A STUDIES ON THE APPROPRIATE ELECTRICITY MANAGEMENT OF KOH CHICK ISLAND, KHLUNG DISTRICT, CHANTABURI PROVINCE

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Thesis
Entitled

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A STUDIES ON THE APPROPRIATE ELECTRICITY MANAGEMENT OF KOH CHICK ISLAND, KHLUNG DISTRICT, CHANTABURI PROVINCE.

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ABSTRACT

The objective of this research was to study the energy management of Koh Chick Island in Chantaburi Province. Future electricity demand and generation needs were forecasted and appropriate electricity management systems were considered.

To gain insight into future electricity demand, the existing electricity consumption in Koh Chick island was studied by employing an electricity consumption questionnaire. The result of the study was later forecasted by using LEAP software. For future electricity generation system alternatives SWOT analysis was used to identify the most effective electricity generation system.

The research has shown that the electricity demand of Koh Chick will increase at average rate of 0.0165% a year, rising from 64,519 kWh in 2007 to 83,661 kWh in 2023. For the future electricity generation, the wind turbine system generates up to 11,367 kWh a year. The solar cell system generation rate will decrease at the rate of 0.5% a year, declining from 10,605 kWh in 2007 to 9,741 kWh in 2023. Electricity generated by diesel engines has a decrease rate of 0.75% a year, decreasing from 89,351 kWh in 2007 to 78,375 kWh in 2023. The diesel generator is a major system to generate electricity. The tendency of diesel fuel prices will increase at the rate of 0.046% a year increasing from 28.74 Baht in 2007 to 48.35 Baht in 2023. Given three results, the electricity generation system will be increased the production cost. Therefore, the solar cell system is recommended as the most appropriate to be used in Koh Chick Island.

KEY WORD: GENERATOR PATTERN/ HYBRID RENEWABLE ENERGY/ APPROPRIATE ELECTRICITY MANAGEMENT

108 P.

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การศึกษารูปแบบการจัดการพลังไฟฟ้าที่เหมาะสมของบ้านเกาะจิก อำเภอขลุง จังหวัดจันทบุรี
(A STUDIES ON THE APPROPRIATE ELECTRICITY MANAGEMENT OF KOH CHICK ISLAND, KHLUNG DISTRICT, CHANTABURI PROVINCE)

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บทคัดย่อ

การวิจัยครั้งนี้ มีวัตถุประสงค์เพื่อศึกษารูปแบบการผลิตพลังงานของหมู่บ้านเกาะจิก เพื่อคาดการปริมาณการผลิตและการใช้พลังงานไฟฟ้าของชุมชนบ้านเกาะจิก และเพื่อเสนอระบบการจัดการพลังงานไฟฟ้าที่เหมาะสมของบ้านเกาะจิก

วิธีการศึกษา ประกอบด้วย การใช้แบบสอบถามเกี่ยวกับเครื่องใช้ไฟฟ้าที่มีใช้งานในปัจจุบันและความต้องการในอนาคต มาวิเคราะห์ด้วยโปรแกรม LEAP. เพื่อพยากรณ์ความต้องการไฟฟ้าในปี 2550-2566 คาดการณ์การผลิตไฟฟ้าของระบบผลิตตั้งแต่ปี 2550-20566 หาผลประกอบการของสำนักงานพลังงานทดแทนบ้านเกาะจิก และหาระบบพลังงานทดแทนที่เหมาะสมกับบ้านเกาะจิก โดยใช้หลักการวิเคราะห์ SWOT ซึ่งมีผู้เชี่ยวชาญ 5 ท่านเป็นผู้ประเมินเทคโนโลยีพลังงานทดแทน

ผลการศึกษา พบว่าความต้องการไฟฟ้าในอนาคตเพิ่มขึ้นในอัตรา 0.0165% ต่อปี ในปี พ.ศ. 2550 มีความต้องการไฟฟ้า 64,519 kWh และปี พ.ศ. 2566 มีความต้องการไฟฟ้า 83,661 kWh การคาดการณ์ระบบผลิตไฟฟ้าพบว่า ระบบพลังงานลมผลิตไฟฟ้าคงที่ 11,367 kWh ต่อปี ระบบพลังงานแสงอาทิตย์ผลิตไฟฟ้าลดลงในอัตราร้อยละ 0.5 ต่อปี ในปี พ.ศ. 2550 สามารถผลิตพลังไฟฟ้าได้ 10,605 kWh และปี พ.ศ. 2566 สามารถผลิตไฟฟ้าได้ 9,741 kWh และระบบดีเซลเจนเนอเรเตอร์ ผลิตไฟฟ้าลดลงในอัตราร้อยละ 0.75 ต่อปี ในปี พ.ศ. 2550 สามารถผลิตไฟฟ้าได้ 89,351 kWh และ ปี พ.ศ. 2566 สามารถผลิตไฟฟ้าได้ 78,375 kWh ซึ่งระบบผลิตไฟฟ้าสามารถผลิตไฟฟ้าพอเพียงกับความต้องการ แต่เนื่องจากระบบดีเซลเจนเนอเรเตอร์เป็นระบบหลักในการผลิตไฟฟ้า มีค่าใช้จ่ายน้ำมันเชื้อเพลิงที่เพิ่มขึ้น ในอัตรา 0.046% ต่อปี ในปี พ.ศ. 2550 ราคาน้ำมันดีเซล 28.74 บาทต่อลิตร และในปี พ.ศ. 2566 ราคาน้ำมันดีเซล 48.35 บาท ส่งผลต่อการบริหารจัดการ ดังนั้นรูปแบบที่เหมาะสมคือจำกัดการใช้ไฟฟ้าตามมาตรการและแผนการจัดการไฟฟ้า และเพิ่มระบบพลังงานแสงอาทิตย์

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LIST OF ABBREVIATIONS

A	Ampare
AC	Alternating Current
Ah	Amp hour
CD	Compact Disc
DC	Direct Current
DEDE	Department of Alternative Energy and Energy Efficiency
DVD	Digital Video Dise
ESCO	Energy Service Company
hr	Hour
kW	Kilo Watt
kWh	Kilo Watt Hour
kWp	Kilo Watt Peak
KMUTT	King Mongkut University of Technology Thonburi
LEAP.	Long range Energy Alternatives Planning System
PV	Photovoltaic
SWOT	Strengths, Weaknesses, Opportunities, and Threats
V	Volt
VCD	Video Compact Disc
W	Watt

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CHAPTER I
INTRODUCTION

1.1 Background and Problem

Thailand still has communities which lag far behind advancement, compared to other countries, since most of them are located in conservative forests, islands, even remote rural areas. It is indispensable that these communities require the electricity for living, but in the light of its locations, it is hard to connect with electric stations. Consequently, residents of these communities must use the electricity from renewable energy; hence, The Thai government has tried to support the installation of solar cells by setting up PV array approximate 120 watt, which is enough for inhabitants to use for 2 fluorescent and a television within 4-5 hours a day (1). In the past, the technology of renewable energy, which has been used in remote areas, had many types, such as centralized PV battery charging stations. Although it has been installed nationwide in remote area, but still have a number of problems, for instance, using of electricity is limited to DC bad managing system, lacking of maintenance system, that will make the solar cells have short life time. It can be used only at certain time, not in 24 hours (2).

Mini-grid or Rural Electricity from Hybrid System has been researched and demonstrated in overseas, yet there are some troubles even though lots of parts of the system have been commercially developed. Those problems, which have affected the quality of service and endurance of the system, are not technical problems; it lacks of the proper and ample training for system controllers as well as technicians, there have not manuals in native language, some equipment was imported. In Thailand, since Mini-grid or Rural Electricity from Hybrid System can be applied in Thailand, King Mongkut’s University of Technology Thonbury (KMUTT) had installed hybrid system on Koh Chick, located in the gulf of Thailand, in Chantaburi province. It occupies 700 Rai, has 98 households–500 people. Almost of families used to using diesel generators producing electricity and storing energy in batteries, which effected

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on the nature and lives. More important, the expense of fuel is so costly, that the Energy Conservation Promotion Fund, Energy Policy and Planning Office have supported for KMUTT to design Mini-grid or Rural Electricity from Hybrid System in Koh Chick (3). There are following features, 7.5 kW for solar cells, 10 kW for wind, and 65 kW for diesel generator (4).

Koh Chick people have been using renewable energy hybrid system for more than 3 years. There are able to use it all day and night, especially they can use all electric appliances excepting air–conditioners. Koh Chick village hybrid power system office was set up its maintenance, management of finance and service system. Nevertheless, there are a number of problems coming from generating system.

The problems dealing with generating system, for instance, the electric equipment is out of order; that is, Inverter could not work for a long time, Koh Chick village hybrid power system office are not able to repair systems thus they have to wait for skilled technicians from KMUTT that it takes much time and cost for fix the system. In addition, the diesel generators are used for a long time; as a result, they are easily broken down and it consumed a great amount of oil.

The problems regarding villagers' consumption of energy, for example, using electric appliances increase and villagers consume the energy, spontaneously-approximate 5.00–8.00 a.m. and 18.00–22.00 p.m. Consequently, the need for energy is considerably required.

This research interest in study generate system and management pattern of the electricity of Koh Chick, which is propose to study on the appropriate controlling the use of energy and operating plans of the Koh Chick electricity system.

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1.2 Objectives

1.2.1 To forecast the quantity of electricity generation and the use of electricity at Koh Chick village,

1.2.2 To study the patterns of the production of electric energy (Energy Service Company: ESCO) at Koh Chick village,

1.2.3 To propose the system of appropriate electricity management for Koh Chick village.

1.3 Scope of study

1.3.1 Study area

The study area is Koh Chick village, the island where is located in Moo 1, Bangchan sub-district, Khlung district, Chanthaburi province. It occupies 700 rais and has approximately 500 residents, 100 families.

Figure 1-1 Location of Koh Chick village

Source: วารสารนโยบายพลังงาน. สำนักงานนโยบายและแผนพลังงาน. 2548 ฉบับที่ 67; 21

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1.3.2 Scope of the study

This research focuses upon three aspects as follows;

1) The electricity system management which set up by Koh Chick village hybrid power system office; the study use some available information of this office that consists of an amount of electricity generated and profit outcome from 2005 to presently 2007.

2) The situation of the electricity consumption forecasted the electricity demand of Koh Chick village for 17 years. The factors of the electricity consumption of Koh Chick village such as income, population, household as well as electric appliances, are available data used for forecasting by analysis the monthly electricity demand including regarding villagers' consumption data.

3) The development of electricity management, the information or data is mentioned as above (1, 2) are analyzed in order to conduct the appropriate electricity management for Koh Chick.

1.4 Conceptual framework

For better understanding of details of this research, the conceptual framework of thesis is summarized in the flow chart following Figure 1-2.

Firstly, analysis of electricity generation of hybrid system from 2007-2023 using efficiency of electric generate data such wind turbine, solar cells, and diesel generator,

Secondly, profit analysis of ESCO, Koh Chick hybrid power system office by account balance information from 2005-2007,

Thirdly, analysis of electricity demand of villager from 2007-2023 applying LEAP software,

Finally, applying SWOT analysis as a tool to conduct the appropriate electric generation system for Koh Chick.

Using all above approaches to conduct a measurement, electricity plan management, and appropriate electric generation system for developing the Koh Chick electricity system in including the efficiency system management.

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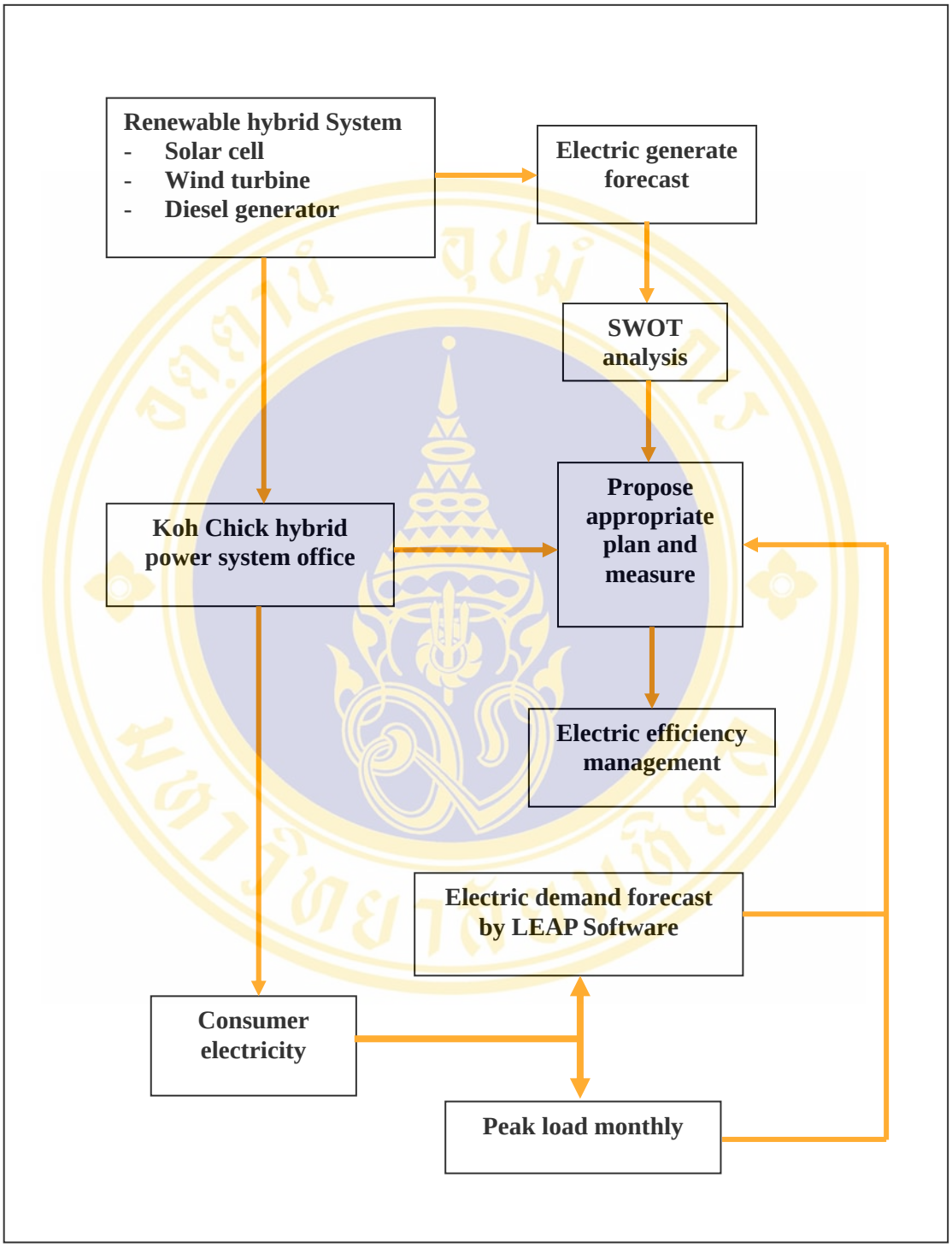

Figure 1-2 Conceptual frameworks

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1.5 Definition

1.5.1 Hybrid Electrification System means electricity generating system from renewable energy resources: solar cell, wind turbine co-operated with diesel generator.

1.5.2 Hybrid-diesel generator represents the diesel generator operated in the hybrid electrification system. Its capability is 50 kWA, 50Hz, 380/220V and 115,080 kWh/year energy generating.

1.5.3 Solar cell is the phenomenon change from solar power to electricity. In the hybrid systems opening, its maximum electric power and energy generating have capability 7.5 kWp and 9,644 kWh/year.

1.5.4 Wind turbine is the phenomenon change from wind power to electricity. In the hybrid systems opening, its maximum electric power and energy generating have capability 10 kW and 11,367 kWh/year.

1.5.5 Energy Service Company (ESCO) is a business that develops, installs, and finances projects designed to improve the energy efficiency and reduce maintenance costs for energy- consuming facilities over certain periods.

1.5.6 Energy management is activity that reduced quantity of used electricity, electricity demand and efficiency electricity manages. It is the design and the plan used electricity to be appropriate usability and have developed police of use electricity correctly. User has understanding that used less electricity but can attain demand.

1.5.7 Load is amount electricity pull from generator system apply follow electrical power of types electric appliances on Koh Chick village.

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1.6 Expected Results

1.6.1 Koh Chick village hybrid power system office can take results of this research to be develop a measure for electric management.

1.6.2 Koh Chick village saving be aware of energy, control using electricity and do not use overload their power.

1.6.3 The institute, which involve in producing electric energy in remote areas can apply the analysis pattern electric management pattern for more efficiency development on a measure of electric management.

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CHAPTER II
LITERATURE REVIEW

This research has studies on A Studies on the Appropriate Electricity Management of Koh Chick Island, Khlung District, Chantaburi Province. The researcher has reviewed a number of academic documents and related the research, in 7 main points as follows;

2.1 Hybrid electrification system technology
2.2 Hybrid power system technology at Koh Chick village
2.3 Energy Service Companies
2.4 Electricity Demand Forecast
2.5 SWOT Analysis
2.6 Background of the studied area
2.7 Relevant research

The detail of literature reviewed has been shown as following;

2.1 Hybrid electrification system technology

Hybrid power system is used to describe any power system with more than one type of generator-usually a conventional generator powered by a diesel or gas engine, and a renewable energy source such as a photovoltaic (PV), wind, or hydroelectric power system. There are thousands of these systems in use today. They range in size from a few tens of watts to tens of kilowatts. The smaller systems are mostly on remote residences where homeowners add a few PV modules to their existing

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to reduce the noise and inconvenience of having the generator running all the time. Convenience may be more important than cost for these homeowner-maintained systems that are installed near their homes. We are going to focus on hybrid systems that are used mainly in remote areas. These systems are often the most cost-effective way to produce power reliably at an unattended site.

Most have a way to store electrical energy to meet the peak load demand or for times when the renewable resource is low. Battery storage for wind or photovoltaic systems and pumped water storage for micro-hydro systems are commonly used. Using storage also increases the flexibility of system control and adds to overall system availability.

The ultimate smart controller is a person, but many hybrids are installed in remote locations. There you must rely on electronic controllers. Based on the parameters such as load demand, generator status, and battery state of charge, the controllers must act to keep power flowing to the load and protect the equipment. Doing this efficiently is not a small task and one consequence is that most hybrid controllers are custom designed. (4)

Method applying hybrid electrification system technology (3)

1) Electricity system of the system communicates

The electrical equipment of the system communicates to want the electric power about 1-4 kW. In far area, the hybrid power system will invest be cheap the free electrical system by solar cell and want a little safe more than diesel generator.

2) The electricity system for a village in far area

The village in far area convenient for hybrid power system because, low price in safe system.

3) The electricity system for office or factory in far area

The hybrid power system in resort or hotel in far area can be related with tourism conserves.

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2.1.1 Renewable energy systems in hybrid system technology

A renewable energy system converts the energy found in sunlight, wind, falling water, waves, geothermal heat, or biomass into a form we can use, such as heat or electricity.

Renewable energy in Thailand was mini- electricity system which install in far area and test in educational institution come form sunlight and wind.

2.1.1.1 Solar energy

Solar radiation as a source of energy is, of cause, the epitome of the clean, sustainable energy technology. Except for residues possibly arising out of the manufacture of solar components (e.g. semiconductors), solar technologies have very low environmental impacts of solar systems in operation are very low and the sources is, for us, inexhaustible. (5)

Solar energy received developed technology for advantage of human. NREL (6) perform research to develop and advance of technologies. These include:

1) Solar cells

Solar cells, also called photovoltaic (PV) by solar cell scientists, Convert sunlight directly into electricity. Solar cells are often used to power calculators and watches. They are made of semi-conducting materials similar to those used in computer chips. When sunlight is absorbed by these materials, the solar energy knocks electrons loose from their atoms, allowing the electrons to flow through the material to produce electricity. This process of converting light (photons) to electricity (voltage) is called the photovoltaic (PV) effect.

Solar cells are typically combined into modules that hold about 40 cells; about 10 of these modules are mounted in PV arrays that can measure up to several meters on a side. These flat-plate PV arrays can be mounted at a fixed angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture the most sunlight over the course of a day. About 10 to 20 PV arrays can provide enough power for a household; for large electric utility or industrial applications, hundreds of arrays can be interconnected to form a single, large PV system.

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2) Type of solar cell (Photovoltaic) (7)

Photovoltaic are about 30 different types devices under development, there are three main technologies in commercial production: monocrystalline cells, polycrystalline cells and thin-film cells.

A) Monocrystalline (single crystal) solar cells are manufactured from a wafer of high-quality silicon and are generally the most efficient cells for converting solar energy into electricity.

Figure: 2-1 Monocrystalline solar cells
Source: www.reihk.com

B) Polycrystalline solar cells are cut from a block of lower-quality multicrystalline silicon and are less efficient, but also less expensive to produce.

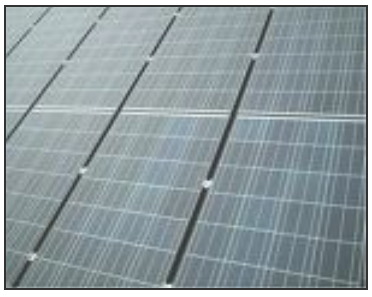

Figure: 2-2 Polycrystalline solar cells
Source: www.krofire.com

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C) Thin-film solar cell, manufactured in process similar to tinting glass, are made of semiconductor material deposited as a thin film on glass or aluminum. Thin-film solar cells are generally only half as efficient as mono and poly crystalline cells, but they are much cheaper to produce and widely used to power consumer devices such as watch and calculators.

Figure: 2-3 Thin-film solar cells
Source: www.technologynewsdaily.com

3) Size of Photovoltaic (solar cell) (7)

The size of a typical PV system varies from 50W-1kW for stand-alone system with battery storage; from 500W-5kW for roof-top residential grid-connected system; and from 10kW-1MW for ground-based grid-connected system and larger building-integrated system.

Photovoltaic modules are solid state devices with no moving part and a demonstrated record of durability and reliability. Photovoltaic modules may operate for up to 30 years and are generally sold with 10-20 year manufacturer warranties. Although Photovoltaic modules themselves require little maintenance, other BOS components may require more maintenance, particularly batteries.

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2.1.1.2 Wind Energy

Wind is simple air in motion. It is caused by the uneven heating of the earth's surface by the sun. Since the earth's surface is made of very different types of land and water, it absorbs the sun's heat at different rates

During the day, the air above the land heats up more quickly than the air over water. The warm air over the land expands and rises, and the heavier, cooler air rushes in to take its place, creating winds. At night, the winds are reversed because the air cools more rapidly over land than over water. (8)

1) Wind Turbine Types (9)

Wind turbines are classified by features into 2 types, i.e.

A) Vertical Axis Turbine (VAWT) a type of turbine with rotor and blades fitted vertically with a horizontal wind movement.

Figure: 2-4 Vertical Axis Turbine

Source: http://www.ecopowerusa.com/png/F19B.jpg

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B) Horizontal Axis Turbine (HAWT) a type of turbine with a rotor fitted parallel to a horizontal wind movement and having blades fitted vertically with wind force.

Figure: 2-5 Horizontal Axis Turbine
Source:http://www.symscape.com/files/images/gearbox_wind_turbine.

2) Sizes of wind turbines (7)

Commercial wind turbines for grid applications range from a rated capacity of 100kW-2MW and average 700 kW, while wind turbines for small, stand-alone applications range from 50W-100kW.

2.1.2 Diesel generator

The principle of diesel engine is different from gasoline one. In gasoline engine, the compound of air and fuel is sucked up in inlet stroke and compound is beaten since the piston can move nearly by top dead center. The spark plug will help to light up the blaze for the combustion. This compound must be uninflammable before or after the lighting at the spark plug or else the engine will be knocked and lose its power.

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On the other hands, in the ottocycle principle of diesel engine, the air is sucked into the cylinder without any fuel. Only air was compressed during the compression stroke and it also compress the piston to its top dead center, which is in high pressure and temperature. Then the oil will be spread.

The different size oil drops turn hot and are evaporated. Oil's stream will mix with that compressed air inside becomes the compound. The rate of the compound inside piston is different in each place and each time. The auto combustion occurs when temperature and the rate of compound are proper. Generally, the oil drops in all size spread in the cylinder and then made the combustion at uncertain places around the cylinder. However, there is a lot of blame in the first track of oil drops spread at the end of compression stroke.

In diesel engine, the temperature may come up at 540º c at the end of compression stroke which has the compressed rate reached at 22.5:1 and the pressure is at 500 pounds/inch² (3,447 kPa). This temperature can make the explosion runs in the cylinder. The combustion rate is controlled by spread oil rate. This makes slow combustion in the engine that can lengthen the time to spark up and combust by controls the compression inside the cylinder. The method works effectively (10)

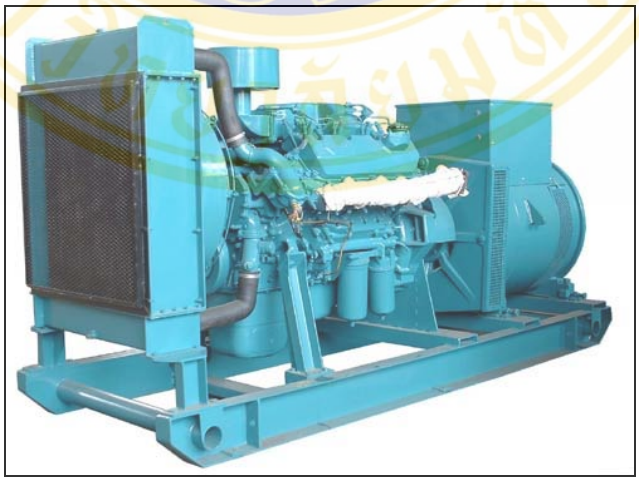

Figure: 2-6 Diesel Generator

Source: http://www.yalaonline.com/market/mbdetail.php?id=I020218

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2.2 Hybrid power system technology at Koh Chick village

2.2.1 Hybrid system design

Hybrid system design comprises the following methods

1) Basic data study

The implementation of hybrid system in Koh Chick is studied into two parts of basic data: meteorology data and electrical load data.

- Meteorology data consists of solar energy per hour, average wind velocity per hour and ambient temperature. There is no meteorology data that is collected in Koh Chick, therefore, the data is gathered from the other measurement stations where have similar condition to this area. These data are wind velocity at Klong Yai meteorology station, ambient temperature at Chanthaburi meteorology station and solar energy at Bang Chan sub-district, Chanthaburi province. The solar energy data is presented in the solar energy map of Department of Alternative Energy Development and Efficiency. (10)

- Electrical load data

The electrical load data of the diesel generator system that is surveyed at Koh Chick in 2002 is shown at Table 2-1. Maximum voltage is 30 kW and the total power demand is 116kWh/day. (10)

For hybrid system design is shown at Table 2-2. Maximum voltage is 37.5 kW and the total power demand is 265kWh/day.

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Table2-1 Koh Chick electrical load in the present (2002)

NO	Electrical load	Power (W)	Total machines	Hours used (hrs/day)	Total power(kWh)
1	18 W electrical light	13	686	4	35.67 2
2	29” television	200	1	4	0.8
3	25” television	150	2	4	1.2
4	21” television	100	6	4	2.4
5	20” television	70	41	4	11.48
6	14” television	50	53	4	10.6
7	B/W 14” television	20	6	4	0.48
8	Stereo	30	63	4	7.58
9	CD player	35	58	4	8.12
10	Fan	35	180	4	25.2
11	Motor/pump	2,500	1	4	2
12	Washer	500	2	2	2
13	Communication hall	90	1	4	0.36
Total		3,793	1,100	50	115.872
Maximum voltage kW					30

Source: ข้อเสนอโครงการระบบผลิตไฟฟ้าด้วยพลังงานทดแทนแบบผสมผสานสำหรับหมู่บ้านชนบท (กรณี หมู่บ้านเกาะจิก). มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี. 2545; 60

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Table 2-2 Hybrid system design of Koh Chick- electrical (100 households) 2002

Electric machines	Power (W)	Total machines	Power (kW)	Hours used (hrs/day)	Days used (days/ month)	Total power (kWh/ mount)
21” television	100	108	10.8	6	30	1944
Refrigerator	53	78	4.13	6	30	744.12
Fan	35	175	6.13	6	30	1,102.5
Electric iron	1,000	21	21.00	1	10	420
Electric cooker	530	88	46.64	1	25	1,166
Microwave	1,200	5	6.00	0.25	30	45
Washer	305	21	6.41	2	10	128.1
Stereo	65	35	2.28	4	30	273
Electric boiler	650	5	3.25	1	25	81.25
Communication hall	90	1	0.09	4	30	10.8
36 W electric light (4 tubes)	184	75	13.8	4	30	1,656
11 W electric light (2 tubes)	32	75	2.4	8	30	864
Total power demand (kWh/month)						7,936.77
Maximum voltage(kW)						35.7
Total power demand (kWh/day)						265

Source: ข้อเสนอโครงการระบบผลิตไฟฟ้าด้วยพลังงานทดแทนแบบผสมผสานสำหรับหมู่บ้านชนบท (กรณี หมู่บ้านเกาะจิก). มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี. 2545; 61

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From the studied basic data, it is concluded that Koh Chick has electricity generating potential from solar energy that is an alternative solution for problems: environmental impacts, fuel cost and the frequent maintenance.

The electricity which is generated from only renewable energy is not suitable because it has the low stability and high investment cost. Therefore, the most suitable electricity generating system for Koh Chick is the hybrid system which consists of solar cell to provide energy during low load and the diesel generator to provide energy during high load demand.

2) Selection of operation system

The selection of operation system consists of system voltage and system operation.

- System voltage

For small hybrid system voltage should be 12-48 V. For medium size should be 120-240 V and the big size be 480-600 V.

For the hybrid system of Koh Chick is the medium size, therefore, the system voltage is 60 V.

- System operation

The system operation must be considered the electrical load the utilization. The result is the hybrid system should be composed of 7 kWp solar cell, 600kWh battery subsystems for energy accumulation and 50 kWA diesel generator.

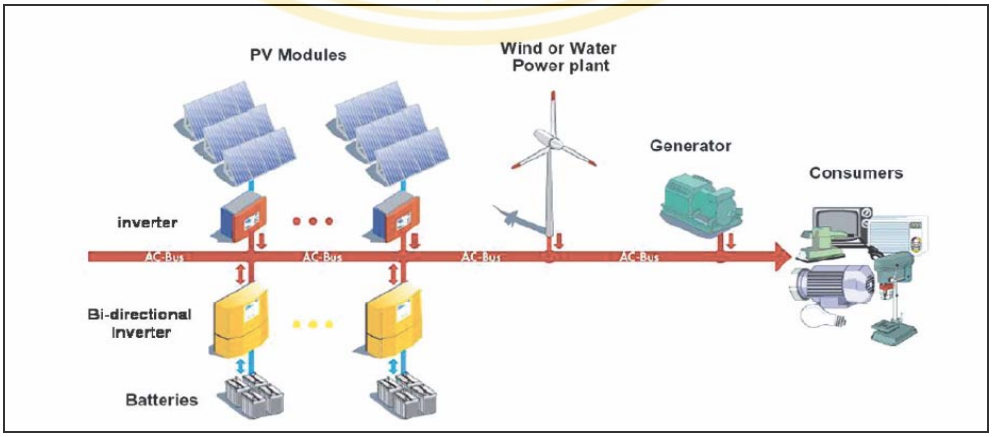

Figure: 2-7 Hybrid system on Koh Chick village
Source: วารสารนโยบายพลังงาน. สำนักงานนโยบายและแผนพลังงาน. 2548 ฉบับที่ 67; 22

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2.2.2 Location for Install Generator at study area (11)

2.2.2.1 Location for Install solar cell

Solar cell must receive sun light every day and every season, especially in December to January have low Declination Angle.

Photovoltaic array in Koh Chick have about 62.4 m^2 will must have free area about 80 m^2 and far the trees or construction about 0.78 up. Vapors of the sea have affect decay of structure, therefore location for install solar cell will far the sea moderately.

From engineer suitability and public participation find area suitability was reservoir zone.

2.2.2.2 Location for Install wind generators

Areas for install want high land because wind speed direct variation with height, this equation.

$$V = 1.0501 \text{Ln}(h) + 3.6821 \text{ m/s}$$

V = Wind Speed (m/s)

h = High (m)

Location of wind turbine must receive the wind every direction and every seasons, especially southwest monsoon on May to October, northeast monsoon end of a month October to February, the trade wind end of a month February and land sea breeze on each day. Wind turbine must far trees or construction about 20 up and high 2 up of these. The work of wind generator system is will make the loud sound about 45 dBA (wind speed 5 m/s) and about 65 dBA (wind speed 20 m/s) which want install far community and vapors of the sea have affect decay of structure.

2.2.2.3 Location for Install diesel generators

Install diesel generator center of burden electricity will have most suitability because reduce losing in the system, price of the system and vapors of the sea have affect decay of structure on May to October. Diesel generator make the loud sound about 94 dBA and have measure protect oiliness.

From engineer suitability, environment effect and public participation find area Koh Chick temple have most suitability.

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2.3 Energy service companies (ESCOs)

NAESCO (National Association of energy Service Companies, USA) (12) get summarize about ESCO as follows, An ESCO, or Energy Service Company, is a business that develops, installs, and finances projects designed to improve the energy efficiency and maintenance costs for facilities over a seven to 10 year time period. ESCOs generally act as project developers for a wide range of tasks and assume the technical and performance risk associated with the project. Typically, they offer the following services: develop, design, and finance energy efficiency projects; install and maintain the energy efficient equipment involved; measure, monitor, and verify the project's energy savings. These help in projects save money and increase efficiency of system.

ESCO employs a wide array of cost-effective measures to achieve energy savings. These measures often include the following: high efficiency lighting, high efficiency heating and air conditioning, efficient motors and variable speed drives, and centralized energy management systems.

For Koh Chick, ESCO will have back role investment because hybrid power system have support the investment from Energy Policy and Planning Office. ESCO must be responsible invest buy electricity meter, buy oil and hire the accountant and officer repair.

Therefore, ESCO of Koh Chick village is company administrated by community. By install electricity meter format pre-paid and villagers must use call time refill card from Koh Chick village hybrid power system office (RSECO). It perform add money and perform limit using quantity the electricity of each the household. As for prince electricity will import funds in village for use administrated hybrid power system to have efficiency usability lifetime. (3)

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2.4 Electricity Demand Forecast

Electricity demand forecast will do peak demand forecast, which peak demand each the years will make search for measure and plan management.

2.4.1 Electricity Demand Forecast by Thailand Load Forecast Subcommittee (13)

Electricity demand forecast of households used End- use principle, which reproduced used electricity in household in every day life. Begin by study electric appliances each type for example; television, air condition, radio etc. Then will study using electric appliances each type, which used electricity in how many is the quantity, How use long ago, how open often and efficiency electric appliances; as follows.

First step= amount household forecast on each year from population and total mass products.

Second step= classify result forecast of amount using electricity in each year and each residence type.

Third step= calculate add rate of electric appliances for example; television, air condition, radio etc. For calculate amount electric appliances in each type of residence.

$$A_{ijt} = S_{ijt} \times C_{ijt} \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

A = amount electric appliances
S = rate electric appliances: household
C = amount household
i = residence type
j = electric appliances type
t = year forecast

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Four step; amount electric power each types of household.

$$E_{it} = \Sigma_j A_{ijt} \times W_{ijt} \times H_{ijt} \times F_{ijt} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

E = electric power

A = amount electric appliances

W = Watt of electric appliances

H = hour in year

F = efficiency

i = residence type

j = electric appliances type

t = year forecast

When add electric on each type of residence, will result electric demand forecast this overall image.

2.4.2 LEAP Software (14)

The LEAP software system is a scenario-based energy-environment modeling tool. Its scenarios are based on comprehensive accounting of how energy is consumed, converted and produced in a given region or economy under a range of alternative assumptions on population, economic development, technology, price and so on. With its flexible data structures, LEAP allows for analysis as rich in technological specification and end-use detail as the user chooses.

With LEAP, the user can go beyond simple accounting to build sophisticated simulations and data structures. Unlike macroeconomic models, LEAP does not attempt to estimate the impact of energy policies on GDP or employment, although such models can be run in conjunction with LEAP. Similarly, LEAP does not automatically generate optimum or market-equilibrium scenarios, although it can be

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used to identify least-cost scenarios. Important advantages of LEAP are its flexibility and ease-of-use, which allow decision makers to move rapidly from policy ideas to policy analysis without having to resort to using more complex models.

At the heart of LEAP is the process of scenario analysis. Scenarios are self-consistent storylines of how an energy system might evolve over time in a particular socio-economic setting and under a particular set of policy conditions. Using LEAP, scenarios can be built and then compared to assess their energy requirements, social costs and benefits and environmental impacts.

2.4.2.1 LEAP structured

- LEAP is structured as a set of eight different "views" of an energy system. These views are listed as graphical icons on the "View Bar", normally located on the left of the screen

- The Analysis View is the place where you create your data structures, models and assumptions in LEAP. In the Analysis view, the screen is divided into three panes. On the left, a hierarchical tree is used to create and organize data structures under four major categories Driver Variables, Demand, Transformation and Resources. The tree is also used to select the data to be edited, which is shown on the right of the screen.

- The Results View displays results in detail for all parts of the energy system. It can be used to create a wide variety of charts and tables covering each aspect of the energy system: demand, transformation, resources, costs, and environmental loadings. Reports can be viewed for one or more scenarios and can be customized in a wide variety of ways. You can also use the "Favorites" option to bookmark the most useful charts for your analysis.

- The Diagram View displays a "Reference Energy System" diagram showing the main energy flows in your system from resource extraction, through the conversion and transport of fuels, through to final energy demand.

- The Energy Balance View displays the results of your calculations as a standard energy balance an aggregate summary of energy consumption, conversion and production in an area table or chart. Energy balances can be viewed for any calculated scenario. Energy balances can also be customized to reflect different energy units.

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- The Summaries View is a general purpose tool with which you can create your own customized tabular reports. Reports can include any data variable or results value as well as your own commented subheadings.

- The Overviews View is used to group together "Favorite" charts created earlier in the Results view. With Overviews, you get a birds-eye view of different important aspects of the energy system, such as costs, environmental impacts, and resource requirements. You can create multiple named Overviews, each of which can display up to 10 different Favorites.

- TED: The Technology and Environmental Database provides extensive information describing the technical characteristics, costs and environmental impacts of a wide range of energy technologies available internationally or in particular developing country regions..

- The Notes View is a simple word processing tool with which you can enter documentation and references for each branch An item on the tree. Use the Print and Print All buttons to print one or all of the notes or the Word buttons to export one or all of the notes to Microsoft Word.

2.4.2.2 Analytical Advances

LEAP includes important analytical advances over earlier versions of the system. Examples include:

- Spreadsheet Linkages: LEAP is designed to act as an open framework for organizing and integrating the results of separate spreadsheet models. It can be dynamically linked to any spreadsheet model, with changes in the spreadsheet automatically reflected in LEAP's results.

- Expression-Based Modeling: LEAP borrows an approach made popular in spreadsheets: the ability for users to enter data using mathematical expressions. Using expressions, variables can be specified to change over time on the basis of simple step or interpolation functions, or on the basis of more complex modeling relationships. Expressions may also reference variables that are specified elsewhere in the system, allowing users to develop sophisticated models.

- Useful Energy Demand Analysis: LEAP includes the optional ability to conduct "useful" energy demand analysis in addition to the standard final energy

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analysis approach. This allows users to explicitly consider demand-side efficiency improvements and fuel switching independently of the evolution of useful energy demands.

- Other Methodological Improvements: The latest version of LEAP includes numerous methodological advances over earlier versions, such as cost-based dispatch of electric power plants, more automated simulation of electric sector capacity expansion, better representation of intermittent renewable, and new approaches for modeling industrial cogeneration.

2.4.2.3 Capacity Building Using LEAP

LEAP's transparent methods and easy-to-use design make key energy policy questions easier to grasp, and so for more than twenty years it has been an important tool in the training programmers of national and regional energy institutions in all major regions of the world.

This research wills electric demand forecast of Koh Chick village by LEAP software because this program can respond wanted of researcher. The researcher want to know quantity of electricity that uses about 15 years in future by show the result was yearly (2007-2023). And this research has variable feature, population rate, household rate, income rate and electric appliances rate. This program have data base of renewable energy (data base of renewable energy is TED).

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2.5 SWOT Analysis (15)

The study of community with energy demand is survey energy demand of energy organization and community for respond want truly of community. The energy wills effect analysis from all factors call SWOT analysis e.g. Strengths, Weaknesses, Opportunities and Threats.

SWOT analysis is situation analysis for organization analysis succeeds find strengths-weaknesses or problem for operate to want in future. The situation analysis will strengths-weaknesses analysis for benefit in specification vision or chooses strategy be appropriate on organization which about strategic decision. The strategic decision is choose determine strategy or means operate for reach vision which choose consider situation in future by use principle about wanted, know situation, see to opportunity and know good point including defect in operate go to destination of organization.

This research will use principle SWOT analysis for find appropriate electricity energy of Koh Chick village from solar system, wind turbine system and diesel generator that have install in Koh Chick and find strengths- weaknesses, opportunity for operate and each problem of electricity generator system by make compare tables follow all factors. SWOT analysis is hybrid technology and social about technology will make different of electricity system and social is listen to opinion of peoples with electricity generator system. SWOT will help find measure and plan for electricity management of Koh Chick village.

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2.6 Background of the studied area

The background of the studied area consists of following aspects (10)

2.6.1 Location

Koh Chick village is location in Latitude 12° N and Longitude 102°E at Moo 1, Bangchan sub-district, Khlung district, Chantaburi province. The total area is 700 rai (1.12 square kilometers) covered 106 households. This site stands beside Trad province in the Gulf of Thailand, 4 kilometers apart from the coast. It is considered not worthwhile to invest conventional distribution system from the coast to Koh Chick.

2.6.2 Geographical character

Koh Chick is a small island. Most of the area is the mixed deciduous forest encompassing the hill about 300 rai (0.48 square kilometers). The beach faces the Gulf of Thailand and the living area is the plain facing the cost of Trad province.

2.6.3 Present land use

Land use is divided into 3 parts: 250 rai (0.4 square kilometers) as agricultural area, 250 rai (0.4 square kilometers) as the rubber plantation area and the rest as the living area.

2.6.4 Climate

Koh Chick climate is tropical monsoon which has average rain about 6 months during May to October. The average rainfall is 2,528.6 millimeters. The average relative humidity is 80% (highest relative humidity is 100% and lowest relative humidity is 33%). The average temperature is 27.5º C (highest temperature is 35º C and lowest temperature is 17º C. The sweeping monsoon is divided into 2 parts:

- The southwest monsoon sweep across Koh Chick during April to October or in the summer and rainy season. For the time being, there is the heavy wave in the evening.

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- The northeast monsoon sweep across Koh Chick during November to March yearly. For November to December, there is heavy wave and the sea is rather calm till wave slightly during January to March.

Table2-3 Rainfall Data 2000-2005

	2000	2001	2002	2003	2004	2005
Rainfall (mm.)	6,281.2	5,431.8	4,398.1	4,331.3	4,326.0	4,853.4
Raining Day	217	231	209	193	174	197

Source: สถานีอุตุนิยมวิทยาตราด (คลองใหญ่)

Table2-4 Temperature Data 1999-2005

Years/Tem.		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1999	**max**	34.7	34.3	36.2	33.8	33.2	33.3	32.0	32.7	33.2	34.0	32.4	36.2
	min	19.8	20.3	21.3	22.7	21.8	22.0	21.8	22.1	22.7	22.3	20.7	17.0
	mean	27.3	27.1	28.3	27.8	27.2	28.9	26.7	27.1	27.2	26.8	27.1	25.7
2000	**max**	33.8	-	-	-	-	-	-	-	32.7	32.6	34.5	34.8
	min	20.2	18.9	19.9	22.7	23.2	22.6	21.8	21.4	22.5	22.8	18.1	21.0
	mean	27.0	26.7	27.8	28.2	28.0	26.8	26.6	27.0	27.3	26.6	27.2	27.5
2001	**max**	33.6	33.3	35.7	34.5	34.8	32.7	32.7	32.3	33.6	33.9	34.7	34.3
	min	18.3	20.8	22.3	23.5	23.0	22.4	22.9	22.9	23.3	22.7	19.5	18.7
	mean	27.0	27.6	27.7	28.6	28.0	27.2	27.1	27.2	27.4	26.8	26.6	26.9
2002	**max**	34.1	32.6	34.0	34.5	34.9	33.5	33.1	32.4	32.5	33.1	34.8	34.4
	min	18.4	19.6	22.5	23.1	23.1	22.3	21.9	22.3	22.7	21.6	21.3	21.6
	mean	26.6	27.1	28.1	28.5	28.2	27.4	28.2	26.5	27.2	27.2	27.9	27.8
2003	**max**	34.2	33.8	34.6	34.4	35.7	33.5	33.1	32.7	32.2	34.6	35.7	35.3
	min	18.4	19.0	20.4	21.1	22.5	22.1	21.3	20.3	20.7	21.7	21.7	19.0
	mean	26.9	27.5	27.7	28.8	28.3	27.6	27.0	27.4	27.0	26.8	28.0	26.9
2004	**max**	32.8	33.8	34.6	35.0	35.8	33.5	32.9	32.7	33.2	35.9	36.1	34.8
	min	18.8	19.1	22.2	23.4	23.0	21.6	21.9	22.5	22.4	21.8	21.2	17.8
	mean	25.8	26.4	28.4	29.2	29.4	27.5	27.4	27.6	27.8	28.8	28.6	26.3
2005	**max**	32.4	32.8	33.7	33.9	34.5	33.3	33.2	32.7	32.8	34.2	34.5	34.1
	min	17.3	21.9	20.3	21.8	21.8	22.9	23.1	22.2	22.6	22.3	21.8	19.7
	mean	26.1	27.8	28.0	28.5	28.6	27.6	26.7	27.3	26.8	27.3	27.5	26.6

Source: สถานีอุตุนิยมวิทยาตราด (คลองใหญ่) (Degree Celsius)

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Table 2-4 Wind Data 1997-2006

Y\M	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	ANNUAL
1997	18	18	15	16	22	18	26	30	20	14	20	15	30
1998	20	12	12	14	30	30	18	17	25	13	15	20	30
1999	14	22	15	20	19	38	34	28	20	20	20	23	38
2000	23	20	26	22	32	28	33	34	30	17	25	19	33
2001	22	20	25	20	26	32	38	39	17	17	16	21	39
2002	18	10	9	22	30	26	37	22	22	11	11	13	37
2003	13	15	10	13	35	25	42	27	27	12	15	17	42
2004	19	15	19	10	25	29	22	26	20	14	14	15	29
2005	21	10	25	15	15	22	34	24	23	12	25	16	34
2006	15	12	15	20	21	26	21	22	22	15	13	18	26
Ext.	23	22	26	22	35	38	42	39	30	20	25	23	42

* (Knots)

Source: สถานีอุตุนิยมวิทยาตราด (คลองใหญ่)

2.6.5 Social condition

People have abided in Koh Chick before 2490 Buddhist Era. The first group migrated from Bang Prid village, tembon Bang Prid, Lam Ngob district, Trad province. At the present, there are a temple, a primary school and health station. The amount of total population is 512 with 266 males and 246 females.

2.6.6 Economic condition

According to the way of life, 8 household have engaged in commerce, 44 household are in fishery, 25 households and the employees, 9 households raise the marine animals and 12 households have the rubber plantations.

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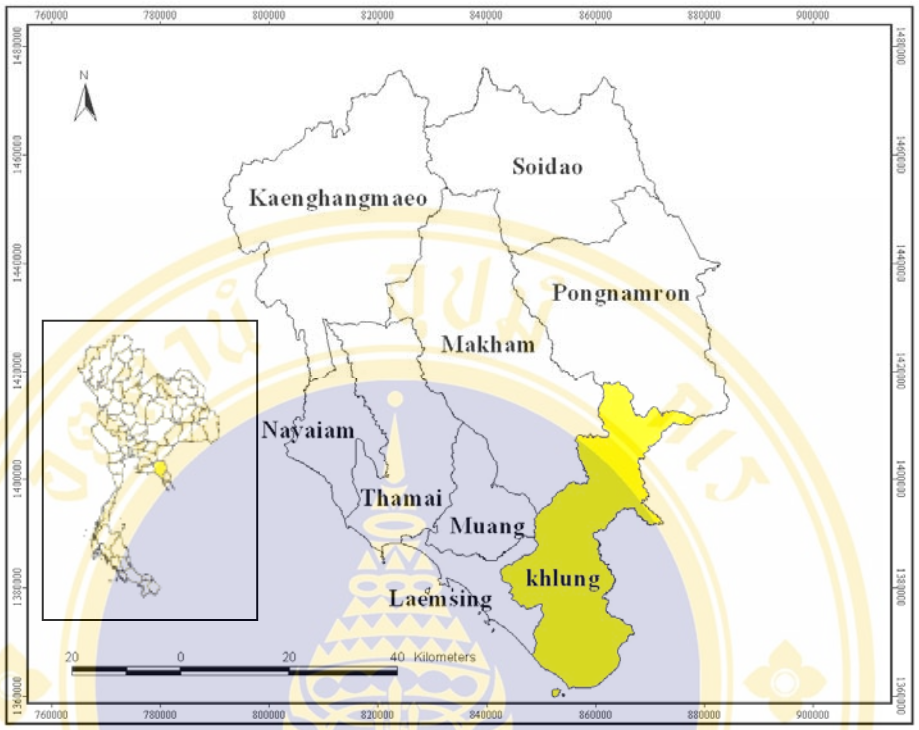

Figure 2-8: Map of Khlung district, Chantaburi Province

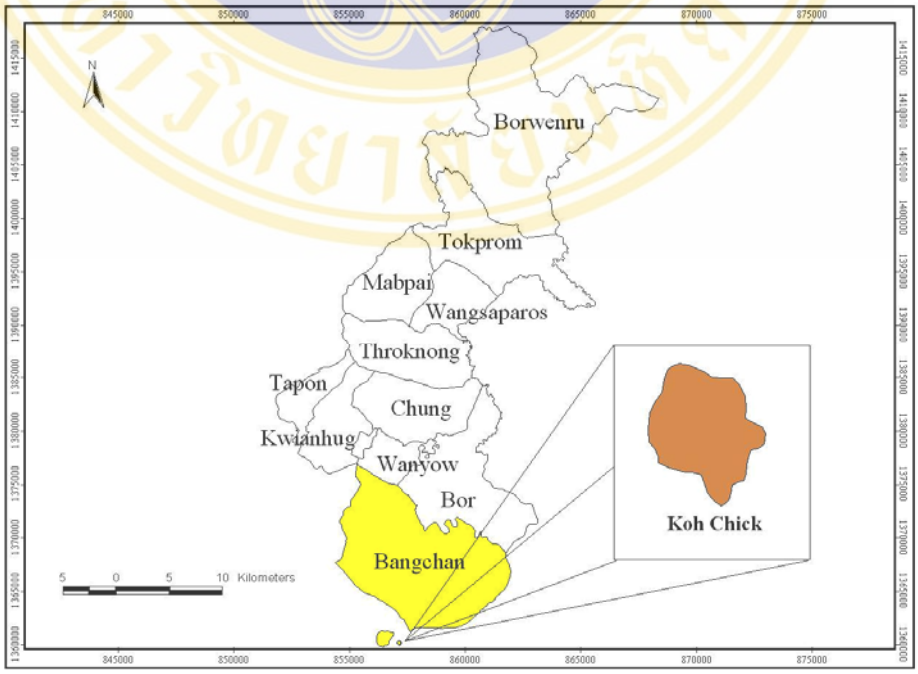

Figure 2-14: Map of Bangchan sub-district, Khlung district

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2.7 Relevant research

2.7.1 Theerapat (16) assesses the hybrid clean energy sources (wind and solar) and a diesel generator electricity generating system installed at Taratao Marine National Park.

From the assessment categorized into aspects: pollution (air, noise and soil contamination) social (user's attitude) economic (NPV, IRR, B/C Ratio and willingness to pay) and experts viewpoint on the technology assessment, those results show that the hybrid system is suitable for the environment and also appropriate regarding acceptability, need and user attitude, but is not viable economically. Since this is a public project, the economic viability should not be given too much weight. Therefore the hybrid system is suitable for the area since it is a beginning of utilizing a renewable and clean energy in a national park where the area is sensitive.

2.7.2 Suwimol (10) assesses the hybrid electrification system for off-grid rural community: Koh Chick village pilot project. The assessment can be categorized into three aspects, objectives: 1) to compare the environmental impacts: air pollution, noise pollution and fuel oil contaminated water and soil from the conventional system (diesel generators) with the hybrid system, 2) to study the economic feasibility of the project and the financial feasibility of Rural Energy Service Company (RESCO) by the cost-benefit analysis with the Net Present Value (NPV), Internal Rate of Return (IRR), and Benefit-Cost Ratio (B/C Ratio) and 3) to study community management of the administrative organization, RESCO, which has been set up to manage the hybrid system.

The results showed that the conventional system produces higher levels of air pollution, noise pollution and fuel oil contaminated water and soil than the hybrid system. The project is economically feasible but RESCO cannot be justified financially. The renewable energy technology of 20 kW solar cells and 10 kW of wind turbine can enhance economic and financial situation. Hence, for highest advantage, the community electricity usage should be managed in accordance with using renewable energy. With financial reforms, RESCO could be the appropriate administrative organization to manage the hybrid. RESCO and community (users) are

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satisfied with the hybrid system for developing renewable energy in areas in without the sources of electricity.

The researches (16 and 10) can be applied in field the production and effect from hybrid power system, because used power resource also Koh Chick village. And can use research result in field RESCO bring adjust be appropriate to efficiency.

2.7.3 Anucha (17) assesses the demand side management case study Chiang Mai University. Begin, study from check and analysis user thoroughly energy in building about 23 faculty. The project considered possibility in the investment on base of analysis of the economics by rate reward value more than 9%. Usability quantity energy in all equipment, will considered classify about 3 groups, as follows; compose light system, air-conditioner system and other system. The consider using electric power of each the system, will separate with time of rate TOU.

The results showed using energy rate of light system, air-conditioner system and other system equal to the percentage 21:19:60 respectively. Time find maximum demand was 2-3 pm. Trend proposals in the reduction maximum demand compose using high efficiency lamp, compact neon lamp, ballast low loss, high efficiency air-conditioner, adjust Load Factor and open or close water pump management.

2.7.4 Maria E, Tsoutsos T (18) assesses the sustainable management of renewable energy sources installations: legal aspects of their environment impact in small Greek islands. Nowadays, an attractive and financing framework has been established in Greece for the development of renewable energy sources (RES). This has resulted in a strong increase of investors' interest, especially in the islands, mainly due to their high renewable energy potential all year round. However, the typical characteristics of the small Greek Island, which constitute sensitive ecosystems with unique attributes of a natural and cultural heritage impose a limitation on the development of energy generation plants using renewable. In order to adopt of sustainable development of these island regions, the application of the proportionality principle in relation to other general principles of environmental law is proposed as a suitable legislative tool for resolution of the foreseeable conflicts.

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The researches (17 and 18) can be applied using management for Koh Chick village about plan and measure.

2.7.5 Yaungket J (19) assesses the results of a situation of electricity consumption to LEAP software in Thailand. The assessment is to brief overview of the electricity consumption in Thailand and discuss the results of the preliminary LEAP analysis, and evaluate the applicability of the LEAP software to forecast electricity consumption in Thailand.

The results showed the model is to generally useful both as problem solution and practical tool. The program was found to be adaptable to the data available and it provides an output estimate of energy consumption. Equally importantly, it can serve as a common structure to help coordinate and analyze the effort background.

2.7.6 Tira F (20) assesses the using electrical power get have high benefit by analysis consumer in Thailand. From efficiency generate electricity of Thai about 6, 552 GWh/ year and high power about 107.5 MW/ year in 1995–2005, when forecast electricity demand in along times about 5-6% different from Department of Alternative Energy Development and Efficiency, Ministry of Energy and Department of Public with another institute. This research will survey the choice for using electricity each area in Thailand then find efficiency using electricity from 2006-2020 by study from electric appliances by use LEAP (Long-range Energy Alternatives Planning) make model with electric appliances which use data base electricity.

The results showed using electricity in 2006 about 39 GWh/ year and increase 35% very years until 2020 using electricity about 5,188 GWh/ year.

The researches (19 and 20) can be applied using LEAP software for forecast electricity demand of Koh Chick village.

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CHAPTER III
MATERIALS AND METHODS

This research, which was based on applied research, studied about the situation of the using electric energy, the forms of administration electric power of the companies, as well as the development of management the generating system of the mixed renewable energy of Koh Chick village.

3.1 Collection

The data used in this research, was divided into 2 categories as follows;

3.1.1 Primary data

This data was taken from using questionnaire collecting information of electric power consumers and administrators managing the system of the hybrid renewable energy.

3.1.2 Secondary data

This secondary data was derived from studying and searching information from a number of sources such as books, documents, related researches available from the internet, even associated organizations or universities as King Mongkut's University of Technology Thonbury (KMUTT), Department of Alternative Energy Development and Efficiency (DEDE) and Electricity Generating Authority of Thailand (EGAT).

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3.2 Materials

The form of questionnaire related to the required data to gather generally basic information dealing with electric appliances which were used by households.

3.2.1 Questionnaire

The questionnaire, which was used in colleting the data concerning the consumption of electric energy, consisted of open-ended question. The interviewees of this questionnaire were head of household.

The questionnaire has mainly 2 parts as followings;

Part I The general information of interviewees; gender, education, status and occupation.

Part II The information of electric energy consumption such as types and numbers of electrical appliances, the electricity actually consumed a certain of electricity (kilowatt-hour), the time duration that an electrical appliances, being used actually, types and sizes of electrical appliances that the respondents expected to have in the future, electricity bill and a knowledge and of producing hybrid renewable energy system.

3.2.2 Materials test

The questionnaire, which were examined so as to check its content validity and quality, were divided into 2 stages as follows;

1) Validity test

To test the content validity, the research had brought the questionnaire to have sane advices and opening from expert at least 3 experts. This is to prove whether they were in accordance with objectives and contents of the research or not and their evaluating the questionnaire by which the following criteria (21)

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+1 = If there is sureness that all of the questionnaires are related to the objectives of the research,

0 = If there is slight sureness that all of the questionnaires are related to the objectives of the research,

-1 = If there is no sureness that all of the questionnaires are related to the objectives of the research.

After that, the researcher tested scores from the decision of 3 experts to find out the content validity by calculate following the formula:

$$IOC = \frac{\Sigma R}{N} \quad \text{..... (3)}$$

Where; IOC = the index of consistency of questions with contents according to experts' decision

R = the total scores from experts' decision

N = the total number of experts

-Any question has scores of ICO getting close to 1.0, it is greatly consistent with the contents.

-Any question has scores of ICO getting close to 0, it is partly consistent with the contents.

-Any question has scores of ICO getting close to minus, it is not consistent with the contents

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2) Confidence

To test the questionnaire confidence by using the formula as Coefficient Alpha devised by Conbach (21).

$$r_{tt} = \frac{k}{k-1}\frac{(1-\Sigma S_i^2)}{S_x^2} \quad \text{..... (4)}$$

Where; K = the total questions of the questionnaire

ΣS_i^2 = the total scores of vary of each question

S_x^2 = Vary of total scores

The score of r_{tt} is between 0-1. However to achieve a reliable level of the research they study employ the r_{tt} of > 0.7 (22), which is this research has r_{tt} of 0.74.

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3.3 Methodology

3.3.1 Study Area

The area of this research was Koh Chick village, Moo 1, Bang Chan sub-district, Khlung district, Chantaburi province. It was the first village of Thailand where hybrid renewable energy was established.

3.3.2 Simple for questionnaire

The researcher collected the information by census random method for 98 household of Koh Chick.

3.3.3 The study of the system of generating hybrid renewable energy of Koh Chick village was studied in 3 stages as follows;

3.3.3.1 The assessment of electricity supply and demands of Koh Chick

A) The forecast of demand of the electricity consumption in the future.

The data collection

- The population increasing rate in Koh Chick from year 2004 to 2007 by using the information from public health worker of Koh Chick village.

- The households increasing rate in Koh Chick from year 2004 to 2007 by using means ($\overline{X}$) and the related information was from the population census of Koh Chick village.

- The income increasing rate in Koh Chick from year 2005 to 2007 from sub-district administration organization.

- The No. and types of electrical appliances increasing rate from year 2005-2007 from questionnaire.

The data analysis

The population increasing rate, the households increasing rate, the income increasing rate and the No. and types were calculated the demand of the electric consumption for 17 years (2007–2023) by using LEAP.

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B) The peak load on monthly

The researcher has studied the information of the electric consumption from the data base of Koh Chick village hybrid power system office by dividing into month.

C) The forecast of electricity generation in the future.

The data collection

- The life time

-The maintenance

The data analysis

The life time and maintenance will affect the efficiency system, electricity generation by collecting data from the Koh Chick village hybrid power system office, to analyze producing electricity in next 17 years.

3.3.3.2 The study of management pattern of electric energy of Koh Chick village

A) The structure of electric management of Koh Chick village.

B) Gathering the data from documents regarding capital account report of Koh Chick village hybrid power system office and calculating the turnover.

C) Analyzing and summarizing a factor data which affected the Koh Chick village hybrid power system office management.

3.3.3.3 The study an appropriate management of Koh Chick village.

A) Collecting and dealing with research documents such as energy demand data and electricity generation system data. In addition to analysis diesel fuel price tendency using MINITAB software, linear regression statistic.

B) All collecting data were analyzed by using SWOT analysis, by 5 experts, for find out the alternative of renewable energy system of Koh Chick village.

D) Analyzing and summarizing were done an appropriate management limitation and electricity management plan of Koh Chick village.

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CHAPTER IV
RESULT AND DISCUSSION

From the study regarding to the proper management of electric energy, the researcher collected data from primary and secondary sources from the relevant organizations as well as questionnaire. The gained data were complied to analyze followings by issues;

4.1 The assessment of electricity supply and demand of Koh Chick,
4.2 The electricity management of Koh Chick village,
4.3 The appropriate electricity management of Koh Chick village.

The details of each result were displayed as follows;

4.1 The assessment of electricity supply and demand of Koh Chick

The study an assessment of electricity supply and demand of Koh Chick can separate 4 issues;

4.1.1 The hybrid system of Koh Chick village as follows;

4.1.1.1 Solar cells system

The solar cells is electricity generation system from renewable energy by install at Koh Chick temple area.

The electrical characteristic of photovoltaic array:

- Type	Single Crystalline
- Maximum power	7.5 kWp (10 arrays)
- Energy generating capability	9,644 kWh/year

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Figure 4-1 Solar cells system at Koh Chick

4.1.1.2 Wind turbine system

The wind turbine is electricity generation system from renewable energy by install at mountain back Koh Chick village.

The electrical characteristic of wind turbine:

- Type Light Wind Model
- Maximum power 10 kW (2 turbines)
- Energy generating capability 11,367 kWh/year

Figure 4-2 Wind turbine at Koh Chick

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4.1.1.3 Diesel generator

The diesel generator is needed when the solar system is cut off or can not generate sufficient electricity load. The capacity of diesel generator in Koh Chick is 50 kWA generator at 380/220 V. The electricity generating capability is expected to be around 115,080 kWh/year while diesel oil demand is 49,641 liters/year.

Figure 4-3 Diesel generator at Koh Chick

4.1.1.4 Battery subsystem

The battery subsystem is store electricity from solar cell and electricity exceed load.

Mechanical characteristic of battery subsystem:

- Type Vented-Type Stationary Lead-Acid Battery
- Total power 252 kWh
- Capacity 700 Ah 180unit

Figure 4-4 Battery subsystem at Koh Chick

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4.1.1.5 Inverter

Three point three-kW bi-directional inverter (3 unit) which change the direct current (DC) from batteries to 3 phase (220 V/phase) alternating current (AC) which 50 Hz frequency are designed to generate electrical load.

Two-kW grid connected inverters (3 units) change the direct current (DC) from photovoltaic to 220V alternating current (AC) with 50 Hz frequency.

Figure 4-5 Inverter

4.1.1.6 Controller unit

Controller unit of the hybrid system consists of the safety subsystem as the following components:

- Electrical shock protectors which are structure grounding and fuse.
- Battery subsystem is protected by using fuse to cut off.
- Lightning protection is composed of lightning safety device (Metal Oxide Varistor; MOV).
- Distribution system is the distribution uses the 3 phase system that is installed thoroughly along the main road from the control building to other places in Koh Chick.

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4.1.1.7 The structure of electricity generation

The electricity generation of Koh Chick was 2 systems as follows;

1) The renewable energy are consists of solar cell and wind turbine. The solar cell can electricity charged into the batteries, which used at night time. The wind turbine can use electricity automatically every time when have wine blow and can electricity charged into the batteries

2) The Diesel generator system which is used at certain time. If the demand of electricity is high, especially 18.00-22.00, the electricity that is not consumed will be charged into the batteries as Figure 4-6.

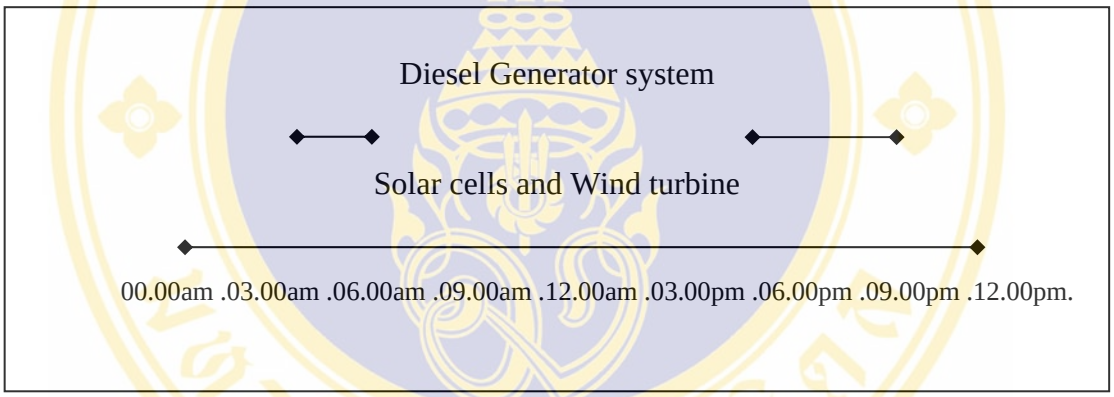

Figure 4-6 The electricity generation of time which each system produces electricity

From the study, the problems affected electricity generation can separate 3 problems, consists the technique, the maintenance and fuel consumption as Table 4-1.

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Table 4-1 The problems found in electricity generation.

Problem	Solar cell	Wind turbine	Diesel Generator
1. Technique	-Rely on solar cell experts. -The system could not be fixed by local mechanics.	-Rely on Wind turbine expert. -The system could not be fixed by local mechanics.	-The system could not be fixed by local mechanics
2. Maintenance	-Weeding frequently cleaned.	-According to regulations of life time -The spares have expensive	-According to regulations of life time -The spares have expensive
3. Fuel consumption	-	-	-The price of fuel oil tends to increase future.

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4.1.2 The forecast of future electricity consumption

The researcher used LEAP program to forecast the future electricity consumption talking into account the population, household, income and electrical appliances. The data were used to calculate the data on population and income, such as the growth rate of population, houses, income and data related to electric appliances.

4.1.2.1 The data on population, household and income

The researcher used the last 5 year data of population and income to show how the tendency of change population both before and after the alternative energy project started is.

1) The population increasing rate

The population data, which were collected the information from public health worker of Koh Chick village, were used to be an indicator of changing population from the past to the present, and to be a data base so as to predict the consumption of the electricity in the future about 17 years. From the gained data, the rate of population rose and dropped alternatively during 2002-2007. From 2002-2003, the population increased from 512 to 538. Yet, that of the year 2004 dropped. During 2005-2006, the population increased from 534-574. In 2007, it decreased again. Rising and dropping of population made the change of population increase about 0.9 percent.

2. The households increasing rate

The data on number of households, which were collected the related information was from the population census of Koh Chick village, were used to be an indicator show the change of number of households using the electricity from the past to the present as well as to be the database predicting the consumption of electricity within 17 years in the future. From the data, it was found that during 2004-2007the number of households was steady. From 2004-2006, there were 88 households using electricity. In 2007, it rose 2 households, totally 90. From the change of households, the number of households using electricity was about 0.76 percent per year.

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3. The income increasing rate

The data on income of Koh Chick, which were collected from sub-district administration organization, were used to be the data show the change of income from the past and to be the database predicting the consumption of the electricity within 17 years in the future. It was found that from 2005-2006 the rate of income dropped from 35,746-34,171 Baht and then it rose in 2550, totally 39,725 Baht. From the rise and drop of income is in 5.92 percent per year.

Limitation affected the increase of population, household and income is due to a small area of Koh Chick, which is not suitable for settlement expanse and its major occupation is small-fishing-boat traditional fishery, that effected influence economic growth.

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4.1.2.2 The data on electric appliances as follows;

1) The data of electric appliances used in 2007

This data were collected by using questionnaire asking every families living in Koh Chick. From the survey of the data in 2007, it was found that mixed energy has been using for 3 years. The result which was shown in the Table 4 - 2 was used to compare the data of electric appliances which were surveyed in 2002 as Table 4-2

Table 4-2 The daily electric burden of Koh Chick in 2007

NO	Electrical appliances	Power (W)	NO. of machines	Average hours used (hrs/day)	Total power(kWh)
1	36 W fluorescent	36	95	4	410.4
2	18 W fluorescent	18	290	4	624.4
3	compact fluorescent	9	80	6	129.6
4	29” television	200	1	4	24
5	25” television	150	3	4	54
6	21” television	100	48	4	576
7	20” television	70	12	4	100.8
8	14” television	50	32	4	192
9	personal computer	180	2	2.30	9.94
10	embroidery Machine	65	4	3	15.6
11	battery charging	300	12	3	86.4
12	stereo	30	40	2	38.4
13	VCD player	50	8	2	12.8
14	electric fan	45	146	5	985.5
15	motor/pump	2,500	2	2	80
16	washing machine	500	17	1	68
17	communication hall	90	2	0.30	0.22
18	refrigerator	100	39	24	2,808
19	microwave	1,000	1	0.30	1.5
20	1 liter-electric rice cooker	450	24	0.45	121.5
21	2.liter-electric rice cooker	600	37	0.45	249.75
22	electric cooking pan	700	2	0.30	2.1
23	iron	750	34	0.45	45.9
24	electric urn	600	22	0.30	118.8
Total					6,503.76

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Table 4-3 The electric appliances in 2007, compared to that of 2002

NO	Electrical load	Total machines (2002)	Total machines (2007)	Rate
1	36 W fluorescent	-	95	-
2	18 W fluorescent	686	290	-0.58
3	compact fluorescent	-	80	-
4	29” television	1	1	0
5	25” television	2	3	0.5
6	21” television	6	48	7
7	20” television	41	12	-0.71
8	14” television	53	32	-0.39
9	14”B/W television	6	-	-
10	personal computer	-	2	-
11	embroidery Machine	-	4	-
12	battery charging	-	12	-
13	stereo	63	40	-0.37
14	CD player	53	-	-
15	VCD player	-	8	-
16	electric fan	180	146	-0.19
17	motor/pump	1	2	1
18	washing machines	2	17	7.5
19	communication hall	1	2	1
20	refrigerator	-	39	-
21	microwave	-	1	-
22	1 liter- electric rice cooker	-	24	-
23	2 liter-electric rice cooker	-	37	-
24	electric cooking pan	-	2	-
25	iron	-	34	-
26	electric urn	-	22	-

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From the table 4-3, it was found that the data of electric appliances in 2007, compared to that of 2002, can be divided according to its types.

A) Lighting

This type consists of 36-18 W fluorescent and compact fluorescent. It was found that 36 W electrical light and lamp of the year 2007 and the use of 18 W is low about 0.58 %.

B) Television and radio type

This type consists of the televisions which are 29", 25", 21", 20", 14" and 14" B/W, personal computers, the players of DVD or CD. The change of using this type is little.

C) Electric appliance and other type

This type consists of electric fans, motor/pumps, communication hall, refrigerator, iron, electric rice cooker and electric urn. In 2007, it was found that after the use of electricity within 24 hours, villagers have bought a lot of electric appliances, such as washing machine, iron, electric pot which need a great amount of power. Consequently, it affects the production of electricity.

From the above data, it indicated that Koh Chick has many kinds of electric appliances which increased from the past on. Besides, the use of medium 18 W light bulbs decreased, but the use of 36 ones rose. For televisions, the use of 21" was high, but the use of 20" and 14" ones dropped. It could be concluded that due to sustainable electric appliances, the villagers liked to but bigger or newer ones to meet their needs.

2) The data on electric appliances that will be used in the future

From the data on the use of questionnaire completed by heads of families in 2007 revealed that villagers' demand of electric appliances was high because they wanted new electric appliances instead of old ones. The result of survey is displayed in the Table 4-4.

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Table 4-4 The electric appliances villagers need in the future

NO	Electrical load	Power (W)	Total machines	Hours used (hrs/day)	Total power(kWh)
1	18 W fluorescent	18	12	4	25.92
2	compact fluorescent	9	20	6	32.4
3	21” television	100	4	4	48
4	14” television	50	1	4	6
5	personal computer	180	3	2.5	16.2
6	stereo	30	1	2	0.96
7	VCD player	50	6	2	9.6
8	electric an	45	13	5	87.75
9	electric urn	600	1	0.45	8.1
10	washing machines	500	10	1	40
11	refrigerator	100	17	24	1,224
12	microwave	1,000	1	0.30	1.5
13	electric cooking pan	700	2	0.30	2.1
14	iron	750	3		
Total					1,492.93

From the table 4-4, it was found that the data of electric appliances can be divided as follows;

A) Lighting

This type consists of 18 W fluorescent and compact fluorescent. It was shown that electric appliances villagers did not want to have been 18 W ones, total 12 fluorescent. The rate of increase was 0.0024 and compact fluorescent, total 20 which its rate of increase was 0.0147.

B) Television and radio type

This type consist of 21” television, personal computer, radio, players of CD or DVD. It was found that the change of this type is not high, for instance, 21” television, total 4 sets. Its rate of increase was 0.0049 14” one, total 1 set. Its rate of increase was 0.0018. There were 6 sets of VCD players and its rate of increase was 0.0441. There was 1 amplifier and 3 personal computers, their rate of increase were 0.0882.

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C) Electric appliances type

This type consists of electric fan, washing machines, refrigerator, microwave and electric urn. It was found that villagers want this it type more than others, for example, 17 refrigerators and its rate of increase was 0.0252. There were 13 fans and its rate of increase was 0.0052. There were 10 sets of washing machines and its rate of increase was 0.0346. There were 3 irons and its rate of increase was 0.0052. There were 2 electric pans and its rate of increase was 0.0588. There was 1 water urn and its rate of increase was 0.0027.

4.1.2.3 The forecast of electricity consuming

The researcher used LEAP software to show the result of the of electricity demand from year 2007-2023, total 17 years by used the data of electricity consumption in 2007 as a database. From the forecast, it was found that the consumption of electricity of Koh Chick's villagers will rise about 0.0165 % a year prediction the year 2007, which the use of electricity will be 64,519 kWh. In 2023, it will be 83,661 kWh, which is different from that of the year 2007 at 19,141 as show Table 4-5

Table 4-5 The forecast of electricity consuming from 2007-2023

Year	Electricity (kWh)	Year	Electricity (kWh)
2007	64,519	2016	74,456
2008	65,532	2017	75,685
2009	66,565	2018	76,941
2010	67,621	2019	78,225
2011	68,700	2020	79,538
2012	69,802	2021	80,881
2013	70,928	2022	82,255
2014	72,079	2023	83,661
2015	73,254		

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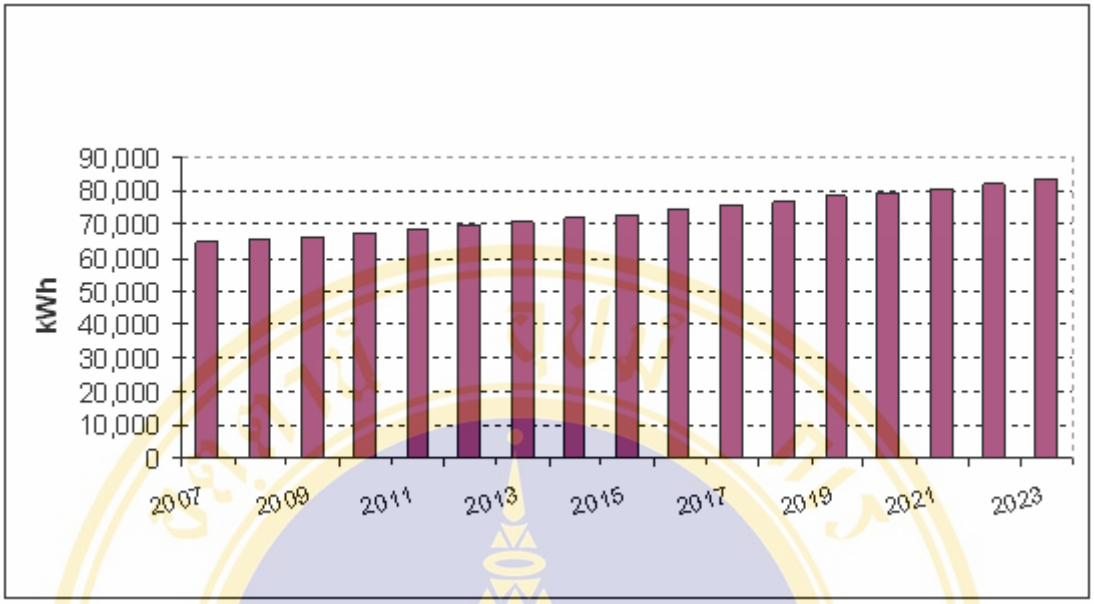

Figure 4-7 The tendency electric demand in future from 2007-2023

4.1.3 The peak load on monthly

In order to show the period of consuming the electricity of a month and a day. To see the change of using electric energy of each time. The gained data can help manage the electric energy. Yet, the researcher was not able to investigate the demand of daily electric consumption because there was not an instrument collecting data and Koh Chick village hybrid power system office did not collect available data. Due to these problems, the researcher studied only the most monthly electric consumption by using the data of the first electric use of hybrid generating system. From September 2004 to May 2007.

From the analysis, the month that had the lowest demand of electricity was November 2005 at 2,420 unit and March 2007 was the highest, at 5,784 unit. Each month had the average demand of electricity was about 4,102 unit. Due to March- June, hot season, people consumed the electricity the most. They used electric fans to ventilate all day and night which caused demand of electricity high. For rainy season was lower demand owing to cool temperature; consequently, electric fans were not used all time, just certain time as show Table 4-6.

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Table 4-6 The peak load on monthly from September 2004 to July 2007

Month / Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
2004	-	-	-	-	-	-	-	-	2,789	3,945	4,048	4,340
2005	5,017	4,435	5,222	5,833	5,753	5,295	4,975	5,030	5,449	2,601	2,420	2,946
2006	3,589	3,364	5,009	4,448	5,169	3,479	3,604	3,525	3,871	4,004	3,635	3,728
2007	5,201	3,354	5,784	3,927	4,144							

(Unit)

* Price of electricity per unit

Aug. 2004-Sep. 2005 unit 12 Baht

Oct. 2005-May 2006 unit 15 Baht

Jun. 2006-Dec. 2006 unit 20 Baht

Jan. 2007-May 2007 unit 15 Baht

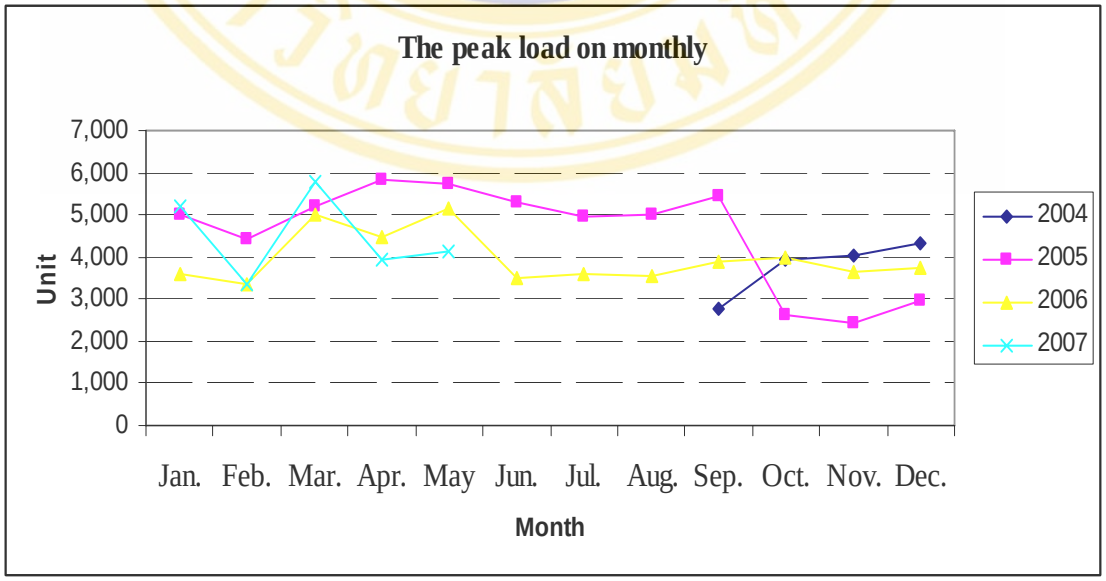

Figure 4-8 The peak load on monthly from Sep. 2004-May 2007

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The behavior on electricity consumption of Koh Chick village was relevant to cost of unit. The villagers began using electric energy on 17 August 2005. At the beginning of the project, people had to pay 12 Baht per a unit. The first use of electricity was 2,789 unit and became higher on September 2005 at 5,449 unit. Since the budget of producing energy was high, the cost of electricity on October was 25 baht a unit, which caused the use of the electricity greatly decreased at 2,601 unit, dropping from the previous month about 2,844 unit. After that the demand of electric energy got higher until May 2006 at 5,169 unit; as a result, the cost of electricity rose from 15 to 20 Baht a unit and it dropped again on June 2006 at 3,479 unit, dropping from the previous month at 1,690 unit. The villagers' consumption was increased to 4,000 unit on January 2007, since the cost of electricity dropped from 20 per unit to 15 per unit; as a result, the electricity consumption highly increased from 5,201 to 1,473 unit. Concluding, the cost of electricity influenced the behavior of villagers on electricity consumption because the high cost affected them aware of using the energy.

4.1.4 The forecast of electricity generation

Forecast the electricity generation of Koh Chick, which consists of solar cell system, wind turbine system diesel generator, can be conducted through by studying the efficiency of each system as follows;

1) Solar cell system

The effectiveness of PV array dropped slowly. The manufacturers had warranted efficiency; no more than 10% drop for life time. The effectiveness of the solar cell is still around 90% within 20 year. Other equipment also will be warranted for 20 years (23). Solar system of Koh Chick can be forecasted the electricity production as show Table 4-7.

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Table 4-7 The forecast of electricity generation from solar cells

Year	Electricity (kWh/year)	Year	Electricity (kWh/year)
2007	10,605	2016	10,119
2008	10,551	2017	10,065
2009	10,497	2018	10,011
2010	10,443	2019	9,957
2011	10,389	2020	9,903
2012	10,335	2021	9,849
2013	10,281	2022	9,795
2014	10,227	2023	9,741
2015	10,173		

From the table, it was found that had the capability of solar system in producing electricity dropped from 2007. It could generate solar energy at 10,605 kWh a year but the effectiveness of solar cells decreased 0.5% a year (0.5 per year+20 year=10 percent of the longevity.) It was shown that solar cells produced decreasingly at 54 kWh a year. In 2023, it can produce the electricity at 9,741 kWh.

2) Wind turbine system

The effectiveness of wind turbine depends on dynamo which is an electric generator. Dynamo is a tool which consists of copper coil and magnet have long lifetime, as a result, it can effectively produce electricity (24). When some engines of the turbine system, such bearing, blade, gasket control system and tower of turbine are damaged, it affects the production of electricity. Therefore, it should be maintained regularly. On the whole, turbine will be guaranteed for 20 years. From the study of turbine system of Koh Chick, it was found that turbine systems has an ability of producing electricity at 11,367 kWh a year and are kept by renewable energy center of Koh Chick, consequently producing electricity is still steady at 11,367 kWh a year.

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3) Diesel generator

The effectiveness of diesel generating system has the figure of decline about 15-20% of its lifetime. For the equipment, such as electric pots should be regularly maintained, such changing motor oil. In general, diesel engines have quality guarantee about 20-25 years. The diesel generator of Koh Chick, which 15% of decline at 20 years of lifetime, can be predicted regarding electric production as show Table 4-8.

Table 4-8 The forecast of electricity generation from diesel generator

Year	Electricity (kWh/year)	Year	Electricity (kWh/year)
2007	89,351	2016	83,177
2008	88,665	2017	82,491
2009	87,997	2018	81,805
2010	87,293	2019	81,119
2011	86,607	2020	80,433
2012	85,921	2021	79,747
2013	85,235	2022	79,061
2014	84,549	2023	78,375
2015	83,863		

From the table, it was found that diesel generator system has low capability of producing electricity. In 2007, it can produce electricity 89,352 kWh a year, yet the effectiveness of diesel engine dropped 0.75% a year. (0.75 a year+20 years = 15% of its lifetime). It indicates that diesel engines produce electricity decreasingly 686 kWh a year.

4) The lost of electricity in wire

The electricity has loss from generator to households and the electric wire made of aluminium. Due to these electric wire are low voltage, it causes push force at the end of the lines about 5%, divided into 2 types-distances for 700 m and 800 m as Table 4-9.

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Table 4-9 The voltage in low voltage system

Lines row	Lines size (mm^2)	Electric current (A)	Distance (m)	Voltage Dip (V)	Voltage Dip (%)
A	95	49.38	700	14.83	4.88
B	95	49.38	800	16.95	5.57

From the table 4-8 it can be calculated to find the loss of electricity. This following is the formula of calculating electric power.

$$P = V + I \quad \text{..... (5)}$$

Where; P = electric power (W)

V = electric current (A)

I = voltage Dip (V)

From the formula, it can calculate to find the electric power that has lost in the electric lines in each year about 6,873 kWh, and then it will be calculated to find the real electric energy which generating from the electric system to consumers. From the calculation,

(Load = electric from source - the figure loss) show Table 4-10.

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Table 4-10 The electricity generation all system during 2007-2023

Year	Electricity (kWh/year)	Year	Electricity (kWh/year)
2007	104,450	2016	97,790
2008	103,710	2017	97,050
2009	102,988	2018	96,310
2010	102,230	2019	95,570
2011	101,490	2020	94,830
2012	100,750	2021	94,090
2013	100,010	2022	93,350
2014	99,270	2023	92,610
2015	98,530		

The forecast of electricity generation that the system can produce in the future is shown in the table 4-10. The capability of electricity generating is getting low in each year which means the effectiveness of generating system deceased in its lifetime.

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4.2 The electricity management of Koh Chick

4.2.1 The structure electricity management of Koh Chick village

Koh Chick village has electricity management namely Koh Chick village hybrid power system office which is a private organization, through villagers arrange it; to set the price that is changed according to the cost of producing electricity. This is different from the renewable energy system of Phukradung which is managed by Phukradung National Park, and supported by the government.

The electricity management of Koh Chick is shown in the Figure 4-9, divided into 2 parts as follows;

1) Renewable power committee of Koh Chick

The committees are elected by people, who live in Koh Chick community. Their functions are: to consider the plan and policy on electric power and to arrange the electricity price by hearing from people's opinion. To make this management fair and correct, they accept other people's opinions and ideas. The committees have period for 3 year and have no wage.

2) Koh Chick village hybrid power system office

The office duty of this center is to maintain the electricity generation system and collect the electricity bills. This Koh Chick village hybrid power system office center consists of the manager, accountant, financial worker, and technician.

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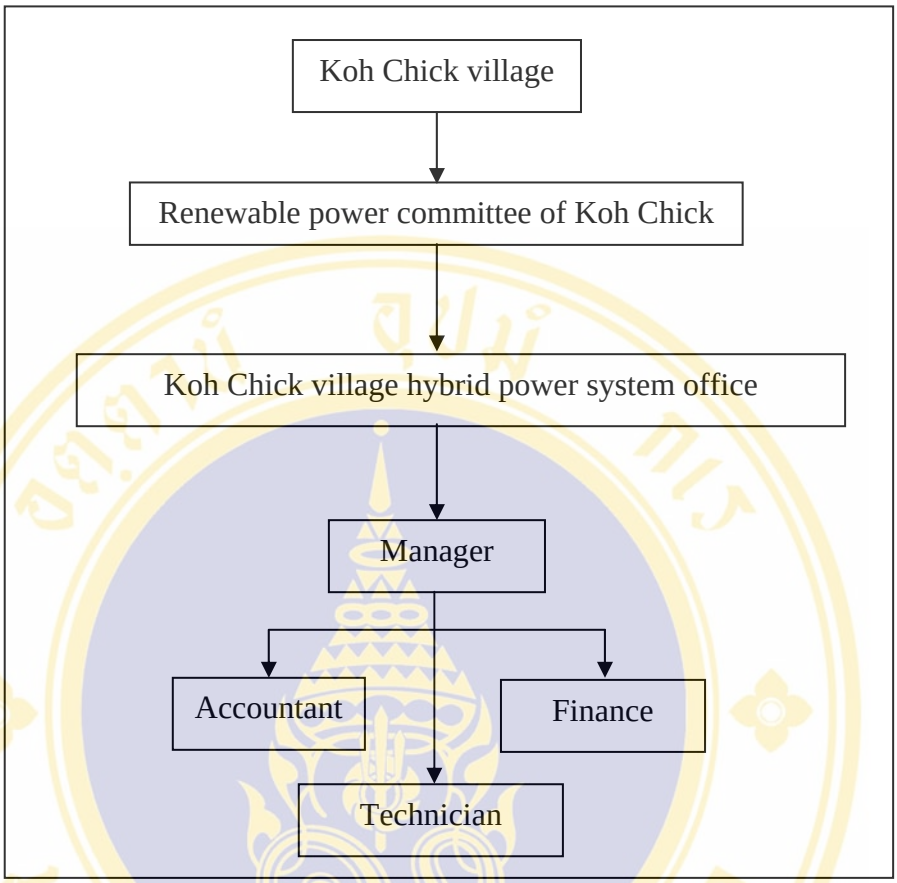

Figure 4-9 The structure electricity management of Koh Chick village

Table 4-11 The personnel structure electricity management of Koh Chick village

Committee related to energy		Koh Chick village hybrid system energy office	
Office	Name	Office	Name
President	Mr. Sahad Chisakronsamud	Manager	Mr. Prakat Teephasai
Secretary	Mr. Prakat Teephasai	Finance	Miss Wiwon Suko
Committee	Mr. Narong Hamsuwan	Accountant	Miss Natnapa Namwong
Committee	Mr. Sanya Losasat	Technician	Mr. Suwit Nutmeeko
Committee	Mr. Sombun Tanpraset		
Committee	Mr. Phamun Phanrod		
Committee	Mr. Datchai Chata		
Committee	Mr. Yem Chatey		
Committee	Mr. Danai Bumroa		

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4.2.2 The turnover of Koh Chick village hybrid power system office

Koh Chick village hybrid power system office has an account book in order to inspect there profit account (income, expenses and liquidity financial).

According to analysis of Koh Chick village hybrid power system office: at the beginning on August 2005 to May 2007 (the last month of study): they lost money 167,212 Baht. The main income come into electricity distribution 2,058,808 Baht, nevertheless main expenses come into salary, fuel, maintenance diesel generator and miscellaneous about 2,226,020 Baht as show Table 4-12.

Table 4-12 The turnover of Koh Chick village hybrid power system office at the beginning project August 2005 to May 2007

Items	Income (Baht)	Expenses (Baht)
Electricity bill from village	2,044,515	-
Electricity bill from use pump	9,173	-
Electricity bill from the Telephone Organization	2,250	-
Pre-Paid card	2,820	-
Other	50	-
Official salary	-	719,340
Fuel oil	-	1,302,160
Telephone	-	5,081
Maintenance diesel generator	-	82,134
Miscellaneous	-	103,892
Stationery	-	13,413
Total	2,058,808	2,226,020

Source: Koh Chick village hybrid power system office (August 2005 to May 2007)

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4.2.3 The factor affecting the capita electric generate

1) The expenses of official salary

The salary of officer is a main expense from beginning the project to the last of study has about 719,340 Baht. Following in the beginning, all of salary about 28,340 Baht a month and become lower to 25,000, 22,000 and 18,500 Baht per month respectively. The salary reduces to support finance of company which is willingness of officer.

2) The expenses of fuel oil

Diesel generator is electricity generation system, which is produced when high electricity demand. Since beginning project to finished study have expenses fuel oil about 1,302,160 Baht, it high capital of company and can't control because of it depend on market. The expenses relate to electricity demand for example; high electricity demand as well as using high fuel oil as Figure 4-10.

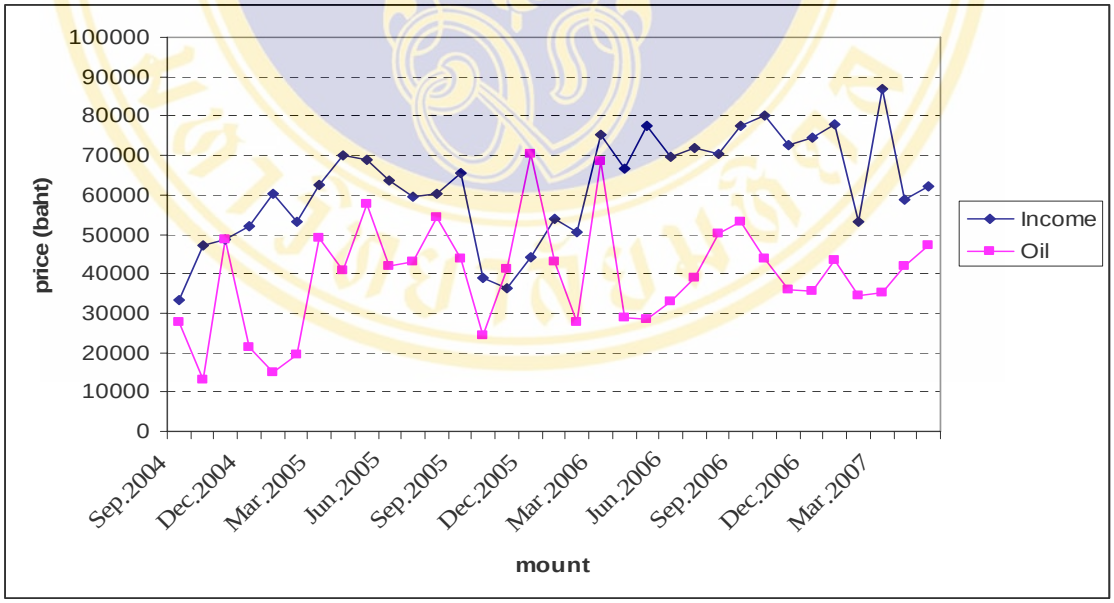

Figure 4-10 The income of electricity bill compare the expanses of fuel oil

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3) The cost of maintenance diesel generator

To keep a certain level of efficiency the diesel generator must be maintained regularly and fixed when broken especially the boiler, which is prone to have problems when their temperature is too high. Since beginning project to finished study have expenses fuel oil about 82,134 Baht.

4.2.4 The problems of a management of Koh Chick village hybrid power system office

The use of electricity of Koh Chick villagers found that the light was put out or end short time. Due to virous factors temperature, wind current. The electricity generation protection system cut it automatically and another cause is production system itself as follows;

1) The maintenance diesel generator system.

Diesel generator is a main system which produces electricity. When the system used for a long period, a boiler may be broken, so this machine have not long lifetime. In addition need to maintain and fixing a part of machine, that must ship to fix at Chantaburi Province. Due to no spare parts to maintain at Koh Chick village, it uses lots of money and increases the company's outlay.

2) Wind turbine system

This system can produce electricity anytime when it is windy. In fact, from two wind turbines, at the study time, the other one was broken. The officials did not know any causes. So, they have waited the worker of the wind turbine company to fix this system (it still in an insurance time).

3) Inverter system

It is a system which changes electric direct current to alternating current. At the time of research, this system was broken. It can use only one machine from two machines. Thus, the use of electricity from solar cell system was lower efficiency and Koh Chick village hybrid power system office can not repair it, they have waited the experts to repair it.

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4) The structure of Koh Chick village hybrid power system office.

The personnel almost are villagers who less skill on technology, the maintenance is limited and this office was insufficient equipments and also spares.

Owing to the problems of electric production system, it shows that the production system has level of high-technology, spares must order and the maintenance needs experts. When it broken must wait for a long time to maintenance, it affects the quantity of electricity which can not produce balanced with system. This problem must correct right now in order to the stable of electricity and monetary matters status of Koh Chick village hybrid power system office.

4.2.5 The satification of Koh Chick villagers with the management of Koh Chick village hybrid power system office.

The questionnaires ask 76 persons. The result found that the most of them pleased (80.3%) with the management of Koh Chick hybrid power system office.

Table 4-13 The satification of Koh Chick village.

	Not pleased	Apathetic	pleased	Very pleased
Answer	6	7	61	2
Percent (%)	7.9	9.2	80.3	2.6

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4.3 The appropriate for electricity management of Koh Chick

Koh Chick village appropriate for electricity management dividing as follows;

4.3.1 The analysis of electricity demand and supply of Koh Chick village.

The analysis demand and supply of can be summarized that the electricity demand will be increasing. The electricity generation system can support the demand in 2007-2023 as show Figure 4-11. The diesel generator is a major system for electricity generation whereas it had high cost that the trend of fuel oil in the market is increasing all the time. All these reasons affect with Koh Chick village hybrid power system office management.

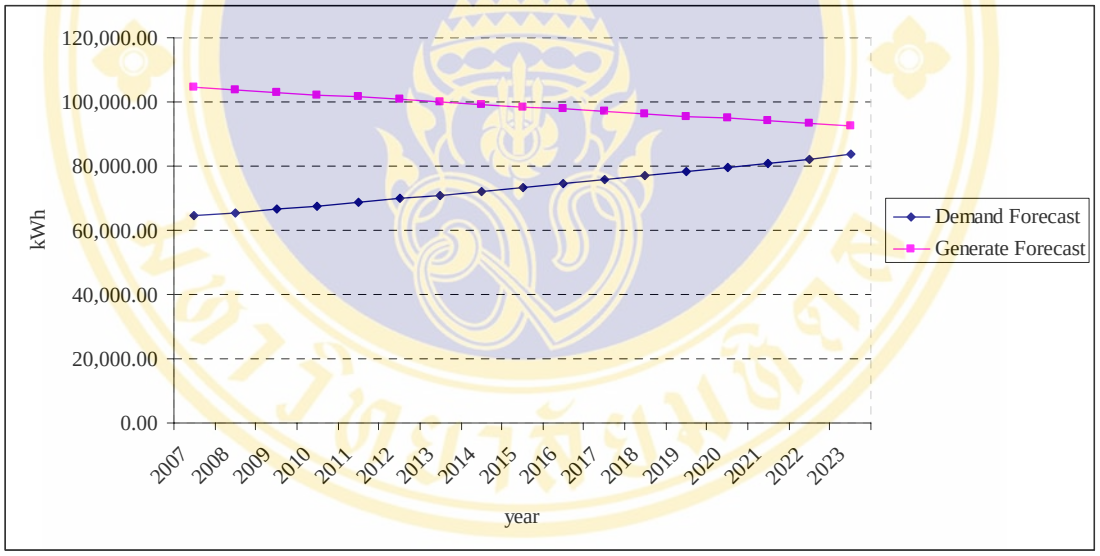

Figure 4-11 The electricity demand and supply in year 2007-2023.

The tendencies of fuel oil production in future.

A) The fuel oil requirement of the world will increase 5-6% a year, however the fuel oil demand in exported fuel oil countries increase more than developed countries and developing countries because of they has price support of fuel oil make cheapness by gasoline price in Saudiarabai about 5 Baht a liter.

B) The fuel oil production of OPEC's will increase. If it has not problem about uncertainties policy in Nigeria, Iraq and Iran. Whereas non-OPEC,

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such as Latin America, Africa and U.S.A, fuel oil production will increase. Both of OPEC and non-OPEC can not produce enough fuel oil for consumer demand. If oil price is lowers, the OPEC want reduce production that affect oil price increase unavoidably.

C) The U.S dollar currency has value of money lower value when compare Euro currency cause oil price has been increased 100 U.S. dollar .By the oil price highest originate 1 in 3 of problem lower U.S. dollar.

Therefore, the price of fuel oil has will be varied or fluctuated that it depended on the amount of production and political reason emphasized by the increase in oil demand taking into account the above mentioned reason. The study assumed that oil prices will increase further in the coming years.

The diesel price from 1996 to 2006 and forecasting of diesel price tendency in 2007-2023 by using MINITAB, which is linear regression statistic analysis. The result found that diesel price is 25.74 Baht a liter in 2007. In addition to year 2023, the diesel prices become to 48.35 Baht a liter that show increasing rate about 0.046% a year show as figure 4-12.

In accordance with forecasting of diesel fuel expense of Koh Chick, the expense increase from 1,277,759 Baht in 2007 to 2,400,142 Baht in 2023 that has different expense amount 1,122,383 Baht as Table 4-14.

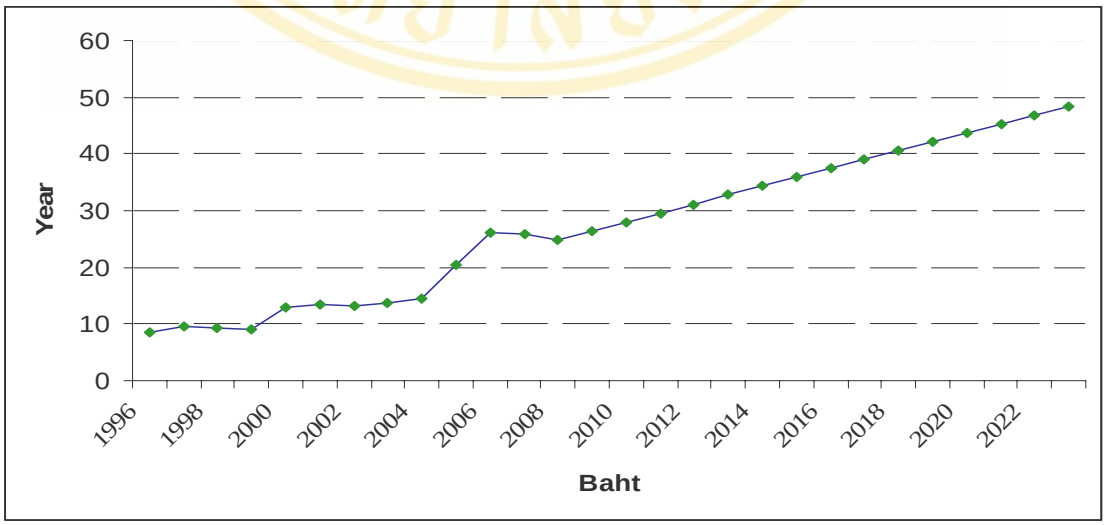

Figure 4-12 The tendency of diesel fuel price in future

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Table 4-14 The diesel fuel expense of Koh Chick village hybrid power system office

Year	Electricity (kWh)	Diesel fuel	Diesel fuel price (Baht/Liter)	Total (Baht)
2007	104,450	49,641	25.74	1,277,759
2008	103,710	49,641	24.91	1,236,557
2009	102,988	49,641	26.48	1,314,493
2010	102,230	49,641	28.04	1,391,933
2011	101,490	49,641	29.60	1,469,373
2012	100,750	49,641	31.16	1,546,813
2013	100,010	49,641	32.73	1,624,749
2014	99,270	49,641	34.29	1,702,189
2015	98,530	49,641	35.85	1,779,629
2016	97,790	49,641	37.41	1,857,069
2017	97,050	49,641	38.98	1,935,006
2018	96,310	49,641	40.54	2,012,446
2019	95,570	49,641	42.10	2,089,886
2020	94,830	49,641	43.66	2,167,326
2021	94,090	49,641	45.22	2,244,766
2022	93,350	49,641	46.79	2,322,702
2023	92,610	49,641	48.35	2,400,142

The renewable energy needed in order for decreasing diesel consumption prevents the impact for electricity demand of Koh Chick people. The renewable energy has potential for install on Koh Chick; that is the solar energy and the wind energy as show Table 4-15.

Table 4-15 The renewable energy has latency

Solar energy (kW)	Power (kWh/year)	Save fuel oil (Liter)	Wind energy (kW)	Power (kWh/year)	Save fuel oil (Liter)
7.5	9,644	4,160	5	5,683	2,452
15	19,288	8,320	10	11,367	4,903
30	38,576	16,640	15	17,051	7,355
45	57,864	24,960	30	34,102	14,710

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The analysis finds appropriate renewable energy on Koh Chick, which is use the SWOT analysis.

4.3.2 The SWOT analysis for appropriate renewable energy system

SWOT analysis is a tool, using analyst social efficiency. This research is to study on an appropriate renewable energy by expert judgments.

The Strength, Weakness, Opportunities and Threats, the concept of SWOT, is applied in analysis by queries on 5 experts. The researcher gives information on general information, location of Koh Chick, climate characteristic, and electricity consumption behavior of villagers. The experts will consider an appropriate renewable energy by using this provided information as show Table 4-16.

Table 4-16 The analysis with SWOT for solar energy and wind energy in Koh Chick

	Solar energy	**Wind energy**
Strengths	- less of maintenance - 20 years of life time - efficiency of energy source - less environment	- less of maintenance - 20 years of life time - efficiency of energy source - less environment
Weaknesses	- put the battery on charge of electricity - can produce electric energy only day-time - require large area to installation - difficult to movement - must have inverter to change electric current - cannot fix when solar cell damages	- produce electric energy when it is windy - wants many areas to install - difficult to movement require many labors and equipments - depend on international technology
Opportunities	- increasing use in rural area - support by the government - has produce industry in Thailand	- support by the government
Threats	- high cost - less skill - the wealth for investment	- high cost - less skill - the wealth for investment

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Table 4-17 The analysis by SWOT

The analysis factors	Solar energy (scores)	Scores average	Wind energy (scores)	Scores average
Strengths	22	4.4	22	4.4
Weaknesses	15	3	15	3
Opportunities	22	4.4	21	4.2
Threats	16	3.2	14	2.8
Total	75	-	72	-

From Table 4-17 the solar energy system has 75 points that more than wind energy system which has 72 points. This is revealed that solar energy is appropriate to install in Koh Chick village.

4.3.3 The understanding of villagers with hybrid system.

The questions can be as 4 topics as follows;

4.3.3.1 The meaning of renewable energy.

The questionnaire asks 76 persons, which is found the most villagers understanding of renewable energy: it means the produce of electricity from natural resources as show Table 4-18.

Table 4-18 The meaning of renewable energy

	The produce of electricity from the one of energy resource	The produce of electricity from many resources in the same time	The produce of electricity from solar cellt or wind	The produce of electricity which can replace each other
Answer	0	0	51	25
Percent (%)	0	0	67.1	32.9

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4.3.3.2 The understanding of renewable energy.

The questionnaire asks 76 persons, which is found the most villagers understanding of renewable energy: it uses natural resources efficiency and the others understood that it can preserve our environment as show Table 4-19.

Table 4-19 The understanding of renewable energy.

	Preserve environment	Use natural resources efficiency	Depend on natural resources which has in this area	Spread energy source	This is the use of one energy to support another energy	All right every choices	Don't understand about renewable energy
Answer	19	23	18	3	1	11	1
Percent (%)	25	30.3	23.7	3.9	1.3	14.5	1.3

4.3.3.3 The understanding on the producing of hybrid electric renewable energy system.

The questionnaire asks 76 persons, which is found the most villagers understanding of renewable energy: it can uses 24 hours as show Table 4-20.

Table 4-20 The understanding about the produce of hybrid electric renewable energy system

	It is a temporary system	It is a 24 hours system	Don't know how long can it use
Answer	1	72	3
Percent (%)	1.3	94.7	4

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4.3.3.4 The understanding on Koh Chick's electricity produces system.

The questionnaire about the understanding of Koh Chick's electricity produce system by 76 persons found that villagers understood about: it can produce electricity from diesel, wind energy and sunlight energy as show Table 4-21.

Table 4-21 The understanding on Koh Chick's electricity produce system

	It can produce electricity by Diesel only	It can produce electricity from wind energy and sunlight	It can produce electricity from diesel, wind energy and sunlight energy
Answer	0	0	76
percent	0	0	100

4.3.4 The analysis a measure and planning of electricity management

4.3.4.1 The information of the government development to Koh Chick village.

According to 3-5 year strategic planning of Bang Chun sub-district administration organization. It has many basic projects to develop that is;

1) Port project.

2) Community water-supply project.

3) Eco- tour project.

All of projects influence to Koh Chick development, labors employment and tourist promotion and affect electricity demand in future.

4.3.4.2 The electricity demand management measurement

- The measurement of Koh Chick village hybrid power system office.

1) Use Pre-Paid card

2) Do not install air-conditions.

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- The additional in controlling electricity consumption

1) Controlling analysis electricity appliances using in Koh Chick village.

A) The lighting, villagers should use lower Watt of fluorescent; for 18 Watt and compact fluorescent instead of 36 W.

B) The television and radio type, villagers should use 14” televisions. In place 21” or 25” televisions.

C) The electric appliances type, presently have increasing tendency to buy refrigerator, washing machine and electric fans. We should choose 5- saving- label electric appliances.

2) The measurement should give knowledge about how to save energy to village.

3) Seasonal consumption, electricity demand in were season in higher the winter season, they should decrease electricity consumption by adjust behind them self such as opening the windows and ventilate the room oriented wind directing.

4.3.4.3 The plan of electric energy management in the future.

As a result, the analysis of Koh Chick village, it has the stability of electricity. On the other trend the prices of fuel oil trend increase that influence of product cost. For this reason it need plan to control electricity consumption as follow;

1) Short-term plan

- Should be maintenance their electricity generation system for optimize and efficiency.

2) Long-term plan

- The renewable committees of Koh Chick village hybrid power system office and villagers should be provide funding to support installation the solar cell system in the future.

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CHAPTER V
CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The objective of this study is mainly to identify electricity generation system and electricity demand for appropriate electricity management of Koh Chick. The result of the study can summarize as follow;

1. The capability of electricity generation system in future (2007-2023) found that wind turbine system has a stable capability, solar cells and diesel generator system has deceased 0.5%, 0.75% a year respectively. In 2023, the forecast of electricity generation of all system shows that they can produce 92,610 kWh of electricity. In additional, by applying LEAP software to forecast the electricity demand in year 2007-2023 of Koh Chick found that the demand has yearly increasing rate at 0.0165%. In 2023 (the electricity demand) will be 83,661 kWh. According to study research, the hybrid system has an adequate power for demand in future (2007-2023).

2. The proportion of hybrid electricity generation system is 18.25% of renewable energy and 81.75% of diesel generator; it shows that diesel generator is a major system to generate electricity. Due to the diesel fuel price, the Koh Chick village hybrid power system office, which management for 3 years, has lost a profit 167,212 Baht. The tendency of diesel fuel prices, by forecasting, found that increasing rate is yearly 0.046% of diesel fuel. The diesel fuel oil price change in year 2007 from 28.74 Baht a liter to 48.35 Baht a liter in year 2023 that has a price different amount 1,122,383 Baht.

3. The effect of the increasing tendency of diesel fuel price on Koh Chick village hybrid power system office management have to develop a renewable energy in order to decrease cost of diesel generator. By using SWOT analysis to study appropriate, which judge of the experts.

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Thus, the appropriate electricity management of Koh Chick is; to practice the measurement and planning of electricity management, and to support to install the solar cells as renewable energy for decreasing cost of diesel generator.

5.2 Recommendation

5.2.1 Research Recommendations

According to this research, the researcher would like to add some interesting recommendations for advantages as follows;

1.1 The energy committees should request the foundation for support their energy conservation. Furthermore, the energy policy and plan office should request budgets to develop the renewable energy system for future and repair electricity generation system for easy to use. Moreover, DEDE should accompany the proper execution of Koh Chick village hybrid power system office such as villagers who want to know new technology.

1.2 King Mongkut's University of Technology Thonbury, which is the authorized institute to develop this system, should always maintain the system and give a technical knowledge to villagers. In addition, they should be able to maintain by themselves and also reduce their fixed-cost.

1.3 The expansion of eco-tourism, is supported by The District Organization, should be limited amount of tourist who want to travel at Koh Chick since many tourists increasingly consume electric energy.

1.4 The electricity cost, which collect stably rate, should let it goes with a high cost of fuel oil.

5.2.2 Recommendations of further Researches

1. According to the electrical quantity data of this present study, further study should collect the data in the real temporal and spatial boundaries.

2. For the further study, economic data should collect or search the real data of GDP in the specific boundary or study area.

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REFERENCES

1. วสันต์ จันทร์สัจจา.โซล่าเซลล์เอื้ออาทร. Available from: http://industrial.se-ed.com/itr112/itr112_167.asp (Accessed 20 พฤษภาคม 2549)
2. มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี. รายงานการวิจัยเรื่อง โครงการระบบผลิตไฟฟ้าด้วยพลังงานทดแทนแบบผสมผสานสำหรับชนบท กรณี หมู่บ้านเกาะจิก. กรุงเทพมหานคร; 2547.
3. สำนักงานนโยบายและแผนพลังงาน. วารสารนโยบายพลังงาน. พิมพ์ บริษัท กราฟฟิคแมส จำกัด. กรุงเทพมหานคร; 2548.67:20-23.
4. Hybrid Power Systems - Issues & Answers. [Online]. Available from: http://www.sandia.gov/pv/docs/Hybook.html. [Accessed 2006 September 21]
5. The Wonderful World of Renewable Energy. [Online]. Available from: http://www.wind-power.com/. [Accessed 2006 September 21]
6. National Renewable Energy Laboratory: NREL [Online]. Available from: http://www.nrel.gov/learning/re_photovoltaics.html. [Accessed 2006 September 19]
7. Fries P. Natural selection, evolving choices for renewable energy technology and policy. United Nation Environment Programme; Copyright 2000.
8. Energy Information Administration. [Online]. Available from: http://www.eia.doe.gov/kids/energyfacts/sources/renewable/wind.html [Accessed 2006 September 25]
9. กรมพลังงานทดแทนและอนุรักษ์พลังงาน. พลังงานลม. [Online]. Available from: http://www.dede.go.th/dede/index.php?id=27 [Accessed 2006 September 25]

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10. Sereepaowong S. Hybrid electrification system for off-grid rural community: Ko Chik village pilot project. [M.S. Thesis in Technology of environment management].Nakornpatom: Faculty of Graduate Studies, Mahidol University; 2005.

11. มหาวิทยาลัยเทคโนโลยีพระจอมเกล้าธนบุรี. รายงานความก้าวหน้าครั้งที่1โครงการระบบผลิตไฟฟ้าด้วยพลังงานทดแทนแบบผสมผสานสำหรับชนบท กรณี หมู่บ้านเกาะจิก. กรุงเทพมหานคร; 2547.

12. National Association of energy Service Companies: NAESCO [Online]. Available from: http://www.naesco.org/about/esco.htm. [Accessed 2006 September 19]

13. การพยากรณ์ความต้องการไฟฟ้า. คณะอนุกรรมการพยากรณ์ความต้องการไฟฟ้า. [Online]. Available from: http://www.eppo.go.th/load/load2004-jan04rev/index.html [Accessed 2006 September 19]

14. LEAP Tools for Sustainable Energy Analysis. [Online]. Available from: http://www.energycommunity.org/default.asp?action=47. [Accessed 2006 September 19]

15. SWOT Analysis. [Online]. Available from: http://www.netmba.com/strategy/swot/ [Accessed 2006 November 20]

16. Klaimukh T. The technology assessment of PV/wind/diesel hybrid system: a case study at Tarutao Marine National Park [M.S. Thesis in Appropriate Technology and Resource].Nakornpatom: Faculty of Graduate Studies, Mahidol University; 2004.

17. อนุชา พรมวังขวา และคณะ. การจัดการความต้องการไฟฟ้าสูงสุดของมหาวิทยาลัยเชียงใหม่. วารสารโลกพลังงาน. ปีที่ 7 ฉบับที่24 กรกฎาคม-กันยายน, 2547.

18. Maria E, Tsoutsos T. The sustainable management of renewable energy sources installations: legal aspects of their environmental impact in small Greek islands. Energy Conversion and Management.45.2004; 631–638

19. Yaungket J. Electricity Situation in Thailand analysis by LEAP Tool, 2004.

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20. Foran T. Securing Energy Efficiency as a Top Priority Electricity Resource: Scenario Analysis of Thailand's Energy Consumption. The Joint Graduate School of Energy and Environment, King Mongkut's University of Technology Thonburi, Bangkok, Thailand; 2006

21. บุญเชิด ภิญโญอนันตพงษ์. การทดสอบแบบอ้างอิงเกณฑ์. แนวคิดและวิธีการ. กรุงเทพมหานคร. โอเดียนสโตร์. 2527; 69.

22. บุญธรรม กิจปรีดาบริสุทธิ์. เทคนิคการสร้างเครื่องมือรวบรวมข้อมูลสำหรับงานวิจัย. กรุงเทพมหานคร. โรงพิมพ์บีบีพลับลิชชิ่ง. 2534; 106-234.

23. ประพิธาริ์ ธนารักษ์. การศึกษาผลตอบแทนทางด้านเศรษฐศาสตร์และการเงิน: ระบบไฟฟ้าจากพลังงานทดแทนแบบอิสระจากสายส่งในชนบท. วิทยาลัยพลังงานทดแทน มหาวิทยาลัยนเรศวร. พิษณุโลก. 2549

24. กองพลังงานทดแทน. สำนักงานวิจัยและพัฒนา. การไฟฟ้าฝ่ายผลิตแห่งประเทศไทย

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APPEXDIX A
LEAP Program

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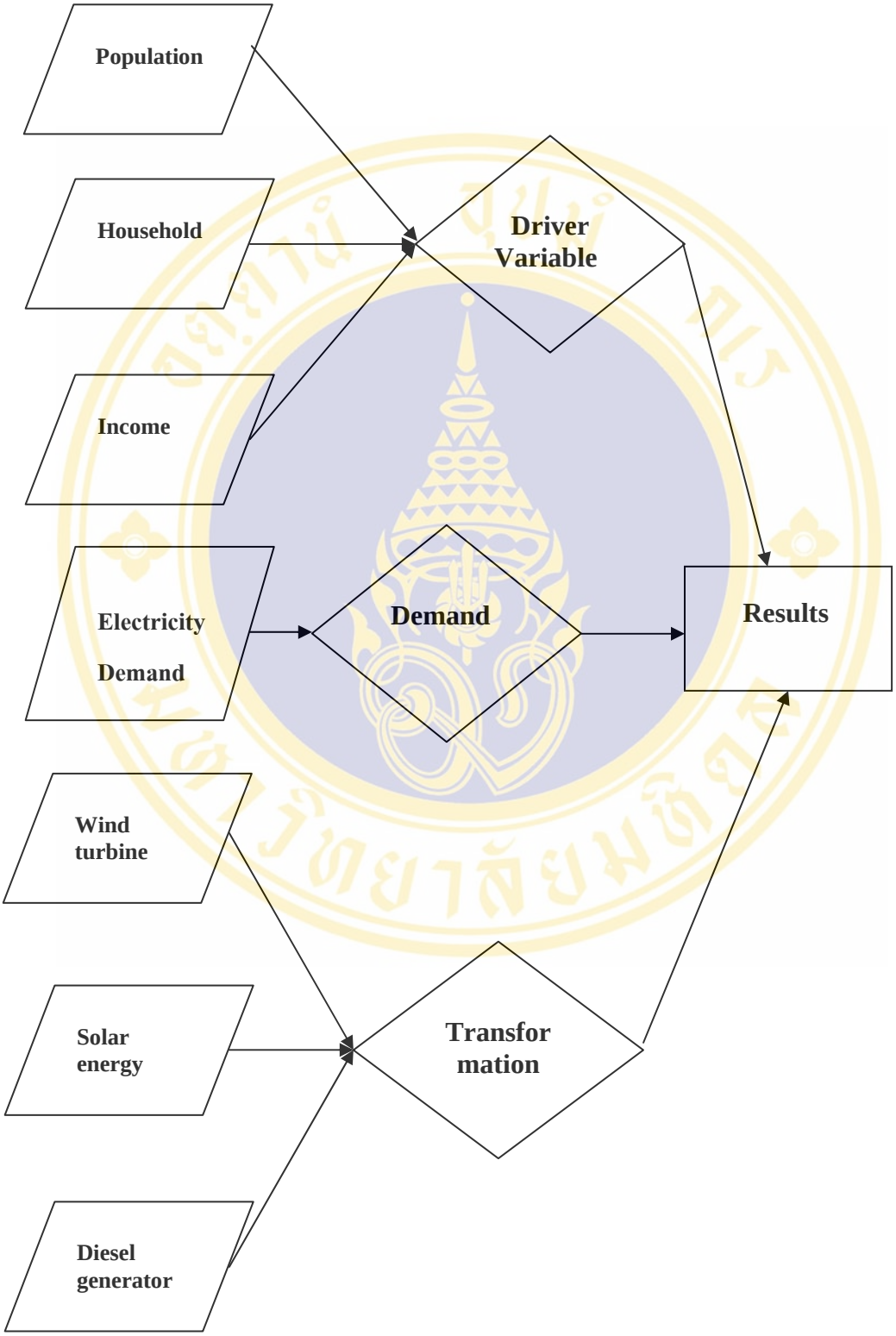
Input data-Result analysis



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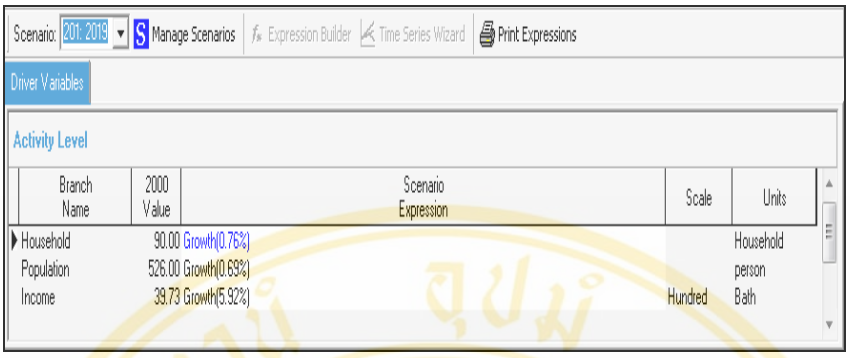
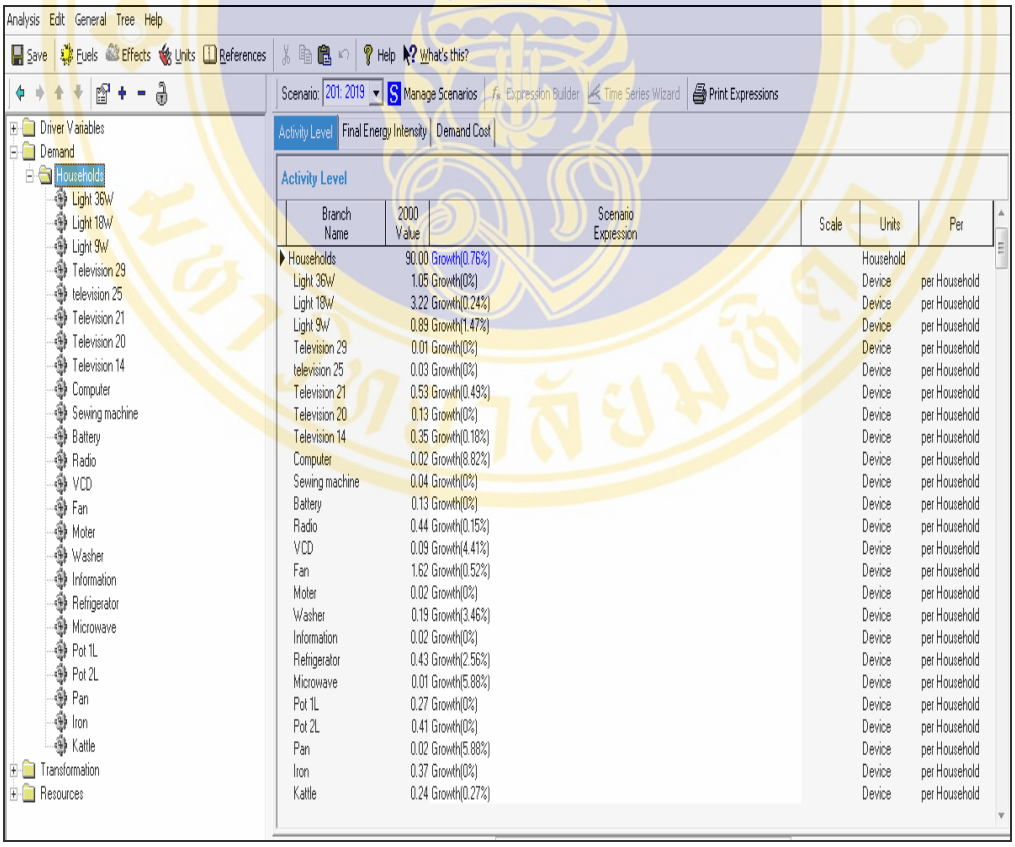
Analysis data in Driver Variables



Analysis data on Demand



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Analysis data in Transformation

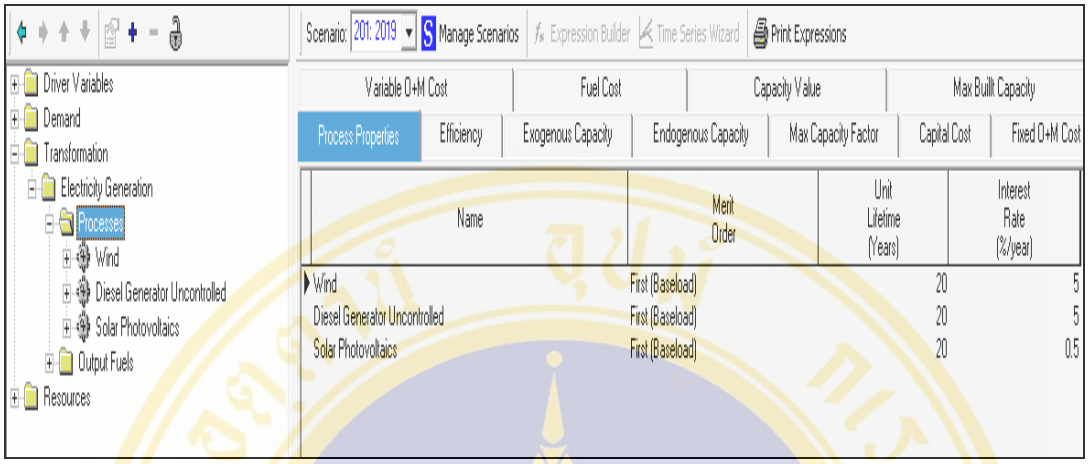
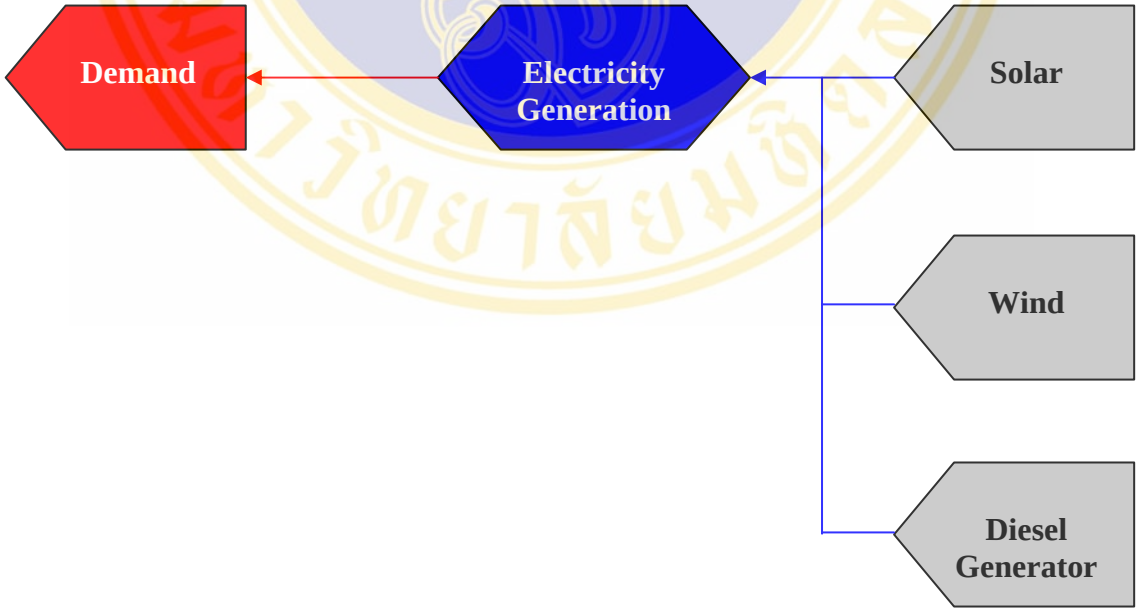


Diagram of analysis



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Analysis result amount electric appliances on 2007- 2023

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Light 36W	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
Light 18W	3.2	3.2	3.2	3.2	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3
Light 9W	0.9	0.9	0.9	0.9	0.9	1	1	1	1	1	1	1	1.1	1.1	1.1	1.1	1.1
Television 29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
television 25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Television 21	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Television 20	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Television 14	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Computer	0	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.1	0.1	0.1	0.1
Sewing machine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Battery	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Radio	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5
VCD	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.2
Fan	1.6	1.6	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.7	1.8	1.8
Moter	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Washer	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Information	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Refrigerator	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Microwave	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pot 1L	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Pot 2L	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Pan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iron	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Kattle	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3

*(device)

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Analysis result used quantity electricity on 2007-2023

	2007	2008	2009	2010	2011	2012	2013	2014
Battery	121.3	121.3	121.3	121.3	121.3	121.3	121.3	121.3
Computer	2.1	2.5	3	3.6	4.2	5	5.9	7
Fan	17,242.30	17,422.10	17,603.80	17,787.30	17,972.80	18,160.20	18,349.50	18,540.90
Information	0	0	0	0	0	0	0	0
Iron	183.5	183.5	183.5	183.5	183.5	183.5	183.5	183.5
Kattle	308	309.7	311.4	313	314.7	316.4	318.1	319.9
Light 18W	21,714.70	21,819.10	21,923.90	22,029.30	22,135.20	22,241.50	22,348.40	22,455.80
Light 36W	4,657.90	4,657.90	4,657.90	4,657.90	4,657.90	4,657.90	4,657.90	4,657.90
Light 9W	1,245.60	1,282.40	1,320.40	1,359.50	1,399.80	1,441.30	1,483.90	1,527.90
Microwave	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4
Moter	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3
Pan	0.4	0.5	0.6	0.6	0.7	0.8	0.9	1
Pot 1L	354.3	354.3	354.3	354.3	354.3	354.3	354.3	354.3
Pot 2L	1,105.90	1,105.90	1,105.90	1,105.90	1,105.90	1,105.90	1,105.90	1,105.90
Radio	182.6	183.1	183.7	184.2	184.8	185.3	185.9	186.4
Refrigerator	13,040.40	13,716.60	14,427.80	15,176.00	15,963.00	16,790.70	17,661.40	18,577.30
Sewing machine	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Television 14	725.8	728.4	731	733.6	736.3	738.9	741.6	744.3
Television 20	141.6	141.6	141.6	141.6	141.6	141.6	141.6	141.6
Television 21	3,297.00	3,329.40	3,362.10	3,395.20	3,428.50	3,462.20	3,496.20	3,530.50
Television 29	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
VCD	12.5	13.6	14.8	16.2	17.6	19.2	20.9	22.8
Washer	139.5	144.4	149.4	154.5	159.9	165.4	171.1	177
television 25	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5

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Analysis result used quantity electricity on 2007-2023

	2015	2016	2017	2018	2019	2020	2021	2022	2023
Battery	121.3	121.3	121.3	121.3	121.3	121.3	121.3	121.3	121.3
Computer	8.3	9.8	11.6	13.8	16.3	19.3	22.8	27	32
Fan	18,734.20	18,929.50	19,126.90	19,326.40	19,527.90	19,731.50	19,937.20	20,145.10	20,355.20
Information	0	0	0	0	0	0	0	0	0
Iron	183.5	183.5	183.5	183.5	183.5	183.5	183.5	183.5	183.5
Kattle	321.6	323.3	325.1	326.8	328.6	330.4	332.2	334	335.8
Light 18W	22,563.70	22,672.20	22,781.10	22,890.60	23,000.60	23,111.20	23,222.20	23,333.80	23,446.00
Light 36W	4,657.90	4,657.90	4,657.90	4,657.90	4,657.90	4,657.90	4,657.90	4,657.90	4,657.90
Light 9W	1,573.10	1,619.70	1,667.70	1,717.10	1,767.90	1,820.30	1,874.20	1,929.70	1,986.90
Microwave	0.4	0.5	0.5	0.6	0.6	0.7	0.8	0.9	1
Moter	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3	17.3
Pan	1.1	1.3	1.4	1.6	1.8	2	2.2	2.5	2.8
Pot 1L	354.3	354.3	354.3	354.3	354.3	354.3	354.3	354.3	354.3
Pot 2L	1,105.90	1,105.90	1,105.90	1,105.90	1,105.90	1,105.90	1,105.90	1,105.90	1,105.90
Radio	187	187.5	188.1	188.7	189.2	189.8	190.4	191	191.5
Refrigerator	19,540.60	20,553.90	21,619.70	22,740.80	23,920.00	25,160.40	26,465.10	27,837.50	29,281.00
Sewing machine	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7
Television 14	746.9	749.6	752.3	755	757.8	760.5	763.2	766	768.8
Television 20	141.6	141.6	141.6	141.6	141.6	141.6	141.6	141.6	141.6
Television 21	3,565.20	3,600.30	3,635.60	3,671.30	3,707.40	3,743.80	3,780.60	3,817.80	3,855.30
Television 29	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6	2.6
VCD	24.9	27.1	29.6	32.2	35.1	38.3	41.8	45.5	49.6
Washer	183.2	189.5	196.1	202.9	209.9	217.1	224.6	232.4	240.5
television 25	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5	17.5

*(kWh)

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APPENDIX B

Turnover

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ผลประกอบการของเดือน กันยายน พ.ศ. 2547 – เดือน ธันวาคม พ.ศ. 2547

รายการ	ก.ย.-47		ต.ค.-47		พ.ย.-47		ธ.ค.-47	
	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย
ค่าไฟฟ้า	33,470		47,340		48,580		52,080	
ค่าบัตรเติมเงิน							100	
ค่าไฟฟ้าจากการใช้น้ำที่บ่อ								
ค่าไฟฟ้าจากองค์การโทรศัพท์								
รายได้อื่นๆ								
เงินเดือน		28,340		25,000		25,000		25,000
ค่าน้ำมันเชื่อเพลิง		27,562		13,007		48,649		21,517
ค่าโทรศัพท์								261
ค่าอุปกรณ์เครื่องยนต์ไฟฟ้า						20,496		
ค่าใช้จ่ายเบ็ดเตล็ด		8,449		7,259		4,724		2,448
จ่ายค่าเครื่องเขียนแบบพิมพ์						1,800		
รวม	33,470	64,351	47,340	45,266	48,580	100,669	52,180	49,226

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ผลประกอบการของเดือนมกราคม พ.ศ. 2548 – เดือน มิถุนายน พ.ศ. 2548

รายการ	ม.ค.-48		ก.พ.-48		มี.ค.-48		เม.ย.-48		พ.ค.-48		มิ.ย.-48	
	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย
ค่าไฟฟ้า	60,210		53,220		62,666		70,000		69,036		63,540	
ค่าบัตรเติมเงิน												
ค่าไฟฟ้าจากการใช้บ่อน้ำ												
ค่าไฟฟ้าจากองค์การโทรศัพท์												
เงินเดือน		25,000		25,000		25,000		25,000		25,000		25,000
ค่าน้ำมันเชื้อเพลิง		15,070		19,470		49,077		40,976		57,799		42,066
ค่าโทรศัพท์		229				1,676		283		52		
ค่าอุปกรณ์เครื่องยนต์ไฟฟ้า						3,400				1,340		
ค่าใช้จ่ายเบ็ดเตล็ด		5,786		660		949				3,310		6,340
จ่ายค่าเครื่องเขียนแบบพิมพ์		956		200						6,432		
รวม	60,210	47,041	53,220	45,330	62,666	80,102	70,000	66,259	69,036	93,933	63,540	73,406

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ผลประกอบการของเดือน กรกฎาคม พ.ศ. 2548 – เดือน ธันวาคม พ.ศ. 2548

รายการ	ก.ค.-48		ส.ค.-48		ก.ย.-48		ต.ค.-48		พ.ย.-48		ธ.ค.-48	
	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย
ค่าไฟฟ้า	59,696		60,360		65,384		39,010		36,300		44,190	
ค่าบัตรเติมเงิน			100									
ค่าไฟฟ้าจากการใช้บ่อน้ำ												
ค่าไฟฟ้าจาก องค์การโทรศัพท์												
เงินเดือน		24,000		22,000		22,000		22,000		22,000		22,000
ค่าน้ำมันเชื้อเพลิง		43,200		54,263		43,753		24,501		41,013		70,239
ค่าโทรศัพท์						428				138		120
ค่าอุปกรณ์เครื่องยนต์ไฟฟ้า		7,245		752		2,170		2,650		240		3,410
ค่าใช้จ่ายเบ็ดเตล็ด		4,329		2,414		1,799		2,457		14,410		3,058
จ่ายค่าเครื่องเขียนแบบพิมพ์						1,250		319		102		300
รวม	59,696	78,774	60,460	79,429	65,384	71,400	39,010	51,927	36,300	77,903	44,190	99,127

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ผลประกอบการของเดือนมกราคม พ.ศ. 2549 – เดือนมิถุนายน พ.ศ. 2549

รายการ	ม.ค.-49		ก.พ.-49		มี.ค.-49		เม.ย.-49		พ.ค.-49		มิ.ย.-49	
	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย
ค่าไฟฟ้า	53,830		50,460		75,135		66,720		77,530		69,580	
ค่าบัตรเติมเงิน					460				120		120	
ค่าไฟฟ้าจากการใช้บ่อน้ำ												
ค่าไฟฟ้าจากองค์การโทรศัพท์												
เงินเดือน		22,000		22,000		22,000		22,000		22,000		18,500
ค่าน้ำมันเชื้อเพลิง		43,200		27,614		68,580		28,980		28,432		33,075
ค่าโทรศัพท์				284		122				278		117
ค่าอุปกรณ์เครื่องยนต์ไฟฟ้า		9,750		4,050						1,250		1,275
ค่าใช้จ่ายเบ็ดเตล็ด		3,075		104		660		410		670		494
จ่ายค่าเครื่องเขียนแบบพิมพ์						104				180		
รวม	53,830	78,025	50,460	54,052	75,595	91,466	66,720	51,390	77,650	52,810	69,700	53,461

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ผลประกอบการของเดือน กรกฎาคม พ.ศ. 25479– เดือน ธันวาคม พ.ศ. 2549

รายการ	ก.ค.-49		ส.ค.-49		ก.ย.-49		ต.ค.-49		พ.ย.-49		ธ.ค.-49	
	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย
ค่าไฟฟ้า	72,070		70,505		77,415		80,080		72,700		74,560	
ค่าบัตรเติมเงิน	360		240		120		240		120		240	
ค่าไฟฟ้าจากการใช้บ่อน้ำ												
ค่าไฟฟ้าจากองค์การโทรศัพท์												
เงินเดือน		18,500		18,500		18,500		18,500		18500		18,500
ค่าน้ำมันเชื้อเพลิง		39,077		50,102		53,263		43,805		36062		35,475
ค่าโทรศัพท์						321		110				253
ค่าอุปกรณ์เครื่องยนต์ไฟฟ้า		2,100		1,250		2,000		1,150		1800		2,030
ค่าใช้จ่ายเบ็ดเตล็ด		3,645		884		1,418		1,836		1360		8,574
จ่ายค่าเครื่องเขียนแบบพิมพ์				1,250								
รวม	72,430	63,322	70745	71,986	77,535	75,502	80,320	65,401	72,820	57722	74,800	64,832

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ผลประกอบการของเดือน มกราคม พ.ศ. 2550– เดือน พฤษภาคม พ.ศ. 2550

รายการ	ม.ค.-50		ก.พ.-50		มี.ค.-50		เม.ย.-50		พ.ค.-50	
	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย	รายรับ	รายจ่าย
ค่าไฟฟ้า	78,015		53,010		86,760		58,910		62,153	
ค่าบัตรเติมเงิน	240				240				120	
ค่าไฟฟ้าจากการใช้บ่อน้ำ			3,200		2,600		760		2,613	
ค่าไฟฟ้าจากองค์การโทรศัพท์	450		450		450		450		450	
อื่นๆ					20				30	
เงินเดือน		18,500		18,500		18,500		18500		18,500
ค่าน้ำมันเชื้อเพลิง		43,487		34,496		35,084		42017		47,285
ค่าโทรศัพท์		130						107		172
ค่าอุปกรณ์เครื่องยนต์ไฟฟ้า		2,410				180		3450		1,420
ค่าใช้จ่ายเบ็ดเตล็ด		1,004		2,818		3,654		2590		2,304
จ่ายค่าเครื่องเขียนแบบพิมพ์		520								
รวม	78,705	66,051	56,660	55,814	90,070	57,418	60,120	66664	65,366	69,681

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APPENDIX C
Questionnaire

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หมายเลขแบบสอบถาม ชุดที่ □□□

แบบสอบถาม

เรื่อง

การศึกษารูปแบบการจัดการพลังงานไฟฟ้าที่เหมาะสม

ของบ้านเกาะจิก อำเภอขลุง จังหวัดจันทบุรี

แบบสอบถามนี้เป็นส่วนหนึ่งของวิทยานิพนธ์

นักศึกษาหลักสูตรวิทยาศาสตร์มหาบัณฑิต สาขาเทคโนโลยีการบริหารสิ่งแวดล้อม

คณะสิ่งแวดล้อมและทรัพยากรศาสตร์ มหาวิทยาลัยมหิดล

หมายเหตุ : โปรดกาเครื่องหมาย “/” ในช่อง □ ที่ผู้สัมภาษณ์เลือก

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ส่วนที่ 1 ข้อมูลทั่วไปเกี่ยวกับผู้ให้สัมภาษณ์

1.1 บ้านเลขที่.....หมู่ที่ 1 บ้านเกาะจิก ตำบลบางชัน อำเภอขลุง จังหวัดจันทบุรี

1.2 ชื่อผู้ให้สัมภาษณ์.....ศาสนา.....

1.3 สถานะ

☐ หัวหน้าครัวเรือน ☐ บุตร

☐ สามี ☐ ผู้อาศัย

☐ ภรรยา ☐ อื่นๆ ระบุ.....

1.4 การตั้งถิ่นฐาน

☐ เกิดที่นี้

☐ ย้ายมาจากจังหวัดจันทบุรี ระบุอำเภอ.....

☐ ย้ายมาจากจังหวัดอื่น ระบุจังหวัด.....

☐ มาพักอาศัยชั่วคราว ไม่ได้ย้ายทะเบียนบ้านมา

1.5 สมาชิกในครัวเรือน

ลำดับที่	เพศ		อายุ	ระดับการศึกษา(จบหรือกำลังศึกษา)
	ชาย	หญิง		

1.6 อาชีพหลัก

☐ ทำการเกษตร ☐ รับจ้าง

☐ ทำประมง ☐ รับราชการ

☐ ทำการค้าขาย ☐ อื่นๆ ระบุ.....

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1.7 อาชีพรอง

☐ ทำการเกษตร ☐ รับจ้าง

☐ ทำประมง ☐ รับราชการ

☐ ทำการค้าขาย ☐ อื่นๆ ระบุ.....

1.8 รายได้

☐ รับจ้างวันละ.....บาท

☐ ทำการเกษตร

☐ 3,000-4,000 บาท/เดือน ☐ 5,000-6,000 บาท/เดือน

☐ 7,000-8,000 บาท/เดือน ☐ 9,000-10,000 บาท/เดือน

☐ มากกว่า 10,000 บาทต่อเดือน ระบุ.....

☐ ทำการค้าขาย

☐ 3,000-4,000 บาท/เดือน ☐ 5,000-6,000 บาท/เดือน

☐ 7,000-8,000 บาท/เดือน ☐ 9,000-10,000 บาท/เดือน

☐ มากกว่า 10,000 บาทต่อเดือน ระบุ.....

☐ รับราชการ

☐ 3,000-4,000 บาท/เดือน ☐ 5,000-6,000 บาท/เดือน

☐ 7,000-8,000 บาท/เดือน ☐ 9,000-10,000 บาท/เดือน

☐ มากกว่า 10,000 บาทต่อเดือน ระบุ.....

☐ทำการประมง

☐ 3,000-4,000 บาท/เดือน ☐ 5,000-6,000 บาท/เดือน

☐ 7,000-8,000 บาท/เดือน ☐ 9,000-10,000 บาท/เดือน

☐ มากกว่า 10,000 บาทต่อเดือน ระบุ.....

☐ อื่นๆ ระบุ.....

1.9 ช่วงเวลาทำงาน

☐ 08.00- 12.00 น. ☐ 16.00- 24.00 น.

☐ 08.00- 16.00 น. ☐ 18.00- 24.00 น.

☐ 12.00- 16.00 น. ☐ 20.00- 05.00 น.

☐ 12.00- 24.00 น. ☐ อื่นๆ ระบุ.....

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1.10 ลักษณะการประกอบอาชีพ

☐ ทำงานสม่ำเสมอ ☐ ทำงานเป็นครั้งคราว

☐ ทำงานเฉพาะช่วงฤดูกาล ระบุ.....

☐ อื่นๆ ระบุ.....

1.11 รายจ่ายของครอบครัว

☐ 3,000-4,000 บาท/เดือน ☐ 5,000-6,000 บาท/เดือน

☐ 7,000-8,000 บาท/เดือน ☐ 9,000-10,000 บาท/เดือน

☐ มากกว่า 10,000 บาทต่อเดือน ระบุ.....

ส่วนที่ 2. ความรู้ด้านพลังงานทดแทนแบบผสมผสาน

ผู้ตอบแบบสอบถามมีความรู้ความเข้าใจเกี่ยวกับเรื่องพลังงานทดแทน ตามหัวข้อนี้เพียงใด

2.1 พลังงานทดแทน คืออะไร

☐ การผลิตไฟฟ้าจากแหล่งพลังงานเดียว

☐ การผลิตไฟฟ้าจากหลายแหล่งพลังงานในขณะเวลาเดียวกัน

☐ การผลิตไฟฟ้า จากแสงอาทิตย์ หรือ ลม

☐ การผลิตไฟฟ้าที่แหล่งผลิตทดแทนกันและกัน

2.1 ความรู้ด้านการผลิตพลังงานทดแทนแบบผสมผสาน

☐เป็นระบบที่ใช้งานได้เพียงชั่วคราว

☐ เป็นระบบที่ใช้งานได้ตลอด 24 ชั่วโมง

☐ ไม่ทราบว่าระบบใช้งานได้นานเท่าไหร่

2.2 ระบบผลิตไฟฟ้าบ้านเกาะจิก เป็นระบบอย่างไร

☐ ผลิตไฟฟ้าจาก ดีเซล พลังงานลม และพลังงานแสงอาทิตย์

☐ ผลิตไฟฟ้าจาก ดีเซล พลังงานลม และพลังงานคลื่น

☐ ผลิตไฟฟ้าจาก ถ่านหิน พลังงานลม และพลังงานแสงอาทิตย์

☐ ไม่ทราบว่าใช้พลังงานอะไรมาผลิตไฟฟ้า

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2.3 ความรู้ความเข้าใจเรื่องพลังงานทดแทน

☐ ช่วยในการรักษาสิ่งแวดล้อม

☐ เป็นการใช้ทรัพยากรธรรมชาติอย่างเต็มศักยภาพ

☐ พึ่งพิงทรัพยากรที่มีอยู่ในพื้นที่

☐ กระจายแหล่งพลังงาน

☐ เป็นการใช้พลังงานอย่างใดอย่างหนึ่งเพื่อเสริมหรือทดแทนพลังงานอีกอย่าง

☐ ถูกทุกข้อ

☐ ไม่เข้าใจเกี่ยวกับพลังงานทดแทน

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ส่วนที่ 3. การใช้พลังงานไฟฟ้า

3.1 เครื่องใช้ไฟฟ้าที่มีใช้งานในบ้าน (ในปัจจุบัน)

เครื่องใช้ไฟฟ้า	กำลังไฟฟ้า	จำนวน (เครื่อง)	ช่วงเวลาที่ใช้งาน	ชั่วโมงที่ใช้งาน (ชั่วโมง)	จำนวนวันที่ใช้งาน/เดือน
โทรทัศน์สีขนาด 29 นิ้ว					
โทรทัศน์สีขนาด 21 นิ้ว					
โทรทัศน์สีขนาด 14 นิ้ว					
ตู้เย็น ขนาด.....					
พัดลม ขนาด.....					
เตารีดไฟฟ้า					
หม้อหุงข้าว ขนาด.....					
เครื่องไมโครเวฟ					
เครื่องซักผ้า					
เครื่องเสียง					
หม้อต้มน้ำ					
หลอดไฟฟ้า ขนาด 40 วัตต์					
หลอดไฟฟ้า ขนาด 36 วัตต์					
หลอดไฟฟ้า ขนาด 18 วัตต์					
หลอดไฟฟ้า ขนาด.....วัตต์					
หลอดไฟฟ้าแบบอื่น ระบุ					
เครื่องคอมพิวเตอร์					
เครื่องปิ้งขนมปัง					
แบตเตอรี่					
โคมไฟฟ้า					
กระทะไฟฟ้า					
อื่น.....					

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3.2 เครื่องใช้ไฟฟ้าที่คาดว่าจะหามาใช้ในบ้านในอนาคต

เครื่องใช้ไฟฟ้า	กำลังไฟฟ้า	จำนวน (เครื่อง)	ช่วงเวลาที่ใช้งาน	ชั่วโมงที่ใช้งาน (ชั่วโมง)	จำนวนวันที่ใช้งาน/เดือน
โทรทัศน์สีขนาด 29 นิ้ว					
โทรทัศน์สีขนาด 21 นิ้ว					
โทรทัศน์สีขนาด 14 นิ้ว					
ตู้เย็น ขนาด.....					
พัดลม ขนาด.....					
เตารีดไฟฟ้า					
หม้อหุงข้าว ขนาด.....					
เครื่องไมโครเวฟ					
เครื่องซักผ้า					
เครื่องเสียง					
หม้อต้มน้ำ					
หลอดไฟฟ้า ขนาด 40 วัตต์					
หลอดไฟฟ้า ขนาด 36 วัตต์					
หลอดไฟฟ้า ขนาด 18 วัตต์					
หลอดไฟฟ้า ขนาด..... วัตต์					
หลอดไฟฟ้าแบบอื่น ระบุ					
เครื่องคอมพิวเตอร์					
เครื่องปิ้งขนมปัง					
แบตเตอรี่					
โคมไฟฟ้า					
กระทะไฟฟ้า					
อื่น.....					

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ส่วนที่ 4 ความคิดเห็นต่อระบบผลิตไฟฟ้าแบบผสมผสานบ้านเกาะจิกในปัจจุบัน

4.1 ท่านคิดว่าระบบไฟฟ้าของบ้านเกาะจิกปัจจุบัน มีความเหมาะสมต่อเกาะจิก เพียงใด

☐ เฉยๆ ☐ เหมาะสมมาก

☐ เหมาะสม ☐ ไม่เหมาะสม

4.2 ท่านคิดว่าระบบผลิตไฟฟ้าพลังงานทดแทนแบบผสมผสาน ระบบไหนที่ท่านพึงพอใจ

☐ ระบบพลังงานลม ☐ ระบบแสงอาทิตย์

☐ ทั้งสองระบบ

4.3 ท่านคิดว่าปัญหาไฟดับ ไฟกระชาก ไฟตก ของบ้านเกาะจิก มาจากสาเหตุใด

☐ ระบบผลิตไฟฟ้าไม่พอต่อความต้องการของชาวบ้าน

☐ ระบบผลิตมีปัญหา อันเนื่องมาจากการชำรุด

☐ สภาพอากาศไม่เหมาะสมต่อการผลิตไฟฟ้า

☐ อุบัติเหตุ

☐ ชาวบ้านใช้ไฟฟ้ามากเกินไป

☐ ทุกสาเหตุ ข้างต้น

4.4 ถ้าท่านเป็นผู้หนึ่งที่ต้องรับผิดชอบปัญหาของสำนักงานไฟฟ้าพลังงานทดแทนบ้านเกาะจิก ท่านจะทำอย่างไร

☐ จัดหาแหล่งผลิตพลังงานไฟฟ้าเพิ่มเติม

☐ จัดระบบการทำงานภายในองค์กรใหม่

☐ เพิ่มประสิทธิภาพของระบบผลิตพลังงานไฟฟ้าเพิ่มขึ้น เช่น ปรับปรุงให้เครื่องยนต์ดีเซลล์ใช้น้ำมันน้อยลง แต่ให้พลังงานไฟฟ้าเท่าเดิม

☐ ปรับปรุงมาตรการการประหยัดพลังงานใหม่

☐ ไม่เปลี่ยนแปลง ให้ใช้เหมือนเดิม

☐ ทุกข้อ ข้างต้น

☐ อื่นๆ ระบุ.....

4.5 ท่านจะมีส่วนร่วมในการบริหารจัดการพลังงานทดแทนของบ้านเกาะจิกอย่างไร

☐ สนับสนุนมาตรการของสำนักงานไฟฟ้าพลังงานทดแทนบ้านเกาะจิก

☐ ลดการใช้พลังงานไฟฟ้า

☐ ใช้เครื่องใช้ไฟฟ้าที่มีประสิทธิภาพ

☐ เสนอมาตรการประหยัดพลังงานไฟฟ้า ระบุ.....

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4.6 ท่านพอใจการบริหารจัดการของสำนักงานไฟฟ้าพลังงานทดแทนบ้านเกาะจิก เพียงใด

☐ เฉยๆ ☐ พอใจมาก

☐ พอใจ ☐ ไม่พอใจ

4.7 การจัดเก็บค่ากระแสไฟฟ้าปัจจุบัน เป็นอย่างไร

☐ เหมาะสม

☐ ไม่เหมาะสม ควรปรับปรุงโดยการ.....

4.8 ราคากระแสไฟฟ้าต่อหน่วยในปัจจุบัน เป็นอย่างไร

☐ เหมาะสมกับสภาวะในปัจจุบัน

☐ ไม่เหมาะ ท่านคิดว่าเหมาะสมในราคาหน่วยละ.....บาท

4.9 การบริหารงานของสำนักงานไฟฟ้าพลังงานทดแทนบ้านเกาะจิก ควรจะเป็นเช่นใด (ตอบได้มากกว่า 1 ข้อ)

☐ ควรมีมาตรการการควบคุมไฟฟ้าที่เข้มงวดกว่านี้

☐ ควรกำหนดเวลา เปิด-ปิด เครื่องกำเนิดไฟฟ้า

☐ ควรกำหนดจำนวนเครื่องใช้ไฟฟ้าต่อครัวเรือน

☐ ควรกำหนดประเภทเครื่องใช้ไฟฟ้า

☐ ควรกำหนดราคาค่ากระแสไฟฟ้าใหม่

☐ ควรมีผู้เชี่ยวชาญระบบผลิตไฟฟ้าเพิ่มขึ้น

☐ ควรมีการแจ้งประกาศล่วงหน้าเกี่ยวกับสถานการณ์ผลิตไฟฟ้าและระบบผลิตให้ชุมชนรู้ล่วงหน้า

☐ ควรมีมาตรการควบคุมการใช้พลังงานไฟฟ้าเพิ่มขึ้น

☐ อื่นๆ ระบุ.....

4.10 ท่านคิดเห็นอย่างไร ถ้ามีการเก็บค่ากระแสไฟฟ้าต่อหน่วยเพิ่มขึ้น เพื่อใช้ขยายขนาดระบบผลิตไฟฟ้าเพิ่มขึ้นในอนาคต (ไม่เกี่ยวกับด้านเชื้อเพลิง)

☐ เห็นด้วย เพราะ.....

☐ ไม่เห็นด้วย เพราะ.....

5 ข้อเสนอแนะ

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APPENDIX D

Estimate Renewable Technology

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แบบประเมินเทคโนโลยีพลังงานทดแทน

แบบสอบถามในการประเมินเทคโนโลยี/การคัดเลือกระบบผลิตพลังไฟฟ้าที่จะนำไปติดตั้งในบ้านเกาะจิก ตำบลบางชัน อำเภอ ขลุง จังหวัดจันทบุรี โดยเรียงตามลำดับความสำคัญของแต่ละปัจจัยตามความคิดเห็นของแต่ละท่าน

โดยให้ทำ เครื่องหมาย **X** ลงในช่องคะแนน โดย

5 หมายถึง ปัจจัยนี้มีความสำคัญมากที่สุด
4 หมายถึง ปัจจัยนี้มีความสำคัญมาก
3 หมายถึง ปัจจัยนี้มีความสำคัญปานกลาง
2 หมายถึงปัจจัยนี้มีความสำคัญน้อย
1 หมายถึง ปัจจัยนี้มีความสำคัญน้อยที่สุด

การประเมินเทคโนโลยี	**ระดับคะแนนของการประเมิน**				
	5	4	3	2	1
จุดแข็ง - พลังงานแสงอาทิตย์ - พลังงานลม					
จุดอ่อน - พลังงานแสงอาทิตย์ - พลังงานลม					
โอกาส - พลังงานแสงอาทิตย์ - พลังงานลม					
อุปสรรค - พลังงานแสงอาทิตย์ - พลังงานลม					

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ตาราง การวิเคราะห์โดยใช้หลัก SWOT ในพื้นที่บ้านเกาะจิก

	พลังงานแสงอาทิตย์	พลังงานลม
จุดแข็ง	- การดูแลรักษา ซ่อมแซมต่ำ - อายุการใช้งานนาน ประมาณ 20 ปี - แหล่งพลังงานมีศักยภาพ - ไม่มีผลกระทบต่อสิ่งแวดล้อม - ประหยัดค่าน้ำมันเชื้อเพลิง	- การบำรุงรักษา ซ่อมแซมน้อยครั้งตามกำหนดในการบำรุงรักษา - อายุการใช้งานนาน ประมาณ 20 ปี - แหล่งพลังงานมีศักยภาพ - ไม่มีผลกระทบต่อสิ่งแวดล้อม - อุปกรณ์เสียสามารถซ่อมได้ - ประหยัดค่าน้ำมันเชื้อเพลิง
จุดอ่อน	- ต้องมีแบตเตอร์รี่สะสมพลังงาน - ผลิตพลังไฟฟ้าได้เฉพาะตอนกลางวัน - ต้องการพื้นที่ติดตั้งมาก - ขนส่งลำบาก - ต้องมี อินเวอร์เตอร์แปลงกระแสไฟฟ้า - แผงโซล่าเซลล์เสียไม่สามารถซ่อมได้	- ผลิตพลังไฟฟ้าได้เมื่อมีกระแสลมที่แรงมากพอ - ต้องการพื้นที่ติดตั้งมาก - การขนส่งลำบากติดตั้งต้องใช้แรงงานและเครื่องมือมาก - ต้องพึงพาเทคโนโลยีจากต่างประเทศ
โอกาส	- มีการใช้พลังงานแสงอาทิตย์ในประเทศไทยเพิ่มสูงขึ้นในเขตชนบท - มีการส่งเสริมจากภาครัฐ - มีโรงงานผลิตในประเทศไทย	- มีการส่งเสริมจากภาครัฐ
อุปสรรค	- ระบบมีมูลค่าลงทุนสูง - แหล่งเงินทุน - ความพร้อมของผู้ใช้	- ระบบมีมูลค่าลงทุนสูง - แหล่งเงินทุน - ความพร้อมของผู้ใช้

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ผู้เชี่ยวชาญประเมินเทคโนโลยีพลังงานทดแทน

ผู้เชี่ยวชาญ	ตำแหน่ง
อาจารย์ จินตนา คุตสิริสุข	นักวิทยาศาสตร์ระดับ 8 กรมพัฒนาพลังงานทดแทนและอนุรักษ์พลังงาน
ดร.วรากร เจริญสุข	อาจารย์ภาควิชาวิศวกรรมไฟฟ้า คณะวิศวกรรมศาสตร์ มหาวิทยาลัยมหิดล
ผศ. ปฐมพงศ์ สงวนวงศ์	อาจารย์คณะสิ่งแวดล้อมและทรัพยากรศาสตร์ มหาวิทยาลัยมหิดล
รศ.ดร. กัมปนาท ภักดีกุล	อาจารย์คณะสิ่งแวดล้อมและทรัพยากรศาสตร์ มหาวิทยาลัยมหิดล
อาจารย์ ธนัท คุณารักษ์	หัวหน้ากองพัฒนาพลังงานทดแทน ฝ่ายพัฒนาและแผนงาน โรงไฟฟ้า การไฟฟ้าฝ่ายผลิตแห่งประเทศไทย

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