biomass power plants. (Mr. Phamin Sawetsira, Mr. Thanet Masanthi, Mr. Navaphon Disatheian, Dr. Nutthapong Peangseang, Mr. Reakrit Khenharach, personal communication, May-June, 2016)

11) The location of small power plants, the important of the location of small power plants affects the effectiveness of small biomass power plants. (Mr. Somnuk JindaSab, Mr. Navaphon Disatheian, Mr. Yai Saithai, Dr. Nutthapong Peangseang, Mr. Aphipong Vitchuvetkamine ,personal communication, May-June, 2016)

12) The executive vision, the importance of the executive vision affects the effectiveness of small biomass power plants. (Ms. Jaruwan Khansonkit , ,personal communication, June 1, 2016)

13) Knowledge development, the importance of Knowledge development affects the effectiveness of small biomass power plants. (Mr. Vasan Vongraj ,personal communication, June 14, 2016)

14) The organizational culture, the importance of the organizational culture affects the effectiveness of small biomass power plants. (Mr. Vasan Vongraj, Mr. Navaphon Disatheian, personal communication, June 14,16, 2016)

15) The supply chain management, the importance of the supply chain management affects the effectiveness of small biomass power plants. (Dr. Nutthapong Peangseang, ,personal communication, June 11, 2016)

16) The community acceptance, the important of the community acceptance affects the effectiveness of small biomass power plants. (Dr. Prasit Siritipratsami, Dr. Nutthapong Peangseang,,personal communication, June 11, 2016)

17) The accessories of connecting to the electricity supply, the important of the accessories of connecting to the electricity supply affects the

effectiveness of small biomass power plants. (Ms. Jaruwan Khansonkit,personal communication, June 1, 2016)

18) The potential of energy grid lines, the importance of the potential of energy grid lines affects the effectiveness of small biomass power plants. (Mr. Monthon Vasuvaranich, Mr. Reakrit Khenharach,personal communication, May 23, 2016)

19) The purchase agreement, the importance of the purchase agreement affects the effectiveness of small biomass power plants. (Mr. Reakrit Khenharach,personal communication, June 23, 2016)

20) The crude oil price, the importance of the crude oil price lines affect the effectiveness of small biomass power plants. (Mr. Phamin Sawetsira, ,personal communication, May 26, 2016)

21) The local politics, the importance of the local politics affects the effectiveness of small biomass power plants. (Mr. Yai Saithai,personal communication, May 12, 2016)

22) The effectiveness of finance, The effectiveness of the finance of small biomass power plants consist of good financial performance, a quick investment return, and a quick cash flow. (Mr. Atichart Raksajit and Dr. Nared Chininmanu, Mr. Reakrit Khenharach, Mr. Yai Saithai, Mr. Somnuk JindaSab, Mr. Siripong Seangsuk, Mr. Aphipong Vitchuvetkamine, Mr. Phamin Sawetsira, Mr. Thanet Masanti, Mr. Navaphon Disatheian ,personal communication, May-June, 2016)

23) The effectiveness of environment, the effectiveness of the environment of small biomass power plants consists of the reduction of the residuals in the area, the reduction of burning and the control of pollution of the biomass power plants. (Ms. Pitsamai Satheanyanon, Dr. Prasert SinsukPrasert, Mr. Monthon Vasuvaranich, Ms. Jaruwan Khansonkit, Mr. Atichart Raksajit and Dr. Nared Chininmanu, Mr. Reakrit Khenharach, Mr. Yai Saithai, Mr. Somnuk JindaSab, Mr. Siripong Seangsuk, Mr. Aphipong Vitchuvetkamine, Mr. Phamin Sawetsira, Mr. Thanet Masanti, Mr. Navaphon Disatheian ,personal communication, May-June, 2016)

24) The effectiveness of communities, the effectiveness of the communities of small biomass power plants consists of the increasing rate of hiring labor in the area, the increasing rate of biomass buying volume in the area, and the supportive community activities (Ms. Pitsamai Satheanyanon, Dr. Prasert

SinsukPrasert, Mr. Monthon Vasuvaranich, Ms. Jaruwan Khansonkit, Mr. Atichart Raksajit and Dr. Nared Chininmanu, Mr. Reakrit Khenharach, Mr. Yai Saithai, Mr. Somnuk JindaSab, Mr. Siripong Seangsuk, Mr. Aphipong Vitchuvetkamine, Mr. Phamin Sawetsira, Mr. Thanet Masanti, Mr. Navaphon Disatheian ,personal communication, May-June, 2016)

4.5.4 The Operational Definition and Measurement

This part is the definition in terms and the measure of the 24 total issues with 3 issues pertaining to the effectiveness of Small Biomass Power plant as: the effectiveness of the environment, the effectiveness of the community and the effectiveness of the finance and there are 21 issues of The key factors to success on the effectiveness of a small biomass power plant listed as the following: Biomass fuel, Technology producing the electricity units, The knowledge, Skill and abilities of employees, The government subsidy, The location of the Small power plant, The community acceptance, The initial project design, The management, The dependence on the biomass fuel from outside, Rules and orders of the government for setting up and operation of the Small biomass power plant, The organizational culture, The executive vision, The potential of energy grid lines, The accessories of connection to the electricity system, The distance of biomass sources, Knowledge development, The supply chain management, The purchase agreement of electricity selling, Local politics, and The crude oil price.

Table 4.5 The Operational Definition, Measurement, and the Question Number

Variable	Operational Definition	Measurement	Question Number
1. The government subsidy	The support of small biomass power plants by the government	1. The support of operation processes on the power plant. 2. The importance of governmental support to the success of the small biomass power plant.	Question number 9-10

Table 4.5 (Continued)

Variable	Operational Definition	Measurement	Question Number
2. The regulations and laws of small biomass power plants operation	The regulations and laws for setting and operating the small biomass power plant	1. The appropriate methods and rules to conduct business of small biomass power plant operation. 2. The appropriate methods and steps to obtain permissions to the setting and operating a small biomass power plant. 3. The convenience of documents and allowance to obtain licenses.	Question number 11-13
3. The initial project design	The technology and model implementation process and design of the project to establish a biomass power plant.	1. The importance of the analysis and cost effectiveness of the project. 2. The importance of the initial project on the initial evaluation and follow-up.	Question number 14-15
4. Biomass fuel	The biomass fuel to produce the electricity units	1. The importance of biomass quantity to the power plant operation. 2. The importance of biomass prices to the power plant operation. 3. The ability of the power plant to obtain the biomass fuel.	Question number 16-18

Table 4.5 (Continued)

Variable	Operational Definition	Measurement	Question Number
5. The biomass fuel management	The management ability to control price and quantity of biomass fuel used in the production of electricity in power plants.	1. The ability to supply a variety of biomass fuels. 2. The ability to control the amount of demand on the operation process. 3. The ability to control the price of biomass fuel.	Question number 19-21
6. The dependence on biomass fuel from outside	The necessity of a biomass power plant to depend on biomass fuel sources from outside the plant.	1. The need to rely on external biomass fuel resources. 2. The modification of biomass feed to fit the operation process at any time. 3. The ability to select and specify the suppliers.	Question number 22-23
7. The distance of the biomass fuel source	The distance the biomass fuel needs to be transported from the resource origin to the small biomass power plant.	1. The distance of the biomass fuel resource and the small biomass power plant. 2. The cost of transporting of biomass fuel.	Question number 24-25
8. Technology necessary in producing the electricity units	The machinery process of producing the electricity units.	1. The efficiency of the machinery process. 2. The capacity of machinery process to reduce operation costs. 3. The valuable of the machinery processes.	Question number 26-28

Table 4.5 (Continued)

Variable	Operational Definition	Measurement	Question Number
9. The administration of the small biomass power plants	The management model in operational processes in the production of a small biomass power plant.	1. Model Management to produce electricity. 2. Effective problem solving in the operation process.	Question number 29-30
10. The knowledge, skill and abilities of employees	The ability, skill and experience of employees in the power plants.	1. The ability to solve the problems on the operation process of producing the electricity units. 2. The ability of working to reduce the operation costs. 3. The ability to improve the operation process.	Question number 31-33
11. The location of a small biomass power plant	The location of a small biomass power plant setting.	1. The ease of access to sources of biomass fuel. 2. The ease of access to the grid lines. 3. The ease of access to utilities.	Question number 34-36
12. The executive vision	The concept of management regarding the production of electricity from biomass.	1. The commitment of the management in production of electricity from biomass. 2. The commitment of the management to resolve the problems of production of electricity from biomass.	Question number 37-38

Table 4.5 (Continued)

Variable	Operational Definition	Measurement	Question Number
		3. The commitment to the development from production of electricity from biomass.	
13. Know-ledge development	The knowledge development on the operation of producing the electricity units from biomass	1. The staff training to improve knowledge about the production of electricity from biomass. 2. Knowledge development of employees by supporting education in the relevant field of power generation from biomass. 3. To accelerate the development of technologies to generate electricity from biomass.	Question number 39-41
14. The organizational culture	The values and beliefs within the working place	1. The values of working in the production of electricity from biomass. 2. The solutions of togetherness on the production of electricity from biomass. 3. The unity of the employees on the production of electricity from biomass	Question number 42-44

Table 4.5 (Continued)

Variable	Operational Definition	Measurement	Question Number
15. The supply chain management	The management of upstream to downstream of the biomass power plant	1. To promote the cultivation of energy crops. 2. To increase the value of agricultural products in the area.	Question number 45-46
16. The community acceptance	The community acceptance of setting and operation of the small biomass power plant.	1. The community acceptance of setting the small biomass power plants. 2. The community acceptance of operating the small biomass power plant. 3. The community support of the small biomass power plant operation.	Question number 47-49
17. The accessories of connecting to the electricity supply	The availability and capacity of equipment to link the electrical system of PEA with a small biomass power plant.	1. The availability of equipment to link electricity into the system. 2. The ability of power plants to solve problems of linking the electricity supply. 3. The stability of the linking electricity supply.	Question number 50-52

Table 4.5 (Continued)

Variable	Operational Definition	Measurement	Question Number
18. The potential of energy grid lines	The availability and capacity of transmission grid lines on the electricity link.	1. The convenience of the connection with the transmission lines. 2. The capacity and speed of linking grid lines. 3. The availability of transmission capacity to the operation of a biomass power plant.	Question number 53-55
19. The purchase agreement	The purchase agreement of electricity selling.	1. The appropriate conditions on the purchase agreements. 2. The appropriate stipulations on the purchase agreements.	Question number 56-57
20. The crude oil price	The change of crude oil prices that effect the operating costs of the small biomass power plant.	The change of crude oil prices that effect the operating costs of the small biomass power plant.	Question number 58
21. local politics	The support or opposition of setting and operating a small biomass power plant from the local unit in the setting area.	1. The duration of the understanding on the establishment of the power plant. 2. To facilitate the coordination with the relevant authorities in establishing a biomass power plant.	Question number 59-61

Table 4.5 (Continued)

Variable	Operational Definition	Measurement	Question Number
		3. The speed of problem solving from local authorities to support the small biomass power plant.	
22. The effectiveness of finance	The successful financial status of small biomass power plant operation.	1.The financial statement 2. The cash flow 3. The return on investment	Question number 62-64
23. The effectiveness of the environment	The success based on the environment of small biomass power plant operation.	1. The reduction of biomass volume in the area. 2. The reduced rate of fire in the area 3. The capacity of environment control.	Question number 65-67
24. The effectiveness of the community	The successful relations with the community of small biomass power plant operation	1. The increasing rate of hiring labor in the area. 2. The increasing rate of biomass buying volume in the area. 3. The support of community activities.	Question number 68-70

Source: The in-depth interview of the 21 sampling on the qualitative research of May-June, 2015.

4.5.5 Creating the Measurement of the Questionnaires

To create the measurement scale based on the questionnaires creating a summated rating scale from the messages from the answers of questionnaire that either agree or disagree on the questions. The score of the answers will be added and averaged to the get score totals. (Suchitra Bunrattapun. 2012, p. 132) The well-known scale is Likert Scale. This scale is created from Rinsis Likert (Suchitra Boonratarapan, 2012). The steps of creating the Likert Scale are as follows: 1) To create a message that is used to measure things and the quantity of message needed to be appropriate. All messages need to be clear with a positive meaning. 2) The set of messages need to be tested with the samples that are similar to the samples of the study. 3) The score is defined on the questionnaire focused into five parts laid-out in this form: most relevant 5, agree 4, moderately agree 3, slightly agree 2, and disagree 1, respectively. This questionnaire was designed to answer the questions of the questionnaire only, which did not allow the respondents to comment.

Table 4.6 The Outcomes on the Questionnaires

Level of Opinion	Scores
Mostly agree	5
Agree	4
Moderately agree	3
Slightly agree	2
Disagree strongly	1

4.5.6 Interpretation of Meaning from the Questionnaire

The interpretation of the questionnaires from the second part of the questionnaire is a key important factor influencing the effectiveness of the small biomass power plant. Question number 9-61 and the third part is the effectiveness of small biomass power plants. Question number 62-70. The interpretation of each question is as follows: The score is defined on the questionnaire focused into five parts laid-out in this form: most relevant 5, agree 4, moderately agree 3, slightly agree 2, and disagree 1, respectively. This questionnaire was designed to answer the questions of the questionnaire only, which did not allow the respondents to comment.

4.6 The Validity Test of the Instrument on the Research

The validity test of the research instrument is to test the maturity of the tools before applying the instrument to the samplings as follows:

4.6.1 The Validation of the Instrument on the Qualitative Research

To test the validity of the content of the interview form for in-depth interviews and the questions listed for the focus group for checking the interview form and the questions listed are correct to the objective of the research study. Furthermore, the questions are correct to the content of the study, and the questions covered all the content needed. After the research was complete the interview form and questionnaire list was designed, the research consulted with both dissertation advisors, Associate Professor Dr. Tippawan Lorsuwanarat and Dr. Sawat Wannrat.

4.6.2 The Instrument Validation on the Quantitative Research

4.6.2.1 Content validity

The research and questionnaire content is validated to ensure it covers all necessary points and that the questions in the questionnaires cover all contents on the purpose. The contents of the questions cover all the independent and dependent variables are exactly within the objectives of the research study. After creating the questionnaires, the questionnaires were inspected for content validity of the research objectives by Dr. Sawat Wanarat and Associate Professional Dr. Tippawan Lorsuwanrat. After inspecting the content validity, the questionnaires are re-inspected for techniques, and terms from experts of the small biomass power plants both Mr. Yai Saithai, the president of Supreme Renewable Energy Co., ltd and Mr. Narakorn Norkaew, manager of Supreme Renewable Energy Co., ltd. After correcting all questionnaires following the recommendations from all experts, the research uses the questionnaires of 30 samples as the first pilot group before using the questionnaires for data collection from all of the further samplings on the research study.

4.6.2.2 Reliability Analysis

After correcting the questionnaires and collecting data from the 30 sampling as a pilot group, the research uses the reliability analysis with Cronbach

Alpha (α: Cronbach Alpha Coefficient). The Cronbach Alpha Coefficient determined not less than 0.70 (Nunnally, 1978, p. 245).

4.7 Data Correction on the Research

On data collection of this research, the researcher used data collected from qualitative research before collecting data from quantitative research. The research used findings of qualitative research for developing the questionnaires of quantitative research. After developing the questionnaires then using the questioners to collect the data to form quantitative research.

4.7.1 Data Correction of Qualitative Methodology

This Qualitative research was used to study data from the primary data by collecting data directly using interview forms while interviewing samples from the specific samplings, the government agencies and experts of small biomass power plants, the private sectors-executives of biomass power plants, and using the questions listed to discuss with the focus group within the community surrounding the Small Power Plants at the meeting place. On the data collection, the researcher collected the data from in-depth interviews and group discussions held in-person in order to be able to inquire and receive more in-depth information. Moreover, in case the researcher has any doubts about the answer, the researcher can ask for more details to get the most complete and accurate account of the information.

The process of data correction of in-depth interviews, including: 1) Preparing the formal letter to the sample for their cooperation with clarity about the objectives of the research study without effecting their working career. 2) Preparing the interview form and asking for the appropriate time and place for interviewing. 3) Interviewing at the correct designated time and place specified for each particular meeting.

The process of data correction of the focus group includes: 1) Preparing formal letters to the sample for their cooperation with clarity of the objective of the research study without effecting their working career. 2) Preparing the question list forms and asking for the appropriate time and place for interviewing. 3) Discussing the time and place specific for the meeting point, The researcher conducted the discussion with the community by proposing the objective of the research study, the benefit of the study and may need every member to show their opinion during the discussions. 4) Closing the meeting by thanking the leaders and members for their time devoted to each focus group.

4.7.2 Data Collecting on the Quantitative Research

The quantitative research was used to study data from the primary data pool by collecting data directly from the executives of small biomass power plants, which totaled 343 power plants spread out all across Thailand. Some data was collected by mailing the questionnaires with cover letters directly to the samplings.

The data collection process in quantitative research is as follows: 1) Preparing the cover letter for explaining and asking for cooperation to answer the questionnaires. 2) Preparing the questionnaires sent together with the cover letter from Graduation Faculty of Nation Institution Development Administration by mailing with Express Mailing Service (EMS) to the executives of the small biomass power plants and packing the envelope with stamps for returning the answer questionnaires. 3) Following the questionnaires by phoning directly to the secretary of the executives of the small biomass power plants for following up the answers. In case the letters are lost, the researcher re-sends the questionnaires to the small biomass power plants. In case the questionnaires are not being answered, the researcher re-processes the questionnaires until the answered questionnaires are received and the full amount of data from each questionnaire is recovered.

4.8 Data Analysis of the Research

On analyzing the data in this research, the researcher analyzed the qualitative research data using the NVivo Pro qualitative analysis program and analyzed the quantitative data using the SPSS Amos program.

4.8.1 Data Analysis of Qualitative Methodology

On analyzing qualitative data, the researcher used recordings of the main points and uses a voice recorder for recoding the data from interviews and group meetings. After interviews and group meetings, the researcher recorded the data and used NVivo Pro Version 11 program to analyses and report the qualitative research data.

4.8.1.1 Data Analysis with NVivo Pro version 11 program

Jones (2007) claimed the qualitative research is related to the implementation and documentation. The researcher needs to manage the information from the study and requires quality programs for managing and analyzing the amount of data. The program used on the qualitative research was NVivo as the qualitative data analysis software. The software manages the details of data, for example, the record, sound records and the conclusion from the qualitative method. The capacity of NVivo program can support the researcher to filing the data, pictures, documents, video clips, and so on, for reference information as the empirical data of research.

The importance of NVivo functions is the management of research data by coding the data, categorizing the data, and deducting unnecessary data from a lot of interview information and documentation studies. On the qualitative research, the data is received from in-depth interviews and the discussions from focus groups. The data is the nature of attitudes, beliefs, behaviors, concepts and emotions related to the factors that influence the effectiveness in the operation of the Small Biomass Power Plant and the effectiveness of the power plants on the economy, environment and community. The research is an important tool on the qualitative method. Then, to analyze the data from in-depth interviews and the discussions more efficiently, the researcher used NVio as the Qualitative Data Analysis Software. This proved to analyze the data, check coding, categorizing, relate the node of the data set, and report the qualitative data from the 19 in-depth interviews of the sampling and 2 discussions of the focus groups of the community surrounding the small power plants, totaling 21 samplings.

4.8.1.2 The Process of Using NVivo Pro Version 11 program to Analyze Qualitative Data

Before using NVivo Pro program to analyze and summarize information on each topic (Node), the researcher needed to summarize the details from the interview as claimed in section 4.8 to transcribe the data from interviews and group meetings to documents. The process of analyzing qualitative data with NVivo Pro program is as follows:

1) Preparing the data, Preparing is the management of data from transcribing the data from interviewing and group meetings, such as, rewriting the data from the recordings, filing and organizing the data to be accessed quickly and easily. On the preparation step, the researcher prepared the documents from interviews of the samplings of the government agencies (6 samplings), the private sectors, the executives of small power plants (13 samplings) and group meetings with two groups, totaling 21 samplings.

2) The working process of NVivo Pro Version 11 is as follows: 1) Coding or cauterizing the data, the coding is the important process, the researcher needs to code to manage the data so the program and recognize it. 2) Use the program to code and node the documentation for analyzing the relations of different information more easily. The program will create the relationships among the information from documents of both in-depth interviews and discussions. The program supports analyzing qualitative data much more conveniently. 3) The Program analyzes the coded data (coding), mention various issues from interviews and focus groups with all the program issues to the researcher for concluding the important issues from the qualitative research data.

4.8.1.3 Triangulation

On the study of the qualitative method, the researcher used data from many sources, such as, text books, articles, documentation, in-depth interviews, and discussions for the data needed. The researcher also used triangulation of the qualitative data. Teddlie and Tashakkori (2009, p. 27) mentioned the meaning of triangulation as the tooling used to check information from various sources, and Thurmond (2001). mentioned the triangulation as a way to integrate data from various sources as from two or more sources. Triangulation methodology, Analyzing, and correlation of the theory. The model of triangulation on the qualitative research, including Data Source Triangulation, Investigator Triangulation, Methodological Triangulation, Theoretical Triangulation, and Data-Analysis Triangulation.

1) Data Source Triangulation, Data Source Triangulation is the method to check the information by timing, spacing, and sourcing from different people. The sources of information may change if time, place and person of the source of information change. The important factors that may affect the sources of information are the situations, events, times, places and people involved.

2) Investigator Triangulation, Investigator Triangulation is used in case the researchers are more than a person. This method is used to check the information, coding, analyzing the information from many researchers checking that the information is correct or not.

3) Methodological Triangulation, Methodological Triangulation or Multi-method, Mixed-Method. Methodological Triangulation is divided into two methods, With-in method triangulation and Between or across-method triangulation, With- in method triangulation is the triangulation using the same methodology of the research study but different correcting data. Between or across-method triangulation is the method that the researcher chooses the methodology from the qualitative methodology or quantitative methodology

4) Theoretical Triangulation, Theoretical Triangulation is the check of theories or hypotheses in order to test the phenomenon.

5) Data-Analysis Triangulation, Data-Analysis Triangulation is analyzing the data with 2 methodologies for scrutinizing information of the qualitative research. Data-Analysis Triangulation is a technique that includes the statistical analysis for analyses of the same or different of data sets.

In this qualitative data analysis, the researcher uses 3 important methods of triangulation as the following: 1) Data Source Triangulation, The research uses the data source triangulation by using many sources of data such as the source of the experts of Small Biomass Power Plants from government and private sectors, the sources of data from different government agencies and different Small Biomass Power Plants of private sectors. The specific samples are categorized by the technology of producing the electricity and the capacity split into three groups, gasification, thermo and fermentation technology. 2) Methodological Triangulation, The research uses Methodological Triangulation by designing the research with Mixed Methods, both qualitative and quantitative Methods, the researcher uses qualitative before quantitative method. 3) Data-Analysis Triangulation, The researcher uses Data-Analysis Triangulation by comparing the result of qualitative and quantitative methods. The data obtained from qualitative research and quantitative research are inter-related or interdisciplinary.

4.8.2 Data Analysis on the Quantitative Researcher

In this study for establishing the relationship between the key factors influencing the effectiveness of small biomass power plants and the effectiveness of small biomass power plants, and testing, analyzing the relationships between the key factors influencing the effectiveness of small biomass power plants and the effectiveness of small biomass power plants. The researchers used the Structural Equation Model with the SPSS AMOS Version 24 program for Exploratory Factor Analysis for organizing and reducing the variables of the data.

4.8.2.1 Exploratory Factor Analysis

Exploratory Factor Analysis is the analyze concepts or theoretical research in support of the study. EFA is a set of techniques to create new variables or new component factors from various variables. The various variables may have close relations together, EFA is a variable statistical analysis technique aimed at reducing the number of variables that were set up and there are a lot of variables. Some variables may have established similar or closed relationships. EFA techniques can group the variables together in the same components that are known as factors. The EFA is used to group the data with Principal Factor Analysis, Factor Extraction, and Rotation Method. On this study, the researcher used EFA on the data from section 2 of questionnaires-the important factors influent to the effectiveness of small biomass power plants from question number 9-61. The statistical analysis of EFA is the Kaiser-Meyer-Olkin Measurement of Sampling Adequacy and the Reduction data techniques by SPSS. Kaiser-Meyer-Olkin Measurement of Sampling Adequacy and Bartlett's Test of Sphericity with the index of Kaiser-Meyer-Olkin Measurement of Sampling Adequacy of data on EFA as following:

0.80 up means the data is very good to the analysis on EFA.

0.70 to 0.79 means the data is good to the analysis on EFA.

0.60 to 0.69 means the data is moderate to the analysis on EFA.

0.50 to 0.59 means the data is limited to the analysis on EFA.

Less than 0.50 means the data is not appropriate to analyze on EFA.

4.8.2.2 Screen Data

This study focuses on the effectiveness of small biomass power plants in Thailand, the finance, the environment and the community as well as the key factors of success to the effectiveness of small biomass power plants. The objectives are to create the model relations of the key factors to success and the effectiveness of the small biomass power plants along with proper analysis and testing of the relations between the key factors of success and the effectiveness with the Structural Equation Model. Then before using the Structural Equation Model on the data collection, the researcher needs to set up the data screen for appropriate data set, the steps of screen data setup are as follows:

1) Sample Size Determination

Many scholars comment on the sample size used in The Structural Equations Model. The sample size should be 100-150 samples (Tinsley & Tinsley, 1987) The sample size should be 100-200 samples (N=100-200) (Boosma, 1985) The sample size should be >100 samples containing three indicators per latent variable. (Boomsma, 1985). The sample size should be 110 samples, in case the sample size is more than 110 samples, it is best to use The Structural Equations Model (N=110) (Dickover, 2009). The sample size should be 150 samples (N=150) (Muthen and Muthen, 2002). Sample size should be 200 samples (N=200) (Hoogland & Boomsma 1998). The size of sample depends on the model created from the research study. This research study is comprised of a sample size of 211 samples. This number of 211 samples is a good fit for analysis with The Structural Equations Model.

2) Missing Data

To analyze confirmatory variables and to test hypotheses using structural equations is necessary to verify the completeness of the questionnaire before analyzing the data. As SPSS AMOS will not analyze data in case of missing values, then before analyzing the data, the researcher needed to complete the questionnaire completely and accurately.

3) Normality Testing

The normality testing for inspecting the data distribution that the indicators have the normality distribution. The Structural Equations Structure Model is the estimate of the parameters of the created model. The normality test used skewness and kurtosis of the data. To test the normality of the data it can be considered from: 1) skewness, if SI = 0 , the data is asymmetric |SI| >0, the data is right or positive skewed. |SI| <0 0 the data is left or negative skewed and 2) kurtosis

KI=0 the data is asymmetric, |KI| >0 the peck of the graph is high, |KI|<0 the peck of the graph is low |SI| >3, and |KI|>10 means the data is not asymmetric. The data of this research study does not have |SI| >3, and |KI| >10 means the data can be used on The Structural Equations Model. (Kanlaya Vanichbuncha, 2013)

4) Outliers

Outliers are the different data bits that separated from, or was divergent from the group data. Outliers are more or less than other data and have wandered from data that is not in the same group. Outliers may come from the damage of data preparation, contamination during preparing samples, instrument problems, and the researcher analysis. Outliers cause disorder in data sets, such as the average and the distribution of data. To examine the variance of multivariate variables, the researcher uses Spss Amos program to evaluate the outliers with Mahalanobis Distance (D) statistics, which measures the difference in standard deviation between the variables and the mean of all variables of each sample. The p-value of X2 is less than 0.05 (X2 <0. 05). It is considered to be of ans abnormal value. (Kanlaya Vanichbuncha, 2013)

4.8.2.3 Confirmatory Factor Analysis: CFA

Confirmatory Factor Analysis: CFA is the technique used to confirm or support the construct validity of the instrument of the research study. In this study the researcher uses SPSS Amos Version 24 to project the confirmatory factor analysis on The Structural Equation Model. SEM is very useful to analyze the relations of the variables, the complicated variables, Multicollinearity, the estimate of errors, the relations of the variables, and the hypothesis testing of the research study. The results compiled by the SEM are easy to explain compared to that of other statistical analysis methods. The researcher uses SEM to test the hypothesis and the relation of the variables.

Confirmatory Component Analysis (CFA), Confirmatory Factor Analysis (CFA) is an assertive analysis of variables derived from exploration (EFA). It is a technique used to support the theory or to confirm the construct validity of the constructed data sets. CFA is one technique in analyzing structural equations, to analyze and confirm previous theories or research to confirm the Factor loading of the variables. This technique is an estimate of the parameters of observed variables against latent variables. The estimation of parameters in the confirmatory factor analysis is Factor loading which is the regression coefficient with the standard value that shows the weight factor of the observation variable to the latent variable. (Kanlaya Vanichbuncha, 2013)

In the analysis of this confirmatory component, the SPSS Amos Version 24 program was used as follows:

1) First Order Confirmatory Factor Analysis, First Order Confirmatory Factor Analysis is to determine whether the indicators are variables to measure the latent variables or not. The first order of confirmatory factor analysis of key success factors of small biomass power plants is to confirm that every indicator from EFA can measure the latent variables. (Kanlaya Vanichbuncha, 2013)

2) The confirmation of the causal model, The confirmation of the causal models of the important key factor effects the effectiveness of small biomass power plants and the effectiveness of small biomass power plants.

(1) The steps of analyzing data on The Structural Equation Model

The first step, the first step is Model Specification. The model specification is taken from the literature review. The first step is very important to create the relationship of the variables on the model continuously. The model is for the things from the researcher's understanding. The Model Specification consists of two models which are: 1) Measurement model, Measurement model is the relation of indicators and latent variables. 2) Structural model, The structural model is specific relation model between independent variables and dependent variables.

The second step is the model identification. The identification refers to the single value for each parameter estimation. The indication refers to a single value for each parameter estimation. In calculating the initial calculation of the matrix of variance and covariance. The model identification is the process to evaluate the model specification having enough data to analyze the parameter estimation of the model, and can be corrected with one answer.

The third step, Parameter Estimation of the Model is the estimation of the parameters of the model and the program will be the parameters to calculate the variance and covariance of the indicators.

The fourth step is Measures of the model fit, Measures of the model fit is the inspectors of the validity of the models by evaluating between the empirical data and the created model with fit indexes. (Kanlaya Vanichbuncha, 2013, p. 108) claimed the fit indexed to measure the model consists of: 1) Chi-square (X^2). 2) Relative Chi-square (X^2/df). 3) Goodness of Fit Index: GFI. 4) Normed Fit Index (NFI). 5) Relative Fit Index (RFI). 6) Incremental Fit Index (IFI). 7) Tucker-Lewis Index (TLI). 8) Comparative Fit Index (CFI). 9) Root Mean Square Residual: RMSR. 10) Root Mean Square Error of Approximation: RMSEA.

The fifth step is Model modification, Model modification is the development stage or adjustment model or more commonly well- known as Re-specification model. The model modification is to eliminate the non-critical path from the model by theory trimming the model to fit.

The sixth step, on this step when the fit indexes of the model are good fits. The researcher has to explain and conclude the results from the data analysis results from the fit model.

4.8.2.4 The Significant Statistics to Analysis with Structural Equation Model

To test the harmony between the model and the empirical data with the significant statistics with the Goodness-of-Fits indexes concluding with: 1) Chi-square (CMIN). 2) The Relative Chi-square (X^2/df). 3) Goodness of Fit Index: GFI. 4) Normed Fit Index: NFI. 5) Relative Fit Index: RFI. 6) Incremental Fit Index: IFI. 7) Tucker-Lewis Index:TLI. 8) Comparative Fit Index: CFI. 9) Root Mean Square Residual: RMSR. 10) Root Mean Square Error of Approximation: RMSEA.

1) Chi-square (CMIN), CMIN is a statistic index used to test statistical hypotheses that functions are harmonious or consistent of the empirical data. Chi-square statistics is the product of the degrees of freedom with the harmonic function. If the homogeneous function is zero or close to zero, then the harmony or consistency between the Model created and the empirical data is achieved. However, CMIN statistics is limited. The use of chi square statistics requires a very large sample sizes. This has disadvantages in using chi-square statistics to check the harmony of models.

2) Relative Chi-square, Relative Chi-square is a statistical analysis model that is sensitive to the size of the sample, so the degree of freedom should be considered. Relative Chi-square has different scholars with different opinions, for example, some scholars have suggested that relative chi-square values are less than 2 (CMIN / df less than or equal to. 2) Means the models created comply with the empirical data, some scholars claim the relative Chi-square should not exceed 3 (CMIN / df is less than or equal to. 3) Means the models created comply with the empirical data, and some scholars argue that the relative chi-square should be no more than 5 (CMIN / df less than or equal to. 5) Means the models created comply with the empirical data. The relative Chi-square is dependent on the relative size of the model that has how many of the numbers of parameters for estimating.

3) Goodness of Fit Index (GFI), GFI is a statistical indicator of overall model performance. If GFI is close to 1, it means the model created complies with the empirical data. The GFI statistic value should be 0.9 or higher that means the model created complies very well with the empirical data.

4) Normed Fit Index (NFI), NFI is the ratio of the model crated that can be improved when compared to the independent model. If the NFI is close to 1, it means the model created complies with the empirical data. The NFI should be 0.9, but some scholars indicated that the NFI tends to be low if the model is small. If the NFI value is greater than 0.8 it means the model created complies with the empirical data. The NFI value depends on the size of the model.

5) Relative Fit Index (RFI), RFI index value is between 0 and 1. If RFI is close to 1 it means the model created complies with the empirical data. RFI statistics value should be 0.9 or higher.

6) Incremental Fit Index (IFI), IFI index value is between 0 and 1. If IFI is close to 1 it means the model created complies with the empirical data. IFI statistics value should be 0.9 or higher.

7) Tucker-Lewis Index (TLI), TLI index value is between 0 and 1. If TLI is close to 1 it means the model created complies with the empirical data. TLI statistics value should be 0.9 or higher.

8) Comparative Fit Index (CFI), CFI index value is between 0 and 1. If the CFI is close to 1 it means the model created complies with the empirical data. CFI statistics value should be 0.9 or higher.

9) Root Mean Square Residual (RMSR), RMSR is the mean of the error obtained by comparing the covariance matrix of the models predicted and the matrix of variance of the sum of the empirical data obtained from the sample. The lowest RMSR value is zero with no maximum value. The RMSR values close to zero means the model created complies with the empirical data.

10) Index Root Mean Square Error of Approximation: RMSEA, RMSEA is the index that shows the difference of the model created to the degree of freedom. RMSEA values close to zero means the model created complies with the empirical data. The RMSEA value should be 0.05-0.08 that indicate the model created complies with the empirical data. In case RMSEA more than 0.08 means the model created does not comply with the empirical data. (Kanlaya Vanichbuncha, 2013)

Table 4.7 The Goodness-of Fits Indexes

Statistics	**Abbreviations**	**Result Required**
Chi-square	CMIN	P value >0.05
Relative Chi-square	CMIN/DF	<2 The model is good fit
		<3 The model is adequate fit
		<5 The model is fit
Good Fit Index	GFI	GFI >0.90 The model is fit
Normalized Fit Index	NFI	NFI >0.90 The model is fit
Relative Fit Index	RFI	RFI >0.90 The model is fit
Incremental Fit Index	IFI	IFI >0.90 The model is fit
Tucker Lewis Index	TLI	>0.90 The model is fit

Table 4.7 (Continued)

Statistics	Abbreviations	Result Required
Comparative Fit Index	CFI	>0.90 The model is fit
Root Mean Square Residual	RMSR	< 0.05 The model is a good fit < 0.08 The model is fit
Root Mean Square Error of Approximation	RMSEA	< 0.05 The model is a good fit < 0.08 The model is fit

Sources: Kanlaya Vanichbuncha, 2013.

4.8.2.5 The Construct Validity Test

Construct validity is a statistical measure that determines whether latent variables created have the qualification and comply with theories. For this research, the researcher investigated the construct validity of the latent variables by testing the reliability of latent variables, Convergent Validity, and Discriminant Validity.

Test of latent variable reliability is to verify the reliability of latent variables in the model that the latent variables in the model are reliable. The Reliability index used for this research is Composite Reliability: CR that Lawrence, Glenn, and Guarino (2005); Adrina (2011), claimed the reliability index to construct validity of the latent variables is Composite Reliability: CR is more than 0.7 (CR > 0.70).

Convergent Validity, Convergent Validity constructs validity to test the indicators of latent variables with similar properties that should be in the same cluster. An index Convergent Validity used is Composite Reliability: CR and Average variance extracted: AVE. Anriana (2011) cites the Average variance extracted (AVE) is the square root of mean variance of all variables of latent variables. Average variance extracted AVE describes the variance of latent variables from the comparison to the correlation of latent variables. The AVE value should be 0.5. The criteria of Convergent Validity is Composite Reliability: CR and Average variance extracted AVE statistic is CR index should be more than AVE and AVE should be 0.5 (CR> AVE, AVE> 0.5) (Lawrence, Glenn, & Guarino, 2005)

Discriminant Validity, Discriminant Validity is a test of observed variables of latent variables that can measure latent variables of the metric and test that the observed variables is the component of the latent variables. The Discriminant Validity index is Maximum Shared Square Variance: MSV and Average Shared Square Variance: ASV. The criteria of Discriminant Validity is MSV which should be less than AVE and ASV which both should be less than AVE (MSV<AVE, ASV<AVE). (Lawrence, Glenn, & Guarino, 2005)

Table 4.8 The Construct Validity Indexes

Indexes	**The Criteria**
Composite Reliability CR	CR > 0.70
Convergent Validity	CR > AVE, AVE > 0.5
Discriminant Validity	MSV<AVE , ASV<AVE

Source: Lawrence, Glenn, and Guarino, 2017.

Formula for calculation Average Variance Extracted: AVE , Composite Reliability: CR

Average Variance Extracted: AVE = $VE = \frac{\sum_{i=1}^{n} \lambda_i^2}{n}$

Composite Reliability: CR = $CR = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + (\sum \epsilon_i)}$

λ_i^2 is factor loading

n is the number of the indicators of the latent variables

δ is the variation of the indicators

4.9 Chapter Summary

In this research, the researcher uses mixed Method design with qualitative research and quantitative research. The methodology of the research uses both qualitative and quantitative research. The population is the small biomass power plants in Thailand that produce the electricity from biomass fuel with Thermo, Gasification and Fumigation with a production capacity less than 10 megawatts. The samplings on the qualitative research is from the government agencies, private sectors as the executives of small biomass power plants and the group meetings. The samplings on the quantitative research is from the small power plants in all of Thailand. The instrument on the qualitative research are interview forms for in-depth interviews, and questions for group meetings. The instrument on the quantitative research is a questionnaire developed from the key findings of qualitative research. The questionnaire consisted of 70 questions. The testing instruments on qualitative research follows the expert's advice while the questions cover the purpose of the research study. The testing instruments on quantitative research is content validation from the experts and the advice of private biomass power plants. Data collection on qualitative research is based on in-depth interviewing methods and group meetings. Data collection on quantitative research is questionnaires directly from executives of the small biomass power plants all across Thailand totaling 343 power plants. Data analysis on qualitative research was done using NVivo program and quantitative research uses structural equations by SPSS and SPSS AMOS.

CHAPTER 5

QUALITATIVE RESEARCH RESULT AND CONCEPTUAL DEVELOPMENT

This chapter consists of qualitative research results, Concept Development, Conceptual Framework, Hypotheses Research and Chapter Summary.

5.1 Qualitative Research Results

Based on a research study in the form of integrated research from Qualitative research and Quantitative research; the researcher used quality research methods to find out the issues to cover the research objectives, concluded the important issues for developing the instrument on the quantitative sets, used the instrument to collect data, get all the data from samplings, analyzed the data by using the statistical analysis of survey variables in quantitative research. As the qualitative research variables are many variables, totaling 21 variants. The research use the Exploratory Factor Analysis to organize and reduce the variables, then created the conceptual framework and set the hypothesis accordingly.

5.1.1 Summary of Interviewed Results by Analyzing Data from NVivo Pro Programs

Conclusion is a matter of Node and Coding from the interviewed data of the interviews, and the questions in the group meetings. The conclusion of the important issues focuses on the important factors affecting the effectiveness of small biomass power plants and the effectiveness of small biomass power plants as the purpose of the research.

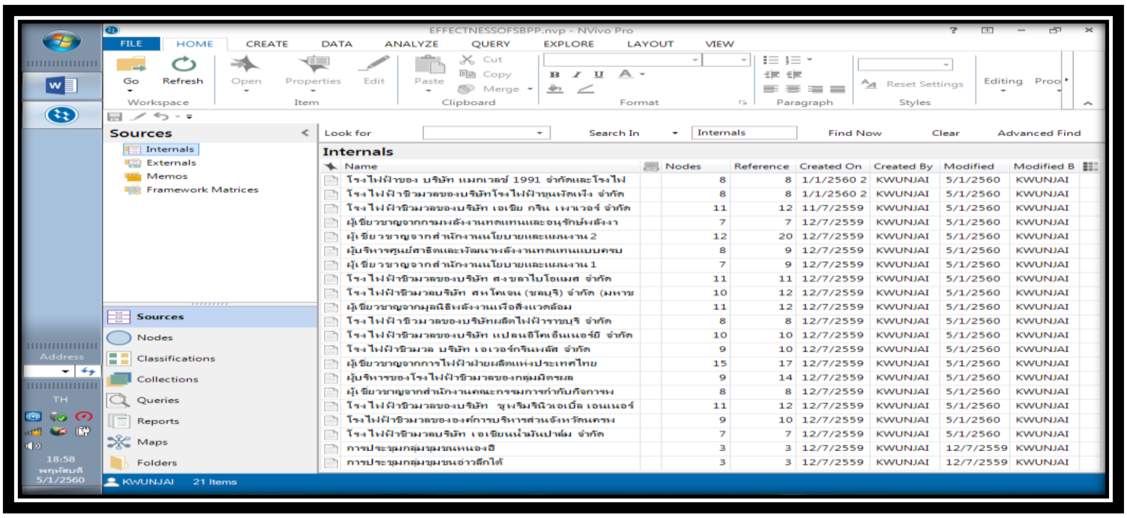

Figure 5.1 Show In-Depth Interview Data Using NVivo Pro Program for Data Management.

From Figure 5.1, Data Analysis and Summary from NVivo Pro Version 11 program to manage the data obtained from in-depth interviews with the government agencies of small biomass power plants, and private sectors of small biomass power plants, totaling 19 samplings and the group meetings of the community surrounding the small power plants, totaling 2 groups for a total of 21 sources of data forming the qualitative research data set.

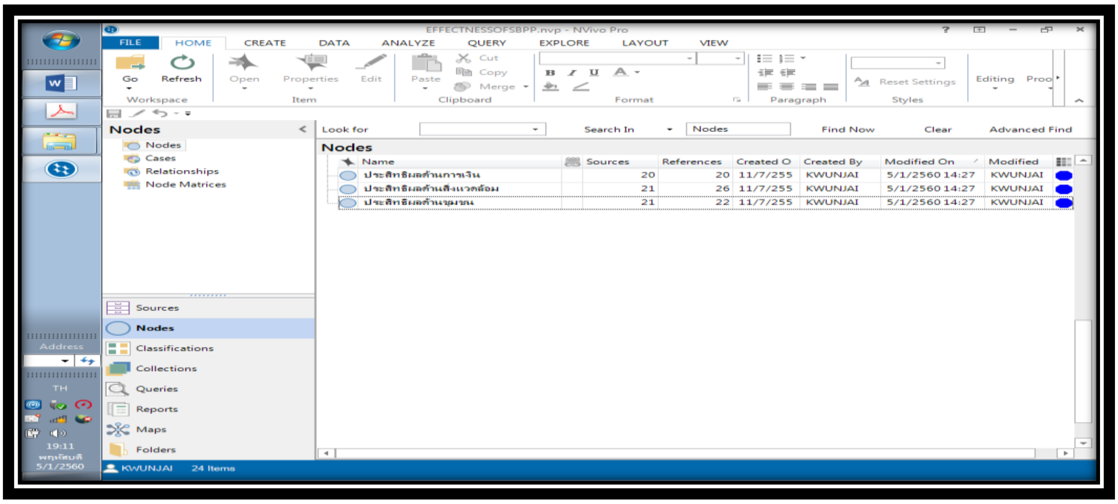

Figure 5.2 Shows the Important Issues of the Effectiveness of Small Biomass Power Plants by Using the NVivo Pro Program

5.1.1.1 The Effectiveness of the Small Biomass Power Plants

The conclusion of the effectiveness of the operation of Small Biomass Power plants from in-depths interviews of the government agencies of Small power plants and the executives of small power plants in private sectors, totaling 19 sampling and group meetings totaling 2 groups for a grand total of 21 sources of data. The researcher use the NVivo Pro program to analyze and conclude the important issues of the effectiveness of the small biomass power plants that consists of the effectiveness of finance, the effectiveness of the environmental and the effectiveness of the community.

Table 5.1 The Relation of Coding and Node of Environmental Effectiveness

Node	Coding
Environmental Effectiveness	1 To support the planting of fast growing trees and energy crops to be the fuel of factories such as Eucalyptus, Tepa, and so on.
	2. Our factory takes waste water from the production process, in case we release the waste water to canals that may affect the environment. The factory uses the waste water for fermentation technology to produce the electricity units which is a better way for adding value to the waste water.
	3. If we use the residuals from agriculture to be fuel for producing electricity use that may increase the use of fast growing crops, expand the forests more, reduce Carbon-monoxide, and release Oxygen into the atmosphere.
	4. The effectiveness of the environment from using biomass to be the fuel for Small Power plants causes the price of biomass fuel to increase, reduces the burning the residuals in the opening landscape, and reduces carbon-monoxide as well.
	5. The factory has our policy to use the recyclable materials from the production process, which saves the resources of the world by using it to it's ultimate benefit and recycle the waste again and again.

Table 5.1 (Continued)

Node	Coding
Environmental Effectiveness	6. To use the residuals from the sugar cane for producing electricity units in small power plants can reduce the amount of carbon-monoxide and reduce the greenhouse effect that causes global warming. 7. The effectiveness of the environment from the production of electricity with biomass is to reduce the amount of waste from agricultural activities, to reduce the burning of biomass that causes fire and smoke, to benefit the community by the residual product from processes to become fertilizer for soil improvement.

Source: Code Summary by node Report NVivo Pro program

1) Environmental Effectiveness

From the in-depth interviews totaling 19 samples and group meetings totaling 2 community groups around the community, 20 samplings mentioned the issues of effectiveness of environment from operating small biomass power plants. For example, recycling the biomass as residuals of agricultural by using the biomass as fuel, reducing the burning in the open landscape, reducing carbon monoxide, adding oxygen from planting, and reducing the import of fuel from foreigners abroad.

Table 5.2 The Relation of Coding and Node of Community Effectiveness

Node	Coding
Community Effectiveness	1. To support community activities, develop the community, support sports, and schools' activities. To give the residual forms from the production process to the farmers both the vinegar and bio char to be fertilizer for their planting activities. 2. Our power plant supports the community activities as to buy the biomass from people, to hire the people in the community to work in the power plant, to sponsor the community on many community festivals. The power plants and community are dependent on each other. 3. To distribute the wealth to the local community for their sustainability. 4. On the operation of small power plants, the power plant is the producer and the community is the supplier of feedstock for the fuel to the power plant. The power plant can support the community as the hiring of workers or officers in the power plant. In the event the plant creates the supply chain to the wood pellet, the members will increase their income. 5. To support the use of the benefit from biomass in ultimate usefulness, reduce the burning, increase their income by buying the agricultural residues from the farmers, and developing the relating industry continuously.

Source: Code Summary by Node Report NVivo Pro Program

2) Community Effectiveness

From the in-depth interviews totaling 19 samples and group meetings total 2 community groups around the community, 20 samplings mentioned the issues of the effectiveness of the community from operating the small biomass power plants, for example, to use the biomass as a fuel that makes the members of the community have more money, to create new careers from building the power plant and hiring the people to work in the power plant, to circulate the money in the community, to reduce the immigration from urban to city, to distribute the incomes, to strengthen the community electrical power, and to support the community activities from Power plants surrounding the foundation. The community can earn or save money on power plants surrounding the foundation to develop the various activities, such as, educational activities, religious activities, public health activities, career development for making the community stronger.

Table 5.3 The Relation of Coding and Node of Financial Effectiveness

Node	Coding
Financial Effectiveness	1. The power plant has their own fuel or biomass, the sugar refineries or mills have more return on investment of money that the power plant stands alone. 2. The return of invest of the power plant is a good return, the cash flow is stable, and there is profit every month. 3. The power plant can operate 24 hours per day and may have a return of investment rate within 4 years. The rate of return is very good and the return of investment is quick.

Source: Code Summary by node Report NVivo Pro program

3) Financial Effectiveness

From the in-depth interviews totaling 19 samples and group meetings totaling 2 community groups around the community, 20 samplings mentioned the effectiveness of finance of small power plants, as follows: the operation of biomass power plants provides a good return. Entrepreneurs have good financial returns, a good cash flow from the investment, project investment is cost effective, and provide a quick payback period.

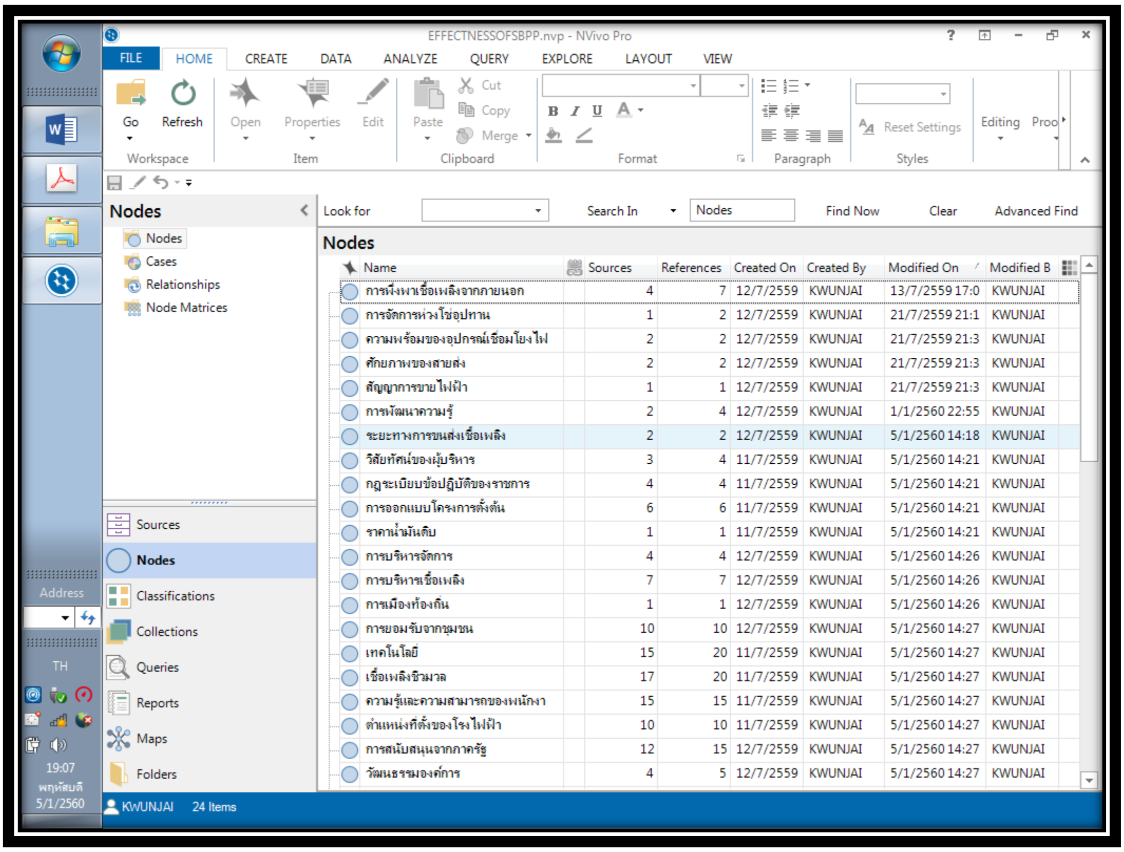

Figure 5.3 Show the Important Issues of the Important Factors Affecting the Effectiveness of Small Biomass Power Plants by Using NVivo Pro Program.

5.1.1.2 The Important Factors Affecting the Effectiveness of Small Power Plants

Figure 4.14 presents a summary of important factors influencing the effectiveness of small biomass power plants from the in-depth interviews totaling 19 samples and group meetings totaling 2 community groups around the community, the research uses NVivo Pro to analyze and conclude the important issues found that are the most important factors influencing the effectiveness of small biomass power plants. These are sorted by reference from samples in descending order ,biomass, technology for producing the electricity, the subsidies from the government, knowledge and skills of the staff, the location of power plants, the community acceptance, the administration of biomass fuel, the dependence on the fuel, the initial project design, rules and orders related to the operation of small power plants, organizational culture, the executive vision, the management, the potential of the grid lines, the linking electricity accessories, distance of transport fuel, the supply chain management, the purchase and contract agreement, local politics and the oil price.

Table 5.4 The Relation of Coding and Node of Biomass Fuel

Node	Coding
Biomass fuel	1. The availability of biomass fuel is necessary in the operations process of producing the electricity. 2. The plant can use the residue from palm oil production. The shells and fibers can be used as fuel to produce electricity. 3. The residuals of agriculture is important as the fuel for the plants. 4. Biomass fuels are important as the fuel of the entire operating system. 5. The power plants that succeed will be the plants that have their own residuals of production processes such as the sugar mills, rice mills and palm mills. 6. Fuel sources are an important factor in the implementation, especially, the agricultural residues. On the process of choosing the location of setting small biomass power plants, the operators need to consider the biomass fuel sources carefully. There is a purchase of corn core from the villagers in the area of 5-7 baht per bag, depending on the moisture of the corn core.

Source: Code Summary by Node Report NVivo Pro Program

1) Biomass Fuel

17 samplings from in-depth interviews mentioned the importance of biomass fuel to the effectiveness of the operation of small power plant as biomass sources. Biomass fuel is the main factor in the electricity production. The

power plants need enough biomass fuel to use throughout the year. Availability of fuel raw materials is a necessity for the generation of electricity. The small-scale biomass power plant that succeeds today is a self-fueled power plant, such as the power plant from the sugar industry, mills from rice husks and the palm oil plantations, and so on. However, the independent power plants without their own fuel sources need to consider the source of fuel.

Table 5.5 The Relation of Coding and Node of Technology Producing the Electricity Units

Node	Coding
Technology producing the electricity units	1. The application of technology to improve the quality of electricity units and the operations systems to lessen the effects of the environment. 2. Most of the biomass power plants that succeed will rely on the technology. The technology necessary to bring from abroad because of their expertise and past research. 3. Technology is an important factor of the operation. Before setting the power plant, the management needs to select the appropriate technology for the operation of the power plant. 4. The gasification technology for small power plants is not stable so we need to import the international technology to use in the power plant. 5. The small power plant that is successful in operation has the technology to easily produce the electricity units. 6. The design of the technology systems need to be related with the biomass fuel and the technology designed can be varied with biomass fuel.

Source: Code Summary by Node Report NVivo Pro Program.

2) Technology Producing the Electricity Units

15 samplings from in-depth interviews, mentioned the importance of technology producing the electricity units effect the effectiveness of the operation of small power plants as the technology of the electricity production is important to the operation of small biomass power plants. The operators need to select the right technology for a particular biomass fuel. Technology systems do not affect the environment must be selected carefully. Currently, biomass power plants use foreign technology because their technology has more efficiency than domestic technology. The operators adapt the foreign technology complying with their operation process, such as, biomass conditions and the adaptation of machinery on the operation process. The design of biomass-based technologies should be designed to accommodate the biomass fuels. If the technologies used to generate electricity are efficient, the biomass power plants can generate electricity efficiently then, the revenue from electricity sales of power units is a good return to the operators.

Table 5.6 The Relation of Coding and Node of the Knowledge, Skills, and Abilities of Employees

Node	Coding
The knowledge, skills and abilities of employees	1. The small biomass power plant operation needs the knowledge, skills and ability of the staff for the power plant's success. 2. The knowledge, ability, problem solving, are the experience for the staff working that are very important parts of the biomass power plant process. 3. The skill of staff is a key factor of the small power plant operation. If the executive has no knowledge and experience of the technology working it will cause the company problems. The skill and knowledge of our company come from the executive learning and the staff knowledge to support and solve all problems on the working process. 4. The company focuses on the knowledge development for the expertise of staff.

Table 5.6 (Continued)

Node	Coding
	5. The gasification technology is an operation process that needs to use the staff knowledge, understanding, and problem solving on the operation processes. 6. On our rice mill and the energy learning center, we need the knowledge, skills, and expertise of our staff to solve the problems and to develop the project to be successful.

Source: Code Summary by Node Report Nvivo Pro Program

3) The Knowledge, Skills, and Abilities of Employees.

15 samplings from in-depth interviews, mentioned the importance of the knowledge, skills and abilities of employees effect the effectiveness of the operation of small power plant as the knowledge, skills and abilities of employees are important factors of the biomass power plant operation. Operation processes require the employee's attention, the knowledge of a team of technical expertise, the ability to solve problems efficiently, the preparation of the backup plan when the problem is not resolved, the developing of team work, and the understanding of the technology within all working processes. If the executives and the employees have knowledge, skills, and experience of the biomass operation there will be very positive effects of the effectiveness of the biomass power plants.

Table 5.7 The Relation of Coding and Node of the Government Subsidy

Node	Coding
The government subsidies	1. The government policy is a key factor to the Small power plant operation, for example, the adders that are the adding price to the selling of electricity units. 2. The first stage of operation of small power plants need the government to subsidies the project. 3. The support from government as BOI support policy. The subsidies from government agencies are key factors of the operation of small power plants. 4. The adding of the selling electricity unity from government agencies is feed-in tariff to increase the units of electricity for supporting the biomass power plants. 5. On the operation of small biomass power plant the entrepreneur needs the government subsidy to drive and develop the biomass power plant business. 6. The government subsidy of infrastructure in Thailand is a strengthening tool for driving the entrepreneur to invest in the small biomass power, for example, the grid line development, the tax exemption, the investment loans, and so on.

Source: Code Summary by Node Report NVivo Pro Program

4) The Government Subsidies

15 samplings from in-depth interviews, mentioned the importance of the government subsidy's effect the effectiveness of the operation of small power plant as the government subsidy is a key factor of the success of small power plants operation, such as, the adder price of the electricity units, changing the form of selling the electricity units to Feed-in Tariff, BOI supports the production process, taxes exemption, and the special additional selling price of electricity units

for 3 border provinces of Thailand. The government subsidy is a driving and developing tool to the operators of the biomass power plant business.

Table 5.8 The Relation of Coding and Node of the Location of Small Power Plants

Node	Coding
The location of the small power plant	1. The selection of the small biomass power plant's location is important to the operation because the location needs to be near fuel sources, sources of water and grid lines. 2. The biomass power plant needs to be located near fuel sources, sources of water, grid lines, utility system, and roads for saving the cost of delivering the fuel. 3. On the selection of the location of biomass power plant need to concern the fuel source, the potential of grid lines, the BOI support of investment area, and the addition of adder electricity units price in special; area.

Source: Code Summary by Node Report NVivo Pro Program

5) The Location of the Small Power Plant

10 samplings from in-depth interviews mentioned the importance of the location of the small power plant effects the effectiveness of the small biomass power plant as the selection of the location of the small biomass power plant is very important. The operators need to consider the grid lines, biomass sources, the utilities facilitation systems, source of water, the accommodation, the transportation and so on. Especially, the location needs to be selected in close proximity to the grid lines, if the location of the plant is very far from the grid line, the operators need to pay a lot of money to link the operation process with the grid line. The cost of linking the grid may affect the operation costs. The location of plants need to be selected near the biomass resource to save the delivery transportation costs and so on. Thus the location of small power plants is an important factor effecting the effectiveness of small biomass power plants.

Table 5.9 The Relation of Coding and Node of the Community Acceptance.

Node	Coding
The community acceptance	1. The community acceptance is a key factor of the small power plant's success. 2. When we claimed the biomass power plants, the community considers whether the setting of the biomass power plants will effect their communities or not. The operator of the biomass power plants need to communicate with the communities, to explain the project purpose, the benefit and the effect of the project to communities for their understanding. The community awareness is the operation process of small power plant impacting their quality of lives and their local environment. 3. As our power plant is located in the community, we have good relations with communities, we trust each other. 4. On the setting of the biomass power plant, the operators have to explain the fact to the communities surrounding the power plants. The operators need to hold public hearings to check the responses from the community. If the communities accept the projects of biomass power plants then the setting and operations are not the problems.

Source: Code Summary by Node Report Nvivo Pro Program

6) The Community Acceptance

10 samplings from in-depth interviews mentioned the importance of the community acceptance of small power plants affect the effectiveness of small biomass power plants. The community acceptance is a key factor to the small power plant's success. Currently, the communities are against the building of biomass power plants. Therefore, the operators who need to perform the setting of the small power plants have to hold public hearings to check the responses from the community. The entrepreneurs need to explain the facts and the effects of the operation of small power plants to the community. What is community awareness,

are the operation processes of small power plants affecting their quality of lives and the environment. If the communities do not accept the projects of biomass power plants then the operators cannot set the power plants.

Table 5.10 The Relation of Coding and Node of Biomass Fuel Management

Node	Coding
The biomass fuel management	1. The entrepreneurs need to find ways to manage the biomass fuel, for example, sing contracts with farmers, and build healthy relationships with the farmers or members in the community to sell their biomass to the power plant. 2. The biomass fuel management is a critical factor of the biomass power plant for preparing enough biomass for the operation period all year long. 3. The power plant needs to control the biomass quality for the demand used on the electricity production. 4. The power plant needs to control the price of biomass. If the costs of biomass vary it will adversely effect the costs of the plant operations. 5. The fuel management, for example, handling the fast growing trees for the fuel and supporting the fuel plants on useless land to become biomass fuel.

Source: Code Summary by Node Report NVivo Pro Program

7) The Biomass Fuel Management

7 samplings from in-depth interviews mentioned the importance of the biomass fuel management affect the effectiveness of small biomass power plants. The fuel management is a critical factor in the implementation of the biomass power plant. The fuel plan needs to be planned to get along with the demand of use in the small power plant. The fuel management needs to control quantity, quality and price. The power plant needs to control the price of the biomass. If the

costs of biomass vary, that will negatively affect the cost of operating the plant. The fuel management, for example, handling the fast growing trees for fuel and supporting the planting of fuel plant on useless land to become biomass fuel. Thus, the biomass fuel management is an important factor on the operation of small biomass power plants.

Table 5.11 The Relation of Coding and Node of the Initial Project Design

Node	Coding
The initial project design	1. Feasibility study of the initial project to determine if the project is likely to be successful. 2. The important aspects of initial project design include, the needs of a turnkey company that has experiences and responsibility of a healthy working environment. 3. The presentation of the initial project analysis of contractors for the establishment of biomass power plants is a project with inflated numbers of the actual figures. It is a larger number regardless of the possible numbers of working factors. 4. The design of a biomass power plant requires the guidance of a knowledgeable, experienced, capable person. That would be a successful biomass fuel project.

Source: Code Summary by Node Report NVivo Pro Program

8) The Initial Project Design

6 samplings from in-depth interviews mentioned the importance of the initial project design affect the effectiveness of small biomass power plants. The initial project design could be designed by the expertise of the operation of a small power plant that supports the efficiency of the operation process. The initial aspects of the design project are the guidelines of investment. The entrepreneur can analyze the working systems from the beginning stage for the initial project, for example, the feasible study, rate of return, period of return on investment

and so on. Designing the initial project requires the experience and use of real numbers for developing the biomass power generation system that actually works. Therefore, the design of the initial project is an important factor in the operation of a small biomass power plant.

Table 5.12 The Relation of Coding and Node of the Management of Power Plant

Node	Coding
The management of power plant	1. Management factors, such as, the operational planning, the fuel planning, the purchase of fuel, the training of staff and the adaptation of working processes to be successful of the overall effectiveness. 2. Management will need to plan their work accordingly, from the beginning of the rice mill process, to the mill for rice quality, and use the rice husk for the fuel to generate electricity. The key of planning is to control the supply for the demand needed.

Source: Code Summary by Node Report NVivo Pro Program

9) The Management of Power Plant

4 samplings from in-depth interviews mentioned the importance of the management of power plants affect the effectiveness of small biomass power plants. The management factors that affect the operation in small power plants, such as, the project analysis from the beginning, the analysis of the operation costs, the cooperation with the government agencies for the allowance, the project planning, the control of operation, the fuel planning, the training, the adjustments of the biomass fuel, the problem solving, the management of operation costs, and so on. Then the management of the power plant is an important factor of the power plant operation.

Table 5.13 The Relation of Coding and Node of the Dependence on the Biomass Fuel from Outside

Node	Coding
The biomass fuel from outside	1. If the new power plants do not have their own fuel source, they need to depend on other sources. They have the costs of operation from the dependence on other sources, which affects the operation of the plants. 2. The power plant does not have their own biomass sources, they may not be a successful one, because of the fuel competition. If the demand of biomass is high, the price of biomass also rises and this negatively affects the cost of operations within the power plant. 3. The entrepreneurs of the power plant needs to find the biomass fuel source because of the high demand of biomass fuel. 4. In the case there is fuel depletion, the price of biomass will be very high, the entrepreneurs of the power plant cannot afford the high price of the biomass prices. The government agencies try to support the small biomass plants by setting zoning for small biomass power plants.

Source: Code Summary by Node Report NVivo Pro Program

10) The Dependence on Biomass Fuel from Outside

4 samplings from in-depth interviews mentioned the importance of the dependence on biomass fuel from outside affects the effectiveness of small biomass power plants. The power plant does not have their own fuel source as the stand alone power plant needs to depend on the biomass fuel from outside. For example, buy the biomass from the farmers or the member in the community and wholesalers. They have the cost of operation which depends on other sources, that effects the operation of the plants. The independent power plants are different from biomass power plants with their own fuel sources. Because power plants that have

their own fuel can recycle waste materials from other productions to benefit their own production process. They can recycle wastes to be their fuel. At present, there are many scrambling to buy biomass fuels. They depend on biomass fuel from outside which is an important factor of the small biomass power plant operation.

Table 5.14 The Relation of Coding and Node of Regulations and Laws for Setting and Operation of Small Biomass Power Plants

Node	Coding
Rules and orders of the government for setting and operation of small biomass power plants	1. On the submission of the allowance of biomass power plants operation, the operators need to prepare a lot of documents to submit for the allowance. 2. The rules and orders are complicated. The operators need to submit the allowance to set up the power plants with many documents and need to deal with many sectors. 3. The entrepreneurs need to understand all documents related to regulations and laws related to the operation of biomass power plants. 4. The government agencies need to adjust or adapt the regulations and laws of small biomass power plant operation to get along with the electricity generator from biomass support policies.

Source: Code Summary by Node Report NVivo Pro Program

11) Regulations and Laws for Setting and Operating the Small Biomass Power Plant

4 samplings from in-depth interviews mentioned the importance of regulations and laws that affect the effectiveness of small biomass power plants. Rules and orders of the government affect the operation process from the beginning stages. The rules and orders are complicated. The operators need to submit the allowance to set up the power plants with many documents and need to

deal with many sectors as well as need to follow the regulations and laws strictly. During the allowance stage, the operators need to prepare a lot of documents to submit for the allowance and deal with many government agencies, such as, allowance permit for setting up the power plants, the permit to sell the electricity units, and the power purchase agreement. The entrepreneur needs to understand all the documents related to regulations and laws associated with the operation of biomass power plants. Then, the regulations and laws are important factors to the biomass power plant operation.

Table 5.15 The Relation of Coding and Node of the Organizational Culture

Node	Coding
The organizational culture	1. The philosophy of work transform the main company to the branch company, for example, cooperation, unity, assisting each other on the working for the success purpose, and to gain commitment in the company. 2. The management team cultivated the employees, for example**,** the development of excellence, morality, patience, sincerity, diligence, commitment, and the responsibility to the social aspects of the organization. 3. The management focuses on hiring the people surrounding the power plants that cause the commitment between the power plant and community.

Source: Code Summary by Node Report NVivo Pro Program

12) The Organizational Culture

4 samplings from in-depth interviews mentioned the importance of the organizational culture affect the effectiveness of small biomass power plants. The management team cultivated the employees, for example, the development of excellence, morality, patience, sincerity, diligence, commitment, and the responsibility of social development. The philosophy of work transforms the

main company to the branch company, for example, cooperation, unity, to assist each other on working for the success of the organization, and to commitment to the company. Organizational culture is based on the collective effort to solve common problems, cohesion, and ownership. Then, the organizational culture is an important factor of the biomass power plant operation.

Table 5.16 The Relation of Coding and Node of the Executive Vision

Node	Coding
The executive vision	1. The management mindset for investing in biomass power plants is important in initiating biomass power plant projects. 2.The management has committed to the development of alternative energy generation, especially the production of biomass from biomass fuel. The biomass residuals are the recycled products from waste to be useful fuel.

Source: Code Summary by Node Report NVivo Pro Program

13) The Executive Vision

3 samplings from in-depth interviews mentioned the importance of the executive vision which affect the effectiveness of small biomass power plants. The executive vision factor is important of the small power plants operation. The management mindset for investing in biomass power plants is important in initiating biomass power plant projects. The management vision of the commitment to develop renewable energy, to add value to the agricultural residues used as fuel to generate electricity. The management is concerned with the environment and the community, the cleanliness and safety of the environment for the health of the people in the community. Then the executive vision is an important factor to the biomass power plant operation.

Table 5.17 The Relation of Coding and Node of the Potential Use of Grid Lines

Node	Coding
The potential use of grid lines	1. On the power supply of power plants up the transmission line. The availability of equipment. Such as transmission lines of electricity. It affects the power supply to the system. 2. The design of grip lines are not designed to support the distribution forms. Government agencies needs to improve the transmission line systems to support production and policies supporting the use of biomass to generate electricity.

Source: Code Summary by Node Report NVivo Pro Program

15) The Potential Use of Grid Lines

2 samplings from in-depth interviews mentioned the importance of the potential use of grid lines which affect the effectiveness of small biomass power plants. When biomass power sells the electricity units they then need to sell to the grid and transmission lines. The potential of grid lines is very important to the biomass power plants. If the transmission line system of the power supply can support the power supply from the biomass power plant thoroughly, the biomass power plant operators can set up power plants without restrictions. Such as, in some areas where entrepreneurs want to set up biomass power plants, there are areas with dense amounts of biomass fuel, but transmission systems are not conducive to electricity generation, the operators cannot setting the power plants there.

Table 5.18 The Relation of Coding and Node of the Accessories to Connect the Electricity

Node	**Coding**
The accessories to connect the electricity	The PEA needs to maintain the accessories to link the electricity in good conditions, if the accessories of linking the electricity are damaged, the power plant needs to restart the operations to connect with the accessories many times that causes operation costs of the production process.

Source: Code Summary by Node Report NVivo Pro Program

15) The Accessories to Connect the Electricity

2 samplings from in-depth interviews mentioned the importance of the accessories to link the electricity to the effectiveness of small biomass power plants. The accessories to link the electricity affect to the cost of operation. If the accessories to link the electricity are damaged, the power plant needs to restart the operation to connect with the accessory many times which causes the operation costs of the production process. The accessories used to connect the electricity are important factors to the biomass power plant operation.

Table 5.19 The Relation of Coding and Node of the Distance of Biomass Sources

Node	**Coding**
The distance of biomass sources	The distance of biomass sources is important to the operation process. The distance of transportation fuel affects the cost of fuel delivery and the cost of operations.

Source: Code Summary by Node Report NVivo Pro Program

16) The Distance of Biomass Sources

2 samplings from in-depth interviews mentioned the distance of biomass sources to the effectiveness of small biomass power plants. The distance of biomass sources is important to the operation process. The distance of transportation fuel affects the costs of fuel and the costs of operations. If the power plant has biomass sources that are far from the plants, the cost of delivery fuel is high and its cost of delivery may affect the operation costs in the power plant.

Table 5.20 The Relation of Coding and Node of Knowledge Development

Node	Coding
Knowledge Development	The company is committed to the knowledge development, such as, the development of technologies used to generate electricity from biomass fuels. The development of the machinery to work properly for developing the process more efficiently and get a high return. The company encourages employees to develop their knowledge of electricity generation from biofuels. There is the creation of a knowledge base on the production of biomass fuels and is ready to provide the knowledge of production visits to other sectors.

Source: Code Summary by Node Report NVivo Pro Program

17) Knowledge Development

2 samplings from in-depth interviews mentioned the importance of knowledge development to the effectiveness of small biomass power plants. The small power plants will succeed if the plants develop the knowledge especially the technology. The knowledge development can improve the quality of jobs, solve the problems, and increase the efficiency of technical workings in the production process and get better returns.

Table 5.21 The Relation of Coding and Node of the Supply Chain Management

Node	Coding
The supply chain management	The operation of small power plants need to be managed from downstream to upstream, for example, to support the firms growing the fast growing plants, to support the agriculture in the country, and to integrate the related industries. Therefore, there are more residuals from the agricultural industry and more of biomass fuel to feed the growing amounts of small biomass power plants.

Source: Code Summary by Node Report NVivo Pro Program

18) The Supply Chain Management

A sampling from in-depth interviews mentions the supply chain management to the effectiveness of small biomass power plants. The operation of small power plants needs to be managed from downstream to upstream, for example, to support the firms growing fast growing plants, to support the agriculture in the country, and to integrate the related industries. Therefore, there are more residuals from the agricultural industry and more biomass fuel to feed the small biomass power plants.

Table 5.22 The Relation of Coding and Node of the Purchase Agreement of Electricity Selling

Node	Coding
The purchase agreement of electricity selling	The purchase agreement of electricity selling is important as the contract provides details and terms of conditions on the implementation of selling the electricity units between the small power plants and the PEA.

Source: Code Summary by Node Report NVivo Pro Program

19) The Purchase Agreement of Electricity Selling

A sampling from in-depth interviews mentioned the purchase agreement of electricity selling to the effectiveness of small biomass power plants. The purchase agreement of electricity selling is important as the contract provides details and terms of conditions on the implementation of selling the electricity units between the small power plants and the PEA.

Table 5.23 The Relation of Coding and Node of Local Politics

Node	Coding
local politics	The local politics is a problem on the setting and operation of small power plants. The problems cause the enterpriser initial set-up and operation hard situations and difficulty. The local politics is a hard problem to solve.

Source: Code Summary by Node Report NVivo Pro Program

20) Local Politics

A sampling from in-depth interviews mentioned local politics to the effectiveness of small biomass power plant. The local politics is a factor related to the establishment of a biomass power plant. This is a political problem of a conflict of interest by setting the small biomass power plant. Therefore, the enterpriser needs to set the small power plant in the area, they need to explain the benefits to the local politicians, focus on the benefit to the community, and prepare the public relationship in the area of setting the small power plant.

Table 5.24 The Relation of Coding and Node of the Crude Oil Price

Node	Coding
The crude oil price	The crude oil prices affect prices of various goods and the cost of operation of biomass power plants

Source: Code Summary by Node Report NVivo Pro Program

21) The Crude Oil Price

A sampling from in-depth interviews mentioned the price of crude oil prices to the effectiveness of the small power plants as the crude oil prices affect prices of various goods and the cost of operation of biomass power plants.

5.1.2 The Fieldwork and Focus Group

In addition to the in-depth interviews and focus group meetings, the researchers used the educational field for more educational contexts of Small Power Plants. The fieldwork for this study are 1) 1) The Chaipattana Rice Mill (Demonstration and Integrated Renewable Energy Development and Demonstration Center), Lat Bua Luang District, Ayutthaya. The project objective of rice development center and the pilot small power plant, capacity is 150 kilowatts. 2) The biomass power plant of Nakhonpanom Provincial Administration Organization, Nakhonpanom province. The small power plant of government sector with a capacity of 350 kilowatts. 3) The small biomass power plant of Asain Palm Oil Company limited, Krabi, uses thermo technology for producing electricity using in the industry and fermentation to produce electricity for sale.

The focus group of meeting with the community 1) Auluktai Community, the leader of the members of the community surrounding the small biomass power plant of Asain Palm Oil Company limited, Aulok, Krabi. 2) Pabak Community, the leader of the members of the community surrounding the small biomass power plant of Nakhonpanom Provincial Administration Organization.

5.1.2.1 The Chaipattana Rice Mill (Demonstration and Integrated Renewable Energy Development and Demonstration Center), Lat Bua Luang District, Ayutthaya.

1) General Information of the Small Biomass Power Plant

(1) The Objectives of the Project

The Objective of the Project is His Majesty the King's Phumipholadulyadech Rama9 established the Center for Learning Management Systems of the rice industry. The rice chain from upstream to downstream completely. The project is for Thai people to improve the quality of life and stay away from poverty following the self-sufficient economy theory under the supervision of the

Chaipattana Foundation. The main objectives are: 1) to support the activities of rice producing process without chemical use 2) to demonstrate the administration of rice and community processes 3) To support the cooperation of zero waste management of rice processes 4) To demonstrate the small biomass power plant for developing interest among organizations both of government and private sectors. The production of electricity on the rice mill using Gasification technology and rice husks as the fuel. The gasification technology is developed from the Energy Department and CP Group. They offer the gasification technology to Chaipattana foundation to celebrate the anniversary, 80 years of King Rama 9.

(2) The Power plant location is 99 Tamboon Ladbuoroung, Aumpur Ladbuoroung, Phanakhonsri Ayutaya Province

Figure 5.4 The Chaipattana Rice Mill (Demonstration and Integrated Renewable Energy Development and Demonstration Center), Lat Bua Luang District, Ayutthaya

(3) Producing Electricity from Biomass

The production of electricity from alternative energy as a result of the rice mills and biomass power plants of the Foundation. The electricity production uses rice husks to produce gas and gasification technology. The energy from the process will be used to produce electricity and steam rice. The objective of the power plant is to focus on the Zero Waste management by using the residuals of the rice production process. The model is for the pilot project for development in the future.

(4) Gasification Technology to Produce Electricity Units

The rice mill uses Gasification Technology to produce electricity units including a 3 stage system from the cooperation and development between the Energy Ministry, Thailand and CP Group as well as to offer the foundation to be the pilot for small power plants and use biomass from the rick husks of the rice production process.

Figure 5.5 Gasification Technology

2) The important factors affecting the effectiveness of small power plants

(1) The Implementation Plan

Operational management has to plan their work accordingly, plan from growing rice, maintaining the rice quality, developing by-products from rice and use the residuals or he rice husks to be the fuel. The management needs to find the market for the production and to seek the customers to buy the products from the project. Regarding the planning, the management needs to plan the production, planning, and marketing plan to be consistent in terms of demand and supply.

(2) The Knowledge and Skills of the Working Practice

The operation of the prototype mill and small biomass power plant needs to use the knowledge and skills of working experience. Expertise in the operations and performance on the processes is necessary. The work necessary to apply their knowledge and skills in solving problems and using the expertise to operate a successful project.

(3) Technology Uses to Produce Electricity

To continue the operation of Very Small Biomass Power plants there is need to maximize the capacity as 10 megawatts. The technology used in the burning are the thermal and the gasification technology. The producers need to compare the technology costs for selecting the operation system, when comparing the thermo and gasification technology costs, the costs of gasification technology is lower than the thermo technology. Normally, the gasification power plant has a capacity of around 1-4 megawatts, if the small power plant needs more capacity than 4 megawatts, the thermo technology is more suitable.

(4) Location of Power Plants

The location of the power plant is an important factor because the power plants need to be close to fuel sources, and have access to the grid lines. For the operation of the power plants they need to be seriously concerned about the fuel source. In case the plants are far away from the biomass fuel, the plants need to pay more costs of transportation, which affects the operation costs of the rice mill project and small power plant of the foundation using the residuals from production rice process in the project.

(5) The Government Subsidies

The government support policies to small power plants are the drive to the operation in the industry. The sample of the government subsidy of the adder price, the tariff or increasing the pricing of electricity units.

3) The Effectiveness of the Small Power Plants

(1) Financial Effectiveness

The biomass power plant of the Foundation has objectives to be the small power plants by using biomass from agricultural residues. The by-products from the operation plants is the heat for baking the rice production, if there is surplus the capacity of operation then they sell it to the PEA. However, this small power plant is a prototype for Thai people or other organizations both private and governmental to develop from the prototype their own model. The operations are intended as a response to the current Zero Waste biomass power plant to full production capacity and improve efficiency of operating.

(2) Environmental Effectiveness

As mentioned above, the purpose is to answer to the Zero Waste model for the integrated rice management industry. To take advantage of all the rice without waste or zero wastes is impossible; truly, no material waste will contribute to a clean environment.

(3) Community Effectiveness

The purposes of the project is to help farmers, the value added to the rick husks and to increasing the farmers' income, improve the quality of life, create careers and increase the money circulating in the community. (Atichart Raksajit & Nared Chininmanu, personal communitcation, June 23, 2016)

5.1.2.2 The Biomass Power Plant of Nakhonphananom Provincial Administration Organization.

1) General Information of the Small Biomass Power Plant

(1) The Objectives of the Project

The Small Biomass Power Plant of Nakhonphananom Provincial Administration Organization is established as a prototype of the community biomass power plant with a capacity of 350 kilowatts. The plant is set up following the government policy in terms of electricity production from renewable energy. The Nakhonphananom Provincial Administration Organization realized the Naknomphanom province has a lot of residual biomass and capacity to plant fast growing trees. Then The Provincial Administration Organization established the small power plants for the community to correct the residual from agriculture to sell to the power plant, and the community planted fast growing trees as the fuel such as Eucalyptus, Acacia, and Tepa trees.

(2) The location, Nakhornpanom Provincial Administration Organization, 151/1 Nakhonphanom-Thautan Road, Taboom Papak, Aumphur Meang, Nakhornpanom Province, 48000

The Power plant location is 256 Moo 2, Taboon Nonghee, Aumphur Meang, Nakhornpanom Province, 48000.

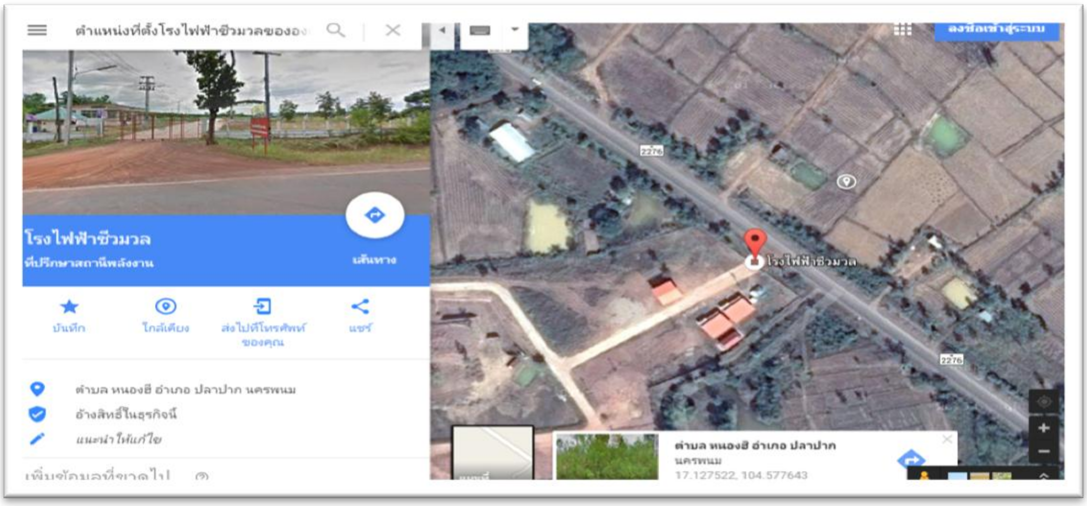

Figure 5.6 Location of the Biomass Power plant of Nakhonphananom Provincial Administration Organization

(3) The Production of Electricity from Biomass

The small power plant of Nakhornpanom Provincial Administration Organization uses the residues and wood chips for fuel for producing electricity units. The capacity is 350 kilowatts and is sold to at 300 kilowatts with a non-firm purchase agreement. The Nakhornpanom Provincial Administration Organization hires a private company to set up the technology and the agreement to transfer knowledge and technology between the organizations. The power plant uses gasification technology to produce gas and uses gas to generate the electricity units.

Figure 5.7 The Biomass Power Plant of Nakhonphananom Provincial Administration Organization.

Small Biomass power plant of Nakhornpanom Provincial Administration Organization

2) The important factors affecting the effectiveness of small power plants of Nakhornpanom Provincial Administration Organization power plant

(1) The Biomass Fuel Source

The fuel source is the key success factor for operating of the power plant. As mentioned, Nakhornpanom is an agricultural province and has a lot of agriculture residuals. Nakhornpanom Provincial Administration Organization needs to bring the residuals to be fuel for the power plant. Moreover, the need to support the community in the province to plant fast growing and energy plants as well.

(2) Technology to Produce the Electricity Units

Technology is another factor to the operation in power plants. Before establishing the power plant, Nakhornpanom Provincial Administration Organization conducted a review and studied biomass power plants in many sources. The Provincial Administration Organization selected Gasification technology with the reason of the reasonable cost of technology, cost of establishing the plant, and cost of the operation in the electricity production process.

(3) The Power Plant Location

The power plant location is important because of establishimng the power plants need to access a water source, fuel source and access to the grid lines.

(4) The Knowledge and the Ability of the Staff

Nakhornpanom Provincial Administration Organization started operating the power plants by transfering knowledge from the private company that established the power plant and set up the technology. The operation in the process included many factors, the need of skill and knowledge to operate the operation system. The engineering and gasification knowledge are very important to the operation, to solve the problems, and to implement the operation system.

(5) The Government Subsidies

The government support policies for small power plants is the drive to the operation in the industry. The Nakhornpanom Provincial Administration Organization power plant has the adder as the very small power plant with a special rate of selling electricity units.

3) The Effectiveness of the Power Plant

(1) Financial Effectiveness

On the project analysis of investment in small biomass power plants. If power plants can be operated full time, the return investment is 4 years. The period of investment return is a short duration and has a good rate of return. However, the purpose of the plant is more than the financial investment as the need to establish the community biomass power plant to return to the community and environment and to establish the resource center of biomass to a electricity center.

(2) Environmental Effectiveness

The small biomass power plant will use agricultural residues to produce electricity, which will have less impact on the environment. In the implementation the contractor supports all areas, particularly in the environmental issues with minimal impact to no impact at all. The smoke created by burning disturbs residents no sound and the waste water used in the manufacturing process must be accounted for. The power plant has a pond to circulate waste water. The operation of the power plant does not affect the environment. Moreover, before establishing the power plant, they set the public hearing to share the ideas and check the community acceptance. The support from the farmers to bring the residuals of agriculture to sell to the power plant as reduce the burning of residual rate is done beforehand. The success of the environmental impact is the residuals become fuel for the power plants which is a substitute of burning.

(3) Community Effectiveness

The benefit of the small power plant to communities are to increase the farmers' income, improve the quality of life, create careers and increase the money circulating in the community. The residuals of the production in the power plants is the ash and water vinegar which are useful for soil improvement. The farmer may bring the residuals to use as fertilizers in their agriculture land. (Siripong Seangsuk, personal communication, June 9, 2016)

5.1.2.3 The Small Biomass Power Plant of Asain Palm Oil Company Limited, Krabi.

1) General Information of the Small Biomass Power Plant

(1) The Company Review and the Important Policies

Asian Palm Oil Company limited is a factory to produce palm oil from the natural palm from the farmers. The main product of the company is the cured palm oil that is sold to the refinery factory.

The company is a pioneer in the form of extracting Palm oil especially with the support of the Department of Industrial Works (DIW) and the application of environmental management systems (EMS) under the "EMS for SMEs" project. The company has certification from the Department of Plants, Thailand in 2548. The company has been recognized by the ISO 14001 standards under environmental policy in 2550.

The company is a pioneer of using wastewater from the palm oil industry to be used in the fermentation technology or biogas to produce electricity. Asain Palm Oil Company limited is the first palm oil company in Thailand that produces electricity from residuals and waste water from thermo and fermentation technology. The company produces thermo technology by using the residuals of palms to produce electricity units to operate the factory and uses the residuals and wastewater from the production process with fermentation technology to produce electricity units to sell to the PEA. The capacity is around 2.60 megawatts. The company has the purchase agreement contract with the PEA for 1 megawatt.

(2) The palm oil factory and power plant location is 99 Moo 2, Tamboon Auluktai, Aumpur Auluk, Krabi Province.

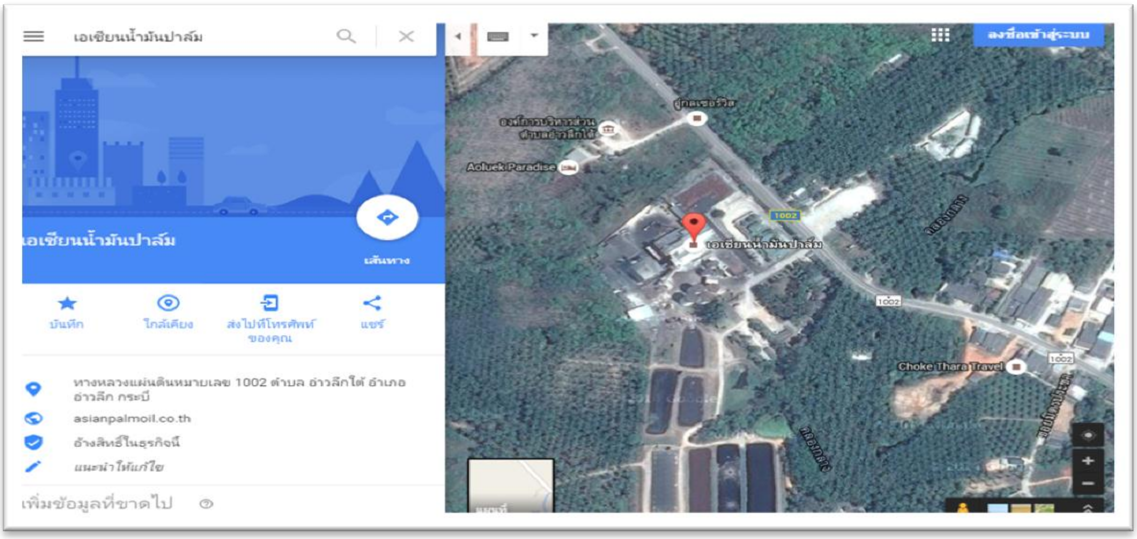

Figure 5.8 Location of the Small Biomass Power Plant of Asain Palm Oil Company Limited, Krabi

(3) The oil production process led to the residual from the process to electricity

The process of oil distillation is 4 stages as follows:

Stage 1) Sterilization, Sterilization will stop the reaction to lipoprotein that causes the fatty acids in the oil fruit and releases from the fruit more easily.

Stage 2) Stripping, Stripping is the process to separate the palm fruit from bunches. Bunches are separated, and oil fruits are chipped in the machine.

Stage 3) Oil Extraction, Beginning the process of oil extraction is done by baking the palm fruit for 20-30 minutes and taking the palm to the machine for separating the shell from seed oil palm.

Stage 4) Clarification, Clarification is the process of separating the oil and solids, for cleaning the oil before delivering to customers.

(4) Palm oil and Biomass

(4.1) The company uses palm shells and seeds for producing electricity by using boiling technology and using the electricity for operational processes inside. Moreover, the company sells the palm shells and seeds as fuel to other companies as well.

(4.2) The company uses waste water for producing the electricity by implementing fermentation technology. The company renews the wastewater and residuals from the production process as biomass liquid by controlling the conditions of microorganisms for producing the electricity and selling to the PEA.

Figure 5.9 On Field Study at the Small Biomass Power Plant of Asain Palm Oil Company limited, Krabi

2) The important factors affecting the effectiveness of power plants

(1) Technology Used in Producing Electricity

The application of technology and efficient use of resources for the production process for the quality of the products and minimal environmental impact is essential. The company is an innovator in the oil palm industry for using the wastewater from the production process with the fermentation technology to producing more electricity units.

(2) The Application for a License to Sell Electricity

The company needs to request permission to produce electricity in the plants, the purchase agreement needs to be complete before the production of the electricity.

(3) The Knowledge and Skill of the Staff

The knowledge and skill of staff is important for solving the problem on operation systems. In the factory the company innovates its biomass and residuals to produce electricity from both the boiler and fermentation technology.

3) The Effectiveness of the Small Biomass Power Plant

(1) Financial Effectiveness

In the palm oil production, the return rate depends on the quality of palm oil. Normally the company buys palm oil from the farmers in the factory area, around 10% is bought from other wholesalers. When buying from wholesalers the quality of palm oil may be mixed with many grades which creates a loss in the production process product at 80%. However, in the section of producing electricity, the rate of return is very good. The company needs to sell the electricity on the purchase agreement.

(2) Environmental Effectiveness

The company tries to operate with minimal environmental impact, for example, to plant trees around the factory for reducing the sounds of operation, to solve problems that effects the community, to support the farmers in the area by distributing the residuals from operation to be fertilizer, to manage the environment, and to support the knowledge of the environment to the community.

(3) Community Effectiveness

The company allocates many benefits to the community, for example, to generate employment in the area, to promote the cultivation of oil palm, to become a purchase center to buy the palm products from farmers in the area in order to reduce transportation costs, to support many activities in the community, to support schools and health activities, and pay the funding to community activities surrounding the power plants. (Jadsada Chotivattna, personal communication, June 6, 2016)

5.1.2.4 The Focus Group with the Community Surrounding the Small Power Plants

The Auluktai community, surrounding Asain Palm oil small power plant, Auluk, Krabi.

The group meeting of The Auluktai community, surrounding Asain Palm oil small power plant, Auluk, Krabi including the leaders and members of the community are: 1) Mr. Bumrung Tavaicheu 2) Mr. Somshong Sirimanon 3) Mr. Narin Sirichoti 4) Mr. Thanongsak Phakaew 5) Mr. Jamnai Chunoo and 6) Mr. Khongpop Chanchinapat

Figure 5.10 Focus Group with the Auluktai Community

1) The relationship between Auluktai community and Asain Palm oil small power plant

Asain Palm oil small power plant is the purchase center of palm oil from the farmers surround the area. The farmers have a fair price of palm oil as sold direct to the factory, to reduce the delivery cost of agricultural products and time of the products being in transportation.

2) The effectiveness of Asain Palm Oil power plant to Auluktai community

(1) Financial Effectiveness

The benefit of financial matters of Asain Palm Oil small power plant to the community is as follows: 1) The purchase center of palm oil in the

Auluk area 2) to reduce the costs of delivery of palm products 3) To increase money circulating in the community 4) Create careers, jobs, and income in the area.

(2) Environmental Effectiveness 1) To support the residuals from the production as fertilization for the farmers 2) to sincerely solve all problems of the environmental effects 3) to support the electricity in the line 4) to support the renewable biomass residuals and wastewater from the production process to produce electricity 5) to use waste water as a fermentation substitute release wastewater in the canal or river 6) to develop by-products from palm and residuals from the factory to the power plant.

(3) Community Effectiveness 1) To support community activities 2) to increase hiring people to work in the factory 3) to support the farmers to grow palms as energy crops 4) to concentrate on the community complaints of the factory working and problems effecting the community caused by the factory. (Auluktai group, focus group, 2016)

Figure 5.11 The Benefit Asain Palm Oil Power Plant to Auluktai Community

5.1.2.5 The Papak Community, Surrounding Nakhornpanom Provincial Administration Organization

Nakhornpanom Provincial Administration Organization selected Taboo Nonghee for setting up the small power plant in a suitable location in the community that has the knowledge of the power plants very well as the community has a strong network. When the leader of the community accepts the different opinions from the members the community becomes the driving force of setting up the Nakhornpanom Provincial Administration Organization small power plant.

The focus group of the Papak community, surrounding Nakhornpanom Provincial Administration Organization including the leader and members of the community are: 1) Pol. Lt. Col. Anucha Chothaisong 2) Mr. Suthit Khongyu 3) Mr. Manit Kimalee 4) Mr. Sathil Namvong 5) Mr. Chartsayam Sombatkhamrai 6) Mr. Thomgsat Kweawvala 7) Ms. Reangma Prasanmitr 8) Ms. Vanida Kweawvala 9) Ms. Khamloon Mulmeang

Figure 5.12 Focus Group with the Papak Community

1) The relationship between The Papak community and Nakhornpanom Provincial Administration Organization

Nakhornpanom Provincial Administration Organization focuses the Papak community using public relations to the community with details and benefits of the small power plant aimed at the community understanding and arranging public hearings within 2 years for checking on the community responses of setting up the power plant in the area.

2) The effectiveness of the small power plant of Nakhornpanom Provincial Administration Organization to Parpak community

(1) Financial Effectiveness

The benefit of finance is the following 1) To be the purchase center of biomass residuals 2) to create careers and incomes 3) to increasing the money circulation in the community.

(2) Environmental Effectiveness

Nakhornpanom Provincial Administration Organization supports growing energy crops such as fast growing trees, napea, and so on.

(3) Community Effectiveness 1) To support the community activties 2) to hire labor from the community 3) to solve the problems from community complaints 4) to distribute the residuals from the power plant to farmers to use as fertilizer 5) to develop by-products from the production process, such as biochar, for soil improvement. 6) Create a learning center of small power plants for government and private sectors 7) to strengthen the renewables as a community power plant 8) to increase the money circulation in the community 9) to responds to the government renewable policies. (The Papak community, focus group, 2016)

Summary of qualitative research, the key findings are as follows: 1) the effectiveness of small biomass power plants and 2) the important factors which affect the effectiveness of small biomass power plants. The important issues are sorted by reference from the sample with reference in descending order as follows:

1) The effectiveness of small biomass power plants consist of Environmental effectiveness, the operation of small biomass power plants is to reduce the burning of waste materials in the area. To recycle biomass residuals and wastes, and to reduce the pollution that affects the environment. Community effectiveness, such as job creation, the community earns income from biomass sales that create income and energy security in the community. Financial effectiveness, the operation of small biomass power plants have good returns, a good cash flow from the investment, cost effective systems, and short terms of the pay-back period.

2) The important factors affecting the effectiveness of small biomass power plants consist of Biomass fuels, Biomass fuel is an important factor as it is the main fuel used in electricity production. The power plants need a lot of biomass fuel to produce all year. Technology of producing the electricity, The operators need to choose the right technology for a wide range of biomass fuels to be

used. The technology used is effective and stable for the production process. The ability and skill of employees, the production process of the biomass power plant requires the knowledge, skill, and the expertise of the team in solving specific problems and the preparation of a backup plan when problems arise. The government subsidies, The government has supported the operation of biomass power plants, such as, the additional price on the purchase of power units, the change of the purchase price form to the feed-in tariff, the fixed price of purchase and so on. Location of the power plant, The operators need to choose the location of the power plant. The location of power plants should be near the biomass fuel source, a water source, the transportation, the transmission lines and the utility system. The community acceptance, the operators need to publicize the biomass power plant project to the community, for example, explain the results, the implications, and the effects of the power plant operation straightforward. Then, the communities surrounding the power plant area are knowledgeable and adopt the biomass power plant project. Biomass fuel management, The operators need to manage the amount of biomass fuel to support the electricity production throughout the year, and control the price of biomass fuel that is the cost of biomass is not affecting the operating costs. The initial project design of biomass power investment, the operators should pay attention to the design of the initial project to analyze the investment project whether the investment is cost-effective or not. The management of the biomass power plant, The management is important from the beginning of the project, the analysis of operating costs of investment, the coordination of government agencies to have the permits, the work plan, and the control of biomass power plants operation. The dependence on external resources, The dependence of the external fuel resource is an important factor for biomass power plants, especially the plants without their own fuel sources. They have to rely on resources from other sources, for example, they need to buy the biomass residuals from farmers or the middlemen. Regulations and laws, The operators need to follow the regulations, laws and procedures rustically to complete the operation of the power plant, for example, the preparation of documents to apply for the establishment of biomass power plants, the allowance process to have the permission to sell electric units, and the contract to sell electricity and electricity units, and so on. The organizational culture, the culture to determine the value of work, let employees be concerned with the importance of biomass power generation and join their efforts to solve common problems on the working process. The executive vision, The executives are committed to continuous production and development of electricity production from biomass fuel. The potential of the grid lines, the potential of the grid lines affects the operation of biomass power plants. If the grid line system of the power supply can support the biomass power plant thoroughly. The operators can set up power plants without restrictions. The accessory of connecting the electricity, The accessories of linking the electricity affect the cost of operation. If the electricity link accessory is damaged, the power plant needs to restart the operation to connect with the accessory many times which causes the operation unexpected costs of the production process. The distance of biomass sources, The distance of biomass sources is important to the operation process. The distance of transportation fuel affects the cost of fuel and the cost of operations. Knowledge development, The small power plants will succeed if the plants develop the knowledge especially concerning the technology. The knowledge development can improve the quality of jobs, solve the problems, and increase the efficiency of technical working in the production process. The supply chain management, The supply chain management can save costs in the production process from managing downstream to upstream operation well and efficiently. The purchase agreement of electricity selling, The purchase agreement of electricity selling is important as the contract provides details and terms of conditions on the implementation of selling the electricity units between the small power plants and the PEA. The local politics is the problems on the setting and operation of Small power plants. The problems cause the enterpriser set up and operation issues that incur unforeseen difficult situations. The crude oil prices affect prices of various goods and the cost of operation of biomass power plants.

5.2 The Conceptual Development

Based on the results of qualitative research, it can be concluded that the operation of a small biomass power plant consists of the pre-establishment phase. They submit allowance phases and the operation phases before the establishment phase of the power plant, the project managers must have the knowledge and ability to make the decision to analyze investment projects. The ability to make decisions on the project investment, the decision of the location of power plants and the biomass resources. Moreover, the inspection of the availability of the connecting grid line system whether to set the power plants. The executives need to consider the government subsidies to support the power plants because the PEA is setting the unit purchase price and is the customer of the biomass power plants. The management should select the right location of setting the biomass power plant, the location should be close to the transmission lines, the utilities, labor source, and the biomass resources. If they make good choices it will save the operation costs substantially. The location of the power plant is appropriate that should be near the source of raw materials near a water source near the utility system and near the transmission lines. (Somnuk Jindasab, personal communication, 2016). When the location is set properly, the operators need to make a community or public hearing in the community to accept the biomass investment project. The operators can set the power in the event the community accepts the biomass power plant project. If the community opposes the action, because of the uncertainty in the operation of the biomass power plant, the biomass power plant will not be able to set up the power plant. The operators need to consider the community acceptant on the project investment.

The construction and operation permit procedures phase, the project managers need to strictly follow the rules and regulations of the biomass power plant setting. In the establishment and operation of biomass power plants, there are several stages of the rules and regulations of the government agencies. Starting from the application for permission to establish a biomass power plant from the Tambon Administration Organization Provincial Administrative Organization, to get the permission of building the power plant from the Tambon Administration Organization, to get the permit from the Division of the Industrial factory Investment promotion from Board of Investment office, to sign the purchase agreement with PEA and so on.

The third phase is the operation of biomass-based power generation. It requires skilled staff to solve problems in the workplace. The supply chain management is to manage the biomass fuel and the demand for biomass fuels' quality to have enough volume to operate. In case the biomass power plant does not have their biomass fuel resource, they need to depend on the biomass fuel from the farmers or the middlemen' supplies. Operating a biomass power plant, executives cultivate the values of work, such as cultivating values in Renewable energy commitment to jointly address the problems arising from the biomass power generation process. The value of the work comes from the instillation and transfer from the executive level in the field of energy conservation, which is an important factor in the operation of small biomass power plants. On the biomass power plant operation, the executives cultivate the values of working, such as cultivating values in production of electricity from biomass residuals, and jointly of problem solving from biomass-based power generation.

There are various variables from qualitative research. The researchers summarized the important issues into 24 variables as follow: 1) The effectiveness of small biomass power plants consist of environmental effectiveness, community effectiveness, and financial effectiveness. The important factors affecting the effectiveness of small biomass power plants consists of biomass fuels, technology of producing the electricity, ability and skill of employees, the government subsidies, location of power plants, the community acceptance, the initial project design of biomass power investment, the management of biomass power plants, the dependence on external resources, regulations and laws, the organizational culture, the executive vision, the potential of the grid lines, the accessories of connecting the electricity, the distance of biomass sources, knowledge development, the supply chain management, the purchase agreement of electricity selling, the local politics and the crude oil prices.

The research uses all important issues from qualitative research to design the instrument of the quantitative research. The questionnaires are the instrument for collecting the data from the small biomass power plants all over Thailand, totaling 343 power plants. When the data is collected from the samplings of quantitative research until the amount of data is sufficient. The researcher analyzes the data by using the Exploratory Factor Analysis to classify all variables from a large number of variables resulting from qualitative research, to group and to create new variables applied to the conceptual frameworks and hypotheses of quantitative research.

The results of the Factor Exploratory Analysis consisted of the statistical criteria of the importance factors affect the efficiency of the small biomass power plant with Kaiser-Meyer-Olkin Measurement of Sampling Adequacy = 0.762 and Bartlett's Test of Sphericity = 0.000. The result was concluded that the data from the samplings are well suitable to analyze with the Factor Exploratory Analysis. When the statistics indicate that the data can be used for the Exploratory Factor Analysis, The research analysis uses the extraction method or factor extraction, the method of extracting the variables by the Principal Component method and Factor Rotation with Varimax rotation method by cutting off criteria was factor loading equal to or more than 0.5. The SPSS reduces and groups the new factors of the important factors affecting the effective of small power plants from the original 21 factors to be a new eight factors as follows: 1) the power network and the transmission lines 2) the skills and capabilities of employees 3) regulations and laws 4) The community acceptance 5) The dependence of the biomass fuel resources 6) the values of work 7) The location of the power plants and 8) the supply chain management. The details of each factor from the Exploratory Factor Analysis with the latent variables and observable variables or indicators are listed hereafter.

The first factor: the power network and the transmission lines consist of the observable variables or indicators are sorted by Factor Loading in descending order. Grid 1 = 0.910, Grid 2 = 0.907, Assess 2 =0.844, Assess 3 = 0.810, Assess 1 = 0.779, and Grid 3 =0.741.

The second factor: The skills and capabilities of employees consists of the observable variables or indicators which are sorted by Factors Loading in descending order, Admin 1 = 0.837 , Admin 2 = 0.826, Skill 1 = 0.729, Skill 2 = 0.635, and Skill 3 = 0.584.

The third factor: Regulations and laws consist of the observable variables or indicators are sorted by Factor Loading in descending order, Regulations 2 = 0.766, Regulations 1= 0.723, Subsidy 1 = 0.607, Subsidy 2 = 0.600 , PPA2 = 0.556 , and PPA 1 = 0.530.

The forth factor: The community acceptance consists of the observable variables or indicators which are sorted by Factors Loading in descending order, Commu 2=0.874, Commu 3=0.860, and Commu 1 =0.838.

The fifth factor: The dependence of the biomass fuel resources consists of the observable variables or indicators which are sorted by Factors Loading in descending order, Distant 1 =0.884, Distant 2 = 0.825, Depend 1=0.742, and Depend 2=0.505.

The sixth factors: The values of work consist of the observable variables or indicators which are sorted by Factors Loading in descending order, Value 1 =0.785, Value 2=0.731, Vision 2 = 0.661 and Vision 2 = 0.514.

The seventh factors: The location of the power plants consists of the observable variables or indicators which are sorted by Factors Loading in descending order, Locate 1 = 0.771, Locate 2 = 0.759 and Locate 3 = 0.730.

The eighth factors: The supply chain management consist of the observable variables or indicators which are sorted by Factors Loading in descending order, SC 1 =0.720, SC 2 = 0.650, Value 3 = 0.655, Fuel 1=0.622, and Fuel 2=0.600.

The effectiveness of small power plants, the research created the latent variables and observation from qualitative research with: 1) Financial effectiveness 2) Environmental effectiveness and 3) Community effectiveness. This consists of the observable variables as follows:

1) Financial effectiveness has the observable variables or indicators as the financial performance, the cash flow, and the quick return of investment period.

2) Environmental effectiveness has the observable variables or indicators as the reduction of agricultural residues, the reduction of combustion rates in areas, and the control of pollution reduction.

3) Community effectiveness has the observable variables or indicators as increasing employment in the area. Increasing the purchase of biomass from the community and supporting community activities.

When the research created the latent variables of the important factors affect the effectiveness of small biomass power plants and the effectiveness of small biomass power plants, the researcher checks the validity of latent variables with Cronbach’s Alpha statistical analysis. The criteria of Cronbach’s Alpha statistics is 0.6-0.7 that indicates the validity of the latent variables. The results of the validity test by Cronbach’s Alpha statistics are as follows: Cronbach’s Alpha of the financial effectiveness is 0.933 (Cronbach’s Alpha = 0.933), Cronbach’s Alpha of the environmental effectiveness is 0.728 (Cronbach’s Alpha = 0.728), Cronbach’s Alpha of the community effectiveness is 0.578 (Cronbach's Alpha = 0.578), Cronbach's Alpha of the Cronbach's Alpha = 0.929, Cronbach's Alpha of the skill and ability of employees is 0.853 (Cronbach's Alpha = 0.853) , Cronbach's Alpha of the regulation and laws is 0.863 (Cronbach's Alpha = 0.863), Cronbach's Alpha of the community acceptant is 0.957 (Cronbach's Alpha = 0.957), Cronbach's Alpha of the dependency of the external biomass resource is 0.832 (Cronbach's Alpha = 0.832), Cronbach's Alpha of value of working is 0.817 (Cronbach's Alpha = 0.817), Cronbach's Alpha of the location of biomass power plant is 0.867 (Cronbach's Alpha =0.867) and, Cronbach's Alpha of the supply chain management is 0.725 (Cronbach's Alpha = 0.725).

5.3 Conceptual framework

The conceptual framework presented in quantitative research is based on the analysis of the factors influencing the effectiveness of small biomass power plants, and the effectiveness of small biomass power plants with the EFA result from the questionnaires. The researcher uses the new factors results to create the latent variable as shown in the Figure 5.13.

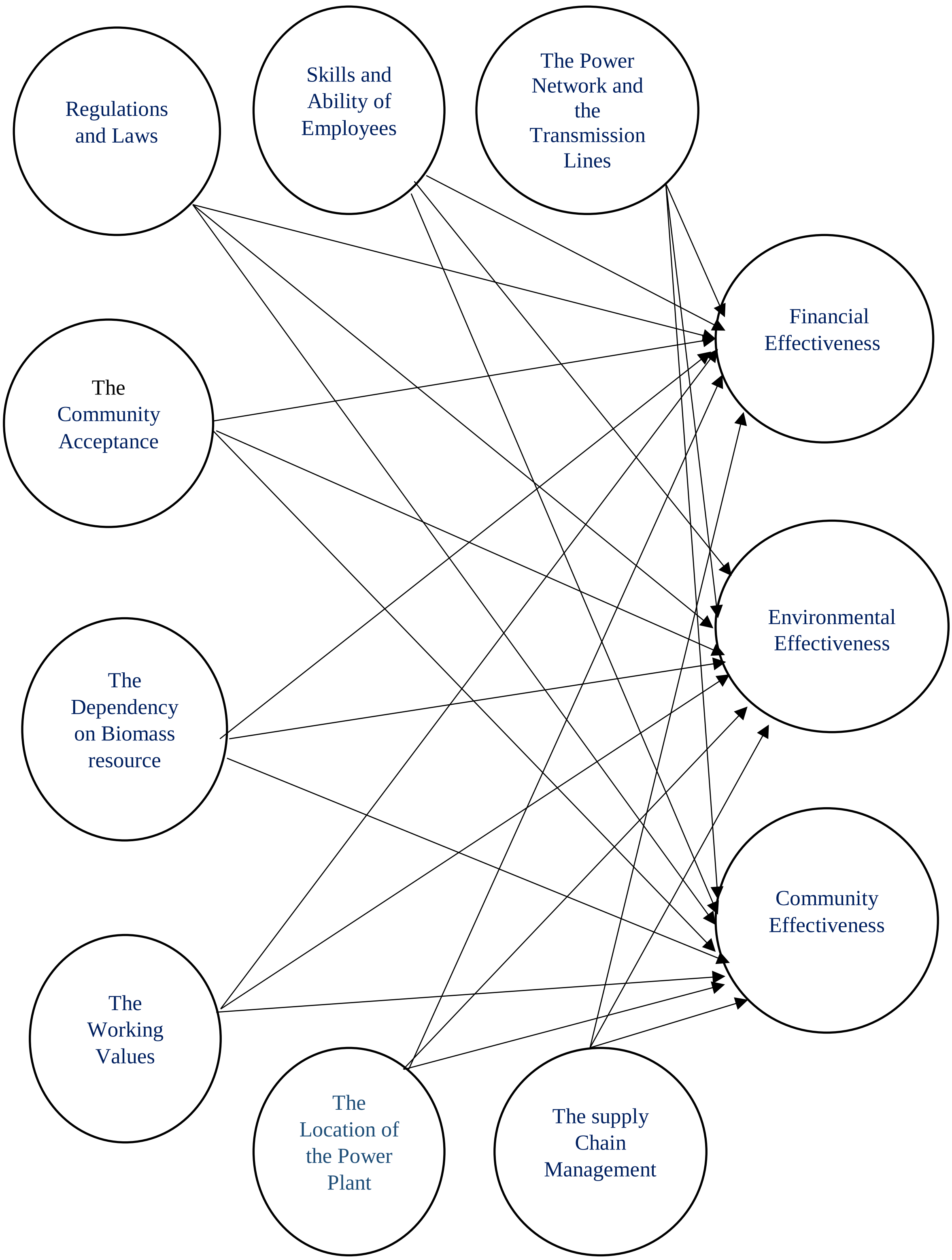

Figure 5.13 Conceptual Framework of the Structural Equation Model

The conceptual framework is developed from the Structural Equation Model based on The Resource Dependency Theory and Resource Based-View with the detail of theory as follows:

1) The latent variables of financial effectiveness have observation variables or indicators which are financial performances, cash flow, short terms of payback period. The financial effectiveness is the success of the financial organization's policy that is an important variable of the effectiveness concept. The model is used to measure the effectiveness of stakeholders' financial success. The Indicators of financial effectiveness of the organization, such as, good financial performance, (Amporn Thamrong, 2008, p. 87), cash flow, and short period of the payback of investment.

2) The latent variables of environmental effectiveness have observation variables or indicators that are the reduction of agricultural residues, reduction of combustion rates in areas, the regulator of pollution control and pollution reduction. The environmental effectiveness is the success of the policy of small-scale biomass power plants that directly affects the environment, such as, the generation of biomass from the recycling of waste materials, to help reduce global warming reduce combustion which causes air pollution. Reducing Carbon monoxide, increasing oxygen from forest reforestation to make the environment better, reduce the fuel imports from foreigners.

3) The latent variables of community effectiveness have observation variables or indicators that are the increase in employment in the area, increase in the purchase of biomass from the community and support of community activities. The community effectiveness is the success of the policy of small-scale biomass power plants that directly affects the community, such as, the creation of jobs, the purchase of biomass residues, agricultural residues, income generation, and cash flows on the community. The concept of effectiveness is the measure of the community benefits received from the organization (Amporn Thamrong, 2008, p. 87).

4) The latent variables of the power network and the transmission lines have the observation variables or indicators that are; the convenience of connection with transmission lines, the availability and speed of linking to the transmission lines and the problem solving ability of the unit in linking the power supply equipment.

The importance of the electrical networks and transmission systems are a major factor which affect the effectiveness of small biomass power plants. Because the power grid and the transmission system are important devices for linking and distributing electricity between manufacturers to the PEA and the end users, they are the important assets of the government agency-PEA which are also important variables of the Resource Based-view. An important emphasis is the important factor of the organizational operation. Barney (1991, pp. 106-107) defined the definition of a sustained competitive advantage as one that depends upon the possibility of competitive duplication. A competitive advantage is sustained only if it continues to exist after efforts to duplicate that advantage have ceased. In this sense, this definition of sustained competitive advantage is an equilibrium definition. The attributes of the organizational resources that lead to the sustained competitive advantage for the firm are the following four attributes: Valuable Resources - Rare Resources, Imperfectly Imitable Resources, and Substitutability. (Barney, 1991; Carmeli & Tishler, 2004; Galbreath, 2005).

5) The latent variables of the skills and ability of employees have observation variables or indicators that are the management model of biomass operation, the efficiency of solving problems in work processes and the ability to solve problems during work. The skills and ability of employees is an important factor of small biomass power plants. The working process of biomass power plant operation require the skill, knowledge, ability of employees to operate and solve the problems in the working process. As the skills and ability of employees is an importance factor of the Resource Based-View, Crook, Todd, Combs and Woehr (2011, p. 444). Human capital refers to the knowledge, skills, and abilities (KSAs) embodied in people. KSAs can be used as tactics. The human capitals are one's education and training, which play an important role in the organization. The investment in training in human capital will influence performance. Knowledge, Skill, Ability: KSAs include experience and education as well as experience are viewed as a central driver of strategy and performance. (Ketchen & Hult, 2007).

6) The latent variables of the regulations and laws have the observation variables or indicators that are the suitability of the procedures for obtaining permits, the appropriateness of the code of conduct, and the level of government support to

small biomass power plant operations. The regulations and laws are important factors of the small power plant operation. The regulations and laws are mandatory for the public sector to enforce publicly, that is the property of the public sector and is an important variable of Resource Based-View. The regulation and laws is an important assets on Resource Based-View, rare, valuable, and Imperfect Imitability that are important to the superior operation of an organization. (Barney, 1991; Carmeli & Tishler, 2004, Galbreath, 2005).

7) The latent variables of the community acceptance has the observation variables or indicators that are the community acceptance of establishment of small biomass power plants, the community acceptance of small biomass power plant operations, and the community support and operation of small biomass power plants. The community acceptance is an important factor of small biomass power plants, from the beginning of establishing the plants, if the community does not accept the establishment of the small biomass power plant it cannot be set up. The community acceptance is an important variable of the Resource Based-View. The important assets of the Resource Based-View are the raw materials, capital, technology, innovation, the community acceptance and the community support that affects the superior performance of the organization. (Galaskiewicz & Marsden, 1978)

8) The latent variables of the dependency of external biomass fuel from the others have the observation variables or indicators that are the distance between the biomass power plant and biomass fuel resource, the cost of delivery of biomass fuel, and the necessity of the dependency on external biomass fuel from others. The dependency on external biomass fuel from others is a very important factor to the small biomass power plant, especially the independent biomass power plant that doesn’t have their own biomass fuel resource. The dependency is an important variable of the Resource Dependency Theory. No organization is completely self-contained. Organizations are embedded in an environment comprised of other organizations. The organizations depend on other organizations for many resources they require. Organizations are linked to environments by federations, associations, customer-supplier relationships, competitive relationships, and asocial-legal apparatuses defining and controlling the nature and limits of these relationships.

Organizations need transactions with other elements in their environment to acquire needed resources. (Pfeffer & Salancik, 1978, p. 2).

9) The latent variables of the value of working have the observation variables or indicators that are the value of working on the production of electricity generation from biomass fuel, the value of problems solving and the executive commitment of problem solving on working processes of the production of electricity generation from biomass fuel. The value of working is an important factor to the small biomass power plant. The value of working or organizational culture is an important variable of the Resource Based-View, is the value, belief, and the principles of the organization. The value of working is the basis of organizational management and behavior. It is an action that supports the core principles of the organization. (Carmeli & Tishler, 2004, p. 1261) claimed the value of working or the organizational culture is the heart of the organization’s operation and an important factor to develop the production and service for superior organizational performance.

10) The latent variables of the location of small biomass power plant have the observation variables or indicators that are the ease of access to fuel sources, the access to the grid lines, and the ease to the utilities. The location of a small biomass power plant is an important factor to the small biomass power plant. The location of small biomass power plant is an important variable of the Resource based-View, and the tangible assets. Barney (1991) claimed the tangible assets of the Resource Based-View as technology, plants, machinery, and the location of the organization, and so on.

11) The latent variables of the supply chain management have the observation variables or indicators that are the support to plant the fuel trees for the fuel resources of power plants, the support to add value of biomass residuals, and the cooperation of working. The supply chain management is an important variable of Resource Dependency Theory and Resource Based-View. From Resource Dependency Theory, the supply chain management is the concept of the dependency of other organizations for the activities to get superior performance (Paulraj & Chen, 2012). From the Resource Based-View, the supply chain management is the ability of the organization for managing the organization’s relations to gain an organizational advantage. (Cousins & Spekman, 2003).

5.4 Hypothesis of the Research

This hypothesis of the research is derived from a summary of causal relationships between the important factors affecting the effectiveness of small biomass power plants and the effectiveness of small biomass power plants.

Hypothesis 1: The availability of power network and the transmission lines are likely to positively correlate with the effectiveness of small biomass power plants.

Hypothesis 1.1: The availability of power network and the transmission lines are likely to positively correlate with financial effectiveness of small biomass power plants.

Hypothesis 1.2: The availability of power network and the transmission lines are likely to positively correlate with environmental effectiveness of small biomass power plants.

Hypothesis 1.3: The availability of power network and the transmission lines are likely to positively correlate with community effectiveness of small biomass power plants.

Power generation and distribution systems are important linkages between biomass power plants and PEA. The power plant produces electricity for distribution through the electricity network and transmission system, and PEA sell the electricity units to the end users, of both the manufacturing sector or factories and the households through the power grid and transmission lines too. The equipment in the electricity transmission system consists of generators or power plants, switching stations, voltage or frequency converters, power lines, voltage substations or distribution stations, high distribution lines, transformers, and low-voltage distribution lines, etc. The power network and the transmission lines are important factors in the operation of biomass power plants. If the power network and the transmission lines are stable and potential, they can supply the small biomass power that can help the power plant to save overhead costs. If the power network and the transmission lines are not stable and potential, the operators need to restart the working process to link with the network and grid lines that cause the power plant operation costs. (Jaruvan Kwansomkid, personal communication, June 1, 2016). The power network and the transmission lines should support the small biomass operations, currently, the problems of the power network and grid line effect the biomass power plant that are not available at the biomass power plant setting. The operators need to look for a new location that has availability of the power network and the transmission lines, then there is the delay of setting the power plants and costs of operation of setting the biomass power plant.

Hypothesis 2: The skills and capabilities of employees is likely to positively correlate with the effectiveness of small biomass power plants.

Hypothesis 2.1: The skills and capabilities of employees is likely to positively correlate with financial effectiveness of small biomass power plants.

Hypothesis 2.2: The skills and capabilities of employees is likely to positively correlate with environmental effectiveness of small biomass power plants.

Hypothesis 2.3: The skills and capabilities of employees is likely to positively correlate with community effectiveness of small biomass power plants.

Human resource are important resources of an organization. There are two streams of research on human resources as a competitive advantage. 1) Human capital itself and capability of managing human capital. Some research proposed human capital itself as a source of sustained competitive advantage. 2) The capacity to manage human capital. Many researchers argue that the source of sustained advantage is the capacity to manage human capital. (Chan, lisman, & Margaret, 2004)

Crook, et al. (2011). Human capital refers to the knowledge, skills, and abilities (KSAs) embodied in people. KSAs can be used as tactics. The human capitals are one's education and training, which play an important role in the organization. The investment in training in human capital influence performance. Knowledge, Skill, Ability: KSAs including experience and education as well as experience are viewed as a central driver of strategy and performance. Human resources as a pool of human capital under the firm's control in a direct employment relationship is a key resource. Human resources practices are the organizational activities directed at managing the pool of human capital and ensuring that the capital is employed towards the fulfillment of the organization's goals. The human capital can be focused on the knowledge, skills, and their abilities. Factors attributing to human resources and competitive advantages are the following 1) Human capital resource as valuable, in order to withhold a sustained competitive advantage, the resources needs to provide value to the firm. The Human capital Theory provides the human will value when both the demand for labor and supply of labor is homogeneous. Schmidt, Hunter, MacKenzie, and Muldrow (1979) provide a means of estimating the financial value that human resources contribute to the firm. 2) Human capital resource are rare, a resource must be rare if it is to be a source of sustained competitive advantage. One can argue human resources are not rare where unemployment exists, as there is an excess of workers. Specifics on the skills of humans analyzed cognitive ability 3) Human resources as inimitable, in order for a resource to be a source of competitive advantage, the resource must be inimitable. The human advantage is most frequently characterized by unique historical conditions, causal ambiguity, and social complex, and thus humans are usually inimitable.

The skills and capabilities of employees is important factor to the operation of a small biomass power plants. From the beginning, the operators need to make the decision on invest in a biomass power plant project, the decision making is based on the knowledge, understanding and expertise, related to the small biomass power plant operation leading to the success of the operation. (Phamin Savetasila, personal communication,May 26, 2016). On the process of power plant generating electricity units from biomass fuel with gasification technology requires the employees who have knowledge, expertise on problem solving, ability, experience of working to solve all problems that can occur in order to have success of operation. (Yai Saithai, personal communication, May 12, 2016).

Hypothesis 3: Regulations and laws is likely to positively correlate with the effectiveness of small biomass power plants.

Hypothesis 3.1: Regulations and laws is likely to positively correlate with financial effectiveness of small biomass power plants.

Hypothesis 3.2: Regulations and laws is likely to positively correlate with environmental effectiveness of small biomass power plants.

Hypothesis 3.3: Regulations and laws is likely to positively correlate with community effectiveness of small biomass power plants.

On the operation of small biomass power plants, the operators need to explore the opinions of the communities in the setting area, to submit the document to install the plant, permits to the local government agencies, to submit the allowance from the power production permit, to submit the purchase agreement of selling the electricity and so on. The regulation and laws related to the setting and operating of small power plants are important to the operators to follow very strictly. The operators need to submit the documents for alliance to many government agencies; they need to prepare many documents for each allowance permit to each agency. (Nuttapong Peangsean, personal communication, June 11,2016). At allowance stage, it takes a long time for permitting what caused the operation costs to the operators of the biomass power plant. The executives have to understand the regulations and laws related the operation of small biomass power plants to reduce the costs of submitting the allowances. If they are not clear about the regulations and laws very clearly, they need to submit a lot of documents many times, that cause the delay and operation cost to small biomass power plant. (Phamin Savetasila, personal communication, May 26, 2016).

Hypothesis 4: The community acceptance is likely to positively correlate with the effectiveness of small biomass power plants.

Hypothesis 4.1: The community acceptance is likely to positively correlate with financial effectiveness of small biomass power plants.

Hypothesis 4.2: The community acceptance is likely to positively correlate with environmental effectiveness of small biomass power plants.

Hypothesis 4.3: The community acceptance is likely to positively correlate with community effectiveness of small biomass power plants.

Community acceptance is central to the operation of a biomass power plant. The problem of establishing a biomass power plant if the community is opposed to establish the power plant. People have a negative opinion about the operation of biomass power plants because of air pollution, and environment pollution. If the community opposes the operation of the biomass power plant, the operators cannot set up the biomass power plants. All parties need to campaign, use public relations, to further the understanding of the operation of power plants until the public clearly understands. If the entrepreneur can solve the problem of community acceptance, that will lead to the success of the small scale biomass power plant management. (Prasit Siriphiprasee, personal communication, June 7, 2016). Significant problems arising from community resistance are the fuel in transportation, the noise pollution, and environment pollution from dust disturbing the community. Therefore, the operators need to understand and solve the problems that the community requests to avoid resistance from the community against the operation of biomass power plants. (Prasert Sinsukprasert, personal communication, May 9, 2016). In the operation or establishment of biomass power plants, the project owners need to make a public hearing for community acceptance before implementation. Community acceptance is an important factor in whether or not a biomass power plant project can take place. The solution to the problem is public relations between the project owner and the community. If the community understands the project very clearly and has good relations with the project owner, then the biomass power plant can be set in the area. (Nattapong Peansen, personal communication, June 11, 2016). Community acceptance of the biomass power plant is important to influence the operation of biomass power plants. Project managers need to build knowledge, understanding, and create community acceptance. The project owner needs to express sincerity by transparently providing information to the community. Biomass power plant operators are required to strictly follow the laws and regulations to ensure community safety of the environment. (Suwaporn Sirikhun, 2010, Department of Alternative Energy Development and Efficiency, 2015b).

Hypothesis 5: The dependence of the biomass fuel resources is likely to positively correlate with the effectiveness of small biomass power plants.

Hypothesis 5.1: The dependence of the biomass fuel resources is likely to positively correlate with financial effectiveness of small biomass power plants.

Hypothesis 5.2: The dependence of the biomass fuel resources is likely to positively correlate with environmental effectiveness of small biomass power plants.

Hypothesis 5.3: The dependence of the biomass fuel resources is likely to positively correlate with community effectiveness of small biomass power plants.

The characteristics of small biomass power plants in Thailand can be classified into two main types of biomass fuels: biomass power plants with their own biomass resources, for example, a sugar-producing power plant, palm oil power plants, etc., Independent power plants are the power plant established without their own biomass resources. Biomass power plants with their own biomass sources have enough fuel to generate electricity but the independent power plant without its own fuel source needs to seek external sources of biomass, such as, to buy the biomass residuals from farmers or middlemen in the area. (Prasert Sinsukprasert, personal communication, May 9, 2016). Therefore, the dependency on external fuels is an important factor for biomass power plants without their own fuel sources, which rely on resources from other sources. However, the dependency of the biomass fuel causes high operation costs. Resource Dependency Theory focuses on the relevance of the organization and the environment in order to obtain the required resources (Pfeffer & Salancik, 1978). The key concept of resource dependency theory consists of a small number of organizations that can use internal strategies and resources. Organizational organization is successful, so organizations need to rely on other organizations (Heidi, 1994).

Hypothesis 6: The values of work are likely to positively correlate with the effectiveness of small biomass power plants.

Hypothesis 6.1: The values of work are likely to positively correlate with financial effectiveness of small biomass power plants.

Hypothesis 6.2: The values of work are likely to positively correlate with environmental effectiveness of small biomass power plants.

Hypothesis 6.3: The values of work are likely to positively correlate with community effectiveness of small biomass power plants.

On the operation of the small biomass power plant, the executive builds on the beliefs and values of work that employees are proud of producing electricity from agricultural residues and the development of excellence (Vasan Vongrat, personal communication, June 14, 2016). The manager cultivates the staff to help solve problems in the work to achieve the success of the team. The beliefs and the values of work values is a requirement of an organization to determine in order for its members to have a common feeling and to encourage members within the organization to empower their organizations to achieve organizational goals. (Navapol Ditthian, personal communication, June 16, 2016). Organizational culture can create a competitive advantage for the organization. The attribution of organizational culture. Barney (1985a) stated that there are 3 important attributes of culture. First, the culture must be valuable. That is, it must do things and behave in ways that lead to high sales, low costs, high margins, and other financially valuable activities. Secondly, the culture must be rare. The attributes and characteristics of the superior performing company will not be found in the cultures of other firms. Thirdly, the culture must be imperfectly imitable. The desired culture cannot be imitated by other firms. Firms without these attributes cannot expect their cultures to be resource of a sustained competitive advantage. Although efforts by less superior firms change their cultures may lead to new valuable attributes, they will not generate sustained superior performance (Barney, 1986).

Hypothesis 7: The location of the power plants is likely to positively correlate with the effectiveness of small biomass power plants.

Hypothesis 7.1: The location of the power plants is likely to positively correlate with financial effectiveness of small biomass power plants.

Hypothesis 7.2: The location of the power plants is likely to positively correlate with environmental effectiveness of small biomass power plants.

Hypothesis 7.3: The location of the power plants is likely to positively correlate with community effectiveness of small biomass power plants.

On the operation of the small biomass power plant, The location of small biomass power plants affects the biomass power plant operation. The location of biomass power plants must be related to the transmission system in order to generate electricity and supply electricity to the transmission lines and to save the operation costs of linking the system. If the location of the power plant is far from the transmission lines, the operators need to invest in linking the transmission lines between biomass power plants and the linkages system. Then, the cost of linking the transmission system a long distance will be a high cost. (Yai Saithai, personal communication, May 12, 2016). The location of the biomass plant must be close to the fuel source in order to facilitate the transportation of biomass fuels into the power plant, close to utility systems, water sources and roads, to facilitate the operation, to coordinate with relevant agencies, water resources, and the transportation systems. (Nuttapong Pheansean, personal communication, June 11, 2016). In case the investors may select the special areas to have special support of electricity units, for example, the setting of the biomass power plants in the border provinces in the South of Thailand (Navaphon Dissatien, personal communication, June 16, 2016). The location of the plant is an important factor of executive decision-making. If the plants is set and needs relocation, the cost of operation is very high and affects the operation costs. The location is important to the process, the performance, and the growth of organization. (Hill & Naroff, 1984). The location of an organization affects the performance, for example, to improve demand flexibility, reduce inventory cost, and collocate design and manufacturing operation to enhance innovation potential. (McIvor, 2013, p. 1). The choice of which parts of manufacturing to outsource is based on ascertaining what will save overhead costs, rather than how the decision-making influences the long capabilities of an organization (Porter & Rivkin, 2012). The decisions on the location of the plant are important for the organization as the location has an impact on the production process, marketing costs, the transportation costs, which affect the profitability of the organization.

Hypothesis 8: The supply chain management is likely to positively correlate with the effectiveness of small biomass power plants.

Hypothesis 8.1: The supply chain management is likely to positively correlate with financial effectiveness of small biomass power plants.

Hypothesis 8.2: The supply chain management is likely to positively correlate with environmental effectiveness of small biomass power plants.

Hypothesis 8.3: The supply chain management is likely to positively correlate with community effectiveness of small biomass power plants.

Supply chain management in biomass power plants is a matter of integrated supply chain management to ensure the successful operation of biomass power plants. Biomass power plants should handle supply chains from upstream to downstream. For example, to create more agricultural output as the more agricultural production, the more biomass residues there are respectively. (Nattapong Peansean, personal communication, June 11, 2016). Supply chain Management of the for biomass power plant begins with planting fast growing trees, supporting the biomass residuals to use as fuel in the power plants, to support the community to take the agriculture production and biomass to sell to the power plants. The management of the biomass fuel should create easy access to the biomass fuel producing plants, to save costs of transportation and operation costs. (Navaporn Dissatien, personal communication, June 16, 2016). On the operation of the small biomass power plant, the manager does public relations with the community to bring the biomass residues to sell to power plants. (Yai, Saithai, personal communication, 2016). The power plant encouraged the community to plant fast growing trees that can be used as a fuel for power plants. (Siripong Sansuk, personal communication, June 9, 2016). The biomass power plants with their own fuel sources, such as, Sahacogen Biomass Power Plant in Lamphun

Province. They have established a system for managing fuel management as a management of the resources, building network systems, creating forest plantations to support fuel management and to secure energy for the power plant. On the other power plant in the Kamphaengpet, there is a joint venture with the paper mills under the Siam Cement Group. The paper mill has the residuals to support the power plant. The power plant has the biomass resource from the group of the two companies. (Aphipong Vithchukamint, personal communication, May 17, 2016).

5.5 Chapter Summary

The qualitative research results is an important factor affecting the effectiveness of small biomass power plants which consist of Biomass fuels, Technology of producing the electricity, the knowledge, skills, and abilities of employees, The government subsidy, Location of power plant, The community acceptance, The initial project design of biomass power investment, The management of biomass power plant, Biomass fuel management, The dependence on the biomass fuel from outside, Regulations and laws, The organizational culture, The executive vision, The potential of the grid lines, The accessory of connecting the electricity, The distance of biomass sources, Knowledge development, The supply chain management, The purchase agreement of electricity selling, The local politics and foreign crude oil prices. The research uses all important issues from qualitative research to design the instrument of the quantitative research. The questionnaires are the instrument for collecting data from the small biomass power plants all over Thailand, totaling 343 power plants. When the data is collected from the samplings of quantitative research until the amount of data is sufficient. The researcher analyzes the data by using the Exploratory Factor Analysis to classify all variables from a large number of variables resulting in qualitative research, to group and, to create new variables then apply conceptual frameworks and hypotheses of quantitative research. The results of Exploratory Factor Analysis are the 8 factors of the important factors affecting the effectiveness of small biomass power plants as follows: 1) The power network and the transmission lines 2) The skills and capabilities of employees 3) Regulations and laws 4) The community acceptance 5) The dependence on the biomass fuel resources 6)

The values of working 7) The location of the power plants and 8) The supply chain management. The effectiveness of small biomass power plants consists of 1) Financial effectiveness 2) Environmental effectiveness and 3) Community effectiveness. The research uses all latent variables to create the conceptual model and set the hypothesis of research respectively.

CHAPTER 6

THE QUALITATIVE RESEARCH AND MIXED MRTHOD RESULT

This Chapter includes, Mathematical symbols and acronyms used in quantitative research reports, Instrument Development Results, The Data Analysis Results from quantitative research, Mixed Method Report , The comparison between the qualitative research results and the quantitative research results, and chapter summary.

6.1 Mathematical Symbols and Acronyms Used in Quantitative Research Reports

The third phase of quantitative research is continuing research from the qualitative research. On the analyzation and report of the quantitative data, the researchers use SPSS program using descriptive statistics to report the characteristics of the samplings in percentages of the general information of small biomass power plants, the important factors affecting the effectiveness of small biomass power plants and the effectiveness of small biomass power plants. The researcher uses SPSS to explore Exploratory Factory Analysis on the important factors affecting the effectiveness of small biomass power plants and SPSS AMOS version 24 program to analyze structural equations to test the correlation between the important factors which affect the effectiveness of small biomass power plants and the effectiveness of small biomass power plants, and the research hypothesis.

Table 6.1 Mathematical Symbols and Acronyms Used in Quantitative Research Reports

Mathematical Symbols and Acronyms Used	Meaning
N	indictors variable number of the latent variable
δ_i	Standard Variation indicator variable
P –Value	Level of statistical significant In case the variable has significant level used ***
Composite Reliability : CR	The confidential level of the variables
Average variance extracted : AVE	The test value of the square root of standard variation is more than the relation of each variables
Average Shared Square Variance : AVS	The average of co variance of the variables
Maximum Shared Square Variance : MSV	The square of the maximum of co variance of the variables
Factor loading	The relation value of the variables
***	Level of significant at 0.05
$\bar{x}$	Average
S.D	Standard Variation
CMIN/DF	Chi-square Statistic Comparing the Tested Model and the Independent Model with the Saturated Mode
AGFI	Adjust Goodness of Fit Index
CFI	Comparative Fit Index
GFI	Goodness of Fit Index
NFI	Normal Fit Index
RFI	Relative fit index

Table 6.1 (Continued)

Mathematical Symbols and Acronyms Used	Meaning
IFI	Incremental fit index
TLI	Lewis Index
RMSR	Root Mean Square Residual
RMSEA	Root Mean Square Error of Approximation

6.2 Instrument Development Results

6.2.1 The Instrument Developing Results

The development of the instrument of the quantitative is the second phase of this research study. The researcher used the qualitative results of the important facts affecting the effectiveness and the effectiveness of small biomass power plant to create the instrument of quantitative research study and validity of the instrument by approval from Associate Professor Dr. Tippawan Loysuwan and Dr. Sawat Wannarat for the consistency and accuracy of language used in the instrument. After approval from professors, the researcher tested the instrument by collecting the data from the executives of small biomass power plants from 4 power plants with a total of 10 samplings and to observe the behaviors of the response ensuring there isn't any doubt or uncertainty of the questionnaires. After they finished the questionnaires, The researcher asked their recommendations for developing the questionnaires. The researcher rewrote the questionnaires with their suggestions and used the questionnaires to collect the data of the first group with an initial first 30 samplings.

6.2.2 The Validity of the Instrument from the First 30 Samplings

The first group of 30 samplings was a reliability analysis of the instrument on the quantitative research study. The first test was to test the confidence level of the quantitative questionnaire before the questionnaire was applied to all samplings of the small power plants in Thailand. The first sample used in the quantitative research was from the small biomass power plant which were samples that the researcher interviewed from qualitative research and their branches. After collecting the data from 30 samplings, the researcher validated questionnaires by using the Cronbach Alpha statistics. The results of reliability of the questionnaires is 0.871 or 87.1% which is a higher than the alpha criteria at 0.70. The results of validity of the important factors affecting the effectiveness is Cronbach Alpha Coefficient as 0.845 or 84.5% which is a higher than the alpha criteria at 0.70. The results of validity of the effectiveness of the small power plants is Cronbach Alpha Coefficient at 0.823 or 82.3%. The research found some items of questions are of the same meaning, the research cut off the items that had the same meaning and submitted the rewritten questionnaires to Dr. Sawat Wanarat to recheck the questionnaires again. After final approval from the professor, the researcher used the updated questionnaires with all 343 samplings.

Table 6.2 The Validity of the First 30 Samplings

Details	**Items**	**Cronbach Alpha Coefficient**
The overall validity of the questionnaire	62	0.871 or 87.1%
The results of validity of the important factors affect the effectiveness	53	0.845 or 84.5%
The results of validity of the effectiveness of the small power plants	9	0.823 or 82.3%

6.3 The Data Analysis Results from Quantitative Research

The data collection with questionnaires from the samplings of the small biomass power plants throughout Thailand totals 343 power plants, the questionnaire respondents total 211 samplings. The research report comprises data from 211 samplings with the SPSS program which used Descriptive statistics to analyze the data from the first section which is the general characteristics of the small biomass power plants, the second section is the important factors affecting the effectiveness and the third sections is the effectiveness of small biomass power plants, all details are listed as follows:

6.3.1 The General Characteristics of Small Biomass Power Plants

1) Population

The study is based on the total population of small-scale power plants that generate electricity from biomass fuel by thermal technology, gasification, and fermentation (Biogas) totaling 343 samplings, which are licensed by the Energy Regulatory Commission and have electricity generation ability not exceeding 10 megawatts. The samplings are licensed through announcement of the Energy Regulatory Commission until December 2016. After the researcher sent the cover letter with the questionnaires to all 343 samplings, 25questionnaires were rejected because they closed their business, then the researcher cut the rejected samplings from 343 samplings, creating a new total with a balance of 318 samplings.

Table 6.3 The Population of Small Biomass Power Plants in Thailand

Part of Thailand	Total
Northern	25
Northeastern	94
Central	68
Western	32
Eastern	25
Southern	74
Total	**318**

2) General Information of the Samplings

The samplings that responded to the questionnaires is 211 from 343 samplings, we found that 25 samplings had closed their business, the remaining balance of the population is 318 samplings, the percentage of the samplings that responded to the questionnaires is 66.35%. Most of responses to the questionnaires are from the Northeastern part of Thailand, with the production capacity of 7-8 megawatts, using thermo technology to generate electricity units, the consultants, engineers, production managers, and factory supervisors, use sugar cane and wood chips as biomass fuel, the quantity of biomass is more than 50 tonnes. The biomass resources are outsourced, and the electricity production period is between 16 hours and 24 hours a day.

(1) The samplings classified by region, the total respondents were 211 samplings at 66% which is classified by region as follows: 70 samplings from the Northeastern area at 33%, 53 samplings from the Central area at 26%, 49 samplings from the Southern area at 23%, 18 samplings from the Northern area at 9%, 12 samplings from the Eastern area at 6%, and 9 samplings from the Western area at 4%, respectively.

(2) Classified by capacity of electricity generating on a purchase contract, The samplings responded to the questionnaires sorted by the capacity of electricity generating on purchase contracts in descending order as follows: 52 power plants have the capacity of electricity generating 7 megawatts - 8 megawatt at 26% , 43 samplings of the capacity: 8 megawatts - 9.9 megawatts at 20% , 40 sampling of capacity at 1 megawatt up to 3 megawatts at 19%, 32 samplings of capacity at 3 megawatts up to 5 megawatts at 15%, 23 samplings of capacity at 5 megawatts up to 7 megawatts at 11%, 21 samplings of capacity at 0.10 megawatt to 1 megawatt at 9%, respectively.

(3) Classified by job title, The samplings responded to the questionnaires sorted by the job title in descending order as follows: 81 samplings from consultants, secretaries, engineers and power plant supervisors at 38%, 60 samplings from general managers at 29%, 53 samplings from power plant managers at 25%, and 17 samplings from executives at 8 %, respectively.

(4) Classified by the type of fuel used in electricity generation, The samplings responded to the questionnaires sorted by the type of fuel used in electricity generation in descending order are as follows: 61 samplings use sugar cane at 29%, 61 samplings use wood chips at 39%, 26 samplings use water recycling in the product process at 12%, 19 samplings use the palm fiber and palm shell at 9%, 17 samplings use husk at 8%, 13 samplings use corncobs at 6%, 13 samplings use cassava root at 6% and 1 sampling used yeast for the production process at 1%, respectively.

(5) Classified by source of biomass fuel used to generate electricity, The samplings responded to the questionnaires sorted by sources of fuel used to generate electricity in descending order as follows: 77 samplings have to buy the biomass from others at 37%, 75 samplings have their own biomass resources at 35% and 59 sampling have their own biomass resources and need to buy more biomass fuel from others at 28%, respectively.

(6) Classified by the amount of biomass used in electricity generated per day, The samplings responded to the questionnaires sorted by the amount of biomass used in electricity generated per day in descending order as follows: 161 samplings use the biomass more than 50 tons per day at 76%, 15 samplings use a quantity of 40-50 tons of biomass at 7%, 14 sampling use biomass at a quantity of 10-20 tons at 7%, 11 samplings use 1-10 tons of biomass at 3% and 4 samplings used 30-40 tons of biomass at 2%, respectively.

(7) Classified by the number of hours of electricity production per day, The samplings responded to the questionnaires sorted by the number of hours of electricity production per day in descending order as follows: 180 samplings produce electricity at 16 hours-24 hours a day at 85%, 13 samplings produce electricity at 12 hours-16 hours a day at 6%, 11 samplings produce electricity 8 hours-12 hours a day at 5%, and 7 samplings produce electricity at 5 hours-8 hours a day at 4%, respectively.

(8) Classified by technology used to generate electricity, The samplings responded to questionnaires sorted by technology used to generate electricity in descending order as follows: 155 sampling use thermo to generate electricity at 74%, 36 samplings use fermentation to generate electricity at 17% and 24 samplings use gasification to generate electricity at 9%, respectively.

(9) Classified by the extra support of electricity generation from biomass. The samplings have extra support of electricity generation from biomass responded on this item with many answers The 211 samplings answered the questions with 306 answers as follows: 113 samplings are supported being exempt on tax of machinery from the Board of Investment (BOI) at 37% of the answers (113/306) and 53.55 % of the total of responded samplings (113/211), 91 samplings are supported by the feed in Tariff at 29.70% of the answers (91/306) and 43.1 % of the total of responded samplings (91/211) , 61 samplings are supported by the adder at 19.9 % of

the answers (61/306) and 28.90 % of the total of responded samplings (61/211), 41 samplings are supported by the corporate tax exemption at 13.40 % of the answers and 19.45 % of the total responded samplings at (41/211), respectively.

(10) Classified by the kind of purchase agreement, The samplings responded to the questionnaires sorted by the kind of purchase agreement in descending order as follows, 178 samplings have a non-firm purchase agreement at 84% and 33 samplings sampling have a firm purchase agreement at 16%, respectively.

(11) The important factors affecting the effectiveness of small biomass power plants, the responded samplings total 211 samplings of the important factors affecting the effectiveness of small biomass power plants as follows: 1) The government subsidies, the samplings have opinions on the importance of government subsidies which were moderately agree to strongly agree. ($\overline{x}$ = 3.70 , S.D. =0.85). 2) Regulations and laws, the samplings have opinions on the importance of regulations and laws which is moderately agree ($\overline{x}$ = 3.34 ,S.D. =0.78). 3) The initial project design of biomass power investment, the samplings have opinions on the importance of the initial project design of biomass power investment which is strongly agree ($\overline{x}$ = 4.09 ,S.D. =0.66). 4) Biomass fuel, the samplings have opinions on the importance of the biomass fuel which is strong strongly agree ($\overline{x}$ = 4.34, S.D. =0.63). 5) The biomass fuel management, the samplings have opinions on the importance of the biomass fuel management which is moderately agree ($\overline{x}$ = 3.23 , S.D. =0.87). 6) The dependence on external biomass resources, the samplings have opinions on the importance of the dependence on external biomass resources which is moderately agree ($\overline{x}$ = 3.18 ,S.D. =0.98). 7) The distance of the biomass fuel delivery, the samplings have opinions on the importance of the distance of the biomass fuel delivery which is slightly agree ($\overline{x}$ = 2.92 , S.D. =0.97). 8) The technology to produce the electricity, the samplings have opinions on the importance of the technology to produce the electricity which are moderately agree to strongly agree ($\overline{x}$ = 3.83, S.D. =0.68). 9) The management of the biomass power plant, the samplings have opinions on the importance of the management of biomass power plants which are moderately agree to strongly agree ($\overline{x}$ = 3.92 ,S.D. =0.68). 10) Ability and skills of employees, the samplings have opinions on the importance of the ability and skills of employees which are moderately agree to strongly agree ($\overline{x}$ =

3.81, S.D. =0.56). 11) The location of biomass power plants, the samplings have opinions on the importance of the location of biomass power plants which is strongly agree ($\overline{x}$ = 4.01 , S.D. =0.72). 12) The executive vision, the samplings have opinions on the importance of the executive vision which is strongly agree ($\overline{x}$ = 4.34 , S.D. =0.62). 13) Knowledge development, the samplings have opinions on the importance of knowledge development which are moderately agree to strongly agree ($\overline{x}$ = 3.66, S.D. =0.70). 14) The organizational culture, the samplings have opinions on the importance of organizational culture which are moderately agree to strongly agree ($\overline{x}$ = 3.93, S.D. =0.52). 15) The supply chain management, the samplings have opinions on the importance of the supply chain management which are moderately agree to strongly agree ($\overline{x}$ = 3.77, S.D. =0.88). 16) The community acceptance, the samplings have opinions on the importance of the community acceptance which is strongly agree ($\overline{x}$ = 4.04, S.D. =0.74). 17) The accessories of connecting to the electricity, the samplings have opinions on the importance of the accessories of connect to the electricity which are moderately agree to strongly agree ($\overline{x}$ = 3.95, S.D. =0.77) . 18) The potential of the grid lines, the samplings have opinions on the importance of the potential of the grid lines which are moderately agree to strongly agree ($\overline{x}$ = 3.99 , S.D. =0.86). 19) The purchase agreement of electricity selling, the samplings have opinions on the importance of the purchase agreement which are moderately agree to strongly agree ($\overline{x}$ = 3.71, S.D. =0.90). 20) The crude oil prices, the samplings have opinions on the importance of the purchase agreement which is slightly agree ($\overline{x}$ = 2.84, S.D. =0.98). 21) The local politics, the samplings have opinions on the importance of the local politics which are moderately agree to strongly agree ($\overline{x}$ = 3.88, S.D. =0.67).

(12) The effectiveness of small biomass power plants, the responded samplings total 211 samplings of the effectiveness of small biomass power plants as follows: 1) Financial effectiveness , the samplings have opinions on the financial effectiveness which is moderately agree ($\overline{x}$ = 3.35 ,S.D.=0.88). 2) Environmental effectiveness, the samplings have opinions on the environmental effectiveness which are moderately agree to strongly agree ($\overline{x}$ = 3.80, S.D.=0.8). 3) Community effectiveness, the samplings have opinions on the community effectiveness which is strongly agree ($\overline{x}$ = 4.22 , S.D.=0.70).

Table 6.4 The General Characteristics of the Small Biomass Power Plants

	Description	Total	%
The Region	Northern	18	9
	Northeastern	70	33
	Northeastern	53	25
	Western	9	4
	Eastern	12	6
	Southern	49	23
Capacity of electricity generation the purchase contact	electricity generating 0.10 Megawatt – 81Megawatt	21	9
	electricity generating 1 Megawatt – 3 Megawatt	40	19
	electricity generating 3 Megawatt – 5 Megawatt	32	15
	electricity generating 5 Megawatt – 7 Megawatt	23	11
	electricity generating 7 Megawatt – 8 Megawatt	52	26
	electricity generating 8 Megawatt – 9.9 Megawatt	43	20
Job Title	The executives	17	8
	Power plant managers	53	25
	General managers	60	29
	Others: as consultants, secretaries, engineers and power plant supervisors	81	38

Table 6.4 (Continued)

	Description	Total	%
Type of fuel used in electricity generation	corncob	13	6
	sugar cane	61	29
	cassava root	13	6
	wood chip	61	29
	husk	17	8
	palm fiber and palm shell	19	9
	water recycling on the product process	26	12
	Other as yeast	1	1
Source of biomass fuel used to generate electricity	have their own biomass resource	75	35
	buy the biomass from other	77	37
	have their own biomass resource and buy the biomass from other	59	28
The amount of biomass used in electricity generated per day	The quantity of biomass used 1 ton-10 tons	11	5
	The quantity of biomass used 10 tons-20 tons	14	7
	The quantity of biomass used 20 tons-30 tons	4	2
	The quantity of biomass used 30 tons-40 tons	6	3
	The quantity of biomass used 40 tons-50 tons	15	7

Table 6.4 (Continued)

	Description	Total	%
	The quantity of biomass used more than 50 tons per day	161	76
The number of hours of electricity production per day	5 hours-8 hours	7	4
	8 hours -12 hours	11	5
	12 hours -16 hours	13	6
	16 hours – 24 hours	180	85
Technology used to generate electricity	Thermo	155	74
	Gasification	20	9
	Fermentation	36	17
The type of purchase agreement	Firm	33	16
	Non Firm	178	84

Table 6.5 The Extra Support of Electricity Generation from Biomass (many answers)

The Extra Support of Electricity Generation from Biomass	**Number of Answers**		**Percentage to the Responded Samplings**
	Number	**Percentage to the Answer**	
Adder	61	19.9	28.9
Feed in Tariff	91	29.7	43.1
Tax exempt from Board of Investment (BOI)	113	37.0	53.55
Corporate tax exemption	41	13.4	19.45
Total		100%	145.0

Table 6.6 The Mean and Standard Deviation of the Important Factors Affecting the Effectiveness of Small Biomass Power Plants.

Factors	**Mean ($\bar{x}$)**	**Standard Deviation (S.D.)**	**Meaning**
1. The government subsidy	3.70	0.85	Moderately agree to strongly agree
2. Regulations and laws	3.34	0.78	Moderately agree
3. The initial project design of biomass power investment	4.09	0.66	Strongly agree
4. Biomass fuel	4.34	0.63	Strongly agree
5. Biomass fuel management	3.23	0.87	Moderately agree
6. The dependence on external biomass resources	3.18	0.98	Moderately agree
7. The distance of the biomass fuel delivery	2.92	0.97	Slightly agree
8. The technology to produce the electricity	3.83	0.68	Moderately agree to strongly agree
9. The management of the biomass power plant	3.92	0.68	Moderately agree to strongly agree
10. Ability and skills of employees	3.81	0.56	Moderately agree to strongly agree
11. The location of biomass power plants	4.01	0.72	Strongly agree
12. The executive vision	4.34	0.62	Strongly agree
13. Knowledge development	3.66	0.70	Moderately agree to strongly agree
14. The organizational culture	3.93	0.52	Moderately agree to strongly agree

Table 6.6 (Continued)

Factors	Mean ($\bar{x}$)	Standard Deviation (S.D.)	Meaning
15. The supply chain management	3.77	0.88	Moderately agree to strongly agree
16. The community acceptance	4.08	0.74	Moderately agree to strongly agree
17. The accessories of connecting the electricity	3.95	0.77	Moderately agree to strongly agree
18. The potential of the grid lines	3.99	0.86	Moderately agree to strongly agree
19. The purchase agreement of electricity selling	3.71	0.90	Moderately agree to strongly agree
20. The crude oil prices	2.84	0.98	Less agree
21. The local politics	3.88	0.67	Moderately agree to strongly agree
23. The Financial Effectiveness	3.35	0.88	Moderately agree
23. The Environment Effectiveness	3.80	0.85	Moderately agree to strongly agree
24. The Community Effectiveness	4.22	0.70	Strongly agree

6.3.2 Screening Data Results, before analyzing the Structural Equation Model, the research has screened data, the results of screening the data are as follows:

1) The sample size, the sample size of the research study is 211 samplings that is appropriated for analysis of the Structural Equation Model

2) Missing Data, The results of the data missing after checking the complete questionnaires, the researcher found 4 questionnaires missing from a total of 215 questionnaires. The 4 issues of missing data found the samplings answer only section 1 which is the general information of small power plants, section 2 which is

the important factors affecting the effectiveness of small biomass power plants and not answering section 3 which is the effectiveness of small biomass power plants. Because of this, the researcher needed to cut off these 4 issues from the complete questionnaires. The researcher prepared the data from 211 complete questionnaires on the SPSS program for further analysis of the data.

3) Normality, Results of the data distribution test from question number 9-70 is an important factor affecting the effectiveness and the effectiveness of small biomass power plants. The normality was found by using skewness and kurtosis statistics. The result of normality is a skewness value less than 3 (ISI < 3) and kurtosis value less than 10 (IKI <10). The skewness value and kurtosis value results indicated that the data is normally distributed. The criteria of a normal index is the skewness greater than 3 (|SI |> 3) and the Kurtosis greater than 10 (| KI |> 10) which indicated that the data is normal and can be used to analyze in a Structural Equations Model.

4) Outliers, the outlier test found that out of 21 samplings there are sampling numbers 18, 173, 174, 1, 75, 74, 128, 12, 22, 136, 37, 50, 176, 100, 101, 166, 167, 25, 95, 93, 94. (Shown on the appendix) The researcher needed to cut off 21 outliers samplings from 211 samplings and the balance of sampling finally totaled 190 sampling from the analysis with the Structural Equation Model. Wang and Wang (2012) claimed the sample size of analysis on the Structural Equation Model should be 100-150 samples which is the appropriate size. (Boosma, 1985, Tinsley & Tinsley, 1987)

6.3.3 Confirmatory Factor Analysis Results

The research use Confirmatory Factor Analysis (CFA) to analysis. 1) The first order of Confirmatory Factor Analysis of the latent model of the importance factors affecting the effectiveness and the latent model of the effectiveness of the small power plants. The first order of analysis of Confirmatory Factor Analysis is to confirm that the indicators of the latent variable is an appropriate measurement of the latent variables. (Kanlaya Vanichbuncha, 2013) 2) The analysis of the Structural Equation Model of the relation between the latent model of the importance factors affecting the effectiveness and the latent model of the effectiveness of the small power plants.

The CFA of 3 models are as follows: 1) First order Confirmatory Factor Analysis of latent models of the importance factors affecting the effectiveness. 2) First order Confirmatory Factor Analysis of latent models of the effectiveness of the small power plants. 3) Structural Equation Model of the relations between latent models of the importance factors affecting the effectiveness and the latent models of the effectiveness of the small power plants.

1) First order Confirmatory Factor Analysis of the importance factors affecting the effectiveness of the small biomass power plant.

The first order analysis of the Confirmatory Factor Analysis of the importance factors affect the effectiveness of the small biomass power plant is to confirm that the indicators of each latent variable of the important factors are appropriate and a good measure.

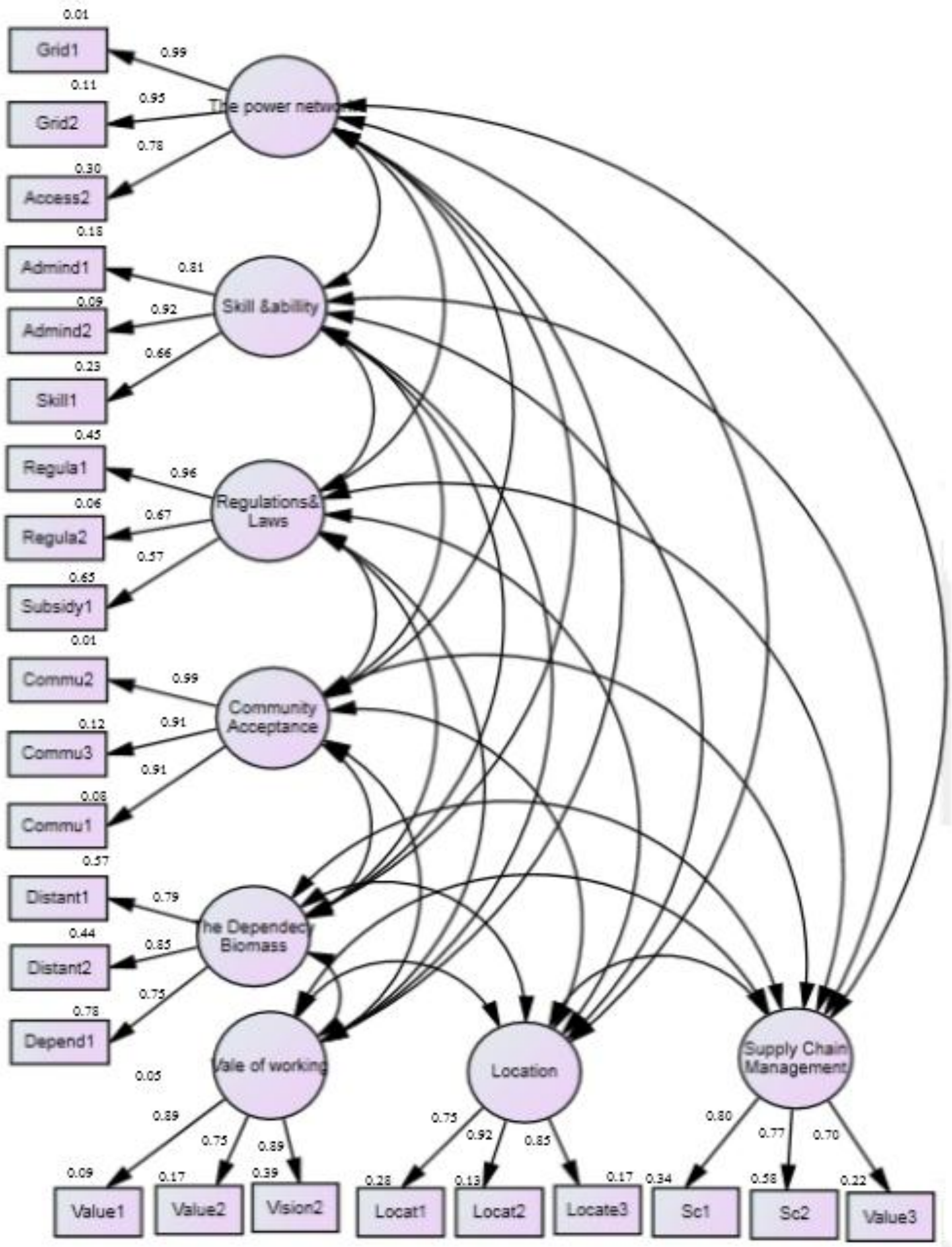

Figure 6.1 First Order Confirmatory Factor Analysis of Latent Model of the Importance Factors Affecting the Effectiveness of the Small Biomass Power Plant. The Fit Index are CMIN/DF = 1.170, GFI = 0.925, NFI=0.939, RFI=0.901, IFI= 0.991, TLI= 0.984, CFI =0.990, RMSR=0.043, RMSEA=0.030

Table 6.7 Show Statistical Value before and after the First order Confirmatory Factor Analysis of the Importance Factors Affecting the Effectiveness of the Small Biomass Power Plant Model.

First Order Confirmatory Factor Analysis	**CMIN /DF**	**GFI**	**NFI**	**RFI**	**IFI**	**TLI**	**CFI**	**RMSR**	**RMSEA**
Index criterion	<3	>0.90	>0.90	>0.90	>0.90	>0.90	>0.90	< 0.05	< 0.08
Standard Model	2.260	0.822	0.846	0.810	0.908	0.884	0.906	0.053	0.082
Adjusted Model	1.170	0.925	0.939	0.901	0.991	0.984	0.990	0.043	0.030

Table 6.7 shows statistical value before and after the First Order Confirmatory Factor Analysis of the important factors affecting the effectiveness of the small biomass power plant model. Fit Index of the standard model including CMIN/df = 2.260 that is acceptable if the model is fit with the empirical data and other indexes as GFI = 0.822, NFI=0.846, RFI=0.810, IFI= 0.908, TLI= 0.884, CFI =0.906, RMSR=0.053, RMSEA=0.082, GFI, NFI, TLI do not pass index criterion. The index criterion fit the index of CMIN/DF <2 indicates that the model fits with the empirical data GFI >0.90 , NFI >0.90, RFI >0.90 IFI >0.90 TLI >0.90 CFI >0.90 RMSR < 0.05 RMSEA < 0.05 (Kanlaya Vanichbuncha, 2013). Then, the researcher needed to adjust the model to have the appropriate statistical index, by using SPSS AMOS program with Modification Identification (MI) index. The researcher followed the Modification Index until all fit index passed the Index criterion. The fit index of the adjusted model including CMIN/DF = 1.170, GFI = 0.925, NFI=0.939, RFI=0.901, IFI=0.991, TLI=0.984, CFI=0.990, RMSR=0.043, RMSEA=0.030. All indexes pass index criterion. Then, the researcher concluded the model fits with the empirical data or Good fit Model. The indicators of the latent variables of the important factors affecting the effectiveness of the small biomass power plant models are appropriate to the latent variables and all indicators are appropriate to measure the latent variables.

Table 6.8 Factor Loading of First Order Confirm Factor Analysis of the Importance Factors Affecting the Effectiveness of the Small Biomass Power Plants

Latent Variables	Indicators	Factor Loading	P-value
The power network and the transmission lines	Gridline2	0.990	***
	Gridline1	0.931	***
	Access2	0.779	***
Skills and ability of employees	skill1	0.665	***
	admin1	0.813	***
	admin2	0.921	***
Regulations and laws	subsidy1	0.566	***
	regula2	0.674	***
	Regula1	0.955	***
The community acceptance	comunity1	0.931	***
	comunityt3	0.906	***
	comunity2	0.990	***
The dependency on biomass resources	Depend1	0.727	***
	distant2	0.849	***
	distant1	0.788	***
The value of working	vision2	0.894	***
	value2	0.745	***
	value1	0.891	***
The location of the power plant	location3	0.854	***
	location2	0.916	***
	Location1	0.748	***
The supply chain management	Value3	0.704	***
	suplymang2	0.773	***
	Suplymang1	0.803	***

Table 6.8 shows Factor Loading of First Order Confirmation Factor Analysis of the important factors affecting the effectiveness of the small biomass power plant found that all factor loading or Standardized Regression Weight of all indicators to the latent variable are significant (p=***) the details of each measurement model is as follows: model 1: The power network and the transmission lines consist of each indicator in descending order, the factor loading, Grid2 = 0.990, Grid1, =0.931 and assess2 =0.779. Model 2: Skills and ability of employees consist of each indicators in descending order, the factor loading, admin2 = 0.921, admin1 = 0.813 and Skill1=0.665. Model 3: Regulations and laws consist of each indicator in descending order, the factor loading, Regula1= 0.955, Regula2 =0.674 and Subsidy1 =0.556. Model 4: The community acceptance consists of each indicators in descending order, the factor loading, comaccept2 =0.990, comaccept1 =0.931, comaccept 3 =0.906. Model 5: The dependency on biomass resources consists of each indicator in descending order, the factor loading, Distan2 =0.849, Distan1 =0.788, Depend1 = 0.727. Model 6: The value of working consists of each indicator in descending order, the factor loading, Vision2 =0.894, Value1 =0.891, Value1 =0.745. Model 7: The location of the power plant consists of each indicator in descending order, the factor loading, Locate2 =0.916, Locate3 = 0.854 and Locate1 = 0.748. Model 8: The supply chain management consists of each indicator in descending order, the factor loading, sc1 =0.803, sc2 =0.773, and Value3 =0.704.

Factor Loading of First Order Confirmatory Factor Analysis of the important factors affecting the effectiveness of the small biomass power plant found that all factor loading or Standardized Regression Weight of all indicators to the latent variable are significant (p=***). The statistical results shown are all indicators being appropriate to measure all latent variables. Moreover, the factor loading of all indicators are more than 0.50.

2) First Order Confirmatory Factor Analysis results of the effectiveness of the small biomass power plant.

The first order analysis of Confirmatory Factor Analysis of the effectiveness of the small biomass power plant is to confirm that the indicators of each latent variable of the effectiveness of the small biomass power plant are appropriate and a good measure.

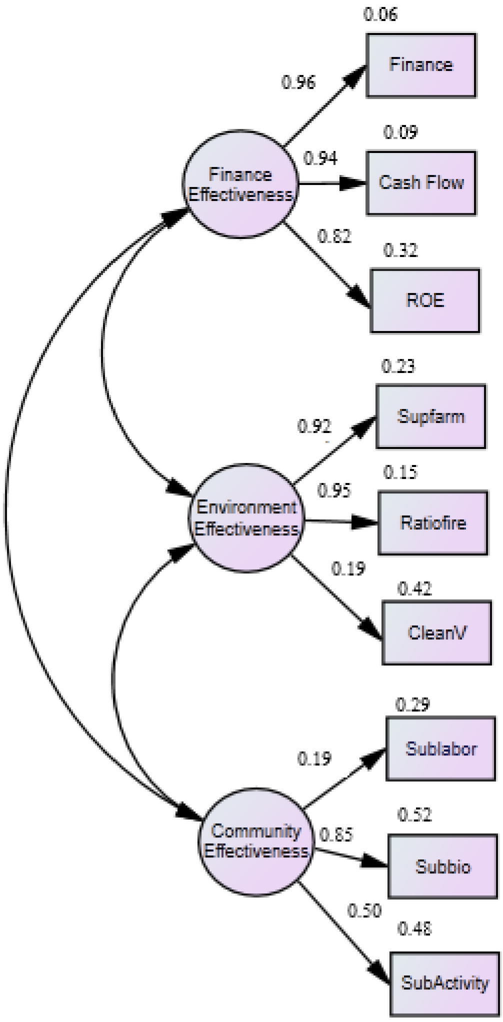

Figure 6.2 First order Confirmatory Factor Analysis of the Latent Model of the Effectiveness of the Small Biomass Power Plants. The Fit Index are CMIN/DF = 1.906, GFI = 0.979, NFI=0.985, RFI=0.945, IFI= 0.993 TLI= 0.973, CFI =0.993, RMSR=0.024, RMSEA=0.069.

Table 6.9 Show Statistical Value before and after the First order Confirmatory Factor Analysis of the Small Biomass Power Plant Model

First Order Confirmatory Factor Analysis	**CMIN /DF**	**GFI**	**NFI**	**RFI**	**IFI**	**TLI**	**CFI**	**RMSR**	**RMSEA**
Index criterion	<3	>0.90	>0.90	>0.90	>0.90	>0.90	>0.90	< 0.05	< 0.08
Standard Model	9.663	0.785	0.815	0.722	0.831	0.744	0.829	0.078	0.214
Adjusted Model	1.906	0.979	0.985	0.945	0.993	0.973	0.993	0.024	0.069

Table 6.9 shows statistical value before and after the first order Confirmatory Factor Analysis of the small biomass power plant model. Fit Index of the standard model includes CMIN/DF = 9.663, GFI = 0.785, NFI=0.815, RFI=0.772, IFI= 0.831, TLI= 0.744, CFI =0.829, RMSR=0.078, RMSEA=0.214. All indexes did not pass the index criterion. The index criterion fit the index of CMIN/DF <2 indicate that the model fits with the empirical data GFI >0.90, NFI >0.90, RFI >0.90 IFI >0.90 TLI >0.90 CFI >0.90 RMSR < 0.05 RMSEA < 0.05 (Kanlaya Vanichbuncha, 2013). Then, the researcher needed to adjust the model to have the appropriate statistical index, by using SPSS AMOS program with Modification Identification (MI) index. The researcher followed the Modification Index until all fit index passed the Index criterion. The fit index of the adjusted model includes CMIN/DF = 1.906, GFI = 0.979, NFI=0.985, RFI=0.945, IFI= 0.993 TLI= 0.973, CFI =0.993, RMSR=0.024, RMSEA=0.069 All indexes pass the index criterion. Then, the researcher concluded the model fits with the empirical data or Good fit Model. The indicators of the latent variables of the small biomass power plant model are appropriate to the latent variables and all indicators are appropriate to measure the latent variables.

Table 6.10 Factor Loading of First Order Confirmatory Factor Analysis of the Effectiveness of the Small Biomass Power Plant

Latent Variables	Indicators	(Factor Loading)	P-value
The financial effectiveness	Finance	0.964	***
	Cash	0.944	***
	ROE	0.817	***
The environmental effectiveness	Supfarm	0.919	***
	Ratiofire	0.948	***
	Clenv	0.191	***
The community effectiveness	Sublabor	0.192	***
	Subbio	0.853	***
	subactivuty	0.497	***

Table 6.10 shows the Factor Loading of the First Order Confirmatory Factor Analysis of the effectiveness of the small biomass power plant found that all the factor loading or Standardize Regression Weight of all indicators to the latent variables are significant (p=***) the detail of each measurement model are as follows: model 1: The Financial Effectiveness consists of each indicators in descending order, the factor loading, finance = 0.964 Cash =0.944, ROE =0.817. Model 2: The Environmental Effectiveness consists of each indicators in descending order, the factor loading, Ratiofire =0.948, Supfarm = 0.919, Clenv =0.191. Model 3: The Community Effectiveness consists of each indicators in descending order the factor loading, Supbio =0.853, SupActivity =0.497 and Suplabor =0.192.

Factor Loading of the First Order Confirmatory Factor Analysis of the effectiveness of the small biomass power plant found that all Factor Loading or Standardized Regression Weight of all indicators to the latent variables are significant (p=***). The statistical results show all indicators are appropriate to measure all latent variables. Moreover, the factor loading of all indicators are more than 0.50.

3) Structural Equation Model to test the relation between latent models of the importance factors affecting the effectiveness and the latent model of the effectiveness of the small power plants.

The First Order Analysis of the two previous is to confirm that the theory of the indicators and latent variables of the conceptual framework on the research study. The results confirm all indicators are appropriate to measure all latent variables following the theory and are prompt to analyze the causal relation between the latent variable of the conceptual framework (Hair, et al. 2006). From picture 5.13 the conceptual framework with 8 latent variables of important factors affecting the effectiveness of small power plants as, The power network and the transmission lines, Skills and ability of employees, Regulations and laws, The community acceptance, The dependency of biomass resource, The value of working, The location of power plant and The supply chain management. The latent variable of the effectiveness of small power plants are 3 variables, The financial effectiveness, The environmental effectiveness and The community effectiveness.

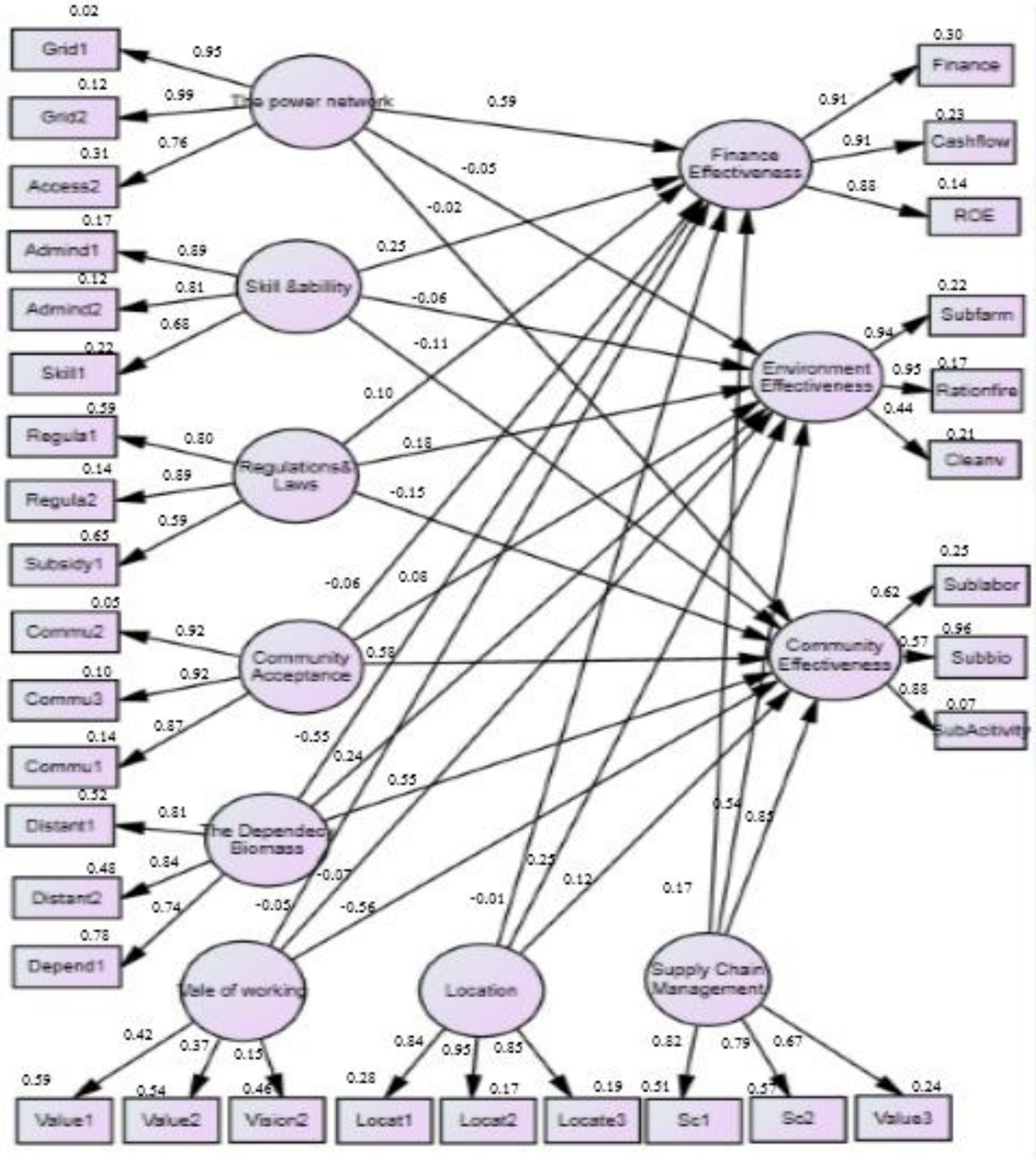

Figure 6.3 Structural Equation Model of the Relation the Importance Factors Affect the Effectiveness and the Effectiveness of the Small Power Plants. The Fit Index are CMIN/DF = 1.175, GFI = 0.932, NFI= 0.953, RFI= 0.882, IFI= 0.993, TLI= 0.980, CFI = 0.992, RMSR= 0.046, and RMSEA=0.030.

Table 6.11 Show Statistical Value before and after the Structural Equation Model of the Relation, the Important Factors affect the Effectiveness and the Effectiveness of the Small Power Plants

Structural Equation Model	**CMIN/DF**	**GFI**	**NFI**	**RFI**	**IFI**	**TLI**	**CFI**	**RMSR**	**RMSEA**
Index criterion	<2	>0.90	>0.90	>0.90	>0.90	>0.90	>0.90	< 0.05	< 0.05
Standard Model	3.656	0.670	0.696	0.652	0.759	0.720	0.756	0.118	0.123
Adjusted Model	1.175	0.932	0.953	0.882	0.993	0.980	0.992	0.046	0.030

Table 6.11shows statistical values before and after the Structural Equation Model of the relationships of the important factors affecting the effectiveness and the effectiveness of the small power plants. Fit Index of the standard model includes CMIN/DF = 3.656, GFI = 0.670, NFI= 0.696, RFI= 0.652, IFI= 0.759, TLI= 0.720, CFI = 0.756, RMSR= 0.118, RMSEA=0.123. All indexes are not passed the index criterion. The index criterion fit the index of CMIN/DF <2 indicate that the model fits with the empirical data GFI >0.90, NFI >0.90, RFI >0.90, IFI >0.90, TLI >0.90, CFI >0.90, RMSR < 0.05, RMSEA < 0.05 (Kanlaya Vanichbuncha, 2013). Then, the researcher needed to adjust the model to have the appropriate statistical index, by using SPSS AMOS program with Modification Identification (MI) index. The researcher followed the Modification Index until all fit index passed the Index criterion. The fit index of the adjusted model includes CMIN/DF = 1.175, GFI = 0.932, NFI= 0.953, RFI= 0.882, IFI= 0.993, TLI= 0.980, CFI = 0.992, RMSR= 0.046, RMSEA=0.030. All indexes pass the index criterion. Then, the researcher concluded the model fits with the empirical data or Good fit Model. The researcher completes the hypothesis result respectively.

4) Construct Validity of the Models

Table 6.12 Construct Validity of the Latent Variables

Latent variable	Indicators	Factor Loading	P-value	CR	AVE	MSV	ASV
The power network and the transmission lines	Access2	0.755	***	0.924	0.805	0.01	0.01
	Grid1	0.927	***				
	Grid2	0.993	***				
Skills and ability of employees	skill1	0.676	***	0.902	0.632	0.10	0.031
	admin1	0.888	***				
	admin2	0.808	***				
Regulations and laws	subsidy1	0.585	***	0.788	0.548	0.127	0.036
	regula2	0.890	***				
	Regula1	0.715	***				
The community acceptance	commu1	0.870	***	0.954	0.85	0.381	0.456
	commu3	0.921	***				
	commu2	0.974	***				
The dependency of biomass resources	Depend1	0.738	***	0.729	0.633	0.116	0.039
	distan2	0.840	***				
	Distan1	0.806	***				
The value of working	vision2	0.131	***	0.605	0.20	0.14	0.04
	value2	0.368	***				
	value1	0.415	***				
The location of the power plant	locate3	0.837	***	0.898	0.716	0.310	0.09
	locate2	0.933	***				
	Locate1	0.761	***				

Table 6.12 (Continued)

Latent variable	Indicators	Factor Loading	P-value	CR	AVE	MSV	ASV
The supply chain management	Value3	0.668	***	0.832	0.582	0.104	0.107
	sc2	0.788	***				
	sc1	0.824	***				
The financial effectiveness	Finance	0.907	***	0.90	0.806	0.368	0.069
	Cash	0.908	***				
	ROE	0.879	***				
The environmental effectiveness	Supfarmer	0.941	***	0.851	0.663	0.149	0.091
	Ratiofire	0.950	***				
	Clenen	0.437	***				
The community effectiveness	Suplabor	0.623	***	0.69	0.43	0.42	0.15
	Supbio	0.371	***				
	supactivuty	0.876	***				

Table 6.12 show Construct Validity of the latent variables of the important factors affecting the effectiveness and the effectiveness of small biomass power plant totaling 11 measurement models. The results of the construct validity of each measurement model, is as follows:

Model 1: The power network and the transmission lines, the model consist of the indicators with factor loading, Gridl2 = 0.993, Gridl1 = 0.927 and Assess2 =0.755, all indicators are significant (p-value= ***) and have a factor loading of more than 0.70. The Convergent Validity and Discriminant Validity of Model 1: The power network and the transmission lines found that the index results are CR =0.924, AVE=0.805, MSV=0.01 and ASV =0.01. All indexes passed index criterion. The index criterion of the Reliability of the latent variables are Composite Reliability: CR > 0.70, Convergent Validity is CR > AVE, AVE > 0.5 and Discriminant Validity is MSV<AVE, ASV<AVE. (Meyers, S. Lawrence and et al, 2005). Then, the research concluded that Model 1: The power network and the transmission lines consist of indicators, Grid2, Grid1 and Assess2, that are appropriate

and good to measure the model. The model has high reliability, the convergent validity and discriminant validity.

Model 2: Skills and ability of employees, the model consist of the indicators with factor loading, Admin1 = 0.888, Admin2 = 0.808, and Skill1 =0.676, all indicators are significant (p-value= ***), the indicators, Admin1 and Admin2 are more than 0.7 and Skill1 is quite close to 0.70. The Convergent Validity and Discriminant Validity of Model 2: Skills and ability of employees found that the index result are CR =0.902, AVE=0.632, MSV=0.10 and ASV =0.031. All indexes passed index criterion. The index criterion of the Reliability of the latent variables are Composite Reliability: CR > 0.70, Convergent Validity is CR > AVE, AVE > 0.5 and Discriminant Validity is MSV<AVE, ASV<AVE. Then, the research concluded that Model 2: Skills and ability of employees consist of indicators, Admin1, Admin2, and Skill1 that are appropriate and good to measure the model. The model has high reliability, a convergent validity and discriminant validity.

Model 3: Regulations and laws, the model consist of the indicators with factor loading, Regula2 =0.890, Regula1 = 0.715, and Subsidy1 =0.585, all indicators are significant (p-value= ***), the indicators, Regula2 and Regula1 are more than 0.7 and Subsidy1 is quite close to 0.70. The Convergent Validity and Discriminant Validity of Model 3: Regulations and laws, found that the index results are CR =0.788, AVE=0.548, MSV=0.127 and ASV=0.036. All indexes passed index criterion. The index criterion of the Reliability of the latent variables are Composite Reliability: CR > 0.70, Convergent Validity is CR > AVE, AVE > 0.5 and Discriminant Validity is MSV<AVE, ASV<AVE. Then, the research concluded that Model 3: Regulations and laws consist of indicators, Regula2, Regula1, and Subsidy that are appropriate and good to measure the model. The model has high reliability, the convergent validity, and discriminant validity.

Model 4: The community acceptance, the model consist of the indicators with factor loading, Commu2 =0.974 Commu3 =0.921 and Commu 1= 0.870, all indicators are significant (p-value= ***), have the factor loading more than 0.70. The Convergent Validity and Discriminant Validity of Model 4: The community acceptance, found that the index results are CR=0.954, AVE=0.850, MSV=0.381 ASV =0.456. All indexes passed index criterion. The index criterion of the Reliability of the latent variables are Composite Reliability: CR > 0.70, Convergent Validity is CR > AVE, AVE > 0.5 and Discriminant Validity is MSV<AVE, ASV<AVE. Then, the research concluded that Model 4: The community acceptance consists of indicators, Commu2, Commu3, and Commu1 that are appropriate and good to measure the model. The model has high reliability, the convergent validity, and discriminant validity.

Model 5: The dependency on biomass resources, the model consists of the indicators with factor loading, Distan2 =0.840, Distan1 = 0.806 and Depend1 = 0.738, all indicators are significant (p-value= ***), have the factor loading of more than 0.70. The Convergent Validity and Discriminant Validity of Model 5: The dependency on biomass resources is found that the index results are CR=0.729, AVE=0.633, MSV=0.116 and ASV =0.039. All index passed index criterion. The index criterion of the Reliability of the latent variables are Composite Reliability: CR > 0.70, Convergent Validity is CR > AVE, AVE > 0.5, and Discriminant Validity is MSV<AVE, ASV<AVE. Then, the research concluded that Model 5: The dependency of biomass resource consist of indicators, Distan2, Distan1, and Depend1 that are appropriate and good to measure the model. The model has high reliability, and there is convergent validity and discriminant validity.

Model 6: The value of working, the model consist of the indicators with factor loading, Value1 =0.415, Value2 =0.368 and Vision2 = 0.131, all indicators are significant (p-value= ***), have the factor loading more than 0.70. The Convergent Validity and Discriminant Validity of Model 6: The value of working found that the indexed results are CR =0.605, AVE=0.20, MSV=0.140 and ASV =0.040. CR, AVE, and MSV passed index criterion. The AVE is less than 0.5 but is acceptable. The index criterions of the Reliability of the latent variables are Composite Reliability: CR > 0.70, Convergent Validity is CR > AVE, AVE > 0.5 and Discriminant Validity is MSV<AVE, ASV<AVE. Then, the research concluded that Model 6: The value of working, consists of these indicators, Value1, Value2 and Vision2 that are appropriate and good to measure the model. The model has high reliability, and true to the convergent validity and discriminant validity.

Model 7: The location of the power plant, the model consists of the indicators with the factor loading, Locate2 = 0.933, Locate 3 = 0.837 and Locate 1=

0.761, all indicators are significant (p-value= ***), have the factor loading of more than 0.70. The Convergent Validity and Discriminant Validity of Model 7: The location of the power plant found that the index results are CR =0.898, AVE=0.716, MSV=0.310 and ASV =0.09. All indexes passed index criterion. The index criterion of the Reliability of the latent variables are Composite Reliability: CR > 0.70, Convergent Validity is CR >AVE, AVE > 0.5 and Discriminant Validity is MSV<AVE, ASV<AVE. Then, the research concluded that Model 7: The location of the power plant consists of the indicators, Locate2, Locate 3, and Locate 1 that are appropriate and good to measure the model. The model has high reliability, and meet the convergent validity and discriminant validity.

Model 8: The supply chain management, the model consist of the indicators with factor loading, sc1=0.824, sc2 =0.788, and value 3 = 0.668, all indicators are significant (p-value= ***), the indicators, sc1, and sc2 are more than 0.7 and value3 is quite close to 0.70. The Convergent Validity and Discriminant Validity of Model 8: The supply chain management, found that the index results are CR =0.832, AVE=0.582, MSV=0.104 and ASV =0.107. All indexes passed index criterion. The index criterion of the Reliability of the latent variables are Composite Reliability: CR >0.70, Convergent Validity is CR>AVE, AVE > 0.5 and Discriminant Validity is MSV<AVE, ASV<AVE. Then, the research concluded that Model 8: The supply chain management, consists of indicators, sc1, sc2and value3 that are appropriate and good to measure the model. The model has high reliability, and conforms to the convergent validity and discriminant validity

Model 9: The financial effectiveness, the model consist of the indicators with factor loading, cash = 0.908, finance =0.907, and ROE =0.879, all indicators are significant (p-value= ***), have the factor loading more than 0.70. The Convergent Validity and Discriminant Validity of Model 9: The financial effectiveness found that the index results are CR =0.90, AVE=0.806, MSV=0.368 and ASV =0.069. All indexes passed index criterion. The index criterion of the Reliability of the latent variables are Composite Reliability: CR > 0.70, Convergent Validity is CR > AVE, AVE > 0.5 and Discriminant Validity is MSV<AVE, ASV<AVE. Then, the research concluded that Model 9: The financial effectiveness acceptance consists of indicators, cash, finance, and ROE that are appropriate and good to measure the model. The

model has high reliability, the convergent validity, and discriminant validity are accurate.

Model 10: The environmental effectiveness, the model consist of the indicators with factor loading, ratiofire = 0.95, Supfarmer = 0.941and Cleanen =0.437, all indicators are significant (p-value= ***), the indicators, ratiofire and Supfarmer are more than 0.7 and Cleanen is quite close to 0.50. The Convergent Validity and Discriminant Validity of Model 10: The environmental effectiveness found that the index results are CR =0.851, AVE=0.663, MSV=0.149 are ASV =0.091. All indexes passed the index criterion. The index criterions of the Reliability of the latent variables are Composite Reliability: CR > 0.70, Convergent Validity is CR>AVE, AVE>0.5 and Discriminant Validity is MSV<AVE, ASV<AVE. Then, the research concluded that Model 10: The environment effective consist of indicators, ratiofire, Supfarmer, and Cleanen that are appropriate and good to measure the model. The model has high reliability, the convergent validity, and discriminant validity are accurate.

Model 11: The community effectiveness, the model consist of the indicators with factor loading Supactivity = 0.876, Suplabor = 0.623 and Supbuy = 0.371, all indicators are significant (p-value= ***), the indicators, Supactivity is more than 0.7, Suplabor is quite close to 0.70, and Supbuy is quite close to 0.50. The Convergent Validity and Discriminant Validity of Model 11: The community effectiveness, CR =0.690, AVE=0.43, MSV=0.42 and ASV =0.15, CR is close to 0.70 and AVE is close to 0.50. All indexes passed index criterion. The index criterion of the Reliability of the latent variables are Composite Reliability: CR > 0.70, Convergent Validity is CR > AVE, AVE > 0.5 and Discriminant Validity is MSV<AVE, ASV<AVE. Then, the research concluded that Model 11: The community effectiveness consist of indicators, Supactivity, Suplabor and Supbuy that are appropriate and good to measure the model. The model has reliability, the convergent validity and discriminant validity are accurate.

6.4 The Hypothesis Test Results

The researcher has constructed and structured equations to test the relationship between the important factors affecting the effectiveness and the effectiveness of biomass power plants. When the researcher adjusted the model until the model has a fit index, which was a good fit to the empirical data, the researcher reported the results of the hypothesis test of the research study.

The statistical hypotheses are tested based on the assumption:

H_0: There is no correlation between important factors variables and the effectiveness of small biomass power plants variables.

H_1: There is correlation between the important factors variables and the effectiveness of small biomass power plants variables.

Specify the statistical significance at 0.5 and 0.1.

Consider significant statistical significance p-value compared with statistically significant difference level $\alpha = 0.05$, which means that the significance level is at a very good significance and $\alpha <0.1$ is significant.

Hypothesis 1: The available of the power network and the transmission lines are likely to positively correlate with the effectiveness of small biomass power plants. The test result of hypothesis 1.1: found that The available of the power network and the transmission lines are positively correlated with the financial effectiveness of small biomass power plants. (p-value =***,α<0.05). The test results of hypothesis 1.2: The available of the power network and the transmission lines do not positively correlate with the environmental effectiveness of small biomass power plants. (p-value =0.529, α >0.10). The test results of hypothesis 1.3: The available of the power network and the transmission lines do not positively correlate with the community effectiveness of small biomass power plants. (p-value =0.153,α >0.10)

Hypothesis 2: The skills and capabilities of employees are likely to correlate positively with the effectiveness of small biomass power plants. The test results of hypothesis 2.1 found that the skills and capabilities of employees positively correlate with the financial effectiveness of small biomass power plants. (p-value =***,α<0.05). The test result of hypothesis 2.2 found that the skills and capabilities of employees does not positively correlate with the environmental effectiveness of small biomass power plants. (p-value = 0.935, α >0.10) The test results of hypothesis 2.3 found that the skills and capabilities of employees does not positively correlate with the community effectiveness of small biomass power plants. (p-value = 0.902,α >0.10)

Hypothesis 3: Regulations and laws are likely to positively correlate with the effectiveness of small biomass power plants. The test results of hypothesis 3.1 found that regulations and laws do not positively correlate with the financial effectiveness of small biomass power plants. (p-value = 0.914, α >0.10). The test results of hypothesis 3.2 found that regulations and laws positively correlate with the environmental effectiveness of small biomass power plants. (p-value = ***,α<0.05). The test results of hypothesis 3.3 found that regulations and laws do not positively correlate with the community effectiveness of small biomass power plants. (p-value =0.310, α >0.10).

Hypothesis 4: The community acceptance is likely to positively correlate with the effectiveness of small biomass power plants. The test results of hypothesis 4.1 found that the community acceptance does not positively correlate with the financial effectiveness of small biomass power plants. (p-value =0.549 ,α >0.10) The test results of hypothesis 4.2 found that the community acceptance does not positively correlate with the environmental effectiveness of small biomass power plants. (p-value =0.282, α >0.10) The test results of hypothesis 4.3 found that the community acceptance positively correlates with the community effectiveness of small biomass power plants. (p-value =***, α<0.05).

Hypothesis 5: The dependence on the biomass fuel resources is likely to positively correlate with the effectiveness of small biomass power plants. The test results of hypothesis 5.1 found that the dependence on the biomass fuel resources positively correlates with the financial effectiveness of small biomass power plants. (p-value = ***, α<0.05). The test results of hypothesis 5.2 found that the dependence on the biomass fuel resources positively correlates with the environmental effectiveness of small biomass power plants. (p-value = ***, α<0.05). The test results of hypothesis 5.3 found that the dependence on the biomass fuel resources positively correlates with the community effectiveness of small biomass power plants (p-value =***, α<0.05).

Hypothesis 6: The values of work is likely to positively correlate with the effectiveness of small biomass power plants. The test results of hypothesis 6.1 found that the values of work does not positively correlate with the financial effectiveness of small biomass power plants (p-value =0.425, α >0.10). The test results of hypothesis 6.2 found that the values of work does not positively correlate with the environmental effectiveness of small biomass power plants (p-value =0.312, α >0.10). The test results of hypothesis 6.3 found that the values of work positively correlates with the community effectiveness of small biomass power plants (p-value =0.08, α<0.10).

Hypothesis 7: The location of the power plants is likely to positively correlate with the effectiveness of small biomass power plants. The test results of hypothesis 7.1 found that the location of the power plants does not positively correlate with the financial effectiveness of small biomass power plants (p-value =0.952, α >0.10). The test results of hypothesis 7.2 found that the location of the power plants does positively correlate with the environmental effectiveness of small biomass power plants (p-value***, α<0.05). The test results of hypothesis 7.3 found that the location of the power plant does not positively correlate with the community effectiveness of small biomass power plants (p-value =0.536, α >0.10).

Hypothesis 8: The supply chain management is likely to positively correlate with the effectiveness of small biomass power plants. The test results of hypothesis 8.1 found that the supply chain management positively correlates with the financial effectiveness of small biomass power plants (p-value=***, α<0.10). The test results of hypothesis 8.2 found that the supply chain management does positively correlate with the environmental effectiveness of small biomass power plants (p-value =***, α<0.05). The test results of hypothesis 8.3 found that the supply chain management does positively correlate with the community effectiveness of small biomass power plants (p-value =***, α<0.05).

Table 6.13 The Hypothesis Test Results

Hypothesis of the Study	Factor Loading	P-value	Conclusion
Hypothesis 1: The available of the power network and the transmission lines are likely to positively correlate with the effectiveness of small biomass power plants.			
Hypothesis 1.1: The available of the power network and the transmission lines are likely to positively correlate with the financial effectiveness of small biomass power plants.	0.586	***	Support
Hypothesis 1.2: The available of the power network and the transmission lines are likely to positively correlate with the environmental effectiveness of small biomass power plants.	-0.039	0.529	Not support
Hypothesis 1.3: The available of the power network and the transmission lines are likely to positively correlate with the community effectiveness of small biomass power plants.	-0.201	0.153	Not support
Hypothesis 2: The skills and capabilities of employees is likely to positively correlate with the effectiveness of small biomass power plants.			
Hypothesis 2.1: The skills and capabilities of employees is likely to positively correlate with the financial effectiveness of small biomass power plants.	0.247	***	Support
Hypothesis 2.2: The skills and capabilities of employees is likely to positively correlate with the environmental effectiveness of small biomass power plants.	-0.06	0.935	Not support

Table 6.13 (Continued)

Hypothesis of the Study	Factor Loading	P-value	Conclusion
Hypothesis 2.3: The skills and capabilities of employees is likely to positively correlate with the community effectiveness of small biomass power plants.	-0.015	0.902	Not support
Hypothesis 3: Regulations and laws are likely to positively correlate with the effectiveness of small biomass power plants.			
Hypothesis 3.1: Regulations and laws are likely to positively correlate with the financial effectiveness of small biomass power plants.	0.010	0.914	Not support
Hypothesis 3.2: Regulations and laws are likely to positively correlate with the environmental effectiveness of small biomass power plants.	0.184	***	Support
Hypothesis 3.3: Regulations and laws are likely to positively correlate with the community effectiveness of small biomass power plants.	-0.159	0.310	Not support
Hypothesis 4: The community acceptance is likely to positively correlate with the effectiveness of small biomass power plants.			
Hypothesis 4.1: The community acceptance is likely to positively correlate with the financial effectiveness of small biomass power plants.	-0.066	0.549	Not support
Hypothesis 4.2: The community acceptance is likely to positively correlate	0.079	0.282	Not support

Table 6.13 (Continued)

Hypothesis of the Study	Factor Loading	P-value	Conclusion
with the environmental effectiveness of small biomass power plants.			
Hypothesis 4.3: The community acceptance is likely to positively correlate with the community effectiveness of small biomass power plants.	0.583	***	Support
Hypothesis 5: The dependence on the biomass fuel resources is likely to positively correlate with the effectiveness of small biomass power plants.			
Hypothesis 5.1: The dependence on the biomass fuel resources is likely to positively correlate with the financial effectiveness of small biomass power plants.	-0.331	***	Support
Hypothesis 5.2: The dependence on the biomass fuel resources is likely to positively correlate with the environmental effectiveness of small biomass power plants.	0.242	***	Support
Hypothesis 5.3: The dependence on the biomass fuel resources is likely to positively correlate with the community effectiveness of small biomass power plants.	0.333	***	Support
Hypothesis 6: The values of work are likely to positively correlate with the effectiveness of small biomass power plants.			
Hypothesis 6.1: The values of work are likely to positively correlate with the	-0.030	0.425	Not support

Table 6.13 (Continued)

Hypothesis of the Study	**Factor Loading**	**P-value**	**Conclusion**
financial effectiveness of small biomass power plants.			
Hypothesis 6.2: The values of work are likely to positively correlate with the environmental effectiveness of small biomass power plants.	-0.072	0.312	Not support
Hypothesis 6.3: The values of work are likely to positively correlate with the community effectiveness of small biomass power plants.	-0.359	***	Support
Hypothesis 7: The location of the power plants is likely to positively correlate with the effectiveness of small biomass power plants.			
Hypothesis 7.1: The location of the power plants is likely to positively correlate with the financial effectiveness of small biomass power plants.	-0.006	0.952	Not support
Hypothesis 7.2: The location of the power plants is likely to positively correlate with the environmental effectiveness of small biomass power plants.	0.254	***	Support
Hypothesis 7.3: The location of the power plants is likely to positively correlate with the community effectiveness of small biomass power plants.	0.120	0.536	Not support

Table 6.13 (Continued)

Hypothesis of the Study	Factor Loading	P-value	Conclusion
Hypothesis 8: The supply chain management is likely to positively correlate with the effectiveness of small biomass power plants.			
Hypothesis 8.1: The supply chain management is likely to positively correlate with the financial effectiveness of small biomass power plants.	0.172	***	Support
Hypothesis 8.2: The supply chain management is likely to positively correlate with the environmental effectiveness of small biomass power plants.	0.341	***	Support
Hypothesis 8.3: The supply chain management is likely to positively correlate with the community effectiveness of small biomass power plants.	0.833	***	Support

6.5 Mixed Method Report

On this Mixed Method Report, the researcher confirms the qualitative research findings with the quantitative research findings. The research concludes and reports separate methodologies between the qualitative method and quantitative method. On the final interference on the mixed method, the researcher used the qualitative to confirm or disconfirm inference. The quantitative research is the second phase that continues the qualitative research. (Tashakkori & Teddlie, 2009).

6.5.1 The Report with the Qualitative Research Findings is Supported by the Quantitative Research Findings

1) First Order Confirming Factor Analysis results of the important factors affecting the effectiveness of small biomass power plants found the factor loading of all observed variables or indicators were correlated with 8latent variables of important factors affecting the effectiveness of small biomass power plants. There are several significances. Then, the researcher concluded that all indicators are appropriate and can measure all 8 latent variables of the important factors affecting the effectiveness of small biomass power plants. All indicators of quantitative research come from the qualitative findings.

2) First Order Confirming Factor Analysis results of the effectiveness of small biomass power plants that found the factor loading of all observed variables or indicators were correlated with 3 separate latent variables of the effectiveness of small biomass power plants. There are several significances. Then, the researcher concluded that all indicators are appropriate and can measure all of 8 latent variables of the effectiveness of small biomass power plants. All indicators of quantitative research come from the qualitative findings.

6.5.2 The Important Factors Affecting the Effectiveness of Small Biomass Power Plants

1) The available of the power network and the transmission lines

The qualitative research findings relate to the important factor of the power network and the transmission lines found that the power network and the transmission lines are important to the small biomass power plant operation. In case the operators need to invest in the biomass power plant project, they need to survey the area of setting to carefully observe that the power network and the transmission lines are available. The power plant needs to sell the electricity units across the power network and transmission lines. In case the power network and grid lines are at full capacity then the operators cannot set the biomass power plants in that area. If the power network and transmission lines are defective that may cause operational costs to the biomass power plants since the operators need to restart the process on the operation process to link with the power network and the transmission lines.

(Nutthapong Peansean, personal communication, June 11, 2016). The results of quantitative analysis in the test of hypothesis 1 to test the relationship between the availability of electricity networks and transmission lines and the effectiveness of small biomass power plants. The results of the test of hypothesis 1.1 show that the availability of electricity networks and transmission systems positively correlated with the financial effectiveness of small biomass power plants. The hypothesis testing results of the quantitative research supports the qualitative research results.

2) Skills and ability of employees

The qualitative research findings relate to the important factor of skills and ability of employees found that skills and abilities of employees is important to the small biomass power plant for evaluating, decision making, and setting up the the power plant. If the executives have the knowledge and ability to make decisions, such as choosing the technology to generate the electricity, problem solving on the working process, so there are fewer mistakes on decision-making. The decision-making in the power plant process requires the skills and capabilities of the employees. Expertise, knowledge, understanding, experience with technology. If the executives and workers have the skills and abilities on the operation process, ability to solve problems on the working process, and can develop the operational process of the electricity production then the power plants are successful. (Yai Saithai, Apipong Vichuvatekamine, Pamint Savetsira, Navaporn Disatien, personal communication, May-June, 2016). The results of quantitative analysis in the test of hypothesis 2 to test the relationship between skills and abilities of employees and the effectiveness of small biomass power plants. The results of the test of the hypothesis 2.1shows that skills and ability of employees positively correlated with the financial effectiveness of small biomass power plants. The hypothesis testing results of quantitative research supports qualitative research results.

3) Regulations and laws

The qualitative research findings relate to the important factors of the regulations and laws that are related to the operation of biomass power and are important to the small biomass power plant operation. Before setting the power plants, the operators need to prepare public hearings for to prepare the communities surrounding the power plant in accordance with government regulations. The operators of biomass power plants need to follow the regulations and laws strictly. They need to prepare a lot of document for the permit process. There are many steps and many sections to the permission process, such as the sub district admission organization provincial section, Power Section, PEA, and Department of Industrial Works and so on. The time consumed on the document and stages of permission may cause the operation costs of the operators of biomass power plants to rise unexpectedly. (Navaporn Disatien, Nutthapong Peansean, Yai Saithai, personal communication, May-June, 2016). The results of quantitative analysis in the test of hypothesis 3 to test the relationships between regulations and laws and the effectiveness of small biomass power plants. The results of the test of hypothesis 3.2 shows that the regulations and laws are positively correlated with the environmental effectiveness of small biomass power plants. The hypothesis testing results of quantitative research supports qualitative research results.

4) The community acceptance

The qualitative research findings relate to the important factor of the community acceptance which is important to the small biomass power plant operation. The community acceptance is the heart of the setting of biomass power plants. If the community does not accept the power plant project, the operators of the biomass power plant cannot establish the plants. When the operators need to set up the power plants, they need to publicly announce the information of the project to the communities to make then understand the project. If the communities understand the project, they are not as likely to object to the biomass power plant project, allowing the operators to set up the power plant. (Navaporn Disatirn, Yai Saithai, Somnuk Jindasab, Nutthapong Peansean, Prasit Siritiprasami, personal communication, May-June, 2016). The results of the quantitative analysis in the test of hypothesis 4 to test the relationships between the community acceptance and the effectiveness of small biomass power plants. The results of the test of hypothesis 4.3 shows that the community acceptance is positively correlated with the community effectiveness of small biomass power plants. The hypothesis testing results of quantitative research supports the qualitative research results.

5) The biomass resource dependency

The qualitative research findings relate to the important factors of the biomass resource dependency found that the biomass resource dependency is important to the small biomass power plant operation. In case there is a biomass power plant that doesn't have their own biomass fuel resource, they need to buy biomass fuel from other sources such as the farmers or the middle man. The biomass resource dependency may make agreements between power plants and the community to supply their biomass to the plants. (Navaporn Disatien, personal communication, June 16, 2016). The results of quantitative analysis in the test of hypothesis 5 to test the relationship between the biomass resource dependency and the effectiveness of small biomass power plants. The results of the test of hypothesis 5.1, 5.2, and 5.3 show that the biomass resource dependency is positively correlated with the financial effectiveness, environmental effectiveness and community effectiveness of small biomass power plants. The hypothesis testing results of quantitative research support qualitative research results.

6) The value of working

The qualitative research finding relates to the important factor of the value of working found that the value of working is important to the small biomass power plant operation. On the working process, the executives have a philosophy of working built into the organizational culture. The executives emphasize the value of working with biomass-based fuels, such as recycling biomass to be fuel in the plants, to add value to agricultural residues, to develop the knowledge related to the biomass to become electricity, to develop the technology to generate electricity from biomass fuels and to build up the value of working together to solve problems in the workplace. (Navaporn Disatien, Vatsan Vongrach, Apipong Vichuvetkamint, personal communication, May-June, 2016). The results of quantitative analysis in the test of hypothesis 6 to test the relationship between the value of working and the effectiveness of small biomass power plants. The results of the test of hypothesis 6.3 shows that the value of working is positively correlated with the community effectiveness of small biomass power plants. The hypothesis testing results of quantitative research support qualitative research results.

7) The location of biomass power plants

The qualitative research findings relate to the important factor of the location of biomass power plants found that the location of biomass power plants is important to the small biomass power plant operation. The selection of the power plant location should be near the transmission lines, the utilities, and biomass resources. Currently, if the operators need to set up the power plants, they need to wait for the announcement from PEA for the purchasing of the electricity, as the transmitting lines are limited. The power plant needs to sell the electricity passing through the transmission lines, thus the establishment of a power plant must be consistent with the power transmission system capabilities and needs. The operators must consider areas established near the transmission system and utilities required by the power plant. The location of a biomass power plant should be near the biomass fuel resource to save on delivery costs. Moreover, the operators can set up the plants in the special area of the 3 provinces in the South of Thailand for having the extra price adder of electricity sales. (Navaporn Disatien, Somnuk Jindasap, Apipong Vitchuvatkamine, Nutthapong Pensean, Prasert Siritipratsami, personal communication , May-June, 2016). The results of quantitative analysis in the test of hypothesis 7 is to test the relationship between the location of biomass power plants and effectiveness of small biomass power plants. The results of the test of hypothesis 7.2 show that the location of biomass power plants are positively correlated with the environmental effectiveness of small biomass power plants. The hypothesis testing results of quantitative research support the qualitative research results.

8) The supply chain management

The qualitative research findings relate to the important factors of the supply chain management power found that supply chain management is important to the small biomass power plant operation. On the working process, the operators need to prepare the biomass fuel to be sufficient to produce electricity units. The operators have to manage on quality, quantity, and price of biomass. The supply chain management will be an important part of reducing operating costs if biomass power plants can plan fuel management by supply chain management. It is the management of raw fuel materials from upstream to downstream, such as, support for energy crops, encouraging farmers to bring wastes to the factory. That can reduce pollution in the environment, increase the value of agricultural residues, and increase income from plantations and recycle agricultural materials for biomass. (Navaporn Disatien, Somnuk Jindasap, personal communication, May-June, 2016). The results of quantitative analysis in the test of hypothesis 8 are to test the relationship between the supply chain management and the effectiveness of small biomass power plants. The results of the test of hypothesis 8.1, 8.2, and 8.3 show that the supply chain management are positively correlated with the financial effectiveness, environment effectiveness and community effectiveness of small biomass power plants. The hypothesis testing results of quantitative research support qualitative research results.

6.6 The Comparison between the Qualitative Research Results and the Quantitative Research Results

The comparison between the qualitative research results and the quantitative research results are the following:

6.6.1 The Qualitative Research Results

The important factors affecting the effectiveness of small biomass power plants consists of biomass fuels, technology of producing the electricity, abilities and skills of employees, the government subsidies, location of power plant, the community acceptance, the initial project design of the biomass power investment, the management of the biomass power plant, the dependence on external resources, regulations and laws, the organizational culture, the executive vision, the potential of the grid lines, the accessories of connecting to the electricity, the distance of the biomass source, knowledge development, the supply chain management, the purchase agreement of electricity selling, the local politics and the crude oil prices.

The effectiveness of small biomass power plants consist of the environmental effectiveness, the operation of small biomass power plants is to reduce the burning of waste materials in the area, to recycle the biomass residuals and waste, and to reduce the pollution that affects the environment. The community effectiveness, such as jobs creation, the community income from biomass sales that creates income and energy security in the community. The financial effectiveness, the operation of small biomass power plants having good returns, a good cash flow from the investment, cost effectiveness, and short term payback period.

6.6.2 The Quantitative Research Results

Model 1: First Order Confirming Factor Analysis results of the important factors affecting the effectiveness of small biomass power plants that found the factor loading of all observed variables or indicators were correlated with 8 latent variables of important factors affecting the effectiveness of small biomass power plants. There are significances (p-value=***). Then, the researcher concluded that all indicators are appropriate and can measure all of the 8 latent variables of the important factors affecting the effectiveness of small biomass power plants. All indicators of quantitative research come from the qualitative findings.

Model 2: First Order Confirming Factor Analysis results of the effectiveness of small biomass power plants that found the factor loading of all observed variables or indicators were correlated with 3 latent variables of the effectiveness of small biomass power plants. There are significances (p-value=***). Then, the researcher concluded that all indicators are appropriate and can measure all of the 8 latent variables of the effectiveness of small biomass power plants. All indicators of quantitative research come from the qualitative findings

Model 3: The relation test between the important factors and the effectiveness of small biomass power plants.

The results of the test of hypothesis 1.1 shows that the availability of electricity networks and transmission systems positively correlated with the financial effectiveness of small biomass power plants.

The results of the test of hypothesis 2.1 shows that the skills and abilities of employees positively correlated with the financial effectiveness of small biomass power plants.

The results of the test of hypothesis 3.2 shows that the regulations and laws positively correlated with the environmental effectiveness of small biomass power plants.

The results of the test of hypothesis 4.3 shows that the community acceptance positively correlated with the community effectiveness of small biomass power plants.

The results of the test of hypothesis 5.1, 5.2, and 5.3 show that the biomass resource dependency positively correlated with the financial effectiveness, environmental effectiveness and community effectiveness of small biomass power plants.

The results of the test of hypothesis 6.3 shows that the value of working is positively correlated with the community effectiveness of small biomass power plants. The hypothesis testing results of quantitative research supports the qualitative research results.

The results of the test of hypothesis 7.2 shows that the location of biomass power plants is positively correlated with the environmental effectiveness of small biomass power plants.

The results of the test of hypothesis 8.1, 8.2, and 8.3 show that the supply chain management is positively correlated with the financial effectiveness, environmental effectiveness and community effectiveness of small biomass power plants.

6.7 Chapter Summary

The quantitative research reports include the reporting of sample characteristics, Exploratory Factor Analysis results to reduce the various variables to be 8 components, the power network and the transmission lines, skills and abilities of employees, regulations and laws, the community acceptance, the resource dependency, the value of working, the location of power plants, and the supply chain management. After obtaining the new components, the researcher used the Confirmatory Factor Analysis with SPSS and AMOS to confirm the variables with the theory as the SPSS and AMOS can work very well on the multiple variables and social research. The researcher created and adjusted the models until the models fit with the empirical data models as follows: Model 1: First Order Confirmatory Factor Analysis of the latent model of the important factors affecting the effectiveness of the small biomass power plant, the fit index are CMIN/DF=1.170, GFI=0.925, NFI=0.939, RFI=0.901, IFI=0.991, TLI=0.984, CFI=0.990, RMSR=0.043, RMSEA=0.030. All indexes passed index criterion. Then, the researcher concluded the model fits with the empirical data or Good fit Model. The indicators of the latent variables of the important factors affecting the effectiveness of the small biomass power plant models are appropriate to the latent variables and all indicators are appropriate to measure the latent variables. Model 2: First Order Confirmatory Factor Analysis results of the effectiveness of the small biomass power plant, the fit index are CMIN/DF=1.906, GFI=0.979, NFI=0.985, RFI=0.945, IFI=0.993 TLI=0.973 , CFI=0.993, RMSR=0.024, RMSEA=0.069. All indexes passed index criterion. Then, the researcher concluded the model fits with the empirical data or Good fit Model. The indicators of the latent variables of the small biomass power plant model are appropriate to the latent variables and all indicators are appropriate to measure the latent variables. Model 3 Structural Equation Model to test the relation between latent models of the important factors affecting the effectiveness and the latent model of the effectiveness of the small power plants. CMIN/DF=1.175, GFI=0.932, NFI=0.953, RFI=0.882, IFI= 0.993, TLI=0.980, CFI=0.992, RMSR= 0.046, RMSEA=0.030. All indexes passed index criterion. Then, the researcher concluded the model fits with the empirical data or Good fit Model. The researcher read the hypothesis results accurately. The reliability test results with Conbrach's alpha, Reliability, Convergent Validity and Discriminant Validity found that all latent variability have reliability, Convergent Validity and Discriminant Validity indexes pass the index criterion. The hypothesis test results, hypothesis test of hypothesis 1, the results of hypothesis test 1.1, 1.2, and 1.3 found that the power network and the transmission lines are positively correlated with the financial effectiveness of small biomass power plants but not correlated with the environmental and community effectiveness. Hypothesis test 2, the results of hypothesis test 2.1, 2.2, and 2.3 found that the test results of hypothesis 2.1 found that the skills and capabilities of employees are positively correlated with the financial effectiveness of small biomass power plants but not correlate with the environmental and community effectiveness. Hypothesis test of hypothesis 3, the results of hypothesis test 3.1, 3.2, and 3.3 found that regulations and laws are likely to positively correlate with the environmental effectiveness of small biomass power plants but not correlate with financial and community effectiveness. Hypothesis test 4, the results of hypothesis test 4.1, 4.2, and 4.3 found that the community acceptance is likely to positively correlate with the community effectiveness of small biomass power plants but not correlate with the financial and environmental effectiveness. Hypothesis test 5, the results of hypothesis test 5.1, 5.2, and 5.3 found that the dependence of biomass fuel resources is likely to positively correlate with the financial, environmental and community effectiveness of small biomass power plants. Hypothesis test 6, the results of hypothesis test 6.1, 6.2, and 6.3 found that the values of work are likely to positively correlate with the community effectiveness of small biomass power plants but not correlate with the financial and environmental effectiveness. Hypothesis test 7, the results of hypothesis test 7.1, 7.2, and 7.3 found that the location of the power plants is likely to positively correlate with the environmental effectiveness of small biomass power plants but not correlate with the financial and community effectiveness. Hypothesis test 8, the results of hypothesis test 8.1, 8.2, and 8.3 found that the supply chain management is likely to positively correlate with the financial, environmental and community effectiveness of small biomass power plants.

CHAPTER 7

DISCUSSION AND SUGGESTION

This chapter included the Mixed Method discussion, Suggestions of this study, Limitations of this study and chapter summary.

7.1 The Mixed Method Discussion

7.1.1 The Important Factors Affecting the Effectiveness of Small Biomass Power Plants

1) The relations between the availability of power networks and the transmission lines and the effectiveness of small biomass power plants.

The qualitative research findings relate to the important factors of the power network and the transmission lines found that the power network and the transmission lines are important to the small biomass power plant operation. The results of quantitative analysis in the test of hypothesis 1 to test the relationship between the availability of electricity networks and transmission lines and the effectiveness of small biomass power plants. The results of the test of hypothesis 1.1 show that the availability of electricity networks and transmission systems is positively correlated with the financial effectiveness of small biomass power plants. Since the power network and electrical system are efficient and well equipped to deliver electricity, power plants are able to sell power units regularly without having to pay for overhead costs to link with the grid lines. The plant can save operating costs if this happens. Therefore, the availability of power grid and transmission systems is positively correlated with the financial effectiveness of small biomass power plants. The hypothesis testing results of quantitative research supports the qualitative research results and conferring about the research result of Nattapong Peansen (2011) claimed good electrical networks have a positive effect on the effectiveness of the renewable energy policy in the form of public and private partnerships. Due to the fact that the power grid is close to the production site, there is no need for additional costs for the transmission system from the power plant to the transmission system. As well as the efficient electricity, network which will support the private sector to expand its capacity as much as possible. On the setting of the power plant, the operator must be aware of the key factors in the operation that the infrastructure for power line connection; because the operator must sell electricity to power through the transmission line.

2) The relationship between skills and abilities of employees and the effectiveness of small biomass power plants.

The qualitative research findings relate to the important factors of skills and abilities of employees found that the skills and abilities of employees is important to the small biomass power plant**.** The results of the quantitative analysis in the test of hypothesis 2 to test the relationship between skills and abilities of employees and the effectiveness of small biomass power plants. The results of the test of hypothesis 2.1 shows that skills and abilities of employees is positively correlated with the financial effectiveness of small biomass power plants. The skills and capabilities of the management and employees affect the operational systems in the production of power units within a power plant with efficiency and stability. When a plant has a good production system, it can produce electricity consistently, the power plant can generate power transmission at any time, and have results providing a good financial performance, good cash flow, return on investment within a short period. Therefore, the skills and abilities of the employees are positively correlated with the financial effectiveness of small biomass power plants. The hypothesis testing results of the quantitative research supports the qualitative research results and in accordance with the Resource-Based View as Human Capital. Human Capital means knowledge, skills, abilities and the experience of humans. These are critically important resources of the organization to create a competitive advantage. Human capital is a valuable resource that is rare, difficult to imitate, and hard to replace. The results are in accordance to the results of Seleim and Bontis (2007) who claimed that human capital is skill, ability, knowledge and experience that affects the organizational effectiveness. Humans are directly linked with the planning in an organization to create an advantage. Research is important to the human capital that is unique, valuable, an organization value, as humans are an important resource, to create an effective organization, to create new opportunities to the business, to reduce barriers, and to increase the efficiency of the organization. The results is accordance with the research of Crook et al. (2011) that human capital is correlated with the effectiveness of an organization. The study is based on the Resource-Based View theory which found that human capital is correlated with organizational effectiveness with a significant relationship. Human capital and the ability of the employees is an important factor in the effectiveness of an organization. Organizations for Economic Co-Operation and Development claimed that the skills and abilities of human capital is an important characteristic to create a positive social society and contribute to the good economy as a whole. (OECD, 2001, p. 18)

3) The relationship between the regulations and laws and the effectiveness of small biomass power plants.

The qualitative research findings relate the important factors of skills and abilities of employees found that skills and abilities of employees is important to the small biomass power plant**.** The results of the quantitative analysis in the test of hypothesis 3 to test the relationship between regulations and laws and the effectiveness of small biomass power plants. The results of the test of hypothesis 3.2 shows that the regulations and laws are positively correlated with the environmental effectiveness of small biomass power plants. To establish and operate a biomass power plant, the operators need to follow legal regulations very strictly. The operators need to make community public hearings on the establishment and operation of the power plant related with and to the environment. The operators need to publicize information to the public and community to understand the project of the power plant, explain that the operation of the power plant does not affect the environment. The biomass power plant project does not have any pollution, sounds, air, smells, or water pollution leeching into and disturbing the community. In case the operators are not following the regulations and laws, the community can make a complaint to government authorities to proceed with the biomass power plant. If a complaint occurs, the operators need to solve all problems very urgently. Therefore, the regulations and laws have a positive relationship to the environmental performance of small biomass power plants. The hypothesis testing results of quantitative research support qualitative research results and comply with the Energy Regulatory Commission (2015). Biomass power plant operators are required to carry out regulatory procedures systematically very strictly. According to the process of licensing the electricity business, and related licenses, and related organizations there are many steps, such as: 1) pre-licensing procedures, 2) application procedures, and 3) building and plant construction procedures, Electricity Generating Authority.

4) The relationship between the community acceptance and the effectiveness of the small biomass power plant.

The qualitative research findings relate to the important factors of the community acceptance which is important to the small biomass power plant operation. The results of quantitative analysis in the test of hypothesis 4 to test the relationship between the community acceptance and the effectiveness of small biomass power plants. The results of the test of hypothesis 4.3 show that the community acceptance is positively correlated with the community effectiveness of small biomass power plants.

The results of the study meet the terms of the public paper that Sivaporn Sirikhun (2011) and Department of Alternative Energy Development and Efficiency (2016b) claimed that the community acceptance of small power plants installation is a very important factor to the biomass operation. In the event that the community objects to the project of the power plants, there will be a very negative affect of the plant’s success. The operators need to publicly inform the community very often from the beginning the project, provide information to community leaders and community members alike, ensure the community of environmental protection, involve community members in the project, focus on stakeholders, and return the profits to the community. The results also comply with Ganzevles, Asveld, and Osseweijer. (2015) who claimed the community acceptance of biomass power plants in the Netherlands. Communities accept the power plant project if the power plants are fair and just to the community. Baten, (2014) studied the community acceptance effect on the biomass power plant operation in Atikokan, Ontario, Canada. The purpose of study is community acceptance from changing Atikokan Power Generation Station from coal fuel to biomass fuel. The study found that as community acceptance rises, the biomass power plant gains benefit from biomass power plant operation. The community acceptance is related to increasing the employment rate, increasing the quantity of waste buying in the area, and supporting community activities in the community.

5) The relationship between the biomass resource dependency and the effectiveness of the small biomass power plant.

The qualitative research findings relate the important factors of the biomass resource dependency which found that the biomass resource dependency is important to the small biomass power plant operation. The results of quantitative analysis in the test of hypothesis 5 to test the relationship between the biomass resource dependency and the effectiveness of small biomass power plants. The results of the test of hypothesis 5.1, 5.2, and 5.3 show that the biomass resource dependency are positively correlated with the financial effectiveness, environmental effectiveness and community effectiveness of small biomass power plants. The biomass resource dependency on external resources is a key factor in the operation of biomass power plants, especially biomass power plants without their own biomass sources, which require the purchase of biomass from outside for their daily production. The hypothesis testing results of quantitative research support qualitative research results and comply with The Resource Dependency Theory that Pfeffer and Salancik, (1978, p. 2) explained that the importance of the organization to depend on other organizations, especially the importance of resources of the organization. The organization needs to acquire and find important resource from outside which is at times very costly. This factor caused the organization to be highly dependent on other organizations. The organizations need to adopt strategies to reduce their dependence on resources. The survival of organizations is about the effectiveness that drives the management process so that the organization seeks only important resources that they need. The key to survival of the organization is the ability to acquire and maintain resources. The organization needs to control resources for organization operations.

6) The relationship between the values of work and the effectiveness of small biomass power plants.

The qualitative research findings relate the important factors of the value of working which found that the value of working is important to the small biomass power plant operation. The results of quantitative analysis in the test of hypothesis 6 to test the relationship between the value of working and the effectiveness of small biomass power plants. The results of the test of hypothesis 6.3 shows that the value of working is positively correlated with the community effectiveness of small biomass power plants. In the operation of a small biomass power plant, managers create work values for employees to take pride in generating electricity from biomass, motivate the employee to join problem-solving procedures, be proud to be part of the success of the biomass power plant operation. The hypothesis testing results of quantitative research support qualitative research results and comply to Schein (1985) who claimed the beliefs and values of employee behavior are conveyed among members of an organization that influence their behavior and decision-making, the organizational structure and organizational effectiveness.

7) The relationship between the location of power plants and the effectiveness of the small biomass power plant.

The qualitative research findings relate the important factor of the location of biomass power plants found that the location of biomass power plants is important to the small biomass power plant operation. The results of quantitative analysis in the test of hypothesis 7 to test the relationship between the location of biomass power plants and the effectiveness of small biomass power plants. The results of the test of hypothesis 7.2 shows that the location of biomass power plants is positively correlated with the environmental effectiveness of small biomass power plants. The operators need to select the location of power plants to be near the electricity network, grid lines, and the utilities to sell the electricity units through the grid lines. Furthermore, locations near biomass fuel sources save the delivery costs of fuel and make a more convenient operation process. The hypothesis testing results of quantitative research support qualitative research results and comply with the Resource-Based View that focuses on the required assets that create a competitive advantage for the organization. The tangible property on Resource-Based View is the location of the company, technology and so on. The results comply with Feeeman, and Styles (2013) which study the influence of the location and organizational performance. The study found that the location of the organization can create a company advantage, as the access the important resource are needed, the coordinators with other agents, the access to public utilities, the labor and business opportunities. This advantageously effects the organizational development and performance.

8) The relationship between the supply chain management and the effectiveness of small biomass power plants.

The qualitative research findings relate the important factors of the supply chain management, which found that the supply chain management is important to the small biomass power plant operation. The results of quantitative analysis in the test of hypothesis 8 to test the relationship between the supply chain management and the effectiveness of small biomass power plants. The results of the test of hypothesis 8.1, 8.2, and 8.3 show that supply chain management is positively correlated with the financial effectiveness, environmental effectiveness and community effectiveness of small biomass power plants. On the operation of small biomass power plants require biomass residues such as rice husks, wood chips, and rubber wood roots and so on to use as biomass fuel for electricity generation. The operators that have their own biomass or have wastes from the production process can use their biomass as fuel for electricity generation. On the other hand, the independent biomass power plants that do not have their own biomass resources need to use careful supply chain management from the supplier who supports the biomass fuel. The operators of power plants need to support the fermented supplies to bring as biomass for their fuel, support the farmers to plants fuel trees or fast growing crops to become biomass fuel. If growing the biomass has a value that is motivation enough for farmers to plant it. When the farmers grow more crops, the quantity of biomass will be higher. The power plant will then have enough biomass fuel for generating the electricity. The hypothesis testing results of quantitative research supports the qualitative research results and complies with the Resource-Based View as the importance of the ability of the business to create a competitive advantage for the business. The result is in accordance with Cousins and Speckerman (2003) who studied the ability to manage resources. The exchange of raw materials from various sources; It is an important factor of the organization to create a competitive advantage. Ferman and King (2005) suggests the success of using biomass fuels in the University of Iowa Biomass Fuel

Project. Estimates of biomass fuels; the amount of fuel required must be adequate throughout the year. Taking into account the cost of transporting fuel.

McCarl, Adam, Alig, and Chmlik (2000) studies the role of supply chain management among biomass fuel suppliers found that the competitiveness of biomass fuel for electrical power plants depends on several key factors in the management of biomass fuels. Especially the success of the development of biomass fuels for shorter crop rotation cycles which will have an impact on the biomass demand of the plant and its ability to control the costs of biomass fuels at higher costs.

7.1.2 The Effectiveness of Small Biomass Power Plants

1) The Financial Effectiveness

From the qualitative research results, the financial effectiveness of small biomass power plants consisted of operating results of good finance performance, a good cash flow, cost effectiveness, and return of investment in a short period. The result comply with Fischer (2005) found that the power plants using gasification technology to generate electricity has a good effect on the economic process as there are new enterprises and creates careers in the community surrounding power plants. The study of Pimanpng Rinsinthu (2013) claimed that the major economic benefits arising from the operation of biomass power plants are the reduction of fossil imports from abroad, reductions in the costs of buying foreign fuel, creating a revolving economy around the power plant, creating jobs, finally promoting the local economy with a greater chance of growth.

2) The Environment Effectiveness

From the qualitative research results, the environmental effectiveness of small biomass power plants consisted of operating results of good environmental performance, consisting of the generation of electricity from biomass fuels with a waste of recyclable materials to help reduce global warming, to reduce combustion that causes air pollution, to reduce carbon monoxide, to reduce the import quantity of coal fuels. The result complies with the generation of electricity from biomass fuels with a waste of recyclable materials, to help reduce global warming, to reduce combustion that causes air pollution, to reduce carbon monoxide, to reduce the import quantity of coal fuels. Varela, Lechon and Saez (1999) studied the strengths of biomass power plants in Spain, the key strengths in biomass power plant operations are the good return on the environment, to reduce carbon monoxide in the atmosphere, reduce the rate of fire because of the collection of waste to be used as fuel for biomass power plants, to reduce the deterioration of the soil and increase the agricultural crops. Fischer (2005) claimed the results of the operation of a good biomass power plant for the environment is to reduce forest fires from the collection of agricultural materials, to reduce the burning of waste materials, and keep the environment clean and safe from wildfires. Cameron (2004) called it the biomass powerhouse that can reduce the amount of carbon monoxide that is polluting the environment along with the benefits of reducing carbon monoxide emissions by carbon trading. In addition to the biomass power plant, it reduces the amount of nitrogen dioxide gas that pollutes the environment. Biomass power plants support the use of scraps of agricultural materials in the area as fuel for electricity generation and reduce the burning of agricultural residues that cause air pollution.

3) The Community Effectiveness

From the qualitative research results, the community effectiveness of small biomass power plants consisted of operating results that are good for the community; by using the biomass to be fuel in the power plant, farmers have more income creating income in the community, creating jobs from setting the power plant to hire the workers from the community, to buy the agricultural residues from farmers that makes money circulate in the community. The results comply with Fischer (2005) who claimed the good benefits from biomass power plants are that the power plant can support the community by creating jobs and the community can develop the biomass to use as fuel to power the plants. The Department of Alternative Energy Development Efficiency (2015b) claimed the benefits from biomass power plants to community as the following: The benefits from the developing funds of the power plant for supporting the community surrounding the plants: The community development funds are used for various purposes such as career development, support for religious, cultural, sporting and music education, public health and environmental support. Baten (2014) referred to the benefits of small biomass power plants to the community as investments in small biomass power plants that will result in a rapid economic recovery of the community as a result of the fast growing trees, transportation, logging in the rapidly growing forest, recycling of the agricultural residues into biomass fuel for plants, reduction in the amount of hidden unemployment, increasing job creation, reducing the migrant labor, and increasing the circulation of money in the community. Gavrilescu (2008) claimed the benefits of using biofuel for their sustainability are the benefits to economy, social and environmental development. 1) Financial benefits as to reduce the currency value of imported fossil fuels from abroad, the development of remote areas by increasing the use of biomass in the area, the increasing value and opportunities for agriculture and the continued industry, increasing value in industrial development in the community on energy services, to add value to community resources, to cooperate in government, private and community investment, and to strengthen the electricity power in the community. 2) Benefits to the social are the increase of the value of energy services in remote areas, to enhance the standard of living for communities in remote areas, to investment in small and medium-sized businesses related to natural energy and to create jobs in the establishment area. 3) Benefits to the environment are a reduction of pollution and reduction of carbon monoxide concentrations in the air.

The test of the hypothesis found that some important factors do not positively correlate with the effectiveness of small biomass power plants. The researcher explained the result that are not the same as the hypothesis of study with the in-depth interview and the literature review as follows:

1) The availability of the power network and the transmission lines have no positive correlation with the environmental and community effectiveness of small biomass power plants.

(1) The availability of the power networks and the transmission lines have no positive correlation with the environmental effectiveness of small biomass power plants.

The results of hypothesis test 1.2 found that the availability of the power networks and the transmission lines have no positive correlation with the environmental effectiveness of small biomass power plants. The researcher explained this results that the availability of power networks and the transmission lines are prerequisite for the provision of the basic service for distribution of the electricity of the operation system. They are an important part of the electricity generation and distribution process and the availability of power networks and the transmission lines have positive correlation with the financial effectiveness of small biomass power plants. However, the environmental effectiveness of small power plant is the reduction of the quantity of the biomass residual waste, the reduction of combustion in open areas that causes air pollution, and the pollution control of biomass power plants. The executives may have a policy to reduce the quantity of the biomass residual wastes, to reduce combustion in open areas that causes air pollution, and to control the pollution of biomass power plant that are different at each power plant. Even the availability of power networks and transmission lines affect the financial effectiveness, the power plant can produce more electricity units and still have good financial performance. However, the more production of electricity may not affect the reduction of biomass residual wastes and the reduction the combustion in open areas that causes air pollution as they have their own biomass resources. The power plant may reduce the control of the pollution in case they produce more electricity units when the numbers of producing hours increase. Then the availability of power networks and the transmission lines have no positive correlation with the environmental effectiveness of small biomass power plants.

(2) The availability of the power networks and the transmission lines have no positive correlation with the community effectiveness of small biomass power plants.

The results of hypothesis test 1.3 found that the availability of the power network and the transmission lines have no positive correlation with the environmental effectiveness of small biomass power plants. The researcher explained this result was that the availability of power networks and the transmission lines are prerequisites for the provision of the basic service for the distribution of the electricity of the operation system and there are no affects to the financial effectiveness. However, the community effectiveness of small power plants are to increase employment in the area, to increase the quantity of biomass fuel from the community and to support the local activities. The executives may have a policy to increase employment in the area, to increase the quantity of biomass fuel from community and to support local activities that are different at each power plant. Even if the availability of power networks and transmission lines affect the financial effectiveness, the power plant can produce more electricity units and have good finance performance. However, more electricity production may not increase the employment in the area in case the power plant hires the work force from other areas. However, more electricity production may not affect the reduction of the quantity of the biomass residual waste in case the power plant does not buy the biomass residuals from farmers as they have their own biomass resources. The power plant may be supporting community activities but it depends on the policy of each power plant. Finally, the availability of power networks and the transmission lines have no positive correlation with the community effectiveness of small biomass power plants.

2) The skills and abilities of employees have no positive correlation with the environmental and community effectiveness of small biomass power plants.

(1) The skills and abilities of employees have no positive correlation with the environmental effectiveness of small biomass power plants.

The result of hypothesis test 2.2 found that the skills and abilities of employees have no positive correlation with the environmental effectiveness of small biomass power plants. The researcher explained this results that the skills and abilities of employees are capable of solving problems that occur during the operation, offering a cost effective working process, developing the knowledge and abilities of employees. The skills and abilities of employees in the power plants affect the financial effectiveness of a small biomass power plant. The skills and abilities of employees in the power plants are skills and abilities of the techniques of working to increase the efficiency of generating electricity, such as , the problem solving on the job, the machine controls, the biomass fuel controls, and so on. However, the environmental effectiveness of small power plants is the reduction of the quantity of the biomass residual wastes, the reduction of the combustion in open areas that causes air pollution, and the pollution control of biomass power plants. The executives may have a policy to reduce the quantity of the biomass residual wastes, to reduce combustion in open areas that causes air pollution, and to control the pollution of biomass power plants that are different at each power plant. If the employees have quality skills of good employees they will positively affect the financial effectiveness of small power plants. However, the more of the electricity production may not affect the reduction of biomass residual wastes or the reduction of combustion in open areas that causes air pollution if the power plants have their own biomass resources. The power plant may reduce control of the pollution control in the event they produce more electricity units as the numbers of production hours increase. Thus, the skills and abilities of employees have no positive correlation with the environmental effectiveness of small biomass power plants.

(2) The skills and abilities of employees have no positive correlation with the community effectiveness of small biomass power plants.

The results of hypothesis test 2.3 found that the skills and abilities of employees have no positive correlation with the environmental effectiveness of small biomass power plants. The researcher explained this result as the skills and abilities of employees are capable of solving problems that occur during the operation, offering a cost effective benefit on the working process, developing the knowledge and abilities of employees, the skill and ability of an employee in the power plant affects the financial effectiveness of a small biomass power plant. However, the community effectiveness of small power plants is to increase employment in the area, to increase the quantity of biomass fuel from community and to support the local activities. The executives may have a policy to increase employment in the area, to increase the quantity of biomass fuel from the community or to support the local activities that are different at each power plant. Even the skills and abilities affect the financial effectiveness; the power plant can produce more electricity units and have a higher financial performance. However, the more electricity production may not affect the increase of employment in the area in case the power plant hires labor from other areas. However, the more electricity production may not reduce the quantity of the biomass residual wastes in case the power plant does not buy the biomass residuals from farmers as they have their own biomass resource. The power plant may support activities of the community but it depends on the policy of each power plant. The skills and abilities of employees have no positive correlation with the community effectiveness of small biomass power plants.

3) The regulations and laws have no positive correlation with the financial or community effectiveness of small biomass power plants.

(1) The regulations and laws have no positive correlation with the financial effectiveness of small biomass power plants.

The results of hypothesis test 3.1 found that the regulations and laws have no positive correlation with the financial effectiveness of small biomass power plants. The researcher explained this is the result of regulations and laws that are the standard regulatory requirement in the setting and the operation of the biomass power plants, such as, the permission to build a factory, the application for Energy Business Licenses, the application for electricity, and the contract for the sale of electricity, and so on. The operators of biomass power plants need to follow the regulations and laws strictly. Regulations and laws are mostly about the requirement of the setting of the biomass power plants. However, the financial effectiveness of small biomass power plants is of good finance performance, a good cash flow, and a short period of return of investment when the financial effectiveness comes from the electricity generation and the sales of the electricity units of the power plants. The samplings of the quantitative research study were small-scale biomass power plants that were established and already in an operating situation. Going through the legislative process must be implemented in the early stages of establishing a biomass power plant so that the regulations and laws have no positive correlation with the financial effectiveness of small biomass power plants.

(2) The regulations and laws have no positive correlation with the community effectiveness of small biomass power plants.

The results of hypothesis test 3.3 found that the regulations and laws have no positive correlation with the community effectiveness of small biomass power plants. The researcher explained the results are that the regulations and laws are the standard regulatory requirement in the setting and the operation of biomass power plants, such as, the permission to build a factory, the apply for Energy Business Licenses, the application for electricity, and the contract for the sale of electricity, and so on. The operators of biomass power plants need to follow the regulations and laws strictly. However, the community effectiveness of small power plants is to increase employment in the area, to increase the quantity of biomass fuel from the community and to support the local activities. Regulations and laws are mostly about the requirement of the setting of the biomass power plants. Regulations and laws are not related to employment in the area, the buying of biomass fuel from the community and the support of the local activities. Therefore, the regulations and laws have no positive correlation with the community effectiveness of small biomass power plants.

4) The community acceptance has no positive correlation with the financial and environmental effectiveness of small biomass power plants.

(1) The community acceptance has no positive correlation with the financial effectiveness of small biomass power plants.

The results of hypothesis test 4.1 found that community acceptance has no positive correlation with the financial effectiveness of small biomass power plants. The researcher explained the results that the community acceptance is at the heart of establishing biomass power plants. This is the first stage of the biomass power plants operation. The operators need to provide information publicly, to communities in the area for the community to accept the biomass power plant project and its operation can be set up as a successful power plant in the community. The community acceptance is the first stage to open for power plant setting but there is not an effect to the financial effectiveness. However, the financial effectiveness of small biomass power plants is of good financial performance, good cash flow, and a short period of return of investment. The financial effectiveness comes from the generation of electricity and the sales of electricity units of the power plants. The samplings of the quantitative research study were the small-scale biomass power plants that were established and in an operating situation. They must go through the community acceptance phases in the early stages of establishing a biomass power plant then the community acceptance has no positive correlation with the financial effectiveness of small biomass power plants.

(2) The community acceptance has no positive correlation with the environmental effectiveness of small biomass power plants.

The result of hypothesis test 4.2 found that the community acceptance has no positive correlation with the financial effectiveness of small biomass power plants. The researcher explained this result is that the community acceptance is the heart of establishing biomass power plants. This is the first stage of the biomass power plant operation. However, the environmental effectiveness of small power plants is the reduction of the quantity of the biomass residual wastes, the reduction of combustion in open areas that causes air pollution, and the pollution control of biomass power plants. The executives may have a policy to increase employment in the area, to increase the quantity of biomass fuel from the community and to support local activities that are different at each power plant. The samplings of the quantitative research study were the small-scale biomass power plant that was established and in an operating situation. Gaining community acceptance must be implemented in the early stages of establishing a biomass power plant. Then the community acceptance has no positive correlation with the community effectiveness of small biomass power plants.

5) The value of working has no positive correlation with the financial and environmental effectiveness of small biomass power plants.

(1) The value of working has no positive correlation with the financial effectiveness of small biomass power plants.

The result of hypothesis test 6.1 found that the value of working has no positive correlation with the financial effectiveness of small biomass power plants. The researcher explained this result is that the value of working consists of an employee's pride of working at a biomass facility generating electricity, problem solving together and working together on the biomass power plant operation. However, the small power plants are small-scale companies that consist of only a few employees as the factory manager, the engineers, the workers to operate the machines and prepare the biomass fuel and the finance staff. The value of working is a chance to increase the working efficiency and the operations in the biomass power plant focusing on the production processes related to the staff and the machinery. However, the financial effectiveness of small biomass power plants is of good financial performance, good cash flow, and a short period of return on investment. The financial effectiveness comes from the electricity generation and the sales of electricity units of the power plants. Accordingly, the value of working has no positive correlation with the financial effectiveness of small biomass power plants.

(2) The value of working has no positive correlation with the environmental effectiveness of small biomass power plants.

The results of hypothesis test 6.2 found that the value of working has no positive correlation with the environmental effectiveness of small biomass power plants. The researcher explained this result as the value of working consists of the employee pride of working on biomass electricity generation, problem solving together and working together on the biomass power plant operation. The value of working is a chance to increase the working efficiency of biomass power plant operations. However, the environmental effectiveness of small power plants is a reduction of the quantity of the biomass residual waste, the reduction of combustion in open areas that causes air pollution, and the pollution control of the biomass power plant. The executives may have a policy to reduce the quantity of the biomass residual waste, to reduce combustion in open areas that causes air pollution, and to control the pollution of biomass power plants that are different at each power plant. Then the value of working has no positive correlation with the environmental effectiveness of small biomass power plants.

6) The location of power plants has no positive correlation with the finance and environment effectiveness of small biomass power plant.

(1) The location of power plants has no positive correlation with the financial effectiveness of small biomass power plants.

The results of hypothesis test 7.1 found that the location of power plants has no positive correlation with the financial effectiveness of small biomass power plants. The researcher explained this result as the location of setting the power plant is an operator’s decision to choose a biomass power plant location. The operators need to locate the power plants in an appropriate area. There is the initial process for selecting the location to build the power plant. However, the financial effectiveness of small biomass power plants is of good financial performance, good cash flow, and a short period of return on investment. The financial effectiveness comes from the electricity generation of the sale of electricity units from the power plants. The samplings of the quantitative research study were small-scale biomass power plants that were established and in an operating situation. Choosing the location of the power plant must be implemented in the early stages of establishing the biomass power plant. Thus, the location of a power plant has no positive correlation with the financial effectiveness of small biomass power plants.

(2) The location of power plants has no positive correlation with the environmental effectiveness of small biomass power plants.

The results of hypothesis test 7.2 found that the location of power plants has no positive correlation with the environmental effectiveness of small biomass power plants. The researcher explained this result as that that the location of setting the power plant is an operator's decision to choose a biomass power plant location. There is the initial process for selecting the location to set up the power plant. However, the environmental effectiveness of small power plants is the reduction of the quantity of the biomass residual waste, the reduction of combustion in open areas that causes air pollution, and the pollution control of biomass power plants. The samplings of the quantitative research study were the small-scale biomass power plants that were established and in an operating situation. Finding the proper location of the power plant must be implemented in the early stages of establishing a biomass power plant. Finally, the location of power plants has no positive correlation with the environmental effectiveness of small biomass power plants.

7.2 Suggestions of this Study

The suggestions of this study are the suggestions of experts from government agencies, the suggestions from operators of small biomass power plants and the suggestions from the researcher.

7.2.1 The Suggestions of Experts of Small Biomass Power Plants from Government Agencies

The government agencies require the biomass power plant operator to comply with the terms and conditions on the purchase contract strictly as it is safety and security in the conditions. The operators should have to sell the electricity units to the transmission lines continuously and should follow the terms of the agreement. The success of small biomass power plants has contributed to many parts of the stakeholders, such as, the developers, the consultants, the owners, and the employees. The operators have to be concerned of all aspects to develop the project of generating electricity from biomass to be successful and complete. The government agencies should develop a personal commitment to fulfill the project, such as, create the careers related to generating electricity from biomass in the university. The university should set up the renewable course, power management, the administration of the power plants need to develop the knowledge of generating biomass broadly and openly.

7.2.2 The Suggestions from Operators of Small Biomass Power Plants Both Government and Private Sectors

1) Government policy, the government agency should support the generation of electricity from biomass continuously and should support it in the same way. The regulations and laws should be compiled with the government subsidies. The support of the operation of small biomass power plants should be appropriate as the technology development, the human development, the logistics of biomass, and so on.

2) The development of systems and equipment linking to the sale of power units between power plants and the PEA. The Improvements in the equipment, the maintenance of the transmission system, the accelerated development of the grid capacity, and the expanded transmission systems are covering the areas that are ready to set up biomass power plants. The transmission systems should be monitored and sufficient for the area and other utilities are ready to establish biomass power plants.

3) Reducing procedures and documentation for the application process. This procedure really should be minimizes the processes involved greatly reduced. There should be a one stop service facility to facilitate and speed up the implementation of various aspects in accordance with the support of biomass power generation.

4) Zoning for the biomass power plant. In the event that the biomass power plant operators have to compete with biomass fuels, then the scarcity of the biomass fuel will cause the price of biomass to fluctuate. The government should set zoning of biomass power plants to solve the establishment of more than one biomass power plant in an area.

5) The price of adders and feed-in tariffs. The price of adders and feed-in tariffs should be priced equally. There should be more financial support made in line with the promotion of biomass-based electricity generation.

6) The terms and conditions of the purchase agreement. The government agency should consider the renewal of the purchase agreement in short periods to extend the time conditions on the purchase agreement for the security of investors, to reduce the disparity in the terms of the power purchase agreement between the new powerhouse and the old power plant. In case the government agency considers the conditions for new operators, they should review the terms and conditions of the original operators.

7) Development and promotion of funding sources. Selection of funding sources for biomass-based biomass projects is a high-value project. Entrepreneurs must choose a knowledgeable financial institution. The financial institution can cooperate with various operators. If the entrepreneur faces a financial institution problem, the financial institution should be flexible, understand the operator's problem, and support the entrepreneur to solve the problem for the success of the investment project.

8) The gasification development. The gasification is suitable for small biomass power plants but there are problems generating the electricity. The government agency should accelerate the development of the gasification systems, accelerate the development of professional persons to be consultants for gasification systems. Gasification development has been a trend in Thailand for many years, but until today, it has not been successful. If other systems were to be used as substitutes, such as steam heating systems, alternative systems should be developed to be cheaper in order to have a suitable price scale to be used in very small biomass power plants.

9) There should be support for public, private and people in biomass power plants: Public Private People Partnership: PPPP. There is a biomass power plant in the community created by PPPP. The community can produce fuel for sale, income is regular, and other incomes arise from agricultural development. There is privatization of the agricultural processing plants in the area, such as , the community provides raw materials to the factory and can have more income in return, the factory can produce agricultural products, and add value to biomass to generate electricity. The public sector benefits from economic growth, employment, income generation, increases in agricultural value. Thus making the community stronger and more sustainable.

7.2.3 The Suggestions from the Researcher

1) Recommendations for applying the results of the study.

(1) Recommendations for the implementation of the study in the public sector. To make the study beneficial to the renewable energy policy from the main factors of the research, such as networks, equipment, and transmission lines should all be developed to have the potential to become useful for small biomass plants. To accelerate the development of transmission lines to cover the areas of agricultural crops that can be used as a fuel for electricity generation. The regulations and laws, there should be a reduction in the paperwork and the allowance process, to be a one-stop service. The skills and abilities of employees, the government agency should develop the techniques, provide training on projects, plan the administration of small biomass power plants. The supply chain management, the government agencies should support the fast growing trees, cultivate the energy crops, and develop the logistical systems.

(2) Recommendations for the application of the results to the private sector. To make the study beneficial to the private sector, small and very small biomass power plant operators, other upstream and downstream operators in biomass power generation, and other businesses, the results of the study can be compared to the importance of key factors in order to study the key factors that may be a weakness in their own operations. To find solutions to problems that may occur in the next operation.

2) Suggestions for the Next Study.

This research is a research project in the year 2016, which was the beginning of the change in purchase price of the units in the feed-in tariff that is a better price than the adders. In the research data collected from samplings, some samplings had a purchase agreement on the adder price. The researcher suggested there should be more research studies on the key factors influencing the effectiveness of biomass power plants again in the next few years, in order to compare the major factors influencing the effectiveness of small biomass power plants.

7.3 Limitations of this Study

The limitations of the study of the important factors affecting the effectiveness of small biomass power plants are as follows:

1) Limitations of time to study, this study is based on the qualitative data collection for a period of 6 months in August to November 2016 and collected quantitative data from the samplings of small biomass power plants in Thailand. The data collection is cross-sectional data that keeps information in one record. The information is from questionnaires of a particular time.

2) Limitations of the instrument of the study, the collected data from this research used both the qualitative and quantitative methods. The data from qualitative research is collected from in-depth interviews from experts of small biomass power plants of public and private sectors. The information of the important factors affecting the effectiveness of small biomass power plants is from their experience and opinions; thus making the information subjective. The researcher developed the instrument of quantitative research from qualitative research to collect the data from all small biomass power plants in Thailand. This study is a study that determines organizational samplings. The answerers of executives represent the organizations that are obtained from personal questions in response to a questionnaire. The data collected from the executives of small biomass power plants were asked for their opinions too.

7.4 Chapter Summary

This research used the Mixed Method Methodology, the researcher used Mixed Methods on the discussion by using the result of quantitative research supporting the results of the qualitative research and discussion the hypothesis results that do not follow the hypothesis of the researcher. The result of the quantitative research found that the keys important affecting the financial effectiveness are the availability of the network and the transmission lines, the skill and ability of employees, the dependency of biomass fuel and supply chain management. The factors affecting the environmental effectiveness are the regulations and laws, the dependency of biomass fuel, the location of power plants and supply chain management. The factors affecting the community effectiveness are the community acceptance, the dependency of biomass fuel, value of working and supply chain management. The suggestions of this study are from the experts from public and private sectors and the researcher respectively. The limitations of this study are the limitations of time and the instruments of the study.

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APPENDICES

APPENDIX A

IN-DEPTH INTERVIEW ISSUES

Part 1: In-Depth Interview Issues from the Expert on Small Biomass Power Plants, Government Agencies.

Interviewee: Dr. Prasert Sinsukprasert, Deputy of Energy Policy and Planning office, Energy Policy and Planning office, Ministry of Energy, Thailand

Date of Interview: May 4, 2016

Part 2: The Small Biomass Power Plants Situation in Thailand

Currently, there are a lot of operations of small power plants in Thailand. The government sectors have a policy to support and promote the small biomass power plants.

Part 3: The Important Factors Affecting the Effectiveness of Small Biomass Power Plants.

The subsidies from the Government, The government supports the operators of small biomass power plants by purchasing power purchase agreements with adder prices and changing the purchase prices to a fixed price as feed-in tariffs to support the operators.

Biomass fuel, Biomass is very important to the power plant operation. In the areas where we have a lot of biomass, when the government supports the biomass power plants, the operators set up a lot of power plant too. The need of biomass fuel is increased, the price of biomass is increased. The price is increased which then affects the operating costs of power plants.

The community acceptance, The community acceptance is an importance factor that affects the effectiveness of the small power plants. If the community is against the project then the operators cannot set up the power plant. The problems from power plant effect the community as the noise from delivery of the biomass fuel and the smell of biomass.

Part 4: The Effectiveness of Small Power Plants

The Financial Effectiveness, The financial effectiveness of small power plants is not quite good especially the independent small power plant that does not have their own biomass fuel resource. However, the power plants that have their own biomass fuel resource may have financial effectiveness.

The environmental effectiveness, the success of biomass power plants to the environment as recycling the agricultural waste to be fuel and reduce the carbon monoxide in the environment.

The community effectiveness, the success of biomass power plants to the environment as creating careers in the community, buying the biomass from farmers that make the farmers have more money.

Interviewee: Mr. Reakrit Khenharach
Director of Renewable Department,
Energy Policy and Planning office, Ministry of Energy
Date of interviewer: May 23, 2016

Part 3: The Important Factors Affecting the Effectiveness of Small Biomass Power Plants.

Technology to produce electricity, Currently the small power plants that use Gasification have problems on the production process. The developers should develop the Gasification technology to be more stable. However, the power plant that doesn't use Gasification does not have technology problems.

Biomass fuel, Biomass fuel is a key success of biomass power plants. If the power plant has their own biomass resource, they may have more success than the independent power plant that does not have their own biomass resource. Biomass fuel is used on the power plants including low moisture and high moisture. Low moisture biomass is used with Gasification technology and high moisture is used with fermentation technology.

The government subsidies, the government subsidies are the motivation to the operators to invest in the power plant project. The government subsidies are the promotions on the power plant projects, the adders, tax exemptions, the funding and so on.

The grid line potential, the grid lines are important to the power plant. The government is developing the grid line system to support the small power plant.

The human capital, the ability and knowledge is required on the operation of power plants. The power plant that use Gasification may need more intention of the knowledge and ability of the operation. This system is still developing.

The biomass fuel management, the power plant needs to manage the fuel, such as, look for available biomass stock, variety of kinds of biomass, the quality of biomass, and control prices of biomass feedstock.

The purchase agreement, the small biomass power plant has both firm and non-firm purchase agreements.

Part 4: The Effectiveness of Small Power Plants

The Financial Effectiveness, The financial effectiveness of small power plants is not quite good especially the independent small power plants that do not have their own biomass fuel resource. However, the power plants that have their own biomass fuel resource may have financial effectiveness.

The environmental effectiveness, the success of biomass power plants to the environment as recycling the agricultural waste to be fuel.

The community effectiveness, the success of biomass power plants to the environment is creating careers in the community, buying the biomass from farmers, and supporting the community activities.

Interviewee: Ms. Pitsamai Satheanyanon, a renewable energy expert
Department of Alternative Energy Development and Efficiency
Date of Interview: May 27, 2016

Part 3: The Important Factors Affecting the Effectiveness of Small Biomass Power Plants.

The subsidies from the Government, the subsidy policy is an importance factor to the biomass operation. The government policy is support of the operators, for example, the adders purchase price, Feed-in Tariffs, the investment support from the Board of Investment, the tax exemption, and the extra support in special areas, and so on.

Biomass fuel, the biomass is important in the operation as the fuel of producing the electricity. In areas where there are a lot of biomass a lot of biomass power plants are also set up. The need of biomass is fuel rises making the price of biomass rise up from 500 baht per ton to 1000 baht per ton. The price of biomass rises which affects the power plant operation. In case the industry has their own biomass resource, they do not have any problems with the biomass resources. However, the independent power plant that does not have any biomass resource needs to depend on the other resources from outside.

Technology for generating the electricity, there is both Gasification and thermo technology used in small power plants. The gasification is the direct combustion to produce gas and use gas for electricity. It is a closed system used to produce electricity in very small power plants. The thermo technology is the burning of fuel for heat and then using heat for generating electricity.

Part 4: The Effectiveness of Small Power Plants

The Financial Effectiveness, The power plants who have their own biomass fuel resources may have financial effectiveness.

The environmental effectiveness, the success of biomass power plants to the environment is recycling the agricultural waste to be fuel and reduce the carbon monoxide in the environment.

The community effectiveness, the success of biomass power plants to the environment is creating careers in the community, the farmers can recycle the biomass by selling it to the power plants that will allow farmers to have more money.

Interviewee: Dr. Prasit Siritipratsami, Director of Engineering, and technical Department Energy Regulatory Commission

Date of Interview: June 7, 2016

Part 3: The Important Factors Affecting the Effectiveness of Small Biomass Power Plants.

Biomass fuel, biomass is important to the power plant as it is their fuel. In some areas biomass is the agriculture waste and very cheap. However, when many biomass power plants set up, they need more biomass. This makes the biomass consumption rise the prices of biomass fuels increase. When price of fuel increases that affects the operation costs of power plants. On the other hand, the purchase price of electricity unis is fixed. The solution is the zoning for setting the biomass power plants.

The human capital, the human capital is important for the power plant operation. There are many universities that teach and develop the biomass power plant operation.

Technology to generate the electricity, when the technology for producing the electricity is Gasification, the government should support and develop the research and techniques of Gasification.

The management of power plants, there are many kinds of management of biomass power plants, for example, the fuel management, the technology management, and so on.

The community acceptance, the community acceptance is a success factor of the biomass power plant operation. Currently, the community is still against the biomass power plant operation. The operators and government sectors need to make public relations better. If the community accepts the biomass power plants project then it will be a successful power plant.

Part 4: The Effectiveness of Small Power Plants

The Finance Effectiveness, the financial effectiveness of power plants is the efficiency of risk management. If the power plant can control operational costs, they are competitive.

The environmental effectiveness, the operators need to follow the regulations and laws strictly, especially, the regulations to control the pollution.

The community effectiveness, in case the operators commit whatever point with the community, the operators need to keep contact with community. The success from power plant to the community is the funding from biomass power plants to the surrounding community.

Interviewee: Dr. Nutthapong Peangseang, Assistance of the project management of renewables, Thasakea Project. Electricity Generating Authority of Thailand

Date of Interview: June 11, 2016

Part 3: The Important Factors Affect the Effectiveness of Small Biomass Power Plants.

The initial project study, this study is for determining whether the project is likely to be successful and evaluating the return on investment of the biomass power plant projects.

Biomass fuel, biomass supply is an important power plant operation. Normally the power plants have their own biomass resource. The independent power plant or new power plants that do not have their own biomass resources need to look for other sources.

Technology for producing electricity, the technology of Gasification that is to directly burn or to produce gas and use the gas to produce electricity units. Gasification is a closed system and the process does not affect the environment.

The community acceptance, the operators of small biomass power plants need to conduct community public hearings to ensure community acceptance before setting the power plants. The community acceptance is an important factor of the power plants. The operators need to protect the community against the power plant project by public relations, promote the project to the community, and explain the details of operations to them for good understanding.

The skills and abilities of the employees, the technical operation of power plants need the skill and ability of employees to solve problems on the working processes to be successful.

The location of setting the power plants, on the set up of the power plants, the operators need to select the location that is near the biomass resources, water resources, and grid lines.

The distance of delivery of biomass fuel, the distance of delivering biomass is important to the biomass power plant, if the power plant is very far from the biomass resource, then the cost of delivery is very high and affects the operation costs.

The government subsidies, the government subsidies are important factors to the operation of biomass power plants. The government has many policies to support the operators, for example, the adder to add more value on the purchase price.

The regulations and laws, the regulations and laws related to the operation of small biomass power plants are complex. The operators need to submit many documents for each allowance. The operators need to follow many steps and many sectors for summiting the allowance.

The supply chain management, the intergrade supply chain is very important to the management of power plants. The operators should management the chain from upstream to downstream. The operators should promote energy trees to have more biomass to support as fuel to sell to the power plant.

Part 4: The Effectiveness of Small Power Plants

The financial effectiveness, normally, the power plants that are successful have their own biomass resources. If they do not have their own biomass, they will not be successful.

The environment effectiveness, the success of biomass power plants to the environment are the recycling of the agricultural waste, to reduce carbon monoxide, to reduce the imported energy quantity from abroad, to promote the alternative energy in the community, to strengthen the energy in the community and to reduce global warming.

The community effectiveness, the success of biomass power plants to the community is an increase of income among the members in the community, to distribute the income, and to create more careers.

Interviewer: Mr. Monthon Vasuvaranich,
The executive of Energy for Environment foundation, Energy for Environment Foundation

Date of Interview: June 14, 2016

Part 3: The Important Factor Affecting the Effectiveness of Small Biomass Power Plant

The government subsidies, the government subsidies are important factors to the effectiveness such as the adder purchase price. If the government sets up the purchase of electricity units at low prices, the biomass is valueless. However, when many power plants are running they need a lot of biomass, and the biomass prices rise substantially.

The availability of the equipment network and transmission lines, If the availability of the equipment networks and transmission lines are complete then there will be support for the biomass power plant operation.

The regulations and laws, the regulations and laws related to the operation of small biomass power plants are complex. The government should support the operators by adjusting the regulations and laws to comply with the support on the generation of the electricity from biomass.

Biomass fuel, Biomass fuel is a very important factor because it is the main fuel to produce the electricity units. The operators need to control the quality and quantity to support the production time in the power plant.

The community acceptance, the community acceptance is a key success of the power plant operation. When the operator will set up the power plant, the community may be concerned about the pollution effects from the power plant operation. The operators need to announce the project to the community publicly for better understanding.

The location of setting the power plants, the location of power plants should be near the biomass resources, water resources, and grid lines.

Part 4: The Effectiveness of Small Power Plants

The financial effectiveness, normally, the investment in the biomass power plants is very good on returns. The success of the power plant depends on their operator’s potential.

The environmental effectiveness, the success of biomass power plants to environment are the recycling of the agricultural waste.

The community effectiveness, the success of biomass power plants to the community is to increase the income of members in the community, to distribute the income, and to create the career.

Part 2: In-Depth Interview Issues from the Experts on Small Biomass Power Plants & Government Agencies

Interviewer: Mr. Yai Saithai
The president of Supreme Renewable Energy Company Limited
Date of Interview: May 12, 2016

Part 3: The Important Factors Affecting the Effectiveness of Small Biomass Power Plants.

Technology for producing the electricity, this is an important factor that affects the company's production. The company focuses on developing the Gasification technology to generate electricity. The gasification consists of the gas production, cleaning, and power engineering. There is closed system that does not affect the environment.

Biomass fuel, this factor is important, as it is the main fuel of the operation.

The skills and abilities of employees, gasification is a sensible system, but the operation system requires the attention of the staff. The working system requires a knowledgeable employee who understands how the process works, has adequate ability to solve problems, and can effectively use their skill and ability on technical terms.

The management in the power plant, the management on the process of working with the fuel management, the planning on the working processes and the management of the techniques and technical terms is critically important.

The community acceptance, the community acceptance is important even before building the power plants. The operators need to explain the information about both benefits and effects to the community. For example ‘Our company has a commitment with the community to save the environment.' 'In case our operations affect the environment and the community complaint, we will close the operation system.'

The local politics, the local politics may have an effect on the set up of the biomass power plant. The operators need to explain the objectives, the benefits, and the effects to the local public sectors.

The subsidies for the government, the government supports the small biomass power plants with an adder purchase price, funding support, and tax exemption, etc. This factor is important to the power plant.

The location, the operators need to select the location of the factory to comply with the utilities, the transmission lines, the supporting area, and the biomass resources.

Part 4: The Effectiveness of Small Power Plants

The financial effectiveness, our operations of the prototype power plant is not financially successful because the production capacity is only 150 kW, the figures on the account are not good.

The environmental effectiveness, the benefits from our operation to the environment are to reduce the burning of agricultural waste in the open areas that effect the air pollution, to recycle waste, and to reduce carbon monoxide.

The community effectiveness, the benefits to the community are to create careers in the community, to increase the income from buying the biomass from the members in the community and to recycle waste in the community.

Interviewee: Mr. Aphipong Vitchuvetkamine
The executive representative from The Sahacogen Group
Power plant in Khamphangpet and Lumpun

Date of Interview: May 17, 2016.

Part 3: The Important Factors Affecting the Effectiveness of Small Biomass Power Plants.

Acceptance from the community, Community acceptance is an important factor in the operation of biomass power plants. Establishing biomass power plants requires the community understanding and acceptance of the biomass power plant project.

Biomass Fuels, biomass fuels are a very important factor. Fuel must be stable, and sufficiently delivered to the power plant for continued operation.

Technologies used to produce the electricity, the company survey of biomass fuel and design of the technology used is critical. The company should decide if the suitability of technology and the kind of biomass fuel, the cost of operation and the capacity of technology would support the variety of biomass fuel.

The skills and abilities of employees, when operations of the power plant find there are not enough highly skilled employees the company can select experts from the mother company to work with the local employees.

The location of the power plant, the location is an important factor to the power plant. The location selection needs to comply with the biomass resources, the distance of delivery of the biomass fuel to the power plant, the transportation systems, the grid lines, and the public utilities.

The government support policies, the power plant operation needs to depend on the government support policies. Currently, the government changes the purchase price of the Feed-in tariff or the fixed price to support the small power plants.

Part 4: The Effectiveness of Small Power Plants

The financial effectiveness, the financial performance of the small biomass power plants is not quite good when compared to other kinds of businesses.

The environmental effectiveness, the company needs to control the environmental pollution, for example, the air, noise, and water control. The benefits of operation to the environment are to reduce the burning of biomass waste in the open areas and to add value to biomass for added income to members in the community.

The community effectiveness, the benefits to the community are to create careers in the community, to increase the income of farmers by buying the biomass from the members of the community, to support the activities in the community.

Interviewee: Mr. Sothana Pheamchart
The executive from Khunpat Peang Power plant
Date of Interview: May 25, 2016.

Part 3: The Important Factors Affecting the Effectiveness of Small Biomass Power Plants.

Biomass Fuel, biomass fuel is an important factor to the power plants. This biomass factor is the most difficult factor to control. Therefore, in the operation of the power plant, it is necessary to focus on the biomass that will be used as fuel for electricity generation.

Technology to generate the electricity units, we use fumigation to change biomass to electricity as these technology is more stable than other technologies used in small power plant.

The skills and abilities of employees, on the operation in power plants; we can train our workers with on the job training to have more skills and higher ability. Normally we have our standard and systematic style in place on the working process.

The management, the management of the power plant process is the control factor, as the design of the technology, the fuel management, and the human management are all variables of the plant process. Skilled management is needed for work to be done efficiently.

Part 4: The Effectiveness of Small Power Plants

The financial effectiveness, we have successful finance performance, because the working process and technology is stable. We have good financial portfolio performance. The return of investment is within 3-5 years.

The environmental effectiveness, we use the fermentation system to produce electricity, we have some smell pollution which affects the community, however we do solve all problems that affect the community.

The community effectiveness, the benefits to the community are to create careers in the community and to support the activities in the community.

Interviewee: Mr. Phamin Sawetsira
The executive of Asia Green Power Company Limited
Date of Interview: May 26, 2016

Part 3: The Important Factors Affecting the Effectiveness of Small Biomass Power Plants.

The skill, knowledge and experience of employees and executives, the decision making of the executives to invest in the power plant is very important. They have to make decisions of investment based on their knowledge and experience in the biomass power plant operation.

Technology to generate the electricity in power plants, the operators need to choose the right technology for the best return. If they should use the wrong technology, the company may lost. The gasification systems in Thailand are not stable, we have to import the engines from overseas then modify them to match with biomass types in Thailand.

The regulations and laws, the operators need to understand all regulations and laws related to the set up and operation of biomass power plants. If they do not understand the regulation and laws clearly, the process of gathering and completing documents may exceed planned time allowances.

Biomass fuel, on the operation of production of electricity, the power plant uses a lot of biomass fuel. If the power plant does not have their own biomass resources, they may be faces with a biomass scarcity situation. Our company has our own biomass fuel as we plant a lot of energy trees.

The location of power plants, the location should be near the biomass resource, the public utilities, and the grid lines.

The crude oil price, the crude oil price varies which affects the cost of operation**.**

Part 4: The Effectiveness of Small Power Plants

The financial effectiveness, during our first stage of production, we did not have successful financial performance.

The environmental effectiveness, our company grows trees surrounding the power plant, the trees can protect the community from the noise of operations.

The community effectiveness, the benefits to the community are to create careers in the community, to support the community with by-products from the power plant, and to support the activities in community.

Interviewee: Ms. Jaruwan Khansonkit
The secretary of the executive of Evergreen Plus Company Limited
Date of Interview: June 1, 2016

Part 3: The Important Factors Affecting the Effectiveness of Small Biomass Power Plants.

The executive vision, the executive vision is a very important factor to operate the biomass power plant.

The skills and ability of employees and the executives, the power plant operation needs the skills and ability of employees as well as knowledgeable executives to solve problems on the working process.

Biomass feedstock, This factor is important as the fuel of production. The company needs to prepare the biomass feedstock to support the production in the power plant.

Technology for generating the electricity, the small biomass power plant needs the closed technology that is safe and friendly to the environment.

The government support policy, this factor is to motivate the private sector to invest in the biomass power plant project. The government support policies are the adders, tax exemption, and so on.

The availability of equipment and grid lines, this factor is very important to the power plant. We sell the electricity through the transmission lines. If the equipment and grid lines are not ready to use, the power plants needs to restart the operation process which makes more costs of operation.

Part 4: The Effectiveness of Small Power Plants

The financial effectiveness, the success of the finance depends on the government subsidies. If we have more adder price, we will have more profit margins.

The environmental effectiveness, the success of power plant operations on the environment are to reduce the waste, to reduce burning in the open areas that cause air pollution, to support the members in the community, to plant the fast growing trees, and to reduce carbon monoxide.

The community effectiveness, the benefits to community are to create careers in the community, to support the community with by-products from the power plant, and to support the activities in the community.

Interviewee: Mr. Phudit Maneechot
The executive from Maxwell Company Limited and BanHun Group
Date of interview: June 1, 2016

The knowledge and ability of managers and employees, this factor is a key to the success of power plant operation. The process should be designed by the experts. The consultants of the power plant project have the knowledge and skills of working.

Knowledge development, employees should develop their knowing of the working process, for example, try to solve all problems and innovate the new products and methodologies.

Biomass fuel, biomass fuel is very important, as it is the fuel of the production process. The operators need to prepare the biomass fuel to be available constantly during the production period.

Technology to produce the electricity, the company needs to develop the technology to be stable and efficient during the production time.

The government subsidy, the government subsidies to the small power plants are The adder and Feed-in tariff.

Part 4: The Effectiveness of Small Power Plants

The financial effectiveness, our company has successful financial performance. We have short times of returns of investment at 3-4 years. We have a lot of profit every year.

The environmental effectiveness, the efficacious operation of the power plant to the environment is to reduce the waste and to reduce burning in the open areas that causes air pollution.

The community effectiveness, the benefits to the community are to create careers in the community, to support the community with by-products from power plant, and to support the activities in the community.

Interviewee: Mr. Vasan Vongraj, The Vice President of the Power plant.
The executive representative from The MITR small power plant Group.

Date of interview: June 11, 2016

Part 3: The Important Factors Affecting the Effectiveness of Small Biomass Power Plants

The executive vision, the executive vision is a very important of the power plant operation. The executive comments on the renewable energy "increase the technology development to use biomass as fuel to produce electricity, and the safety of the community." "Our mission is to increase renewable development to create the innovation and increase creativity within the community."

The organizational culture, the executives are cultivated in the corporate culture for the development of excellence, educational development, technology development, and CSR to the community.

The technology to produce electricity units, the implementation of biomass power plants need proper technology. The technology should match with the biomass being used. We are a success because we have developed technology and innovated continuously.

The skill and ability of employees, our company focuses on human development. We have the funding to support our employees to study and have seminars both in Thailand and abroad.

The initial project design, this factor is very important. If the initial project is designed from the expert consultancy, the project will likely be a success. The initial project design should come from the knowledge and the truth of working details.

The knowledge development, when working in the biomass power plant it is imperative to address problems, improve performance, develop knowledge and technology to be more efficient and increase the return on investment.

Part 4: The Effectiveness of Small Power Plants

The financial effectiveness, we are a success because we have our own biomass fuel resources. In case the independent power plant does not have their own biomass fuel it will be hard to succeed.

The environmental effectiveness, we concern ourselves with the environmental pollution. We use ISO 14001 to control our environment. We also use Zero Waste Management systems. The success of the biomass power plant to the environment is to recycle the waste, to reduce the imports of fuel from abroad, and to reduce carbon monoxide.

The community effectiveness, the benefits to the community are to create careers in the community, to financially support to the power plant's surroundings, and to support the activities in the community.

Interviewee: Mr. Thanet Masanthi
The factory manager of Plan Econergy Company Limited

Date of interview: June 13, 2016

Part 3: The Important Factors Affecting the Effectiveness of Small Biomass Power Plants.

Biomass fuel, this factor is very important as it is the main fuel in the production process. The biomass is prepared to support the factory in large amounts of tones per year.

Technology, the operators need to choose the appropriate technology to produce the electricity, is should be good match with the biomass types found in the local area. The Gasification technology has a more detailed operation process than others.

Skills and abilities of the employee, as I claimed, the gasification technology has more details about the operation, the employees need to have knowledge, skills, and the ability to solve all the problems that may occur on the working process.

The community acceptance, when the operator of power plant sets up the plant, the community concern the operation of the power plant may affect their conduct. The operators need to publicly announce the details of working at the power plant to the community to make them understand the power plant.

The location of power plant, the location of the power plant should be near a water supply, biomass resource, and grid lines.

The initial project, the design of the working process and technology of the initial project is very important. The initial project needs to be designed from an expert consultant. If the initial project is workable then there will be efficiency and effectiveness.

Part 4: The Effectiveness of Small Power Plants

The finance effectiveness, the success of the financial strength will be seen in the long term. At first, we have to adapt the technology and the engine for the production process.

The environmental effectiveness, we concern ourselves with waste to be uses as recycled materials for the fuel to produce electricity.

The community effectiveness, the benefits to the community are to create careers in the community, to buy biomass from the community, to be the learning center of renewable energy, and to support the community activities.

Interviewee: Mr. Somnuk JindaSab
Deputy of Rachaburi Holding Company Limited
Date of interview: June 13, 2016

Part 3: The Important Factors Affecting the Effectiveness of Small Biomass Power Plants.

Biomass fuel, the biomass fuel is very important to the power plant operation. The operator needs to manage the biomass to be enough for the operation during peak times and to control the cost of the biomass.

The community acceptance, this factor is the key success of the power plant operation. The operators need to publicly inform the community for their acceptance. The community is concerned with the effects of their quality of life, and the sustainability of their economic benefit.

The location of the power plant, the operators need to select the location to set the power plant. The location needs to be near the water, the grid lines, and the public utilities.

The government subsidies, the government subsidy policy should be clear for the operators of biomass power plants. The government policy should be supportive of private practices.

Part 4: The Effectiveness of Small Power Plants

The financial effectiveness, we have successful financial performance. Our cash flow is quite good. The return of investment is of a short period.

The environmental effectiveness, the success of power plant operation to the environment is the operation balancing the carbon monoxide.

The community effectiveness, the benefits to the community are to reduce the fuel imports from aboard and to reduce the burden of compensation for agriculture. When the government can reduce the burden on both sides, it will have a tremendous amount of money. The money should be to cause the circulation in the economy, to distribute the wealth more evenly between private individuals and the community, and to ensure sustainability of the community.

Interviewee: Mr. Navaphon Disatheian
Date of interview: The executive of Songkhla Biomass Company Limited
Date of interview: June 16, 2016

Part 3: The Important Factors Affecting the Effectiveness of Small Biomass Power Plants.

The initial project design, the initial project investment should be designed by a professional team of experts of the biomass power plant operation.

The community acceptance, the community acceptant is an important factor to operate the biomass power plant. We have a good relationship with the community as we have joined the activities and trust each other.

The biomass fuel, the biomass fuel is the main fuel in the production process. We have to manage the biomass to be enough for running the operation when necessary, to control the cost of the biomass, to keep the volume of biomass going continuously.

The skills and abilities of employees, the operation of the biomass power plant needs skills and abilities to solve working process issues and technical problems on the production process.

The location of the power plant, we need to select the location that is ready to set-up, for example, a location near the grid lines, a special area that has more support and so on.

The organizational culture, the organization culture comes from the mother company, as the commitment, the philosophy of working, and the building of team work.

Part 4: The Effectiveness of Small Power Plants

The financial effectiveness, we are a success of financial performance. Our cash flow is quite good. The return of investment is of a short period.

The environmental effectiveness, the success of the power plant operation to the environment is to recycle the agricultural waste and control the pollution of the operation process as to **not** affect the environment.

The community effectiveness, the benefits to the community are to buy the biomass from the community members, to hire the members from community, and to support the community activities.

APPENDIX B

QUESTIONAIRE

QUESTIONAIRE

The Effectiveness of Small Biomass Power Plants in Thailand From Resource-based View and Resource Dependence Theory

Introduction

This questionnaire is being used to collect data, which is part of a dissertation for a doctor of philosophy (Ph.D) degree presented at the school of Public Administration, National Institute of Development Administration (NIDA), by Kwunjai Chotsuwan. The contents of individual questionnaires will not be divulged nor will the identities of those completing them.

The objectives of the study are to study and establish a model of the relationship between the factors that influence the effectiveness and effectiveness of small biomass power plants. The data will be used only for academic purposes and it is not an evaluation of you or your department or organization. The answers of these questionnaires will be reported in terms of statistical summaries of overall organization, not individuals.

Please complete the questionnaire to the best of your knowledge and please answer all questions.

Thank you very much,
Kwunjai Chotsuwan

Section 1: The general information of small power plants

1. What is your Job title?

☐ The executive ☐ The power plant manager ☐ The general manager

☐ Other (please specific)……….

2. What kind of biomass fuel is used in electricity generation?

☐ Corncobs ☐ sugar cane ☐ cassava root ☐ wood chip ☐ husk

☐ Palm fiber and palm shell ☐ water recycling on the product process

☐ Other (please specific)………

3. What is the source of biomass fuels used in electricity?

☐ The power plant has their own biomass resource

☐ The power plant buys the biomass from others

☐ The power plants have their own biomass resources and buy the biomass from others

4. What is the amount of biomass used in electricity generation per day?

☐ 1 ton-10 tons ☐ 10 tons-20 tons ☐ 20 tons-30 tons

☐ 30 tons-40 tons ☐ 40 tons-50 tons ☐ more than 50 tons per day

5. What is your production period per day?

☐ Less than 5 hours ☐ 5 hours-8 hours ☐ 8 hours up -12 hours

☐ 12 hours up -16 hours ☐ 16 hours – 24 hours

6. What kinds of technology are used to generate electricity?

☐ Thermo ☐ Gasification ☐ Fermentation ☐ other (please specific) …………..

7. What kinds of extra support of electricity generation from biomass are used at your power plant?

☐ Adder ☐ Feed-in Tariff ☐ Tax exempt from Board of Investment (BOI)

☐ Corporate tax exemption ☐ other (please specific) ………………….

8. What kinds of Power Purchase Agreement-PPA is your power plant under?

☐ Power Purchase Agreement-PPA: Firm

☐ Power Purchase Agreement-PPA: Non-Firm

☐ other (please specify) …………..

Section 2: The important factors affecting the effectiveness of small power plants. Please remark ☑ on the column that is exactly of your opinion. The columns are separated into 5 columns, strongly agree, mostly agree, moderately agree, less agree, and don’t agree.

The important factor affect the effectiveness of small power plant	**Opinion level**				
	strongly agree (5)	**mostly agree (4)**	**moderately agree (3)**	**less agree (2)**	**don’t agree (1)**
9. Your power plant is well supported by the government.					
10. The government support affects the success of your power plant.					
11. The regulations and laws are very suitable for your power plant operation.					
12. The steps of the regulation and laws are very suitable for your power plant operation.					
13. The step of allowance are convenient for your plant to prepare documentation for its operation.					
14. The initial project of investment is important to your power plant.					
15. The initial project of investment from an expert consultant is very important to your power plant.					
16. The biomass fuel preparation is very important to your power plant.					
17. The price of biomass fuel is very important to your power plant operation cost.					
18. Finding alternative biomass fuels to replace the scarce biomass fuels is important to your power plant.					

The important factor affect the effectiveness of small power plant	**Opinion level**				
	strongly agree (5)	**mostly agree (4)**	**moderately agree (3)**	**less agree (2)**	**don't agree (1)**
19. Your power plant can use a variety of biomass fuels to generate electricity.					
20. Your power plant can control the quantity of biomass as needed.					
21. Your power plant can control the price of biomass used.					
22. Your power plant needs to buy biomass from other sources, such as farmers, middlemen, etc.					
23. Your power plant can change the biomass fuel supplier to meet the needs of biomass fuel.					
24. Your power plant depends on other distant sources of biomass fuel.					
25. Your power plant has an increased operating cost from biomass fuel transportation.					
26. The technology used to generate the electricity unit is the most effective.					
27. The technology used to generate the electricity unit can reduce operating costs.					
28. The technology used to generate the electricity unit is worth the investment to your biomass power plant project.					
29. Your power plant has a management model to solve the problems of power generation.					
30. A management model in your power plant can solve the problem of power generation very successfully.					

The important factor affect the effectiveness of small power plant	Opinion level				
	strongly agree (5)	**mostly agree (4)**	**moderately agree (3)**	**less agree (2)**	**don't agree (1)**
31. Your employees use their skills and abilities to solve the problems that occur in their work.					
32. Your employees present the working methods that can reduce operation costs.					
33. Your power plant is focused on developing employees to gain knowledge and expertise.					
34. Your power plant location has easy access to biomass fuel.					
35. Your power plant location has easy access to the grid lines.					
36. Your power plant location has easy access to public utilities, a water resource, labor, and transportation.					
37. The executive is committed to the development of biomass power generation.					
38. The executive is committed to solve problems of biomass power generation.					
39. Your power plant supports employees to develop their knowledge related to biomass power generation.					
40. Your power plant encourages employees to further their education in the field of biomass-related power generation.					
41. Your power plant is developing technologies and knowledge related to biomass power generation.					
42. Your power plant instills a lot of value in working with employees.					

The important factor affect the effectiveness of small power plant	Opinion level				
	strongly agree (5)	**mostly agree (4)**	**moderately agree (3)**	**less agree (2)**	**don’t agree (1)**
43. Your employees give priority to solving problems together.					
44. Your employees are fully cooperative on the working process.					
45. Your power plant encourages farmers to grow energy crops or other plants that can be used as fuel for power plants.					
46. Your power plant is promoting the increase in the value of agricultural products that can be used as waste fuel for electricity generation.					
47. The community accepts your power plat setting.					
48. The community accepts your power plat operation.					
49. The community supports your power plant operation.					
50. The equipment connection of the power supply can be connected to the transmission system very well.					
51. The public sector can solve all problems related to the defect of equipment of transmission.					
52. The equipment maintaining the connection of the power supply is stable all the time.					
53. Your power plant is very convenient to connect with a power supply to the power transmission system.					

The important factor affect the effectiveness of small power plant	**Opinion level**				
	strongly agree (5)	**mostly agree (4)**	**moderately agree (3)**	**less agree (2)**	**don't agree (1)**
54. Your power plant can quickly link the power supply to the transmission lines.					
55. The transmission lines of the power supply system can support the transmission from your power plant at all times.					
56. The conditions and terms of the power purchase agreement are reasonable.					
57. The time constraints of the power purchase agreement are reasonable.					
58. The change of crude oil price affects your operation costs.					
59. In establishing your power plant, it takes time to publicize the project to the sub district or municipal administration in order to gain acceptance of the power plant project.					
60. Your power plant has been facilitated by the sub district or municipal administration for permission.					
61. The sub district or municipal administration are supportive to solve problems if your power plant receives unjustified complaints or problems related to government agencies.					

Section 3: The effectiveness of small power plants.

Please remark ☑ on the column that is exactly accurate of your opinion. The opinions are separated into 5 columns, strongly agree, mostly agree, moderately agree, less agree, and don't agree.

The effectiveness of small power plants	**Opinion level**				
	strongly agree (5)	**mostly agree (4)**	**moderately agree (3)**	**less agree (2)**	**don't agree (1)**
62. Your power plant has good financial performance.					
63. Your plant has good cash flow and financial performance.					
64. Your power plant has a quick payback period.					
65. Your power plant reduces the biomass waste from burning in open ares by buying the biomass from farmers.					
66. Your power plant reduces the rate of burning of waste in open areas.					
67. Your power plant has pollution control measures that affect the environment, such as air pollution, water and noise.					
68. Your power plant supports the employment of community workers in the area surrounding the power plant.					
69. Your plant supports the purchase of biomass from surrounding communities.					
70. Your power plant supports community activities.					

Section 4: Your suggestions (if you may have suggestion for this study)

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THANK YOU

APPENDIX C

STATISTICAL REPORT

Exploratory Factor Analysis Result: KMO and Bartlett's Test

KMO and Bartlett's Test	
Kaiser-Meyer-Olkin Measurement of Sampling Adequacy	0.782
Bartlett's Test Of Sphericity	
Approx. Chi-Square	8974.286
Df	1378
Sig	0.000

Exploratory Factor Analysis Result

Indicators	Factor							
	1	2	3	4	5	6	7	8
Grid1	0.910							
Grid2	0.907							
Access2	0.844							
Access 3	0.810							
Access 1	0.779							
Grid 3	0.741							
Admin1		0.837						
Admin 2		0.826						
Skill1		0.729						
Skill2		0.635						
Skill3		0.584						
Reg2			0.766					
Reg1			0.723					
Subsidy1			0.607					
Subsidy2			0.600					

PPA2			0.556					
PPA1			0.530					
Commu2				0.874				
Commu 3				0.860				
Indicators	**Factor**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
distant1					0.884			
distant2					0.825			
Depend1					0.742			
Depend2					0.505			
Value1						0.785		
Value2						0.731		
Vision2						0.661		
Vision1						0.514		
Loca1							0.771	
Loca2							0.759	
Loca3							0.730	
Scm1								0.720
Scm2								0.650
Corp								0.655
BioFuel1								0.622
BioFuel2								0.600

Remark: Factor loading less than 0.5 were depressed.

Outlier Report

Observation number	Mahalanobis d-squared	p1	p2
18	60.975	.002	.317
173	59.926	.003	.090

Observation number	Mahalanobis d-squared	p1	p2
174	55.976	.008	.149
1	54.832	.010	.099
75	54.272	.011	.051
74	52.788	.016	.064
128	52.321	.018	.038
12	52.079	.019	.018
22	50.462	.026	.047
136	50.222	.028	.027
37	49.725	.031	.023
50	49.587	.032	.012
176	49.319	.034	.007
100	48.785	.038	.008
101	48.785	.038	.003
166	48.211	.042	.004
167	48.211	.042	.002
25	47.923	.045	.001
95	47.512	.049	.001
93	47.460	.049	.001
94	47.460	.049	.000
153	47.419	.050	.000
111	47.267	.051	.000
3	47.124	.053	.000
9	46.697	.057	.000
175	46.633	.058	.000
55	46.575	.059	.000
116	46.570	.059	.000
151	46.504	.060	.000
152	46.504	.060	.000
17	46.233	.063	.000
154	46.048	.065	.000
126	44.986	.080	.000
127	44.986	.080	.000
14	44.602	.086	.000
70	43.128	.112	.000

Observation number	Mahalanobis d-squared	p1	p2
71	43.128	.112	.000
45	42.984	.114	.000
131	42.710	.120	.000
132	42.710	.120	.000
162	42.343	.128	.000
163	42.343	.128	.000
104	42.249	.130	.000
105	42.249	.130	.000
139	41.945	.137	.000
140	41.945	.137	.000
114	41.811	.140	.000
115	41.811	.140	.000
20	40.883	.163	.000
135	40.880	.163	.000
16	40.358	.177	.000
54	40.141	.183	.000
52	39.929	.189	.000
49	39.565	.200	.001
43	38.759	.226	.006
44	38.759	.226	.004
164	38.417	.237	.006
73	38.406	.238	.004
129	37.954	.254	.011
130	37.954	.254	.007
177	37.815	.259	.007
51	37.422	.273	.015
53	36.591	.306	.086
27	35.236	.363	.542
28	35.236	.363	.480
47	35.220	.363	.425
48	35.220	.363	.365
46	35.077	.370	.373
158	34.610	.391	.541
159	34.610	.391	.479

Observation number	Mahalanobis d-squared	p1	p2
10	34.232	.408	.606
7	34.135	.413	.594
137	34.063	.416	.570
23	34.004	.419	.539
31	33.935	.422	.513
32	33.935	.422	.453
61	33.896	.424	.413
62	33.896	.424	.355
72	33.090	.463	.697
150	32.797	.477	.772
172	32.797	.477	.724
11	32.212	.506	.888
63	31.914	.521	.928
64	31.914	.521	.905
108	31.403	.547	.968
109	31.403	.547	.955
110	31.403	.547	.939
68	31.381	.548	.923
69	31.381	.548	.899
2	31.256	.554	.903
106	31.109	.561	.910
107	31.109	.561	.884
165	30.840	.575	.921
21	30.775	.578	.911
138	30.556	.589	.933
26	30.027	.616	.981
8	29.935	.620	.980
65	29.741	.630	.985
89	29.449	.645	.992
90	29.449	.645	.988

BIOGRAPHY

NAME	Miss Kwunjai Chotsuwan
ACADEMIC BACKGROUND	Bachelor of Business Administration, 1991 Ramkhamhaeng University, Bangkok, Thailand Master of Business Administration, 1995 Murray State University, Kentucky, USA
EXPERIENCE	Manager at Supreme Renewable Energy Company Limited Marketing Manager at Dr. Ed & Toys Company Limited Marketing Analysis at NTS Steel Group Management Trainee at Linville Group