HOME ELECTRIC ENERGY SAVING MODEL
THROUGH ENVIRONMENTAL EDUCATION PROCESS

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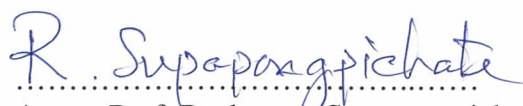
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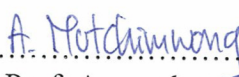Mr. Taradol Tepareenun
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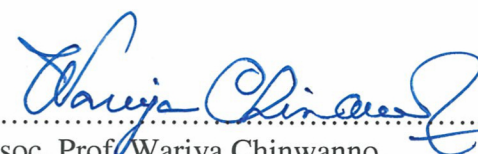
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ABSTRACT

The purposes of this research were 1) to develop the electric energy saving model in households through the environmental education process, and 2) to evaluate the effectiveness of the electric energy saving model in households through the environmental education process. The research instruments included the use of an electric energy questionnaire, the electric energy saving control equipment evaluation form, the electrical energy saving understanding test, the behavior and quantity of electric energy use interview, and the satisfaction about the training evaluation form. There were two sample groups: 1) 351 people who were the leaders of their households in Amata Nakorn Industrial Estate area who gave information about the use of electric energy in households and 2) 14 households for evaluating the effectiveness of the electric energy saving model.

The results of this research found that 1) most of the residents in households did not know how to save electric energy, never get information about energy conservation, and have never been trained about energy saving. The electric energy used on average was 287.7 units/household; 2) The development of the electric energy saving model through the environmental education process should consists of two main parts: the construction of knowledge and understanding about the use of electric appliances and the management of electric energy use, and the development of electric energy saving equipment. It is indicated that the electric energy saving equipment could reduce the use of electricity about 13.14 percent. The knowledge about electric energy saving of the control group after training was significantly higher than before, at the 0.05 level, and also significantly higher than the control group at the 0.05 level; and 3) the behaviors in the use of electric energy of the control group had improved and could save electric energy.

The related organizations or communities should apply the electric energy saving model to give the knowledge to community members for sustainable electric energy saving. In addition, the process of educating community members should begin from a leader of each household because he/she could transfer knowledge to other members, which is a proactive problem solving process that involves community participation.

KEY WORDS: HOME ELECTRIC ENERGY SAVING /
                          ENVIRONMENTAL EDUCATION PROCESS /
                          ENERGY SAVING MODEL

267 pages

รูปแบบการประหยัดพลังงานไฟฟ้าภายในบ้านโดยผ่านกระบวนการสิ่งแวดล้อมศึกษา

HOME ELECTRIC ENERGY SAVING MODEL THROUGH ENVIRONMENTAL EDUCATION PROCESS

ธราดล เทพอารีนันท์ 5037902 SHED/D

ศษ.ด. (สิ่งแวดล้อมศึกษา)

คณะกรรมการที่ปรึกษาวิทยานิพนธ์: ภัทรบูรณ์ พิชญไพบูลย์, Ed.D., พรธิดา วิเศษศิลปานนท์, Ph.D., ธีระพล เทพหัสดิน ณ อยุธยา, Ed.D.

บทคัดย่อ

การวิจัยครั้งนี้มีจุดประสงค์เพื่อ 1) พัฒนารูปแบบการประหยัดพลังงานไฟฟ้าภายในบ้านโดยผ่านกระบวนการสิ่งแวดล้อมศึกษา 2) ประเมินประสิทธิผลของรูปแบบการประหยัดพลังงานไฟฟ้าภายในบ้านโดยผ่านกระบวนการสิ่งแวดล้อมศึกษา เครื่องมือที่ใช้ในการวิจัยได้แก่ แบบสอบถามเรื่องการใช้พลังงานไฟฟ้าภายในบ้าน แบบประเมินคุณภาพอุปกรณ์ควบคุมการประหยัดพลังงานไฟฟ้า แบบทดสอบวัดความรู้เรื่องการประหยัดพลังงานไฟฟ้าภายในบ้าน แบบสัมภาษณ์พฤติกรรมและปริมาณการใช้ไฟฟ้าในครัวเรือน และแบบประเมินความพึงพอใจของผู้เข้ารับการอบรม กลุ่มตัวอย่างแบ่งเป็นสองกลุ่มคือ 1) ผู้นำครัวเรือนในเขตนิคมอุตสาหกรรมอมตะนคร จังหวัดชลบุรี จำนวน 351 คน ที่ให้ข้อมูลเกี่ยวกับการใช้พลังงานไฟฟ้าในบ้าน 2) ครัวเรือนที่เป็นกลุ่มตัวอย่างหาประสิทธิภาพของรูปแบบการประหยัดพลังงานไฟฟ้าจำนวน 14 ครัวเรือน

ผลการศึกษาพบว่า 1) คนในครัวเรือนส่วนใหญ่ไม่รู้วิธีประหยัดพลังงานไฟฟ้าจากเครื่องใช้ไฟฟ้าภายในบ้าน ไม่เคยได้รับข่าวสารเกี่ยวกับการอนุรักษ์พลังงาน ไม่เคยได้รับการฝึกอบรมความรู้เกี่ยวกับการประหยัดพลังงานไฟฟ้ามาก่อน มีการใช้พลังงานไฟฟ้าในปริมาณเฉลี่ย 287.7 หน่วยต่อครัวเรือน 2) การพัฒนารูปแบบการประหยัดพลังงานไฟฟ้าภายในบ้านโดยผ่านกระบวนการสิ่งแวดล้อมศึกษา สรุปได้ว่า การประหยัดพลังงานไฟฟ้าจะให้ได้ผลดีที่สุดนั้นต้องประกอบด้วยส่วนสำคัญ 2 ส่วน คือ การสร้างความรู้ ความเข้าใจเกี่ยวกับวิธีการใช้อุปกรณ์ไฟฟ้าในบ้าน รวมถึงการบริหารจัดการการใช้ไฟฟ้าให้กับคนในครัวเรือน และการพัฒนาอุปกรณ์ช่วยในการประหยัดพลังงานไฟฟ้า จากการดำเนินการพบว่า อุปกรณ์ช่วยประหยัดไฟฟ้าสามารถลดการใช้พลังงานไฟฟ้าลงจากเดิมได้ร้อยละ13.14 ความรู้เรื่องการประหยัดไฟฟ้าก่อนและหลังการทดลองของกลุ่มทดลอง (ผู้ที่เข้ารับการอบรม) แตกต่างกันอย่างมีนัยสำคัญทางสถิติที่ระดับ 0.05 และความรู้หลักการอบรมสูงกว่ากลุ่มควบคุมอย่างมีนัยสำคัญทางสถิติที่ระดับ 0.05 3) พฤติกรรมในการใช้พลังงานไฟฟ้าระดับครัวเรือนของกลุ่มทดลองก่อนและหลังการทดลองเกิดการเปลี่ยนแปลงพฤติกรรมในการใช้งานเครื่องใช้ไฟฟ้าไปในทางที่ดีและประหยัดพลังงานไฟฟ้ามากขึ้น

ข้อเสนอแนะ หน่วยงานที่เกี่ยวข้องหรือชุมชนต่างๆ ควรมีการนำรูปแบบการประหยัดพลังงานไฟฟ้าไปประยุกต์ใช้ในการให้ความรู้กับชุมชนในการประหยัดพลังงานไฟฟ้าอย่างยั่งยืนต่อไป และแนวทางการให้ความรู้นั้นควรจะเริ่มจากหัวหน้าครัวเรือนเป็นสำคัญ เพราะหัวหน้าครัวเรือนเป็นผู้นำในการถ่ายทอดความรู้ที่ดียังสมาชิกในครัวเรือนและเป็นการแก้ปัญหาเชิงรุกที่ชุมชนเข้ามามีส่วนร่วมอย่างแท้จริง

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CHAPTER I
INTRODUCTION

1.1 Background and significance of the study

Nowadays world population is increasing rapidly prompting demands in many areas such as food, energy, habitat and facility. Today economic system has changed to be free enterprise system or capitalism. Whoever possessing production capacity can equally make products to compete in world market, thus there have been many countries throughout the world laying down policy emphasizing mainly on industry as it is understood to be able to generate more income than agriculture. Subsequently there have been many new entrepreneurs who take advantage of human demands as main mean to gain money and assets by manufacture of products for distribution sufficiently according to the human need. Development of country needs money and huge amount of resources. To conduct business nowadays people reply mainly on electric energy so electric energy is extremely necessary for human.

Electric energy is basic utility that is very important for the development of country both economically and socially because power takes part in supporting and pushing development in every aspect to be able to expand extensively, rapidly and continuously. An average electric energy usage index of people is directly related to economic growth of the country (Faculty of Engineering, Chulalongkorn University, 1999), thus electric energy usage of the economically advanced countries is quite high. Presently electricity can be generated by 2 ways, first by non-fuel such as dam water, solar power, wind, underground heat and by fuel such as natural gas, lignite, bunker oil, diesel oil, waste and nuclear (Electricity Generating Authority of Thailand, 2008). Now ratio of fuel for electricity generation of Thailand relies on natural gas 66.2%, lignite 12.6%, imported coal 8.4%, hydropower 5.5%, bunker oil 2.7% and other alternative power 1.6% from Laos 1.5%, Malaysia 1.5% and diesel oil 0.03% (Electricity Generating Authority of Thailand, 2008).

Thailand started to have electricity for the first time on 20 September B.E. 2472 (1929) during the reign of King Rama 5 (Office of Energy Policy and Plan 2007:7) and in 2008 Thailand had electricity generation capacity totaling 29,140.16 megawatt generating from many sources being 59.72% from government power plant i.e. Electricity Generating Authority of Thailand (EGAT), power of Department of Alternative Power & Power Conservation and power plant of Provincial Electricity Authority with total capacity of 15,793.56 megawatt and the balance 10,931 megawatt or 40.286% buying from private sector and neighboring countries. Rapid expansion of business and industry sector plus continuous increase of population causes domestic electric energy to rise. It was found that the statistic of electric energy requirement in Thailand between 1999-2006 increased for 61.84%. In 2006, the total rate of electric use was 141,947.58 megawatt and it is estimated that in 2021 the total power use will be 325,697 megawatt.

From the above-mentioned power use, in order to meet consumers' demand the government has to build more power plant and to build each power plant the government not only that the country has to pay a lot of money but the country has to face many significant problems such as pollution, loss and unworthy in generating and distribution process plus protesting from environmental conservationist and from those affected by the construction of power plant and the power generation from depleting natural resources no matter they are the generation from natural gas, coal and bunker oil that are very much used now. These resources are natural resources that will disappear after use and cannot be brought back for re-use (Yodyiam Theptaranon 1996:42-46). Besides the fuel source shortage problem there are other problems as well which is environmental impact problem because the utilization of fuels normally can cause subsequent good and bad effects. The environmental impact from use of fossil fuel is global warming which results from the accumulation of green house effect that consists of carbon dioxide and nitrous oxide from fossil burning, ozone from the combination of carbon monoxide and oxygen from fossil burning. There are too much of these gases in stratosphere. These gases normally allow short-wave radiation from the sun to pass through the surface of the earth and will absorb and intercept heat radiation originating from the earth surface causing earth temperature to rise as if the earth is covered by many layers of glasshouses, thus huge

amount of heat accumulation has taken place over the earth surface causing climate change, severe revolving storms, rising sea level from polar ice dissolution and ecosystem change especially plants that respond positively to carbon dioxide will increase in size and volume while some other plants and animals will die out or reduce in number. Blossoming and fruit-bearing behavior of plants will change and affect living creatures especially human (Department of Environmental Quality, Ministry of Environment and Natural Resources, 2009:24).

In view of above problems, the government has accelerated to reduce the use of electric energy seriously by using power conservation measure in order to reduce expense on fuel and to promote power saving and reduce the increase of power from abroad. The government has determined the policy and guideline for power conservation for the first time in the national economic and social development plan no. 5 (B.E. 2525-2529) continuously till the national economic and social development plan no. 10 (B.E. 2550-2554) (Office of The National Economical and Social Development Board, 2008) and in order for the supervision and power conservation to proceed systematically, the National Energy Commission has drawn up to improve the Energy Conservation Promotion Act (No.2) B.E. 2550 to be in effect from 1 June 2008 (Office of Policy and Plan for Energy, Ministry of Energy 2008).

Main target within the scope of power conservation of machineries, equipments and the promotion of use of tools and materials according to the Energy Conservation Promotion Act (No.2) B.E. 2550 are the manufacturers and distributors of machinery or equipment or tool and material for high efficiency in power conservation. The materials and equipments for power conservation are classified into categories. Quality and standard must show power use efficiency value because nowadays the government is trying to find various methods, be it the provision of knowledge about electricity or the right way of using electrical appliances, the electricity saving method and the manufacturing of power-saving electrical appliances. It is considered that if electric appliances are designed to save power then the use will be worthwhile such as electric appliance with power-saving label No. 5. From past to present there have been old model of electric appliances with no power-saving label sold in the market for long time (Office of Policy and Plan for Energy, Ministry of Energy 2008). However, the way of solving problem for the time being is purely the

way of solving problem at its end result so substantial power saving result could not be achieved. Therefore, the best way to solve power use problem is to change the behavior of the power users because human is the cause of using huge amount of electric energy due to no right knowledge on how to use power such as the use of air conditioner is concentrated only on the purpose of cooling but no idea how cool can be suitable for him or herself. Mostly we can see that people are under thick blanket while air condition is turned on. Regarding the use of electric energy for lighting purpose, people do not know what kinds of bulb is the most suitable and power-saving. Environmental study will be used help solve and improve power use behavior of human in order to suit the demand.

        Environmental study is a learning process emphasizing general knowledge about natural and social environment. Factors being both abstract and concrete that cause environmental change and impact to human to create attitude, behavior and goodwill that will maintain and develop environmental and life quality of the whole (Vinai Veeravattananon 2003:77-87) by emphasizing on providing knowledge and understanding about the power problem situation and power use method on how to have the optimal efficiency and to instill awareness in worthwhile use of power and to avoid to take advance of the generation to be born later to have electric energy to use in future until there is a positive attitude in saving or reducing the use of power and consequently can develop skill in solving problem relating to the use of electric energy and ability to conduct evaluation from the arisen situation and data as well as to participate in taking responsibility to urgently solve problems that will happen and at the same time make use of technology to control the domestic use of electric energy as deemed fit for each household user. People can adjust and control the use of electric appliance by themselves. The equipment is used to control unnecessary use of electric energy such as for case if a person has to go out to do something and leaves the air conditioner working which is the use of power for nothing. This equipment for controlling unnecessary use of power consists of various electronic circuits such as sensor, control circuit and electricity distributing unit packed in control box in order to function to regulate electric appliances. This equipment is widely used having microcontroller as an essential part in controlling the entire system.

Microcontroller is a semi-conductor combining many functions in it with the structure similar to computer i.e. data and program receiving unit, processing unit, memory unit and output unit. These components are complete in itself thus the size is small so able to write program to control the functioning of various accessories attached to it. It is convenient to be applied for use (Faculty of Engineering, Kasetsart University 2008). Nowadays microcontroller has been used to regulate electric appliances such as TV, air conditioner, washing machine, telephone, printer and etc. However, it has not been used to control household power saving. Most of the power-saving equipments in use for the time being are merely equipments to filter interference signals that cause equipment to function at low efficient rate when comparing to the electric energy used. Household electric energy use is mainly for lighting and air conditioning purpose which is the main demand of power use of Thai people.

From the research work relating to the behavior and knowledge of electric energy saving, it is obvious that knowledgeable persons can save power more than the non-knowledgeable ones. However, most research works provide abstract knowledge plus training media in form of book given to trainees cannot be fully utilized. Therefore, the researcher has an idea to bring media in form of equipment to combine for the development of method of household power saving through environmental study process in order to be used to change behavior and reduce household power use. The trainees will learn electric energy and power saving as well as equipment for controlling power saving by microcontroller as regulator of electric appliance. Users can program to control time and functioning of household electrical appliance by themselves. From the survey of regular use and connection to censor circuit for the case of no user in the area and able to set the right and suitable period of time as per the use of electric appliance and after the trainees have taken part in the trial use of power saving method through environmental study process, the trainees will change their behaviors in saving power and reduce using electric energy from the knowledge received. The need to set suitable period of time for using household electrical appliance in order to gain optimal benefit and from the theory of creating the body of knowledge resulted from the process of absorbing experience is the process to happen when person reacts to environment. When persons take notes of the stimulus into the brain, learning will take place when person takes action (Brain) to link the stimulus to

old information being present in mental structure (Schema) that person has accumulated since the start of the process that mental structure absorbing new stimulus or the process of old and new knowledge linking perfectly and meaningful to that person, thus that person will be in equilibrium condition understanding himself as he himself is a person who thinks and creates the meaning of such thing. Therefore, it should be the household to set period of time to control the functioning of electrical appliance from old and new knowledge received. In future while users have to be in the place where there is no equipment for controlling power saving and from the knowledge received will create awareness in power saving.

From this research the researcher has chosen the sample group from household in Tamlueng Municipality in industrial community in Amata Nakorn Industrial Estate, Chonburi Province by aiming that households in this area are very close to the community really living in the area and devoting time with the use of similar electric appliances in each house knowing best the power use information, thus able to disseminate knowledge into village better than other people living outside the said village as per recent sample regarding the provision of knowledge about bird flu, dengue fever and etc. From the comparison of information of power use of the Ministry of Energy between household in urban and rural areas, households in urban area use power 16% of the total households while households in rural area use 84% of the total households. (Department of Development of Alternative Energy, Ministry of Energy 2009:7). As for the volume of electric energy use in provincial area is 65% of the total electric energy while metropolitan area uses 38% of the total electric energy and the trend of power use in provincial are will increase continuously as a result of distributing industry to rural area. (Office of Policy and Plan for Energy, Ministry of Energy: 2007).

From the above, researcher realizes the importance of the study of various bodies of knowledge that influence electric energy saving. The inspection, analysis, synthesis and design of equipment for controlling the use of household electrical appliances will lead to the development of method of household power saving through environmental study process. The afore-said development of method has never been studied before. If such method is developed successfully, it is expected to change human behavior in household power saving and control power expense which will

help people to save expense on public utilities and will be beneficial to electric energy conservation at the same time considered as conservation of natural resources and environment to last for future use.

1.2 Objective of the study

1.2.1 To develop the electric energy saving model in household through the environmental education process

1.2.2 To evaluate the effectiveness of electric energy saving model in household through environmental education process

1.2.2.1 To study the knowledge level of energy saving and behaviors of electric energy saving in household before and after getting the developed model.

1.2.2.2 To study the relationship between knowledge of electric energy saving and   the electric cost quantity after using the developed model.

1.3 Research questions

1.3.1 What kind of Electric energy saving model in household through environmental education process which is developed to apply in the household of Nong Tam Leung Sub-district municipality in the Amata Nakorn Industrial Estate, Chonburi province? And how is it effective?

1.3.2 Is the knowledge level about energy saving and behaviors on electric energy saving in household of Nong Tam Leung Sub-district municipality in Amata Nakorn Industrial Estate, Chonburi province before and after getting the developed model different from the previous time?

1.3.3 How is mutual relationship between knowledge of electric energy saving and electric value quantity after getting the developed model?

1.4 Research hypothesis

1.4.1 Electric energy saving model in household through the environmental education process which is developed to apply in the household of Nong Tam Leung Sub-district municipality in the Amata Nakorn Industrial Estate, Chonburi province has effectiveness to reduce the electric value quantity.

1.4.2 The knowledge level of energy saving and behaviors on electric energy saving in household of Nong Tam Leung Sub-district municipality for Amata Nakorn Industrial Estate, Chonburi province before and after getting the developed model are different from the previous time by statistic significance.

1.4.3 Knowledge between electric energy saving and electric value quantity after getting the developed model has mutual relationship.

1.5 Research conceptual framework

According to this research, the researcher studied and collected the data of various researches related to the electric energy saving, it was found that there were several electric energy saving researches. Thus, the researcher surveyed those researches by collecting the various kinds of uses and applied them with the environmental education and created the concept framework in various aspects to be used for developing the electric energy saving model in household through environmental education process. The concept framework got was as follows:

Environmental Education Process		
Community Education 1. Electrical equipment using in the household 2. Behaviors of electric energy using 3. Electric value quantity within household	**Development of electric energy saving model within households through the environmental education process** 1. Perception about electric energy 2. Electric energy saving 3. Design of control equipment of electric energy saving	**Effectiveness of electric energy saving model within households through the environmental education process** 1. Reduction of electric value quantity 2. Knowledge of electric energy saving 3. Behaviors of electric energy saving

Figure 1.1 Concept Framework of Research

According to the above framework, the environmental education process was covered all in the research. It included the education of household data in Nong Tam Leung Sub-district municipality of Amata Nakorn Industrial Estate, Chonburi province. The data from community consisted of electric equipment used in the household, behaviors of electricity use and the electric value quantity of each household. These data were synthesized to be the electric energy saving model in household through the environmental education process which consisted of contents about perceptions of electric energy, electric energy saving and design of control equipment for electric energy saving until it led to the evaluation of effectiveness of developed model for reducing the electric value quantity. This helped the households have knowledges in terms of electric energy saving increasingly and have the behaviors of electric energy saving correctly and appropriately.

1.6 Scope of the study

According to the research of electric energy saving model in household through environmental education process, the researcher determined the scope of project research as follows:

1.6.1 The scopes of contents included:

- The electric equipment used in the household

- Perception about electric energy

- Electric energy saving

- Electric value quantity of each household

- Design of control equipment for electric energy saving

- Behaviors of electricity use

1.6.2 Scope of population included:

Population used in this research was the households in the Amata Nakorn Industrial Estate of Nong Tam Leung Sub-district municipality, Pantong District, Chonburi province for 3,782 households.(Nongtamleung Subdistrict Municipality Office, 2010)

Table 1.1 Population Numbers of Nong Tam Leung Sub-district municipality

Space	All populations (person)	All populations (household)
Nong Tam Leung Sub-district municipality	8,224	3,782
Total	**8,224**	**3,782**

Sample group used in this research included

1. The sample group used in the data collection about electric energy use by households of Nong Tam Leung Sub-district municipality in the Amata Nakorn Industrial Estate, Pantong district, Chonburi province for 351 samples. The interview was done with the household leaders for 351 persons. These were from the determination of sample group size by using the instant table of Robert V. Krejcie and W. Morgan (Raweewan Chinatrakul, 1999: 111) and did a systematic random sampling. The calculation method was as follows (Sin Panpinij, 2008:121-137).

2. The calculation of time for example selection from the ratio of population and the sample size needed was as follows:

$$I = \frac{N}{n}$$

$$\frac{8,224}{315} \approx 26$$

When   I   substitutes the interval between population (26)

N   substitutes all populations (8,224 persons)

n   substitutes the number of sample (315 persons)

2. Random sampling; the initial numbers by simple random sampling got from lot (got No. 14)

3. Selection of the next number; by adding the initial number which could be caught and each interval from census data of Nong Tam Leung Sub-district municipality (14,28,42,56, ...,8164,8190)

4. Searching the number of households from the data base which have been ordered already from Nong Tam Leung Sub-district municipality and the interval calculated to get the sample group according to the determination used in the study of problem situations in terms of electricity use as overall image of the households

Table 1.2 Number of Sample group in the study of problem situations in terms of electricity use as overall image of the households

Space	All populations (household)	Sample Group (Sample)
Nong Tam Leung Sub-district municipality	3,782	351
Total	**3,782**	**351**

2. The sample group used in the experiment was 14 households of Nong Tam Leung Sub-district municipality which had the members in each household for 5 persons up, 70 persons in total from all 351 sample groups. The selection was carried out by purposive sampling. The sample group was divided into 2 groups, 7 households per group. The first group was the control group, the second group was the experimental group using the electric energy saving model in household through the environmental education process and the control equipment of electric energy saving

within household. The sample group had to be passed the consideration of qualifications as follows:

2.1 To be the person who was interested in the electric energy saving

2.2 To be the house ready for installing the control equipment of electric energy

2.3 To have the household members for 5 persons up

2.4 To have the electric value quantity used for 450 unit up per month or 1,200 baht up because the equipment to control the electric energy saving was very expensive, so if the quantity of electricity was high, Its cost could be worthy within 2 years.

Table 1.3 Number of sample group in the used experiment of electric energy saving model in household through environmental education process

Space	All Populations (household)	Sample Group (household)
Nong Tam Leung Sub-district municipality	3,782	14
Total	3,782	**14**

1.6.3 Scope of studied place included:

- The area in the Nong Tam Leung Sub-district municipality, Amata Nakorn Industrial Estate, Chonburi province

1.7 Definitions

1.7.1 Electric energy saving model in household through environmental education process means the application of environmental education process in order to get knowledge about the behaviors of electric energy use and reduce the electric value quantity of households in Nong Tam Leung Sub-district municipality, Amata Industrial Estate, Chonburi province. The knowledge contents were about electric

energy, electric energy saving within households and the design of control equipment of electric energy saving. According to the study of real data from the areas and literature reviews, they were applied to develop the electric energy saving model in household through environmental education process.

1.7.2 Environmental education means the educational process emphasizing general data about natural environments and social environments, the factors both subjectivity and objectivity which caused the change of environments and effects happened to the human being. Moreover, it was to create the attitudes, behaviors, and value for preserving or developing the quality of environments, quality of life of both individuals and human as a whole. This research emphasized the electric energy saving to reduce the electric energy and reduce the environmental problems from using the electric energy in the future.

1.7.3 The control equipment of electric energy saving means the electronic equipments which the researcher developed and used to control the electricity system within household. This included the learning set of Microcontroller, power supply, circuit for controlling the work of electric equipment, and the circuit to investigate the movement for work controlling of appliances to be appropriate to the time period used for electric energy of household in working. The circuit of movement investigation performed the duty as investigating the movement in household while there are some electrical equipment is being used, therefore the signal would be sent to be processed at the Microcontroller learning set and this Microcontroller would send the signal of electricity use to the working control circuit of electric equipment to control the work of various electric equipment which is being used. In case of electric use in bedroom which consisted of air conditioner, fan, TV, electric bulb, when they are all used, it would have the circuit to investigate the movement to catch and check whether there was a user in the room, therefore the Microcontroller learning set would send the signal to the circuit of work control of electric equipment that it couldn't close the electric equipment. At the same time, if the user went out of the room for a long time, then the circuit would investigate the movement to perform the duty to indicate that no one was in the room and would let the Microcontroller learning set process by being designed to delay the time as long as the program users did it. If the time was over according to the determined program and no one was in the room, all of the electricity

would be turned off their operations. It there was the users came back to the room before the time of electric equipment was set, the electric equipment would be operated or work continuously. In case the users slept in the room, the circuit for investigating the movement would check and found that there was a user but no movement within the room, it would command the Microcontroller learning set to the circuit of working control of electric equipment which performed the duty as turning on-off the air conditioner and TV together with turning on the fan instead to help the weather in the room have wind blowing. This could help reduce the electric value quantity. Therefore, it could help each household get knowledge in electric energy saving and change the behaviors in electric energy saving of household.

1.7.4 Electric energy means the quantity of electronic power use within a time. The unit used is kilowatt hour (kWh).

1.7.5 Air conditioning system means the electric energy use from cooling equipment around the used space which includes air conditioner in separate form, air conditioner in set, air conditioner in window adjustment. The unit used is kilowatt hour (kWh).

1.7.6 Light electric system means electric energy use from the equipment which gives the light around the used space which includes electric bulb, and electric lamp. The unit used is kilowatt hour (kWh).

1.7.7 Electric energy accounting means the investigation of use condition of electric energy and order the use rate of electric energy separated systematically. This includes air conditioner system, electricity and light system, and others to design the period time of electricity use appropriate and reduce the quantity of electric energy use.

1.7.8 The electric equipment within the household means the electric equipment used in the household in common. These includes computer, air conditioner, electric bulb, vacuum bottle, TV, fridge, fan, sawing machine, iron, rice cooker, water heater and water pump, etc.

1.7.9 Knowledge about the electric energy means the fact, truth, rules and regulation, and details about energy saving no matter what general knowledges about electric equipment and energy rate use of electric equipment on each kind. This indicated to be the score result from the achievement measurement both before and

after the experiment by using the electric energy saving model in household through the environmental education process.

1.7.10 Behaviors electric energy saving means actions or operation for using the electric energy and light in daily life effectively, this indicated from the interview both before and after the experiment by using the electric energy saving model in household through environmental education process.

1.7.11 Electric energy saving in household means the energy reduction by planning and managing the energy use appropriately to get the highest benefits from the design of time period in electric equipment use which would be used appropriated to the time period of use.

1.7.12 Community education means searching information which will be the ways to develop the electric energy saving model in household through the environmental education process. This consists of the data on electric equipment used in the household, behavior of electric use and electric value quantity in each household.

1.8 Expected outcome and uses

1.8.1 To know about the state of electric energy use within household in Nong Tam Leung Sub-district municipality.

1.8.2 To get the electric energy saving model in household through environmental education process.

1.8.3 To be able to apply the electric energy saving model in household through environmental education process for electronic saving and reduce the electric value quantity in household.

1.8.4 To be the way for improvement and enhancement of electric energy saving use for changing the users' behaviors.

CHAPTER II
LITERATURE REVIEW

For this study of electrical energy saving model in the household through the environmental education process, the researcher studied and reviewed the literature and the related researches as follows:

2.1 Concepts of environmental education

2.1.1 Meaning of the environmental education

2.1.2 Recommendations of environmental management

2.1.3 Elements of management on environmental education

2.1.4 Development of training curriculum for environmental education

2.2 Instructional media

2.2.1 The meaning of instructional media

2.2.2 Type of instructional media

2.2.3 Value of instructional media

2.2.4 Principles of instructional media selection

2.3 Concepts about related theories

2.3.1 Instruction based on theory of constructivism

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2.4.5 Ways to solve the problems

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2.6 Energy saving

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2.6.3 Electrical energy saving from the electric equipment within household

2.6.4 Quantity electricity use in the household

2.7 General information of microcontroller learning

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2.7.3 Usage of learning set of microcontroller

2.7.4 Qualification of microcontroller in each number of MCS51 (51,52,1051,2051)

2.7.5 The equipment to control the electrical energy saving

2.7.5.1 The internal structure of the control equipment of electrical energy saving

2.7.5.2 Work structure of control equipment for electrical energy saving

2.8 Literature review

2.1 Concepts of environmental education

2.1.1 Meaning of the environmental education

Environmental education is a process to give knowledges to people. In the past, people just talked about 'environment'. General people gives the meaning of the environment that is the natural environment both living things and non-living things and man-made environment both physical construction, i.e., the household, building,

work of art, ancient remains, or abstract environment, such as culture, customs, life, social environments, technological environments, etc.

Winai Weerawattananont (2003: 17-18)Environmental education; there is mentioned in the conference of the United Nations Organization in terms of environment of human being at Stockholm, Sweden, one of the conclusions was that the environmental education would be the crucial instruments to solve the quality of environments. Later, in 1975, the Unesco Organization set the practical conference of environmental education at Belgrade, Ukoslavia to request various countries to cooperate. For organizing the environmental education to people in their own countries, so it has the mutual announcement called The Belgrade Charter by having the Environmental Education Goal which is "to develop the quality of world population to have the realization, connection about the environment and involved problems and let the knowledge, attitudes, motivation, and participation for working both in personal and in public to lead to problem solving and prevention not to make a result of new environments"

Moreover, the Belgrade Charter determined the environmental education objectives that it aimed to let persons and society achieve through things as follows:

1) Awareness: to have the realization and active or awake about environment by the public and the related problems.

2) Knowledge: to have the basic understanding about environment by public both the problems related with the roles and the responsibility of human being in those problems.

3) Attitude: to have the social values which has the relationship or connection with the environment and motivation which would be participated in preventing and imporving the environment.

4) Skills: to be skillful in solving the environmental problems.

5) Evaluation ability: to know to evaluate the measure in terms of environment, education, project of various factors in terms of ecology, politics, economics, society, morality, and education.

6) Participation: to have the development feeling to have the responsibility and it is seen that the environmental problems are urgent issues and should strict to the practical which is appropriate to solve those problems.

Moreover, there are several academic persons who gave various meanings as follows:

Kasem Chankaew(1982 : 5-9) said that the environmental education was the process of giving knowledge systematically and typically in development knowledge, attitudes, awareness, sensitivity and skills in order to get the idea of know how to think and do it and solve the problems. For reserving and protecting as well as managing the natural resources and environment and for being giving knowledge in every level of ages, race, as well as economic and social status, also people process in giving environmental knowledges must be acceptable process according to the customs and traditionsas well as cultures, therefore the instructors have to perceive both instructional methods and courses contents to be harmonious with the daily life very well.

Winai Weerawattananont and Bancheun Sripanpong (1994: 46-52) gave the meaning of environmental education that was the educational process about natural environments and human being created and as well as the concrete and abstract factors which caused the change of environment conditions and effects happened towards the human being to create the behavior or value and society to preserve and improve the quality of environments.

Waraporn Srisupan gave the meaning of environmental education as the process of education which made people know the nature and roles of people relating to other elements with the objective that wanting the individual to live in the society happily all at the local, country, and the world level.

2.1.2 Recommendations of environmental management

According to the conference of United Nation in the Tbilis, Winai Weerawattananont (1996: 28-29), there were the ways of environmental management as follows:

1. To consider the overall image of environments both from nature and artificial things from technology as well as from economy, politics, technology, culture, history, moral, as well as arts and beauty;

2. To consider as the long life learning;

3. To consider as the interdisciplinary approach by starting from the specific contents in terms of that couse and other related courses.

4. To use the contents the issues for locality, country, region, and international in order to see the environments in different regions;

5. To focus on the crucial environmental events which just havppens and then link them through the past;

6. To encourage the value and importance of mutual cooperation in the locality, country and universal for preventing and solving the problems environment

7. To be sure that the environments are the basis of development and progress of the nation, society and humankind

8. To encourage the learners to have the roles of seeking experiences and environmental learning in order that the society would accept other problems will happen consequently.

9. To create the links of feeling, knowledge, solving problem skills, and clearing the value through the learners of every age and emphasize to give feeling of concern about the environments of locality.

10. To help the learners discovers the real causes of environments;

11. To emphasize the complexity and variety of environmental problems, therefore it should develop in terms of consideration and skills to solve the problems;

12. To use the learning states from various environments and learning methods according to the contents of learning by contents of courses by the real practice and direct experiences

2.1.3 Elements of management on environmental education

Temduang Rattanatassanee (1996: 131-180) said that environmental education management depended on 2 parts of element as follows:

1. Knowledge of environments; the acquisition of knowledges has to rely on learning, remembering, criticizing, judge, detection of the environmental issues, experience, theory, and the principle which depend on the relationship between the various subject courses and science until they become the environmental concepts.

For giving knowledge of environmental education, the concept of environmental education is very crucial whch should let the learners acknowledge to

cause the understanding and realize how the problems of environment happened affect orther matters.

Concept is the either conclusion or principle of crucial issues on environments got from the single experience on that issue but several times and then use the characteristics of that issue to classify the conclusive ideas and understandings of that point.

Crucial concept of environment, i.e. concept of ecological basis, concept of energy, concept of poplation, concept of human being, concept of ethic on environment, concept of pollution.

2. Instructional process of environmental education is the strategy of applying the curriculum effectively and the achievement of purposes set. Hence, the process of environment focuses on the educational process which gives perception about the concept of environments until the person realizes to create the consciousness and attitudes to be responsible of cooperation and prevention about the environmental problems.

2.1.4 Development of training curriculum for environmental education

2.1.4.1 Meaning of training

The scholars in varius fields gave meaning of training such as:

Beach (1980: 3) said training meant "process organized to let the person learn and be skillful for one of the purposes by focusing on one of the specific issues and to change the behaviors of the person according to the required direction".

Surapol Chantrapat (1986: 1) suggested that "the training is the process to develop people which combining the learning activities together systematically and coduct them continuously in order to let the trainees change themselves in a better ways in terms of their knowledges, skills, and attitudes in one of the items or all items mentioned altogether".

Pleaung Kumut (1977: 28) said that "the training is the program which the education comprises of the learaning and teaching activities too help the trainees have the educational experiences which make the trainees realize the learning, skills, and attitudes which are the goals of training".

According to the meaning of training mentioned above, the researcher can conclude the meaning of the training as the typical process which lets the person get learing and develop their ideas, skills, attitudes and change their behavior according to the purposes of training by organizing under the appropriate conditions and time.

2.1.4.2 Elements of training curriculum

The element of traning curriculum comprises of 4 parts (Temduang Rattanatassanee: 2008: 184-185)

1. Purposes

Purposes of training might be determined from the organization or department about the destination of desired behaviors. The determination of traning purposes should be the in the form of measurable and observable behavior purposes.

2. Courses content

Courses determination for the training should be in accordance with the purposes of training, the concepts should be substantial, reliable, modern and correct in accordance with the requirement, interest, maturity, experiences of the trainees as well as the real situations and problems in the present time and possible trends in the future which be balance both width and depth dimension.

3. Curriculum application

The applying of urriculum includes the method of instructional organizing of the lecturer, learning experiences organizing, training techniques, materials and visual aids which support the convey of of knowledges, skills, and attitudes effectively.

Methods and techniques in the training such as lecture, discussion leading, team discussion, workshop, sub-group discussion, roles play, demonstraional education, interview, seminar, administration game, practice, outdoor education, relationship group activity, teaching on investigation.

4. The evaluation is about the consideration of behavioral change of the trainees whether it is changeable according to the conditions and criteria indicated in the behavioral purposes. The evaluation of traning practice may be conducted through 3 stages as follows: evaluation before training, evaluation during

traingin, and evaluation after training. The evaluation includes the readiness of place and facilities, lecturers, trainees, contents, methods, equipment, training documents, and materials/tools. In terms of evaluating the curriculum, it will consider the details of contents such as the ease and difficulty, appropriateness, coverness, application, time period, and time set which how much it is appropriate.

2.1.4.3 Stage of training project

Temduang Rattanatassanee (2008 : 184-197) proposed the steps of training project as follows:

1. Principle and Rationale; analyze the necessity of training and indicate its necessity and importance of training

2. For the purpose determination of curriculum is to let the trainees realize to change the behavior in all of knowledge, understanding, theory, principle, attitude, skills which will make a result of change and improvement of problems essential for the training.

3. The determinination of curriculum and the topic of courses to become a curriculum for training to change the trainees' behavior in various terms in order to have the behaviors concordant with the purposes of curriculum.

4. It has to determine the techniques and methods and materials for the training to let the learning process run effectively.

5. To determine the details and and topics of training is to determine purposes, ways of training, methods of training in order to let everyone understand the methods which will be beneficial and ways for all lecturers, trainees, and the involved.

2.1.4.4 Process of training management

Temduang Rattanatassanee (2008: 184-197) said that the process of training management included as follows:

1. Survey, investigate, and analyze the problems condition.

2. Find the necessity of training.

3. Determine the purposes of training.

4. Determine the purposes of courses.

5. Determine the training ways.

6. Determine the training procedures.

7. Determine the place for training.

8. Determine the trainees and lecturers.

9. Determine the ways and evaluation methods.

According to the meaning mentioned, it can be concluded that the environmental education is the process of giving perception in terms of environments in order to let people realize the knowledges, attitudes, skills, participation and ability to evealuate the environmental situations to act through the environments and change the behaviors of living in the environments correctly. In addition, to use the training to be the process which makes the trainees understand and get how to cooperate for sovling the problems happened mutually.

2.2 Instructional media

2.2.1 The meaning of instructional media

The word of "media" is from Latin languate of "medium" which is transalted as "between" which means anything used for containing the information in order to let the receiver be able to commumicate direct to the set purposes. When the media are used for learning process, it is called **"Instructional media"** which means any media which contain the contents of learning matters both the instructors and learners use for being the learning instruments of contents or matters. The instruction of the past time is usually viewed as the same image which was about conveying the knowledges from the instructors to the learners by using the instructional media to be the medium to convey knowledges, ideas, skills, and experiences to the learners to get the ideas of learning. Today, it is accepted that learning is not limited just in the classroom or in school. The instructors and learners can learn from various media and even learn every time and every place. The media used for learning according to the primary curriculum of education, therefore it is called "instructional media" which means everything around no matter what it is the media, real thing, person, place, event, or idea, there are regarded as instructional media depending on whether we learn from that thing or if we apply that thing to our learning.

Instructional media means any media such as record player, slide, radio, television, video, chart, etc. This contains the contents of instruction to use for being the instrument or channel for the instructors to the learners which help the learners get the instruction according to the purposes or objectives the instructors very well set or organized.

2.2.2 Type of instructional media

The instructional media can categorized according to the characteristics into 3 types as follows:

1. Printed media means books, documents, presses which express or arrange the matters and knowledges by using the written or typed letters to be the media for expressing meaning. There are several kinds of printing media, i.e. documents, text books, newspaper, magazine, journal, record, report, etc.

2. Technological media means the instructional media produced for using together with the instrument of audio visual materials or the instruments about new technologies, such as magnetic picture-recording tape (video), audio cassette tape, slide, instructing computer media. Moreover, the technological media also include various processes involved with applying the technology in the learning process, such as using internet for distance learning via the sattlelite, etc.

3. Other media: Not only 2 types of media mentioned above, but also other media which support the learners' learning regarded as important not less than print media print media and technological media. The media mentioned include as follows:

1) Person: person means anyone who has knowledges, abilities, skills in various fields which can convey his/her knowledges, conceps and experiences through other persons, such as local personnel, physician, policeman, businessperson, etc.

2) Nature and environment: this means things exising int the nature and environments around the learners, such as vegetables and plants, fruit, phenomenon, laboratory, etc.

3) Activities/process: means the activity or process which the instructors and learners determine to encourage the learning experiences. It is used for

practising the skills which have to be practiced. The skills which have to use the thinking process, practice, situations encountering and knowledge application of the learners, such as role plays, demonstration, exhibition, project, game, music, etc.

4) Materials, instruments, and equipment: it means the materials invented for the parts of learning, such as the chart model, map, table, statistic as well as the media of essential instruments and equipment which have to be used, such as scientific test equipment, technician instruments, etc.

4. Multimedia: Education technologist divides the multimedia to be 2 meaning, which are, multimedia, the multimedia is used by being intergrated for instruction, for example, using the video for a lecture to the learners by having print media integrated in or using the learning or teaching set. For the multimedia, learners and media will have no any feedback and interaction to each other but in terms of "multimedia". According to the vocabulary definition of Royal Institute, the multimedia in the 2nd meaning is about the multimedia based on computer for presenting the information or production to present the various kinds of information, such as slide, motion, alphabets, and sounds in terms of multi media. The user communicates the media directly. Using computer in this multimedia can bue used in 2 aspects as follows:

- Using computer is a basis for information presentation by controlling the co-equipment used for work, i.e. presentation in terms of the type of interactive video. For using in this case, computer is used to be the medium for controlling the processing of video and CD-Rom to present the slide and motion according to the lessons contents by alphabets or letters appeared on the computer screen as well as controlling the typewriter for typing various information of the lessons and the study results of learners and human as well.

- Using the computer based for producing the multimedia file by various computer program, such as Toolbook and Authorware. These computer programs can help producing file, lessons/training or presentation by using several dimensions of media. Each file has the contents of letters, graphics movement graphics in vedio and audio together in the same file, thus the user only opens the file to study or propose the work according to the computer program has done to get complete details.

For presentation in the form of multimedia, it gives several dimensions of media which helps the user be able to see the information on the screen with various aspects, such as letters, images and sound. In addition, if any users want to know additional information, they only click on that word or symbles done in the form of link button, they will get images, sounds or description appeared for them.

2.2.3 Value of instructional media

Both of learners and instructors are able to get the benefits from the instructional media as follows:

1) Media and learners

1.1) To help the learning goes effectively because it helps the learners understand the sophisticated contents easier in a short time and and gets the concepts of that issue correctly and quickly.

1.2) To urge and create the interest through learners so that they will always enjoys leraning.

1.3) To get the direct understanding and mutual experiences fromt the learners on that studied bject.

1.4) To help learners have a chance to particitate in learning activities more which will create good human relationship between the learners and the instructors.

1.5) To help create the good characteristics in searching knowledges and create ideas for learners from using those media.

1.6) To help solve problems in terms of difference among individuals by setting the individual media for each individual.

2) Media and instructor

2.1) Using the media and equipment for the study help create a pleasant and interesting atmosphere in class. The instructiors themselves feel enjoy teaching more than using only the lecture technique. Moreover, the instructors feel more confident.

2.2) Media can reduce the burdens of teachers or instructors in terms of contents preparation because sometimes the students or learners can educate themselves from several media.

2.3) The media urge the instructors to be always enthusiastic for preparing good and new materials for teaching as well as discovering serveal kinds of techniques for more interesting learning.

Nontheless, the instructional media will be value or worthy when the instructors apply them in appropriate ways, therefore, before applying each media, the instructors should study the characteristics and qualification of each instructional media, observe advantages and disadvantages involved with the media as well as producing and applying the media appropriate to the instructional situations in order to achieve the goals and purposes required or organized.

2.2.4 Principles of instructional media selection

The effective instructional media selection for learners is regarded as a really crucial point. The instructors must set the behavioral purposes of learning definitely or certainly in order to use those purposes to be the indicator for selecting the instructional media appropriately. Moreover, there are still other principles to be considered as follows:

1. Media must be related to the contents of lessons and objectives of the lessons.

2. The instructor must select correct, modern, and interesting contents. The most important, the contents selected should well affect the learning the most.

3. The media should be appropriate with the age, educational level, knowledges and direct experiences of the learners.

4. The media should be convenient for use and not too much complex or sophisticated.

5. The media should have high quality on production techniques and have trueness and clearness.

6. The media shouldn't be too much expensive; on the other hand, it should be produced worthily for time and investment wasted.

In conclusion, the review of instructional media, the researcher brought the concepts of invented materials to apply for the various operations which help the learners learn effectively and urge the learners for their interests. The media should be modern, clear, and true together with time and investment worthiness.

2.3 Concepts about relataed theories

2.3.1 Instruction based on theory of constructivism

For creating the knowledge base, the important point which should be considered is to create the knowledges, instructional principles based on constructivism, process of constructivism, instructional form based on the constructivism, co-operation learning techniques, characteristics of instructors teaching based on constructivism, classroom atmospheres which support the learning based on constructivism, and students' characteristics learning based on constructivism in oreder to be the conceptual framework to be applied for creating curriculum and organizing the learning and teaching based on constructivism.

2.3.1.1 Theory of constructivism

The theory of constructivism is a theory about knowledge and learning based on the psychological basis, philos and humanity descriped as what the knowledge is and how the knowledges comes. However, the concepts about learning are based on 2 crucially psychological theories including the Piaget's developmental theory, and Vygotsky's socio-cultural theory.

2.3.1.1.1 Piaget's developmental theory

Tissana Khammanee, et.al., (2005: 65-67) indicated about the knowledge construction theory or constructivism that it was based on the Piaget's concepts. Piaget suggested that the nature of human being (Pannee Chor. Jenjit, 1995: 32-35) naturally, the human beings had the 2 basic trends since they were born which included the system organization of knowledge structures and adaptation of knowledge structures.

1) Organization of knowledge structures; this is about internal organization by integrating various processes to be the system continuously and consistently.

2) Adaptation of knowledge structures; this is about the adaptation through the environments which are the trends since human being was born. The human beings adapt themselves they have the interaction with environments. There are 2 processed of adamptation, which are, assimilaton process and accommodation process, this is about adapting the previously intellectual structures to be concordant with the new environments.

- Process of experience assimilation; this is happened when the person interacts with the environments, when the person acknowledges the arouse through his/her brain, the learning will be happened when the person acts (by brain channel) to link the arouse with the previous information existed in the intellectual structure of him/her (schema) which the person has accumulated since he/she was born. The process which the previously intellectual structure absorbs and receives the new arouse or the process which the new knowledge and old knowledge can be linked harmoniously as well as having the meanings with that person which will make that person in the equilibrium have his/her own understandings because he or she is a person who thinks and create the meanings by himself/herself (Tissana Khammanee, 2005: 72-74) as shown in the figure 2.1 which presents the learning process by absorbtion.
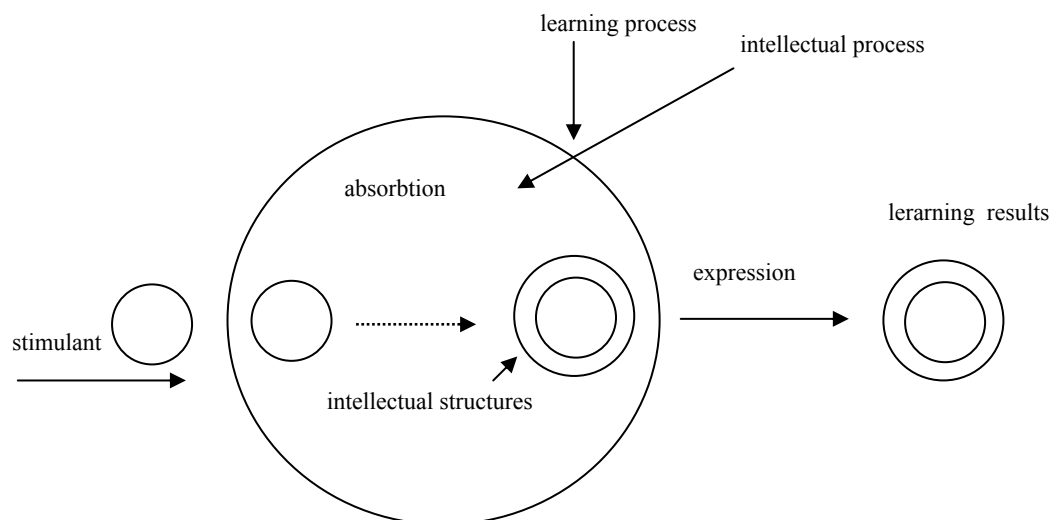
Figure 2.1 Which presents the learning process by absorption

- Accommodation process; This is happened when the person interacts with the environments by being able to adapt his/her previous understandings to meet the new environments or it is about changing the previous ideas to be concordant with the new things (Pannee Chor. Jenjit, 1995, 38: 20) as (Tissana Khammanee, 2005: 52) expressed the adaptation of accommodation process. When the person receives the arouse and tries to absorb and link the new arouse wtith his/her old knowledges exsiting in the structures of his/her own intellectual structures, however, it cannot be absorbed and linked meaningly so that it causes "imbalanced

conditions". When the person imbalanced conditions, he/she will feel confused and doubted. The person tries to adapt those conditions by using the his/her own intellectual process for discovering and finding the ways to create the meanings of new arouses with the previous exsisting things. In many cases, the social process can be helped in finding opinions or using the thinking processes until the person can create the meaning of that thing concordant with the previous things. The created meaning therefore learning results of the learning process which is regarded as the process of creating meanings of information, arouse, and experiences. Each person may create those things differently and may reflect the person to adapt himself/herself about the intellectual structures (Tissana Khammanee, 2005: 72-74) as shown in the figure 2.2 which expressed the adaptation process to be balanced in the learning process.
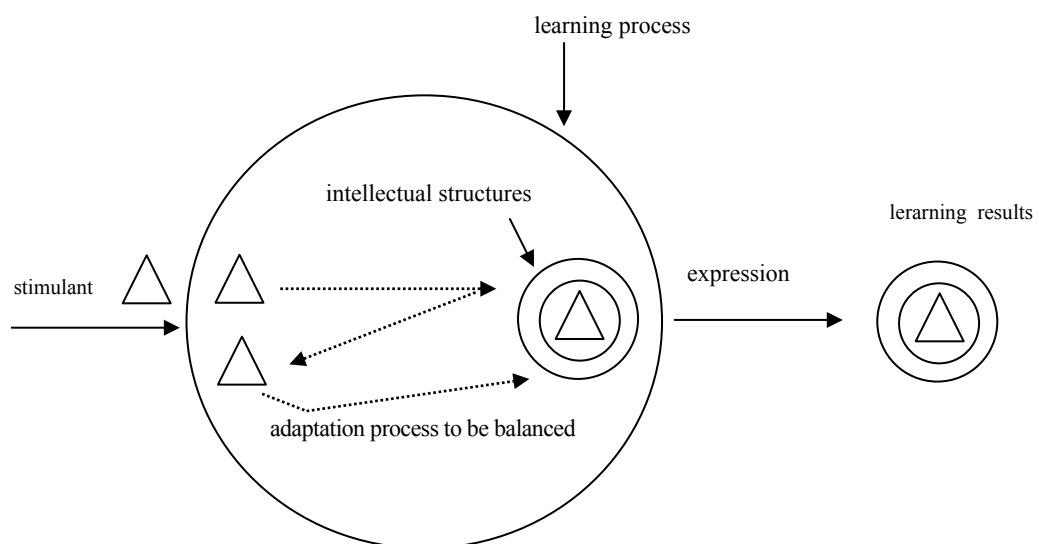
Figure 2.2 Which expressed the adaptation process to be balanced in the learning process

2.3.1.1.2 Vygotsky's socio-cultural theory

The concepts of Vygotsky is considered to be the crucially lerning basis based on the constructivism. Vygotsky believed that the crucial elements influenced the individual's learning was about cerating the medium and having social and cultural interaction. Moreover, Vygotsky gave the concepts about personal interaction and environments around, especially the social and cultural environments to develop the leaning ability of individuals. The help and suggestions from the persons more skillful will help tha person be able to solve the problems

which he/she cannot sort it out by himself/herself. The experiences from problem solving will let that person learn and be able to solve by his/own ability in a later time (Renshaw, 1998: 6-8).

According to the learning theory of Piaget and Vygotsky, it was found that Piaget and Vygotsky had different views on learning. Piaget viewed that learning will occur in each individual when the person interacts with the environments. The person's intellectual development is involved with the process of experiences absorbtion and the process of accommodation adaptation. This is called the adaptation of previous accommodations to be concordant with the new environments until they meet the balance and can create the meanings of that new thing to the previous thing. Whereas Vygotsky viewed that learning was caused by having social interaction using cultural medium created by human being. He also viewed that the help and suggestions from the skillful person will help the person learn and can solve the problems in a later time.

2.3.1.2 Meaning of instruction based on constructivism

Several educators mentioned the constructivism similarly, such as, Fosnot (1996 : 8-11) said that "the theory to create the knowledge base is about knowledge and learning based on the basis of psychology, philos, and humanity which explained that what the knowledge is and how the knowledge comes. This theory explained that the knowledge is such a temporary thing, changeable, and has the development by using the medium of society and culture. While learning is a self-controllable process but has to fight with the contradiction between previous knowledge and new knowledge. This is the way to creat the new knowledge instead".

Glaserfeld (cited inCheek, 1992: 26-27) suggested about the constructivism that "constructivism depends on 2 principles; 1) knowledge is not caused by only the acknowledgement but it is created by the learners with their understanding, 2) the duty of acknowledgement is the adjustment and processing of all experiences but not for discorvering the real things".

Wilson (cited in cited in Wantipa Rodrangka, 1998: 46-48) said about the creating of knowledge base that the "Constructivism is the theory of knowledge which is used to explain that how we know and what we know. The constructivism is therefore the thinking method of knowledge and learning".

In conclusion, the constructivism is the theory based on the the basis of psychology, philos, and humanity which explains that the knowledge is not from only acknowledgement such a single thing but it is created by itself. It is adapted by the previous knowledge with the new knowledge until it creates the knowledge base by itself. To cerate the knowledge base thus is about the thinking of knowledge and learning.

2.3.1.3 Instructional principle basedon constructivism

The concepts bout constructivism, Moscovici studied and analyzed the instructional and learning process, it was found that in the instructional process and learning process based on the constructivism consisted of 2 basic principles, which included the knowledges caused by the learners who took a real action in the social context by being the creator of knowledge base, which is, it's responsible for things which the person will learn and methods of learning.

Fosnot (1996: 12-17) mentioned about the principle of instruction based on the constructivism that the educators determined the principles as follows:

1. Set the problems to be involved with the learners themselves.

2. Determine the learning structures. It should be determined by learning structures in the form of big ideas or basic concepts.

3. Find and realize the value of students' views.

4. Adapt the curriculum to be matched with the students' expectation.

5. Evaluate the students' learning in the context of teaching.

Watts viewed that the instructional theory based on the constructivism should be as follows:

1. Cognitive construction; the key of instruction based on the constructivism is that the perception is the result of conceptual creating proactively. To create the concept is from the relationship between the previous knowledge and the new knowledges.

2. Constructive processes; these processes, i.e. to create or not to create the new knowledge; for the new knowledge construction;l the perception

must have the structure and collection. Gilbert and Swift explained in the form of main principles which could be able to lead to the change a little and it was according to the less criteria. The activity being conduted had the clear structures but not in depth. Moreover, it emphasized the process no matter how much the in-depth structures are. The students could adapt it gradually in their daily lives.

3. Oppositionality; while creating and considering to select various meanings, it should consider and compare other meanings. The theory of creating the knowledge base should suggest the variety and relationship among the ideas more than the development. The easy thought and the developmentof concept is more valuable than tlo create the concepts.

4. Critical realism; the concept about theory of constructivism is viewed as the knowledge was not permanent. The knowledges in this world were created based on the influence of natural resources. The context of person, language, motivation, and others were considered and judged by various criteria, such as benefits, rationals, and good origination.

5. Self-determination means the students can crate the responsibility of their own by 2 types which include the type viewed by teachers, this is viewed that to create own ideas reflects the students'ideas or it is called (reflection), and for the typed viewed by the students, it is viewed that to create the students' own ideas to be the learning.

6. Collegiality; According to the instruction based on constructivism, there is the meaning including the social context which has the communication, exchange, test, conversation, and report. IN addition, the teaching based on the constructivism still has the meaning in terms of concern, such as conceptual concern, theory about self-personality, development of human being, career self-esteem.

The instruction based on good constructivism in the classroom should be different from the general class by focusing on the construction of learners' thaught or new thought construction of the learners, the learners should have the responsibility towards several ways of learnings, make a decision by themselves and discuss or express the opinions with others to lead into the required goals.

2.3.1.4 Process of constructivism

In the process of constructivism; it should be considered about the principles of process to create knowledge base by the steps as follows:

1. First step; it is the conceptual construction. While the students start with the process to select the activities within the area of specific problems, the teacher can see the students survey the conceptual space of each problem, then how the students bring the perception which is "how does it work?" by the students' theory. The idea linking and relating altogether, interesting thought, and thins happened for a while to be put into the conceptual dimention, the students will change all the domain, general knowledge, principle, reason, belief, possibility, and views of range. In addition, to search the ways to solve the problems will be the drivi to create, newly crate or adjust the theory of the students better.

For the interesting project sould be complex in terms of creating the concepts and using the studetns' theory more than creating the concepts and using the easy and common theory.

2. Step 2; the process which creates the concept must be clear, in the problem solving, it is the step which leads the conceptual space to create the conceptual frameworks by making the concepts clear. Moreover, there is the survey of conceptual framework in terms of benefits, importance, and and application among the problem solving. There are several opportunities that the students do not express their theory clearly. This may be because they have no time suffient or they lack opportunity or they may have excess information until they cannot categorize the problems clearly. Nevertheless, there are some points which can be seen clearly during the time of students' working when the students express their preference about the machnism involoved with the situations they have some knowledges on them.

3. Step 3; the co-operation work which emphasizes the constructivism in terms of society, it is acceptable that to create the new knowledge is the new relation and linking together among direction, motivation, and purposes of each person within the direction, motivation, and purposes of the closed group or the situations in society.

However, for co-operation with others, it is not about to crate the knowledge base in individual or groups but in practical, it can be done either separately or cooperately. It can be seen that in the past, it might be emphasized only the individual. However, the individual case is also important whereas the co-operation is acceptable in terms of creating social comstructivism and instructional management based on constructivism which gives the opportunity for the students to have the mutual interation between friends and teachers.

2.3.1.5 Instrutional form based on constructivism

2.3.1.5.1 The instruction based on the constructivism

Yager (1991: 52-57) proposed the method for instruction according to constructivism as follows:

1) Find, use questions and ideas of the students to suggest all of the lessons and units.

2) Recognize and support the creative ideas of the students.

3) Support the students in terms of leadership, coooperative learning, information resources, and practice or taking action from the learning process.

4) Use the ideas, experiences, and interests of students for teaching and learning.

5) Support the information resources use varied from textbooks, documents, and professionals.

6) Support students in terms of giving suggestions about the causes of events and situations, and support them to be able to predict the results by using the continuous information.

7) Find the ideas of students before the teachers express their ideas or before studying any idea from textbooks or other information resources.

8) Support the students to discuss for constructing the concepts and listening to others' opinions.

9) Give an appropriate time for reflecting and analyzing the students' thought as well as recognizing and using all of ideas or thoughts created by the students.

10) Support the own analysis, collect the real information to support the ideas and create the new knowledges.

11) Indicate the problems which are interested in among the students and the results which will be happened to be the initiation of the lessons.

12) Use the information from individual and meterias to be the initiative information able to apply for the problem solving.

13) Involve with the students for finding the information which can apply the problem solving in the real life.

14) Extend the learing areas from in the classroom periods to in the classroom and extend to the school level.

15) Emphasize the scientific effects through each student.

16) Refrain from considering that only contents which is existed for students.

17) Focus on consciousness in caree, especially the career involved with science and technology.

2.3.1.5.2 Strategy in teaching based on constructivism

Yager proposed the strategy of instruction based on the construtivism as follows:

1) Introduction

- Observe things around and various environments to set the questions

- Ask the questions

- Consider all of the possible answers from each question

- Record the unexpected things

- Indicate the situations which the students acknowledge in different ways

2) Conduction

- Let the students participate in a crucial events

- Brain storm to find variously possible alternatives

- Find information

- Examine by using any equipment

- Observe the specific phenomena

- Design the experiment

- Collect and organizethe information system

- Use the problem solving streategy

- Choose the data resources appropriate

- Discuss the problem solving together with friends

- Design and have an experiment

- Evaluate and argue about various alternatives

- Indicate the problems and the consequence effects

- Give the definition of parameter of detection and investigation

- Data analysis

3) Explanation and problem solving methods

- Communicate the information and ideas

- Construct and explain the form

- Construct the new explanation

- Review and analyse the answers of problems

- Use the group evaluation

- Integrate the answers of problems by using the existed experiences

4) Operation

- Make a decision

- Bring knowledges and skills to be applied

- Transform the knowledges and skills

- Exchange the information and ideas

- New questions

- Develop the happened results and support the thought

- Use the form and thoughts to urge the discussion and be accepted by others

2.3.1.5.3 Instruction based on constructivism

When teachers understand and admire the human beingship of new perception construction, therefore it is possible to set the education by supporting the constructivism to students broadly. To organize the education which support the learning of students are as follows (Brooks, 1993: 20-22):

1) Teacher must not let the students uphold only the curriculum which focuses on boring fact but try to motivate the students to focus on the big concepts.

2) Teacher must create the enjoyment in the study to let the students follow the contents with their interest and can link various ideas to create the new ones and can summarize to be the conclusion.

3) Teacher should exchange crucial information with students that world is the complex and sophisticated place that there are several views and they are often interpreted.

4) Teacher should give knowledge to the students that learning and process of learning evaluation is the complex effort and has to use flexible thought which is not able to manage by just simple methods.

According to the study of instructioan principle based on constructivism, this can be concluded that knowledge must be originated by the learners themselves. The learners have to take action in the real situations and the learners themselves have to be responsible for constructing knowledges. In addition, it is found that teachers should have understanding about the learning theory based on constructivism and apply the knowledges of instruction as well as the research to be participated in the instruction.

2.3.1.6 Cooperative learning technique

2.3.1.6.1 Meaning of cooperative learning

Several educators give the meaning of cooperative learning similarly that the cooperative learning is about organizing or managing the students who have diffrent abilities to cooperate to one another by small group learning to achieve mutual goals or the goals of the group. Slavin and Husen suggested that there should have around 4 members for one group. The members of group have to be responsible for things they are learning and help friends to get knowledges of learning as well. There are contributions or help to one another by having the mutual goals of cooperation. This is in accordance with Johnson who said that the work for group's goals is that the members are responsible for themselves and groups; they are trained and used the skills of mutual work. The contributions depend on the contributions of each individual in the group and all members will get the success altogether. Moreover, Husen added that cooperative learning is about sharing ideas of work and and mutal responsibility among the group.

According to the meanings of cooperative learning mentioned by the educators, it can be concluded that cooperative learning is about the organization of learning which the students have different abilities but have to cooperate by small group around 4 members. All of them have to help to one another and have the mutual responsibility for mutually successful goals.

2.3.1.6.2 Principles of cooperative learning

For cooperative learning, Kagan indicated that the cooperative learning had to consist of 4 main principles as follows:

1) Positive interdependence; mutual dependence and help in order to get successful and understand that each success of individual means the success of the group as well

2) Individual accountability; the responsibility is in individual, everybody in the group has the role, duty, and responsibility to search knowledges for work. Every member of the group must aknowledge the same thing they have mutual learned. These are considered as the success of the group.

3) Equal participation; everybody must participate in searching, reading, and working equally. It is done by determining the roles for each as well as determining the roles both before and after, such as who speaks, speak to whom, who records, etc.

4) Simultaneous interaction; all members have to work, think, read and listen altogether.

2.3.1.6.3 Characteristics of cooperative learning

The characteristics of cooperative learning; Johnson suggested that it consisted of as follows:

1) Positive relationship; this means members of group work by having mutual goals and have to mutually work, participate, share equipment, materials, information. Everyone has the roles and duties and have mutual success. The members feel that they will be successful when all members are also get successful. All will get benefits and rewards of contributions equally.

2) Interaction which is supported to one another, related, and exchanged the opinions. In addition, explaining the knowledges to friends in the group is a crucial aspect of direct interaction for cooperative learning. Hence, it should be exchanged the information back and open the opportunity for the members to propose new ideas to choose things which are the most appropriate.

3) Responsibility; this is the responsibility of learning on each individual by helping and supporting to one another in order to get successful according to the group's goals. All members are confident and ready to get the test by individual.

4) Interpersonal skills and sub-group skills; the students should be practiced these skills first because they are considered to be the crucial skills which cand help groups reach successful and should be practiced for communicative skills, leadership, trust others, decision making, and problem solving. The teachers should set the situations which will help the students be able to work or study effectively.

Moreover, in 1991, Johnson increased the other one element of cooperative learning as follows:

5) Group process; this is the process which works in procedures or it has the methods to help the group work effectively, which is, all members must make understanding the goals of work, plan of work mutually, operate according to the plan as well as evealuating the results and improving the work.

The elements of all five cooperative learning have mutual relationship to help the cooperative learning go well and achieve the goals determined by the group.

Moreover, Nattaya Pilantananan (2000: 55-58) mentioned the attributes of cooperative learning that it was different from the study of normal grop by comparing as appeared in the Table 2.1.

Table 2.1 The comparison between cooperative learning attributes and normal study

Cooperative learning attributes	Normal study learning attributes
1. Creative dependence	1. No dependence
2. Each person has to be responsible to the group	2. Responsibility to the group is not focused clearly
3. Attributes of group is heterogeneous	3. Attributes of group is heterogeneous heterogeneous or homogeneous
4. Exchange of group leadership	4. There is only one group leader got by selection
5. Exchange of responsibility to each other	5. Treat and be responsibie only each individual's matters
6. Focus on work method and maintain the quality of work	6. Be interested in only the group contribution
7. The learners learn the skill of mutual work in group	7. The learners neglect skills practice of group work
8. The instructor has the opportunity to recommend the group work periodically	8. The instructor usually lets the learners work alone
9. The group process makes the learners successful	9. The success is considered from individual work then it is combined altogether

It can be concluded that the cooperative learning is a technique which allows the students who have different abilities to work together by a small group around 4 members to help to one another and have the mutual responsibility which means the success of the group and give benefits to students in encouraging the social skills, thinking skills, speaking, expressing, showing opinions, and doing in action equally and helping to one another.

2.3.1.7 The instructior teaches according to the knowledge base construction

For instructional setting to let the knowledge base construction is originated by itself, the instructor is the person who has the really crucial roles and must know and understand the attributes of instructor both teaching and acting towards the students which will create the learning atmosphere by constructing the knowledge base by itself as well as acting in general. This can be seen from the Brooks' opinions (1993: 20:22) which mentioned the attributes of teachers teaching in accordance with the way of knowledge base construction as follows:

1) Support and accept the freedom of thought and creativity of the students.

2) Use the raw materials and primary information resources as well as the materials and equipemtn used by practical, mutually exchange and interacet. All of the activities run naturally.

3) It should determine the framework to let the students do in terms of using thought, such as classification, anlayzation, prediction, and creativity.

4) It should let the students respond the teaching and learning to be the impulse towards the instruction, adapt the instructional strategies as well as the lesson contents.

5) It should ask the understanding of students' concepts before exchanging theirs.

6) It should support the students to have a discussion between teachers, friends of students.

7) It should support the knowledge seeking of students by letting the students ask thoughfully. The most important, the questions should be a kind of open-ended questions and support them to ask to one another.

8) It should seek the elaboration in internal response of the students.

9) It should support the students about experiences which may cause contradiction towards the assumption which the students set at the first time and support the students to have a discussion and express the opinions.

10) It should give time to the students for let them think appropriately after asking them the questions.

11) It should give time to the students to create the mutually good relationship.

12) It should support the natural curiousness of the students by using the learning cycle model.

Ernest mentioned aobut the roles of teachers in teaching and learning for the students to create their knowledge base by themselves as follows:

1. To be able to acknowledge and analyze the previous knowledges of the students quickly.

2. To select the instructional strategies which help sovle the variant concepts from the students.

3. To get interested in the thinking process and self-supervision of the students.

4. To encourage the students to apply the concepts they learn to use in various contexts.

5. To consider the objectives in the study of the students, the difference between the objectives of the teaching and learning or the instruction.

6. To consider the learning context of the students.

It can be concluded that the characteristics of the teachers teaching according to the ways of creating the knowledge base must understand the nature and teaching principles based on the knowledge base construction by encourage and accept the freedom of thinking and creation of the students, support the practical of the students and organize the exchange and interaction to one another as well as applying the concepts which the students have learn to be used in the various contexts and in the real situations.

2.3.2 Theories about behavior of human being

Because in the education about behavior of human being, the educators and the behaviorists as well as various scholars have cerated the concepts and theorist related to the education of human's behaviors numerously. The interesting and relevant behaviours in this research included as follows:

Benjamin S. Bloom's theory

Bloom (1971: 271) mentioned about the behavior that it was the activity which the human being act could be observable or unobservable. These behaviors might be divided into 3 parts as follows:

1. Cognitive Domain behaviors; this item has the states of knowledge ability, idea using, and the intellectual development which all are about the acknowledgement and expression of behaviors and knowledges. It can be concluded that this behavior tell use that how much the person knows or doesn't know which can be divided into 6 stages as follows:

1.1 Knowledge and ability; this is to remind the various stories that the preson ever experiences. The stories can be from any location and place.

1.2 Comprehension; this is the next stage from the knowledge. When a person knows, then he or she can interpret or predict or extend the contents according to his or her new ideas or views in order to make them broader than the truth.

1.3 Application; this means the person can take the perception which he or she already has had to solve the new and strage problems of that issue.

1.4 Analysis; this is about the ability to take the criterias, regulations, and various kinds of methods of the stories that the person has already experienced with or knowm to solve the problems of new situations.

1.5 Synthesis; this is the stage which can combine the sub-contents to become the new-contents through improvement and development.

1.6 Evaluation; this is the stage which the person can make a decision by using the criterias and standard set.

2. Affective Domain; this behavior item means the feeling of favour, interest in various values. The adaptation of values is the behavior difficult for the seeing and understanding because it is happened in the human's mind which has to use the special instrument. To organize this behavior, it can be divided into 5 stages as follows:

2.1 Receiving or Attending.

2.2 Responding is the behavior which develops after acknowledgement, namely, when the acknowledgement is occurred, the person will start to have the interaction to respond the stimulus.

2.3 Valuing; this is the stage which the person realize the value of materials, phenomena, and behaviors by himself/herself. In addition, it includes the taking social criteria to decide the value of various things which the person expresses; which means the consistency, the attribute of belief, or attitudes which control the person's behavior. On the other hand, the response will be in accordance with value which the person upholds.

2.4 Organization; this stage is the about the various value the person has. Therefore, the person has to consider the relationships of those values by rearranging the significance of value the systematic organization of value and the system development gradually until it becomes the new values.

2.5 Characterization by Value; this stage is about the development of the action of persons according to the value system he upholds which expresses in the consistent and automatical form without any involvement with the emotions.

3. Psychomotor Domain; this is the behavioral stage which expresse about the physical ability including the action. On the other hand, this behavior expressed can be evaluated easily but the process which will cause this behavior will use time period and decision making in several stages.

2.3.2.1 Nature of behavior

To understand behaviors of human, it's really necessary to know about the nature of behaviors or it can be separated that the regulations about the behaviors of Temduang Rattanatassanee (2008: 162-164) proposed the stages of organizing the training project as follows:

1. The behavior; it must have various behaviors both internal and external behaviors, normal or abnormal behaviors. All should have a cause to drive the person to behave something, such as the peson has a meal may cause from the hunger or the appetite.

2. The same causes may not be necessary to lead to the same behaviors. This can be seen from the nurse injects the vaccine to the students group. Some may cry due to the pain and some may look at the needle but feel nothing, some may be smile and some may look at the other side, etc.

3. The different behaviors may be caused by the same causes, such as the some persons may have the different manners when they feel lazy, such as some may close their eyes, some may like playing cards, some may like watching movie, some may like music, and some may like sleeping. These different behaviors are all from the same casues, which is, the laziness to work.

4. One behavior may be from various casuses; such as the person has the meal at the expensive restaurant may cause from various reasons, such as feeling hungry, like listening to the music while eating, like good service, like to be seen that the person has high taste.

The regulations or the nature of all four behaviors will help the preson who studies about the behavior perceive the base of behaviors better.

2.3.2.2 Measure of behavior

The personal behavior has both internal and external sides. To study the behavior, this can be done in several ways. If it is the external behavior which the person expresses and other persons can see will be able to do by both direct and indirect observation. However if it is the internal behavior, it cannot be seen by observation and it must be done by interview, having test by asking questions and experiment both in the laboratory and community. Therefore the instruments to measure the behavior can be carried out by creating questionnaire, interview, observation together with interview or use orhter instruments, such as blood pressure measure instrument, stethoscope, etc. Somjit Supannatas (1893: 14-18) mentioned about the two methods of educational behavior as follows:

1) Direct educational behavior; this can be done by;

1.1) Direct Observation; for example, the teacher observes the behavior of students in the classroom by telling the students that the teacher will observe what the students are doing in the classrrom. However, with this observational method, the student may not express their real behaviors.

1.2) Naturalistic Observation; The person wants to observe the behaviors but do not distueb the persons who are being observed and they will not be kbown that they are being observed. With this method, it's rather real behaviors and can take the results to explain the behaviors in the place nearby or similar. The restriction of natural observation is that it takes a long time. Moreover, the observation has to be done continuously for a lot of time. Some behaviors may need the observation up to 50 years or 100 years.

In conclusion, the observation of behavior either the person who is being observed is aware or not, the observer has to be careful and observe systematically and record when the behavior can be observed. In addition, the observer must not bias through the person being observed in order to get the study result accurate and reliable.

2) Indirect education; this can be divided into many ways:

2.1) Interview; this is the method which the person who studies wants to ask the information from the person or group of persons which can be carried out by asking face-face directly or there is a mediator to do the duty of asking questions, such as using the interpretator to interview for the persons who say in different languages. The interview is done in orde to know the person's behaviors which can be divided into 2 main types, which are, direct interview and indirect interview. For The indirect interview or informal interview, the interviewer can say anything but insert the contents which the interviewer wants to know when there is an opportunity. The responder or interviewee will never know things which the interviewer specifies in order to know the behaviors. The interviewer will get a lot of information. However, the restriction is there are some issues which the interviewee doesn't want to expose.

2.2) Questionnair; It is one of the methods which is appropriate for studying the behaviors of the numerous people, literate people, or it is used for questioning the persons who stay away or far from another. Moreover, it can ask about the past behaviors or the tendency of behaviors in the future as well. In addition, the advantages of using questionnaire are that the user can use the single information with the concealed behaviors or various behaviors which expressed to others by other ways. The persons who are studied are sure that it is the secret. The other advantage is the questionnaire can be studied at any time.

2.3) The experiment is the study of behaviors done by the person who is studied will be controlled according to the observer wants. Actually, the control can be done in the laboratory. Nontheless, to study behaviors in community by controlling variables can be little possible. The experiment in the laboratory would limit the information. Sometimes, it cannot be used in the real situations. However, this method is really useful in the study of medical behaviors on individuals.

2.4) Doing the record; this method makes us know about the personal behaviors by letting each individual do the record of behavior himself/herself. The record may be about the routine or about the study of each kind of behaviors, such as eating behaviors, working behaviors, health working behaviors, or environmental behaviors, etc.

This can be seen that the behaviors are the action or expression for practice which is the result from the internal environments, i.e. belief, value, attitudes, personality, and previous experience. These are the impulse for expressing to be the external behaviors which can be exposed by being able to be seen or being the behaviors both being disclosed and unobservable except using the tool to measure. The internal behaviors and external behaviors are related and rational to each other. For this study, the indirect study was carried out by using the interview to be the research instrument.

2.4 Electrical energy

Electricity is involved and closed with people the most. The electricity is processed from energy resources convenient for utilization. Currently, the electrical energy is a extremely crucial factor for developing economy and society of the country both in the powerful countries or developing countries as well as Thailand.

2.4.1 Background of electrical energy

Some scientists construct innovation called electrical energy system existing in nowadays. This is originated around 60 years before the Buddha era till 19th

century which every human being apply all in the household, school, office, or in the industrial factory. These mentioned cannot be without electricity (Mohamed, 2009: 1)

Telis of Milatus (cited in The Electricity Generating Authority of Thailand, 1994: 21), the ancient Greek philosophers and mathimaticians discovered "static electricity" accidentally. One day, he saw the small piece of wood moving and attaching the amber which he just picked up to scrub to each other until it causes the spark but he didn't realize he could discover the really important things through human being later time.

In B.E. 2143, it was appeared that the book named 'De Magnete' was published. This was the report of the laboratory of Sir William Gilbert (cited in The Electricity Generating Authority of Thailand, 1994: 24). This reported that not only amber but also other materials, such as sulphur, glass and lac. When they are scrubbed until caused heat, they would attract other small materials as well. Gilbert called this gravity of static electricity of the electricity from Greek language 'Elektron' which meant 'amber'.

In B.E. 2363, there were the numerous invention of electric equipment by several Greek scientists, such as Stephen Gray, Granvil Wheler, Benjimin Franklin and Alesandro Volta. Especially Volta was the inventor of battery called Voltaic Pile. Moreover at that same year, Hans Oersted, the Denmark people discovered that the electric currents had the gravity whereas the Andre Marie Ampere, French also invented the electromagnetic. This can be counted that it is the beginning of history which leads the science of electrical conductivity to apply in later time. For Michael Faraday, he discovered the principle of electromagnetic induction based on the Dynamo construction in the present era.

In conclusiton, it can be seen that the electricity is developed and applied more in all production, delivery ststem, as well as the electric equipment installment by modern technology unlimitedly all the time. The electricity becomes the crucial factor in the existence of human being in this present time a lot.

2.4.2 Electrictity and Electric situation in Thailand

The terms of "electricity" and "electricity enterprise" is assumed that these terms were used since B.E. 2427 in the HM King Rama V reign.

The production of electrical energy at the first stage was conducted by the government only. Later, the government transferred the enterprise to the Bangkok Electric Light Syndicate Company. The company had the contract to pay for the electricity to the roads and various governmental places. However, the company had to go out of business because of the loss and it was sold to the The Siam Electricity Co. Ltd. located the power plant and the office around the Wat Ratburana Worawiharn Temple or Wat Liab because the cost of electricity production was rather high so the electricity use was only in the city areas. Until the World War II, the power plant was exploited until it couldn't continue the enterprise. Therefore, it was the terminated time of electricity enterprise in Thailand before the World War II.

After the World War II, the government tried to find the way to sort out the crisis in terms of energy by starting the survey, study, and plan to find other energy resources to product the electricity futher. Until B.E. 2500, there was the establishment of Yanhee electricity authority to be responsible to pay for the electricity to other provinces. Most of the power plant at the first stage is usually the small power plant of small disel and the electricity manufacturing machine would be run only at the night time. Therefore, the government established several orginizations to be responsible for the electrical energy.

The Electricity Generating Authority of Thailand Act (EGAT) determined the Electricity Generating Authority of Thailand considered to be the only one state enterprise responsible for manufacturing and delivering the electricity current within the country as well as being ready for the development of electrical energy production and being ready to step to the electricity needs growing fast together with the economic and social development of Thailand.

For the situation of electricity requiremtn, it can be seen that the direct relationship and economic situations of the country, namely, there is the changes according to the economic growth, number of population, quality and electricity cost. For measuring the economic growth, the electricity requirement is one of the indexes which can tell that how the economic growth at that time is and if this assumption is true, it can be confirmed that the economy of Thailand has growe really fast, namely, in B.E. 2512, it was the first year of establishment of The Electricity Generating Authority of Thailand to produce the electricity currents. However, the electricity

requiremtn was only 907,000 kilowatts, in B.E. 2538, on March 30 th, 1995, the electricity requirement was up to 11,639.9 million watts and it still had higher tendency. The Electricity Generating Authority of Thailand also tried to develop the resources to produce the electricity to meet the sufficient needs and in time. Moreover, the additional construction of transmission line to be ble to convey the energy to various areas in the case of electrical problem which influenced the security and reliability of electricity use. The areas which used the electricity really highly were Metropolitan Electricity Authority (Thailand) areas, i.e. Bangkok and suburbs (Demand-Side Management Office, 1995: 4-5).

2.4.3 Resources and situations of fuel and energy problems

2.4.3.1 Where is electrical energy?

The electricity is originated by several ways, such as

- Natural originate, i.e., lightning, thunderbolt, some kinds of animals which have their own electricity, such as electric eel, etc.

- Heat energy is changed to be the electrical energy

- The light is changed to be the electrical energy by solar cell

- The chemical interaction can be caused the electricity, such as battery, dry battery, dried cell.

- For the electricity used according to the household in nowadays, the electric generator will do the duty to change the energy to become the electrical energy according the principle of induction of Michael Faraday, namely, when there is the rolling of coil in the magnetic field, it will cause the electric pressure in the coil, thus it creates the electric current for us to use as required.

2.4.3.2 The resources of electricity generation in Thailand

The electricity is not the energy resource but only a form of energy which can work. The electrical energy we use in our daily life was from several kinds of energy resources to let the electric generator work and causes the electrical energy, energy resources, i.e.

- Coal; it is originated by plants which accumulated the energy from sun in the form of biomass dead and collected under the ground. The change of world surface-layer makes the humus become the coal. The human beings use the coal

for being the fuel, boiling water to become the steam which has the power to drive the generator to produce the electricity and deliver through the lines for all households. 26% of the electricity is from the use of Liknite to be the fuel.

- Water power; it is originated by the solar cell which makes water in the river and ocean vapors to become steam. Then, the steam will be combined to become clouds and rain falling into the ground and collecting together to become stream. When the water route is blocked, it can lift the height level of water and originates a lot of water power to be used for rolling the mill to originate the electricity production. The 7.4% of electricity is originated by water power.

- Petrolium products; the little plants in the sea collected the energy in the form of these biomass, sea animals that eat plants. When anmimals and plants die and they are collected under the sea, the change of world surface-layer for million years caused the fossils collected to become the pitrolium fuel. When the crude and natural gas dug and drilled and delivered through refinery to become the fuel and produced. The electricity current for 66.6% is from using the pitrolium product to be the fuel.

- Solar Cell: this can change the sunlight energy to be the electrical energy directly. It is mostly from the half-conductor in a kind of Silicon, Germanium or other substances which give the phenomena of electricity current originate from the light. In theory, the solar cell can change the solar cell energy to be the electrical energy up to 22%.

2.4.3.3 Fuel and energy

To acquire the fuel and energy for electric current generation to be sufficient for the people's requirement can be done in 2 aspects, which are

1. Develop the existed or created resources, such as

- Water power; although being the cycle resources, medium and huge dam construction may be affected seriously towards the environments, therefore it should be considered carefully. While the small size of water power electricity project should be supported for people living in the distant localities.

- Garbages of big cities

- The rests from agricultural materials, such as chaff, bagasse and charcoal

- Wind energy

- Geothermal energy

- Sunlight power

2. Buy the fuel and energy from foreign countries, such as

- Buy the electrical energy from neighbor countries by linking the electric wire and cable, such as Lao, Malaysia, and Myanma, etc.

- Coal from Australia, Indonesia, China and other countries

- Natural gas (fluid); its price may be more expensive in the future but it may be imported by several countries, such as Gatar, Oman, Australia, Brunai, and Malaysia.

- Petrol; the price is not certain and the price in the future may be more expensive.

- Nuclear energy for Thailand still has no decision making seriously.

- Moreover, it should push the development of basin among the rivers, i.e., Khong river, Salawin river, Saimei river, Kra canal, Nam Mei, and Mae-Kok, etc.

For the development of procution resources, delivery and distribution system; the The Electricity Generating Authority of Thailand, Metropolitan Electricity Authority (Thailand) and Regional Electric Power Plant already made the long plan. However, such the plan usually has to be adjusted to be in accordance witht the situations always especially the conditions of social and environmental problems which make the electricity development run difficultly because almost all kinds of electric generation resources will affect the environments like lignite, dam, and reservoir which has to use the widespread areas which will be the forests area, residence, land. Perhaps, it causes the problem of water and climate quality, such as Mae-Moh, etc. However, the survery of Thai evergy resources still continue. If it cannot be surveyed, it still has to buy the fuel and energy from the foreign countries in order to get the sufficient energy to produce the electricity current to be sufficient to the country needs further.

2.4.3.4 Problem situations on fuel and energy resources

The requirement of electricity use of the country is increasing. However, several projects of dam and power plant construction are restrained. The limitation of electricity current generation is the energy resources used is the primary energy of generation. Most of them involve with the environments which casue a lot of problems from power plant construction. There are 2 main causes included as follows:

(1) Protest from local people

When considering the energy in our country, there are few alternatives. The primary energy which is appropriate and gives electricity and other benefits include water power plant. However, for our country, the appropriate water power resources are limited and the construction affects the environments rather highly although there are efforts to improve the environments to be appropriate, however there is the protest currents continuously.

Lignite is another primary energy which the The Electricity Generating Authority of Thailand developed for producing the electric current but it causes the pollution sometimes which causes the problems to some people in some areas and this causes the protest through various kinds of media.

(2) Protest from general people

- Power plant of newclear energy

Although the needs of electricity use are a lot, general people still has the opinion not to build the nuclear power plant with several reasons as the following:

- The use has to be careful and keep the regulations strictly.

- The image which people feel towards the nuclear power plant after the case of chernobyl was not rather good, namely, the result of electricitu explosion, it caused people dead more than 300 persons. Moreover, it was predicted that for more than 70 years, there would have around 5,000 - 150,000 people suffering from cancer disease and have to die before the appropriate time caused by the radioactive element (Green World Foundation, 1994: 82-83).

- The project of financial problems; because it has to use really high investment around 65,000 million baht/1,000 makkawats (The Electricity Generating Authority of Thailand, 1995: 40)

Nontheless, there is no clear decision making that it will have the construction of nuclear power plant because it is not sure about the safety, however, it has the realization about the need of seeking other energies to substitude mentioned above. The electricity has given convenience through the humen beings for along time until it is the crucial thing which cannot be lacked of and it is increased its use. It can be said that any society has no electricity, that society cannot find the progress. However, the electricity used today cannot be kept in the container; therefore it has to have the machine operating to produce the electricity for usage all the time. Moreover, the power plant is not the electrical energy resource. The real electrical energy resource is the thing which will change to become the "electrical energy", such as water, petrol, natural gas; therefore these coals are extrememly crucial. We have to find it sufficiently, however, therse are the natural resources which the more we use the more it will be wasted.

In conclusion, the need of electricity use is increased all the time which causes the problem of finding the electricity and each power plant which has to use the time to conduct before construction for several years. The most important, it causes the wastes of natural resources numerously collected for millions years. Hence, if people in Thailand mutually cooperate to save the electricity, not only Thailand will have sufficient electricity to use but also help preserve the natural resources to be used forever.

2.4.4 Requirement of electrical energy

According to the statistic of increase ratio of Thai citizen around 1.5% per year, it causes the construction of city or new community as well as residences, i.e., developed housing, condominium, flat, townhouse, and numerousely huge size of industrial factory which needs the electrical energy to be the main. The index indicates the need of electricity which is increasing in each year is from GDP, namely, it the electricity is much, so does the GDP and if the electricity is little, so does the GDP. From the past, the rate of electricity use increase is still more than the rate of GDP increasing (The Electricity Generating Authority of Thailand, 1995: 28)

For the prediction of electricity requirement in the long terms, it is conducted by the prediction staff of electricity need which consists of National Energy

Policy Council, Department of Energy Development and Promotion, Provincial Electric Authority, Metropolitan Electricity Authority (Thailand), The Electricity Generating Authority of Thailand and The Thailand Development Research Institute. There are the experts from Canada to participate with, the prediction is observed by the economic situations which is predicted in advance for analyzing with other factors by predicting the needs of electric use 15 years in advance (since 1991) to generate the electricity current to be able to catch up with various situations. In addition the prediction will be similar to the real situation a lot which expresses the requirement of electricity use increasing in each range of the National economic and social development plan of various issues as the Table 2.2 as follows:

Table 2.2 Prediction of electricity requirement in the development plan of 7th -9th issue

volume	during the year of	requirement of electricity use increasing around (Mekkawatt)	average of percentage per year
7	2535-2539	1,000	10.2
8	2540-2544	1,200	7.8
9	2545-2549	1,300	6.1

According to the prediction report, it indicates that this would seek for the electricity to be sufficient. The Electricity Generating Authority of Thailand (EGAT) planned the construction of electricity generation resources by letting it finish with the requiremet. However, in the real situation, it has to encounter the problems and obstacles very much as mentioned above especially in terms of construction of electricity generation resources, construction of electricity delivery system as well as addition and extension of electric distributing system which is not be able to conduct or slowly conduct. If this problem is being inceased and people lack of cooperation of electricity use econmomically and effectively, it may cause Thailand to encounter the lack of electricity in the future.

2.4.5 Ways to solve the problems

The electricity has been used increasing so far. The energy used, one part was in the form of Primary Energy i.e. natural gas, coal, lignite, firewood, etc. by using in the industrial fields and households mostly. And other parts are in the form of secondary energy i.e. gasoline and electricity.

Electricity is considered to be the energy used in every field. Therefore, the electricity generation is considered to be crucial. However, because of the generation process is complex and takes time as well as the limitation. Hence, it's necessary to determine various measures to preserve the energy including the electricity energy preservation as well. The conduction is done as follows:

Because the fuel used for the generation or production and the productivity of energy in Thailand is really concerned. Moreover, it is the close issue which affects the living from the level of family to country. If we still ignore and has no idea to campaign and cooperate concreately, in the future we have to encountrer with the crisis certainly.

To let everyone cooperate to one another to save the electricity used increasingly and sustainly, the most effectiveness is to give education and knowledge as well as the fundamental information in terms of electrical energy saving. This likely is the direct duty of the knowledgeable scholars to give knowledges and correct ways in using the electric equipment which is considered to be the basis of electrical energy saving through involved people and general people. Therefore, to find the way of creating the consciousness to the society for supporting the change of behaviors for using electricity savely more and more, this is the recommendations as follows: (Yodyiam Teptaranont, 1996: 63-66).

1. The building and household should respond the electrical energy saving. The building design for construction, materials used, direction of building, all indicates how the electricity is used more or less or whether it used excessively. The building and household can be the part to save the electrical energy saving easily and can be done immediately as follows:

- The design of building; it should give shadow for building; it means that it should have the weatherboard or have the roof which protrudes out of the house. This is about trying not to let the sunlight be in the building or the wall directly

because the wall will keep the heat and then the air-conditioner will have to be use excessively.

- The construction of well or pond; it should be located appropriately; otherwise it becomes the huge mirror which reflects both sunlight and heat through the building.

- The growing plants; this gives the shadows to the building and helps save the use of air-conditioner.

- Kitchenware; it should be selected by only the equipment which helps save the electricity, especially the primary equipment which we use regularly as follows:

1) Change the ne-on or fluorescence from the fat bulb to the thin bulb.

2) Change the red bulb to be the white and soft bulb with stick bulb.

3) Choose the household equipment (refridgerator, air-conditioner) of number 5.

After that, we should turn off the electricity and various appliances which we don't use. If it is inconvenient, we have to waste money for installing the equipment which helps setting the time of turning on-turning off automatically or the timer, etc.

- Wear the heat-resistant insulation; if we have a chance to construct a new house or maintain and improve the old house, we shouldn't feel pity to waste money for installing the heat-resistant insulation to prevent the heat into our house. The best space for installing the heat-resistence material is around the every part of the surface of building, roof, and various walls.

2. We should use the savely equipment increasing starting from the electric equipment used in the household, such as electric bulb, refridgerator, air-conditioner, etc. Moreover, it should give knowledges in terms of effectiveness of various uses of equipment clearly as follows: (Demand Side Management Office, 1995: 19-31).

2.1 The electricity and light; this should be used by the fluorescence instead of light bulb which has the filament because it gives the light more around 4-5 times. Moreover, it has longer useful life and it should turn off the light every time when finish using, always clean the light bulb, for the color of the wall or ceiling, it should avoid the dark colors.

2.2 Refridgerator; this should be placed appropriately; the best is far away from the wall not less than 15 cms to let the air conveniently ventilate. The refridgerator shouldn't be turned on too often and should melt the ice always. The most important, the number 5 should be used to save the electricity cost.

2.3 Television; this shouldn't be plugged in left but should install the timer swhitch to help turn off the receiver of television automatically. In addition, it should be turned on at the time of watching only.

2.4 Air-conditioner should be selected to be appropriate to the room and install at the appropriate place.

- Only the necessary parts should be turned on.

- Only choose the air-conditioner in a type of number 5.

2.5 Iron; each time of ironing, it shouldn be done in a lot of quantity and continuity. Should set the heat button appropriately and don't wet the cloth. Before finishing the ironing, the plug should be turned off for a while.

2.6 Electric stove; before cooking, it should have planned what to do before-after. It shouldn't turn on the door of stove door too often and should turn off the switch before finishing cooking.

2.7 Washing machine; should wash the clothes in the suitable quantities and should use the washing machine which wastes electricity cost a little.

2.8 Vaccumn cleaner; when finishing the cleaning, the dust should be left every time because the more the dust has, the more the block and the gravity will be decreased.

2.9 Hair dryer; it should be used appropriately and should clean hair until it dries before hair drying.

2.10 Water pump; the pump which is controlled by the pressure should be careful about the leaking water around the pipe because the presuure will be reduced and the machine will work automatically.

In conclusion, the literature review of electrical energy, the researcher brings the concept thtat electrical energy is regarded as a crucial tool for the economic and social development of the country. It is used widespread. The most important, the electricity current generation must be done by using various energies to generate the electricity current. Currently, the pitrolium product is being used the most (66.6%). This energy is called the non - renewable energy. Moreover, the construction of electricity generation causes a lot environmental problems but at the present time, each year the tendency of electricity requirement is increasing. The good problems solving is that it should have the equipment which can save the electricity more. Moreover, it should give knowledges in terms of use effectiveness for using various electric appliances.

2.5 Energy preservation

In the current situation, the energy consumption behaviors are changing. There are the uses of facilities in daily life increasingly. These causes the increase of energy use rates every year. This is considered to be the hard burden to the financial status and investment of the country for providing the energy to be sufficient, in-time and appropriate. The government realizes this problem so the conduction is carried out by preserving the energy to be sufficient and in-time. In the the fifth National Economic and Social Development Plan, there was an issue of National Energy Policy Council Act B.E. 2535 (1992) which was announced in the the government gazette and in force on on 3rd April in the same year Energy Policy and Planning Office, 2008:19-24).

Porama Satawetin (1980:1) suggested that the energy reservation could be done by 2 aspects as follows:

1. Technology; try to find new techniques which save or reduce the energy instead of old techniques.

2. Human and society; they are the energy users, so it has to create the attitudes and understanding about the lacking of concept in terms of preservation which is the energy saving without any technological research.

Wijit Kongpool (1981: 131-132) mentioned about the energy saving that this could be done in several ways; from reducing the working hours of entertaining places, petrol pump day off for some day, stop using the air-conditioner and electric equipment if unnecessary, reduce the electricity use in the governmental places and business organizations as well as doing campaign to persuade people to use life savely in every level. To save and reduce the requirement in routine life has to be done seriously and always because it can solve several kinds of problem in a permanent method.

Charauy Boonyubol and others (1986: 21) mentioned about the ways to save the energy. It can be divided into 4 types as follows:

1. Reduce the waste of unnessary energy;

2. Change to use the process depended on the energy less;

3. Reduce the activities whiehc have to use the unnecessary energy which means the change of life being.

4. Increase the effectiveness of equipment, system, and process which use the energy which can be done by the appropriate design.

Jirapol Sintunawa (1991: 92) suggested that the most important to help reserve the nature is that everyone must have the consciousness to reserve the nature; everyone must have the consciousness to save the energy. The crucial principle of energy saving includes as follows:

1. Reduce of use and reduce of waste in every point and every step.

2. Increase the effectiveness of use to have more quantities.

3. Increase the every side of resources by circulation and recycle the resources, such as paper, metal, and plastic.

4. Plant the trees to absorb the carbondioxide.

5. Avoid the use of products and technology dangerous to the environment.

6. Publize this thought to people around.

Macweck said that there were 3 basic wyas to effectively reduce the energy use as follows:

1. Improve the effectiveness by cutting off the unnecessary use in the households and production or increase the effectiveness of equipment.

2. Reduce the use by issuing the better regulations or use but less. If possible, it may be applied by the economic system to be the force.

3. Seek for the better energy substitution. The project of life and nature recovery (1991: 180) indicated that the energy reservation was not the force of using energy less but it means using the energy effectively, which meant using the energy in the same quantity but getting more benefits or getting the equal benefits but using the energy less. Therefore the energy reservation is about the elimination of using energy which is not beneficial and valuable for the economy and society as well as using the limited resources to get the most benefits.

Energy reservation can be considered into 2 ways as follows:

1. Increase the effectiveness of the manufacturers and distributors

The effectiveness of the manufacturer means to use the fuel existed in the same quantity but to produce the electricity current to be more or to produce the electrical energy in the same quantity but use the fuel less. Whereas the effectiveness of distributors means to reduce the loss of electrical energy during the time of sending the electric current between the delivering the electric current from the manufacturer to the consumer which means the reduction of loss in the delivery line.

2. Increase the effectiveness of the users

The effectiveness of user means to use the electrical energy limitedly existed to be the most beneficial, i.e. to reduce the quantity of electricity consumption in the activities wheich are not beneficial and to use the existing energy to be more beneficial or to utilize from the electrical energy in the same quantity but to use the electrical energy less, such as to use the highly effective electric bulb can reduce the electricity use up to 10% by still giving the equal light. Hence, to energy reservation in terms of the user means it includes the energy saving and to increase the effectiveness of energy use.

Paul (1992: 99) said that the energy reservation consists of 4 activities including:

1. Improve the effectiveness of burning the most and leave the waste from the burning the least which causes the cost reduction for machine maintenance and energy saving.

2. The waste processing left from the process to be the highest benefits.

3. The use of benefits to be the most valuable as much as possible.

4. The leaving of wastes to the environment to be the least as much as possible.

2.5.1 The Energy Conservation Promotion Act (2ndissue) B.E. 2550

The Energy Conservation Promotion Act B.E. 2550 which has been in force since 1st June, B.E. 2008 by having the intentijon to support the udiscipline for energy reservation and let to have the investment for energy reservation in the factory and building by using the measure to force together with the giving of motivation, namely, to set the fund for financial support to the persons who desire to increasr the effectiveness of the energy use and have the punishment for the factory and the controlled building which ignore and not practice according to the law of the determined department.

The policy to save and reserve the energy; this would support in the parts involved with the people directly, i.e., the project of doing the conservation promotion plan of energy in residence, review and study the status of using the energy in the residence term, study and collect the information of conservation project of energy in terms of residence, study and estimate the potentials of energy reservation in the 2 groups, electric equipment and appliances for 5 kinds, such as refridgerator, air-conditioner, fluorescence bulb, ballads and fan , insulator and constructions materials for 10 kinds, such as brick, block concrete, tinted glass, fiber, fiber glass, foam as well as studying the problems and obstacles in preserving the energy in the residence.

2.5.2 The target group of the Energy Conservation Promotion Act B.E. 2550

The main target group which the Energy Conservation Promotion Act B.E. 2550; this supervises and helps, which included:

1) Industrial industry

2) Business building

3) The manufacturer and distributor of highly effective equipment, materials which help in the energy saving

The secondary purpose which the the Energy Conservation Promotion Act B.E. 2550 supervises and helps, i.e. the residence group and small commercial building (Energy Policy and Planning Office, Ministry of Energy: 2008), thus the owner of controlled building or factory within the scope according to the the Energy Conservation Promotion Act B.E. 2550 which is the building or factory which use either energy for benefiting in terms of energy reservation in the machine or equipment and support the use of materials use to reserve the energy to let the cabinet by recommendations of National Energy Policy Council which has the authority to issue the ministerial regulations as follows:

1. Determine the machine or equipment according to the types, size, quantity, energy use, rate of energy waste and the effectiveness of energy use to be the machine or the highly effective e quipemnt.

2. Determine the materials according to the type of quality and standart. It is the material to be used for reserving the energy. The manufacture and the distributor of machine or highly effective equipment or the material used for reserving the energy according to the paragraph 1 has the right to receive the support and help according to the Clause 40.

2.5.3 Benefits of energy reservation according to the Energy Conservation Promotion Act B.E. 2550

The law of energy conservation promotion according to the Energy Conservation Promotion Act B.E. 2550 (Energy Policy and Plannig Office, Ministry of Energy: 2008), this is the law which helps the nations use the energy more economically and effectively which gets advantages for every part as follows:

1. The nation has the energy reservation systematically and continuously.

2. There is the follow system of operation according to the policy and plan which will make the energy saving as overall image more effective.

3. The factory owner and building will get the benefits from money contribution, money support for the investment and energy reservation conduction or problem solving about the environments caused by the energy reservation from the Energy Conservtion Promotion Fund.

4. The factory and building owner will get benefits in the long term in terms of reducing the expenses of energy per the products.

5. The manufacturer and distributor of machine or highly effective equipment or the materials to use for reserving energy will get benefits from the money support and contributions for investment from the fund to support the energy reservation.

6. The building owner in general will utilize from the measure of energy reservation by using the highly effective products of energy in the cheaper price.

In conclusion, according to the literature review of electrical energy reservation, the researcher brings the concept that currently, there are the facilities in the daily life increasingly which cause the rate of energy use more and more, so the energy reservation which can be carried out in terms of technological term is about trying to find the new techniques which help save the electricity by reducing the wastes of unnecessary energy. For human and society, it has to create the attitudes and understanding to accept the ideas about energy reservation in the The Energy Conservation Promotion Act still has to help the manufacturers and distributors of highly effective equipment which helps save the energy.

2.6 Energy saving

2.6.1 The definition of energy saving

There are the definitions of energy saving as follows:

1) Energy saving means the reduction of energy use by planning and managing the energy use to be appropriate in order to get the optimum benefits without making the process or product activities low. Moreover, this has to be under the determined condition, such as the quality of products which are not changed (Boonyong Limchupornwikul, 1987: 124)

2) Energy saving means the reduction of energy use to reduce the production cost under the determined condition. To try to increase or decrease the index value of energy which is a part of energy saving is a result of the used overall energy value and the energy price per unit of products has a low value (Jearanai Lekuthai, 1993: 101)

3) Energy saving means the management of some energies to get the optimum benefits without any disadvantage through other activities (Wichai Tiampracha, 1993: 114)

In conclusion, the energy saving therefore means the effort of reducing the quantity value of energy used under the condition fo management of using energy without any effect through the activity of living by trying to control the equipment use to be the optimum effectiveness, reduce the energy wastes, increase the useful life of equipment to be appropriate to the time of use and helps save the energy use of the country.

2.6.2 Electrical energy saving in the system

The electrical energy is really crucial and essential in the daliy life, therefore the electrical energy saving in all system should be considered by the elementas as follows:

1) Value reduction of electrical energy

The electrical energy value is the fee calculated from the amount of electrical energy need in each month. The electrical energy got is from using equipment, instruments, machine, and others. The electricity authority will ask for the electrical energy fees in the different reates of each kinds of electrical use. The way to reduce the electrical energy fee can be done by reducing the electrical energy use.

2) Control of the electrical energy peak demand

The peak demand value of electrical energy is the fee calculated by the electricity authority from the electrical average peak demand in 15 minutes of that month (Department of Energy Development and Promotion, Ministry of Science, Technology and Environment, 1993) without charging the fee from the requirement of peak electrical energy to the non-profit governmental organizations. However, the peak demand of electrical energy will be the indicator to measure to kbow about the effectiveness of using the electrical energy as a whole system. If the the demand value of electrical energy is peak or ooptimum. It means that the effectiveness of electrical energy use as a whole system has a low value. Hence, the control of demand value of electrical energy which can be done by setting the time period of the electrical energy use to be appropriate averagely. The use of electrical energy in each time period to have the equal quantity, the average of electrical energy use in each time period to

have the similar quantity can be considered by the value of load factor. For the load factor, this is the ratio of average electrical energy used within the time period which determines towards the peak electrical energy at the same period time (Sakol Prom wong, 1993: 44).

Load Factor (LF) = (average electrical energy in the time period determined (kW)/peak electrical energy at the same time period (kW)) x 100%.

The advantage of reduction of requirement value of the peak electrical energy as follows:

1. Let the effectiveness of using the peak electrical energy as follows or it has the load factor very high. It can be seen that the higher the load factor value, the average of electrical fee per units is lower.

2. Reduce the waste of electrical energy in the transformer

3. Reduce the loss in the main line and feed line of electric current to enable the electric equipment to be installed increasingly.

2.6.3 Electrical energy saving from the electric equipment within household

Home is the place for residing, preventing from sun and rain and the save place from nature, human, animal which will disturb or harm us. Nowadays, the technological advancement and adjustment according to the economic conditions and society, there is different construction through the households. The house which is constructed by different size and materials, no matter what will construct the house, buy the house, rent the house, the kind of office building, the things we should consider are not only about space, location, transportation, price, and environments which will help the decision making appropriately. Moreover, it will be one thing which will be looked over is about the various expenses within the household. Not only the materials, furniture to decorate the house, it also has the needed electric appliances, such as electricity bulb, television, iron, fan, refridgerator, etc. In addition, the electrical appliances which facilitates, such as air-conditioner, washing machine, water heater, etc. These electrical appliances had to use the energy in all cases which will cause the monthly expenses. The cost will be more or less depends on correct using. Therefore, if anyone chooses electrical appliances to be appropriate for the

exsistence, necessity, and the numbers of members, this will get the benefits from using the electrical appliances really. In addition, if anyone knows the use methods, treatment, maintenance of the existed electrical appliances to be good conditions always and investigate or check each electrical appliances which kind of them use the energy more of less in order to be use correctly. This can help saving energy and expenses in household. Furthermore, things which will make the energy save is from concerning and having ther real intention. This will start from you yourself also the members in family have to cooperate by as follows:

1. To construct the consciousness and give knowledges in terms of energy saving to the members of family.

2. To use electric equipment as necessary boith amount and time of usage

3. To use electric equipment highly effective

4. To use the electric equipment which its size is appropriate to the useage

5. To reduce the electric appliances which have high watts

6. To maintain the electric equipment regularly

For the ways of practical to originate the eclectrical energy saving from using the electrical appliances within the house as follows:

2.6.3.1 Computer

Currently, any organization no matter what the governmental or private section, there is the application of computer to be used in the organizations numerously which will cause the condution of organization systematically to be able to develop the work continuously and systematically. In addition, this will help know the various news and information conveniently and fast. The computer is therefore crucial equipment in the office. For this recommened method, it can be used to be the practical at home as well to reduce the expense of electrical energy.

Recommendations for using and taking care of computer

1. It should place the computer in the area which the weather can be ventilated comfortably.

2. It should set the Screen Saver system to maintain the quality of computer screen.

3. It should be checked that the energy saving system of the machine has already been installed and let the system work. If not, it should be managed in order to help save the elecricity.

Recommendations in the energy saving from computer use

1. Don't turn on the computer but leave it without using. Moreover, it should be instralled by the system of reducing the electrical current go into the computer during the time of not working to help reduce the electric saving up to 35 – 40. If the screen is shut down immediately after it is not used anymore for more than 15 minutes, it will save the electricity for 60%.

2. Switch off the computer and the result printer when it isn't used continuously for 1 hour and should turn off the plug when finish using.

3. If in the office, there are a few people using the computer, so they should use the computer mutually. This will be more appropriate than letting all staff have each computer but the use is not worthy.

4. If you use most of the time outside the organization, you should use the notebook instead because it uses the energy only 1 in 10 of the table computer. However, it depends on how often you use your computer as well.

5. It should select the computer which has the energy saving by observing from the Energy Star symbol because this system uses the electric power less around 55% while wating for its work.

6. It should use the computer system which has the screen not too big size, such as only 14 inches because it will use the less energy than the big size screen.

7. For selecting the result printer, it should be considered to buy the printer in ink jet type or dot matrix type although some printers work slowly and have a loud noise. Moreover, the printer in ink jet type uses the electricity only 70 – 90 of electricity use of lasor printer, however, to select what kind of printer will be used, it should consider the necessary of work to be the decision making.

8. To produce any document, if there is the amendment of documents, it should be amended on the computer screen completely and on the documents printed from the printer several times in order to save all electricity, paper, ink and prevent from the deterioration of the result printer very much.

2.6.3.2 Air-conditioner

Air-conditioner is a kind of really famous appliance. It can be seen that the various buildings or workplaces or even households have the air-conditioner to use widespread. At the same time, the air-conditioner is recognized as the electric appliances which have to use the electricity current the most. It is estimated that more than 60% of electricity used within the office building is from the air-conditioner use. With this reason, it is hoped that everyone should concern and use the air-conditioner which has the most effectiveness and help save the energy and it should select the air-conditioner to be appropriate to the size of the room. Moreover, having primary knowledge about the way of energy saving is also important in order to get the cooperation and practical correctly further.

Recommendations for using and taking care of the air-conditioner

1. Always clean the air filter not to have the dust. This can help save the energy around 5%-7% per year.

2. Don't bring things to block the way of wind to be in and out of the air extractor set installed outside the building as it will let the machine be not able to extract the heat fully and the machine has to work hard and waste the electricity.

3. Don't install the set of extracting the heat near the wall too much because the machine will use the electricity more and up to 5-20%. The best way is it should be set far away from the wall around 15 c.m. in order to let the machine be able to extract the heat very well.

Practical Way of energy for the air-conditioner use

1. It should close the door and windows tightly while turning on the air-conditioner and it should install the curtain or shade or plant the trees around the buildings to prevent from the sunlight being through in the room. This can reduce the work burden of air-conditioner. Planting one big tree can give the coolness equal to one air-conditioner cooljess or giving the coolness around 12,000 BTU.

2. Avoid bringing the kitchenwares or containers which have the extremely hot surface, such as electri stove, hot pan, or kettle into the air-conditioning room. The food should be cooked completely before bringing into the room.

3. Set and adjust the temperature to be appropriate, for example;

3.1 Around the general workplace and central space, the temperature set should be 25 degree celcius.

3.2 Around the workplace near the glass window, the temperature set should be 24 degree celcius.

3.3 In the computer room, the temperature set should be 22 degree celcius.

For the temperature adjustment, every temperature which is increased for 1 degree celcius from 25 degree celcius can help save the energy of air-conditioner for 10%. However, it shouldn't be over 28 degree celcius because the temperature level within the room will not be cool although the machine still works continuously.

4. It shouldn't plant the trees or dry the clothes in the air-conditioning room because it will increase the humidity within the room and it will make the air-conditioner works harder.

5. During the time which the room is not used or before turning on the air-conditioner around 1-2 hours, it should turn on the door and window left to let the outside air go through the old air within the room to help reduce and ventilate various smells without turning on the fan to ventilate because turning on the air-conditioner together with the fan for ventilation will make the air-conditioner work hard and use the electricity current more consequently.

6. Turn off the air-conditioner every time which anyone thinks he/she will not be in the room for more than an hour for general air-conditioner, and 30 minutes for the air-conditioner Nmuber 5 energy saving type.

7. For the building which is installed by theh glass wall, the glass should be in a type of reflecting the heat radiation instead of general clear glass. In case of old building and general clear glsss has been used, it should be considered for fixing the film in a type of reflecting the heat radiation.

8. It should stop smoking in the room which has air-conditioner because it must turn on the fan for ventilation to ventilate the smoke and smell out of the room. Therefore, the air-conditioner will work harder and use more energy.

9. It should select to buy the air-conditioner which has the popular brand name becaue it is the reliable machine and should buy the machine which has been approved by the energyNumber 5 use which indicates that it has high effectiveness and save the electrical energy. The approved label is attached at the machine which can be seen clearly.

2.6.3.3 Electric blub

Electric bulb is the electric equipment which gives light. At the present time, the electric bulb is really necessary through the existence of human being. The electric bulb used in nowadays has various kinds. Each electric bulb gives the light value differently. Therefore, the selection is crucial and it should consider several elements mutually before using. Not only considering to use the highly effective electric bulb (electric bulb which gives much light quantity but the watt is low), the useful life is long, the color of light from the electric bult must be appropriate with the usage attributes, etc. Moreover, it should consider the energy saving and expenses which will happened as well. Some usage has to use the electric bulb without the energy, therefore, to use the electric bulb, it should consider the appropriateness and purposes of usage further.

Recommendations of usage and treat the electric bulb to save the energy

1. Should maintain the electric equipment always and continuously by cleaning the lid of electric lamp and the reflecting sheet the lamp to make the light equipment clean and bright effectively every 3-6 months.

2. Should select the electric bulb which has the durable and strong structure approved by the approval symbol of industrial standard quality, Thai Industrial Standards Institute (TISI) to extend the useful life of the electric bulb to be longer and more effective. In addition, it should select the electric bulb which has the lebel expressed the effectiveness by selecting the highly effective generation and has the lebel of number 5 which is energy saving.

3. Should select the table lamp around the place which the special light is needed, such as for reading, sawing, etc. This helps save the electricity better than using the light for a whole space of the room.

4. Don't turn on the light when no one in the room. Should turn off the light every time when it isn't used because turning off the switch during the lunch time for 1-1.5 hours, the electric bulb can reduce the energy use and collected heat very much. Moreover, it helps extend the useful life of light equipment as well.

5. Reduce the number of electric bulb around the place which has the light from nature, such as kitchen, corridor, window edge, etc.

6. For the place necessary to turn on the light all day and all night both in and out of the building or even the place which the heavey light is not needed, therefore the low watt of electrical bulb should be used in order to save the electricity.

7. The electrical switch should be used separately to turn on and off only the place needed instead of using the huge switch to control the turning on-off of the elcectrical bulb because it will waste the electrical energy due to not being able to turn off only which is unnecessary but having to turn on-off all with the one huge switch.

8. If the lighting system of some places has the light higher than it's necessary, the electrical bulb in some places should be taken off both ballads and starters (in the case of fluorescence is used).

9. Always observe the change of work of the electrical bulb, such as color and light of the electrical bulb whether it is bright as the same or not. If the electrical bulb is twinkling, it should be changed immediately because the electrical bulb which is twinkling uses the higher energy than the normal bulb.

10. Avoid using the dark colors for the wall and ceiling as the light color will help reflect the light and give more light which can reduce the amoung of using the electrical bulb.

11. When the new electrical bulb is needed, the electricity bulb should be replaced, such as thin bulb or fluorescence compact bulb used instead of incandescent light bulb. This will save the energy more than the bulb for 4-5 times and have the useful lifelonger than the incandescent light bulb up to 8 times.

2.6.3.4 Heat kettle and electric kettle

Heat kettle and electric kettle Is a electric appliances used for boiling the water. It is considered as the electric appliances which uses the high electrical energy. In general, the electric power used is between 500-1300 watts, therefore if you want to buy the heat kettle or electric kettle, you should choose the generation which has the effective insulator to prevent the heat. Moreover, the treatment and work method also important. If it is used correctly, it can be extended the useful life as well as being able to save the electrical energy.

Recommendations of vacuum bottle and electric kettle treatment

1. Always take care of the electrical line and plug joint which is usually always damageds.

2. The water used for boilig should be clean because if the water isn't clean, the internal surface of the kettle will change the color and causes the rust and dregs.

3. Always clean the kettle inside and don't let it have the dregs which will become the resistance for conveying the heat from the heat coil through the water, therefore the time to boil water is longer and waste both energy and expenses.

4. If it's unnecessary to use the vacuum bottle or electric kettle, it should pour the water left and clean until the kettle dry before keeping it.

5. The cleansing of kettle can be done by:

Body and kettle lid; use the cloth to clean with a little water carefully.

The internal kettle; use the sponge or soft cloth to clean thoroughly by water, pour the water left completely, don't pour water through other parts of the kettle except the internal kettle. And don't use the sharp things or scottbright to scratch or rub the internal kettle because it will make the enameled substances.

Recommendations of vacuum bottle and electric kettle use for energy saving

1. It should put the water to have appropriate quantity for boiling appropriate for using, don't put water too much or too less from the determined quantity as not only it will not help the energy, but also cause damage to the kettle or boiling kettle.

2. Don't plug in for boiling water for a long time before the time of real use.

3. It shouldn't boil water around the area which has air-conditioning because it increases the moisture and heat which will make the air-conditioner work hard and waste the electrical energy.

4. It shouldn't bring the cool water to boil because it wastes the electrical energy.

5. It should plug off when finish using the hot water to reduce the energy waste and shouldn't plug in if the water is not needed. However, if necessary to use the hot water consistently, such as, in some offices which have to use the hot water for preparing drink to the quests, so it shouldn't plug off frequently because every time the plug is pulled out, the temperature of water will gradually reduced and cannot keep the heat for so long. When plug in again, the machine will start boiling the water which will waste more.

2.6.3.5 Television

Television takes the role in the daily life both within the household and office building because it gives all entertainment, knowledge, and news and information quickly and can catch up with the events. The television famous in nowadays has both color and white-color which will have a lot of sizes from small to big size. In the present time, the manufacturer developed the systems and forms of television to be modern to respond the users' need all the time. This can be seen that there are all common, remote control, flat and curve screen, etc.

For buying the television, the user should consider the appropriateness of size, electric power use, such as television with big size uses more electrical energy than a small size or even the same size television, the television with remote control will use more electrical energy than the television of common system

because there is the additional circuit, therefore, in using the television, not only considering about the aspects and components of various systems, it should consider about the wastes of using the electrical energy which will cause the various expenses consequently.

Recommendations for using the television to save the electrical energy

1. Shouldn't turn on the television left when there is no one watching it.

2. Don't plug in since the television in terms of having the remote control, the machine will be able to support the picture or image immediately when pressing the turning on button. If the plug is still turned on, it will make the electrical energy work all the time although the machine is not used. Therefore, it should switch off every time when no one is watching and should turn off the plug every time after turning off the switch to save the electrical energy and externd the useful life of television as well.

3. It shouldn't adjust the screen to be brighter since it will reduce the useful life of the cathode ray tube and waste the energy.

4. Shouldn't turn on several televisions at the same time to watch the same program.

5. Shouldn't turn on the television left in advance just to wait for the favorite program but should turn on when ther real time of that program comes.

6. Shouldn't turn on the television by extending the line through video because it wastes the electrical energy for the video unneccessarily.

7. It should select the television which has the automatic time-off because it will save the electrical energy use for anyone who likes sleeping in front of the television screen or forgetting to turn off the television.

2.6.3.6 Refridgerator

Refridgerator is an electric appliance which is necessary in the daily life of each family. The benefits are used for keeping the fresh food, ice manufacturing or keeping the food which its frozen is needed. The need of refridgerator tends to be increased continuously. Currently there is the development in

terms of work system, size, and various shapes to make convenience for the users, such as door, close-open, both one door and 2 doors up. Hence, for choosing the refridgerator, each family should consider the appropriateness of use benefits in terms of size or quantity of things which will be frozen or needed temperature to kep or reserve the food, etc. Moreover, how to use the refrigerator is also important to help for the electrical energy saving and possible expenses. This is because the refridgerator is the electric appliance which uses the energy a lot and continuously through all useful life. This causes the wastes of energy. With this cause, the organizations both governmental and private get interested in and campaigns to use the refridgerator which saves the energy. This can be seen from using the lebel of saving electricity number 5 which indicates the value level of effectiveness attached at the front of the refridgerator to express the details to get refridgerator known that how many electrical energy that machine uses per year and how much it costs each year. The number expressing the value of effectiveness level of refrigerator can be divided into 5 levels as follows:

Number 1: the cooling ability of the refridgerator is lowly effective.

Number 2: the coolig ability of the refridgerator is fairly effective.

Number 3: the coolig ability of the refridgerator is moderately effective.

Number 4: the coolig ability of the refridgerator is well effective.

Number 5: the coolig ability of the refridgerator is very well effective.

The higher number of effictiveness, it indicates that the refridgerator is able to be cool much but use the electricity only a little when compared with other refridgerators in the same capacity.

Not only choosing the refridgerator which saves the energy, but also treating and maintaining the refridgerator in a correct way which can save the electricity expense as well as extending the useful life to be longer.

Recommendations of refridgerator for energy saving

1. Buy the refridgerator which has the ice melting system by the automatic button of ice melting or No Frost because this uses less energy.

2. Buy the one-door refridgerator instead of several doors because several refridgerators use huge compressure which has to use lots of electrictity.

3. Buy the refridgerator which has the thick insulator around to prevent from the cooling loss and it should be the insulator to prevent from the heat in an injection foam kind because it would help the food easy to be cool and wastes the electricity less.

4. Buy the light color refridgerator because it helps better light reflection within the room which the refridgerator is installed. This helps reduce the work of compressor which has to work hard from the heat within the room.

5. Buy the durable and strong refridgerator which get the standard quality mark of industrial products standard.

6. Use the refridgerator number 5 can save the electrical energy up to 20%.

Methods of refridgerator treatment for energy saving

1. The installment of refridgerator; it should be located far away from the back wall and side wall for not less than 15 centimeters and far away from the ceiling for not less than 30 centimeters to let the equipment release the heat of refridgerator very well and it shouldn't let the refridgerator be touched with the sun light or near the stove or any cooking equipment because it will let the refridgerator release the heat not very well and it wastes the electricity.

2. Set the switch of temperature control to be cooler and more electricity waste. It should be set at the cooling level at number 3 because the appropriate temperature and the reservation of food value in the refridgerator should be at the level of 4-6 degree celcius whereas the freezer should have the temperature between -15-18 degree celcius. If the temperature level is apart from this determination, itn should be adjusted at the new temperature because if the temperature of refridgerator is set cooler than it is determined for one degree celcius, the electricity use will be increased up to 25%.

3. Don't bring things which heat is remained or still warm into the refridgerator but wait until it is cool first because the refridgerator has to start accumulating the cooling again. Moreover, it will let the room get hotter because the compressor will work harder in order to release the heat out through the ventilation sheet installed at the back of the refridgerator.

4. Needed things or food used very oftern should be kept in the area at hand within the refridgerator in order to get convenience for picking up things. In addition, the refridgerator shouldn't be turned off- on too much often or turned on for a long time since the compressor will work harder in order to keep the internal temperature of the refridgerator set to be equal like the previous time.

5. Shouldn't freeze things in the refridegerator too much because it will cause the circulation of weather within the refridgerator is not rather well which some parts are not cool which affect the compressor work longly and it wasts the electric power.

6. Always melt the ice and don't let the ice stick at the ice chnnel too much by pressing the button or pull the plug out until the ice is melt absolutely.

7. Is should investigate the door rubber edge of the refridgerator by stapping the paper between the the rubber edge then shut the door. If the paper can be moved up and down, it is shown that the rubber edge is deteriorated and should be replaced as it will make the compressor works harder and wastes the electricity.

8. In case of the brownout, it should unplug the refridgerator temporarily.

9. Don't use the hard things or sharp things to pry the ice as it may cause the cooling pad damaged.

10. In case of the refrigerator will not be used for several days, it should be unplugged the refridgerator first and then clean it and open its door to prevent it from the bad smell.

2.6.3.7 Fan

Fan is the electric appliance which gives the cooling by the wind. It is famous in almost households because the price is cheap. The fan used in

nowadays has 3 types, namely, table fan, floor fan and wall fan. To buy the fan, it should consider its operation to compare the competency of the fan in each generation as well as studying the use method to let it be maintained and cared effectively including have the long useful life which will get advantage through the user in terms of electric energy saving and expenses within the house.

Recommendations for buying the fan to save the electrical energy saving

1. To buy the common fan because it will save the electrical energy more than using the fan with remote control.

2. The table fan is cheaper than the floor fan and uses the electrical energy lower because it has the motor size and electric power lower than the floor fan which will give more wind power.

3. Choose the strong and durable fan which is approved by the industrial products standard.

4. Buy the fan which has the label shown the effectiveness and choose the highly effective generation.

5. Choose the fan which has the fan blade and electric power appropriate to the use space and the number of persons in the family, such as, if it is used for one person or no more than 2 persons, it should use the table fan because of the wind power is sufficient and save the electricity more than other kinds of fan.

Recommendations for using the fan to save the electrical energy

1. It should use the speed or strength of the wind appropriate to the need and place. If the wind is too strong, it has to use the electricity more.

2. It should palce the fan in the area which has comfortable weather because the fan uses the principle of sucking air from the area around the back of the fan than release to the front side, such as if the weather around the fan is damp and wet, the wind got will be hot and damp and wet as well. Moreover, the mortor still ventilate the heat better and its condition is not too much deteriorated.

3. If the temperature observed by the body of fan especially around the motor, if it's too hot, it should be stop in order to extend the useful life of the motor.

4. Don't turn on the fan and leave it while there is no one. If it is not required, it should be turned off to let the motor to be relaxed and this can help reduce the deterioration.

5. Don't plug in and left without anyone especially the fan with its remote control because it will have the electricity flow always to fee the electrical equipment.

2.6.3.8 Washing machine

The washing machine is the famous electriciy today because of its facilities and helps save the workforce and time of housewife in this era. This can be called the labour saving device of family wihch has limited time. if this electricity is used in a correct way, it can help save the energy and expenses. The way to save the energy when using this washing machine and be able to extend its age included the following:

1) It should soak the clothes before washing with the machine to let it easy and be able to choose the program of washing which will save the electricity.

2) The washing machine which has the dryer within itself will waste the electricity more than the common type. Moreover, it should dry the clothes with the sunlight or the place with has the wind blowing.

3) The quantity of clothes whichi will be washed should be in accordance with the rate of the machine, don't put the clothes too much more or less.

4) It should use the program which uses the hot water for washing only because it will waste the electricity very much.

5) It should set the program of washing to be appropriate with the type of clothes always.

6) It should use the size of washing machine to be appropriate to the work.

- The machine with the top lid or cover is appropriate for clothes which has the clothes not too much.

- The machine with has the lid at the front is appropriate for high quantity of clothes or for washing the blankets.

7) It should set the quantity of water and put the detergent to be appropriate with the quantity of clothes which will be washed.

2.6.3.9 Electric iron

Electric iron is the electric appliances which are in the type of giving heat which is beneficial for the clothes in order to let the clothes clean beautiful. Nowadays, the electric iron is used in almost all of the houses. The electric iron is considered to be the electric appliances used the electric power highly. For choosing the electric iron, some may think that if to buy the electric iron with a little electric power, it will save the electric energy. However, actually it is not like that. This is because the heat got from the iron which has a little electric power or the heat not sufficient for the type of clothes will make the clothes ironed is not smooth and use time to make it smooth for a longer time. This will make it use the electrical energy more. Therefore, to buy the iron to be appropriate to the usage, it should know about how to use which will help save the electrical energy and expenses from using the iron in each family.

Recommendations of using the electric iron for energy saving

1. It should keep the clothes which are waited for ironing neatly and try to make the clothes crumpled the least because it will use time more than the clothes which is crumpled only a little.

2. Before ironing, the kind of clothes should be separated into thick clothes and thin clothes in order to be convenient for choosing the first and after. The clothes should be ironed starting from the thin clothes first or clothes which need the little heat first, and when the iron starts to be hotter, so the clothes which need the high heat will be ironed after that.

3. For ironing in each time, it should wait until there are clothes much enough and it shouldn't be ironed only one suit because it will waste the electrical expenses.

4. Watering: this shouldn't water too much because it will waste the heat unnecessarily because watering until it is too much wet will use the time to iron the clothes longer than ever for 2 times of ironing the clothes which are watering appropriately. The iron has to use the quantity of heat more than ever and it will waste the electricy more.

5. At the front of the iron: (the heat sheet attached with the clothes), if there is the dirty stain, use the sponge to clean it because the dirty stain will be the heat resistance value which has to use the heat more.

6. It should unplug the iron before finishing ironing around 3-4 minutes because the rest heat in the iron can iron the clothes which don't need the heat much, such as handkerchief, etc.

2.6.3.10 Rice cooker

Because Thai people have rice for their main menu, therefore they have had relationship or connection with the rice for a long time. To get rice which is ready to eat, it has to bring rice to cook to make it ripe. In the past, cooking rice took time a lot because we had to find coal or firewood to be the fuel for boiling. Moreover, the container used for cooking rice called rice cooker has been developed its style continuously until the present time. We can see the electrical rice cooker which is convenient and fast for cooking until it is popular in every household. Because of using the rice cooker has to use the electrical energy to help, therefore to select the appropriateness with the size of family or use requirement is considered to use the rice cooker effectively and use the energy only necessary and not to let it waste in order to save the energy and electricity as well.

Recommendations for using the electrical rice cooker for energy saving

1. To cook rice by the electrical rice cooker is cooking by not draining off water from the boiled rice, therefore it has to measure the quantity of water to be appropriate. If there is too much water, it will make the rice wet and the cooker still cooks until the water will be finished so it wastes the electrical energy.

2. While cooking rice with the electric rice cooker, it shouldn't turn on the lid of rice cooker to see that whether the rice is ripe or not, or to stir rice not to let it stick with the bottom of the cooker while cooking because it will lose the heat wastefully and wastes the electrical energy.

3. It shouldn't cook rice in the air-conditioning room because the heat from the rice cooker will let the air-condiction work harder and the steam happened while cooking will condense and become the water drop unnecessarily.

4. It should cook the rice to be appropriate to the quantity of members so that the rice will not be rested too much. For warming, it will make the rick dry because the water will vapour out. Always stir rice before warming or water it a little bit, or add the vinegar to help the rice softer as the same time.

5. It should unplug immediately when stop using it.

2.6.3.11 Electric water heater

Electric Water Heater is an electric appliance popular in this present time because the user mostly gets benefits from bathing with warm water for eliminating the fat or dirty things from the body better than using the cooling water. Moreover, it will make more comfortable than bathing with cool water because the electric water heater is the equipment which has to use the electrical energy. Nornally, it uses the electrical energy around 900-4,800 watt depending on the size. Thus, the user should know about the way to save the energy and to reduce the electricity fees within the household. These are the recommendations about how to use the electric water heater to save the energy as follows:

1. It should consider the electric water heater to be appropriate to the main use, such as to use the electric water heater for bathing only, therefore it should install the equipment only one place.

2. It should use the shower which can save the water up to 25%-75%.

3. Take care of the equipment and don't let it leak from the shower because it wastes water and the electric water heater will work harder which causes the electrical energy waste.

4. It should choose the electric water heater which has the bucket to keep within the body of equipment and has the insulator to cover because it can save the energy for 10%-20%.

5. It should install the electric water heater in a kind of one equipment per one bathroom because it helps save the electrical energy much more than one equipment but feed the warm water for several rooms at one time.

6. It shouldn't turn on the electric water heater all the time while using soap, showering, or using shampoo because it will waste both water and electricity.

7. It shouldn't adjust the level of water speed at the highest but should adjust at the moderate level.

8. It should turn off the wate valve and switch immediately when it is finished using. It, it shouldn't turn on the switch left as it will waste the electricity.

2.6.3.12 Water pump

The water pump is an instrument which does the duty as increase the energy to the water of fluid. The energy which does the duty to drive the pump may be the electric motor, engine wind, human force, or energy from various resources. However, the popular one is the electric motor to let the water or fluid move from one place to another place which is higher or in the farther distance. Therefore, the water pump is a kind of electric equipment necessary for the industry or households especially in the condominium building, office, various commercial buildings, or in some places, it needs to pump the water from underground. Therefore, using water by the water pump correctly will help use the electricity and water effectively.

Recommendations in using the water pump for energy saving

1. To turn on the water tap affects the work of water pump. Therefore, to savethe water and electricity, it should turn on the water tap as necessary. If it's necessary to turn on the water several spots at the same time, such as to use the shower to take a bath together with washing plates and water the plants, it

will help the pump work all the time. It should turn on the water tap in each spot by letting water flow moderately to reduce the water pump from hard work.

2. It shouldn't turn on the water pump when there is no one at home or when it has not been used for a long time.

3. It should turn off the water tap tightly. Although only one drop of water, if it has been droped for a long time, it will let the water pump run.

4. Don't turn on the water tap to the strongest level because it will let the pump work harder and it will waste the water and electricity.

5. It shouldn't use the water pump for watering the plants or yard. It should use the water from washing or avoid the water use by normal tap without using the water pump.

6. It shouldn't wash the clothes or containers or fruit directly from the water tap piece by piece because it will waste both water and electricity.

7. It should take care of the water pump, head of shower and all equipment not let them leak because the pump will work harder and use more electricity.

8. It should choose the water pump which has the bucket of pressure to be composed successfully in set because it will affect the water pressure reservation from using and help save the energy.

9. It should choose the water pump which uses the highly effective motor.

2.6.4 Quantity electricity use in the household

The quantity of electricity use in the household is about finding the total sum of quantity on the electricity use from electric appliances which are used in the household within an hour. This is equal to the ratio between the the total value of electricity power from the electric appliance of each type in one hour and the value of electricity power used in a unit (1,000). This can be calculated by:

The quantity of electricity use in the household by unit per hour = total value of electricity power from the electric appliance of each type/1,000

It can be observed that the electricity power is got from the manual of use or the label attached with the electric appliances written as electric power which has the units equal to Watt.

This can be calculated the electricity fee by comparing with the rate of electricity as follows:

5 units (units 1-5) is 0.00 baht

The next 10 units (units 6-15) is equal to 1.3576 baht per unit

The next 10 units (units16-25) is equal to 1.5445 baht per unit

The next 10 units (units 26-35) is equal to 1.7968 baht per unit

The next 65 units (units 36-100) is equal to 2.1800 baht per unit

The next 50 units (units 101-150) is equal to 2.2734 baht per unit

The next 250 units (units 151-400) is equal to 2.7781 baht per unit

More than 400 units (units 401 henceforth) is equal to 2.9780 baht per unit

In conclustion, according to the review of energy saving, the researcher brought the concepts which try to reduce the quantity value of electricity under the conditions of energy management without any effects towards the residence activity and control the various equipment uses highly effective and appropriate to the time period of use and the time period of use from doing the energy for investigating the electrical energy from existed electric appliances in the household, and the analysis of electrical energy quantity used with the time period.

2.7 General Information of microcontroller learning

2.7.1 The learning set of microcontroller

Microcontroller (Faculty of Engineering, Kasetsart University, 2008) is the IC: Integrated Circuit or the equipment in a type of half-conductor which collects the various functions within itself by having the structure nearly the computer, which is, the internal side consists of the units to accept the information and program, processing units, memory units, result unit. These components are completed in itself and it has a small size. Also, it can write the program of controlling the operation of various equipment attached with it which is easy for application which can program

the work sophisticatedly which can receive the information in the form of digital sign entering into the processing, then it sends the results of digital information to be applied as required.

2.7.2 Internal and external construction in the learning set of microcontroller

Microcontroller within the chip has the memory units, Port in the one chip which may be called the single chip computer. The microcontroller is a kind of microprocessor. It is like the CPU or Central Processing Unit used in the computer but it is developed by separating later to use in the cycle of control work, which is, it is substituted in usage which had to add the external cycles the same as microprocessor which combines the necessary cycles, such as memory units and input/output some parts into the same IC and add some cycles to let them be able to be appropriate to the control work, such as timer cycle, communication cycle, sequential communicating circuit, sign transformer circuit, and analog to be digital, etc.
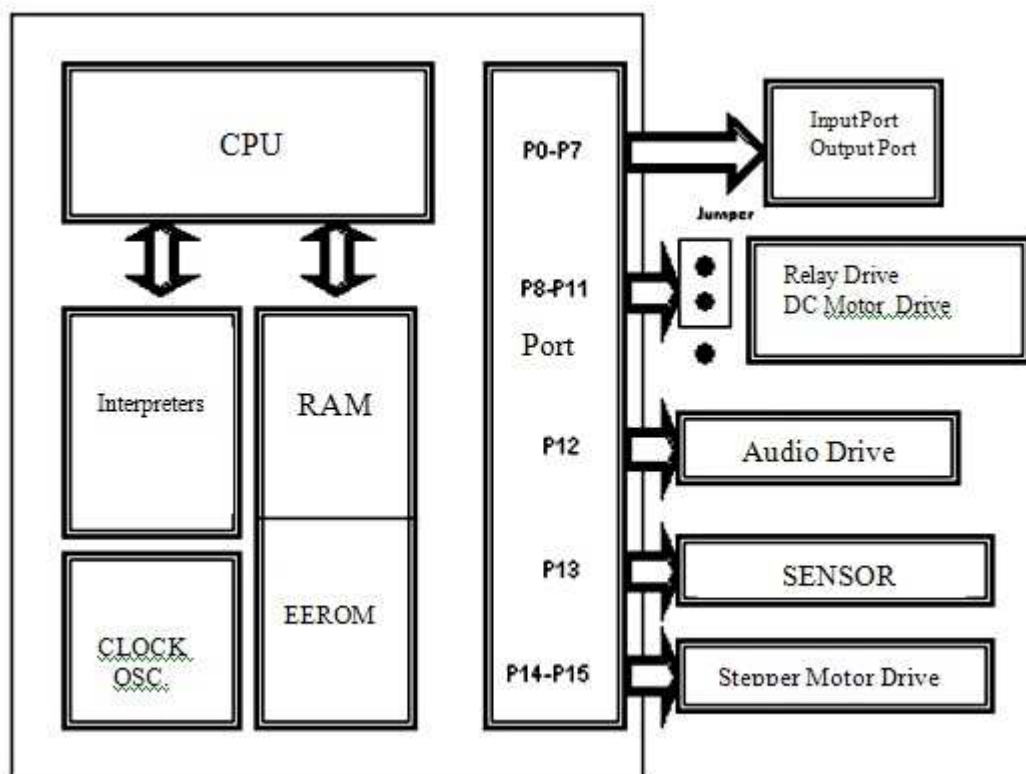
Figure 2.3 Internal structure of microcontroller
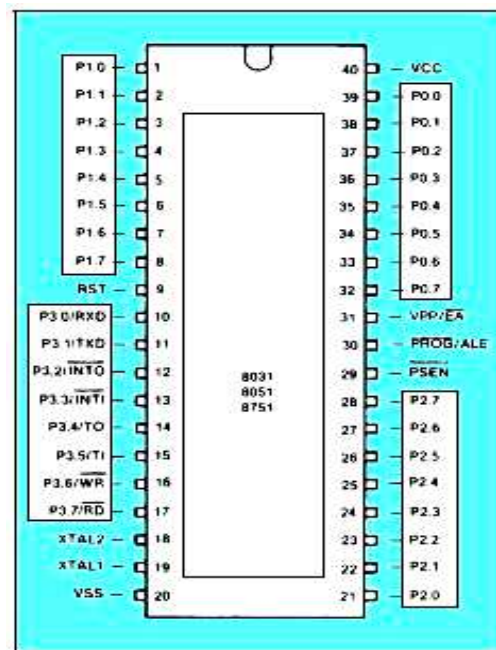
Figure 2.4 External structure of microcontroller

2.7.3 Usage of learning set of microcontroller

Microcontroller can be applied widespread by being embedded in orther equipment system to control some work, such as to use in a car, microwave stove, air-conditioner, automatic washing machine, etc. This is because the microcontroller had the advantages appropriate to the controlled work in several items, such as;

- IC chip and the system got is a small size;

- The system got is cheaper than the microprocessors chip

- The cycle got is sophisticated only a little and reduce the potential errors in the cycle.

- The qualification is added for the specific work especially the work applicable for the usage.

- Help reduce the time period in the system development.

There are many brands, families, and numbers of microcontrollers. Each number has the internal structure and be able to work differently so it is appropriate to each case of use. Nowadays, the electronic electric appliances almost every kind, such as air-conditioner, washing machine, radio, television, car, etc all have the microcontroller to be the controller for various equipment or various procedures.

2.7.4 Qualification of microcontroller in each numberof MCS51 (51,52,1051,2051)

Micorcontrollers used widespread in the present time have various numbers. Each number is different according to the internal qualification of microcontroller and it will depend on the need of use by the user. The qualifications according to each number are as follows:

1. Microcontroller of number AT89C51

- This is the chip which has 40 legs size. Its specific characteristics are as follows:

- There is the memory program in a type of Flash Memory or the type which can be written and erased quickly. Its size is 4 kilobites which is durable through the writing and erasing for 1000 times and still maintain the data value for 10 years.

- It works at the clock frequency of 0-24 Mekka Hurtz.

- It prevents the data reading from the memory units of Memory Lock Program for 3 levels.

- There are the memory units of or Ram withing the chip for 128 bites.

- There are input/output which can be programmed for 32 legs.

- There are 2 setting/counting programs of 16 bites.

- Be able to get the interrupt or sign to interrupt for working in advance from 5 resources.

- There is the channel for delivering and receiving sequential data which can be programmed.

2. Microcontroller of number AT89C52

- It is a chip size of 40 legs. Its various attributes are as follows:

- The are memory unit of Flash Memory program or the type which can be written and erased quickly in a size of 8 kilobytes and resistance for writing and erasing for 1000 time and its value can be kept for 10 years.

- It works at the clock frequency of 0-24 Mekkahurtz.

- It prevents the reading from the Program Memory Lock for 3 levels.

- There is the ram within the chip for 256 bytes.

- There are legs of input/output which can be programmed for 32 legs.

- There is the set/time counting for the size of 16 bytes for 3

- It can accept the Interrupt for working in advance for 8 resources.

3. Microcontroller of number AT89C1051

- It is the chip of 20 legs size, its attributes various aspects as follows:

- It has the memory unit in a type of memory flash in a size of 1 kilobyte.

- It is available at the clock sign between 0-24 MHz.

- It prevents the information reading from the memory program for 2 levels.

- It has the memory of ram within the chip for 64 bytes size.

- It has the leg of input/output which can be programmed for 15 legs.

- It has on setting/counting of time with the size of 16 bytes.

- It can accept the interrupt for 3 resources.

- The output can lead to drive the LED tube directly.

- It has the comparison of analog comparator in the chip.

4. Microcontroller of number AT89C2051

- It is the chip of 20 legs which its attributes for various aspects as follows:

- It has memory units in a type of memoty flash in a size of 2 kilobytes.

- It works at the clock sign between 0-24 MHz.

- It prevents the information reading of program memory units for 2 levels.

- It has the units of ram memory within the chip with the size of 128 bytes.

- It has the legs of input/outout which can be programmed for 15 legs.

- It has 2 setting/counting of time with the size of 16 bytes.

- It accepts the interrupt for 5 resources.

- The output can be driven the LED tube directly.

- It has the analog comparator in the chip.

- It has the channel of serial UART channel for 1 channel.

2.7.5 The equipment to control the electrical energy saving

It is the equipment which the researcher creates from the interview of electricity use in the residences of community to control the work of electrical equipment within each house of the community. Each of household in the community will be the program designer used for controlling the work of electric equipment being

used in the household. The electrical energy saving equipment is designed from bringing the various electronic circuits to be applied to the work control of the electric equipment. According to the previous researches, there is the creation of equipment to control the electrical energy saving numerously, such as automatic fan to adjust the speed according to the environmental conditions and technological use of Why Wire! to control the wireless electric system within the household etc.

2.7.5.1 The internal structure of the control equipment of electrical energy saving

The control equipment of electrical energy saving is about the taking the electronic cycle, i.e. learning set of microcontroller, power supply, work contro cycle of electric equipment and the cycle to detect the movement to control the work of electric appliances by having the units of memory for collecting the information in the learning set of microcontroller to be used for controlling the operation of various cycles. Its structures are as follows:
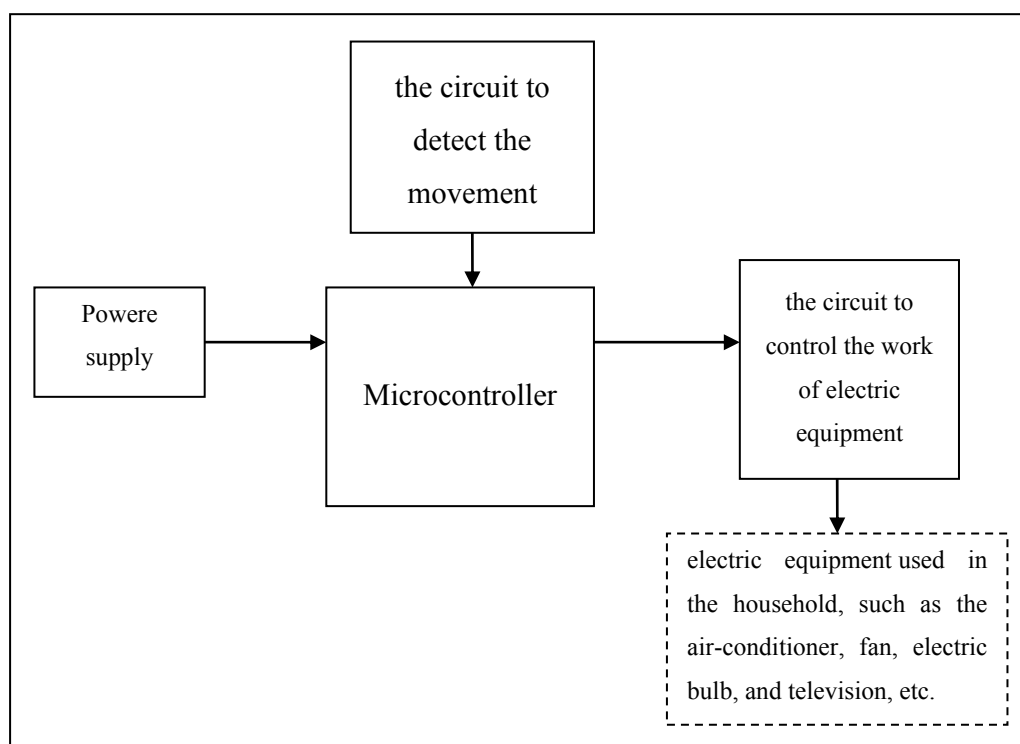
Figure 2.5 The internal structure of the control equipment of electrical energy saving

2.7.5.2 Work structure of control equipment for electrical energy saving

The equipment to control the electrical energy saving will get the electrical current to feed the circuit from the power supply. The work of using the circuit for catching the movement to do the duty of investigating the movement within the house while there is the users of electric equipment, so it will be the sign delivery to be process at the learning set of microcontroller and lerning set of microcontroller will send the electrical use sign to the circutit which controls the work of electrical equipment to control the work of electrical equipment which is being used.

In case of the sample which using the bedroom consisted of the air-conditioner, fan, television, and light bulb, these air-conditioner, light bulb, and television will be opened to work by having the circuit to detect the movemet to check that there is a person in the room, then it will order the work to the learning set of microcontroller to send the signal to the work control circuit of the electric equipment that it cannot turn off the electric equipment. At the same time, if the user goes out for a long time, therefore, the circuit detecting the movement will do the duty as no one uses or has a movement in the room, thus the learning set of microcontroller will process that it is designed to wait for a time as long as the time which the user sets the program. If the time is over than determined and there is no one in the room, all of the electric equipment will be closed whereas there is a user goes back into the rom before the time determined, the electric equipment will work further. In case of the user sleeps in the room, the circuit detects the movement but reports that there is the user but no movement in the room, those will order the learning set of microcontroller to send the sigh to the circuit of work control of the electric equipment to do the duty of turning off the air-conditioner and television together with turning on the fan instead to help the air within the room ventilate instead.

In conclusion, for the review of microcontroller, the researcher brought concept that microcontroller is the equipment which can be used to control the various electric appliances and be able to program the work from the need of user. The size is small and compact by collecting the various circuits within the body so that it is easy for use. The price is not too much expensive. Therefore, it is brought to develop to be the equipment to control the electric energy saving within the house.

2.8 Literature review

2.8.1 Domestic Research

Jearanai Lekuthai (1993: 78-84) researched about energy and electric saving account within Thammasat University, Rangsit Center, it was found that the university used the electrical energy at the average of 375,671.51 kilowatts-hour per month (646,060.82 baht). The maximum value of need of electrical energy was at the average of 1,335.86. In addition, in terms of educational building, it was found that there was the overall electrical energy use of the educational building in the air-conditioning system at the average of 29.41, the lighting system at the average of 31.51, and other equipment at the average of 39.08. This also saved the electrical energy by improving the transformer by combining the some transformer altogether. With this way, it would save the energy about 20,464.24 kilowatts-hours per year (33,766 baht per year). In addition, to use energy saving light bulb could save the energy about 85,624.32 kilowatts-hours per year (141,280.13 baht per year).

Jearanai Masamarn (1986: 80-83) studied the electrical energy saving in the hospital and equipment to measure the electricity power, it was found that the sample hospital used the electrical energy in the air-conditioning system at 54.4%, lighting system at 28.4, and other equipment system at 17.1%. The index of overall electric power use per area was 39.4 watt per squaremeter and 37.75 kilowatts-hour per day per bed, for the electrical energy expense, it was 348,110 baht per month and power factor was equal to 0.65 which its value was low and had to be improved.

Jullada Chaihuadcharearn (1993: 73) studied the factors influenced towards the behavior of electrical energy saving in households of housewife in the Bangkok metropolitan areas, the study found that the housewives who had the different number of members in the households would have the electrical energy saving behavior differently by statistical significance at 0.05 whereas the professional housewives who had different levels of education, family incomes per month, electricity expenses per month, time for living and areas of living, it had no the behavior of electric saving in the household differently by statistic significance anymore.

Chart Rithirun (1993: 92-96) studied the electrical energy use of Ital Thai Building a high building with 16 floors, the air-conditioning area was 6,380

squaremeters. The electrical energy used was 2,063,000 kilowatts hour per year. The highest electrical energy was at the average of 640 kilowatts. The load factor was 37% and the electric expense was 3,840,000 baht per year. The way to offer for improving the effectiveness of energy of air-conditioning system and light system by analysying from the measured information could reduce the the energy use in the light system by setting the lamp set and using the energy saving equipment instead of the former system and replacing the air-conditioner in a type of new center instead of the machine currently used. This was expected to reduce the energy about 440,000 kilowatts-hours per year, the amount which could be saved was 890,000 baht per year, approximately. The investment reward per light improvement would give only 15% per year.

According to the research about electrical energy management of the office building, hospital, and educational institute, it was found that they mostly used the electrical energy more than any other types of energy. The quantity of electrical energy use could be divided according to the table 2.3 (King Mongkut's University of Technology Thonburi, 1999: 36)

Table 2.3 Quantity of electrical energy use in the building separated according to various systems

Building	Air-conditioning system (%)	Electric lighting system (%)	Other systems (%)
hotel	60-70	15-20	10-25
office	50-60	20-30	10-20
department store	60-65	20-25	10-20
hospital	50-60	20-30	10-30
educational institute	30-45	30-50	5-40

According to the information mentioned above, the consideration of electrical energy saving therefore focuses on the air-conditioning system and lightning system to be the main. This can be concluded that the ways of electrical energy saving of air-conditioning system and lightning system of the previous study were as follows:

1. Bringing highly effective equipment in the energy saving to be used, such as changing ballast, light bulb or electric lamp to be the energy saving set or changing to use the highly effective air-conditioner. Although this method would be invested more highly and the time of investment cost would be returned may be used a long time, around 2-5 years, it can save the energy around 30%.

2. The manintenance of any equipment to be effective and the least loss, such as the maintenance or cleaning of electrical lamp, light bulb, ventilation sheet, expansion coil or conndensor of air-conditioner, this is such an easy way, low investment, and short-time fund return. Moreover, it can be done immediately without the professionals.

3. Equipment or process improvement in order to reduce the electrical energy use, such as improving the power factor of transformer, or moving the load of transformer, as well as the ways to manage in the system which has to rely on the professionals to help in analysis   and measurement. This method uses high investment but can save the energy up to 40%.

Narong Watcharasatian (2000: 79-81) studied the development of the wind speed adjustment according to the automatic environment, it was found that the design of fan which could help in electrical energy saving should be designed to be appropriate to the body during the time of the most comfort in controlling the wind speed blowing through the body between 27-36.5 degree celcius, and the relative humidity at 50-80% by using the microcontroller of MCS-51 in controlling the fan would have the speed adjustment for 6 levels between 0.5 and 3m/s which could save the electrical energy around 10-30%, approximately.

Tippawan Kwansrisutti (1997: 68-72) studied the level of acception, the use of equipment for electric saving within the households of people in Bangkok, the case study of electric saving equipment, the project of people cooperation of energy saving, The Electricity Generating Authority of Thailand studied factors affecting the acceptance of using the electric saving equipment in the household   and studied the problems and obstacles, and and recommendation about the acceptance of using the electric saving equipment in the household of people in Bangkok, The sample group was the representatives of each household age 18 years old up living in the Bangkok and the census was in the Bangkok for 400 persons. It was found that the people in

Bangkok accepted the use of electric sacing equipment in the household in the moderate level.

Bansiya Sawangjang (2001: 76-78) studied about the integration of contents on the environmental education entitled of electrical energy and water resource in the statistic lessons for the 1st year students of The Armed Forces Academies Preparatory School. The study was found that the integration of contents on the environments entitled the electrical energy and water resources in the statistic lessons affected the learning of the 1st year students of The Armed Forces Academies Preparatory School which were the experimental groupl; the students had the higher grade of the statistic lessons after getting studied by integration instruction when compared with the group learned the statistic lessons by normal instruction.

Patamaporn Chorpkijjakarn (2001: 80-83) studied the behaviors and requirement of the interests to build an energy saving house, it was found that most of them had the educational level at Bachelor's degree up, the income of the family was more than 30,000 baht/month. This is in accordance with the assumption set in this research. The secondary data collection was carried out by studying the documents of literature reviews both plan or drawing of energy saving house and the related information from the Energy Policy and Plannig Office, Bangkok, Thailand. The interest group of energy saving house mostly was between 31 and 50 years old. The marital status was married, the number of members in the family was around 4-5 persons. Most of the interests on energy saving house seeking for or having an idea to build the residence were mostly civil servants and resided in the up-country. The type of residence was a single house and the occupation status was the owners of the house.

Pawana Watcharasatian (2002:71-72) studied the energy saving in the office of the personnel in Thammasart University, it was found that the personnel of Thammasart Universtity had different knowledge about the how to use electrical energy savely from the Energy Policy and Plannig Office, Bangkok, Thailand. The behaviors of electrical energy use in the office were different by statistical significance at the .05 level. This could be explained that the knowledges in this issue of the personnel in Thammasart University had the relationship with the behaviors of electrical energy saving.

Rawiwan Sinehasarn (1998: 100-104) studied the research of satisfaction and attitudes towards the media exposure of Thai helps Thai and Mutual Enery Saving Campaign Project for people in Bangkok, it was found that the easy way to save the energy through various media and information could invoke or make the sampel feel interested in saving the energy at a high level. The sample tended to save the electrical energy higher than the oil energy especially the Car Pool Project. The sample group for 43.2% viewed that it probably was not successful because it caused the inconvenience for travel. The frequency of media exposure of the campaign from the newspaper media and brocheur/poster had the relationship with the tendency of behavior for saving energy while the television media, radio, and magazine had no relationship with the tends of behavior for the energy saving.

Wannaporn Limprasertkul (2001: 106-108) studied the factors affecting the acceptance and selection of electric appliances use energy saving within households of lecturers in the colleges under the Department of Vocational Education, Saraburi province. According to the analysis result, the sample group was mostly male, age between 21 and 30 years old, the educational level was bachelor's degree, the operation time period was between 1 and 10 years, the number of members in the family was between 4 and 6 persons, the electric expense at the average was less than 500 baht, the number of electric appliances which was the best energy saving was fluorescence bulb, there had the information acknowledgement at the moderate level, the acknowledgement of information in terms of high level of elctric situation had the knowledge about electric appliances in a high level, the acknowledgement in a moderate level, and the attitudes in the moderate level.

Wichchuda Mekanuwong (1993: 88-92) studied the tionbehavior of ownership and electric appliances use of residences in the Metropolitan Electricity Authority (Thailand) area, it was found that the electric appliances in a kind of electric rice cooker had the crucial effects influencing to determine the number of hour of electric rice cooker use, i.e. the number of members in the household and the number of electric rice cooker in household. For the electric appliances in a kind of fan all were the crucial factors affecting to determine the numbers of hour and fan use, i.e. the number of fans in household. The number of members in the household using the lectric appliances in a kind of air-conditioner had the only crucial factor affecting the

number of air-conditioner hours use, i.e. the income of households only. The electric appliances in a kind of washing machine had the crucial factors affecting to determine the hour numbers of washing machine use, i.e. the numbers of members in the family to be only factor. The electric appliances in a kind of the electric iron had the crucial factors affecting to determine the numbers of hours for using iron, i.e. the members of members in the household only one factor. The electric appliances in a kind of color television has the crucial factors affecting to determine the number of hours of television use, i.e. the number of color television in the household, average electrical energy of color television and the number of members in the household. The electric appliances in a kind of fluorescence bulb had the crucial factors affecting to determine the numbers of hours of fluorescence bulb use, i.e. the number of fluorescence bulb in the household, the number of room in the household and number of members in the household. When predicted the number of hours of the electric appliances use and the demand of electrical energy, it was found that in the future (1993-1999) expected that the number of hours of the electric appliances use rather be stable all years but the demand of electrical energy tends to be higher in the future especially the demand of electrical energy of the air-conditioner which tended to be higher every year or around (49-58%) of all the electrical energy . This was from the result of the number of air-conditioner was higer every year. Moreover, the air-conditioner was the electric appliances which had the electrical energy per machine was the most maximum (watt per machine) when compared with all seven electric appliances. For the second part of this study, it was about the peak demand of electrical energy found that the household had the peak demand at 09.00 p.m. and had the electric power value up to 571 kilowatt or at the average of 0.99 kilowatt per household. This was the result of demand of electric appliances use from all 7 types especially the electric appliance in a kind of air-conditioner, fluorescence bulb and color television.

Weera Teerawongsakul (1997: 104-106) studied the knowledge and behaviorof eletric energy saving in the households of people in the Lampang Municipality. The sampel group is the people residing in the Lampang Municipality for 390 persons; it was found that people in the Lampang Municipality had knowledge and behavior of electrical energy saving at the moderate level in all 3 aspects which included the method of electric appliances use and its maintenance. The people who

had different education and career would have different knowledge about the telectrical energy saving in the houwsehold by statistic significance at .05 level but the people who had the average income of the household per month and the expense of electric bill per month and the difference of acknowledgement on news and information had no different on knowledge about the electrical energy saving in the household. Whereas the people who had different educational level would have different behaviors about the electrical energy saving in the household by statistic significance at .05 and .01 level, respectively. However the people who had the average income of the household per month, electric bill expense per month, the different acknowledgement of information had no difference in the behavior about electrical energy saving in the household and relationship between the knowledge and behavior of electrical energy saving in the household had the positive relationship by statistic significance at .01 levels.

Wantanee Wannarat (2000:71-95) studied the creation and experiment of using the training curriculum on environmental education in terms of energy preservation and environments in school, case study of Mahidol Wittayanusorn School, Puttamonton District, Nakhonpathom province by testing this curriculum with the 36 samples. The study found that the students had nerver got environmental training at the average of 88.89%, this was ever be 11.11% and wanted to participate in the training of environmental education in terms of the energy and environment reservation in school at the high level for 56.48%, the average was 37.04%, and a little was 6.48%. Moreover, the achievement evaluation used by questionnaire and evaluation of the training curriculum used by the questionnaire to ask opinions, the research result found that the created curriculum was effective and appropriate to be used in the training. After trying out, the result found that the trainees had the knowledge higher by statistic significance at 0.05 levels. In addition, the average score after the training of trainees had the higher value than the average score of the persons who didn't participate by statistic significance at 0.05 levels as well. Also, the the trainees were satisfied with the curriculum and training process.

Sirirat Oopatinnaket (2001: 88-91) studied the behavior of electrical energy saving of Mattayomsuksa 6 students in the Rachasrima Municipality, it was found that the students had the behavior of electrical energy saving at the moderate

level. The simple regression analysis found that the attitudes electrical energy saving, news and information receiving about the electrical energy saving from the individual media and receiving the news and information about the electrical energy saving from the media had a positive influence through the behavior of electric energy saving by statistic significance at .05 level whereas the multi regression analysis found that the independent variable group affected the dependent variables by statistic significance at .05 level. All of the 10 independent variables could explain the variance of the behavior of electrical energy saving for 12.9% and for the multi regression analysis, it was found that the attitudes about the electrical energy saving could explain the variance of behavior of electrical energy saving the best for 9.2%, the second was the receiving about the electrical energy saving from the individual media which could explain that it was increasd for 2.5% whereas other independent variables didn't increased the power to explain the variance of the behavior of electric energy saving by statistic significance at .05 level.

Somjit Buates (1998: 113-118) studied the behaviors of energy reservation of the primary students of schools under the Bangkok Primary Education Service Area Office. The instrument used was questionnarire. The study was found that the students of primary 2 who had the knowledge of energy and energy reservation much would have the positive attitudes. Moreover the interaction of knowledges and attitudes mutually affected through the behaviors of energy reservation on the primary 4 students who had the parents who had the educational level higher than the bachelor's degree had the behavior of energy reservation more correctly than the group which had mothers who had the educational level lower than Bachelor's degree.

Sukanya Tantiprasoplap (2001: 116-118) studied the construction and tried out the training curriculum of environmental education about the electrical energy preservation for the personnel of Ramatibbodee Hospital. The achievement results of the training by using the knowledge test and curriculum evaluation of training by using the opinion questionnaire. The research results found that the training curriculum created was effective and appropriate to apply to the training. And after trying out, it appeared that the trainees got knowledge of electrical energy preservation higher than before getting training.

Supaporn Songpracha (2009: 113-116) researched about the family ecological model for health promotion of the family in Nakorn Prathom province. The model used the questionnaire for collecting data. The research result revealed that when organizing the stage of problems solving on environments in the village, the members of household mutually participate in the problems solving about the trash in their households, the member together analyzed the problems, planned and co-operate. Moreover, they warned to one another. As a result, they developed the correct knowledge and therefore their trash management was better.

Sutticha Boonyamanee (2000: 87) studied about the establishment and experiment of reading the supplemental books on the topic of "electrical energy savings within the house" for students at the levelo of Prathomsuksa 6. The study result found that the the study achievement after the experiment (after reading the supplemental books of "energy savings within households") in the experimental group and control group, there was the statistically significant difference at 0.05, that was, the experimental group got more knowledge and higer than the persons in the control group who didn't read books.

Sopida Pattanaporn (1997: 131-133) studied about the establishment and experiment of traning on the environmental education in terms of seashore natural resources researvation for the secondary level teachers: case study of Ranong province, the research result found that the mean of trainee teachers after the training was higher than before training by statistic significance at 0.05 level.

Seree Worapong (2008: 118-120) did the research about the integration of environmental education for the teachers in basic educational school. The research studied the environments in school and community and created the integration model of environmental education for the teachers in the basic educational school. The results found that most of the schools didn't integrate the environmental education with the learning substances, therefore when the teachers created the learning substances by integrating with the environmental education, it was found that the model had the high effectiveness and it led the mean of achievement in terms of environmental education of the teachers and students before and after organizing the activities of environmental education had the difference at statistical significance at 0.05 level and found that the learning achievement of the students according to the substance groups were at a higher rate and it was the very good level.

Uriwan Poolsin (2002: 101-104) studied the energy reservation in and out of the control building, it was found that the office building and educational institutes used the electrical energy for 269,316 and 602,608 kilowatt-hour per year, the expense was about 903,970 and 2,056,300 baht per year, approximately. The proportion of using the main energy was at the air-conditioner system (69% and 55%), light system (14% and 15%) of the electrical energy use, respiectively. According to the evaluation of building energy saving potentials, it revealed that the measuere of energy saving which was appropriate to both buildings included the control of maximum electric power requirement, improvement of air-conditioner maintenance, the use of highly effective lighting equipment, such as using the fluorescence compact bulb, highly effective reflecting lamp, ballard which has the low loss, the building frame improvement, etc. Both of the buildings were effective in the energy saving for 13.9% and 27.03% of all the electrical energy used.

2.8.2 International research

Afgan, N.H., et.al., (1998: 235-286) studied about the development of sustainable energy, it was found that there had to survey and find the available data proposed until it helped the development of sustainable energy successful. This had to be understood about the meaning of sustainability and any sustainability presented in this world. Moreover, it's necessary to have the engineering method of sustainable development focusing on the potential revise in the engineering development which would be the ways to the sustainable development. There were main 7 parts related which were the problems through the development, i.e. energy resources and development, potential measurement of technologies on wether treatment effectiveness, information technology, new and substitute energy resources, effectovemess of environment and reduction of newclear energy use for environmental preservation. However, the key factor found was the educational factor which was the keybone which would lead to the economic development, no matter what the distance learning system which was the crucial part of the technology of new energies.

Adnan Midilli, et.al., (2006: 3623-3633) studied the strategies of clean energy for sustainable development, it was found that the problem solving of environment had to calculate the energy use from various documents which would be

the value indicating the ratio energy use which could see the waste occurred from the energy use by considering the ratio of effects crucial for the policy establishment of clean energy as well as using the useful technology to reduce the effects from energy use and the support from the governmental organizations for the change of energy of fossil fuel to become the clean energy in the future.

Cook (1996: 972) studied the behaviors of energy reservation on the families participated in the energy investigation service within the households, it was found that the knowledgeable families on energy reservation realized the benefits of energy reservation of the hosts who were the main person for researving the energy.

Duaine (1981: 325-327) studied and compared the use of simulated situations and the methods of environmental description on energy to develop the consciousness of energy, attitudes of persons who had the different brain levels. The objectives of this study were to compare the ways to develop the consciousness of energy and good attitudes in using the energy cleverly and energy reservation of each person which had different brain levels. The independent variable was the brain levels and instructional methods. The instructional method was about the comparison between instruction by creating the simulated situations and the description methods. The samples were the voluntary students from Science field. The samples were divided into 2 groups. The group using the description method had 20 personns whereas the group using the stimualated situations had 25 persons. The research results revealed that the simulated situations affected the development of consciousness more than the description methods. The persons who had better brain levels would have the consciousness more than the persons who had the less brain levels. The ways of description and the simulated situations were not affected the individual consciousness when they had the similar brain levels. However, the simulated situations and the ways of description affected the consciousness of the persons if they had different brain levels.

Jebaraj, S and Iniyan, S (2006: 281-311) studied the review of various energy models, it was found that the quantity of energy requirement was increased continuously. The model which helped the appropriateness with the substituted energy included sunlight, wind, bio-energy and energy from water which was the required energy in India, so it's necessary to have a plan in decentralization from the central

parts. To apply the technology of energy reservation, to recycle, and to plan and collect the energy to be used substitutely when necessary were applied by the educational model as follows: the plan model, requirement model, and energy production model, energy prediction model, substituted energy model, and waste release model.

Ramachandra, T.V., et.al., (1997: 563-599) studied the energy use in industry to be useful in the Karnataka, India and potentials in the energy saving, it was found that the energy was important for industrial production and it's not sufficient in the energy to be appropriate to the extension of population. This affected the energy crisis, such as the energy fuel was the main factors towards the electrical energy more than the nuclear fuel and water. This would be the potential problems, therefore the methods to reserve the energy were created as follows:

- Improved the effectiveness of equipment and changed the equipment which saved the energy.

- Used the energy to be the most worthwhile.

- Used the substituted energy to be as much as possible.

- Supported to use the bio-energy resources.

- Stop using the resources which were rest only a little.

According to the followment of this method and after having surveyed for 7 years, it was found that in the Kannataka, India, this could save the industrial energy for 27.27%, approximately or around 1,541 million kilowatts per year.

Stewart (1982: 228-241) studied the relationship between knowledge, attitude, and house shape and the results of energy use in the residence by dividing the samples to be 2 groups including the group of effective energy users and the group of residents who lived in the energy saving residences. The attitudes survey and energy saving techniques questionnaire were used designed by the researcher and studied by the electric bill in the summer seaso of each sample household. The research results found that if people had positive thinking about energy preservation or had knowledge of energy more, they tended to use the energy more savely than the people who had negative attitudes about energy preservation or had the energy knowledge less. In addition, the attitudes of people residing in the effectively saved energy residence would have the positive attitudes and had more knowledge than the people residing in the less saved energy residence.

Toshihiko NaKata (2004: 417-475) studied the construction of economic and environmental energy model. This was about the alteration of energy use and could lead to the national energy construction, energy replaced the system and environmental problem solving. The model construction was viewed by the top to bottom and the bottom to the top which emphasized the balance, follow, and application among various models. However, technology was still regarded as the crucial part of the need of energy use which was the results leading to the energy production as the users' needs. These are the conditions of market organism. Nowadays, movie takes the role for making understanding of alteration on energy system. However, the movie did not change ideas of decision making on energy use at all. Therefore, the economic and environment ener use is the good things to lead to the energy and environment use appropriately.

Zhenjun Ma, et. al., (2009: 1870-1833) studied the research of enegy saving on building construction in Hongkong. The study was found that the building construction in Hongkong mostly focused on coolness requirement for the air-conditioner system more than the past year. This made the result of the increased energy use up to 40%, hence, it's necessary to reduce the energy and improve this issue to the sustainable environments. This method consisted of the policy of energy saving measurement, policy of energy, energy accounting, and effectiveness evaluation of design control which would be proposed through the local governmental section. All of the mentioned above could lead to the energy effectiveness and researvation for building construction.

For conclusion of the literature review, it can be seen that the energy preservation can do in several ways, such as the policy determination, training, technology use for energy saving, energy saving equipment change, materials for energy saving. This can be seen that now the electrical energy is the crucial factor for living. Also, the electric equipment used numerously today is based on the air-conditioner and light system. Hence, the researcher brought the concept which took the materials to be the technology for energy saving and the knowledges of energy saving to be studied because the researcher views that the persons who have knowledges on energy will be able to save the energy more than the persons who have less knowledge of using technological materials to be the helpers for more making understanding on the energy saving.

CHAPTER III
MATERIALS AND METHODS

For the study of electric energy saving model in household through environmental education process, the purposes of this research were to develop the electric energy saving model in household through environmental education process, study the energy saving and behaviors on electric energy saving in household before and after getting the developed model, and study the relationship between the knowledges of electric energy saving and the amount of electricity used bills after getting the developed model. Therefore, this study used the qualitative method to evaluate the behavior of electric energy use and evaluate knowledges and amount of electricity used from trying using the electric energy saving model in household through environmental education process for this research methodology.

3.1 Area selection for the research

The general states of Nong Tam Leung Sub-district municipality, Pantong District, Chonburi province could be divided into 9 villages, populations were 8,224 persons in total, 3,782 households, 3 primary schools, 1 high school, 1 technological school, 1 Eastern College of Technology (E-TECH)), 6 temples, 2 shrines, 2 health care, 54 medium size and 32 huge size industrial factories. Most of the traditional occupations were agriculturers, fishery, and animal feeding. Until 1989, the Amata Nakorn Industrial Estate was established and this made the life style of community in this area change from agriculture to industry. Most of the people sold their lands to the Amata Nakorn Industrial Estate while the former environments full of rice fields, fruit garden, sugarcane field, and cassava field became the industrial factories instead.

For the cause of selecting the area by purposive sampling, this was because the area was involved with the electricity use and the quantity of electric energy use was very high due to being the industrial community which had a lot of

factories. Moreover, the households had the elderly and small children living in the house while most of people went to work, therefore it caused a lot of quantity use on electric energy which could be seen the break even point quickly. Furthermore, the compared data about energy use of Ministry of Energy between the households in city and rural. The households in city used the energy for 16% whereas the households in rural used the energy for 84% (Department of Development of Alternative Energy, Ministry of Energy 2009:7). As for the volume of electric energy use in provincial area was 65% of the total electric energy while metropolitan area used 38% of the total electric energy and the trend of power use in provincial would increase continuously as a result of distributing industry to rural area. (Office of Policy and Plan for Energy, Ministry of Energy: 2008). Hence, the researcher decided to choose the area around the community of Nong Tam Leung Sub-district municipality in the Amata Nakorn Industrial Estate, Chonburi province for this research.

3.2 Determination of target population

For this research, the researcher determined the target population as follows:

Population: The population was the household in the in Amata Nakorn Industrial Estate, Nong Tam Leung Sub-district municipality, Pantong District, Chonburi province for 3,782 households. (Nongtamleung Subdistrict Municipality Office, 2010)

Table 3.1 Population Numbers of Nong Tam Leung Sub-district municipality

Area	All populations (household)
Nong Tam Leung Sub-district municipality	3,782
Total	**3,782**

3.3 Sample group selection

For this research, the researcher determined the sample group to be studied as follows:

Sample group:

1. The sample group used in the data collection about electric energy use by households of Nong Tam Leung Sub-district municipality in the Amata Nakorn Industrial Estate, Pantong district, Chonburi province for 351 samples. The interview was done with the household leaders for 351 persons. These were from the determination of sample group size by using the instant table of Robert V. Krejcie and W. Morgan (Raweewan Chinatrakul, 1999: 111) and did a systematic random sampling. The calculation method was as follows (Sin Panpinij, 2008:121-137).

1.1 The calculation of time for example selection from the ratio of population and the sample size needed was as follows:

$$I = \frac{N}{n}$$

$$\frac{3,782}{351} \approx 11$$

When   I   substituted the interval between population (11)

N   substituted all populations (3782 households)

n   substituted the number of sample (351 samples)

1.2 Random sampling; the initial numbers by simple random sampling got from lot (got No. 11).

1.3 Selection of the next number; by adding the initial number which could be caught and each interval from census data of Nong Tam Leung Sub-district municipality (11,22,33,44,.......,3454,3780)

1.4 Searching the number of households from the data base which have been ordered already from Nong Tam Leung Sub-district municipality and the interval calculated to get the sample group according to the determination used in the study of problem situations in terms of electricity use as overall image of the households.

Table 3.2 Number of Sample group in the study of problem situations in terms of electricity use as overall image of the households

Area	All populations (household)	Sample group (sample)
Nong Tam Leung Sub-district municipality	3,782	351
Total	**3,782**	**351**

       2. The sample group used in the experiment was 114 households of Nong Tam Leung Sub-district municipality which had the members in each household for 5 persons up, 70 persons in total from all 351 sample groups. The selection was carried out by purposive sampling. The sample group was divided into 2 groups, 7 households per group because we produced 7 devices for saving the electric energy. The first group was the control group, the second group was the experimental group using the electric energy saving model in household through the environmental education process and the control equipment of electric energy saving within household. The sample group had to be passed the consideration of qualifications as follows:

       2.1 To be the person who was interested in the electric energy saving

       2.2 To be the house ready for installing the control equipment of electric energy

       2.3 To have the household members for 5 persons up

       2.4 To have the electric value quantity used for 450 unit per month or 1,200 baht because the equipment to control the electric energy saving was very expensive, so if the quantity of electricity was high, its cost could be worthy within 2 years.

3.4 Research methodology

       The researcher collected the data both in the primary sources and the secondary sources and brought the data collected from the reality to be analyzed to find the conclusion by researching. The methodologies used for this research were as follows:

1) Documentary study

Because this research aimed to develop the electric energy saving model in household through environmental education process, therefore the researcher studied the related documents and literatures to collect the knowledge base from the document to get the secondary data from books, journals, articles, theories and concepts, research result, and related documents as follows:

1.1) Learning materials

1.2) Equipment to control the electric energy saving

1.3) Energy conservation

1.4) Electric energy saving

1.5) Research related to the energy saving

1.6) Concepts and theories related to the learning

2) Household study

Because this research aimed to study the knowledge level on energy saving, behavior of electric energy saving in household before and after getting the developed model. Moreover, it was the part of development on the electric energy saving model in household through environmental education process. The data studied were as follows:

2.1) Electric appliance used in the household

2.2) Behaviors of electric use of household

2.3) Amount of electricity bills in each household

Data collection

The researcher collected the data from the created instruments between 1st July, 2010 and 30th April, 2011 as follows:

Table 3.3 Stages of Data Collection

Target group	Before the development of electric energy saving model in household through environmental education process	The development and experiment to use electric energy saving model in household through environmental education process	After using the electric energy saving model in household through environmental education process
1. Household of Nong Tam Leung sub-destrict Municipality (351 persons)	1. Questionnaire on data of electric use, behavior of electric use, and the amount of electricity bills	-	-
2. Experimental group of Nong Tam Leung households (7 households)	1. Knowledge test on electric energy saving	1. Two days training about electric energy and electric energy saving 2. Installing the control equipment of the electric energy saving designed to be appropriate to the real time use as necessary and then feeding the data into the micro controller in the control equipment of electric energy saving and using it for 3 months	1. Knowledge test on electric energy saving 2. The questionnaire of behaviors and quantity of electric use after having installed the control equipment of the electric energy saving already for 3 months

Table 3.3 Stages of Data Collection (cont.)

Target group	Before the development of electric energy saving model in household through environmental education process	The development and experiment to use electric energy saving model in household through environmental education process	After using the electric energy saving model in household through environmental education process
2. Experimental group of Nong Tam Leung households (7 households) (cont.)			3. Evaluation form of satisfaction on training project of electric energy saving model in household through environmental education process
3.Control group of Nong TamLeung households (7 households)	1. Knowledge test on electric energy saving		1. Knowledge test on electric energy saving

In order to make it clear and easy to understand, the research methodology was divided into 4 stages as follows:

Table 3.4 Time period of research methodology

The researcher collected the data between 1st, July 2010 and 30th, April 2011

Stage	Time Period (Month)									
	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	April
Stage 1 The study of household data to analyze the requirement and electric energy use	←→									
Stage 2 The development of electric energy saving model in household through environmental education process			←→							
Stage 3 To try out the electric energy saving model in household through environmental education process					←———————→					
Stage 4 Conclusion, Analysis, and Discussion on Research Data									←→	

Stage 1: The study of household data to analyze the requirement and electric energy use

For the study of household data to analyze the requirement and electric energy use in the Nong Tamleung household municipality, Amata Nakorn Industrial Estate, Chonburi Province, the researcher study the basic information about electric energy saving model in household through environmental education process by collecting all data got from the 351 samples to synthesize the electric energy saving model in household through environmental education process for the further stage. The analysis was divided into 2 stages as follows:

Stage 1: The study of basic data from documents, literatures related to the energy conservation both in and out of the country in order to study the information of electric energy saving.

Stage 2: The researcher study the basic data of Nong Tamleung household municipality, Amata Nakorn Industrial Estate, Chonburi Province by asking the involved persons including Nong Tamleung household municipality, Pantong District, Amata Nakorn Industrial Estate, Chonburi Province. The issues included the knowledges about electric use in the household, behaviors of electric use in the household and the amount of electricity bills in each household.

Research instrument

1. The questionnaire about data of electric use in 351 households of Nong Tamleung municipality which included electric equipment in the air-condition system, light, and all other systems of each home. The time period of using the electric equipment in the air condition system, light, and other systems. The methodology of electric energy saving, amount of electricity bills used in the last 3 months since July - September 2011, behaviors of electric use, and all problems towards electric energy use of each households were carried out as follows:

- To study and collect the data of electric use in the households from the documents and literatures related to the electric use.

- To create the questionnaire from the studied data

- To propose the created questionnaire to the advisor and co-advisor who supervised the thesis to check the validity and ask for the improvement of questionnaire.

- To adjust and improve the questionnaire and then propose the advisor and co-advisor to take into the consideration again.

- To bring the questionnaire to test the validity by finding the Index of Consistency (IOC) of the statement whether it could measure the electric use in household, behaviors of electric use in household, and the amount of electricity bills in each household according to the purposes required to be measured. The questionnaire would be investigated by 5 experts according to the score given as follows:

Score + 1   for the statement sure about the purposes required to measure.

Score   0   for the statement unsure whether it was in accordance with the purposes required to measure.

Score – 1   for the statement sure that it was not in accordance with the purposes required to measure.

- To record the consideration results done by the experts in each item and find the Index of Consistency (IOC) according to the purposes required to measure by using the formula (Raweewan Chinatrakul, 1999: 141-159)

$$\textbf{IOC} = \frac{\Sigma R}{N}$$

When   IOC   substitutes the Index of Consistency between the item and the purpose required to measure

ΣR substitutes the total score of opinions in each item of all experts

N   substitutes the number of experts

- To bring the scores in each item evaluated by the experts to find the **IOC** value and compare with the criteria of Index of Consistency or IOC between the contents used in the research about the behaviors of electric energy use and the experts' opinions. According to the results of finding IOC between the contents and the experts' opinions of the stage 3 with 38 items, it was found that the **IOC** was between 0.67-1.00 with 34 items and the **IOC value** was between 0.32 and 0.48 for 4 items. Therefore, the researcher improved the questions item as follows:

- To improve the questionnaire according to the suggestions of the experts which recommended about language use which had better more correct and compact as well as some sides might be added.

- To bring the questionnaire to try out with 30 other samples who were not the sample group to analyze for the reliability of the instrument by finding the Cronbach's alpha coefficient (Raweewan Chinatrakul. 1999:158)

$$r_\alpha = \left[\frac{K}{(K-1)} \right]\left[1 - \left(\frac{\Sigma S_i^2}{S_t^2} \right) \right]$$

When r_α substitutes the coefficient value of reliability of the questionnaire

S_i^2 substitutes the variance of questionnaire

ΣS_i^2 substitutes the sum of variance of each questionnaire item

S_t^2 substitutes the variance of total scores of the questionnaire

K   substitutes the amount of items in the questionnaire

Table 3.5 The analysis result of reliability of questionnaire about the behavior of electric energy use classified by the equipment

Equipment	Reliability
1. Electricity and light	0.77
2. Iron	0.86
3. Fridge	0.87
4. Rice cooker	0.85
5. Television	0.74
6. Radio	0.78
7. Fan	0.88
8. air-condition	0.83
9. Kettle	0.86
10. Computer	0.82
11. Water pump	0.76
12. Water heater	0.78
13. Washing machine	0.85
Total	0.84

- To improve and adjust the questionnaire and do the original.

Stage 2: The development of electric energy saving model in household through environmental education process

The stages of developing the electric energy saving model in household through environmental education process

The researcher brought the data results of 315 samples from household of Nong Tamleung municipality and documents related to the electric energy to develop to be the electric energy saving model in household through environmental education

process which included the contents about the electric energy and equipment used for controlling the electric energy saving before using it in the further step. The components were included as follows:

1. Knowledge and understanding about the electric energy

2. Electric energy saving

3. Design of equipment to control the electric energy saving

Research instrument

The research instruments of this research included as follows:

1. The equipment to control the electric energy saving which the researcher developed by the questionnaire asking about the electric use data of households to control the work of electric equipment within the household. The household designed and controlled the work of electric equipment used in the household. The methods of work were as followed:

- To study the general data of the learning set of Microcontroller.

- To survey and analyze the energy use from the electric equipment in the household.

- To study the data of equipment for controlling the work of electric equipment.

- To design the equipment of controlling the electric energy saving.

- To bring the equipment of controlling electric energy saving together with the quality evaluation form, equipment of controlling electric energy saving to propose to the technological and engineering experts to check the appropriateness.

- To improve and adjust the equipment to be appropriate.

- To bring the equipment of controlling the electric energy to try out through the households which were not the sample group.

- To improve and adjust to be ready for the application or use.

Stage 3: To try out the electric energy saving model in household through environmental education process

The researcher tried out the electric energy saving model in household through environmental education process with the industrial households in the Amata

Nakorn Industrial Estate, Chonburi province. 7 households or 35 samples were selected from Nong Tamleung Municipality to know about the knowledges level and behavior of energy saving both before and after using the model. Moreover, this was to know about the satisfaction level of the samples who tried out this model. The procedure was carried out as follows:

   3.1 To connect with 14 households selected from Nong Tamleung municipality, Amata Nakorn Industrial Estate, Chonburi province or selected from 70 samples. The samples were divided into 2 groups, 7 households per group. The first group was the control group and the second group was the experimental group. The experimental group was tried out by the electric energy saving model in household through environmental education process.

   3.2 To connect with the location used for training and giving knowledge.

   3.3 To make an appointment of the date of training and giving knowledges

   3.4 To collect the data of 14 households in the Nong Tamleung municipality, Amata Nakorn Industrial Estate, Chonburi province or around 70 samples who were both the control and experimental group. The test used was the achievement test of the electric energy saving of the households in Amata Nakorn Industrial Estate, Chonburi province before using the electric energy saving model in household through environmental education process.

   3.5 To train and give the knowledges about the electric energy saving, and the design of the control equipment for electric energy saving to 7 households of the experimental group or around 35 samples for 2 days between 5-6, October, 2011 at Nong Tamleung municipality within the topic as follows:

    - Electric energy

    - Problems of electric energy

    - Requirement of electric energy use

    - Electricity production from various fuels

    - Effects from the electric energy use

    - Problem solving of electric energy use

    - Use quantity of electric energy use within household

- Electric energy saving

- Techniques of energy saving house

- Appliance energy saving

- Basic calculation of electricity bills

- Control equipment of electric energy saving

3.6 All of the 7 households which were the experimental group would be designed to control the performance of electric equipment within the house to be appropriate with the real time as necessary and then fed the data or program into the micro controller in the control equipment of the electric energy saving and let it start working.

3.7 After training and giving knowledges, the control equipment of electric energy saving would be installed to 7 households selected for being the experimental group.

3.8 To record the quantity of electric use in the last 3 months of the experimental group between August and October, 2011.

3.9 To collect the data in 14 households which were both control group and experimental group of Nong Tam Leung municipality in the Amata Nakorn Industrial Estate, Chonburi province. The test was carried out by the achievement test at the household level about the knowledges of electric energy saving after using the electric energy saving model in household through environmental education process.

3.10 To collect the data of 14 households in the Nong Tam Leung Sub-district municipality in the Amata Nakorn Industrial Estate, Chonburi province both control and experimental group by using the satisfaction evaluation form of the training project on the electric energy saving model in 7 households which were the experimental group through environmental education process after using the electric energy saving model in household through environmental education process.

3.11 To collect 14 households data of the experimental group in the Nong Tam Leung Sub-district municipality in the Amata Nakorn Industrial Estate, Chonburi provinceน by using the interview form of behaviors on the household level for electric energy use after using the electric energy saving model in household

through environmental education process and the control equipment of electric energy saving for at least 3 months.

3.12 After trying out with the control equipment of electric energy use for 3 months between November and March, 2011 by recording the quantity of electric use after installing the control equipment of electric energy use of the experimental group for 7 households.

This research was carried out by using 2 groups of experimental form by measuring the results both Pretest and Posttest Control Group Design. The form was as follows: (Sin Panpinij, 2008: 50-54)

3.13 To analyze the data

Table 3.6 The procedure of trying out the electric energy saving model in household through environmental education process

The examples used in the experiment	Result measurement before the doing the pre-test	Experiment by using the developed model	Measurement after the post-test
Control group (7 households)	Measurement test	-	Measurement test
Experimental group (7 households)	Measurement test	trying out the model	Measurement test, interview form, satisfaction evaluation form

Research instrument

The instruments used for this research included:

1. The test for measuring the knowledges of electric energy saving in 14 households of Nong Tamleung municipality, Amata Nakorn Industrial Estate, Chonburi province both the experimental and control group. The test was created by the researcher for giving knowledges about the electric energy before and after using

the electric energy saving model in household through environmental education process. The process included as follows:

  - To study the contents of knowledge about the electric energy, data to save the electric energy from various electric equipment

  - To create the knowledge measurement form of electric use in the households

  - To bring the test created to propose the advisor and co-advisor to check the validity and ask for the recommendations for improving the test.

  - Adjust and improve the test, then propose the advisor and co-advisor to take into the consideration again.

  - To check the validity of the test by finding the IOC of the statement that whether it can measure the knowledges about the electric energy, data of electric energy saving from the various electric equipment, and the purposes of measurement. The test would be investigated the validity by 3 experts.

  Score + 1 for the statement sure about the purposes required to measure.

  Score 0 for the statement unsure whether it was in accordance with the purposes required to measure.

  Score – 1 for the statement sure that it was not in accordance with the purposes required to measure.

  - To record the consideration results done by the experts in each item and find the Index of Consistency (IOC) according to the purposes required to measure by using the formula (Raweewan Chinatrakul, 1999: 141-159)

$$\textbf{IOC} = \frac{\Sigma R}{N}$$

  When **IOC** substitutes the Index of Consistency between the item and the purpose required to measure

    ΣR substitutes the total score of opinions in each item of all experts

    N substitutes the number of experts

  - To bring the scores in each item evaluated by the experts to find the **IOC** value and compare with the criteria of Index of Consistency or IOC between the contents used in the research about the behaviors of electric energy use and the

experts' opinions. According to the results of finding IOC between the contents and the experts' opinions of 30 items, it was found that the **IOC value** was between 0.58 and 1.00 for 25 items and **IOC** was between 0.42 and 0.50 for 5 items, the researcher improved these question items.

- To improve the test according to the experts' recommendations about the language adjustment to be more and correct. Moreover, some points might have more questions.

- To try out the test with the samples who were not the experimental group for 35 persons to analyze the difficulty and ease value of the instruments by using the technique of 50% (Pannee Leekijwattana, 2007: 87-94)

$$P = \frac{R_H + R_L}{n_H + n_L}$$

When P substitutes the ease and difficulty value

R_H substitutes the high number of items that the samples answer the questions.

R_L substitutes the low number of items that the samples answer the question.

n_H substitutes the high number of samples answering the question.

n_L substitutes the low number of samples answering the question correctly.

- To improve the test by selecting the questions which have the ease and question values at the moderate level.

- To try out the test with 30 samples who were not the experimental group to analyze the Discrimination Power of the instruments to categorize the persons to be different two groups by using the technique of 50% (Pannee Leekijwattana, 2007: 87-94)

$$r = \frac{R_H - R_L}{n_H}$$

When r substitutes the Discrimination Power

R_H substitutes the high number of items that the samples answer the questions.

R_L substitutes the low number of items that the samples answer the question.

n_H substitutes the high number of samples answering the question correctly.

- The scores got from the question items of electric energy saving within the households were qualified for 25 items and were not qualified for 5 items. Therefore, the researcher improved the question items.

- To improve the test by selecting the moderate to high levels of Discrimination Power questions

- To try out the test with 30 samples who were not the samples of this research to analyze the reliability of the instrument by finding the Reliability Coefficient according to the Kuder-Richardson KR-20 method (Raweewan Chinatrakul, 1999: 141-159)

$$\text{KR-20 or } r_{tt} = \frac{K}{K-1}\left[1 - \frac{\sum pq}{S^2}\right]$$

By r_{tt} or kr_{20} substitutes reliability of Kuder-Richardson

K   substitutes the question items

P   substitutes the proportion of the samples who answer the question correctly in each item.

(R/N when R is the number of samples who answer the question correctly in that item and N substitutes the number of the samples who answer the question ……………………………………………………………………………………………..).

q   substitutes the number of samples who answer wrongly in each item.

S^2 substitutes the variance value of all items

- The scores of reliability got from all of the question items equal to 0.70.

- To improve and adjust the test and make it to be the original series.

2. The interview of behaviors and quantity of electric use in 7 households experiment group in the Nong Tam Leung Sub-district municipality in the Amata Nakorn Industrial Estate, Chonburi province. The researcher interviewed the behaviors of quantity electric use before and after using the electric energy saving model in household through environmental education process. The procedures were included as follows:

- To determine the purposes of interview.

- To analyze the behavior of interview in each item.

- To create the interview from the behavioral indicators.

- To propose the interview created by the researcher to the advisor and co-advisor in order to investigate the validity and ask from the recommendation for improving the interview.

- To adjust and improve the interview and then propose to the advisor and co-advisor in order to take into consideration again.

- To check the interview form to investigate the validity by finding the IOC of the statement that whether it could be used to interview the behavior of electric use by letting the interview form investigated by 3 experts.

- To record the consideration result of the experts in each item to find the IOC of the statements according to the purposes required to measure (Raweewan Chinatrakul, 1999: 141-159)

$$\textbf{IOC} = \frac{\Sigma R}{N}$$

When   **IOC**   substitutes the Index of Consistency between the item and the purpose required to measure

ΣR substitutes the total score of opinions in each item of all experts

N   substitutes the number of experts

- To bring the scores evaluated by the experts to find the **IOC** value and then compare them with the criteria of IOC between the contents used in this research about the electric energy saving with the experts' opinions. According to the IOC

value between the contents and experts' opinions for 14 items, it was found that the **IOC** value was between 0.69-1.00 for 12 items and the **IOC value** was between 0.46-0.50 for 2 items. The researcher improved the question items as follows:

- To improve the interview form according to the experts' recommendations which included the adjustment of language which it might be more กระชับ ad correct as well as some issues which might add the additional questions.

3. The evaluation form of satisfaction in the project of electric energy saving model in 7 households of experimental group through environmental education. The researcher created the interview by evaluating the satisfaction after getting training the developed model by the procedures as follows:

- To study the ways of creating the evaluation form of satisfaction from the related documents.

- To analyze the contents, select the instruments and determine the criteria for evaluating the satisfaction of the study by using the skills practice of rhyming words writing

- To create the evaluation form of satisfaction, characteristics of evaluation form in terms of Rating Scale. The level of satisfaction value was as follows:

Score level 5	means	satisfied the most
Score level 4	means	satisfied very much
Score level 3	means	satisfied moderately
Score level 2	means	satisfied a little
Score level 1	means	satisfied the least

Then, Mean would be found and translated the meaning of point average by using the criteria as follows: (Boonchom Srisaard, 1992).

Average score level	4.50 – 5.00	means	satisfied the most
Average score level	3.50 – 4.49	means	satisfied very much
Average score level	2.50 – 3.49	means	satisfied moderately
Average score level	1.50 – 2.49	means	satisfied a little
Average score level	1.00 – 1.49	means	satisfied the least

- To bring the evaluation form of satisfaction to check the validity by finding the ICO that whether it could evaluate the satisfaction according to the purposes required to measure by letting the evaluation form investigated by 3 experts.

Score + 1   for the statement sure about the purposes required to measure.

Score   0   for the statement unsure whether it was in accordance with the purposes required to measure.

Score – 1   for the statement sure that it was not in accordance with the purposes required to measure.

- To record the consideration result of the experts in each item to find the IOC of the statements according to the purposes required to measure (Raweewan Chinatrakul, 1999: 141-159)

$$\textbf{IOC} = \frac{\Sigma R}{N}$$

When   **IOC**   substitutes the Index of Consistency between the item and the purpose required to measure

ΣR substitutes the total score of opinions in each item of all experts

N   substitutes the number of experts

- To bring the scores evaluated by the experts to find the **IOC** value and then compare them with the criteria of IOC between the contents used in this research about the electric energy saving with the experts' opinions. According to the IOC value between the contents and experts' opinions for 21 items, it was found that the **IOC** value was between 0.62-1.00 for 21 items.

- To improve the evaluation form of satisfaction according to the recommendation of the experts.

- To publish the evaluation form of satisfaction for further educational usage.

Stage 4: Conclusion, analysis, and discussion on research data

The researcher brought the data got from the survey and measurement of the sample group to analyze the data. The research results were as follows:

1. Qualitative Analysis: This is the behavioral evaluation of electric use by analyzing the contents and collecting data from the interview form of behaviors on the electric energy at household level in the Nong Tam Leung Sub-district municipality,

Amata Nakorn Industrial Estate, Chonburi province before and after using the electric energy saving model in household through environmental education process to know the changed behaviors from the experimental group which used the electric energy saving model in household through environmental education process and the control group that how much or how it was changed (conclusion about quantitative data analysis that if the sample had more knowledges, whether or how they change their behaviors of electric energy saving).

2. Quantitative Analysis: This is about the knowledge evaluation by collecting the data got from the questionnaire on electric use data in household, the knowledge test about electric energy saving of the Nong Tamleung Sub-district municipality households, Amata Nakorn Industrial Estate, Chonburi province, and the evaluation form of satisfaction in the training project on electric energy saving model in household through environmental education process to explain the data on personal factor in using the electric energy in nowadays. The researcher was the person who evaluated both before and after the training and evaluated the satisfaction of the trainees, processed and analyzed the quantitative data by using the statistical program for the research or the SPSS for windows. The data analysis was carried out as follows:

- Range

- Percent

- Mean

- Standard Deviation

- To compare the difference of the Mean of knowledge scores between before and after the experiment by using the analytical statistics of Paired t-test.

- To analyze the relationship between knowledge of electric energy saving and the amount of electricity bill after getting the developed model by using the statistics to analyze the Pearson Correlation Coefficient for data analysis.

CHAPTER IV
RESULTS

For this research, the researcher created the model of electrical energy saving in the household through the process of environmental education. The researcher developed and tried out the mentioned model with the Nong Tam Leung Sub-district municipality, Pan Tong District, Chonburi Province. The data analysis was appeared as follows:

4.1 The study of household data in terms of requirement and use of electrical energy by categorizing the data analysis results respectively was as follows:

4.1.1 General data of the respondents

4.1.2 General data about electrical energy use in households

4.1.3 Behaviors of electrical energy use and conservation ways of electrical energy

4.1.4 Receiving news and information as well as knowledge about conservation of electrical energy

4.2 Development of electrical energy saving model in household through environmental education process

4.3 The trial of electrical energy saving model in household through environmental education process categorized by data analysis results respectively as follows:

4.3.1 Knowledge in electrical energy saving in households of Amata Nakorn Industrial Estate, Chonburi Province

4.3.2 Behaviors in the electrical energy use at the household level

4.3.3 Satisfaction of training project on the electrical energy saving model within households through environmental education process

4.3.4 Quantity of electricity use in the households

4.3.5 Relationship between knowledge in the electrical energy saving and the amount of electricity costs after using the developed model

4.1 The study of household data for analyzing the electrical energy use and requirement

The study of household data for analyzing the electrical energy use and requirement in households of Nong Tam Leung sub-district municipality, Amata Nakhon Industrial Estate, Chonburi province. The knowledges emphasized the electricity use in households, behaviors of electricity use in households, and electricity costs in households. The data collection was carried out from 351 samples. The analysis results were as follows:

4.1.1 General data of the respondents

Table 4.1 General data of the respondents classified by the number and percentage

Personal traits	Number (persons)	Percentage
Gender		
male	69	19.7
female	282	80.3
Total	351	100.0
Age		
< 20 years	9	2.6
21-40 years	77	21.9
41-60 years	216	61.5
> 61 years	49	14.0
Total	351	100.0
Family status		
leadership	67	19.1
couple	204	58.1
siblings /descendents	60	17.1
residents	20	5.7
Total	351	100.0

Table 4.1 General data of the respondents classified by the number and percentage
(cont.)

Personal traits	Number (persons)	Percentage
Educational level		
Primary school	147	41.9
High school	135	38.5
Diploma or vocational certificate, high vocational certificate	30	8.5
Bachelor or higher	39	11.1
Total	351	100.0
Career		
General employed	164	46.7
Trade or private business	148	42.2
Governmental servants or state enterprise	19	5.4
Students	20	5.7
Total	351	100.0
How long have you been in this village?		
11-15 years	48	13.7
16-20 years	28	8.0
> 21 years	275	78.3
Total	351	100.0
Have you ever participated in the training course since the past 2 years?		
No	293	83.5
Yes	58	16.5
Total	351	100.0

Table 4.1 showed the study as follows, it was found that Most of the
sample group was female for 80.3%, age between 41-60 years old for 61.5%. The
marital status was mostly married for 58.1% and the educational level was primary

school for 41.9%. most of the sample group had lived in this village for 21 years up
for 78.3% and had never participated in the training course since the past 2 years for
83.5%. The family members residing in the household were about 4 persons per
household, averagely.

4.1.2 General data about electrical energy use in households

Table 4.2 General data about the electrical energy use in households categorized by
the number and percentage

Number (Units)	Number (households)	Percentage
Light Bulb		
8-15	116	33.0
20-25	176	50.1
30-50	175	16.9
Total	351	100.0
Compact fluorescent Lamp		
0	91	25.9
1	95	27.1
2	105	29.9
3	40	11.4
5	20	5.7
Total	351	100.0
Television		
1	20	5.7
2	194	55.3
3	117	33.3
4	20	5.7
Total	351	100.0
Refrigerator		
1	233	66.4
2	100	28.5
3	18	5.1
Total	351	100.0

Table 4.2 General data about the electrical energy use in households categorized by
the number and percentage (cont.)

Number (Units)	Number (households)	Percentage
Refrigerator Number 5		
0	176	50.1
1	125	35.6
2	50	14.2
Total	351	100.0
Fan		
1	56	16.0
2	144	41.1
3	40	11.4
4	71	19.1
5	40	11.4
Total	351	100.0
Fan Number 5		
0	8	2.3
1	134	38.2
2	147	41.9
3	23	6.5
4	27	7.7
5	12	3.4
Total	351	100.0
Air Conditioner		
0	134	38.2
1	138	39.3
2	60	17.1
3	14	4.0
4	5	1.4
Total	351	100.0
Air Conditioner Number 5		
0	180	51.3
1	116	33.0
2	41	11.7
3	11	3.1
4	3	0.9
Total	351	100.0

Table 4.2 General data about the electrical energy use in households categorized by the number and percentage (cont.)

Number (Units)	Number (households)	Percentage
Computer		
1	126	35.9
2	205	58.4
3	20	5.7
Total	351	100.0
Rice Cooker		
1	255	72.6
2	96	27.4
Total	351	100.0
Boiling Pot		
0	58	16.5
1	273	77.8
2	20	5.7
Total	351	100.0
Iron		
1	235	67.0
2	116	33.0
Total	351	100.0
Microwave		
0	86	24.5
1	265	75.5
Total	351	100.0
VCD and DVD player		
1	104	29.6
2	247	70.4
Total	351	100.0

Table 4.2 General data about the electrical energy use in households categorized by
the number and percentage (cont.)

Number (Units)	Number (households)	Percentage
Radio		
1	19	5.4
2	332	94.6
Total	351	100.0
Washing Machine		
1	304	86.6
2	47	13.4
Total	351	100.0
Water Heater		
0	21	6.0
1	132	37.6
2	198	56.4
Total	351	100.0
Water Pump		
1	337	96.0
2	14	4.0
Total	351	100.0
Hair Dryer		
1	150	42.7
2	201	57.3
Total	351	100.0
Electric Stove		
0	271	77.2
1	80	22.8
Total	351	100.0

The average of retroactive electricity rate

the number of months back in 2011	the average of electricity costs (unit/351 households)	the average of electricity costs (unit/households)	S.D.
September	100,415	286.08	142.28
August	103,330	294.38	143.04
July	99,316	282.95	142.01
total average was 3 months	101,020.33	287.80	

Table 4.2 showed the study as follows, it was found that the number of light bulbs used in each household mostly equal to 16-30 light bulbs for 66.1%, secondly was 0-15 light bulbs for 33.0%. For compact fluorescent lamp to save the electricity energy, there were mostly 2 bulbs for 29.9%, secondly was 1 bulb for 27.1%. The number of television used in each household was 2 televisions for 55.3%, the secondly was 3 televisions for 33.3%, the number of refrigerators of each household was one for 66.4%, secondly was two for 28.5%, there was no use of refrigerator of number 5 for electricity saving for 50.1%, secondly was 1 refrigerator for 35.6%, the number of fans was 2 fans for 41.1%, secondly was 4 fans for 19.1%, there was the use of fan number 5 for electricity saving for no fans or 80.6%, the second was 1 fan for 17.7%, the number of air-conditioner use was only one or 39.3%, secondly, the air-conditioner use of number 5 for electricity saving was no have for 51.3%, secondly was 1 air-conditioners for 33.0%, the number of computers in each household was 1 computers for 61.5%, secondly was 2 computer for 15.7%, the number of rice cooker was only one for 72.6%, secondly was 2 rice cookers for 27.4%, the number of boiling pot was only one or 77.8%, secondly was none or 16.5%, there was the number of iron only one or 67%, secondly was 2 irons or 33%, the number of microwave was only one for 75.5, secondly was none for 24.5%, the number of VCD and DVD was two for 70.4%, secondly was only one for 29.6%, the number of radio was two for 94.6%, secondly was only one for 5.4%, the number of washing machine for one per household for 86.6%, secondly was two for 13.4%, the

number of water heater was none for 67.8%, secondly was one for 27.5%, the number of water pump was one for 75.8%, secondly was none for 24.2%, the number of hair dryer was one for 28.9%, secondly was two for 21.1%, the electric stove was none for 77.2%, secondly was one for 22.8%, and the electricity costs which had a large quantity was in September 2010 for an amount of 282.95 unit/household, secondly was in August 2010 for 294.38 unit/household , lastly was in July 2010 for 282.95 unit/household.

4.1.3 Behaviors of electrical energy use and conservation ways of electrical energy

Table 4.3 Perception of electricity costs saving from the electric appliances in the households categorized by the number and percentage

Do you know how to save the electricity costs from the appliances in the household?	Number (persons)	Percentage
Know	139	39.6
Don't know	212	60.4
Total	351	100.0

Table 4.3 showed the study as follows, it was found that most of the samples didn't know how to save the electricity costs from the electricity in households for 60.4% whereas the sample who knew was 39.6%. The samples who knew usually turned off the electricity when it was unnecessary only in terms of the light bulb. For the samples who didn't know how to save the electricity viewed that they had normally used the equipment according to the necessary of usage and it likely saves the energy already.

Table 4.4 The behaviors of electrical energy use categorized by the number and percentage

Behaviors of electrical energy use	frequency used		
	regularly	**sometimes**	**never**
	Number	Number	Number
	(%)	(%)	(%)
Electricity and light			
1. turn on the light but it is left without anyone uses it	151 (43.0)	157 (44.7)	43 (12.3)
2. use the compact fluorescent to save the electricity	245 (69.8)	15 (4.3)	91 (25.9)
3. turn on the electricity only at the place is used	155 (44.2)	166 (47.3)	30 (8.5)
4. plug in the electricity equipment and left	153 (43.6)	168 (47.9)	30 (8.5)
5. check and clean the light bulb	159 (45.3)	29 (8.3)	163 (46.4)
Iron			
6. plug in the iron and left it without using it	162 (46.2)	157 (44.7)	32 (9.1)
7. iron the clothes for several suits per time	156 (44.4)	165 (47.0)	30 (8.5)
Refrigerator			
8. turn on –off the refrigerator unnecessarily	162 (46.2)	152 (43.3)	37 (10.5)
9. put things in the refrigerator fully	167 (47.6)	168 (47.9)	16 (4.6)

Table 4.4 The behaviors of electrical energy use categorized by the number and percentage (cont.)

Behaviors of electrical energy use	frequency used		
	regularly Number (%)	**sometimes** Number (%)	**never** Number (%)
Rice cooker			
10. turn on the rice cooker lid while it's cooking	172 (49.0)	145 (41.3)	34 (9.7)
11. cooking the rice in the air-conditioning room	46 (13.1)	135 (38.5)	170 (48.4)
12. plugged in the rice cooker	205 (58.4)	32 (9.1)	114 (32.5)
Television			
13. Turn on the television while sleeping or without watching	168 (47.9)	160 (45.6)	23 (6.6)
14. turn off the television from remote control	152 (43.3)	163 (46.4)	36 (10.3)
15. set the time off for the television	42 (12.0)	151 (43.0)	158 (45.0)
Radio			
16. turn on the radio without listening	147 (41.9)	156 (44.4)	48 (13.7)
17. turn off the radio from the remote control	151 (43.0)	176 (50.1)	24 (6.8)
18. set the time off for the radio	24 (6.8)	152 (43.3)	175 (49.9)

Table 4.4 The behaviors of electrical energy use categorized by the number and percentage (cont.)

Behaviors of electrical energy use	frequency used		
	regularly	**sometimes**	**never**
	Number	Number	Number
	(%)	(%)	(%)
Fan			
19. urn on the fan without using	147	159	45
	(41.9)	(45.3)	(12.8)
20. place the fan at the good atmosphere areas	136	181	34
	(38.7)	(51.6)	(9.7)
Air-conditioner			
21. turn on the air-conditioner without anyone in the room	10	185	156
	(2.8)	(52.7)	(44.4)
22. turn on the air-conditioner at the temperature lower than 25 degree Celsius	135	54	162
	(38.6)	(15.4)	(46.2)
23. left the door open while the air-conditioner is working	0	128	223
	(0.0)	(36.5)	(63.5)
24. turned off the air-conditioner before the usage will be finished in advance for 15 minutes	15	73	263
	(4.3)	(20.8)	(74.9)
The electric kettle			
25. lug in the electric kettle for a long time	97	69	185
	(28.3)	(19.6)	(52.7)
26. put water in the kettle for a lot of quantities	177	111	63
	(49.5)	(31.6)	(17.9)
27. use the cool water for boiling	0	71	280
	(0.0)	(20.2)	(79.8)

Table 4.4 The behaviors of electrical energy use categorized by the number and
percentage (cont.)

Behaviors of electrical energy use	frequency used		
	regularly Number (%)	**sometimes** Number (%)	**never** Number (%)
Computer			
28. turn on the computer without using	12 (3.4)	152 (43.3)	187 (53.3)
29. set the time of screen use	63 (18.0)	85 (24.2)	203 (57.8)
30. unplug when it is not used	243 (79.2)	41 (11.7)	67 (19.1)
The water pump			
31. turn on the water pump and leave water	185 (52.7)	34 (9.7)	132 (37.6)
32. turn off the tap but not tight or made the water dropped	168 (47.8)	88 (25.1)	95 (27.1)
33. use the shower to take a bath	186 (53.0)	22 (6.3)	143 (40.7)
The water heater			
34. turned on the water heater all the time while taking a bath	45 (12.9)	45 (12.8)	261 (74.3)
35. set the maximum water pressure to take a bath	39 (11.2)	69 (19.6)	243 (69.2)
The washing machine			
36. soak the clothes before washing with the washing machine	10 (2.8)	173 (49.3)	168 (47.9)
37. set the program to be appropriate with the kind of clothes	157 (44.7)	172 (49.0)	22 (6.3)

When categorizing the behaviors of electrical energy use according to the electric appliances in each type as shown in the table 4.4, it was found that

1. Electricity and light; it was found that in most of the households, the light was turned on without using sometimes at the average of 44.7%, used the compact fluorescent bulb for saving electricity always at the average of 69.8%, turned on the electricity only required sometimes at the average of 47.3%, plugged in the electric equipment and left it sometimes at the average of 47.9%, the light bulb was never checked or cleaned at the average of 46.4%.

2. Iron; it was found that in most of the households the iron was plugged in and left it without using it regularly at the average of 39%, ironed the clothes for several suits in one time for sometimes at the average of 47%.

3. Refrigerator; it was found that in most of the households, the refrigerator was turned on-off more unnecessary regularly at the average of 46.2%, put things in the refrigerator fully sometimes at the average of 47.9%.

4. Rice cooker; it was found that in the most households, the lid of rice cooker was not turned on while it was cooking at the average of 87.2 %, never cooked in the air-conditioning room at the average of 100.0%. it was found that most households plugged in the rice cooker always and left it at the average of 58.4%,

5. Television; it was found that in the most households, the television was turned on while the members were sleeping or without watching at the average of 47.9%, turned off the television from remote control sometimes at the average of 46.4%, never set the turning off time for the television at the average of 45%.

6. Radio; it was found that in the most households, the radio was turned out while there was no one listening to it sometimes at the average of 44.4%, turned off the radio from remote control sometimes at the average of 50.1%, never set the time of turning off radio at the average of 49.9%.

7. Fan; it was found that in the most households, the fan was turned on while no one used it sometimes at the average of 45.3%, opened the fan left in the good atmosphere areas sometimes at the average of 51.6%.

8. Air-conditioner; it was found that most households turned on the air-conditioner and left it without anyone in the room sometimes at the average of 52.7%, never turned on the air-conditioner at the temperature lower than 25 degree celcius at

the average of 46.2%, never opened the door left the door open while the air-conditioner was working at the average of 63.5 %, never turned off the air-conditioner before stop using it for 15 minutes at the average of 74.9 %.

9. Electric kettle; it was found that the most households never plugged in the electric kettle and left it for a long time at the average of 52.7%, regularly put the water in the electric kettle for several quantities at the average of 49.5%, never used the cool water to boil water at the average of 79.8%.

10. Computer; it was found that most households never turned on the computer without using at the average of 53.3%, never set the time to restore the screen at the average of 57.8%, unplugged when there was no usage always at the average of 79.2%.

11. Water pump: it was found that most households regularly turned on the pump without using at the average of 52.7%, turned off the tap but not tight or the water was dropped regularly at the average of 47.8%, used the shower regularly to take a bath at the average of 53.0%.

12. Water heater; most households never turned on the water heater all the time while having a shower at the average of (74.3) and never set the water pressure at the maximum level for at the average of 69.2%.

13. In terms of washing machine, it was found that most of the households sometimes soaked clothes before putting them into the machine for 49.3%, and sometimes set the program of washing to be appropriate to each type of clothes for 49%.

4.1.4 Receiving news and information as well as knowledge about the electrical energy preservation

Table 4.5 Receiving news and information as well as knowledge about electrical energy conservation categorized by the number and percentage

You ever received the news and information about energy preservation	Number	Percentage
ever	131	37.8
never	220	62.7
Total	351	100.0

Table 4.5 showed the study as follows, it was found that most of the households had never received the news and information about energy conservation at the average of 62.7%, ever received the news and information about the energy conservation at the average of 37.8%

Table 4.6 Receiving the news and information as well as knowledge about the electrical energy conservation categorized by the number and percentage

Media which were received the news and information as well as knowledges about the conservation of energy	Number	Percentage
Television	76	59.3
Radio	23	17.1
Newspaper	14	11.4
magazine/journal	8	6.8
governmental documents	4	3.1
brochure/leaflet	3	1.4
neighbors	2	0.6
relatives/persons in the family	1	0.3
Total	131	100.0

Table 4.6 showed the study as follows, it was found that most of the households received the news and information as well as knowledge about the energy conservation from television at 59.3%, secondly was from the radio at 17.1%, and from newspaper at 11.4%, respectively.

Table 4.7 Requirement of news and information about the electrical energy conservation categorized by the number and percentage

Requirement of news and information about the electrical energy preservation	Number	Percentage
require	308	87.7
didn't required	43	12.3
Total	351	100.0

Table 4.7 showed the study as follows, it was found that most of the households required the news and information about the electrical energy conservation for 87.7% and they didn't require for 12.3%

Table 4.8 News and information about the required electrical energy conservation categorized by the number and percentage

News and information about the required electrical conservation	Number	Percentage
1. General data about the electrical energy	108	8.3
2. Ways of electrical energy conservation	190	17.9
3. Electrical energy audit	162	14.5
4. Effectiveness of electric appliances	152	13.1
5. Benefits from electrical saving equipment	144	12.0
6.The methods how to use each kind of electrical equipment	186	17.5
7.Advantages and disadvantages of electrical energy conservation	116	10.0
8.Roles of people for electrical energy conservation	104	6.3
Total	1,156	100.0

Table 4.8 showed the study as follows, it was found that most households needed the news and information about ways to conserve the electrical energy for 17.9%, secondly, the method of using the electrical equipment in each kind for 17.5% as well as news and information about the audit of electrical energy for 14.5%, respectively.

4.2 Development of electrical energy saving model in the household through the environmental education process

According to the study the basic data from documents, literatures related to the energy conservation both in and out of the country in order to study the information of electric energy saving and study the basic data of Nong Tamleung household municipality, Amata Nakorn Industrial Estate, Chonburi Province by asking the involved persons including Nong Tamleung household municipality, Pantong District, Amata Nakorn Industrial Estate, Chonburi Province. The issues included the knowledges about electric use in the household, behaviors of electric use in the household and the amount of electricity bills in each household that helped the researcher to got the people needs. The researcher who got that knowledge developed Home Electric Energy Saving Model Through Environmental Education Process that consisted the content of Electric Energy, and equipment to control the electric energy saving before using this model. The components were included as follows:

1. Knowledge and understanding about the electric energy that is the knowledge of electric energy, the situation of electric in Thailand, the needs of electric, and the ways to solve electric problem.

2. Electric energy saving that the researcher developed is to be the handbook of electric energy saving from electric equipment in household for example : Light System, Air Conditioner, Refrigerator, Computer, Electric Pot, Television, Electric Fan, Washing Machine, Iron, Rice Cooker, Water Pump, and etc…

3. Design of equipment to control the electric energy saving that can help to control Electric Equipment in household to be suitable for using and reducing an electric energy.

According to the data analysis above, Home Electric Energy Saving Model Through Environmental Education Process was analyzed and shown in Figure 4.1
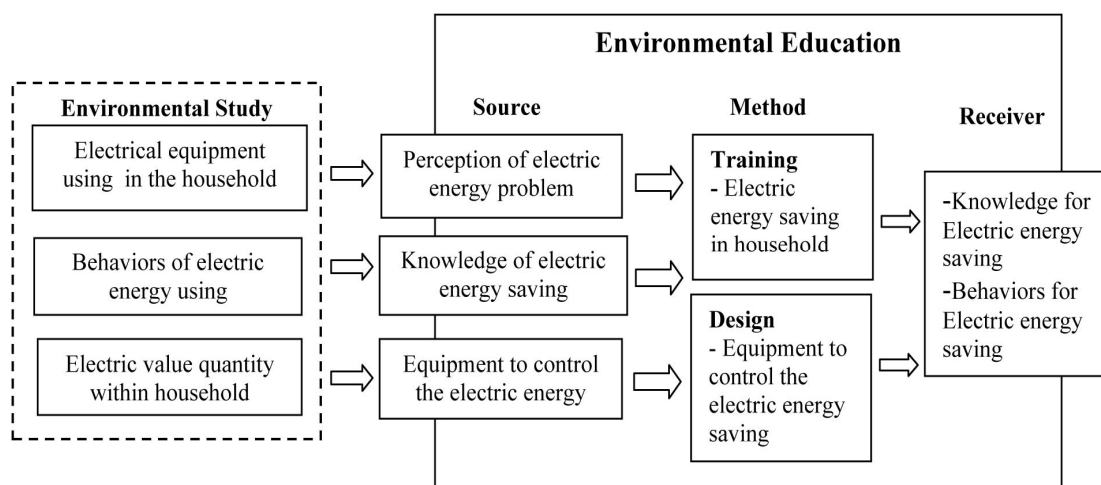
Figure 4.1 Home Electric Energy Saving Model Through Environmental Education Process

Table 4.9 The evaluation of control equipment on electrical energy saving of experts categorized by the number and percentage

Evaluation topic	Evaluation level					
	the most appropriate Number (%)	much appropriate Number (%)	moderate appropriate Number (%)	a little appropriate Number (%)	the least appropriate Number (%)	average value (level)
1. Control equipment model of electrical energy saving						
1.1 There is the consistent relationship with the electric appliances in the household	1 (20.0)	4 (80.0)				4.2 (much)
1.2 The style is appropriate and beautiful	1 (20.0)	2 (40.0)	2 (40.0)			3.8 (much)

Table 4.9 The evaluation of control equipment on electrical energy saving of experts categorized by the number and percentage (cont.)

Evaluation topic	the most appropriate Number (%)	much appropriate Number (%)	moderate appropriate Number (%)	a little appropriate Number (%)	the least appropriate Number (%)	average value (level)
1.3 The materials used are appropriate and durable	3 (60.0)	2 (40.0)				4.6 (the most)
1.4 The structure is compact and appropriate for the usage	3 (60.0)	1 (20.0)				4.4 (the most)
1.5 There is the system of use prevention of the machine in case of the error usage	1 (20.0)	4 (80.0)	1 (20.0)			4.2 (much)
2. Usage of control equipment of electrical energy saving						
2.1 There is the interaction of program to be easy and convenient for the user	3 (60.0)	2 (40.0)				3.6 (much)
2.2 The user can control the work of equipment very well	4 (80.0)	1 (20.0)				3.8 (much)

Table 4.9 The evaluation of control equipment on electrical energy saving of experts
categorized by the number and percentage (cont.)

Evaluation topic	Evaluation level					
	the most appropriate Number (%)	much appropriate Number (%)	moderate appropriate Number (%)	a little appropriate Number (%)	the least appropriate Number (%)	average value (level)
2.3 Easy to install and convenient for the usage	2 (40.0)	3 (60.0)				3.4 (moderate)
2.4 Flexible and could respond the interpersonal difference	4 (80.0)	1 (20.0)				3.8 (much)
2.5 There is the safety for the use	3 (60.0)	2 (20.0)				3.6 (much)

Table 4.9 showed the study as follows. In order to make the control
equipment of electrical energy saving created have the most qualitative before using in
the real situation, the researcher developed the created equipment to the technological
and engineering experts to be investigated by categorizing the data analysis results to
be 2 sides, which included the design of control equipment of electrical energy saving
and the work of control equipment of electrical energy saving before having the real
experiment by categorizing the data analysis results as follows:

According to the study of control equipment design of electrical energy
saving, it was found that the continuous relationship on the electric appliances in the
household was at the much appropriate at the average of 4.2, the appropriate and
beautiful model at the much appropriate level at the average of 3.8. The materials
applied were appropriate and durable at the most appropriate level at the average of
4.6, the structure was compact and appropriate for the usage at the most appropriate
level at the average of 4.4, there was the prevention system of machine in case of the
errors occurred at the much appropriate at the average of 4.2.

According to the usage of control equipment of electrical energy saving, it was found that there was the interaction of program to be easy and convenient for the users at the much appropriate level at the average of 3.6, the user could control the work of equipment good at the much appropriate level at the average of 3.8, easy to install and convenient for use at the moderate level at the average of 3.4, flexible and could respond the interpersonal difference at the much appropriate level at the average of 3.6, safe for usage at the much appropriate level at the average of 3.8.

4.3 The trial of electrical energy saving model in the household through the environmental education process categorized by the data analysis results respectively as follows:

This research analyzed the results of knowledge test on electrical energy saving behaviors of electrical energy use and satisfaction on the training of electrical energy saving model in the household through environmental education process as follows:

4.3.1 Knowledge on electrical energy saving in the households of Amata Nakhon Industrial Estate, Chonburi Province

The comparison of scores on knowledge test of the Amata Nakhon Industrial Estate households, Chonburi Province, the details were as follows:

1. The knowledge comparison of households in the electrical energy saving in the control group's households. The control group had never got additional knowledges both before and after the test for 35 persons. The results were appeared as follows:

Table 4.10 The comparison of average scores of the knowledge test in the electrical
energy saving both before and after the experiment of the control group

Control group	n	$\overline{\text{X}}$	SD	t	P - value
before the experiment	35	11.08	3.02	0.22	0.82
after the experiment	35	11.11	2.95		

*p < 0.05

According to the Table 4.10: it indicated that the average score of
knowledge test on electrical energy saving of the control group who had never got
knowledge at all both before and after the experiment had the similar value, which was
11.08 and 11.11, respectively. When compared the average score of the both group by
using t-test, it was found that the average scores both before and after the experiment
of control group was different by not having statistic significance at the 0.05 level.
This was shown that the knowledge of electricity saving of the control group's
households had not change during the time of the study.

2. The comparison of knowledge in the households about the electrical
energy saving in the experimental group's households, the experimental group had
ever got additional knowledge from their old knowledge and after the experiment for
35 persons. The results were appeared as follows:

Table 4.11 Comparison of average scores of knowledge measurement test in the
electrical energy saving both before and after the experiment from the
experimental group

Control group	n	$\overline{\text{X}}$	SD	t	P - value
before the experiment	35	11.31	2.80	24.27*	0.01
after the experiment	35	23.80	1.99		

*p < 0.05

According to the table 4.11, it was shown that the average score,
knowledge measurement test in the electrical energy saving of experimental group
before the experiment (never got knowledge) and after the experiment (got the

knowledge) had the different value, which was 11.31 and 23.80, respectively. When compared the average scores of both groups by using t-test, it was found that the average scores on the households of the experimental group, they had more knowledge by statistic significance at 0.05 levels. It was shown that the electrical energy saving model in the household could increase the level of knowledge on the electricity saving in households significantly.

       3. The comparison of knowledge in the households on electrical energy saving in the household of both experimental group and control group after having the experiment for 70 persons; the results were appeared as follows:

Table 4.12 The comparison of average scores of knowledge test in the electrical energy saving after the experiment of both experimental group and control group

Control group	n	$\overline{\mathrm{X}}$	SD	t	P - value
before the experiment	35	11.11	2.95	23.19*	0.01
after the experiment	35	23.80	1.99		

*p < 0.05

       According to the table 4.12, it indicated that the average scores knowledge test on electrical energy saving of the control group (didn't get knowledges) and the experimental group (got knowledge) after the experiment had the different value which was 11.11 and 23.80, respectively. When compared the average scores of the both groups by using t-test, it was found that the average scores of households on experimental group got more knowledge than the control group by statistic significance at 0.05 level. This suggested that the knowledge giving design could significantly increase the knowledges level on electricity use in the households.

4.3.2 Behaviors in electrical energy use at the household level

       The study of behaviors in electrical energy use after the experiment the electrical energy saving model in all 7 households of experimental group, the researcher used the method of interview about the behaviors on electrical energy use

of each households both before and after using the model in order to know about the behavioral change on electricity use in the following topics:

1. The computer use before and after the training

According to the interview, the households which had the behaviors of computer use found that before the trail, there was the turning on computer left while doing other activities in the household such as having a shower, washing the car, watching the television, having conversation with friends, loading various work, having meals, and turning on the songs from computer but leaving it without listening. After the experiment, the behaviors were changed, for example, the households turned to use the notebook instead of desktop computer which could save the electricity for 10 times although its usage would not be so convenient as the desktop computer. Moreover, the computer was turned off after stopping working or doing other activities.

2. Air-conditioner use before and after the training

According to the interview of households in terms of the behavioral use of air-conditioner, it was found that before a trial, the air-conditioner was used all the time when anyone felt hot and uncomfortable. Most of the samples usually turned on the air-conditioner after coming back from the office until morning before going to work again. If it was holiday, the air-conditioner was turned on from morning to noon since the sample still felt the weather was hot whereas after the experiment the behaviors were changed, the samples in the households turned off the air-conditioner after sleeping for 3 hours and used the fan instead of turning on the air-conditioner until morning. Some of them opened the windows when came back home and turned on the fan in stead of air-conditioner in some days when the weather is not hot.

3. Electric bulb use before and after the training

According to the interview, in terms of electric bulb behavior, it was found that before the experiment, there was the usage without considering the electricity quantity because the sample thought that the electricity was wasted less when comparing with other equipment whereas after trial when the sample knew about the data of electrical energy saving, there were the changed behaviors, the samples in households turned off the light when there had no usage more, some households turned on the light only one bulb for the sleeping time, some households turned to use

the compact fluorescent bulb since there had no the spread of heat and helped save the electricity as well.

4. Vacuum bottle and kettle use before and after the training

According to the interview of the samples in households in terms of behaviors on using the vacuum bottle and electric kettle, it was found that before the experiment, there was the usage by putting water fully and plugged in all day because most of them thought that the vacuum bottle could cut off the electricity automatically when it is too hot and it would not waste the electricity used for ยง the drinks. Some family members I households unplugged when they remembered the vacuum bottle was plugged in whereas after the experiment the behaviors of family members were changed. Some samples put water in with the adequate quantity required and when it was hot enough, then unplugged it because they realized that when a little water was put, it would be hot quickly which help save the electricity costs

5. Television use before and after the training

According to the interview, the households in terms of the behavior of television use, it was found that before the experiment, the households turned off the television normally but some households turned on the TV while cooking. For some households which have children live in usually turned on and left for them to watch the cartoon program. Moreover, at the bedtime, most of the samples turned on the television and left it until they work up when they felt the program disturbed them from sleeping. After the experiment, the changed behaviors included the households turned to turn off the switch by themselves instead of using the remote control or when they felt drowsy, they would turn it off. Some households would turn off the television immediately but some turned to learn how to set up the on-off time to be the most appropriate.

6. Refrigerator use before and after the training

According to the interview, the behaviors of refrigerator use found that before the experiment, the sample opened the refrigerator regularly and usually put a lot of stuff in it because they thought that all their stuff would be rotten when they were left outside the fridge. After the experiment, the changed behaviors included the households put the stuff less because they already realized that putting too much stuff would make the fridge give the coolness insufficiently. Some stuff might be rotten and

couldn't consume. Moreover, when the ice had to be melt, the coolness would be less as well.

7. The fan use before and after the training before and after the training

According to the households interview in terms of the behavior of fan use, it was found that before the experiment the samples turned on the fan together with turning on the air-conditioner since they thought that the weather would ventilate well and it could spread the coolness and usually turned on like this all the them while staying at home. Some households forgot to turn off when they left out. For after the experiment, the behaviors changed included the households would turn off the fan after using and cleaned it more frequently when they saw the dust stick the paddle and the fan guard. Some households opened the window instead. When the sleeping time, they would turn on the fan after turning the air-conditioner off when they felt that the coolness was still remained.

8. Washing machine use before and after the training

According to the households interview in terms of the behavior of washing machine use, it was found that before the experiment the samples usually use the washing machine without soaking clothes because they thought that it wasted time and inconvenient. After the experiment, the behaviors changed included the households turned to soak the clothes to reduce time of washing with the 2 buckets washing machine type which would help the clothes more quickly clean and reduce time of washing whereas the automatic washing machine with only one bucket has no the soaking system therefore when the weight of clothes were much, the machine would calculate the time of washing more.

9. Iron use before and after the training

According to the households interview in terms of the behavior of iron use, it was found that before the experiment the iron was used almost every day before the family members got dressed and went to work out but some members would iron their cloths in a large quantity only once. Most of them usually iron the clothes without continuity and did other activities at the same time but not long time much whereas after the experiment, behaviors changed included most of the households turned to iron the clothes for a lot of quantities in one time when they knew the rate of electricity waste. Some of them turned to use the electric steam iron instead because

they realized that it is convenient and reduced the time which could help save the electrical energy more.

10. Water heater use before and after the training

According to the households interview in terms of the behavior of water heater, it was found that before the experiment there was the frequency of usage in the morning because the family members thought that it was cleaner when they had a shower with the warm water. However, using water with the maximum rate would accelerate the temperature a lot and they usually opened the water left until finish having a shower. For the experiment, the behaviors changed included the samples turned to reduce the water pressure which would help the boiling pot not have to work all the time. Moreover, they turn off water while using the soap which made the machine stop working.

11. Rice cooker use before and after the training

According to the households interview in terms of the behavior of rice cooker, it was found that before the experiment only a few of households unplugged all day and for the family members who didn't work out because rice would be rotten and not warmed. Moreover, the members realized that cooking in a large quantity would save time and could eat for several meals. For after the experiment, there were the behaviors changed include the members of family in the household unplugged when the rice was already ripe and they usually cooked with microwave instead in order to reduce time and electrical energy for warming the rice.

12. Water pump use before and after the training

According to the households interview in terms of the behavior of water pump, it was found that before the experiment the members of family in the households plugged in all the time because they thought that the machine would not work when there was no one use it and the machine would work just only a few times. For after the experiment, the behaviors changed included the households turned to unplugged and would use when the water pressure was decreased and it would be decreased and it is usually decreased in the morning. Some households were careful not to make the water drop wastefully because they realized that the water pump worked fore several times in one day.

4.3.3 Satisfaction of training project on electrical energy saving model in the household through the environmental education process

Table 4.13 Satisfaction evaluation of trainees categorized by the number and percentage

Personal traits	Number	Percentage
Gender		
male	9	25.7
female	26	74.3
Total	35	100.0
Age		
21-40 years	11	31.4
41-60 years	16	45.7
> 61 years	8	22.9
Total	35	100.0
Educational level		
Primary school	13	37.1
High school	10	28.6
Diploma or vocational certificate, high vocational certificate	7	20.0
Bachelor or higher	5	14.3
Total	35	100.0
Career		
Agriculture	6	17.1
General employed	14	40.0
Trade or private business	12	34.3
Governmental servants or state enterprise	2	5.7
Students	1	2.9
Total	35	100.0

According to the table 4.13, it indicated that for the personal information of the samples, they were mostly female for 74.3%, secondly were male for 25.7%, most of the samples were between 41-60 years old for 45.7%, secondly were between 21-40 years old for 31.4%, and 61 years old up for 22.9%. For educational background, most of them graduated at the Prathomsuksa level for 37.1%, secondly was Mattayomsuksa level for 28.6%, and Diploma level/vocational certificate/high vocational Certificate for 20%, respectively. For career, most of the samples were general employed for 40%, secondly was trading/private business for 34.3%, respectively.

Table 4.14 Satisfaction Evaluation of trainees categorized by the number and percentage

	Satisfaction level / Perception / Knowledge Application					S.D.	average value (level)
Opinion issues	the most 5 Number (%)	much 4 Number (%)	moderate 3 Number (%)	a little 2 Number (%)	the least 1 Number (%)		
Lecturer							
1. Conveying knowledges of the lecturer was clear	23 (65.7)	12 (34.3)				0.481	4.6 the most
2. Ability to explain the contents	24 (68.6)	11 (31.4)				0.471	4.6 the most
3. Linking the contents of training	10 (28.6)	20 (57.1)	5 (14.3)			0.648	4.1 much
4. the completeness of contents for training	28 (80.0)	7 (20.0)				0.169	4.2 much
5. Time period use is concordant with the time required	9 (25.7)	26 (74.3)				0.443	4.2 much
6. Answering the question of training	7 (20.0)	28 (80.0)				0.443	4.2 much
Place/Time/Food							
1. clean and appropriate places	7 (20.0)	24 (68.6)	4 (11.4)			0.562	4.0 much
2. readiness of audio visual equipment	9 (22.5)	22 (62.9)	4 (11.4)			0.601	4.1 much
3. time of training is appropriate	12 (34.3)	23 (65.7)				0.481	4.3 much
4. food is appropriate	12 (34.3)	22 (62.9)	1 (3.9)			0.553	4.2 much

Table 4.14 Satisfaction Evaluation of trainees categorized by the number and percentage (cont.)

Opinion issues	Satisfaction level / Perception / Knowledge Application					S.D.	average value (level)
	the most 5 Number (%)	much 4 Number (%)	moderate 3 Number (%)	a little 2 Number (%)	the least 1 Number (%)		
Perception							
1. perception of this issue before training participation	3 (7.4)	5 (12.3)	7 (16.9)	20 (63.4)		0.507	3.4 moderate
2. perception in this issue after training participation	32 (91.4)	3 (8.6)				0.235	4.8 the most
3. be able to tell the benefits	26 (74.3)	9 (25.7)				0.443	4.2 much
4. be able to tell the advantages	25 (71.4)	9 (25.7)	1 (2.9)			0.490	4.2 much
5. be able to explain the details	10 (28.6)	20 (57.1)	5 (14.3)			0.648	4.1 much
6. be able to organize the concept system	6 (17.1)	23 (65.8)	6 (17.1)			0.594	4.0 much
7. systematical development process of the concept integration to the team work /personnel adjustment/ work system evaluation for operation	15 (42.9)	17 (48.6)	3 (8.6)			0.639	4.3 much

Table 4.14 Satisfaction Evaluation of trainees categorized by the number and percentage (cont.)

Opinion issues	Satisfaction level / Perception / Knowledge Application					S.D.	average value (level)
	the most 5 Number (%)	much 4 Number (%)	moderate 3 Number (%)	a little 2 Number (%)	the least 1 Number (%)		
Knowledge Application							
1. be able to apply knowledges got in the electrical energy saving for household	21 (60.0)	13 (37.1)	1 (2.9)			0.557	4.5 the most
2. be able to publicize knowledges/ be able to convey knowledges to the community	14 (40.0)	17 (48.6)	4 (11.4)			0.667	4.2 much
3. be able to give consultancy to the colleagues	15 (42.9)	12 (34.3)	8 (22.9)			0.445	4.2 much
4. feel confident and be able to apply the knowledges received	28 (80.0)	7 (20.0)				0.405	4.2 much

According to the table 4.14, it suggested the satisfaction evaluation of the trainees in terms of lecturer found that the conveying knowledges of the lecturer was clear at the most level with the average of 4.6%, the ability to explain the contents was at the most level with the average of 4.6%, the linking the contents of training was at the much level with the average of 4.1%, completeness of contents for training was at the much level with the average of 4.2%, and the time period use is concordant with the time required was at the much level with the average of 4.2%, and the answering the question of training was at the much level with the average of 4.2%.

In terms of place/time/food, it was found that clean and appropriate place at the much level with the average of 4.0%, the readiness of audio visual equipment is at the much level with the average of 4.1%, the time period of training was appropriate at the much level with the average of 4.3%, and food was appropriate at the much level with the average of 4.2%.

In terms of perception, it was found that perception in this issue before participating in training was at a moderate level with the average of 3.4%, perception in this issue after participating in training was at the most level with the average of 4.8%, could indicate the benefits at the much level with the average of 4.2%, could indicate the advantages at the much level with the average of 4.2%, could explain the details at the much level with the average of 4.1%, could organize the concept system/could process the concept to the work development systematically at the much level with the average of 4.0%, and could integrate the concept to team work/adaptation of personnel/evaluating the work system at the much level with the average of 4.3%.

In terms of knowledge application, it was found that for the item of being able to apply knowledges in the electrical energy saving in the household at the most level with the average of 4.57%, being able to publicize the knowledges/conveying the knowledges to the community was at the much level with the average of 4.28%, being able to give consultancy to the colleagues at the much level with the average of 4.20%, and for having confidence and being able to apply the knowledges was at the much level with the average of 4.20%.

4.3.4 Quantity of electricity use of households

According to the test of using electrical energy saving model in the household through the environmental education process with the experimental group for 7 households, then did the record of electricity costs before participating in the training for 3 months since July-September 2010, and after participating in the training for 3 months since November 2010-January 2011. The total mean or average points are shown in the table 4.15.

Table 4.15 Quantity of average electricity use of households categorized by test time period

Test time period	Quantity of average electricity use			quantity of average electricity use 3 months in total (unit/7 households)
	retroactive for 1 month (unit/7 households)	retroactive for 2 month (unit/7 households)	retroactive for 3 month (unit/7 households)	
before the model trial	518.8	531.1	513.4	521.1
after the model trial	438.1	457.7	461.8	452.5

According to the table 4.15, it was found that the quantity of average electricity use before the experiment was at the highest level during retroactive time of 3 moths with the average of 531.1 units/7 households, secondly was during the retroactive time of 1 month with the average of 518.8 units/7 households, respectively, and the quantity of average electricity use was 3 months in total with the average of 521.1 units/7 households.

Whereas the quantity of average electricity use after the experiment had the maximum use during the 3 months retroactive time with the average of with the average of 461.8 units/7 households, secondly, during the retroactive time of 2 months with the average of 457.7 units/7 households, respectively, and the quantity of average electricity use for 3 months with the average of 452.5 units/7 households.

The quantity of electricity use quantity of electricity use before the experiment for the average of 3 months with the average of 521.1 units/ 7 households and after the testing at the average of total 3 months with the average of 452.5 units/ 7 households, this was the reduction of electricity costs at the average of 68.6 units/7 households or at the average of 13.16.

4.3.5 Relationship between knowledges in electrical energy saving and electricity costs after using the developed model

For the analysis of relationship between the knowledges in the electrical energy saving and electricity costs after using the electrical energy saving model through the environmental education process of the households in the Amata Nakorn Industrial Estate, Chonburi province for 35 households, this used the analysis of Pearson Correlation Coefficient as the details shown in the table 4.16.

Table 4.16 Relationship between knowledges in the electrical energy saving and electricity costs after using the electrical energy saving model through the environmental education process

Variable	Knowledges in electrical energy saving	electricity costs
Knowledges in electrical energy saving	1.000	-0.415(0.013)*
Electricity costs	-0.415(0.013)*	1.000

* had the statistic significance at the .05 level

According to the table 4.16, the relationship between knowledges in the electrical energy saving and the electricity costs after using the developed model, it was found that the coefficient relation value was equal to -0.415. The Sig value was equal to 0.013 and the sample size was equal to 35. The correlation coefficient of variable itself was always equal to 1. Here was the two way probability equal to 0.013 less than 0.05. Therefore, it could be concluded that the knowledge in the electrical energy saving and the electricity costs after the experiment had the negative relationship. When the households got more knowledge, the electrical energy use will be reduced.

According to all information mentioned above, it can be seen that the electrical energy saving through the environmental education process such as the training and knowledge giving on electrical energy saving as well as bringing technologies to help electrical energy saving, the households in Nong Tam Leung municipality could reduce the expenses on electricity costs.

CHAPTER V
DISCUSSION

This study was about the electrical energy saving model in the households through the environmental education process. The purposes of this study were to 1) develop the electrical energy saving model in the households through the environmental education process 2) evaluate the effectiveness of electrical energy saving model in the households through the environmental education process. The study was divided into to study the knowledge level of the energy saving and behaviors on electrical energy saving in the households both before and after getting developed the model, and to study the relationship between the knowledge on electrical energy saving and the electricity costs after having used the developed model. The qualitative analysis was used to evaluate the behaviors of electricity use and the quantitative analysis was used to evaluate the knowledge on electrical energy saving by developing and having trail the mentioned model through the community in Nong Tam Leung municipality, Amata Nakorn Industrial Estate, Pantong District, Chonburi Province, then the data was analyzed. The researcher discussed and reported as the details as follows:

5.1 The study of building the electrical energy saving model in the household through the environmental education process

For the electrical energy saving model in the household through the environmental education process in the households of Nong Tam Leung municipality, Amata Nakorn Industrial Estate, Pantong District, Chonburi Province, the data survey from households in terms of electrical equipment use for the households behaviors about the electricity use, electricity costs in each household was found that most of the households had never participated in the training course in terms of knowledges on

electrical energy saving before at the average of 83.5 and had the electrical energy use in a large quantity at the average of 287.7 units per household. Furthermore, the households had never known about the methods of electrical energy saving from the electric appliances in the household at the average of 60.4 and they had never received news and information about how to preserve the energy at the average of 62.7 and they wanted to access news and information about the electrical energy saving at the average of 87.7%. This is in accordance with the study of Wantanee Wannarat (2000: 72-74) about the construction and trial of training curriculum of environmental education entitled the energy and environmental conservation and in school; case study of Mahidol Wittayanusorn School, Puttamonton District, Nakorn Pathom Province, the research revealed that there were the students who had never participated in the environmental training for 88.89%, participated in the environmental training for 11.11%, and would like to participate in the environmental training at the much level for 56.48%, moderate level for 37.04% and a little level for 6.48%. This indicated that the samples mostly realized the importance of conservation on electrical energy. Therefore, it should organize the training in order to develop this perception to the households for feeling active and participate in environmental conservation which helps change the behaviors in terms of electrical energy use and electrical energy conservation which will be affected through society and nations further.

5.2 Preparation of construction on electrical energy saving model within households through environmental education process

The researcher studied the theories and concepts about the environmental education from the experts of environmental education in order to be used for organizing the environmental education process, such as the study of Winai Weerawattananont and Bancheun Sripanpong (1994: 46-52), the factors for organizing the environmental education of Temduang Rattanatassanee (1996: 131-180), the development of training curriculum on environmental education from the students, such as Beach (1970: 3), Surapol Jantrapat (1986 : 1), Plaung Kumut (1977: 28), and Temduang Rattanatassanee (2008: 184-185) as well as the theories which originated

the learning and change of behaviors on electrical energy saving, such as the theory of knowledge base construction of Tissana Kammanee, et.al., (2005: 65-67), Pannee (1995: 32-35), theory of social culture of Vygotsky and Renshaw (1998: 6-8), instructional principles according to the knowledge base construction of Fosnot (1996: 8-11), instructional conduction according to the knowledge base construction of Yager (1991: 52-57), and the theory about behaviors of human by Bloom (1971: 271), etc to determine the structural model of training together with the data of electrical energy use in households, electrical equipment used in households, behaviors of electrical energy use, and conservation ways of electrical energy as well as creating the learning media of microcontroller learning set of Faculty of Engineering, Kasetsart University (2008) in order to create the control equipment media of electrical energy saving which was considered as a part for controlling the electrical equipment and helped reduce the quantity of electricity costs.

5.3 Development and experiment of electrical energy saving model in the household through the environmental education process

In order to let the control equipment of electrical energy saving constructed was effective before the real use or application, the researcher developed the constructed equipment to let the experts or professionals in terms of technology and engineering investigate by categorizing the data analysis results into 2 sides, which included the design of control equipment of electrical energy saving and use of control equipment of the electrical energy saving before the real experiment in terms of the design of control equipment on the electrical energy saving found that it was appropriate at the much level at the average of 4.2% whereas the use of control equipment on electrical energy saving found that it was appropriate at the much level at the average of 3.6%.

In terms of the contents of training, the research studied the requirement of the households in Nong Tam Leung municipality, Amata Nakhon Industrial Estate, Chonburi province for 351 samples, it was found that most of the households required the news and information about the ways to preserve the electrical energy for 17.9%,

secondly was the ways to use the electrical equipment of each type for 17.5%, as well as the news and information about the audit of electrical energy for 14.5%, the effectiveness of electric appliances for 13.1%, the benefits received from the electrical saving equipment for 12.0%, the advantages and disadvantages of electrical energy preservation for 10.0%, general data about electrical energy for 8.3%, respectively. The researcher create the contents appropriate to the context of households before giving a lecture or training course and proposed the contents to let the experts investigate therefore the contents were correct and appropriate for the trainees, This is in accordance with the research of Sukanya Tantiprasoplap (2001: 112) about the construction and trial of training curriculum of environmental education entitled the electrical energy preservation for the personnel in Ramathibodi Hospital, the research was found that it had better to survey the necessity of training in order to get the comprehensive contents and appropriate with the trainees. Moreover, the research was in accordance with the research of Seri Worapong (2008: 118-120) about the research of integration on environmental education for the teachers in schools at the basic educational level by studying about environments in school and community. The research revealed that the teachers were the person who made the learning matters integrated with the environmental education which would make the average scores of the students achieved the environmental education at the very good level. This research is in accordance with the research of Adnan Midilli et.al., (2006: 3623-3633) about the strategies of clean energies for sustainable development, the research was found that the resolution of environmental problem should be calculated about the energy use from various documents which would indicate the rate of energy use which could show the wastefulness happened by the energy use by considering from the ratio of crucial effects towards the construction of clean energy policy as well as using the beneficial technologies for reducing the effects from the energy use. This research is in accordance with Ramachandra's research, T.V., et.al., (1997: 563-599) which studied about the energy use in the industrial field to be beneficial in Kanataka, India and potentials in energy saving, the research was found that energy was crucial for industrial production. Therefore, it was concluded that the methods about the plan to preserve the energy by improving the effectiveness of equipment and changing the equipment which saved the energy and used it with the most worthiness.

After developing the created model, the researcher trained and gave knowledge about the electrical energy, electrical energy saving and design of control equipment of electrical energy saving to the experimental group for 7 households or around 35 persons for 2 days. For the training course, the researcher also presented the knowledges about electrical energy saving which were up-to-date and appropriate to the context of households in the form of training documents in order to let the sample group be able to publicize through other people. The contents presented for being the learning media in the form of control equipment of electrical energy saving for the sample group to design the time of work control of electrical equipment within households by themselves. For this experiment, the researcher tested knowledges in terms of electrical energy saving and interviewed the behaviors of electricity use before starting the experiment as well as collecting data about electrical use quantity three months back. After finishing the training course, the researcher test the knowledges on electrical energy saving again in order to perceive the knowledge change about the electrical energy saving of the sample group as well as the satisfaction from this training course. Then, the researcher installed the control equipment of electrical energy saving to 7 households of sample groups. After the equipment had been installed for 3 months, the researcher recorded the past electricity use again as well as interviewing the behaviors of electricity use after finishing the test of using the developed model created by the researcher. This is in accordance with the study of Supaporn Songpracha (2009: 113-166) about the model of family ecology for health promotion in households of Nakhon Pathom Province, the research revealed that there was the stage organizing to solve the environmental problems in the members' villages in the households, there was the participation of solving problems about trash in households, there were the members of family mutually analyzed the problems, planned, and took action mutually. Moreover, they reminded to one another. With these mentioned above, they all developed the correct knowledges and made the trash management was solved in better ways.

According to the evaluation of satisfaction which is a method to investigate the way of training course in terms of lecturer, it was found that the lecturers were experts and able to convey the knowledges to the trainees clearly at the much appropriate. Moreover, the training model which consisted of lecture,

demonstration and inquiry of trainees made the atmosphere of training looked friendly and the trainees weren't bored, giving the opportunity for the trainees to ask the questions, and places for training arrangement were much appropriate. This was because the conference room used was just established belonged to the Nong Tam Leung Municipality; therefore it was convenient in terms of facilities such as air-conditioner, audio visual equipment, and learning materials. For it was the new room, however, its smell of paint color still existed and this might cause the obstruction of learning atmosphere. For the perception of the trainees, it was at the much appropriate level. The trainee could identify the advantages and benefits of training course. For applying knowledges, it was at the much appropriate level as well. The trainees could bring the knowledges got to develop themselves and convey to other people which would lead to electrical energy saving in the household further.

5.4 The evaluation result of effectiveness of electrical energy saving model in the household through the environmental education process.

According to the effectiveness evaluation of electrical energy saving model in the household through the environmental education process, it's included:

5.4.1 The results got from the knowledge score test and compared with the score both and after the experiment by using the model to the households as control group who never got knowledges (without answering the answers of the test both before and after using the test model), the result found that before the experiment, the average of knowledge scores were equal to 11.08, the standard deviation was 3.02, and after the experiment, the average of knowledges score was equal to 11.11, the standard deviation was 2.95, when brought the average scores of both groups to compare to each other and analyzed by using the t-test , the result found that the average scores both before and after the experiment, the control group had the difference by having no statistical significance at 0.05 level. This suggested that the knowledges in the electricity saving of the households for control group had no alteration during the time of the study. This result is in accordance with the research of Sutticha Boonyamanee (2000: 72) who studied about the construction and trial of

supplemental reading book entitled "electrical energy saving in the house" for Mattayomsuksa 6 students, the study result found that both groups of students were equal in term of basic knowledges about electrical energy saving in household by statistic significance at 0.05 levels.

5.4.2 The results got from the knowledges score and comparison of the score before and after the experiment of using the model to the households as the experimental group who got knowledges (without answering the questions of the test both before and after the experiment of using the model), the results found that before the experiment, the average knowledge score was equal to 11.31, the standard deviation was 2.80 whereas after the experiment the average knowledge score was equal to 23.80, the standard deviation was equal to 1.99. When comparing the average score of both groups and analyzing by using t-test, it was found that the average score before and after the sample group was different by statistical significance at 0.05 levels. This indicated that the electrical energy saving model in the household could increase the knowledges level of electrical energy saving in households by having significance. This is in accordance with the study of Sutticha Boonyamanee (2000: 72) about the construction and trial of supplementary reading book entitled "electrical energy saving in the house" for Prathomsuksa 6 students, the study found that the students who tried reading the supplementary reading book of electrical energy saving in the house increased their knowledges by statistic significance at 0.05 level. This is in accordance with the research of Sukanya Tantiprasoplarp (2001: 105-106) about the construction and trial of training curriculum on environmental education entitled the conservation of electrical energy for the personnel in Ramathibodi Hospital, the research found that the personnel in the hospital who tried using the training curriculum of environmental education in terms of conservation on electrical energy increased their knowledges by statistic significance at 0.05 levels.

5.4.3 The results got from the test of knowledges score and the knowledge comparison about the electrical energy saving of the control group (didn't' get knowledge) and the experimental group (got knowledge). After the experiment, it was found that the control group had the average knowledge score equal to 11.11, the standard deviation was 2.95, and the experimental group had the average knowledge

equal to 23.80%, the standard deviation was 1.99%. When brought the average scores of the both groups to compare to each other, analyzed the data by using t-test, it was found that the average scores after the experiment of control group and experimental group was different by statistic significance at 0.05 level. This indicated that the electrical energy saving model in the household could increase the knowledges of electrical energy saving in households significantly. This is in accordance with the research of Wantanee Wannarat (2000: 90-91) who studied the construction and experiment about training curriculum of environmental education entitled the energy and environmental preservation in school: Case Study of Mahidol Wittayanusorn Scgool, Phuttamonton District, Nakorn Pathom Province, the research was found that the average scores after training of the trainees had the value higher than the average scores of the persons who didn't participate the training course by statistic significance at 0.05 level. This is also in accordance with the research of Sopida Pattanaporn (1997: 131-133) about the construction and trial of training curriculum on environmental education entitled the preservation of coast resources for the teachers at secondary school levels: Case Study of Ranong Province, the research was found that the average scores of the trainees after getting the training course had the scores higher than before getting the training by statistic significance at 0.05 level.

5.4.4 The behaviors in electrical energy use at the household level of experimental group before and after the trial of model, it was found that the behaviors of electricity use both before and after the training through the interview, the sample had the behaviors of using the electrical equipment in the way of reducing the electric energy more than the past time. The behaviors which were changed after getting the training were as follows:

1) The sample turned on the electrical equipment when they had to use only, for example, the computer and electric bulb use; before getting the training, there was the turned on and left without use or when it had to be used in a short time, however, after the training, the samples turned off the various equipment every time when they didn't use the it.

2) The sample tried to use the substituted equipment which could reduce the electrical energy use, such as changed the computer use from table computer to notebook, used fan instead of air-conditioner, chose the stick electric bulb

instead of normal electric bulb, cooked rice by microwave instead of warmed rice in the rice cooker, used the steam iron instead of normal iron, etc.

3) The sample used various equipment appropriate and directed to characteristics of use, for example, kettle; before participating in training, the sample usually filled the water fully but after participating the training course, they filled the water according to the real need, or another example; for refrigerator use, the sample put stuff not too much and melted the ice, and for the washing machine, the sample soaked clothes before washing them for the washing machine of two buckets and they would not soak the clothes and leave them in the one bucket of washing machine. For using the iron, the sample would iron the clothes in a large quantity continuously instead of ironing only a few pieces or bit by bit. Also the water level set of the water heater, the sample would set the low level instead of turning on the water in the strongest level, and unplugged when the rice cooker is ripe, etc.

4) The sample used the various equipment as necessary, such as air-conditioner, it was found that the samples after participating the training course had the behaviors of using air-conditioner less both turning on in a shorter time and opening the window to help ventilate the air instead of using the air-conditioner, turned on the electric bulb only in the room used, opened the refrigerator only when the sample had to pick up or put the stuff.

5) The sample unplugged or switched off after use every time after having participated, such as rice cooker, kettle, water pump, or fan, etc. For television use, before getting training, the sample usually turned off the electricity equipment by using the remote control but after the training, the sample changed their behaviors by turning off the television by switching off instead.

It can be seen that the developed model and the experiment used with the leaders of households could make the change through the use behaviors of electric appliances in the better way. This is in accordance with the research of Cook (1996: 972) who studied the behaviors of energy preservation of families participating in the check service of energy in the households, the research revealed that the family which had the knowledges about energy preservation realized the benefits of energy preservation, the house owners were the main persons for preserving the energy. This is also in accordance with the research of Somjit Buates (1998: 106) who studied the

behaviors of energy preservation of primary level students under the Bangkok Primary Education Service Area Office; it was found that most of the students had the attitudes of energy preservation at a much level. When considering in details, it was found that most of the students had the attitudes about the electric appliances use in a kind of television, refrigerator, electric bulb, light bulb to save the energy the most because these electric appliances involved with the daily life of the students the most and the students were embedded about the attitudes in terms of using the electric appliances to be save the energy from their parents who gave them the suggestions and moral supports. Moreover, the media such as television which had the campaign to promote and publicize the energy preservation until it was collected to be the knowledges of energy preservation very much and it made the result of good attitudes towards the energy preservation more. This is also in accordance with the research of Jullada Chaihuadcharearn (2536: 73) studied the factors influencing the behaviors of electrical energy saving in households of the housewives in Bangkok metropolitan area. The research result found that the housewives who had different careers, educational level, family monthly incomes, expenses of monthly electricity costs, time period of residence living, and residence areas had no the difference on the behaviors of electricity saving in households by statistical significance. In addition, this was in accordance with the research of Weera Teerawongsakul (1997: 104-106) about the study of knowledges and behaviors of energy electricity saving in the households of people in Muang Lampang Municipality, the research was found that people who had the different average monthly incomes of households, monthly electricity costs expenses, perception of news and information had no difference about the behaviors on the electrical energy saving in households by statistical significance. Moreover, the relationship between the knowledges and behaviors of electrical energy saving in households had the positive relationship by statistic significance at .01k level. This is also in accordance with the research of Sirirat Uppatinket (2001: 88-91) about the study of behaviors on electrical energy saving of the Mattayomsuksa 6 students in Nakhonratchasima Municipality, Nakhonratchasima province, the research revealed that the attitudes about electrical energy saving of news and information about the electrical energy saving from personal media and the receiving of news and information about the electrical energy saving from media had the positive results

towards the behaviors of electrical energy saving by statistic significance at .05 level. In addition, this is in accordance with the research of Pawana Wacharasatian (2002: 71-72) which was about the study of electrical energy saving in the personnel office of Thammasat University, the research was found that the personnel of Thammasat University had the different knowledges about the electrical energy saving of the National Energy Policy Office differently by having the behaviors of electrical energy saving in the office differently by statistic significance at the .05 degrees. This is because when the households knew the ways to save the electrical energy saving correctly, therefore, they could apply all knowledges in their daily life correctly.

5.4.5 The comparison of electricity costs before and after the experiment by using the model which the researcher developed; before the experiment, there were the average of electricity costs equal to 521.1 units per months whereas after the experiment, the model developed by the researcher had the average of electricity costs equal to 425.5 units per months, the research revealed that the households reduced the electricity use at the average of 68.5 units per months for 13.14%, averagely whereas the relationship between the knowledges about the electrical energy saving and electricity costs after the experiment of using the developed model , it was found that the coefficient relation value was equal to -0.415, and the value of Sig was equal to 0.013, the sample size was equal to 35, the correlation coefficient of the variables was equal to 1 always. Here, the two ways probability which could be calculated was equal to 0.013 which was less than 0.05. This can be concluded that the knowledges in the electrical energy saving and the electricity costs after the experiment had the negative relation, when the households got more knowledge, the electrical energy use would be decreased.

In conclusion, the electrical energy saving model in the household through the environmental education process created by the researcher affected the energy saving of the households in Nong Tam Leung Municipality in Amata Nakorn Industrial Estate, Pantong District, Chonburi Province. The households could bring the knowledges and ways of electrical energy saving got to apply in the daily life of their own, also they could be the medium to spread and convey their knowledges to other persons who were involved with. Furthermore, this could help the country save the expenses of electrical production and reduced the environmental destruction as well.

CHAPTER VI
CONCLUSION AND RECOMMENDATIONS

This research was about the study of electrical energy saving model in the household through the environmental education process. The purposes of this research were to:

1) Develop the electrical energy saving model in the household through the environmental education process

2) Evaluate the effectiveness of electrical energy saving model in the household through the environmental education process. This was considered by:

2.1) The knowledges level of energy saving and behaviors in the electrical energy saving in the household before and after receiving the developed model.

2.2) The relationship between the knowledges of electrical energy saving and electricity costs after using the developed model.

The researcher used the model of qualitative analysis for evaluating the behaviors of electricity use and used the quantitative analysis for evaluating the knowledges in electrical energy saving. The conclusions and recommendations could be concluded as follows:

6.1 Target population and sample group

1) The population for this research was 3,782 households in Amata Nakorn Industrial Estate, Nong tam Leung Sub-district Municipality, Pantong District, Chonburi Province.

2) The sample group used for collecting data about the electrical energy use was the households of Nong Tamleung Sub-district Municipality in Amata Nakorn Industrial Estate, Pantong District, Chonburi Province for 351 samples. The research

was carried out by interviewing 351 leaders of households. The sample size was got from the instant Table of Robert V.Krejcie and W. Morgan (Raweewan Chinatrakul, 1999: 111), then randomized by the method of systematic random sampling.

3) The sample group used for the experiment was 14 households of Nong Tam Leung Municipality which had the members in each household in total from all 351 samples. The samples selection was used by purposive sampling. The sample group was divided into 2 groups, 7 households for each group. The control group and the experimental group used the electrical energy saving model in the household through the environmental education process and the control equipment electrical energy saving in the households.

6.2 The instruments used for the research

The instrument used for the research, the researcher divided the data collection into 2 parts which included the Review Data and Field Data. There were 5 types of data collection by Field Data which included the questionnaire in terms of electrical energy use in the household, quality evaluation form of the control equipment of electrical energy saving, test form for knowledge measurement of electrical energy saving in the household, interview form of behaviors and quantity of electricity use in households and the evaluation form of satisfaction of the trainees.

6.3 Research Methodology

This research divided the methodology to be 4 stages as follows:

Stage 1: The study of households data for analyzing the requirements and electrical energy use

Stage 2: The development of electrical energy saving model in the household through the environmental education process

Stage 3: The using experiments of electrical energy saving model in the household through the environmental education process

Stage 4: Conclusion, analysis, and discussion the data got from the research

6.4 Data analysis

The data of research consisted of both qualitative and quantitative data. The researcher chose the analysis methods in several ways including the data analysis by using the document analysis, descriptive analysis by using the explanation of average amount and percentage of the sample group, t-test Independence used in the comparison of knowledge both before and after the experiment and the statistical analysis by Pearson Correlation Coefficient used in the analysis of finding the relationship between the electricity cost and knowledges of electricity use.

6.5 Research conclusion

6.5.1 Electrical energy use in households

According to the survey results of households in Nong Tam Leung Municipality in Amata Nakorn Industrial Estate, Pantong District, Chonburi Province, it was found that most of them were female for 80.3%, age between 41-60 years old for 61.5%, marital status was married for 58.1%, most of them had the career of being employed in general work for 39.5%, most of them had been living in this village for 21 years up for 78.3%, they had never been trained sine 2 years past for 83.5%, the family members living in each household were 4 persons averagely, they used the electrical equipment in various kinds including the electric bulb in each household, most of them had 16-30 electric bulbs for 66.1%, 2 television used in each household for 55.3%, 1 refrigerator in each households for 33.3% 2 fans in each household for 41.1%, 1 air-conditioner in each household for 39.3%, 1 computers in each household for 61.5%, 1 rice cooker in each household for 72.6%, 1 electric hot pot in each household for 77.8%, 1 iron in each household for 67%, 1 microwave in each household for 75.5%, 2 VCD and DVD in each household for 70.4%, 2 radios in each household for 94.6%, 1 washing machine in each household for 86.6%, no water

heaters in each household for 67.8.%, 1 water pump in each household for 75.8%, 1 hair dryers in each household for 78.9%, and the electricity costs in average which had the large quantity of usage in the last 3 months for 287.8 units/households.

6.5.2 Behaviors of electrical energy use and the ways of electrical energy preservation

According to the survey result of households in the Nong Tam Leung Municipality in the Amata Nakorn Industrial Estate, Pantong District, Chonburi Province, the research was found that most of them didn't know the ways to save the electricity costs from the electric appliances in households for 60.4%, and they knew the ways to save the electricity costs for 39.6%, most of them who knew the ways save the electricity energy by turning off the light when there was unnecessary use but only in terms of the electric bulb. Whereas the persons who didn't know because they thought that they had to use the equipment according to the necessity towards the usage which it probably has already saved the energy. When classified the behaviors of electrical energy use according to the electric appliances of each kind, it could be classified into:

1. Light and electricity use, it was found that most of the households turn on the light unnecessarily sometimes at the average of 44.7%, used the stick electric bulb always at the average of 69.8%, turned on the light only when it was required sometimes at the average of 47.3%, plugged in the electrical equipment and left it sometimes at the average of 47.9%, never been checked and cleaned the electric bulb at the average of 46.4%.

2. Iron use, it was found that most of the households regularly plugged in the iron unnecessarily at the average of 39%, and ironed the clothes for large amount quantities sometimes at the average of 47%.

3. Refrigerator use; it was found that most of the households regularly turned on and off the refrigerator unnecessarily at the average of 46.2%, put on too much stuff in the refrigerator sometimes at the average of 47.9%.

4. Rice cooker use; it was found that none of the households turned on the rice cooker while cooking regularly at the average of 87.2 %, never cooked rice in the air-conditioning room at the average of 100.0 %.

5. Television use, it was found that most of the households, the television was turned on while they were sleeping or they didn't watch it regularly at the average of 47.9%, turned off the television from the remote control sometimes at the average of 46.4%, never set the off-time for the television at the average of 45%.

6. Radio; it was found that most of the households turned on the radio while unnecessary use for sometimes at the average of 44.4%, turn off the radio from the remote control for sometimes at the average of 50.1%, and never set the off-time of the radio at the average of 49.9%.

7. Fan; it was found that most of the households turned on the fan and left it without using sometimes at the average of 45.3%, placed the fan in the comfortable air ventilation sometimes at the average of 51.6%.

8. Air-conditioner use, it was found that most of the households never turned on the air-conditioner when no one was in the room at the average of 44.4, never turned off the air-conditioner at the temperature lower than 25 degree celcius at the average of 46.2 %, never opened the door while the air-conditioner is turned on at the average of 63.5 %, never turned off the air-conditioner before stopping working for 15 minutes at the average of 74.9 %.

9. Electric kettle; it was found that most of the households never plugged in the electric kettle for a long time at the average of 52.7%, put on water in the electric kettle in the large quantity regularly at the average of 49.5%, never used the cool water for boiling at the average of 79.8%.

10. Computer; it was found that most of the households never turned on the computer without using at the average of 53.3%, never set the time of screen saver at the average of 57.8%, unplugged when there was no using regularly at the average of 79.2%.

11. Water pump; it was found that most of the households turned on the water pump regularly at the average of 52.7%, turned off the water pump but not tight or the water still dropped regularly at the average of 47.8%, used the shower for having shower regularly at the average of 53.0%.

12. Water heater; it was found that most of the households never turned on the water heater all the time when having a shower at the average of 74.3%, never set the maximum water pressure for having a bath at the average of 69.2%.

13.Washing machine; it was found that most of the households soaked clothes before washing sometimes at the average of 49.3%, set the program of washing to be appropriate to the kind of clothes sometimes at the average of 49%

6.5.3 News and information as well as the knowledges about the electrical energy preservation

According to the survey of households in Nong Tam Leung Municipality in Amata Nakorn Industrial Estate, Pantong District, Chonburi Province, it was found that most of the households had never got news and information about the energy preservation at the average of 62.7% and there was the requirement of news and information about the preservation and energy saving at the high level by dividing it into various issues as follows: Ways to preserve the electrical energy for 17.9%, ways to use the electrical equipment in each kind for 17.5%, news and information about the audit of electrical energy for 14.5%, effectiveness of electric appliances for 13.1%, advantages and disadvantages of electrical energy preservation for 10%, general data about electrical energy for 8.3%, the roles of people for preserving the electrical energy for 14.5%.

6.5.4 Development of electrical energy saving model in the household through the environmental education process

According to the survey, the researcher developed the equipment created for letting the technological and engineering professions investigate by categorizing the data analysis results which could be divided into 2 aspects which included the design of control equipment of electrical energy saving and in terms of use of control equipment electrical energy saving before the real experiment for designing the control equipment of electrical energy saving, the result found that it was at the much appropriate level with the average of 4.2%, whereas in terms of usage of the control equipment of electrical energy saving, it was found it was at the much appropriate lever with the average of 3.6%.

6.5.5 The comparison of knowledge of households in the electrical energy saving in the household of the control group who had never got the additional knowledges from the previous time before the experiment and after the experiment for 35 persons, it was found that the average scores knowledge test in the electrical energy

saving of control group who had never had the knowledge at all before the experiment and after the experiment had the nearly value, which was, 11.08 and 11.11, respectively. When brining the average scores of both groups to compare to each other by using t-test, it was found that the average scores before an after the control group was different by no statistical significance at 0.05 level. It indicated that the knowledges in electricity saving of households control group had no change in the time period of the study.

6.5.6 The comparison of knowledge of households in the electrical energy saving of the household for the experimental group who have got the additional knowledges from them previous time before and after the experiment for 35 persons, the results found that the average scores knowledge test in the electrical energy saving of experimental group before the experiment (had never got knowledges) and after the experiment (got knowledges) had the different value, which was 11.31 and 23.80, respectively. When brought the average scores of the both groups to compare to each other by using the t-test, it was found that the average scores of the households experimental group got more knowledges by statistical significance at 0.05 level. This suggests that the electrical energy saving model in the household could increase the level of knowledges in terms of electricity saving in households by statistical significance.

6.5.7 The comparison of knowledge of households in the electrical energy saving for the household of experimental group (got knowledge) and control group (never got knowledges) after the experiment for 70 persons, it was found that the average scores knowledge test in the electrical energy saving of the control group (never got knowledges) and the experimental group (got knowledge) after the experiment had the different value, which was, 11.11 and 23.80, respectively. When brought the average scores of both groups to compare to each other using the t-test, the result found that the average scores of the households for the experimental group got more knowledge than the control group by statistic significance at 0.05 level. This suggests that the model of giving knowledge could increase the level of knowledge in terms of electricity use in households by statistical significance.

6.5.8 The behaviors in the electrical energy use at the household level which was changed from the test use in terms of saving the electrical energy in the household through the environmental education process, the result found that the sample group had the behaviors of electrical equipment use in the way which could help saving the electricity more by being able to conclude the behaviors which had the change as follows: turned on the electrical equipment as much as using, selected the substitute equipment to reduce the electrical energy use, used the various equipment to be appropriate and direct to the characteristics of using various equipment when only necessary and unplugged or switched off after using.

6.5.9 The satisfaction of training project of electrical energy saving model in the household through the environmental education process evaluated various kinds of aspects which could be evaluated as follows:

Lecturer: the trainees gave the opinion that the conveying knowledges of the lecturers was clearly, the lecturer could explain and linked the contents completely and used time in accordance with the time required as well as answering the questions clearly as overall image at the much level.

Place, time and food: the trainees gave the opinion that the place was clean and appropriate as well as having the readiness of the audio visual equipment, used the time of training sufficiently, and the food was appropriate as overall image at the much level.

Perception: it was found that the trainees had the perception in this points increasingly after the training and could explain the benefits, advantages or explained the details, organized the idea system/processed the ideas to the development systematically, and could integrate the concept to the team work/personnel adaptation/revolution of work system for the operation as overall image at a much level.

Knowledge application, it was found that the trainees could apply the knowledges got to be used in the electrical energy saving in the household, could bring the knowledge to publicize/convey to the community and could give the consultancy to the colleagues as well as applying the knowledges as overall images at the much level.

6.5.10 Quantity of electricity use in the households, it was found that during before the experiment, the average of electricity costs was equal to 521.1 units per months whereas after the experiment, the model which was developed by the researcher had the electricity costs averagely was equal to 425.5 units per months, it was found that the households reduced to use the electricity at the average of 68.5 units per months at the average of 13.14%.

6.5.11 Relationship between knowledges in the electrical energy saving and the electricity costs after using the developed model, it was found that the relationship between knowledges in the electrical energy saving and the electricity costs after the developed model, it was found that the coefficient relation value was equal to -0.415, the Sig was equal to 0.013 and the sample size was equal to 35 by using correlative coefficient of the variables was equal to 1 always. Here, the probability in the two ways which could be calculated was equal to 0.013 which was less than 0.05. This could be concluded that the knowledges in the electrical energy saving and electricity costs after the experiment had the negative relationship, which was, when the households got more knowledge, it would reduce the electrical energy use.

6.6 Recommendations

6.6.1 Recommendations from research result

6.6.1.1 According to the research result, it was found that electrical energy saving model in the household through the environmental education process could increase knowledge of electricity use through people and could reduce the electricity use very well. Thus, the related organizations or various communities can apply these development ways of training model to give knowledges to the community for the energy saving.

6.6.1.2 Not only building the knowledge of electricity use correctly, changing the behaviors of electrical energy saving, and reducing the electricity costs, the research also found that the ways to conserve electricity very well must bring the technology in electrical energy saving to be used together.

6.6.1.3 Currently, the problem of high quantity use of electrical energy is still the chronic problem and it is well recognized that its effects are severe and will become the serious disaster, such as air pollution, global warming, consciousness building in the electrical energy saving in the household through the environmental education process, this will be the important part. According to this research, the governmental organizations should support the application seriously and determine it to be the National Agenda because the environmental education is the sustainable ways more than the technological use of energy saving by starting at the leader of households first so that it will be the sustainably intrusive problem solving participated by the community really.

6.6.1.4 The crucially environmental problem all over the world being interested is the global warming. The sustainable ways to solve the problems are to create the consciousness towards resource uses savely and valuably, or it should campaign to have the friendly products with the environments. Therefore, it should have the organizations do the campaign of electrical energy saving model in the household through the environmental education process for the activities further.

6.6.2 Recommendations for further research

6.6.2.1 According to the research results, to bring the electrical energy saving model in the household through the environmental education process was effective, therefore it should bring this model to have a further research by using in other regions which have the problems in terms of electrical energy use, such as, in the central region, it may use technologies which control the work of electrical equipment in the big building, etc.

6.6.2.2 Not only giving knowledge about the electrical energy saving in the house through the environmental education process, but also apply the various energies saving, such as water saving, oil saving, etc.

6.6.2.3 It should bring this model that can apply to be the Computer Assisted Instruction for increasing knowledge to save the electric energy.

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APPENDICES

APPENDIX A
TOOLS USED ON THE RESEARCH

แบบสอบถาม
เรื่อง การใช้พลังงานไฟฟ้าภายในบ้าน

<u>คำชี้แจง</u>

    แบบสอบถามนี้เป็นส่วนหนึ่งของการศึกษาวิจัยเรื่อง รูปแบบการประหยัดพลังงานไฟฟ้าภายในบ้าน โดยผ่านกระบวนการสิ่งแวดล้อมศึกษา โดยมีวัตถุประสงค์เพื่อศึกษาข้อมูลทั่วไปเกี่ยวกับการใช้พลังงานไฟฟ้าใน ครัวเรือน พฤติกรรม การใช้พลังงานไฟฟ้า แนวทางการอนุรักษ์พลังงานไฟฟ้า และการได้รับข่าวสารและความรู้ เรื่องการอนุรักษ์พลังงานไฟฟ้า

    การวิจัยครั้งนี้เป็นส่วนหนึ่งของการทำวิทยานิพนธ์ของนักศึกษาระดับปริญญาเอกสาขาวิชา สิ่งแวดล้อมศึกษา คณะสังคมศาสตร์และมนุษยศาสตร์ มหาวิทยาลัยมหิดล เพื่อนำผลการวิจัยไปใช้เป็นแนวทาง ในการแก้ไขปัญหาการใช้พลังงานไฟฟ้าของครัวเรือนเทศบาลตำบลหนองตำลึง เขตนิคมอุตสาหกรรมอมตะนคร จังหวัดชลบุรี ให้เป็นไปอย่างเหมาะสม

    แบบสอบถามชุดนี้มี 4 ตอน คือ

  <u>ตอนที่ 1</u> ข้อมูลทั่วไปของผู้ตอบแบบสอบถาม

  <u>ตอนที่ 2</u> ข้อมูลทั่วไปเกี่ยวกับการใช้พลังงานไฟฟ้าในครัวเรือน

  <u>ตอนที่ 3</u> พฤติกรรม การใช้พลังงานไฟฟ้า และแนวทางการอนุรักษ์พลังงานไฟฟ้า

  <u>ตอนที่ 4</u> การได้รับข่าวสารและความรู้เรื่องการอนุรักษ์พลังงานไฟฟ้า

  วิธีตอบแบบสอบถาม

1. ทำเครื่องหมาย ✓ ลงใน ( ) หน้าคำตอบที่ท่านต้องการในคำถามแต่ละข้อ

2. เติมคำตอบลงในช่องว่างที่เว้นไว้หลังคำถามแต่ละข้อ

3. กากบาททับหมายเลข ที่ท่านต้องการมากที่สุด

ข้อมูลเหล่านี้นำมาเพื่อใช้ทำการศึกษาวิจัยเท่านั้นและจะปิดเป็นความลับ

        ขอขอบพระคุณทุกท่านอย่างสูงที่ได้ให้ความอนุเคราะห์

            นายธราดล เทพอารีนันท์

          นักศึกษาปริญญาเอก สาขาสิ่งแวดล้อมศึกษา

           คณะมนุษศาสตร์และสังคมศาสตร์

             มหาวิทยาลัยมหิดล

<u>ตอนที่ 1 ข้อมูลทั่วไปของผู้ตอบแบบสอบถาม</u>

คำชี้แจง โปรดทำเครื่องหมาย (✓) หรือเติมคำลงในช่องว่างที่ตรงกับข้อเท็จจริง
ที่เกี่ยวกับตัวท่านมากที่สุด

1. เพศ   (   ) ชาย   (   ) หญิง

2. อายุ   (   ) ต่ำกว่า 20 ปี   (   ) 21 - 40 ปี
                 (   ) 41- 60 ปี   (   ) 61 ปีขึ้นไป

3. สถานะในครอบครัว
                 (   ) เป็นหัวหน้าครอบครัว   (   ) คู่สมรส
                 (   ) พี่น้อง ลูกหลาน   (   ) ผู้อาศัย

4. ระดับการศึกษา
                 (   ) ประถมศึกษา   (   ) มัธยมศึกษา
                 (   ) อนุปริญญา, ปวช., ปวส.   (   ) ปริญญาตรีหรือสูงกว่า

5. ท่านอาศัยอยู่ในชุมชนนี้ มาเป็นเวลานานเท่าใด
                 (   ) ต่ำกว่า 5 ปี   (   ) 5 - 10 ปี   (   ) 11 - 15 ปี
                 (   ) 16 - 20 ปี   (   ) 21 ปีขึ้นไป

6. ในระยะ 2 ปีที่ผ่านมาท่านเคยเข้ารับการฝึกอบรมความรู้เกี่ยวกับการประหยัดพลังงานไฟฟ้าหรือไม่
                 (   ) ไม่เคย
                 (   ) เคยจำนวน ....ครั้ง
                         ครั้งที่ 1 เรื่อง...
                         ครั้งที่ 2 เรื่อง...

<u>ตอนที่ 2 ข้อมูลทั่วไปเกี่ยวกับการใช้พลังงานไฟฟ้าในครัวเรือน</u>

คำชี้แจง โปรดทำเครื่องหมาย (✓) หรือเติมคำลงในช่องว่างที่ตรงกับข้อเท็จจริง
ที่เกี่ยวกับตัวท่านมากที่สุด

1. บ้านของท่านมีอุปกรณ์ไฟฟ้าชนิดใดบ้าง ปริมาณเท่าไร (ตอบได้มากกว่า 1 ข้อ)

(   ) หลอดไฟฟ้าธรรมดา .... หลอด

(   ) หลอดตะเกียบประหยัดไฟ .... หลอด

(   ) โทรทัศน์ .... เครื่อง

(   ) ตู้เย็นธรรมดา .... เครื่อง

(   ) ตู้เย็นประหยัดไฟเบอร์ 5 .... เครื่อง

(   ) พัดลม .... เครื่อง

(   ) พัดลมเบอร์ 5 .... เครื่อง

(   ) เครื่องปรับอากาศ .... เครื่อง

(   ) เครื่องปรับอากาศเบอร์ 5 .... เครื่อง

(   ) คอมพิวเตอร์ .... เครื่อง

(   ) หม้อหุงข้าว .... เครื่อง

(   ) หม้อต้มน้ำร้อน .... เครื่อง

(   ) เตารีด .... เครื่อง

(   ) ไมโครเวฟ .... เครื่อง

(   ) วีซีดี,ดีวีดี .... เครื่อง

(   ) วิทยุ .... เครื่อง

(   ) เครื่องซักผ้า .... เครื่อง

(   ) เครื่องทำน้ำอุ่น .... เครื่อง

(   ) เครื่องปั๊มน้ำ .... เครื่อง

(   ) เครื่องเป่าผม .... เครื่อง

(   ) เตาอบไฟฟ้า .... เครื่อง

2. ปริมาณค่าไฟฟ้าที่ท่านจ่ายย้อนหลัง 3 เดือนปริมาณเท่าไร

ย้อนหลัง 1 เดือน ....หน่วย

ย้อนหลัง 2 เดือน ....หน่วย

ย้อนหลัง 3 เดือน ....หน่วย

<u>ตอนที่ 3 พฤติกรรมการใช้พลังงานไฟฟ้า และแนวทางการอนุรักษ์พลังงานไฟฟ้า</u>

คำชี้แจง โปรดทำเครื่องหมาย (✓) หรือเติมคำลงในช่องว่างที่ตรงกับข้อเท็จจริง
ที่เกี่ยวกับตัวท่านมากที่สุด

1. ท่านรู้วิธีประหยัดค่าไฟฟ้าจากเครื่องใช้ไฟฟ้าในบ้านท่านหรือไม่ อะไรบ้าง

   (   ) รู้ ระบุ..

   ....

   ....

   ....

   (   ) ไม่รู้ ………………………………………………………………………………

2. ท่านเคยมีพฤติกรรมการใช้พลังงานไฟฟ้าดังต่อไปนี้หรือไม่ มากน้อยเพียงใด

พฤติกรรมการใช้พลังงานไฟฟ้า	ความถี่ที่ใช้		
	เป็นประจำ	เป็นบางครั้ง	ไม่เคย
ไฟฟ้าและแสงสว่าง			
1. เปิดไฟทิ้งไว้โดยที่ไม่ได้ใช้งาน			
2. ใช้หลอดตะเกียบประหยัดไฟ			
3. เปิดไฟฟ้าเฉพาะที่ต้องการใช้เท่านั้น			
4. เสียบปลั๊กอุปกรณ์ไฟฟ้าทิ้งไว้			
5. ตรวจสอบและทำความสะอาดเครื่องใช้ไฟฟ้า			
เตารีด			
6. เสียบปลั๊กเตารีดทิ้งไว้ขณะที่ไม่ใช้งาน			
7. รีดผ้าทีละมากๆ			
ตู้เย็น			
8. เปิด-ปิดตู้เย็นเกินความจำเป็น			
9. ใส่ของในตู้เย็นจนเต็ม			

พฤติกรรมการใช้พลังงาน	ความถี่ที่ใช้		
	เป็นประจำ	เป็นบางครั้ง	ไม่เคย
หม้อหุงข้าว			
10. เปิดฝาหม้อหุงข้าวดูขณะหุงข้าว			
11. หุงข้าวในห้องเครื่องปรับอากาศ			
12. เสียบปลั๊กหม้อหุงข้าวทิ้งไว้			
โทรทัศน์			
13. เปิดทีวีทิ้งไว้ในขณะนอนหลับหรือไม่ใช้งาน			
14. ปิดทีวีจากรีโมท			
15. ตั้งเวลาปิดทีวี			
วิทยุ			
16. เปิดวิทยุทิ้งไว้ขณะที่ไม่ใช้งาน			
17. ปิดวิทยุจากรีโมท			
18. ตั้งเวลาปิดวิทยุ			
พัดลม			
19. เปิดพัดลมทิ้งไว้ขณะที่ไม่ใช้งาน			
20. ตั้งพัดลมไว้ในที่อากาศถ่ายเทสะดวก			
เครื่องปรับอากาศ			
21. เปิดเครื่องปรับอากาศทิ้งไว้ เมื่อไม่มีใครอยู่ในห้อง			
22. เปิดเครื่องปรับอากาศที่อุณหภูมิต่ำกว่า 25 องศา			
23. เปิดประตูห้องทิ้งไว้ขณะเปิดเครื่องปรับอากาศ			
24. ปิดเครื่องปรับอากาศก่อนเลิกใช้งาน 15 นาที			
กาต้มน้ำ			
25. เสียบปลั๊กกาต้มน้ำร้อนทิ้งไว้เป็นเวลานาน			
26. ใส่น้ำในกาต้มน้ำปริมาณมากๆ			
27. ใช้น้ำเย็นในการต้มน้ำ			
คอมพิวเตอร์			
28. เปิดคอมพิวเตอร์ทิ้งไว้โดยไม่ใช้งาน			
29. ตั้งเวลาพักหน้าจอ			
30. ถอดปลั๊กออกเมื่อไม่ใช้งาน			

พฤติกรรมการใช้พลังงาน	ความถี่ที่ใช้		
	เป็นประจำ	เป็นบางครั้ง	ไม่เคย
ปั๊มน้ำ 31. เปิดปั๊มน้ำทิ้งไว้ 32. ปิดก๊อกน้ำไม่สนิทหรือทำน้ำหยด 33. ใช้ฝักบัวอาบน้ำ			
เครื่องทำน้ำอุ่น 34. เปิดเครื่องทำน้ำอุ่นตลอดเวลาในการอาบน้ำ 35. ตั้งแรงดันน้ำสูงสุดในการอาบน้ำ			
เครื่องซักผ้า 36. แช่ผ้าก่อนเข้าเครื่องซัก 37. ตั้งโปรแกรมซักให้เหมาะสมกับชนิดผ้า			

<u>ตอนที่ 4 การได้รับข่าวสารและความรู้เรื่องการอนุรักษ์พลังงานไฟฟ้า</u>

คำชี้แจง โปรดทำเครื่องหมาย (✓) หรือเติมคำลงในช่องว่างที่ตรงกับข้อเท็จจริง

       ที่เกี่ยวกับตัวท่านมากที่สุด

1. ท่านเคยได้รับข่าวสารเกี่ยวกับการอนุรักษ์พลังงานไฟฟ้าหรือไม่

        (   ) เคย   (   ) ไม่เคย   (ข้ามไปตอบข้อ 3)

2. ท่านเคยได้รับข่าวสารเกี่ยวกับการอนุรักษ์พลังงานไฟฟ้าจากสื่อใดต่อไปนี้ (ตอบได้มากกว่า 1ข้อ)

        (   ) โทรทัศน์

        (   ) วิทยุ

        (   ) หนังสือพิมพ์

        (   ) นิตยสาร / วารสาร

        (   ) เอกสารจากทางราชการ

        (   ) แผ่นพับ / ใบปลิว

        (   ) เพื่อนบ้าน

        (   ) ญาติพี่น้อง / บุคคลในครอบครัว

        (   ) เจ้าหน้าที่ของหน่วยงานราชการ

        (   ) อื่น ๆ (ระบุ) ....

3. ท่านต้องการได้รับข่าวสารเกี่ยวกับการอนุรักษ์พลังงานไฟฟ้าเพิ่มเติมหรือไม่

        (   ) ต้องการ (ทำต่อข้อ 4)   (   ) ไม่ต้องการ

4. ข่าวสารเกี่ยวกับการอนุรักษ์พลังงานไฟฟ้าเรื่องใดที่ท่านต้องการทราบ (ตอบได้มากกว่า 1ข้อ)

(   ) ข้อมูลทั่วไปเกี่ยวกับพลังงานไฟฟ้า

(   ) แนวทางการอนุรักษ์พลังงานไฟฟ้า

(   ) การทำบัญชีพลังงานไฟฟ้า

(   ) ประสิทธิภาพของเครื่องใช้ไฟฟ้า

(   ) ประโยชน์ที่ได้รับจากอุปกรณ์ประหยัดไฟฟ้า

(   ) วิธีการใช้อุปกรณ์ไฟฟ้าแต่ละประเภท

(   ) ผลดีและผลเสียของการอนุรักษ์พลังงานไฟฟ้า

(   ) บทบาทของประชาชนในการอนุรักษ์พลังงานไฟฟ้า

(   ) อื่นๆ (ระบุ)………………………………………………………………….......

………………………………………………………………………………………

ขอขอบพระคุณอย่างสูง

นายธราดล เทพอารีนันท์

นักศึกษาปริญญาเอก สาขาสิ่งแวดล้อมศึกษา

คณะมนุษศาสตร์และสังคมศาสตร์

มหาวิทยาลัยมหิดล

แบบประเมินอุปกรณ์ควบคุมการประหยัดพลังงานไฟฟ้า

ชื่อผู้ประเมิน .... ตำแหน่ง ....

วันที่ประเมิน ....

ชื่อเครื่องมือ อุปกรณ์ควบคุมการประหยัดพลังงานไฟฟ้า

ผู้ผลิต นายธราดล เทพอารีนันท์ สาขาสิ่งแวดล้อมศึกษา คณะสังคมศาสตร์และมนุษยศาสตร์
มหาวิทยาลัยมหิดล

วัตถุประสงค์ เพื่อใช้ในการประเมินการออกแบบและการใช้งานของอุปกรณ์ควบคุมการประหยัด
พลังงานไฟฟ้า

กำหนดใช้กับบุคคล ครัวเรือนเทศบาลตำบลหนองตำลึง เขตนิคมอุตสาหกรรมอมตะนคร จังหวัด
ชลบุรี

คำชี้แจง

โปรดทำเครื่องหมาย / ลงในตารางให้ตรงกับความคิดเห็นที่มีต่ออุปกรณ์ควบคุมการประหยัดพลังงาน
ไฟฟ้าโดยมีระดับความคิดเห็นดังนี้

5	หมายถึง	เหมาะสมมากที่สุด
4	หมายถึง	เหมาะสมมาก
3	หมายถึง	เหมาะสมปานกลาง
2	หมายถึง	เหมาะสมน้อย
1	หมายถึง	เหมาะสมน้อยที่สุด

หัวข้อการประเมิน	ระดับการประเมิน				
	5	4	3	2	1
1. การออกแบบอุปกรณ์ควบคุมการประหยัดพลังงานไฟฟ้า					
1.1 มีความสัมพันธ์ต่อเนื่องกับเครื่องใช้ไฟฟ้าภายในบ้าน	....	....	....	....	....
1.2 รูปแบบเหมาะสม	....	....	....	....	....
1.3 วัสดุที่นำมาใช้มีความเหมาะสมและทนทาน	....	....	....	....	....
1.4 โครงสร้างมีความกระทัดรัดเหมาะสมในการใช้งาน	....	....	....	....	....
1.5 มีระบบป้องกันการทำงานของตัวเครื่องในกรณีเกิดความ ผิดพลาด	....	....	....	....	....
2. การใช้งานของอุปกรณ์ควบคุมการประหยัดพลังงานไฟฟ้า					
2.1 มีปฏิสัมพันธ์ให้โปรแกรมใช้ง่ายสะดวกต่อผู้ใช้งาน	....	....	....	....	....
2.2 ผู้ใช้งานสามารถควบคุมการทำงานของอุปกรณ์ได้ดี	....	....	....	....	....
2.3 ติดตั้งง่ายและสะดวกต่อการใช้งาน	....	....	....	....	....
2.4 มีความยืดหยุ่น สนองต่อความแตกต่างระหว่างบุคคล	....	....	....	....	....
2.5 มีความปลอดภัยต่อการใช้งาน	....	....	....	....	....

ข้อเสนอแนะอื่นๆ

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ขอขอบพระคุณอย่างสูง

นายธราดล เทพอารีนันท์
นักศึกษาปริญญาเอก สาขาสิ่งแวดล้อมศึกษา
คณะมนุษศาสตร์และสังคมศาสตร์
มหาวิทยาลัยมหิดล

แบบทดสอบวัดความรู้
เรื่อง การประหยัดพลังงานไฟฟ้าภายในบ้าน

<u>คำชี้แจง</u>

1. แบบทดสอบฉบับนี้เป็นแบบทดสอบเพื่อวัดความรู้ครัวเรือนเทศบาลหนองตำลึง เขตนิคมอุตสาหกรรม อมตะนคร จังหวัดชลบุรี ในเรื่องการประหยัดพลังงานไฟฟ้าภายบ้าน

2. แบบทดสอบเป็นแบบเลือกตอบมี 4 ตัวเลือก จำนวน 30 ข้อ

3. ให้เขียนเครื่องหมาย X บนตัวอักษร ก,ข,ค, หรือ ง ตามที่เห็นว่าถูกที่สุดเพียงข้อเดียว

<u>**ตัวอย่าง**</u> ไฟฟ้าที่ใช้ตามบ้านเรือนเกิดจากอะไร

    ก. เกิดจากการหมุนกังหันซึ่งต่อแกนเข้ากับไดนาโมแล้วส่งไปตามสายพาน

    ข. เกิดจากไดนาโมต่อกับสายไฟฟ้า

    ค. เกิดขึ้นเองตามธรรมชาติ

    ง. เกิดจากการปิด- เปิดสวิตซ์

ข้อที่ถูกที่สุด คือ ข้อ ก. ให้เขียนเครื่องหมาย X บนตัวอักษร ก. ดังนี้ ⤬.

4. เวลาในการทำแบบทดสอบ 30 นาที

ขอขอบพระคุณทุกท่านอย่างสูงที่ได้ให้ความช่วยเหลือ

นายธราดล เทพอารีนันท์
นักศึกษาปริญญาเอก สาขาสิ่งแวดล้อมศึกษา
คณะมนุษศาสตร์และสังคมศาสตร์
มหาวิทยาลัยมหิดล

คำชี้แจง **ให้เขียนเครื่องหมาย X บนตัวอักษร ก, ข, ค หรือ ง เห็นว่าถูกต้องที่สุดเพียงข้อเดียว**

1. พลังน้ำจะทำให้เกิดกระแสไฟฟ้าได้อย่างไร

    ก. พลังน้ำจากที่สูง ⎯⎯⎯▶ กังหันต่อแกนกับไดนาโม ⎯⎯⎯▶ กระแสไฟฟ้า

    ข. พลังน้ำจากที่สูง ⎯⎯⎯▶ กังหัน ⎯⎯⎯▶ กระแสไฟฟ้า

    ค. พลังน้ำจากที่สูง ⎯⎯⎯▶ ไดนาโม ⎯⎯⎯▶ กระแสไฟฟ้า

    ง. พลังน้ำจากที่สูง ⎯⎯⎯▶ มอเตอร์ ⎯⎯⎯▶ กระแสไฟฟ้า

2. พลังความร้อนที่ใช้ในการผลิตกระแสไฟฟ้ามาจากไหน

    ก. ถ่านหิน ก๊าซธรรมชาติ น้ำ

    ข. ก๊าซธรรมชาติ น้ำมัน น้ำ

    ค. น้ำมัน ก๊าซธรรมชาติ ถ่านหิน

    ง. น้ำ ก๊าซธรรมชาติ น้ำมัน ถ่านหิน

3. ทรัพยากรธรรมชาติที่ต้องสูญเสียไปในการผลิตกระแสไฟฟ้า ข้อใดถูกต้องที่สุด

    ก. ป่าไม้ ก๊าซธรรมชาติ

    ข. ถ่านหิน ก๊าซธรรมชาติ น้ำมัน และป่าไม้บางส่วน

    ค. น้ำมัน ป่าไม้ ถ่านหิน

    ง. ถ่านหิน น้ำมัน น้ำ

4. หลอดไฟฟ้าต่อไปนี้หลอดชนิดใดใช้ไฟน้อยที่สุด เมื่อให้แสงสว่างเท่ากัน

    ก. หลอดกลมแบบมีไส้ชนิดธรรมดา

    ข. หลอดคอมแพคฟลูออเรสเซนต์ (ตะเกียบ)

    ค. หลอดฟลูออเรสเซนต์ (หลอดนีออน)

    ง. หลอดไฟฮาโลเจน(สปอร์ตไลท์)

5. การติดตั้งเครื่องปรับอากาศอย่างเหมาะสมมีวิธีเลือกอย่างไร

    ก. ขนาดใหญ่จะได้เย็นมากๆ

    ข. ขนาดพอดีกับขนาดของห้อง

    ค. ขนาดเล็กเพื่อการประหยัด

    ง. ขนาดเท่าใดก็ได้ตามที่ความพอใจ

6. การปฏิบัติกับตู้เย็นต่อไปนี้ข้อใดไม่ถูกต้อง

    ก. วางตู้เย็นจากฝาผนังอย่างน้อย 15 เซนติเมตร

    ข. ไม่ควรวางตู้เย็นใกล้แหล่งความร้อน

    ค. การปิด – เปิดตู้เย็นบ่อยๆ จะทำให้เปลืองไฟยิ่งขึ้น

    ง. การวางตู้เย็นบริเวณมุมห้องจะทำให้เป็นระเบียบถึงแม้จะอับไปหน่อย

7. การตั้งอุณหภูมิในตู้เย็นควรตั้งไว้ที่หมายเลขใดจึงจะประหยัดค่าไฟมากที่สุด

        ✗ หมายเลข 3

        ข. หมายเลข 5

        ค. หมายเลข 1

        ง. หมายเลขใดก็เย็นเท่ากัน

8. ในช่องแช่แข็ง หากมีน้ำแข็งเกาะมากๆจะดีหรือไม่เพราะอะไร

        ก. ดี เพราะช่วยให้ของในตู้เย็น เย็นเร็วขึ้น

        ข. ดี เพราะมีน้ำแข็งเกาะมาก แสดงว่าตู้เย็นเย็นจัด

        ค. ไม่ดี เพราะจะทำให้ใช้ไฟมาก สิ้นเปลืองมาก

        ✗ ไม่ดี เพราะทำให้แช่ของได้น้อย

9. ข้อต่อไปนี้เป็นเหตุผลที่ต้องช่วยกันประหยัดพลังงาน <u>ยกเว้น</u> ข้อใด

        ก. เพื่อลดปริมาณป่าไม้ที่ถูกทำลาย

        ข. เพื่อลดการสูญเสียแหล่งแร่ธาตุ

        ค. เพื่อไม่ให้ต้นน้ำลำธารถูกทำลาย

        ✗ เพื่อไม่ให้เกิดผลเสียต่ออุตสาหกรรมป่าไม้

10. เพื่อรีดผ้าอย่างประหยัดพลังงานไฟฟ้าควรทำอย่างไร

        ก. รีดผ้าวันละชุดก็พอจะได้ประหยัดพลังงานไฟฟ้ายิ่งขึ้น

        ข. รีดผ้าวันเว้นวัน ดีกว่าจะได้ไม่ต้องลำบากมาก

        ✗ รีดผ้าคราวละมากๆ ให้ครบจำนวนที่จำเป็น

        ง. รีดผ้าคราวละเท่าใดก็ได้ตามความสะดวก

11. ข้อใดเป็นวิธีการใช้เตารีดอย่างถูกต้องและเหมาะสมที่สุด

        ✗ รีดผ้าต้อง ไม่พรมน้ำจนเปียกเกินไป เฉพาะผ้าที่จำเป็น

        ข. ควรตั้งระดับความร้อนให้สูงมากๆผ้าจะเรียบดี

        ค. รีดผ้า วันละ 1 ชุดที่ต้องใช้

        ง. รีดผ้าคราวละมากๆโดยไม่คำนึงถึงความจำเป็นในการใช้งาน

12. ข้อใดเป็นการใช้พลังงานอย่างประหยัดเพื่อช่วยอนุรักษ์ทรัพยากรธรรมชาติ

        ก. การใช้ตามความต้องการ

        ข. การเก็บรักษาไว้โดยไม่นำมาใช้

        ✗ ใช้ให้เกิดประโยชน์อย่างฉลาดและคุ้มค่า

        ง. การนำมาใช้ให้มากที่สุด

13. การใช้เครื่องปั๊มน้ำที่ดีควรปฏิบัติอย่างไร

    ✗ หมั่นตรวจปั๊มน้ำอย่างสม่ำเสมอไม่ให้เกิดรอยรั่ว

    ข. ควรตรวจปั๊มน้ำทุก 10 ปี

    ค. การตรวจปั๊มน้ำบ่อยๆ ทำให้เสียเวลาไม่มีความจำเป็น

    ง. ควรเปิดปั๊มน้ำตลอดเวลา เพื่อสะดวกในการใช้งาน

14. หากท่อที่ต่อกับปั๊มน้ำมีรอยรั่วจะส่งผลเสียอย่างไร

    ✗ ปั๊มน้ำจะทำงานได้ไม่เต็มที่ตลอดเวลาและจะเปลืองพลังงานไฟฟ้าอย่างมาก

    ข. ทำให้น้ำหยุดไหลทันที

    ค. เกิดไฟฟ้าลัดวงจร

    ง. ปั๊มน้ำจะเสียทันที

15. คำกล่าวต่อไปนี้ ข้อใดกล่าว<u>ไม่ถูกต้อง</u>

    ก. โทรทัศน์เมื่อเลิกดูควรปิด

    ข. ปิดไฟฟ้าทุกครั้งหลังการใช้

    ค. ไฟฟ้าถ้าเลิกใช้อย่าเปิดไว้ให้สิ้นเปลือง

    ✗ การปิด – เปิดไฟฟ้าบ่อยๆจะทำให้สิ้นเปลืองไฟฟ้ามากขึ้น

16. ข้อใดต่อไปนี้กล่าว<u>ไม่ถูกต้อง</u>

    ก. อย่าแช่นมในตู้เย็นขณะที่นมร้อนอยู่

    ข. ควรเปิดไฟเฉพาะจุดที่ต้องการเท่านั้น

    ค. การประหยัดพลังงานไฟฟ้ายังไม่ถึงเวลาที่ต้องทำ

    ✗ ควรทำความสะอาดหลอดไฟฟ้าอยู่เสมอ

17. การผลิตกระแสไฟฟ้าต้องเสียทรัพยากรจำนวนมากดังนั้นเราจึงควร

    ก. เลิกใช้ไฟฟ้าจะได้ไม่สิ้นเปลืองทรัพยากรธรรมชาติ

    ข. ไม่ใช้ทรัพยากรธรรมชาติในการผลิตไฟฟ้า

    ✗ ใช้พลังงานไฟฟ้าอย่างเหมาะสมเท่าที่จำเป็น

    ง. สั่งซื้อทรัพยากรธรรมชาติจากต่างประเทศมาใช้งาน

18. ข้อใด "ไม่ใช่" เป็นการใช้เครื่องใช้ไฟฟ้าอย่างประหยัด

    ก. ควรปิดสวิตซ์เครื่องใช้ไฟฟ้าทุกครั้งเมื่อเลิกใช้งาน

    ข. ใช้ไฟฟ้าอย่างถูกต้อง เหมาะสมตามเวลาและโอกาส

    ค. ตรวจสอบเครื่องใช้ไฟฟ้าให้อยู่ในสภาพดีเสมอ

    ✗ เปิดพัดลมตลอดเวลา เพื่อจะได้ไม่ต้องเปิดเครื่องปรับอากาศ

19. เครื่องใช้ไฟฟ้าชนิดใด <u>ไม่ช่วย</u> ประหยัดพลังงานไฟฟ้า

      ก. เครื่องปรับอากาศเบอร์ 5

      ✗ หลอดไฟฟ้าชนิดสปอร์ตไลต์

      ค. หลอดไฟฟ้าชนิดหลอดตะเกียบ

      ง. โทรทัศน์ที่สามารถตั้งเวลา ปิด – เปิด ได้

20. วิธีส่งเสริมให้ทุกคนช่วยกันประหยัดพลังงานไฟฟ้า ข้อใด<u>ไม่เหมาะสม</u>

      ก. ส่งเสริมให้มีการจัดนิทรรศการเกี่ยวกับการประหยัดพลังงานไฟฟ้า

      ข. จัดทำและเผยแพร่หนังสือเกี่ยวกับการประหยัดพลังงานไฟฟ้า

      ค. โฆษณาเกี่ยวกับการประหยัดพลังงานไฟฟ้าได้

      ✗ อยู่เฉยๆก็ช่วยประหยัดพลังงานไฟฟ้าได้

21. เราจะลดจำนวนหลอดไฟฟ้าในบ้านโดยวิธีใด

      ก. ทำเพดานให้สูง

      ข. ใช้โคมไฟให้เหมาะสม

      ✗ ทาสีเพดานและผนังสีอ่อนๆ

      ง. ติดปลั๊กไว้ที่ต่ำๆ

22. เครื่องใช้ไฟฟ้าชนิดใดเปลืองไฟฟ้ามากที่สุด เมื่อใช้ระยะเวลาเท่ากัน

      ก. หลอดฟลูออเรสเซนต์

      ข. วิทยุ

      ค. โทรทัศน์

      ✗ เตารีดไฟฟ้า

23. ข้อใดไม่ช่วยในการประหยัดพลังงานไฟฟ้า

      ก. ปิดไฟทุกครั้งเมื่อเลิกใช้

      ข. หมั่นทำความสะอาดหลอดไฟฟ้าเสมอ

      ค. ผนังห้องควรทาสีอ่อน

      ✗ เปลี่ยนมาใช้หลอดไส้ธรรมดาแทน

24. ถ้าจำเป็นต้องเปิดไฟฟ้าทิ้งไว้ทั้งบ้าน ควรใช้หลอดชนิดใด

      ✗ หลอดฟลูออเรสเซนต์

      ข. หลอดแสงจันทร์

      ค. หลอดไส้

      ง. หลอดชนิดใดก็ได้

25. ข้อใดต่อไปนี้เป็นเรื่องเกี่ยวกับการใช้เครื่องปรับอากาศอย่างถูกต้อง

      ก. ปิดเครื่องปรับอากาศทุกครั้งที่ออกจากห้องนานเกิน 30 นาที

      ข. เปิดเครื่องปรับอากาศไว้ล่วงหน้าก่อนใช้

      ค. เปิดหน้าต่างไว้เล็กน้อยขณะเปิดเครื่องปรับอากาศจะช่วยระบายอากาศได้

      ง. เครื่องปรับอากาศที่ดีเปิดเมื่อใดเย็นทันทีไม่ต้องรอนาน

26. ข้อใดเป็นสิ่งควรปฏิบัติขณะรีดผ้า

      ก. รีดผ้าทุกชิ้นที่ซักเสร็จ

      ข. ขณะรีดผ้าดูโทรทัศน์ไปด้วยจะช่วยให้เพลิดเพลินไม่รู้สึกเบื่อ

      ค. พรมน้ำให้เปียกแฉะก่อนรีดจะทำให้รีดเรียบง่ายขึ้น

      ง. รีดผ้าคราวละมากๆ เฉพาะผ้าที่จำเป็น

27. หลอดไฟฟ้า ฟลูออเรสเซนต์ดีกว่าหลอดไฟฟ้าทังสเตนอย่างไร

      ก. ประหยัดพลังงานไฟฟ้ามากกว่า

      ข. ให้แสงสว่างนวลกว่า

      ค. เกิดความร้อนน้อยกว่า

      ง. ถูกทุกข้อ

28. ใครช่วยประหยัดพลังงานได้มากที่สุด

      ก. เรณูรีดผ้าทุกวันเพื่อประหยัดเวลาโดยพรมน้ำก่อนรีด

      ข. แดงรีดผ้าทุกวันโดยไม่พรมน้ำ

      ค. ดำรีดผ้าทุก 10 วัน โดยพรมน้ำให้ทั่วก่อนรีด

      ง. สมศักดิ์รีดผ้าทุก 7 วันโดยไม่พรมน้ำ

29. การรีดผ้าด้วยเตารีดไฟฟ้าในแต่ละครั้ง เราควรรีดหลายๆตัวและควรรีดให้เสร็จในช่วงเวลาเดียวกันเพราะ
    อะไร

      ก. ผู้รีดไม่เสียเวลาบ่อย

      ข. ช่วยให้ประหยัดไฟ

      ค. ไฟเรียบเสมอและผ้าจะเรียบเร็ว

      ง. เตารีดไม่เสียง่าย

30. การรีดผ้าลักษณะใดที่จะทำให้ผ้าเรียบเป็นระเบียบและประหยัดไฟ

      ก. ผ้าที่ตากจนแห้ง

      ข. ผ้าแห้งที่พับไว้อย่างเป็นระเบียบ

      ค. ผ้าแห้งพรมน้ำเล็กน้อยจนทั่ว

      ง. ผ้าแห้งพรมน้ำให้เปียกชุ่ม

แบบสัมภาษณ์พฤติกรรมและปริมาณการใช้ไฟฟ้าในครัวเรือน
เทศบาลตำบลหนองตำลึง ในเขตนิคมอุตสาหกรรมอมตะนคร จังหวัดชลบุรี

พฤติกรรมและปริมาณการใช้ไฟฟ้าภายในครัวเรือน

<u>**คำชี้แจง**</u> กรุณาตอบข้อคำถามต่อไปนี้ ให้ตรงกับสภาพความเป็นจริงของท่านให้มากที่สุด

1. ก่อนและหลังการอบรมท่านมีวิธีการใช้งานเครื่องคอมพิวเตอร์อย่างไร

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2. ก่อนและหลังการอบรมท่านมีวิธีการใช้งานเครื่องปรับอากาศอย่างไร

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3. ก่อนและหลังการอบรมท่านมีวิธีการใช้งานหลอดไฟฟ้าอย่างไร

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4. ก่อนและหลังการอบรมท่านมีวิธีการใช้งานกระติกน้ำร้อนและกาต้มน้ำอย่างไร

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5. ก่อนและหลังการอบรมท่านมีวิธีการใช้งานโทรทัศน์อย่างไร

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6. ก่อนและหลังการอบรมท่านมีวิธีการใช้งานตู้เย็นอย่างไร

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7. ก่อนและหลังการอบรมท่านมีวิธีการใช้งานพัดลมอย่างไร

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8. ก่อนและหลังการอบรมท่านมีวิธีการใช้งานเครื่องซักผ้าอย่างไร

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9. ก่อนและหลังการอบรมท่านมีวิธีการใช้งานเตารีดอย่างไร

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10. ก่อนและหลังการอบรมท่านมีวิธีการใช้งานเครื่องทำน้ำอุ่นอย่างไร

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11. ก่อนและหลังการอบรมท่านมีวิธีการใช้งานหม้อหุงข้าวอย่างไร

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12. ก่อนและหลังการอบรมท่านมีวิธีการใช้งานปั้มน้ำอย่างไร

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13. ก่อนการอบรมปริมาณค่าไฟฟ้าย้อนหลัง 3 เดือน มีปริมาณเท่าไร

       ย้อนหลัง   เดือนกรกฎาคม 2553..หน่วย

       ย้อนหลัง   เดือนสิงหาคม   2553..หน่วย

       ย้อนหลัง   เดือนกันยายน   2553..หน่วย

14. หลังการอบรมปริมาณค่าไฟฟ้าย้อนหลัง 3 เดือน นับจากวันสมภาษณ์นี้ มีปริมาณเท่าไร

       ย้อนหลัง   เดือนพฤศจิกายน 2553..หน่วย

       ย้อนหลัง   เดือนธันวาคม   2553..หน่วย

       ย้อนหลัง   เดือนมกราคม   2554..หน่วย

                   ขอขอบคุณในความร่วมมือของท่าน

                                 ผู้วิจัย

แบบประเมินความพึงพอใจของผู้เข้ารับการอบรม
โครงการอบรมรูปแบบการประหยัดพลังงานไฟฟ้าภายในบ้านโดยผ่านกระบวนการสิ่งแวดล้อมศึกษา

<u>คำชี้แจง</u>

       1.   โปรดตอบแบบประเมินความพึงพอใจตามความเป็นจริง ทั้งนี้เพื่อที่จะได้ข้อมูลที่ถูกต้องและสามารถนำไปใช้ประโยชน์ต่อส่วนรวมได้มากที่สุด

       แบบประเมินฯ ชุดนี้จัดทำขึ้นโดยมีวัตถุประสงค์เพื่อประเมินรูปแบบการประหยัดพลังงานไฟฟ้าภายในบ้านโดยผ่านกระบวนการสิ่งแวดล้อมศึกษา

       ผู้ศึกษาขอขอบพระคุณเป็นอย่างสูงที่กรุณาสละเวลาตอบแบบประเมินฯ

แบบประเมินความพึงพอใจชุดนี้มี 3 ตอน คือ

<u>ตอนที่ 1</u> สถานภาพทั่วไป

<u>ตอนที่ 2</u> ระดับความพึงพอใจ / ความรู้ความเข้าใจ / การนำไปใช้ ต่อการเข้าร่วมโครงการ

<u>ตอนที่ 3</u> ข้อเสนอแนะอื่นๆ

วิธีตอบแบบประเมินความพึงพอใจ

1.   ทำเครื่องหมาย ✔ ลงใน ( ) หน้าคำตอบที่ท่านต้องการ
2.   เติมคำตอบลงในช่องว่างที่เว้นไว้หลังคำถามแต่ละข้อ
3.   กากบาททับหมายเลข ที่ท่านต้องการมากที่สุด

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       2.   ข้อมูลเหล่านี้นำมาเพื่อใช้ทำการศึกษาวิจัยเท่านั้นและจะปิดเป็นความลับ

                          ขอขอบพระคุณทุกท่านอย่างสูงที่ได้ให้ความอนุเคราะห์

                                     นายธราดล เทพอารีนันท์

                            นักศึกษาปริญญาเอก สาขาสิ่งแวดล้อมศึกษา

                                คณะมนุษศาสตร์และสังคมศาสตร์

                                        มหาวิทยาลัยมหิดล

<u>**ตอนที่ 1**</u> **สถานภาพทั่วไป**

<u>**คำชี้แจง**</u> โปรดทำเครื่องหมาย ✔ ลงในช่อง ☐ หน้าข้อความ

1. เพศ

      ☐ หญิง   ☐ ชาย

2. อายุ

      ☐ ต่ำกว่า 20 ปี   ☐ 21-40 ปี   ☐ 41-60 ปี   ☐ 61 ปีขึ้นไป

3. การศึกษา

      ☐ ประถมศึกษา   ☐ มัธยมศึกษา

      ☐ อนุปริญญา, ปวช., ปวส.   ☐ ปริญญาตรีหรือสูงกว่าปริญญาตรี

4. อาชีพ

      ☐ เกษตรกรรม, ทำสวน. ทำไร่   ☐ รับจ้างทั่วไป   ☐ ค้าขาย / ธุรกิจส่วนตัว

      ☐ รับราชการ / รัฐวิสาหกิจ   ☐ นักเรียน / นักศึกษา   ☐ อื่นๆ ระบุ...............................

<u>**ตอนที่ 2**</u> **ระดับความพึงพอใจ / ความรู้ความเข้าใจ / การนำไปใช้ ต่อการเข้าร่วมโครงการ**

<u>**คำชี้แจง**</u> โปรดทำเครื่องหมาย ✔ ลงในช่องที่ตรงกับความพึงพอใจ / ความรู้ความเข้าใจ / การนำไปใช้

       ของท่านเพียงระดับเดียว

ประเด็นความคิดเห็น	ระดับความพึงพอใจ / ความรู้ความเข้าใจ / การนำความรู้ไปใช้				
	มากที่สุด 5	มาก 4	ปานกลาง 3	น้อย 2	น้อยที่สุด 1
ด้านวิทยากร					
1. การถ่ายทอดความรู้ของวิทยากรมีความชัดเจน					
2. ความสามารถในการอธิบายเนื้อหา					
3. การเชื่อมโยงเนื้อหาในการฝึกอบรม					
4. มีความครบถ้วนของเนื้อหาในการฝึกอบรม					
5. การใช้เวลาตามที่กำหนดไว้					
6. การตอบข้อซักถามในการฝึกอบรม					

ประเด็นความคิดเห็น	ระดับความพึงพอใจ / ความรู้ความเข้าใจ / การนำความรู้ไปใช้				
	มากที่สุด 5	มาก 4	ปานกลาง 3	น้อย 2	น้อยที่สุด 1
ด้านสถานที่ / ระยะเวลา / อาหาร					
1. สถานที่สะอาดและมีความเหมาะสม					
2. ความพร้อมของอุปกรณ์โสตทัศนูปกรณ์					
3. ระยะเวลาในการอบรมมีความเหมาะสม					
4. อาหาร มีความเหมาะสม					
ด้านความรู้ความเข้าใจ					
1. ความรู้ ความเข้าใจในเรื่องนี้ก่อนการอบรม					
2. ความรู้ ความเข้าใจในเรื่องนี้หลังการอบรม					
3. สามารถบอกประโยชน์ ได้					
4. สามารถบอกข้อดีได้					
5. สามารถอธิบายรายละเอียดได้					
6. สามารถจัดระบบความคิด/ประมวลความคิด สู่การพัฒนางานอย่างเป็นระบบ					
7. บูรณาการทางความคิดสู่การทำงานเป็นทีม/ การปรับตัวของบุคลากร/การปฏิรูประบบ การทำงานในการปฏิบัติงาน					
ด้านการนำความรู้ไปใช้					
1. สามารถนำความรู้ที่ได้รับไปประยุกต์ใช้ในการ ประหยัดพลังงานไฟฟ้าภายในบ้านได้					
2. สามารถนำความรู้ไปเผยแพร่/ถ่ายทอดแก่ ชุมชนได้					
3. สามารถให้คำปรึกษาแก่เพื่อนร่วมงานได้					
4. มีความมั่นใจและสามารถนำความรู้ที่ได้รับ ไปใช้ได้					

<u>**ตอนที่ 3**</u> **ข้อเสนอแนะอื่นๆ**

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ขอขอบคุณที่ให้ความร่วมมือในการตอบแบบสอบถาม

นายธราดล เทพอารีนันท์
นักศึกษาปริญญาเอก สาขาสิ่งแวดล้อมศึกษา
คณะมนุษศาสตร์และสังคมศาสตร์
มหาวิทยาลัยมหิดล

คู่มือ

การประหยัดพลังงานไฟฟ้า

จากอุปกรณ์ไฟฟ้าภายในบ้าน

โดย นายธราดล เทพอารีนันท์

การประหยัดพลังงานไฟฟ้า

จากอุปกรณ์ไฟฟ้าภายในบ้าน

บ้านเป็นสถานที่อยู่อาศัย พักผ่อนนอนหลับ คุ้มแดดคุ้มฝน เป็นที่ปลอดภัยจากภัยธรรมชาติ คน สัตว์ ที่จะมารบกวนหรือทำร้ายเรา ปัจจุบันความก้าวหน้าทางเทคโนโลยีและการปรับตัวตามภาวะเศรษฐกิจ และสังคมทำให้มีการสร้างบ้านที่มีลักษณะ ขนาด และทำด้วยวัสดุที่แตกต่างกัน เมื่อจะสร้างบ้าน ซื้อบ้าน เช่าบ้านหรืออาคารสำนักงาน สิ่งที่เรานำมาพิจารณานอกจากลักษณะบ้านหรืออาคาร ขนาดวัสดุที่ใช้แล้ว ยังคำนึงถึงพื้นที่ใช้สอยที่ตั้งการคมนาคม ราคาและสิ่งแวดล้อมต่าง ๆเป็นสิ่งที่ช่วยให้มีการตัดสินใจได้อย่างเหมาะสม และยังมีอีกสิ่งหนึ่งที่มักจะมองข้ามกันไปก็คือ ค่าใช้จ่ายต่างๆภายในบ้าน ซึ่งนอกเหนือจากวัสดุ

อุปกรณ์เฟอร์นิเจอร์ตกแต่งบ้านแล้ว ยังมีเครื่องใช้ไฟฟ้าที่จำเป็น เช่น หลอดไฟฟ้า โทรทัศน์ เตารีด พัดลม ตู้เย็น ฯลฯ และรวมถึงเครื่องใช้ไฟฟ้าที่อำนวยความสะดวกต่างๆเช่น เครื่องปรับอากาศ เครื่องซักผ้า เครื่องทำน้ำอุ่น ฯลฯ ซึ่งเครื่องใช้ไฟฟ้าเหล่านี้ล้วนต้องใช้พลังงานทั้งสิ้น อันจะก่อให้เกิดค่าใช้จ่ายประจำทุกเดือน โดยจะมากหรือน้อยขึ้นอยู่กับการใช้ที่ถูกวิธี ดังนั้นถ้าหากรู้จักเลือกเครื่องใช้ไฟฟ้าให้เหมาะสมกับสภาพความเป็นอยู่ ความจำเป็น และจำนวนสมาชิก ก็จะได้รับประโยชน์จากการใช้เครื่องใช้ไฟฟ้าอย่างแท้จริง รวมถึงถ้ารู้จักวิธีการใช้การดูแล บำรุงรักษาเครื่องใช้ไฟฟ้าที่มีอยู่ให้อยู่ในสภาพดีอยู่เสมอ และ

ตรวจสอบดูเครื่องใช้ไฟฟ้าแต่ละชนิด ใช้พลังงานมากน้อยเท่าใดเพื่อจะได้ใช้ให้ถูกต้อง ซึ่งจะช่วยให้ประหยัดพลังงาน และค่าใช้จ่ายภายในบ้านได้ และสิ่งที่จะทำให้การประหยัดพลังงานได้ผลก็คือ การเอาใจใส่และมีความตั้งใจจริง โดยเริ่มจากตัวท่านเองและสมาชิกภายในครอบครัวต้องร่วมมือกัน

ด้วยการ

1. สร้างจิตสำนึกและให้ความรู้ด้านการประหยัดพลังงานแก่สมาชิกในครอบครัว

2. ใช้อุปกรณ์ไฟฟ้าเท่าที่จำเป็นทั้งจำนวนและเวลาในการใช้

3. ใช้อุปกรณ์ไฟฟ้าที่มีประสิทธิภาพสูง

4. ใช้อุปกรณ์ไฟฟ้าที่มีขนาดเหมาะสมกับการใช้งาน

5. ลดการใช้เครื่องใช้ไฟฟ้าที่มีวัตต์สูงๆ

6. บำรุงรักษาอุปกรณ์เครื่องใช้ไฟฟ้าเป็นประจำ

สำหรับแนวทางในการปฏิบัติเพื่อให้เกิดการประหยัดพลังงานไฟฟ้าจากการใช้เครื่องใช้ไฟฟ้าภายในบ้านมีดังนี้

3

คอมพิวเตอร์

ปัจจุบันองค์กรต่างๆไม่ว่าจะเป็นภาครัฐหรือเอกชน ต่างได้มีการนำคอมพิวเตอร์เข้ามาใช้งานในองค์กรต่างๆ มากมาย ซึ่งมีผลให้การดำเนินงานในองค์กรนั้นดำเนินไปได้ อย่างมีระบบ สามารถพัฒนาการทำงานได้อย่างต่อเนื่องเป็นระบบ เครือข่าย และยังทราบข่าวสารข้อมูลต่างๆได้อย่างสะดวกและรวดเร็ว คอมพิวเตอร์ จึงจัดได้ว่าเป็นอุปกรณ์ที่มีความสำคัญชนิดหนึ่งในสำนักงานในยุคปัจจุบัน ซึ่ง วิธีการที่แนะนำนี้จะสามารถใช้เป็นแนวทางการปฏิบัติที่บ้านได้ด้วย เพื่อเป็นการ ลดค่าใช้จ่ายในการใช้พลังงานไฟฟ้าได้

คำแนะนำในการใช้และดูแลคอมพิวเตอร์

- ควรตั้งคอมพิวเตอร์ในที่มีอากาศถ่ายเทสะดวก เพื่อระบายความร้อนของเครื่อง
- ควรตั้งระบบ Screen Saver เพื่อรักษาคุณภาพของหน้าจอคอมพิวเตอร์
- ควรตรวจสอบว่าระบบประหยัดพลังงานของเครื่องถูกตั้งให้ระบบทำงานแล้ว หรือไม่ ถ้ายังควรตั้งให้ระบบให้เครื่องทำงานเพราะจะเป็นการช่วยประหยัด ไฟฟ้า

4
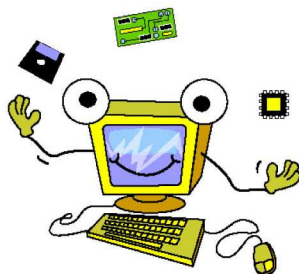
คำแนะนำในการประหยัดพลังงานจากการใช้คอมพิวเตอร์

1. อย่าเปิดเครื่องคอมพิวเตอร์ทิ้งไว้ถ้าไม่ใช้งาน และควรติดตั้งระบบลด
กระแสไฟฟ้าเข้าเครื่องเมื่อพักการทำงาน เพราะจะช่วยลดการประหยัดไฟฟ้าได้
ร้อยละ 35 – 40 และถ้าหากปิดหน้าจอทันทีเมื่อไม่ใช้นานเกินกว่า 15 นาทีซึ่งจะ
ประหยัดไฟฟ้าได้ร้อยละ 60

2. ปิดสวิตซ์เครื่องคอมพิวเตอร์และเครื่องพิมพ์ผล เมื่อไม่มีการใช้งาน
ติดต่อกันถึง 1 ชั่วโมง และควรถอดปลั๊กออกเมื่อเลิกใช้งาน

3. ถ้าภายในสำนักงานมีกลุ่มคนที่
ใช้เครื่องคอมพิวเตอร์เป็นจำนวนน้อย
ควรจะใช้คอมพิวเตอร์ร่วมกันโดยเลือกใช้
ระบบให้เหมาะสม จะดีกว่าที่บนโต๊ะ
ทำงานของทุกคนมีคอมพิวเตอร์ทุก ๆโต๊ะ
แต่ใช้งานไม่คุ้มค่า

4. ถ้าหากท่านใช้เวลาส่วนใหญ่อยู่นอกหน่วยงาน ท่านควรเลือกใช้
คอมพิวเตอร์แบบกระเป๋าหิ้ว แทนเครื่องคอมพิวเตอร์แบบตั้งโต๊ะ เพราะเครื่อง
คอมพิวเตอร์แบบกระเป๋าหิ้วใช้พลังงานเพียง 1 ใน 10 ของเครื่องคอมพิวเตอร์แบบ
ตั้งโต๊ะ แต่ทั้งนี้ขึ้นอยู่กับว่าท่านใช้คอมพิวเตอร์บ่อยมากน้อยแค่ไหน

5

5.   ควรเลือกใช้คอมพิวเตอร์ที่มีระบบประหยัดพลังงานโดยสังเกตจาก สัญลักษณ์ Energy   Star   เพราะระบบนี้จะใช้กำลังไฟฟ้าลดลงถึงร้อยละ 55 ในขณะที่รอทำงาน

6. ควรเลือกใช้ระบบคอมพิวเตอร์ที่มีจอภาพไม่ใหญ่จนเกินไป เช่น ขนาด 14 นิ้ว เพราะจะใช้พลังงานน้อยกว่าจอภาพที่มีขนาดใหญ่

7.   ในการเลือกซื้อเครื่องพิมพ์ผล ควรเลือกพิจารณาเลือกซื้อเครื่องพิมพ์ แบบพ่นหมึก (ink jet) หรือแบบเข็ม (dot matrix) แม้ว่าบางเครื่องทำงานช้าและ มีเสียงดัง นอกจากนี้เครื่องพิมพ์แบบพ่นหมึกจะใช้ไฟฟ้าเพียง 70 – 90 ของการใช้ ไฟฟ้าของเครื่องพิมพ์เลเซอร์ แต่ทั้งนี้การที่จะเลือกใช้เครื่องพิมพ์แบบใดนั้นขอให้ พิจารณาจากความจำเป็นของงานเพื่อประกอบการตัดสินใจด้วย

8. ในการผลิตเอกสารใดๆ หากมีการแก้ไขเอกสาร ควรตรวจแก้ไขบน จอคอมพิวเตอร์ให้เรียบร้อยก่อนควรที่จะตรวจแก้ไขบนเอกสารที่พิมพ์จาก เครื่องพิมพ์หลายๆครั้ง เพราะจะทำให้เกิดการการประหยัดทั้งไฟฟ้า กระดาษ หมึกพิมพ์ และยังการสึกหรอของเครื่องพิมพ์ผลได้อย่างมาก

6
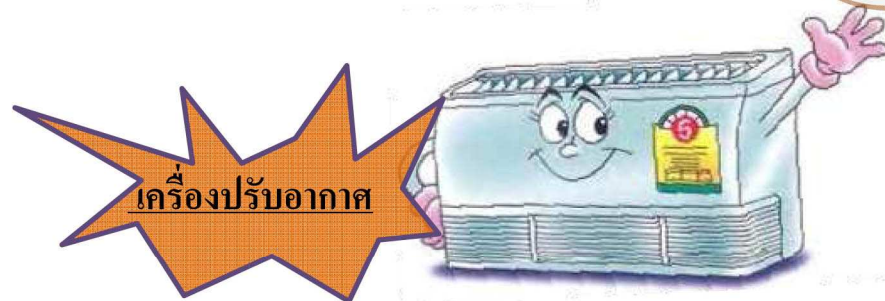
เครื่องปรับอากาศ

เครื่องปรับอากาศเป็นเครื่องใช้ไฟฟ้าชนิดหนึ่งที่ได้รับความนิยมมากใน
ปัจจุบัน จะพบว่าอาคารหรือสถานที่ทำงานต่างๆหรือแม้ตามอาคารบ้านเรือน
ต่างๆที่นิยมใช้กันอย่างแพร่หลาย ในขณะเดียวกันเครื่องปรับอากาศจัดว่าเป็น
เครื่องใช้ไฟฟ้าที่ใช้กระแสไฟฟ้ามากที่สุด ประมาณการว่าไฟฟ้ากว่าร้อยละ 60
ของการใช้ไฟฟ้าภายในอาคารสำนักงาน เกิดจากการใช้เครื่องปรับอากาศ ด้วย
เหตุนี้ทุกท่านคงเอาใจใส่และควรใช้เครื่องปรับอากาศที่มีประสิทธิภาพสูงและ
ประหยัดพลังงาน และควรเลือกเครื่องปรับอากาศให้เหมาะสมกับขนาดของห้อง
นอกจากนี้การมีความรู้เบื้องต้นเกี่ยวกับแนวทางการประหยัดพลังงาน ก็เป็นสิ่ง
สำคัญ เพื่อช่วยให้เกิดความร่วมมือและปฏิบัติได้อย่างถูกต้องต่อไป

คำแนะนำการใช้และดูแลเครื่องปรับอากาศ

1.   หมั่นทำความสะอาดแผ่นกรองอากาศ
อย่างสม่ำเสมอเพื่อไม่ให้มีฝุ่นจับ ซึ่งจะเป็นการ
ประหยัดพลังงานได้ถึงร้อยละ 5-7

2.   อย่านำสิ่งของไปวางขวางทางลมเข้า -
ออกของชุดระบายอากาศที่ตั้งอยู่ภายนอกอาคาร
เพราะจะทำให้เครื่องระบายความร้อนได้ไม่เต็มที่
ทำให้เครื่องต้องทำงานหนักและสิ้นเปลืองไฟ

7

3. อย่าติดตั้งชุดระบายความร้อนใกล้ผนังเกินไป เพราะเครื่องจะใช้ไฟมากขึ้นถึงร้อยละ 15-20 ทางที่ดีแล้วควรตั้งให้ห่างจากผนังอย่างน้อย 15 ซม. เพื่อให้เครื่องระบายความร้อนได้ดี

แนวทางการปฏิบัติในการประหยัดพลังงานในการใช้เครื่องปรับอากาศ

1. ควรปิดประตูหน้าต่างให้สนิทขณะเปิดเครื่องปรับอากาศและควรติดตั้งผ้าม่าน หรือที่บังแดด หรือปลูกต้นไม้รอบๆอาคารเพื่อป้องกันความร้อนจากแสงแดดที่ผ่านเข้ามาในห้อง เป็นการลดภาระการทำงานของเครื่องปรับอากาศ ทั้งนี้ต้นไม้ใหญ่ 1 ต้น ให้ความเย็นเท่ากับเครื่องปรับอากาศ 1 ตันหรือให้ความเย็นประมาณ 12000 บีทียู
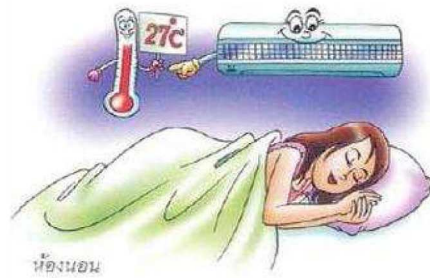
2. หลีกเลี่ยงการนำเครื่องครัวหรือภาชนะที่มีผิวหน้าร้อนจัด เช่น เตาไฟฟ้า กระทะร้อน หม้อต้มน้ำ เข้าไปในห้องที่มีการปรับอากาศ ควรปรุงอาหารในครัวให้เสร็จเรียบร้อยก่อนแล้วจึงนำเข้าไปรับประทานภายในห้อง

3. ปรับตั้งอุณหภูมิให้อยู่ในระดับที่เหมาะสม ตัวอย่างเช่น

8

3.1 บริเวณที่ทำงานทั่วไปและพื้นที่ส่วนกลาง ควรตั้งอุณหภูมิ 25 องศาเซลเซียส

3.2 บริเวณที่ทำงานใกล้กับหน้าต่างกระจก ควรตั้งอุณหภูมิ 24 องศาเซลเซียส

3.3 ในห้องคอมพิวเตอร์ ควรตั้งอุณหภูมิ 22 องศาเซลเซียส

โดยการปรับอุณหภูมินั้น ทุกอุณหภูมิที่เพิ่มขึ้น 1 องศาเซลเซียส จาก 25 องศาเซลเซียส จะช่วยประหยัดพลังงานของเครื่องปรับอากาศได้ถึงร้อยละ 10 แต่ทั้งนี้ไม่ควรตั้งอุณหภูมิเกิน 28 องศาเซลเซียส ขึ้นไป เนื่องจากระดับอุณหภูมิภายในห้องจะไม่เย็น ทั้งที่เครื่องทำงานอยู่
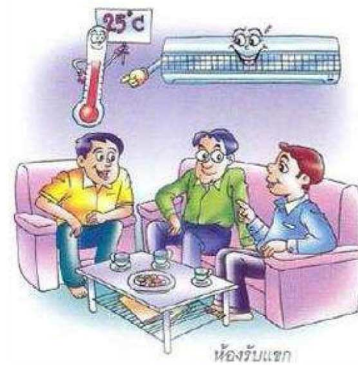
4. ไม่ควรปลูกต้นไม้หรือตากผ้าในห้องที่มีการปรับอากาศเพราะจะเป็นการเพิ่มความชื้นภายในห้อง ทำให้เครื่องปรับอากาศต้องทำงานหนัก

5. ในช่วงเวลาที่ไม่ใช้ห้องหรือก่อนเปิดเครื่องปรับอากาศประมาณ 1-2 ชั่วโมง ควรเปิดประตูหน้าต่างทิ้งไว้ เพื่อให้อากาศจากภายนอกเข้าไปแทนที่อากาศเก่าภายในห้อง เพื่อเป็นการช่วยลดและระบายกลิ่นต่างๆให้น้อยลงโดยที่ไม่จำเป็นต้องเปิดพัดลมระบาย

อากาศ เพราะการที่เปิดเครื่องปรับอากาศไปพร้อมๆกับการเปิดพัดลมระบาย
อากาศจะทำให้เครื่องปรับอากาศทำงานหนักและใช้กระแสไฟฟ้ามากขึ้นตามไป
ด้วย

6 ปิดเครื่องปรับอากาศทุกครั้งที่จะไม่อยู่ภายในห้องนานเกินกว่า 1
ชั่วโมงสำหรับเครื่องปรับอากาศทั่วไปและ 30   นาที สำหรับเครื่องปรับอากาศ
ประหยัดพลังงานเบอร์ 5

7. สำหรับอาคารที่ทำงานที่
ติดตั้งผนังกระจก ควรใช้กระจกชนิด
สะท้อนรังสีความร้อนแทนที่จะใช้
กระจกใสธรรมดา สำหรับกรณีที่เป็น
อาคารเก่าใช้กระจกใสธรรมดา ควร
พิจารณาติดฟิล์มชนิดสะท้อนรังสี
ความร้อน

8. ควรงดสูบบุหรี่ในห้องที่ติดเครื่องปรับอากาศ เนื่องจากจะต้องเปิดพัด
ลมระบายอากาศเพื่อระบายควันบุหรี่และกลิ่นออกจากห้อง ซึ่งจะทำให้
เครื่องปรับอากาศทำงานหนักขึ้น และใช้พลังงานเพิ่มขึ้น

9.   ควรเลือกซื้อเครื่องปรับอากาศที่มี
เครื่องหมายการค้าเป็นที่รู้จักทั่วไปเพราะเป็น
เครื่องที่มีคุณภาพเชื่อถือได้ ควรเลือกซื้อเครื่องที่
ผ่านการรับรองการใช้พลังงานหมายเลข 5   ซึ่ง
แสดงว่าเป็นเครื่องที่มีประสิทธิภาพสูง ประหยัด
พลังงานไฟฟ้า โดยมีฉลากปิดที่ตัวเครื่องให้เห็น
ได้อย่างชัดเจน

10

หลอดไฟฟ้า

หลอดไฟฟ้าเป็นอุปกรณ์ไฟฟ้าที่ให้แสงสว่าง ปัจจุบันมีความจำเป็นต่อการดำรงชีวิตของมนุษย์เราอย่างมาก หลอดฟ้าที่ใช้กันอยู่มีมากมายหลายชนิด หลอดไฟฟ้าแต่ละชนิดมีคุณสมบัติในการให้ค่าความสว่างต่างกัน ดังนั้นในการเลือกใช้ก็เป็นสิ่งสำคัญ ควรพิจารณาหลายๆองค์ประกอบร่วมกันก่อนที่จะนำไปใช้งานซึ่งนอกจากจะพิจารณาเลือกใช้หลอดไฟฟ้าที่มีประสิทธิผลสูง(หลอดไฟฟ้าที่ให้ปริมาณแสงออกมามากแต่ใช้วัตต์ต่ำ) อายุการใช้งานนาน สีของแสงที่มาจากหลอดไฟต้องเหมาะสมกับลักษณะการใช้งาน ฯลฯ แล้วควรคำนึงถึงการประหยัดพลังงานและค่าใช้จ่ายที่จะเกิดขึ้นตามมาด้วย แต่ทั้งนี้การใช้งานบางประเภทก็จำเป็นต้องใช้หลอดไฟฟ้าที่ไม่ประหยัดพลังงานก็มี ดังนั้นการนำหลอดไฟฟ้าไปใช้ก็ควรต้องพิจารณาเหมาะสมกับวัตถุประสงค์ในการใช้งานต่อไป

คำแนะนำในการใช้และดูแลหลอดไฟฟ้าเพื่อให้เกิดการประหยัดพลังงาน

1.   ควรบำรุงรักษาอุปกรณ์ไฟฟ้าแสงสว่างอย่างสม่ำเสมอและต่อเนื่องด้วยการทำความสะอาดฝาครอบโคมไฟฟ้าและแผ่นสะท้อนแสงในโคมไฟ เพื่อให้อุปกรณ์แสงสว่างมีความสะอาด และให้แสงสว่างอย่างมีประสิทธิภาพทุกๆ 3-6 เดือน

2.   ควรเลือกใช้หลอดไฟฟ้าที่มี

11

โครงสร้างหลอดคงทนแข็งแรง ได้รับเครื่องหมายรับรองคุณภาพ
มาตรฐานอุตสาหกรรม สำนักงานมาตรฐานผลิตภัณฑ์อุตสาหกรรม
(สมอ.) เพื่อยืดอายุการใช้งานของหลอดไฟฟ้าให้ยาวนานขึ้นและมี
ประสิทธิภาพ และควรเลือกใช้หลอดไฟฟ้าที่มีฉลากแสดงถึง
ประสิทธิภาพ โดยเลือกรุ่นที่มีประสิทธิภาพสูง และมีฉลากประหยัด
ไฟเบอร์ 5
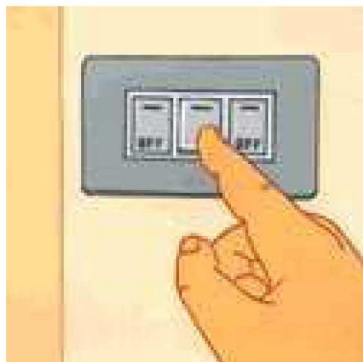
3. ควรเลือกใช้ไฟตั้งโต๊ะในบริเวณที่
ต้องการแสงสว่างเป็นพิเศษ เช่น อ่านหนังสือ
เย็บผ้า ฯลฯ จะประหยัดกว่าประหยัดไฟทั้ง
ห้อง

4. อย่าเปิดไฟทิ้งไว้เมื่อไม่มีคนอยู่
ควรปิดสวิตช์หลอดไฟฟ้าทุกครั้งที่ไม่ใช้งาน
เพราะการปิดสวิตช์หลอดไฟฟ้าช่วงเวลา
รับประทานอาหาร เป็นเวลา 1-1.5 ชั่วโมงจะช่วยลดการใช้พลังงานและการสะสม
ความร้อนได้อย่างมาก นอกจากนี้ยังเป็นการช่วยยืดอายุการทำงานของอุปกรณ์แสง
สว่างได้อีกด้วย

5. ลดจำนวนหลอดไฟฟ้าในบริเวณที่
อาศัยแสงสว่างจากธรรมชาติได้ เช่น บริเวณ
ห้องครัว ระเบียงทางเดิน ริมหน้าต่าง ฯลฯ

6. สำหรับบริเวณที่จำเป็นต้องเปิด
หลอดไฟฟ้าทิ้งไว้ทั้งคืน ไม่ว่าจะเป็นในอาคาร
หรือนอกอาคาร หรือบริเวณที่ไม่ต้องการแสง
สว่างมากนัก ควรใช้หลอดไฟฟ้าที่มีวัตต์ต่ำ
เพื่อเป็นการประหยัดไฟฟ้า

12
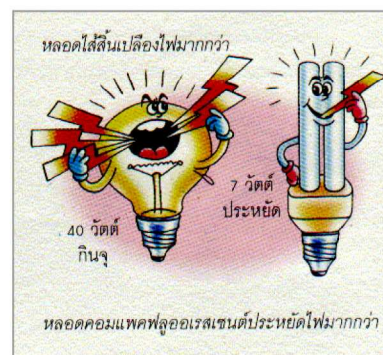
7. ควรแยกสวิตต์ไฟฟ้าออกจากกัน ให้สามารถเปิด – ปิดได้เฉพาะจุด แทนการใช้สวิตต์ใหญ่ควบคุมการเปิด-ปิดหลอดไฟฟ้าทั้งชั้นเพียงจุดเดียว เพราะจะทำให้เกิดการสิ้นเปลืองพลังงานไฟฟ้า เนื่องจากถ้าจุดใดไม่จำเป็นต้องใช้ไฟฟ้าแสงสว่างเราไม่สามารถปิดได้เพราะถ้าปิดก็ต้องปิดหมด ถ้าเปิดก็ต้องเปิดหมดทั้งชั้นด้วยต้นเหตุที่ใช้สวิตต์ใหญ่รวมกันจุดเดียว

8. ถ้าระบบแสงสว่างบางแห่งมีความสว่างสูงมากเกินจำเป็น ควรจะถอดหลอดไฟฟ้าบางส่วนออกทั้งถอดบัลลาสต์และสตาร์ทเตอร์ออกด้วย (กรณีที่ใช้หลอดฟูออเรสเซนต์)

9.   หมั่นสังเกตการณ์เปลี่ยนแปลงการทำงานของหลอดไฟฟ้า เช่น สังเกตุสีและแสงของหลอดไฟฟ้าว่าสว่างเหมือนเดิมหรือไม่ หรือถ้าหลอดไฟฟ้ามีการกระพริบควรรีบเปลี่ยนหลอดไฟฟ้าทันที เพราะหลอดไฟฟ้าที่กระพริบจะใช้พลังงานสูงกว่าหลอดปกติ
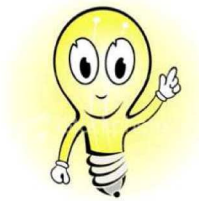
10 . หลีกเลี่ยงการทาสีฝาผนังและเพดานห้องด้วยสีทึบแสง เนื่องจากสีผนังและเพดานที่ทาด้วยสีอ่อนจะช่วยสะท้อนแสงและให้ความสว่างมากขึ้น เป็นการช่วยลดจำนวนการใช้หลอดไฟฟ้าลดลงได้

11. เมื่อต้องการเปลี่ยนหลอดไฟฟ้าใหม่ ควรเปลี่ยนมาใช้หลอดประหยัดไฟ เช่น การใช้หลอดผอม หรือหลอดคอมแพคฟลูออเรสเซนต์ แทนการใช้หลอดไส้จะประหยัดพลังงานได้มากกว่าหลอดไส้ถึง 4-5 เท่า และมีอายุการใช้งานนานกว่าหลอดไส้ 8 เท่า

13
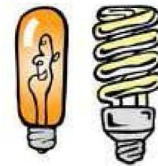
กระติกน้ำร้อนและกาต้มน้ำไฟฟ้า

กระติกน้ำร้อนและกาต้มน้ำไฟฟ้า เป็น
เครื่องใช้ไฟฟ้าที่ใช้สำหรับต้มน้ำให้ร้อนเพื่อใช้ดื่ม
จัดเป็นเครื่องใช้ไฟฟ้าที่ใช้พลังงานไฟฟ้าสูงชนิด
หนึ่ง โดยทั่วไปจะมีขนาดที่ใช้กำลังไฟฟ้าระหว่าง
500-1300 วัตต์ ดังนั้นถ้าหากท่านจะซื้อกระติกน้ำ
ร้อนหรือกาต้มน้ำไฟฟ้านั้น ควรเลือกรุ่นที่มีฉนวนกันความร้อนที่มีประสิทธิภาพ
นอกจากนี้การดูแลรักษาและวิธีการใช้งานก็เป็นสิ่งสำคัญ หากรู้จักใช้อย่างถูกวิธี
แล้วก็จะช่วยยืดอายุการใช้งาน ตลอดจนสามารถช่วยประหยัดพลังงานไฟฟ้าได้

คำแนะนำในการดูแลรักษากระติกน้ำร้อน   และกาต้มน้ำไฟฟ้า

1. ควรหมั่นดูแลสายไฟฟ้า
และขั้วปลั๊กซึ่งมักจะเป็นจุดที่ชำรุด
อยู่เสมอ

2. น้ำที่ใช้ต้มควรเป็นน้ำที่
สะอาด เพราะถ้าน้ำไม่สะอาดจะ
ทำให้ผิวด้านในกระติกเปลี่ยนสี
เกิดคราบสนิมและตะกรันขึ้นได้

14

3. หมั่นทำความสะอาดตัวกระติกด้านใน อย่าให้มีคราบตะกรันเพราะจะเป็นตัวต้านทานการถ่ายเทความร้อนจากขดลวดความร้อนไปสู่น้ำ ทำให้ต้องใช้เวลาในการต้มน้ำนานขึ้นทำให้สูญเสียพลังงานและค่าใช้จ่าย

4. ถ้าไม่มีความจำเป็นต้องใช้กระติกน้ำร้อน หรือกาต้มน้ำร้อนไฟฟ้า ควรเทน้ำทิ้งและทำความสะอาดให้แห้งก่อนเก็บ

5. การทำความสะอาดส่วนต่างๆของกระติกน้ำร้อนทำได้โดย

<u>ตัวและฝากระติก</u> ให้ใช้ผ้าชุบน้ำบิดให้หมาดแล้วเช็ดอย่างระมัดระวัง

<u>ตัวกระติกด้านใน</u> ใช้ฟองน้ำหรือผ้านุ่มๆ เช็ดให้ทั่วล้างให้สะอาดด้วยน้ำ เทน้ำที่ใช้ล้างออกให้หมด อย่าให้น้ำราดลงบนส่วนอื่นๆของตัวกระติก นอกจากภายในกระติกเท่านั้น อย่าใช้ของมีคมหรือฝอยขัดหม้อขูดหรือขัดตัวกระติกด้านใน เพราะจะทำให้สารเคลือบหลุดออกได้

<u>คำแนะนำในการใช้กระติกน้ำร้อนและกาต้มน้ำร้อนไฟฟ้า</u>
<u>เพื่อการประหยัดพลังงาน</u>

1. ควรใส่น้ำเพื่อต้มให้มีปริมาณพอเหมาะกับการใช้ อย่าใส่น้ำในปริมาณที่มากหรือน้อยกว่าปริมาณที่กำหนด เพราะนอกจากจะไม่ประหยัดพลังงานแล้วยังก่อให้เกิดความเสียหายต่อตัวกระติกหรือกาต้มน้ำ

15

2. อย่าเสียบปลั๊กเพื่อต้มน้ำไว้นานก่อนถึงเวลาการใช้งานจริง

3.   ไม่ควรต้มน้ำในที่มีการปรับ
อากาศ เพราะเป็นการเพิ่มความชื้นและ
ความร้อนทำให้เครื่องปรับอากาศต้อง
ทำงานหนักสิ้นเปลืองพลังงานไฟฟ้า

4.   ไม่ควรนำน้ำเย็นไปใช้ในการ
ต้ม   เพราะเป็นการสิ้นเปลืองพลังงานไฟฟ้า
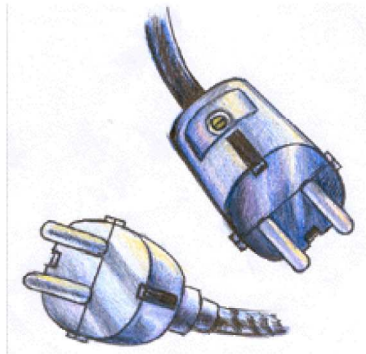
5.   ควรถอดปลั๊กเมื่อเลิกใช้น้ำร้อน
แล้ว เพื่อลดการสิ้นเปลืองพลังงาน ไม่ควร
เสียบปลั๊กแช่ทิ้งไว้ถ้าไม่ต้องการใช้น้ำแล้ว
แต่ถ้าหากมีความจำเป็นต้องการใช้น้ำร้อนเป็น
ระยะเวลาต่อเนื่อง เช่น ในสถานที่ทำงานบาง
แห่งต้องใช้น้ำร้อนสำหรับการเตรียมเครื่องดื่ม

ต้อนรับแขก ก็ไม่ควรดึงปลั๊กออกบ่อยๆ เพราะ
ทุกครั้งที่ดึงปลั๊กออกอุณหภูมิของน้ำจะค่อยๆ
ลดลง กระติกไม่สามารถเก็บความร้อนได้นาน
เมื่อจะใช้งานใหม่ก็ต้องเสียบปลั๊กและเครื่องจะ
เริ่มทำการต้มน้ำใหม่ ทำให้สิ้นเปลืองมากขึ้น

16

โทรทัศน์

โทรทัศน์เข้ามามีบทบาทในชีวิตประจำวัน   ทั้งภายในบ้านเรือนและอาคารสำนักงานต่างๆ เพราะเป็นสิ่งที่ให้ความบันเทิง ความรู้   และได้รับทราบข้อมูลข่าวสารต่างๆ ได้อย่างรวดเร็วและและทันเหตุการณ์ โทรทัศน์ที่นิยมใช้กันอยู่ทุกวันนี้มีทั้งประเภทที่เป็นสีและประเภทที่เป็นขาวดำ ซึ่งมีหลายขนาดตั้งแต่ขนาดเล็กไปจนถึงขนาดใหญ่ ปัจจุบันผู้ผลิตได้มีการพัฒนาระบบและรูปแบบต่างๆของโทรทัศน์ให้มีความทันสมัย เพื่อตอบสนองความต้องการของผู้ใช้อยู่ตลอดเวลา ซึ่งจะเห็นว่ามีทั้งระบบธรรมดาทั่วไป ระบบรีโมทคอนโทรลจอภาพชนิดจอแบน จอโค้ง ฯลฯ

ในการเลือกซื้อโทรทัศน์นั้น ผู้ใช้ควรคำนึงถึงความเหมาะสมของขนาดการใช้กำลังไฟฟ้า เช่นโทรทัศน์ที่มีขนาดใหญ่ จะใช้พลังงานไฟฟ้ามากกว่าที่มีขนาดเล็ก หรือในโทรทัศน์ขนาดเดียวกันแต่มีการใช้ระบบรีโมทคอนโทรล ก็จะใช้พลังงานไฟฟ้ามากกว่าโทรทัศน์ระบบธรรมดาทั่วไปเนื่องจากมีวงจรเพิ่มเติมดังนั้นในการเลือกใช้โทรทัศน์ นอกจากจะคำนึงถึงลักษณะและส่วนประกอบของระบบต่างๆแล้ว ควรคำนึงถึงความสิ้นเปลืองของการใช้พลังงานไฟฟ้า อันก่อให้เกิดค่าใช้จ่ายต่างๆตามมาด้วย

17

คำแนะนำในการใช้โทรทัศน์ให้ประหยัดพลังงานไฟฟ้า

1. ไม่ควรเปิดโทรทัศน์ทิ้งไว้เมื่อไม่มีคนดู

2. อย่าเสียบปลั๊กทิ้งไว้ เพราะถ้าเป็นโทรทัศน์ประเภทที่มีระบบรีโมท คอนโทรล เครื่องจะสามารถรับภาพได้ทันทีเมื่อกดปุ่มเปิด ถ้าหากเสียบปลั๊กทิ้ง ไว้ จะทำให้มีการใช้พลังงานไฟฟ้าตลอดเวลาเมื่อยังเสียบปลั๊กอยู่แม้ว่าจะไม่เปิดใช้ เครื่องก็ตาม ดังนั้นควรปิดสวิตซ์ทุกครั้งเมื่อไม่ต้องการดู และควรถอดปลั๊กออก ทุกครั้งหลังปิดสวิตซ์ เพราะนอกจากจะเป็นการประหยัดพลังงานไฟฟ้าแล้ว ยัง เป็นการยืดอายุการใช้งานโทรทัศน์อีกด้วย

3. ไม่ควรปรับจอภาพให้สว่างมาก เกินไป เพราะจะทำให้หลอดภาพมีอายุการใช้ งานสั้น และสิ้นเปลืองพลังงาน

4. ไม่ควรเปิดโทรทัศน์หลายๆเครื่อง ในเวลาเดียวกันเพื่อดูรายการเดียวกัน

5. ไม่ควรเปิดโทรทัศน์ทิ้งไว้ล่วงหน้า เพียงเพื่อที่จะรอดูรายการที่ชื่นชอบ ควรเปิดรายการนั้นเมื่อถึงเวลาที่ออกอากาศ

6. ไม่ควรเปิดโทรทัศน์ด้วยการต่อสายผ่านเข้าเครื่องวีดีโอ เพราะต้อง สิ้นเปลืองการใช้พลังงานไฟฟ้าให้กับเครื่องวีดีโอโดยไม่จำเป็น

7. ควรเลือกใช้โทรทัศน์ที่มี ระบบตั้งเวลาปิดอัตโนมัติ เพราะจะเป็น การช่วยประหยัดการใช้พลังงานไฟฟ้า สำหรับผู้ที่ชอบนอนหลับหน้าโทรทัศน์ หรือลืมปิดเครื่อง

18

ตู้เย็น

      ตู้เย็นเป็นเครื่องใช้ไฟฟ้าที่มีความจำเป็นในชีวิตประจำวันของแต่ละ
ครอบครัว โดยประโยชน์ก็เพื่อใช้ในการเก็บรักษาอาหารสด การผลิตน้ำแข็ง หรือ
เก็บอาหารที่ต้องการแช่แข็ง เช่นไอศครีม ฯลฯ ซึ่งนับวันความต้องการใช้ตู้เย็นมี
แนวโน้มจะสูงมากขึ้น ปัจจุบันได้มีการพัฒนาในเรื่องของระบบการทำงาน ขนาด
และรูปร่างต่างๆเพื่อความสะดวกของผู้ใช้ เช่นประตู ปิด – เปิด มีทั้งแบบบานเดียว
หรือตั้งแต่ 2 บานขึ้นไปดังนั้นในการเลือกใช้ตู้เย็นแต่ละครอบครัวควรพิจารณาถึง
ความเหมาะสม ประโยชน์ของการใช้งานในด้านขนาดหรือปริมาณสิ่งของที่จะทำ
การแช่เย็น หรืออุณหภูมิที่ต้องการเก็บและถนอมอาหาร เป็นต้น นอกจากนี้ในการ
ใช้ตู้จะต้องใช้งานให้ถูกวิธี เพื่อช่วยในการประหยัดพลังงานไฟฟ้าและค่าใช้จ่ายที่
จะเกิดขึ้น เนื่องจากตู้เย็นเป็นเครื่องใช้ไฟฟ้าที่ใช้พลังงานมากและต่อเนื่องตลอด
อายุการใช้งาน ทำให้เกิดการสิ้นเปลืองพลังงาน ด้วยเหตุนี้หน่วยงานทางภาครัฐ
และเอกชนต่างให้ความสนใจและมีการรณรงค์ให้มีการใช้ตู้เย็นที่ประหยัดพลังงาน
ดังจะเห็นได้จากการที่มีการใช้ฉลากประหยัดไฟเบอร์ 5 ซึ่งเป็นการแสดงระดับค่า
ประสิทธิภาพติดอยู่ด้านหน้าของตู้เย็น เพื่อแสดงรายละเอียดให้ทราบว่าตู้เย็นเครื่อง
นั้นๆใช้พลังงานไฟฟ้าเท่าใดต่อปี คิดเป็นจำนวนเงินปีละเท่าไร หมายเลขที่แสดงค่า
ระดับประสิทธิภาพของตู้เย็นนี้แบ่งเป็น 5 ระดับคือ

19

หมายเลข 1   แสดงถึงระดับความสามารถในการทำความเย็นของตู้เย็นมี
ประสิทธิภาพต่ำ

หมายเลข 2   แสดงถึงระดับความสามารถในการทำความเย็นของตู้เย็นมี
ประสิทธิภาพพอใช้

หมายเลข 3   แสดงถึงระดับความสามารถในการทำความเย็นของตู้เย็นมี
ประสิทธิภาพปานกลาง

หมายเลข 4   แสดงถึงระดับความสามารถในการทำความเย็นของตู้เย็นมี
ประสิทธิภาพดี

หมายเลข 5   แสดงถึงระดับความสามารถในการทำความเย็นของตู้เย็นมี
ประสิทธิภาพดีมาก

ทั้งนี้ตัวเลขระดับประสิทธิภาพยิ่งมากยิ่งแสดงว่าตู้เย็นนั้น มีความสามารถ
ในการทำความเย็นมากแต่จะกินไฟน้อย เมื่อเปรียบเทียบกับตู้เย็นที่มีความจุ
เดียวกัน

นอกจากจะเลือกใช้ตู้เย็นประหยัดพลังงานแล้ว การใช้ตู้เย็นรวมไปถึงการ
ดูแลรักษาที่ถูกวิธี ก็เป็นการช่วยประหยัดค่าไฟฟ้า และยังสามารถยืดอายุการใช้งาน
ให้ยาวนานได้อีกทางหนึ่งด้วย

<u>คำแนะนำในการเลือกซื้อตู้เย็นที่มีการประหยัดพลังงาน</u>
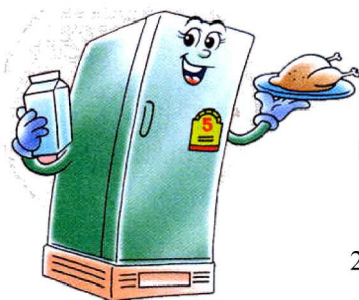
1. เลือกซื้อตู้เย็นที่มีระบบละลายน้ำแข็ง
ด้วยปุ่มแทนระบบละลายน้ำแข็งอัตโนมัติ (No
Frost) เพราะจะใช้พลังงานน้อยกว่า
2.   เลือกซื้อตู้เย็นชนิดประตูเดียวแทนหลายประตู

20

เพราะตู้เย็นหลายประตูจะใช้คอมเพรสเซอร์ขนาดใหญ่ซึ่งจะทำให้ใช้ไฟมาก

　　　3.เลือกซื้อตู้เย็นที่มีฉนวนโดยรอบหนา เพื่อป้องกันการสูญเสียความเย็น และควรเป็นฉนวนกันความร้อนชนิดโฟมฉีด เพราะจะทำให้อาหารเย็นได้ง่ายและใช้ไฟฟ้าน้อยกว่า

　　　4. เลือกซื้อตู้เย็นที่มีสีอ่อน เพราะจะทำให้การสะท้อนแสงภายในห้องที่ติดตั้งตู้เย็นดีขึ้น เป็นการช่วยลดการทำงานของคอมเพรสเซอร์ที่ต้องทำงานหนัก อันเกิดจากความร้อนภายในห้อง

　　　5.　　เลือกซื้อตู้เย็นที่มีความคงทนแข็งแรง และได้รับเครื่องหมายรับรองคุณภาพมาตรฐานผลิตภัณฑ์อุตสาหกรรม

　　　6. เลือกใช้ตู้เย็นที่มีฉลากประหยัดไฟเบอร์ 5 ถึงร้อยละ 20

<u>วิธีการดูแลตู้เย็นให้มีการประหยัดพลังงาน</u>
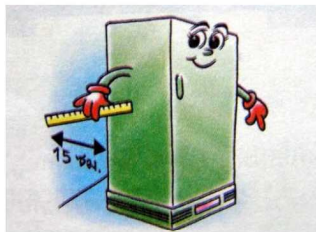
　　　1. การติดตั้งตู้เย็นควรตั้งห่างจากผนังด้านหลัง และด้านข้าง ไม่น้อยกว่า 15　เซนติเมตร และห่างจากฝ้าเพดานไม่น้อยกว่า 30　เซนติเมตร เพื่อให้อุปกรณ์ระบายความร้อนของตู้เย็นระบายความร้อนได้ดี และไม่ควรให้ตู้เย็นถูกแสงแดดหรืออยู่ใกล้เตาประกอบหรือหุงต้มอาหารทุกชนิด เพราะจะทำให้ตู้เย็นระบายความร้อนไม่ดี สิ้นเปลืองไฟ

　　　2. ตั้งสวิตซ์ควบคุมอุณหภูมิให้เย็นมากยิ่งเปลืองไฟมากขึ้น ควรตั้งที่ระดับความเย็นที่เบอร์ 3　เนื่องจากอุณหภูมิที่เหมาะสมกับการรักษาคุณค่าอาหารในตู้เย็นควรอยู่ที่ 4-6 องศาเซลเซียส　ส่วนในช่องแช่แข็งควรมีอุณหภูมิระหว่าง ลบ 15-18 องศาเซลเซียส　ถ้าระดับอุณหภูมิตู้เย็นอยู่นอกเหนือจากเกณฑ์ที่กำหนดนี้ ต้อง

21

ปรับที่ควบคุมอุณหภูมิใหม่เพราะถ้าตั้งอุณหภูมิตู้เย็นไว้เย็นกว่าที่กำหนดไว้   1 องศาเซลเซียส การใช้ไฟฟ้าจะเพิ่มขึ้นถึง 25 %

 3. อย่านำของที่ยังมีความร้อนหรืออุ่นเข้าไปแช่ทันทีควรรอให้เย็นก่อนเนื่องจากตู้เย็นต้องเริ่มสะสมความเย็นใหม่ นอกจากนี้จะทำให้ภายในห้องร้อนขึ้นเนื่องจากคอมเพรสเซอร์จะทำงานหนักขึ้น เพื่อระบายความร้อนออกทางแผงระบายความร้อนหลังตู้เย็น

 4. ควรเก็บสิ่งของหรืออาหารที่ต้องการใช้บ่อยๆให้อยู่ในพื้นที่ใกล้มือภายในตู้เย็นเพื่อให้เกิดความสะดวกในการหยิบใช้และไม่ควร ปิด - เปิด ตู้เย็นบ่อยหรือเปิดทิ้งไว้นานๆเพราะจะทำให้คอมเพรสเซอร์ทำงานมากขึ้น เพื่อรักษาอุณหภูมิภายในตู้เย็นที่ตั้งไว้ให้เท่าเดิม

 5. ไม่ควรแช่ของจนแน่นตู้ เพราะจะทำให้การหมุนเวียนของอากาศเย็นภายในตู้เย็นทำได้ไม่ดี ทำให้บริเวณบางส่วนไม่เย็น มีผลทำให้คอมเพรสเซอร์ทำงานนานสิ้นเปลืองกำลังไฟฟ้า

 6. หมั่นละลายน้ำแข็งอย่าให้เกาะช่องน้ำแข็งมากเกินไปโดยกดปุ่มละลายน้ำแข็งหรือดึงปลั๊กออกจนน้ำแข็งละลายหมด

 7. ควรตรวจสอบขอบยางประตูตู้เย็น โดยเสียบกระดาษระหว่างขอบยางแล้วปิดประตู ถ้าสามารถเลื่อนกระดาษขึ้นลงได้แสดงว่าขอบยางเสื่อม ควรเปลี่ยนใหม่เพราะจะทำให้คอมเพรสเซอร์ทำงานหนักสิ้นเปลืองไฟ

 8. ในกรณีที่ไฟฟ้าตก ควรดึงปลั๊กตู้เย็นออกชั่วคราว

 9. อย่าใช้ของแข็งหรือของมีคมงัดหรือแงะน้ำแข็ง เพราะอาจทำให้แผงความเย็นชำรุดเสียหายได้

 10. ในกรณีที่ไม่ได้ใช้งานหลายวัน ควรถอดปลั๊กตู้เย็นแล้วทำความสะอาดตู้เย็น และเปิดประตูแง้มไว้เพื่อไม่ให้เกิดมีกลิ่นเหม็นอับ

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พัดลม

พัดลม เป็นเครื่องใช้ไฟฟ้าที่ให้ความเย็นโดยแรงลม ซึ่งเป็นที่นิยมใช้กัน ทั่วไปแทบทุกครอบครัว เนื่องจากมีราคาไม่แพงมากนัก พัดลมที่ใช้กันในปัจจุบันมี อยู่ 3ประเภท คือพัดลมตั้งโต๊ะ พัดลมตั้งพื้น และพัดลมติดผนัง ซึ่งในการที่จะเลือก ซื้อพัดลมมาใช้นั้น ควรพิจารณาถึงหลักการทำงานเพื่อเปรียบเทียบสมรรถนะของ พัดลมในแต่ละรุ่น รวมถึงควรศึกษาถึงวิธีการใช้เพื่อให้สามารถดูแลบำรุงรักษา พัดลมได้อย่างมีประสิทธิภาพ และมีอายุการใช้งานที่นาน ซึ่งจะส่งผลดีต่อผู้ใช้งาน ในด้านการประหยัดพลังงานไฟฟ้า และค่าใช้จ่ายภายในบ้านได้

<u>คำแนะนำในการเลือกซื้อพัดลมเพื่อการประหยัดพลังงานไฟฟ้า</u>

1. เลือกซื้อพัดลมที่เป็นแบบธรรมดา เพราะจะประหยัดไฟกว่าระบบรีโมท คอนโทรล

2. พัดลมตั้งโต๊ะจะมีราคาต่ำกว่าพัดลมตั้งพื้น และใช้พลังงานไฟฟ้าต่ำกว่า เนื่องจากมีขนาดมอเตอร์และกำลังไฟฟ้าต่ำกว่าแต่ พัดลมตั้งพื้นจะให้แรงลมมากกว่า

3. เลือกพัดลมที่มีความคงทนแข็งแรง ได้รับเครื่องหมายรับรองคุณภาพมาตรฐาน อุตสาหกรรมสำนักงานมาตรฐาน ผลิตภัณฑ์อุตสาหกรรม (สมอ.)

4.　　เลือกซื้อพัดลมที่มีฉลากแสดงถึงประสิทธิภาพ และเลือกรุ่นที่มี ประสิทธิภาพสูง

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5.   เลือกซื้อขนาดพัดลมที่มีใบพัด และกำลังไฟฟ้าที่เหมาะสมกับขนาดพื้นที่ใช้ สอย และจำนวนคนในครอบครัว เช่น ถ้าต้องการใช้เพียงคนเดียวหรือไม่เกิน 2   คน ควรใช้พัดลมตั้งโต๊ะ เพราะความแรงของลมเพียงพอ และยังประหยัดไฟกว่าพัดลมชนิดอื่นๆ
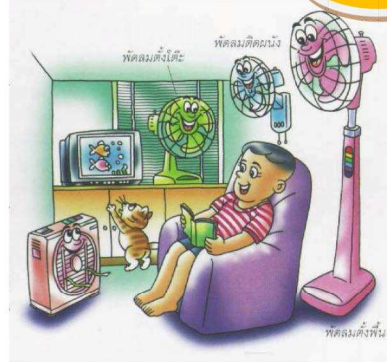
<u>**คำแนะนำในการใช้พัดลมให้มีการประหยัดพลังงานไฟฟ้า**</u>

1.   ควรเลือกใช้ความแรงหรือความเร็วของลมให้เหมาะสมกับความต้องการและสถานที่ เพราะหากความแรงของลมมากขึ้นจะใช้ไฟมากขึ้นตามไปด้วย

2. ควรวางพัดลมในที่ที่มีอากาศถ่ายเทได้สะดวก เพราะพัดลมใช้หลักการดูดอากาศจากบริเวณรอบๆทางด้านหลังของตัวใบพัดลมแล้วปล่อยออกสู่ด้านหน้า เช่นถ้าอากาศบริเวณรอบพัดลมอับชื้น ก็จะได้ลมร้อนและอับชื้นเช่นกันนอกจากนี้มอเตอร์ยังระบายความร้อนได้ดีขึ้น ไม่เสื่อมสภาพเร็วเกินไป

3. สังเกตุอุณหภูมิของตัวพัดลม โดยเฉพาะบริเวณมอเตอร์ถ้าร้อนจนเกินไป ควรหยุดพักพัดลมเพื่อยืดอายุการใช้งานของมอเตอร์

4. ไม่เปิดพัดลมทิ้งไว้ในขณะที่ไม่มีคนอยู่ เมื่อไม่ต้องการพัดลมควรรีบปิดเพื่อให้มอเตอร์ได้มีการพัก และไม่เสื่อมสภาพเร็วเกินไป

5. อย่าเสียบปลั๊กทิ้งไว้โดยเฉพาะพัดลมที่มีระบบรีโมทคอนโทรลเพราะจะมีไฟฟ้าไหลเข้าตลอดเวลา เพื่อหล่อเลี้ยงอุปกรณ์อิเล็คทรอนิคส์

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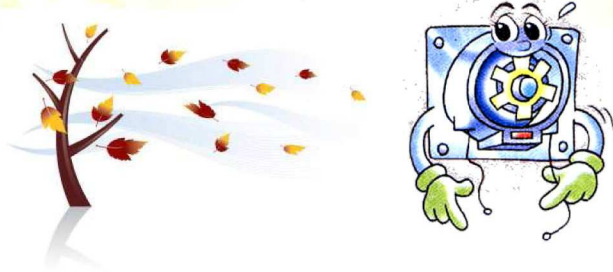
เครื่องซักผ้า

เครื่องซักผ้า เป็นเครื่องใช้ไฟฟ้าที่กำลังเป็นทีนิยมกัน มากในขณะนี้ เนื่องจากเป็นการอำนวยความสะดวก และช่วยประหยัดแรงงานและเวลาของแม่บ้านในยุคปัจจุบัน จัดว่าเป็นเครื่องทุ่น แรงสำหรับครอบครัวที่มีเวลาจำกัด ซึ่งในการใช้งานนั้นหากมีการใช้ถูกวิธีก็จะช่วย ประหยัดพลังงานและค่าใช้จ่ายได้ ซึ่งในการใช้เครื่องซักผ้าเพื่อให้เกิดการประหยัด และสามารถยืดอายุการใช้งานของเครื่องให้ยาวนานนั้น สามารถปฏิบัติได้ดังนี้

1.   ควรแช่ผ้าก่อนเข้าเครื่องจะทำให้ง่ายต่อการซักผ้าและสามารถเลือก โปรแกรมซักแบบประหยัดได้

2. เครื่องซักผ้าที่มีเครื่องอบแห้งในตัวจะสิ้นเปลือง ไฟฟ้ามากว่าแบบธรรมดา ควรตากผ้ากับแสงแดดหรือในที่ มีลมพัดผ่าน

3. ปริมาณผ้าที่ซักให้เป็นไปตามพิกัดของเครื่อง อย่าใส่ผ้าน้อยหรือมากเกินไป

4. ควรใช้โปรแกรมที่ใช้น้ำร้อนซักผ้าเมื่อจำเป็นเท่านั้น เพราะจะสิ้นเปลือง ไฟฟ้ามาก

5. ควรตั้งโปรแกรมการซักผ้าให้เหมาะสมกับชนิดของผ้าทุกครั้ง

6. ควรเลือกขนาดของเครื่องซักผ้าให้เหมาะสมกับการใช้งาน

    - เครื่องเปิดแบบฝาบนหมาะกับการซักผ้าที่ไม่มาก

    - เครื่องแบบเปิดฝาหน้าเหมาะกับการซักผ้าจำนวนมากหรือซักผ้าห่ม

7. ควรตั้งปริมาณน้ำและใส่ผงซักฟอกให้พอดีกับจำนวนผ้าที่จะซัก

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เตารีดไฟฟ้า

เตารีดไฟฟ้า เป็นเครื่องใช้ไฟฟ้าที่จัดอยู่ในประเภทที่ให้ความร้อน ซึ่ง ให้ประโยชน์ในการรีดผ้าที่เราสวมใส่เรียบร้อย สวยงามเพิ่มความสะอาดเรียบร้อย ให้กับผู้สวมใส่ ปัจจุบันนิยมใช้กันแทบทุกครอบครัว ทั้งนี้เตารีดไฟฟ้าจัดว่าเป็น เครื่องใช้ไฟฟ้าที่ใช้กำลังไฟฟ้าสูงชนิดหนึ่ง ในการเลือกซื้อเตารีดไฟฟ้ามาใช้นั้น บางท่านคิดว่าถ้าหากซื้อเตารีดไฟฟ้าที่มีขนาดกำลังไฟฟ้าน้อย จะเป็นการประหยัด พลังงานไฟฟ้าและค่าไฟมากกว่าเตารีดไฟฟ้าที่มีกำลังไฟฟ้ามาก ซึ่งในความเป็น จริงแล้วมิได้เป็นเช่นนั้นเนื่องจากความร้อนที่ได้จากเตารีดที่มีกำลังไฟฟ้าน้อยหรือ ความร้อนไม่พอเพียงกับชนิดของผ้านั้นๆก็จะทำให้ผ้าที่รีดไม่เรียบและต้องใช้เวลา ในการรีดนาน ทำให้ต้องใช้พลังงานไฟฟ้าเพิ่มมากขึ้น ดังนั้นในการเลือกซื้อเตารีด ให้เหมาะสมกับการใช้งานรวมถึงการรู้จักวิธีการใช้ก็เป็นสิ่งหนึ่งที่ช่วยให้เกิดการ ประหยัดทั้งพลังงานไฟฟ้า และค่าใช้จ่ายที่เกิดขึ้นจากการใช้เตารีดให้กับแต่ละ ครอบครัวได้

คำแนะนำในการใช้เตารีด ไฟฟ้าเพื่อการประหยัดพลังงาน

1. ควรเก็บผ้าที่รอการรีดให้ เรียบร้อย และทำให้เสื้อผ้ายับน้อยที่สุด เพราะการรีดผ้าที่ยับมากจะใช้เวลาในการ รีดนานกว่าผ้าที่ยับน้อย

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2. ก่อนจะรีดผ้าทุกครั้ง ควรแยกประเภทผ้า หนา ผ้าบางไว้เพื่อความสะดวกในการที่จะเลือกรีด ผ้าก่อนหรือหลัง โดยควรที่จะเริ่มรีดผ้าบางๆหรือผ้า ที่ต้องการความร้อนน้อยก่อน พอเตารีดเริ่มร้อนมาก ขึ้นแล้วจึงรีดผ้าที่ต้องการความร้อนสูง

3.ในการรีดผ้าแต่ละครั้งนั้น ควรรอให้ผ้าที่ รีดมากพอสมควรแล้วจึงรีด ไม่ควรรีดทีละชุด เพราะจะทำให้เปลืองค่าไฟฟ้า

4. การพรมน้ำไม่ควรพรมน้ำมาก จนเกินไปจะทำให้สูญเสียความร้อนในการ รีดมากขึ้นโดยไม่จำเป็น เพราะการพรมน้ำ เปียกเกินไปจะทำให้ใช้เวลาในการรีดนาน เป็น 2 เท่าของการรีดผ้าที่พรมน้ำพอดี เตา รีดต้องใช้ปริมาณความร้อนที่มากกว่าเดิม ซึ่งจะทำให้เปลืองไฟฟ้ามากขึ้น

5. ตรวจดูหน้าเตารีด (แผ่นความร้อนที่สัมผัสกับผ้า) ถ้ามีคราบสกปรกให้ ใช้ฟองน้ำชุปทำความสะอาด เพราะคราบสกปรกจะเป็นค่าต้านทานความร้อน ทำ ให้ต้องใช้ความร้อนเพิ่มขึ้น

6. ควรดึงปลั๊กเตารีดก่อนเสร็จสิ้นการรีด ประมาณ 3-4 นาทีเพราะความ ร้อนที่เหลืออยู่ในเตารีดยังสามารถรีดผ้าชนิดที่ไม่ต้องการความร้อนมาก เช่น ผ้าเช็ดหน้า เป็นต้น

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หม้อหุงข้าว

เนื่องจากคนไทยรับประทานข้าวเป็นอาหารหลักจึงผูกพันกับข้าวมาเป็นเวลานาน การที่จะได้มาซึ่งข้าวที่พร้อมสำหรับการบริโภคก็คือ ต้องนำข้าวมาหุงต้มให้สุกก่อนซึ่งในอดีตการหุงข้าวต้องใช้เวลาในการหาฟืนหรือถ่านมาเป็นเชื้อเพลิงในการหุงต้ม และภาชนะที่ใช้สำหรับหุงข้าวก็ได้แก่หม้อหุงข้าว ซึ่งได้มีการพัฒนารูปแบบมาเรื่อยๆจนถึงปัจจุบันที่เราเห็นกันในรูปของหม้อหุงข้าวไฟฟ้า ที่มีความสะดวกรวดเร็วในการหุงข้าวจนเป็นที่นิยมกว้างขวางทุกครอบครัว เนื่องจากการใช้หม้อหุงข้าวต้องใช้พลังงานไฟฟ้ามาช่วยในการทำงานของตัวเครื่อง ดังนั้นการรู้จักเลือกซื้อให้เหมาะสมกับขนาดของครอบครัวหรือความต้องการใช้ จัดว่าเป็นการใช้หม้อหุงข้าวอย่างมีประสิทธิภาพ และใช้พลังงานเท่าที่จำเป็นไม่ให้สิ้นเปลืองโดยเปล่าประโยชน์ ประหยัดพลังงานและประหยัดค่าไฟฟ้าอีกด้วย

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<u>คำแนะนำในการใช้หม้อหุงข้าวไฟฟ้าเพื่อการประหยัดพลังงาน</u>

1. การหุงข้าวด้วยหม้อหุงข้าวไฟฟ้า ก็คือการหุงข้าวแบบไม่เช็ดน้ำ ดังนั้นจะต้องกะปริมาณน้ำให้พอเหมาะ ถ้าเติมน้ำมากเกินไปนอกจากจะทำให้ข้าวแฉะแล้ว ตัวหม้อจะยังหุงอยู่จนกว่าน้ำจะแห้งหมด ทำให้สิ้นเปลืองพลังงานไฟฟ้าโดยเปล่าประโยชน์

2. ขณะหุงข้าวด้วยหม้อหุงข้าวไฟฟ้า ไม่ควรเปิดฝาหม้อข้าวเพื่อดูว่าข้าวสุกหรือยัง หรือเพื่อคนข้าวไม่ให้ติดก้นหม้อขณะหุง เพราะจะทำให้สูญเสียความร้อนไปโดยเปล่าประโยชน์ ทำให้เสียค่าไฟเพิ่มขึ้น

3. ไม่ควรหุงข้าวในห้องปรับอากาศ เพราะนอกจากความร้อนที่เกิดจากการหุงข้าวจะทำให้เครื่องปรับอากาศทำงานหนักแล้วไอน้ำที่เกิดขึ้นขณะหุงข้าวยังไปกลั่นตัวเป็นหยดน้ำโดยไม่จำเป็น

4. ควรหุงข้าวให้พอดีกับจำนวนคนข้าวจะได้ไม่เหลือมาก การอุ่นจะทำให้ข้าวแข็ง เพราะน้ำระเหยออกมา ก่อนอุ่นข้าวทุกครั้งอาจจะพรวนข้าวให้ร่วนพรมน้ำเล็กน้อยแล้วค่อยอุ่น หรือจะใช้น้ำส้มสายชูพรมเล็กน้อยจะช่วยให้ข้าวนุ่มเหมือนเดิม

5. ควรถอดปลั๊กออกทันทีเมื่อเลิกใช้งาน

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เครื่องทำน้ำอุ่นไฟฟ้า

เครื่องทำน้ำอุ่นไฟฟ้า เป็นเครื่องใช้ไฟฟ้าที่นิยม
ใช้กันมากในปัจจุบัน เนื่องจากส่วนใหญ่ผู้ใช้ได้รับ
ประโยชน์จากการอาบน้ำอุ่นในการขจัดไขมันหรือสิ่ง
สกปรกที่ติดตามร่างกายได้ดีกว่าน้ำเย็น และยังทำให้รู้สึก
สบายตัวกว่าอาบน้ำเย็น เนื่องจากเครื่องทำน้ำอุ่นเป็นอุปกรณ์ที่ต้องใช้พลังงานงาน
ไฟฟ้าซึ่งปกติแล้วจะใช้พลังงานไฟฟ้าประมาณ 900-4,800 วัตต์ซึ่งก็แล้วแต่ขนาด
ดังนั้นผู้ใช้ควรทราบถึงวิธีการใช้ เพื่อประหยัดพลังงานและเพื่อลดค่าใช้ไฟฟ้า
ภายในบ้าน จึงขอแนะนำ
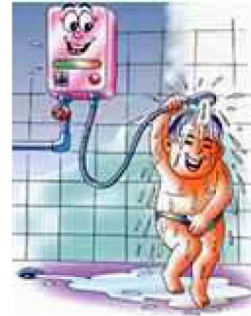
วิธีการใช้เครื่องทำน้ำอุ่นไฟฟ้าเพื่อประหยัดพลังงานดังนี้

1. ควรพิจารณาเลือกเครื่องทำน้ำอุ่นให้เหมาะสมกับการใช้เป็นหลัก เช่น
ต้องการน้ำอุ่นเพื่ออาบน้ำเท่านั้นก็ควรติดตั้งชนิดทำน้ำอุ่นได้จุดเดียว

2. ควรเลือกใช้ฝักบัวชนิดที่ประหยัดน้ำ เพราะสามารถประหยัดน้ำได้ถึง
ร้อยละ 25-75

3. ดูแลอย่าให้น้ำรั่วจากฝักบัว จะเป็นการสิ้นเปลืองน้ำและเครื่องทำน้ำอุ่น
จะทำงานมากกว่าปกติ เป็นการสิ้นเปลืองพลังงานไฟฟ้า

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4.   ควรเลือกใช้เครื่องทำน้ำอุ่นที่มีถัง เก็บภายในตัวเครื่องและมีฉนวนหุ้ม เพราะ สามารถลดการใช้พลังงานได้ร้อยละ 10-20
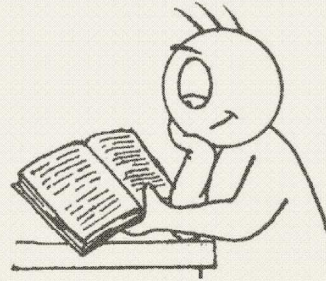
5.   ควรติดตั้งเครื่องทำน้ำอุ่นชนิดป้อน น้ำร้อน 1 เครื่อง 1ห้องน้ำ จะประหยัดไฟกว่าที่ติดตั้งเครื่องทำน้ำอุ่นเครื่องเดียวแต่ ป้อนน้ำอุ่นได้ครั้งละหลายๆห้อง

6.ไม่ควรเปิดเครื่องทำน้ำอุ่นตลอดเวลาในขณะฟอกสบู่ อาบน้ำ หรือสระ ผม เพราะจะทำให้สิ้นเปลืองทั้งน้ำและไฟฟ้า

7. ไม่ควรปรับระดับความแรงของน้ำไว้ที่ระดับแรงสุดควรปรับไว้ที่ระดับ ปานกลาง

8. ควรปิดวาล์วน้ำและสวิตซ์ทันทีเมื่อเลิกใช้งาน ไม่ควรเปิดสวิตซ์ทิ้งไว้จะ เป็นการสิ้นเปลืองไฟฟ้า

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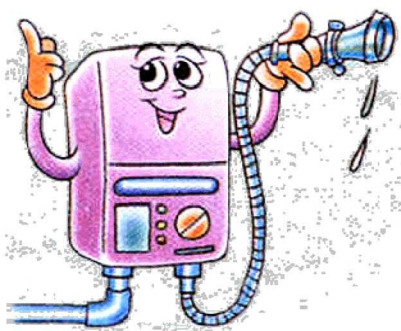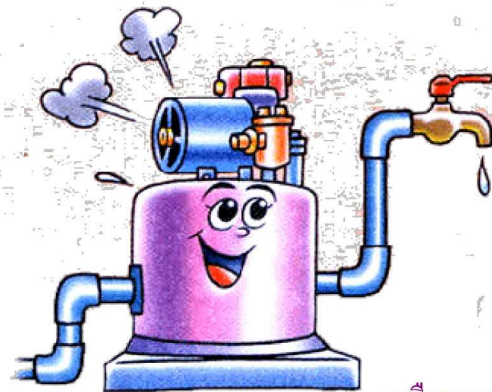
เครื่องปั๊มน้ำ

ปั๊มน้ำ เป็นเครื่องมือกล ที่ทำหน้าที่เพิ่มพลังงานให้กับน้ำ หรือของเหลว พลังงานที่ทำน้ำที่ขับปั๊มอาจจะเป็นมอเตอร์ไฟฟ้า เครื่องยนต์ แรงลม แรงคน หรือพลังงานจากแหล่งอื่นๆ แต่ที่นิยมใช้คือมอเตอร์ไฟฟ้า เพื่อทำให้น้ำหรือของเหลวเคลื่อนที่จากตำแหน่งหนึ่งไปยังอีกตำแหน่งหนึ่งที่อยู่สูงกว่า หรือในระยะที่ไกลออกไป ปั๊มน้ำจึงเป็นอุปกรณ์ไฟฟ้าที่มีความจำเป็นในอุตสาหกรรมหรือตามบ้านเรือน โดยเฉพาะตามที่พักอาศัยซึ่งเป็นอาคารชุด ตามสำนักงาน อาคารพาณิชย์ต่างๆ หรือในบางพื้นที่ที่ต้องการสูบน้ำจากใต้ดินขึ้นมาใช้ดังนั้นการใช้น้ำโดยผ่านเครื่องปั๊มน้ำอย่างถูกวิธี จะเป็นการใช้ไฟฟ้าและน้ำอย่างมีประสิทธิภาพด้วย

คำแนะนำในการใช้เครื่องปั๊มน้ำเพื่อการประหยัดพลังงาน

1. การเปิดก๊อกน้ำเพื่อใช้น้ำจะมีผลต่อการทำงานของปั๊มน้ำ ดังนั้นเพื่อเป็นการประหยัดน้ำและไฟฟ้าควรเปิดก๊อกน้ำใช้ตามความจำเป็น แต่ถ้าหากมีความจำเป็นจะต้องเปิดใช้น้ำหลายจุดพร้อมกัน เช่นใช้ฝักบัวอาบน้ำพร้อมกับล้างจานและรดน้ำต้นไม้จะทำให้ปั๊มน้ำทำงานตลอดเวลา ควรเปิดใช้ก๊อกน้ำแต่ละจุดโดยให้น้ำไหลแต่พอประมาณ เพื่อลดการทำงานหนักของปั๊มน้ำ

2. ไม่ควรเปิดปั๊มน้ำทิ้งไว้เมื่อไม่อยู่บ้านหรือไม่ใช้งานนานๆ

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3. ควรปิดก๊อกน้ำให้สนิททุกครั้ง เพราะถึงแม้ถ้ามีน้ำหยดเพียงเล็กน้อยติดต่อกันนานๆก็ทำให้ปั๊มน้ำเดินเครื่องได้

4. อย่าเปิดก๊อกน้ำไปที่ระดับแรงสุด เพราะจะทำให้ปั๊มทำงานหนักเป็นการสิ้นเปลืองน้ำและไฟฟ้า

5. ไม่ควรใช้ปั๊มน้ำในการฉีดน้ำรดต้นไม้หรือสนามหญ้า ควรใช้น้ำจากการซักล้างหรือการต่อน้ำจากก๊อกน้ำปกติที่ไม่ต้องใช้ปั๊มน้ำ

6. ไม่ควรซักผ้าหรือล้างถ้วยชามหรือล้างผลไม้โดยตรงจากก๊อกน้ำทีละชิ้น เพราะจะเป็นการสิ้นเปลืองทั้งน้ำและไฟฟ้า

7. คอยดูแลรักษาท่อน้ำ หัวฝักบัว และอุปกรณ์ต่างๆไม่ให้รั่วซึม เพราะปั๊มจะทำงานมากขึ้นและใช้ไฟฟ้ามากขึ้น

8. ควรเลือกใช้ปั๊มน้ำที่มีถังความดันประกอบสำเร็จเป็นชุดเพราะจะมีผลต่อการรักษาความดันของน้ำในการใช้งานและช่วยประหยัดพลังงานได้ด้วย

9. ควรเลือกใช้ปั๊มน้ำที่ใช้มอเตอร์ที่มีประสิทธิภาพสูง

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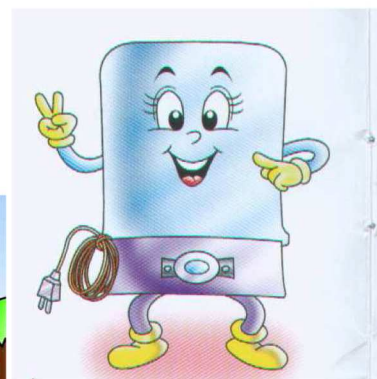
การทำบัญชีพลังงานไฟฟ้า (Energy Audit)

การทำบัญชีพลังงานไฟฟ้า เป็นการศึกษา
ตรวจสอบสภาพการใช้พลังงานไฟฟ้าเพื่อการวาง
แผนการจัดการพลังงานไฟฟ้า เพื่อแนวทางประหยัด
พลังงานไฟฟ้า มีขั้นตอนปฏิบัติตามลำดับ 3 ขั้นตอน
ดังนี้ (สำนักงานคณะกรรมการนโยบายแห่งชาติ, 2540)

1. การตรวจสอบและวิเคราะห์การใช้พลังงานเบื้องต้น

(Preliminary audit)

เป็นการตรวจสอบรวบรวมและศึกษาข้อมูลด้านการผลิต ระบบการใช้
พลังงานในปีก่อน ๆ ที่ทางผู้อยู่อาศัยจดบันทึกไว้ เพื่อต้องการทราบปริมาณการใช้
พลังงานทุกรูปแบบค่าใช้จ่ายด้านพลังงาน ผลผลิตที่ได้ต่อปริมาณพลังงานที่ใช้ ตัว
แปรการใช้พลังงานในแต่ละช่วงตลอดจนรายละเอียดที่เกี่ยวข้อง

2. การตรวจสอบวิเคราะห์การใช้พลังงานโดยการสำรวจ

ขั้นตอนแรกเป็นการสำรวจแผนผังบริเวณอาคาร ที่จะทำการสำรวจ เพื่อให้
ทราบถึงลักษณะทั่วไปของ
บริเวณอาคาร กระบวนการผลิต
และอุปกรณ์ เครื่องจักรต่างๆ
พิจารณาบริเวณที่มีการใช้
พลังงานในรูปแบบต่างๆ และ
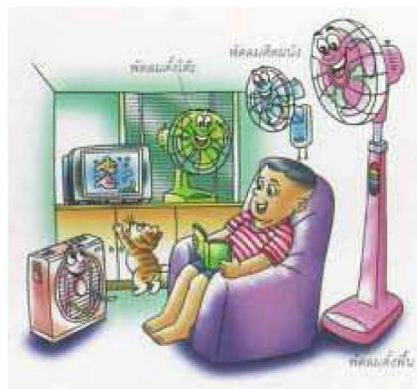บริเวณที่เกี่ยวข้อง และขั้นตอน

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การเข้าสำรวจ เพื่อหาต้นเหตุการณ์สูญเสียพลังงาน ทำการสำรวจการใช้พลังงานทุก
ระบบทั้งในช่วงทำการผลิต และช่วงหยุดการผลิต รวมทั้งการตรวจวัดโดยใช้
เครื่องมือวัดต่าง ๆ ทำให้ได้ข้อมูลสภาพการใช้พลังงาน

3. การตรวจสอบและการวิเคราะห์การใช้พลังงานอย่างละเอียด

(Detailed audit)

ผลของการตรวจสอบและการ
วิเคราะห์การใช้พลังงานขั้นต้น นำ
ข้อมูลมาพัฒนารูปแบบการประหยัด
พลังงานไฟฟ้าภายในบ้านโดยผ่าน
กระบวนการสิ่งแวดล้อมศึกษา ว่า
จะต้องมีการปรับปรุงแก้ไขส่วนใดบ้าง
ซึ่งจะต้องทำการตรวจสอบและ
วิเคราะห์อย่างละเอียด โดยทำการ
ตรวจวัดและบันทึกข้อมูลอย่างต่อเนื่อง หรือเป็นช่วงเวลา อย่างน้อย 1   สัปดาห์
เพื่อให้ทราบถึงสภาพการทำงานและวิเคราะห์การสูญเสียพลังงาน โดยจัดทำสมดุล
พลังงานความร้อนของอุปกรณ์หลักและ
ของที่อยู่อาศัย เพื่อหาประสิทธิภาพของ
ระบบและประสิทธิภาพของอุปกรณ์
วิเคราะห์ทางด้านเศรษฐศาสตร์และ
ทางด้านการเงินในแต่ละมาตรการ เพื่อ
การลงทุนที่เหมาะสมและมีความเป็นไป
ได้

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การวิเคราะห์ทางด้านเศรษฐศาสตร์

การวิเคราะห์ทางด้าน เศรษฐศาสตร์ เป็นการประเมินผล ที่ช่วยในการตัดสินใจพิจารณาถึง ความคุ้มค่าของการลงทุนหรือการ ดำเนินการในโครงการใดโครงการ หนึ่ง ทั้งนี้โดยการเปรียบเทียบ

ระหว่างสิ่งที่ต้องใช้ไปกับผลที่คาดว่าจะได้รับกลับคืนมา(ชูชีพ พิพัฒน์ศิถี, 2538) โดยจะหาความคุ้มทุนจากเงินที่สามารถประหยัดได้จากพลังงานไฟฟ้าที่ต้องใช้ไป เปรียบเทียบกับเงินที่ลงทุน เป็นวิธีการที่จะช่วยตัดสินใจในการลงทุนเพราะฉะนั้น ความเหมาะสมในการดำเนินการลงทุนเพื่อการประหยัดไฟฟ้า จะพิจารณาจาก ปริมาณการใช้ไฟฟ้าในบ้าน และระยะเวลาคืนทุน (Payback Period) (วันชัย รุจิรว นิช,2531) ดังนี้
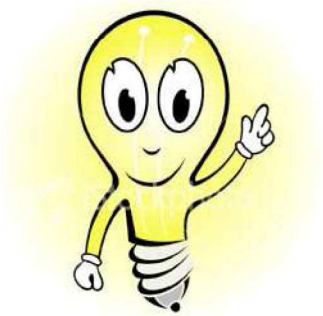
1. ปริมาณการใช้ไฟฟ้าในบ้าน

ปริมาณการใช้ไฟฟ้าในบ้าน คือ การหา ผลรวมของปริมาณการใช้ไฟฟ้า จาก เครื่องใช้ไฟฟ้าที่มีการใช้ในบ้านในหนึ่งชั่วโมง ซึ่ง มีค่าเท่ากับอัตราส่วนระหว่างค่าผลรวมของกำลัง งานไฟฟ้าจากเครื่องใช้ไฟฟ้าแต่ละชนิดในหนึ่ง ชั่วโมงกับค่ากำลังงานไฟฟ้าที่ใช้ในหนึ่งยูนิต(1,000) สามารถหาได้โดย

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ปริมาณการใช้ไฟฟ้าในบ้านในหนึ่งชั่วโมง(Unit/Hour) = ผลรวมของกำลังงานไฟฟ้าจากเครื่องใช้ไฟฟ้าแต่ละชนิด/1,000

สามารถสังเกตุค่ากำลังงานไฟฟ้าได้จากคู่มือการใช้งานหรือแถบป้ายที่ติดกับเครื่องใช้ไฟฟ้าที่เขียนว่า กำลังไฟฟ้า ซึ่งมีหน่วยเป็นวัตต์ (Watt) สามารถคำนวณค่าไฟฟ้าได้โดยเปรียบเทียบกับอัตราค่าไฟฟ้าได้ดังนี้

5 หน่วย (หน่วยที่ 1-5) เป็นเงิน 0.00 บาท

10 หน่วยต่อไป (หน่วยที่ 6-15) หน่วยละ 1.3576 บาท

10 หน่วยต่อไป (หน่วยที่16-25) หน่วยละ 1.5445 บาท

10 หน่วยต่อไป (หน่วยที่ 26-35) หน่วยละ 1.7968 บาท

65 หน่วยต่อไป (หน่วยที่ 36-100) หน่วยละ 2.1800 บาท

50 หน่วยต่อไป (หน่วยที่ 101-150) หน่วยละ 2.2734 บาท

250 หน่วยต่อไป(หน่วยที่ 151-400) หน่วยละ 2.7781 บาท

เกินกว่า 400 หน่วย (หน่วยที่ 401 เป็นต้นไป) หน่วยละ 2.9780 บาท

2. ระยะเวลาคืนทุน (Payback Period)

ระยะเวลาการคืนทุนเป็นวิธีการที่ง่ายและอาศัยพื้นฐานความคิดที่ไม่สลับซับซ้อนมากนัก กล่าวคือ เป็นการพิจารณาถึงจำนวนปี หรือช่วงเวลาที่จะได้รับผลตอบแทนคุ้มค่ากับค่าใช้จ่ายที่ลงทุนของโครงการ ดังนั้นโครงการใดที่มีระยะคืนทุนสั้นจะได้ความสำคัญสูงกว่าโครงการที่มีระยะคืนทุนมากกว่าโดยเปรียบเทียบ ระยะเวลาในการคืนทุน ซึ่งมีค่าเท่ากับอัตราส่วนระหว่างค่าใช้จ่ายที่

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ลงทุนต่อผลตอบแทนจากการดำเนินงานสามารถหาได้โดย   (ประสิทธิ์ ตงยิ่งศิริ ,2538)

ระยะเวลาคืนทุน = เงินลงทุน/เงินค่าพลังงานไฟฟ้าที่ประหยัดได้ใน 1 ปี

สรุปจากการทบทวนเรื่องการประหยัดพลังงาน ผู้วิจัยได้นำแนวคิดในการพยายามที่จะลดค่าปริมาณการใช้ไฟฟ้า ภายใต้เงื่อนไขของการบริหารจัดการพลังงานโดยไม่มีผลกระทบต่อกิจกรรมการอยู่อาศัย และควบคุมการใช้อุปกรณ์ต่างๆ ได้มีประสิทธิภาพสูงเหมาะสมกับระยะเวลาการใช้งาน จากการทำบัญชีพลังงานในการตรวจสอบการใช้พลังงานไฟฟ้าจากเครื่องใช้ไฟฟ้าที่มีอยู่ในบ้าน การวิเคราะห์ปริมาณพลังงานไฟฟ้าที่ใช้กับระยะคุ้มทุนในการลงทุนนำอุปกรณ์ควบคุมการประหยัดพลังงานไฟฟ้ามาใช้

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เอกสารอ้างอิง / แหล่งข้อมูล

http://www.crintermex.com

http://www.telepart.net/index.php?lay=show&ac=article&Id

http://www.library.cmu.ac.th/webpage2548/page01.html

http://www.oknation.net

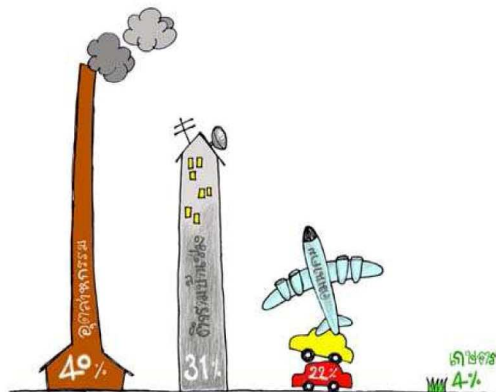http://www.oknation.net/blog/25-27/2008/07/02/entry-1

วารสารโลกพลังงาน

กองทุนเพื่อส่งเสริมการอนุรักษ์พลังงาน สำนักงานนโยบายและแผนพลังงาน

สถาบันจัดการและอนุรักษ์พลังงาน มหาวิทยาลัยเชียงใหม่

สถาบันวิจัยและพัฒนาวิทยาศาสตร์และเทคโนโลยี มหาวิทยาลัยเชียงใหม่

รวบรวมโดย

นายธราดล เทพอารีนันท์

นักศึกษาสาขาวิชาสิ่งแวดล้อมศึกษา

คณะสังคมศาสตร์และมนุษย์ศาสตร์

มหาวิทยาลัยมหิดล

APPENDIX B
THE PICTURES

การสอบถามข้อมูลการใช้พลังงานไฟฟ้าในชุมชน

การสอบถามข้อมูลการใช้พลังงานไฟฟ้าในชุมชน

การสัมภาษณ์ข้อมูลการใช้ไฟฟ้าในชุมชน

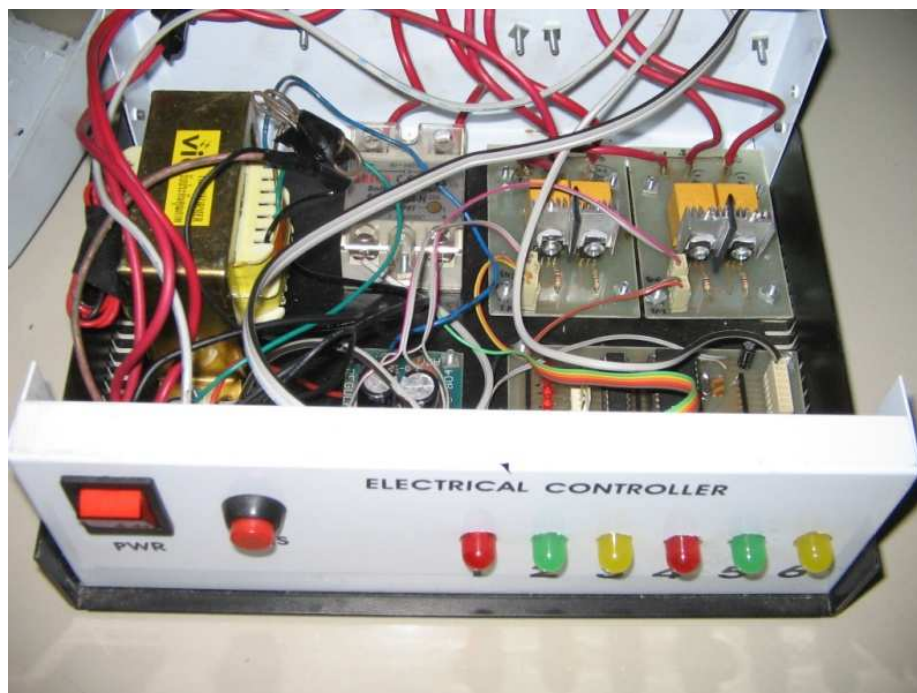

การอบรมให้ความรู้ในการประหยัดพลังงานไฟฟ้า

การซักถามความเข้าใจในการประหยัดพลังงานไฟฟ้าภายในบ้าน

ชุดอุปกรณ์ควบคุมการประหยัดพลังงานไฟฟ้าภายในบ้าน

อุปกรณ์ตรวจจับความเคลื่อนไหว

อุปกรณ์ควบคุม

ค่าไฟฟ้าแต่ละครัวเรือนที่ติดตั้งอุปกรณ์

บ้านที่ใช้ในการติดตั้งอุปกรณ์ควบคุมการประหยัดพลังงานไฟฟ้า

บ้านที่ใช้ในการติดตั้งอุปกรณ์ควบคุมการประหยัดพลังงานไฟฟ้า
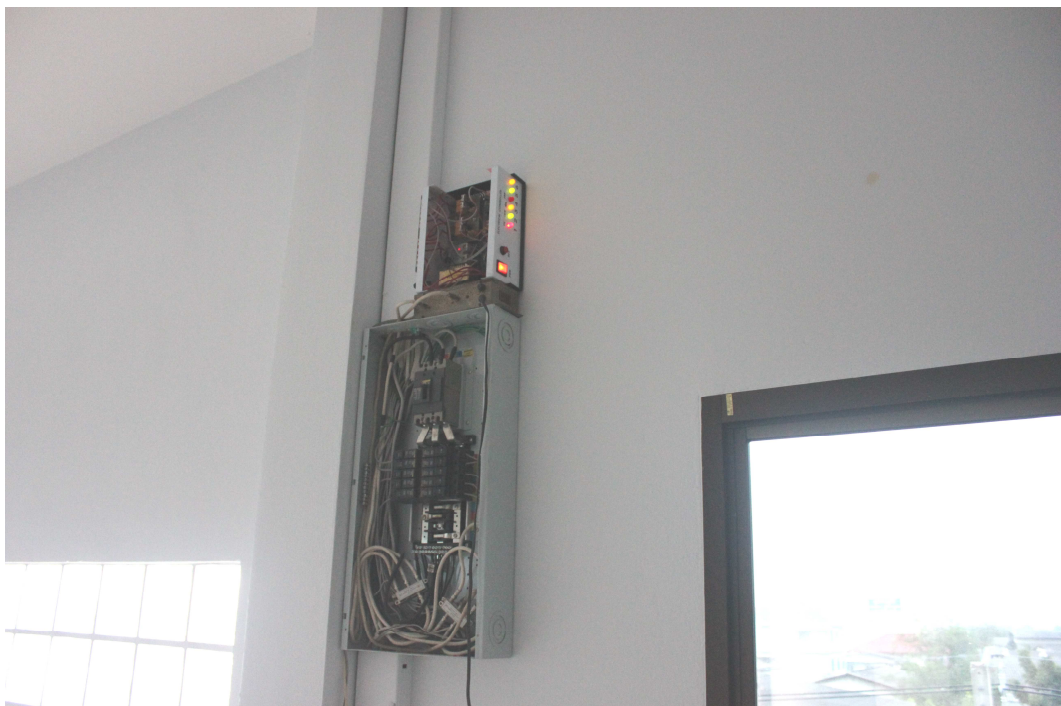

ตำแหน่งในการติดตั้งอุปกรณ์ตรวจจับความเคลื่อนไหว

ตำแหน่งในการติดตั้งอุปกรณ์ตรวจจับความเคลื่อนไหว

ตำแหน่งในการติดตั้งอุปกรณ์ตรวจจับความเคลื่อนไหว

ตำแหน่งการติดตั้งอุปกรณ์ควบคุม

ตำแหน่งการติดตั้งอุปกรณ์ควบคุม

COA.No.2010/027.3008

Documentary Proof of The Committee for Research Ethics (Social Sciences)

Title of Project: Home Electric Energy Saning Model Through Environmental Education Process
(Thesis for Ph.D.)

Principal Investigator: Mr.Taradol Tepareenun

Name of Institution: Social Sciences & Humanties, Mahidol University

Approval includes:
1) MU-SSIRB Submission form version received date 8 July 2010
2) Participant Information sheet for Experiment Group version date 11 August 2010
3) Participant Information sheet for Control Group version 11 August 2010
4) Informed Consent form version date 11 August 2010
5) Questionnaire version received date 8 July 2010
6) Knowledge Test version received date 8 July 2010
7) Interview Guideline version received date 8 July 2010

The Committee for Research Ethics (Social Sciences) is in full compliance with International Guidelines of Human Research Protection such as Declaration of Helsinki, The Belmont Report, CIOMS Guidelines and the International Conference on Harmonization in Good Clinical Practice (ICH-GCP)

Date of Approval: 30 August 2010

Date of Expiration: 29 August 2011

Signature of Chairman:..

(Emeritus Professor Santhat Sermsri)

Signature of Head of the Institute:...

(Assoc. Prof. Dr.Wariya Chinwanno)

Dean of Faculty of Social Sciences and Humanities

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