CHAPTER I

Introduction

Structure and Rationale of the Study

Electricity is the flow of electrons. It is a secondary energy source which means that it can be acquired from the conversion of other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources, which are called primary sources. The energy sources that is use to make electricity can be renewable or non-renewable, but electricity itself is either renewable or non-renewable.

Despite its great importance in our daily lives, most of the users rarely stop to think what life would be like without electricity. Yet like air and water, users tend to take electricity for granted. Everyday, they use electricity to do many jobs for us -- from lighting and heating/cooling our homes, to powering our televisions and computers.

Of all the domestic appliances that is commonly used as well as in some establishment the air- conditioner has the highest power consumption (NSO, 2005). But since it is still very useful in ventilating an enclose room many establishment would still prefer to use it to satisfy their ventilating and conditioning needs.

With the rising cost of electricity, various team of engineers, environmental consultants who formed a partnership to develop ranges of special products designed to maximize energy efficiency and increase awareness of energy saving.

This study is conducted to test energy saving capabilities using the three methods namely: (1) heat insulation which uses E- shield insulating film as a device; (2) heat sensor on air-conditioner compressors; and (3) special lubricating oil on air- conditioners which uses "ARTIKOOL™" lubricating oil.

Heat insulation uses insulating film that is attached to the inner side of the glass windows in the room. It minimizes the heat that comes from the sunlight passing through the glass windows. It also blocks the cold air to exhaust from the room. The cold air will just bounce back to the room air space. Therefore the temperature of the room will remain cold as desired.

Heat sensor of the air conditioner compressor will automatically monitor the temperature of the air- conditioner. It will maintain the desired room temperature. The device will automatically cut-off if the temperature gets cooler than desired, therefore minimizes the over cooling of the air conditioner. And then it will also automatically turn on the unit if the temperature exceed beyond the setting.

The lubricating oil will be applied to the compressor of the air conditioner. It will lubricate the unit to minimize friction loss. The air- condition unit will satisfy the desired temperature but with a minimal cost in the operation.

The researchers use air- conditioner as our testing equipment since it is the highest energy consuming appliance that is domestically used and in all establishments.

Statement of the Problem

This study aims to find out if an Energy saving measures using three conditions namely heat insulation; heat insulation and heat sensor controlling system on air- conditioner compressor; as well as the heat insulation, heat sensor controlling system and the special lubricating oil on air- conditioner compressor.

More specifically, it answers the following questions:

1. How does this energy saving method reduce the usage of kilowatt consumption and save money in office?

    a. E-Shield heat insulation

    b. E-Shield heat insulation and heat sensor controlling system

    c. E-Shield heat insulation and heat sensor controlling system and special lubricating oil.

2. For a given period, how much energy is being saved if the three measures are being introduced?
3. How much expenses will be spent in doing the three methods? Does buying the heat insulators, heat sensor and special lubricating oil worth the cost of acquiring the energy saving measures and the savings in the cost of electricity?

Objectives of the Study

This study has the following objectives:

1. To apply the energy saving methods and verify its capability to reduce and save the electrical energy consumption and money;
2. To determine the energy consumptions in following conditions:

    2.1. without energy saving device

    2.2. with energy saving device

        a. E-Shield heat insulation

        b. E-Shield heat insulation and heat sensor controlling system on Air- conditioner compressor

        c. E-Shield heat insulation, heat sensor controlling system on Air- conditioner compressor and Oil for the Air-con Compressor

3. Determine the cost of energy consumption with and without the energy saving measures.

3.1. without the energy saving device.

3.2. with the energy saving device

a. E-Shield heat insulation

b. E-Shield heat insulation and heat sensor controlling system on Air- conditioner compressor

c. E-Shield heat insulation, heat sensor controlling system on Air- conditioner

4. Determine the cost of acquiring the heat insulator, heat sensor on air conditioner Compressors and Special Lubricating Oil on Air Conditioner Compressor.

5. Compare the cost of in problem 3 and the saving when using the energy saving measures and determine the net savings.

Significance of the Study

The purpose of this study is to exchange experience with technologies, and strategies to quickly reduce electricity use with the smallest possible economic and social impacts.

This will provide individuals, small business and institutions with solutions to reduce energy use, cut energy costs and shrink their carbon footprints. Saving energy is one of the most important things that can be done for the environment.

It will also contribute and enable key decision-making in the electricity system and to build emergency strategies and deal more effectively with temporary shortfalls in electricity supplies. In understanding the ability to influence the demand for electricity adds to the overall security of the electricity grid.

Scope and Limitations of the Study

This study limits only to the differentiation between the data taken in a normal setting and the data taken with the methods being applied. The data is gathered within five-days with the applied methods and another five-day without the methods.

The meter reading will be done during sunny days and will be done 9 hours a day for a five day period. The setting of the air condition unit from the start of the data gathering will remain until the data gathering will finished regardless of how many people get inside and out of the room.

With the methods used, the data has three phase stages. First it is conducted with the wall insulations. Second, is the adding of heat sensor of the cooling Air-condition system. And third, is the adding of the oil for the efficient capability of the Air-con. The data in every phase stage will be taken in 5 random sunny days to make it more reliable.

According to Philippine National Statistics Office, 66.6% of the electricity is consumed by space cooling using air- conditioner. The load that is being used is the office unit of the chancellor. The same kilowatt-hour meter is used to measure the actual electrical energy consumptions of office unit with and without the energy saving device. Such that using the "TRANE" brand of air-condition unit one of the based-condition since it is the one that is available in the chancellor's office.

The energy monitoring was only limited to the energy consumption of the Office of the Chancellor and its adjoining staff room since it is where the "E-SHIELD" insulating film being installed. And the heat sensor device and the "ARTIKOOL™" lubricating oil was installed and applied to the "TRANE" air-conditioner in this room.

Thus, monitoring in the room temperature and humidity is included.

Definitions of Terms

The following terms defined below are the technical terms used in this paper. This would give reader the idea about the terms being used.

Air- conditioner. An appliance or a device for cooling and controlling the humidity and purity of the air circulating in a space ("Heating, Ventilating, and Air Conditioning (HVAC)." Microsoft® Student 2007. Redmond, WA: Microsoft Corporation, 2006.).

Circuit breaker. A device designed to open and close a circuit by non- automatic means and to open the circuit automatically on pre- determined over current without damage to itself when properly applied within its rating (*Philippine Electrical Code- 2000 Part 1 volume 1*, June 2002).

CO_2 Emissions. The amount of CO_2 emitted by the air- conditioner to the atmosphere during its operation ("Atmosphere." Microsoft® Student 2007. Redmond, WA: Microsoft Corporation, 2006).

Electric meter or energy meter. A device that measures the amount of electrical energy consumed (supplied or produced by a) by a residential, commercial, or industrial establishment (*Philippine Electrical Code- 2000 Part 1 volume 1*, June 2002).

Electrical energy. A source of energy commonly used to run an electrical devices (Halliday, David; Resnick, Robert; Walker, Jearl. "Electric Potential". *Fundamentals of Physics*, 5th ed. John Wiley & Sons. 1997).

Heat insulation. A process of insulating a room from outside heat and trapping of cold air from exhaustion (http://en.wikipedia.org/wiki/Heat_insulation).

Humidity. Defined as the ratio of the partial pressure of water vapor in a parcel of air to the saturated vapor pressure of water vapor at a prescribed temperature (Needham, Joseph. "Science and Civilization": Volume 4, Physics and Physical Technology, Part 2, Mechanical Engineering. Taipei: Caves Books Ltd. Pages 99, 151, 233; 1986).

Kilowatt hour. The unit of electrical energy consumption (*Philippine Electrical Code- 2000 Part 1 volume 1*, June 2002).

Lubricating oil. A substance introduced between two moving surfaces to reduce the friction between them, improving efficiency and reducing wear (San Andrés. L. "Introduction to pump rotordynamics, Part 1. "Introduction to hydrodynamic lubrication". MEEN626 Lubrication Theory Class:Syllabus FALL2006. 2007).

Memory. This is a device that has an ability to store, retain, and subsequently retrieve information (“http://en.wikipedia.org/wiki/Memory”).

Outlet. A point on the wiring system at which current is taken to supply utilization equipment (*Philippine Electrical Code- 2000 Part 1 volume 1*, June 2002).

Sensor. This is a device that measures a physical quantity and converts it into a signal which can be read by an observer or by an instrument (“http://en.wikipedia.org/wiki/Sensor”).

Transmitter. This is an electronic device which, usually with the aid of an antenna, propagates an electromagnetic signal such as radio, television, or other telecommunications (“http://en.wikipedia.org/wiki/Transmitter”).

CHAPTER II

Review of Related Literature and Related Studies

This chapter includes discussion on the grid of Electricity consumption, Efergy Meter and the literature of insulating film, heat sensor and lubricating oil.

Review of Related Literature

The "Efergy" Energy Meter

When it comes to making home improvements to save electricity and help save the environment, lots of users are somewhat lackluster, despite their best intentions. What users need are incentives, and even more importantly, instant tangible results. Enter EFERGY Smart Meter, the real-time electricity monitor.

Using one discreet unit that clips on to a wire from the electricity meter and a portable handheld LCD display, it could be seen exactly how much electricity used at any given time. The idea is to make the users more energy aware and thus more energy efficient, as well as unearth those stealth energy eaters that cost it a lot more.

Now fully educated, users are in a position to make the necessary lifestyle changes to reduce their carbon footprint and reduce your electricity bills. Try

switching appliances off and on - the electricity energy monitor shows instant results in the portable LCD display.

EFERGY has a portable monitor that could be taken from room to room to see at a glance which appliances are devouring the most electricity. It is accurate to within +/- 5%. It can be safely installed in minutes with no need for expert knowledge or assistance. The CPU memory stores previous data too.

Any techno-phobes have nothing to worry about either as this home electricity meter monitor installs in less than 30 seconds, while the neat LCD display is easy to read and navigate.

It has the following specifications:

- Wirelessly monitor of electricity consumption
- Instant read-out of how much money are spending
- Updates every 6 seconds
- Measures CO2 emissions per kWh and cost per kWh
- Memory mode to check power consumption over the past days, weeks or months
- Product dimensions (H)8.5cm x (L)8.5 x (D)2cm - Display Unit
- Box dimensions (H)19cm x (L)19cm x (D)4.5cm
- Package weight 338g
- Power requirements 4 x AAA batteries

FIGURE 2.1. Physical appearance of an "EFERGY" meter

EFERGY tells every 6 seconds how much power you are consuming, how much money this is costing and an estimate the contribution to the climate change. If turn a set of lights ON or OFF, users can see instantly the change this has to their energy use. Once have this information to hand means the family, or business, can visually see the benefits of saving energy.

The data is stored daily in an easy to access CPU memory so the effects of changing energy habits can actually be seen. Comparing day-to-day usage it gives direct feedback of how daily changes of habit toward energy use can have an effect on costs and estimates the personal contribution to the climate change in terms of carbon emissions.

The EFERGY meter is an excellent educational device. It is easy to use, displays personal energy consumption and increases awareness of important issues related to electricity, energy and the environment ("*The Real Time Electricity Monitor*", http://www.efergy.com/en/index.php).

E- Shield insulating film

E- Shield insulating film is a low E- film fastened from the inside of the glass with at least a 1 inch gap from the window. It will insulate the room from external heat that will pass through the window. with the E- shield in place heat is limited in travelling between the inside and outside of the room. It can save up to 20% of energy consumption. ("*Become a Smart Energy Saving Company*" Misty Mountain Aes Co.)

Energy saving system

This energy saver is suitable for home or commercial air- conditioners. It directly attaches to the air- conditioner, no need to interfere the existing wiring system. It automatically regulates and compensates the air to maintain the set temperature. This energy saver continuously reduces energy usage without affecting room temperature and comfort level. Even if this unit became faulty, it will not affect the normal operation of the air-conditioner. Such are the benefits

this energy saver brings convenience, quality life, effortless energy conservation and investment money back guarantee.

There is no need for additional wiring or manual operation, employing the most advance temperature compensating technology, completely eliminates the problem of air- condition compressor running continuously due to malfunctioning cause by uneven room temperature, or the huge difference in temperature between room and the external environment. This will enable to control and save 10%- 50% of energy consumption. ("*Windows and Split Type Air-conditioning Energy Saving System*" Khaloofa Al Asmary Trading Est.)

ARTIKOOL™ - refrigerant oil additives

ARTIKOOL is a covalent polarized refrigerant oil additive. Every kind of cooling equipment can use this P.R.O.A. such as coolers, a/c, heat pumps, chillers, and refrigerated trucking. An exceptional blend of natural and synthetic oil us used to make the ARTIKOOL™. Metal and primary lubricants treated with ARTIKOOL™ defended against friction, which causes heat, wear and corrosions that can occur when the compressor operates. Able to blend with any refrigerant or non- silicon oil for compressors, ARTIKOOL™ is a conditioner and film strength builder. Additionally, wear s reduced through ARTIKOOL™'s thermal

stabilizer which enables compressor fluid to run in extreme temperatures of -40 degrees F to +300 degrees F.

ARTIKOOL™ increases the compressor oil film strength helping to prevent abnormal wear which can occur as a result of "mixed film" lubrication. The "mixed film" condition occurs when there is sporadic surface-to-surface contact. This sporadic contact results from temperature increases or irregular loads.

Lubrication is vitally important to keep the tiny imperfections, visible only under magnification, from meeting and interlocking with those on the opposite side. ARTIKOOL™ works to prevent the interlocking and resultant break-off particles of metal imperfections meet and thus reduces excessive high temperature and deterioration. The protection ARTIKOOL™ provides is different from a/c compressor lubricant in that it lubricates with a coating action which remains on all the metal surfaces, including invisible flaws, to keep metal parts apart (*"ARTIKOOL™"*, http://www.artikool.com).

Review of Related Studies

Electricity remains as the universal source of energy

According to the results of the survey, 14.6 million households or 87.6 percent of the 16.6 million households used electricity during the period October 2003 to September 2004. This was 3.6 percentage points higher compared to the recorded level of 10.8 million households in 1995, which comprised 83.9 percent of the total 12.8 million households.

From 1995 to 2004, the number of liquefied petroleum gas (LPG) household users doubled in number from 4.2 million households to 8.6 million households; an increment from the ratio of one in every three households in 1995 to a ratio of one in every two households in 2004.

In 2004, a total of 1.9 million households and 551 thousand households used gasoline and diesel, respectively, for power generation and transportation. On the other hand, 55 thousand households each used gasoline and diesel for power generation in 1995.

Among the conventional types of fuel, kerosene became less popular, registering a decrease of 23.6 percentage points from 79.9 percent in 1995 to 56.3

percent in 2004 ("*October 2004 Household Energy Consumption Survey"*, National Statistics Office, Manila, Philippines, August 2005).

Electrical energy consumption on homes

Electricity provided lighting to 92.1 percent of the 14.6 million households who reported to be users of electricity. Eighty percent of the electricity users used fluorescent lamps with an average annual consumption of 132 KWh; 53.4 percent used incandescent lamps, an average of 79 KWh; and 36.9 percent used compact fluorescent lamps, an average of 63 KWh. Sixteen percent of the households used other lamps such as Christmas lights, tiffany and neon lights, which consumed around 2.8 KWh per month or 34 KWh for the whole year.

The second major use of electricity was for household recreation as reported by 85.4 percent of the total household electricity users. Among the electric appliances for household recreation, colored television recorded the biggest usage at 80.4 percent. The use of VHS, betamax, laser disc, DVD or CD ranked second with 24.7 percent of household electricity users. Only a few (4.0 percent) used black and white TV for viewing. In terms of average annual consumption, each household consumed about 210 KWh for colored TV; 92 KWh for black and white TV; and 55 KWh for VHS, betamax, laser disc, DVD or CD.

Listening to music was enjoyed by almost one in every five households using the stereo, cassette or radio. On the average, each household consumed 243 KWh for stereo, 79 KWh for cassette and 80 KWh for radio. Likewise, karaoke or music mate was used more frequently on a longer period of time by 12.8 percent of the households as can be seen by a higher average consumption of 399 KWh.

More than half of the households used electricity for space cooling (66.6%) and ironing (51.3%). For space cooling, 99.4 percent used electric fan consuming about 296 KWh per year, while 8.8 percent used air conditioner consuming about 3,914 KWh which is about 12 times as much as that of electric fan. Flat iron, on the other hand, consumed about 95 KWh during the year.

Forty percent of the households claimed that they used electricity for refrigeration- either through the use of an ordinary or frost-free refrigerator which usually consumes around 1,000 KWh to 1,500 KWh annually, or through the use of a freezer which consumes around 2,400 KWh. About 27 percent used washing machine for laundry which, on the average, comprised 100 KWh of their total annual consumption.

The use of electricity for cooking and food preparation was reported by 15.8 percent of the electricity users. The rice cooker was the most common cooking equipment registering an annual consumption of 223 KWh. (“*October*

2004 Household Energy Consumption Survey", National Statistics Office, Manila, Philippines, August 2005).

CHAPTER III

Methodology

This chapter presents the methods of the study. It discusses about the procedure to follow in conducting the study. This includes the work-flow chart in gathering data to be used in this study, namely: EFERGY meter installation procedures, installation procedure of the three energy-saving measures and costs computation methods.

Data gathering

In gathering data in this study several procedures are depicted in the given figure 3.1. First thing to do is to install the EFERGY meter that will be used in meter reading and cost computations. Before applying the three methods to be tested initial meter reading should be done. The data taken in this procedure is the common reference of comparing data with the three methods used. The data taken in each day in every phase will be tallied in a table shown in Table 3.2. Then the data will be summarized in Table 3.1.

TIME	KWH CONSUMPTION PER DAY IN KWH						
	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	AVE.	TOTAL
8AM							
9AM							
10AM							
11AM							
12NN							
1PM							
2PM							
3PM							
4PM							
5PM							
TOTAL							

Table 3.1. Daily EFERGY meter reading data sheet

There are three stages in cost computation using the methods being introduced. Each stage corresponds for an energy saving method to be used. First is the computation with the insulating material installed. Second stage is using the insulating material plus the air- condition heat sensor controlling system. The third stage is the combination of the three energy saving methods. Table 3.1 will also be used in data gathering in the second and third stage. Table 3.2 shows the summary of all the data taken from first to the last stage. The data will be taken in several days. It is assumed that the rate per kWh in the first day of the data gathering is equal to the rate per kWh in the last day of the data gathering.

Energy saving methods	Consumption		Cost	
	Ave. daily (AEC)	Weekly	daily	weekly
1.Without the devices				
2.Heat insulation				
3.Heat insulation and Heat sensor/ control system				
4.Heat insulation, heat sensor/control system and oil lubrication				

Table 3.2. Summary of all consumptions and its cost

The activities that have been done in this research are shown in Figure 3.1. The first step was the installation of the EFEERGY meter that was used in reading the energy consumption in a day. Initial reading was made without the devices. This was taken in 5 days. In each methods corresponds to a device(s) that was installed. Meter reading in each method was taken also in 5 days. Then the data in each method was then compared to the initial data.

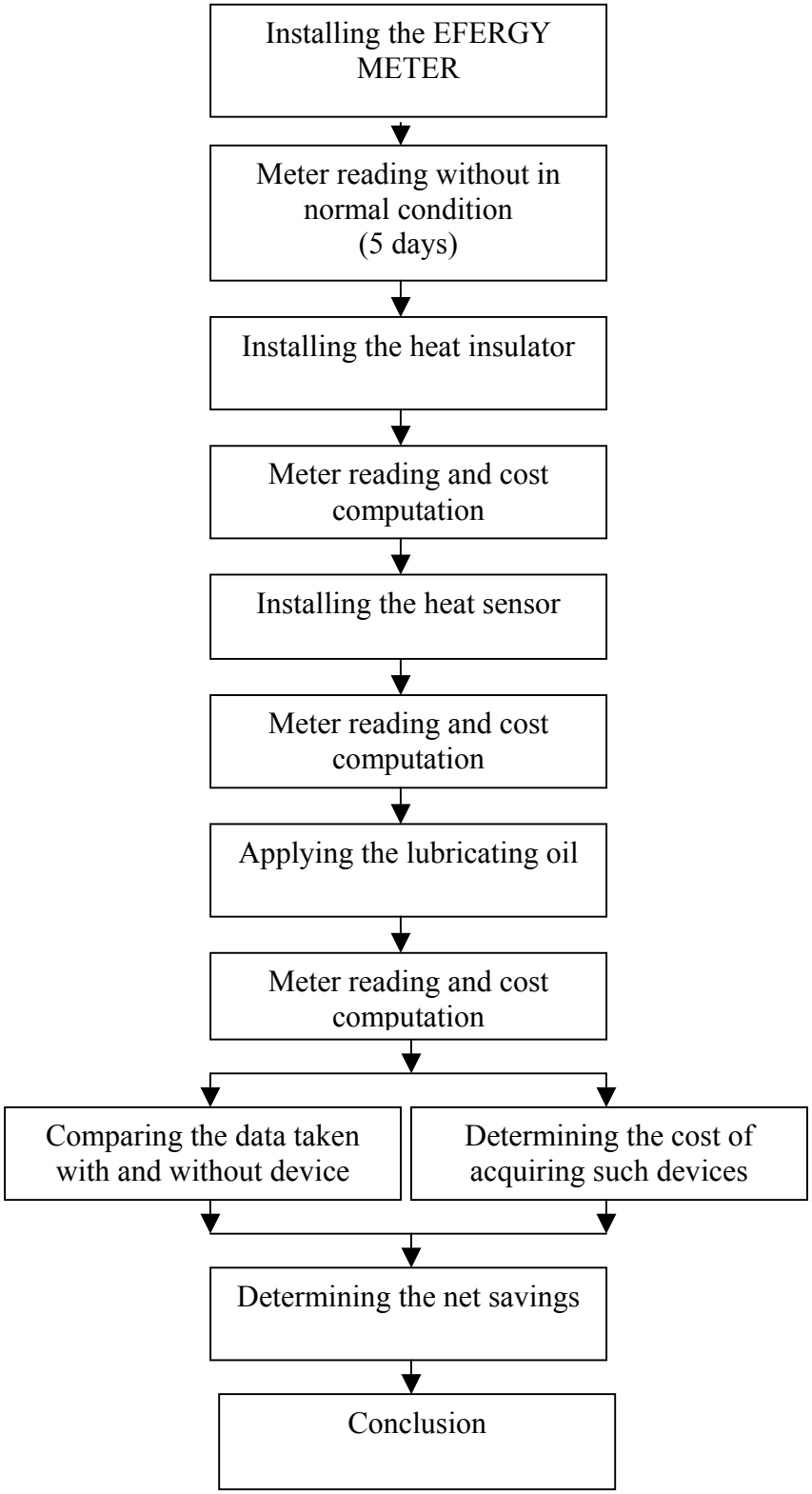

Figure 3.1. Activity workflow

Installing the devices

Below are the installing procedures of the device to be used in each phase. First is the installation of the EFERGY meter that will be used in monitoring and reading the energy consumption. Second is the installation of the insulating film which is for the first method to be tested. It uses E- shield insulating film brand since it is the only film available. Next is the installation of the heat sensor. The second method to be tested will be the combination of the insulating film and heat sensor. This will be followed by the application of the ARTIKOOL™ Lubricating oil. The third method to be tested will the combination of the three devices used the insulating film, heat sensor and the lubrication oil.

Installing the EFERGY meter

Below are the procedures in installing the EFERGY meter which is used in reading the energy consumption.

1. Remove items from packaging.
2. Locate electricity meter. Locate electricity meter and identify live supply cable.
3. Locate LIVE wire. The hinged clip on the sensor is designed to clip around the LIVE insulated power supply cable coming from the electricity meter to the consumer unit (fuse box).

4. Insert batteries into sender box. Unscrew backing plate on the sender box and install batteries provided. Plug sensor cable Jack Plug into any one of the sockets located at the bottom of the sender unit.
5. Insert batteries into remote monitor. Insert the batteries into the remote monitor. The portable display monitor allows the users to view energy consumption anywhere in their house or office (Note: The remote monitor may not connect to and lock with the sender box if the batteries are not installed into the sender box before the remote monitor).

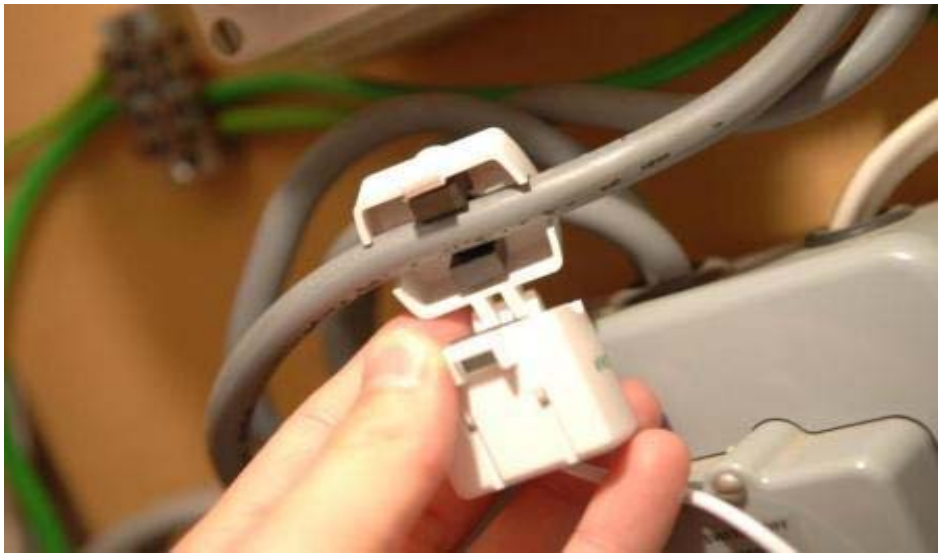

Figure 3.2. EFERGY meter transmitter installation

The Testing Procedure

In order to receive the information according to particular case, there is a need to set the EFERGY parameters. It will take 3 minutes. Press and Hold the EFERGY button until the screen flashes. The flashing screen is warning that the

values of each parameter can now be set. The first parameter is the Voltage. Use the forward and backward buttons to set the particular parameters. Press the EFERGY button to go to the next parameter. Once finished setting all parameters press the Memory button and the information will be stored in the CPU memory.

Installing the E- shield insulating film

Prepare the 1in. x 1 in. stick that will accommodate in the length of the window perimeter the film to be attached, furniture nails, hammer, steel rule and a wood stapler. Measure the perimeter of the window where the film is to be attached. Then make a frame using the 1in x 1 in. stick that will fit in the size of the window. Attached the insulating film to the frame then attach the frame with the film to the window

Installing the heat sensor device

First, open the cover of the air- condition unit. Fix and secure the energy saver device and connect its power to air to air- condition power line. Look for the thermostat sensor of the air- condition. Insert thermostat sensor to temperature sensor first introduction hole of the compensation device. Switch to cold position using conversion switch and connect the data line plug to the data line socket. Reinstall the cover of the air- condition unit. Switch on the air-

condition unit. Then monitor and record the energy consumption using the EFERGY meter for 5 days. The data is then to be compared to the result of the second phase.

Applying the lubricating oil (ARTIKOOL™)

Prior to installing ARTIKOOL™ be sure safety switches for both high and low pressure are properly working. Installation should be done only by a qualified licensed A/C or refrigeration technician. Determine the proper amount of ARTIKOOL™ to be installed into the units. This is usually 5% of the compressor's oil charge. Use the standard hand held refrigeration oil pump for the installation. These pumps usually deliver between 1.0 to 1.5 ounces of product per stroke. Pre- determine the pump capacity to know how many strokes are necessary. Attach a standard refrigerant gauge hose to the pump with the Schrader valve needle depressor end being the loose end. All air should be purged from the hose. Stroke the pump until the hose is completely filled with ARTIKOOL™. Attach the pump hose lightly to the Schrader valve of the suction line of the compressor. Stroke the pump until a small amount of ARTIKOOL™ runs out and covers the Schrader valve. This ensures all air is fully purged from the line. Tighten the hose on the Schrader valve, and pump in the correct amount

of ARTIKOOL™. Disconnect the hose from the suction line Schrader valve; the installation complete.

Meter reading with the installed device

The EFERGY meter is already calibrated into kilo-watt-hour (kWh) unit of measurement. The data with the device will be taken 5 days in each phase. Then the cost of each phase will then be computed and will be compared the data without the device.

Reading procedure

The EFERGY meter is already calibrated into kWh. Meter reading at the start of the day is recorded then after an hour another meter reading will be done. Reading in the second hour will be subtracted by the reading in the first hour and the difference will be the consumption in kWh in that hour. And this procedure will be the reading procedure in the succeeding hour.

Tabular presentation

The data taken in every phase will be presented in a table like shown below.

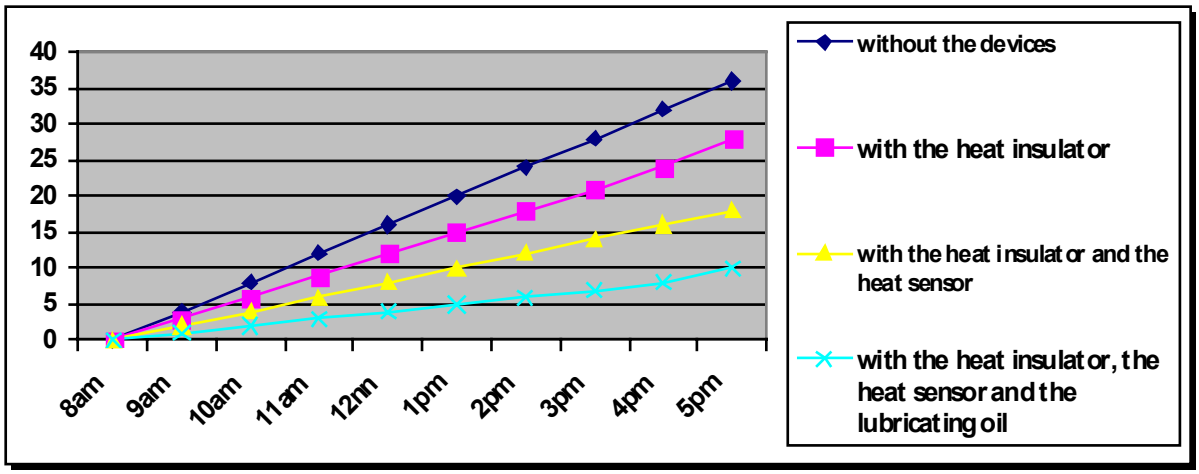

Figure3.3. Sample tabular presentation of data taken

The X- axis corresponds to the designated hour and the Y- axis corresponds to the energy consumption. In every first day in each phase will be presented in one table.

Determining the gross savings

This data, denoted by GS, can be computed by using the formula:

GS = (energy consumed without the device – energy consumed with the device) X

(Cost per kWh)

A positive result will indicate a savings and a negative result will indicate a loss as well.

Determining the net savings

This data, denoted by NS, can be computed by using the formula:

NS = (GS X estimated life span) – cost of the material

The cost of the material plus the labor cost should be computed so that the total expenses can be calculated when it could be returned.

Cost computations

The formula for estimating the cost is shown below:

COST CONSUMPTION (in pesos) = ENERGY CONSUME X RATE PER KWH

CHAPTER IV

Results and Discussions

This chapter shows the result of the data gathering and interpretation of each data and the comparison of the data with and without implementing the methods introduced.

The energy saving methods

In this study the air- conditioner energy consumption was monitored separately using the EFERGY meter. It has a wireless transmitter and receiver component. The first stage of the data gathering is the heat insulation using the E-Shield insulating film. The insulating film will trap the cold air in side the room and blocks it from exhausting. The second stage is the heat insulation and addition of the heat sensor of the air conditioner compressor. The sensor will automatically maintain the set temperature of the air- conditioner. The third stage is the heat insulation, heat sensor controlling system and the addition of special lubricating oil on the air- conditioner compressor.

Data in normal condition

The energy consumption was monitored initially without the three methods introduced. The data is shown in Table 4.1.

TIME	KWH CONSUMPTION PER DAY IN KWH						
	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	AVE.	TOTAL
8AM	0	0	0	0	0	0	
9AM	3	5	2	5	2	3.4	
10AM	5	9	5	7	5	6.2	
11AM	7	12	9	10	7	9	
12NN	10	14	12	12	10	12.4	
1PM	16	18	16	15	12	15.4	
2PM	18	23	21	18	15	19	
3PM	21	26	26	20	17	22	
4PM	24	29	29	23	19	24.8	
5PM	26	31	31	25	21	26.8	
TOTAL	**26**	**31**	**31**	**25**	**21**	**26.8**	**134 kWh**

Table 4.1. Initial energy consumption in normal condition

Therefore, based on the Table 4.1, in five days of normal condition the air-conditioner will consume an average of **26.8kWh** of electrical energy per day. For five days of operation without the devices the air conditioner had consumed a total of **134 kWh** of energy.

Cost computations

Assume rate per kWh is P5.00.

Without the devices (C1):

C1= (energy consumption in kWh per day) X (rate per kWh)

= 26.8kWh/day X P5.00/kWh

C1= P134.00/day

Assume in 1 week there are only 5 days the room was used then the cost of energy consumption per week is given by:

= 134kWh X P5.00/kWh

= P670.00

Therefore without the devices the cost of energy consumption per week is P670.00.

Data results and cost computations with the devices

Table 4.2 shows the average electrical energy consumption in five random days using heat insulation method.

TIME	KWH CONSUMPTION PER DAY IN KWH						
	DAY 1	**DAY 2**	**DAY 3**	**DAY 4**	**DAY 5**	**AVE.**	**TOTAL**
8AM	0	0	0	0	0	0	
9AM	2	1	2	3	2	2	
10AM	4	2	4	6	5	4.2	
11AM	7	4	7	8	7	6.6	
12NN	9	6	10	10	11	9.2	
1PM	12	9	12	12	13	11.6	
2PM	14	12	14	14	16	14	
3PM	17	15	16	16	18	16.4	
4PM	19	18	17	19	20	18.6	
5PM	21	20	18	21	22	20.4	
TOTAL	**21**	**20**	**18**	**21**	**22**	**20.4**	**102 kWh**

Table 4.2. Energy consumption using heat insulation method

Therefore, based on the Table 4.2, using heat insulation methods the air-conditioner will consume with the average of **20.4kWH** of electrical energy per

day. Using heat insulating film the air- conditioner had consumed a total of 102KWH in five days.

Cost computations

Assume rate per kWh is P5.00.

With E-Shield heat insulating film (C2):

C2= (energy consumption in kWh per day) X (rate per kWh)

= 20.4 kWh/ day X P5.00/ kWh

C2= P102/day

Assume in 1 week there are only 5 days the room was used then the cost of energy consumption per week using heat insulating film is given by:

= 102kwh X P5.00/kwh

= P510.00

Therefore using the heat insulating film the cost of energy consumption per week is P510.00.

Table 4.3 shows the average electrical energy consumption in five random days using heat insulation and heat sensor controlling system method.

TIME	KWH CONSUMPTION PER DAY IN KWH						
	DAY 1	DAY 2	DAY 3	DAY 4	DAY 5	AVE.	TOTAL
8AM	0	0	0	0	0	0	
9AM	2	2	2	2	3	2.2	
10AM	3	4	3	3	4	3.4	
11AM	6	6	5	5	6	5.6	
12NN	7	9	7	8	7	7.6	
1PM	9	13	9	10	8	9.8	
2PM	11	15	11	10	10	11.4	
3PM	14	16	13	12	12	13.4	
4PM	15	18	14	14	14	15	
5PM	17	19	16	15	16	16.6	
TOTAL	**17**	**19**	**16**	**15**	**16**	**16.6**	**83kWh**

Table 4.3.Energy consumption using heat insulation and heat sensor controlling system method

Therefore, based on the Table 4.3, using heat insulation and heat sensor controlling system methods the air- conditioner will consume an average of **16.6KWH** of electrical energy per day. For five days of operation the air-conditioner had consumed a total of 83KWH with heat insulating film and heat sensor device.

Cost computations

Assume rate per kWh is P5.00.

With heat insulating film and heat sensor device (C3):

C3= (energy consumption in kWh per day) X (rate per kWh)

= 16.6kwh X P5.00/kwh

C3= P83.00/day

Assume in 1 week there are only 5 days the room was used then the cost of energy consumption per week using heat insulating film and heat sensor is given by:

= 83kwh X P5.00/kwh

= P415.00

Therefore using the heat insulating film and heat sensor the cost of energy consumption per week is P415.00.

Table 4.4 shows the average electrical energy consumption in five random days using heat insulation and heat sensor controlling system and oil lubrication method.

TIME	**KWH CONSUMPTION PER DAY IN KWH**						
	DAY 1	**DAY 2**	**DAY 3**	**DAY 4**	**DAY 5**	**AVE.**	**TOTAL**
8AM	0	0	0	0	0	0	
9AM	2	1	1	2	1	1.4	
10AM	3	3	2	5	3	3.2	
11AM	5	5	2	7	4	4.6	
12NN	6	7	3	8	7	6.3	
1PM	8	9	4	8	8	7.4	
2PM	10	11	5	9	9	8.8	
3PM	11	13	7	9	12	10.4	
4PM	12	15	9	9	15	12	
5PM	13	17	10	11	17	13.6	
TOTAL	**13**	**17**	**10**	**11**	**17**	**13.6**	**68kWh**

Table 4.4.Energy consumption using heat insulation, heat sensor controlling system and oil lubrication

Therefore, based on the Table 4.4, using heat insulation, heat sensor controlling system and oil lubrication methods for the air- conditioner will

consume an average of **13.6kWh** of electrical energy per day. For five days of operation the air- conditioner had consumed a total of 68KWH of energy using heat insulating film, heat sensor and lubricating oil.

Cost computations

Assume rate per kWh is P5.00.

With heat insulating film, heat sensor device and lubricating oil (C3):

C4= (energy consumption in kWh per day) X (rate per kWh)

= 13.6kWh X P5.00/kWh

= P68.00/day

C4= P68.00/day

Assume in 1 week there are only 5 days the room was used then the cost of energy consumption per week using heat insulating film, heat sensor and lubricating oil is given by:

= 68kwh X P5.00/kwh

= P340.00

Therefore using the heat insulating film and heat sensor the cost of energy consumption per week is P340.00.

Figure 4.1 shows the variation of consumption every hour in each phase. The X- axis corresponds to the instantaneous time and the Y-axis corresponds to the cumulative average energy consumption in kWh.

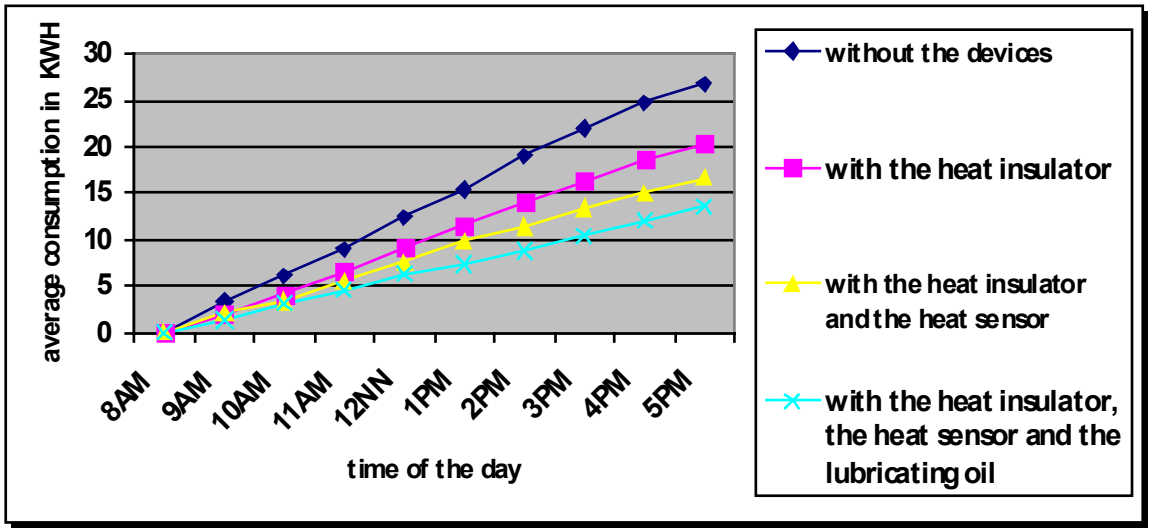

Figure 4.1. Average daily energy consumption

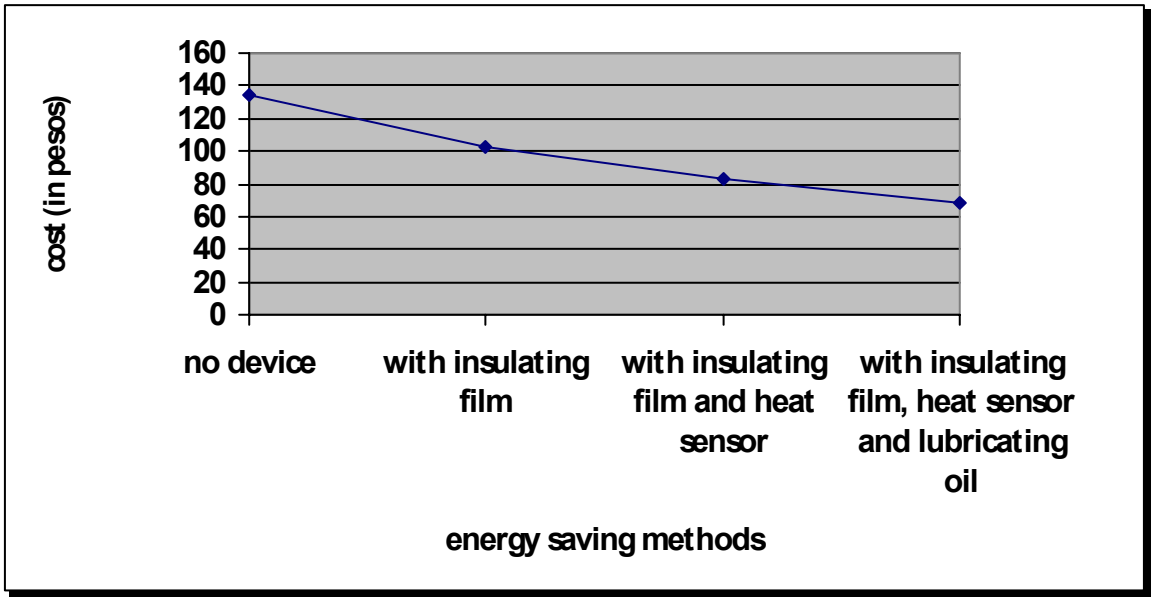

Figure 4.2. Average daily energy consumption cost

Figure 4.2 shows the average daily energy consumption cost.

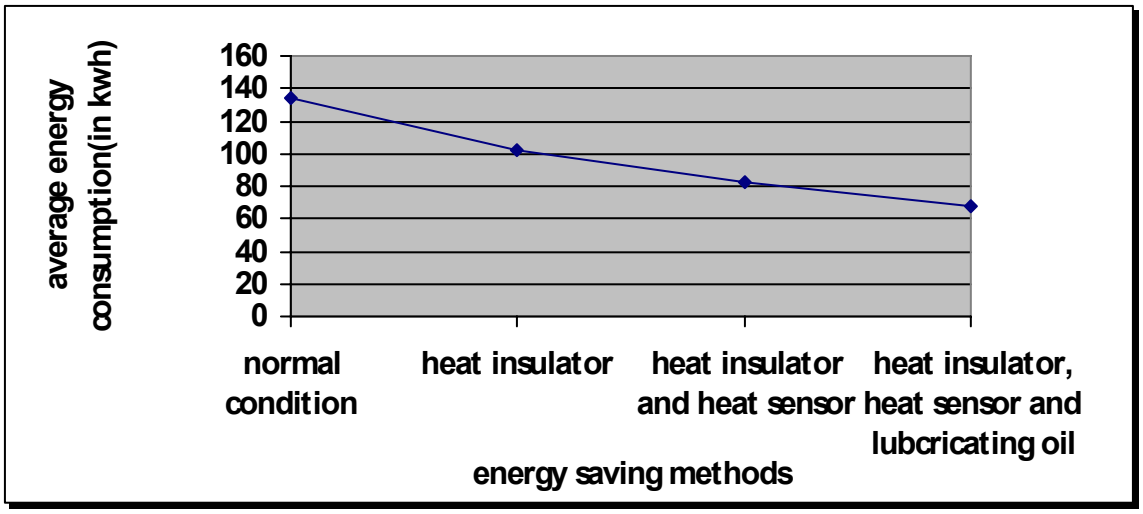

Figure 4.3. Weekly energy consumption

Figure 4.3 shows the weekly energy consumption of each method.

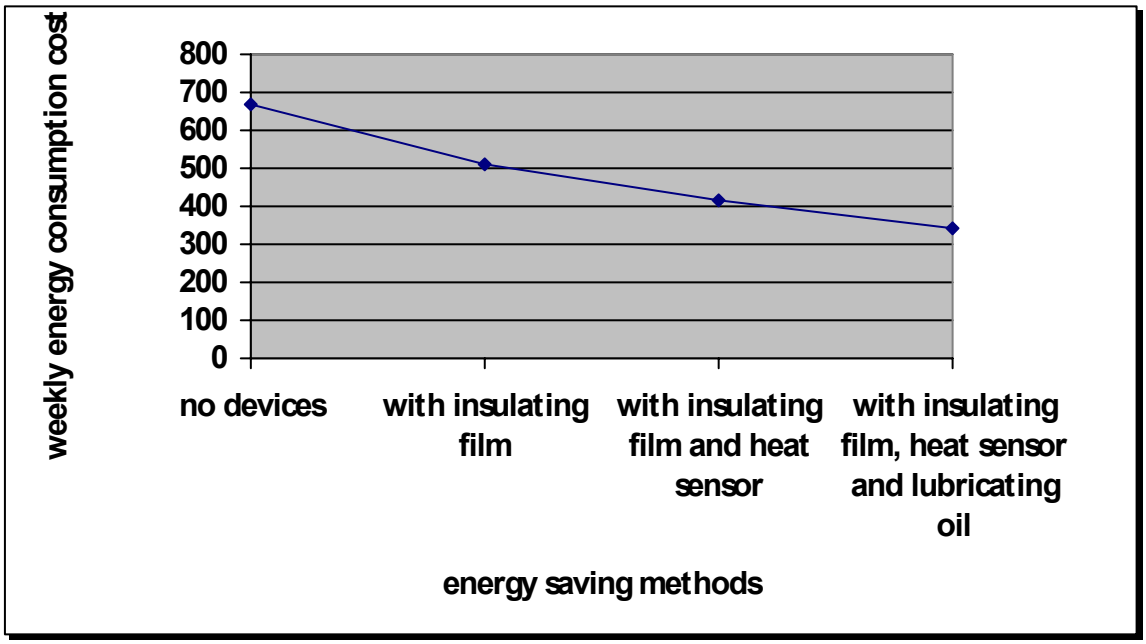

Figure 4.4. Weekly energy consumption cost

The weekly energy consumption cost in each method is shown in Figure 4.4. It is shown that the third energy saving method introduced save more energy than the others.

Table 4.5 shows the summary of the average energy consumption in khw in every method used with its corresponding cost in pesos.

Energy saving methods	Consumption		Cost	
	Ave. daily (AEC)	Weekly	daily	weekly
1.Without the devices	**26.8**	**134**	**P134**	**P670**
2.Heat insulation	**20.4**	**102**	**P102**	**P510**
3.Heat insulation and Heat sensor/ control system	**16.6**	**83**	**P83**	**P415**
4.Heat insulation, heat sensor/control system and oil lubrication	**13.6**	**68**	**P68**	**P340**

Table 4.5. Summary of all consumptions and its costs

The gross savings (GS)

1. With E-Shield heat insulating film (GS1):

GS1= (AEC1- AEC2) X (rate per kWh)

= (26.8kWh/day- 20.4 kWh/day) X P5.00/kWh

= 6.4kWh/day X P5.00/kWh

= P32.00/day

GS1= P32.00/day

2. With heat insulating film and heat sensor device (GS2):

GS2= (AEC1-AEC3) X (rate per kWh)

= (26.8kWh/day- 16.6kWh/day) X (P5.00/kWh)

= 10.2kWh/day X P5.00/kWh

= P51.00/day

GS2= P51.00/day

3. With heat insulating film, heat sensor device and oil lubricator (GS3):

GS3= (AEC1-AEC4) X (rate per kWh)

= (26.8kWh/day-13.6kWh) X (P5.00/kWh)

= 13.2kWh/day X P5.00/kWh

= P66.00/day

GS3= P66.00/day

Energy saving methods	**Cost consumption**					**Total consmpt'n per week**	**Weekly Savings**
	Day 1	**Day 2**	**Day 3**	**Day 4**	**Day 5**		
1.Without devices	130	155	155	125	105	670	0
2. heat insulation	105	100	90	105	110	510	160
3. heat insulation and heat sensor controlling system	85	95	80	75	80	415	255
4. heat insulation, heat sensor controlling system and oil lubrication	65	85	50	55	85	340	330

Table 4.6. Gross weekly savings per method

Table 4.6 and Figure 4.5 show the weekly gross savings in each method. It is shown that the savings are increasing in each method.

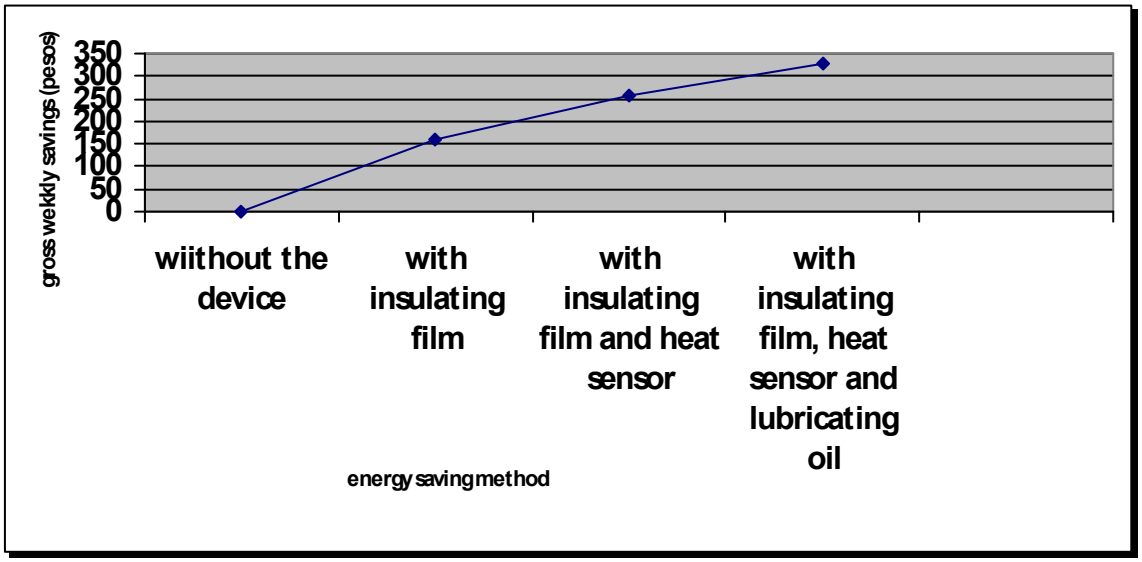

Figure 4.5. Gross weekly savings

Cost of materials

The EFERGY meter cost P5, 160 (120 dollars- exchange rate @P43 per dollar) and it will last for 5 years. The E-shield insulating film cost for P300/m^2 and the room being studied consumed 29.6645 m^2 (approximately 30 m^2). And the film will last up to 5 years. The heat sensor will cost 100 dollars (approximately P4, 300) and it will last up to 5 years. The lubricating oil cost 60 dollars/oz (approximately P2, 580/oz.) and the 3-ton TRANE air conditioner used 3 oz. The oil only added once until air- conditioner compressor Freon will be charge. During Freon charging the there is a need for adding oil with the amount

of 10% of the amount in the initial application (Office of the Chancellor, MSU-IIT). The summary of material cost is shown in Table 4.7.

DEVICES	APPROXIMATE COST	ESTIMATED LIFE SPAN
E-shield insulating film	P3600 .00	5 years
Heat sensor device	P4, 300 .00	5 years
ARTIKOOL™ Special lubricating oil	P7, 740.00	10 years
TOTAL	**P15640.00**	

Table 4.7.Estimated costs of acquiring materials and its estimated life span

The Net savings (NS)

1. With heat insulating film (NS1):

NS1= (GS1 X estimated life span) - material cost

Estimated life of heat insulating film is 5 years. Assumed the room studied will be used for 5 days a week and there are only 22 days in a month. So, estimated life span in days is given by;

Estimated life span in days= 5 years X 12 months/year X 22 days/ month

= 1, 320 days approximately.

So,

NS1 = (P32.00/day X 1, 320 days) - (P9, 000 + P5, 160)

= P28, 080.00

NS1= P28, 080.00 for 5 years (P21.27/day)

2. with heat insulating film and heat sensor device (NS2):

NS2= (GS2 X estimated life span)- material cost

Estimated life of heat insulating film and heat sensor device are all 5 years. Assumed the room studied will be used for 5 days a week and there only 22 days in a month. So, estimated life span in days is given by;

Estimated life span in days= 5 years X 12 months/year X 22 days/ month

= 1, 320 days approximately.

So,

NS2 = (P51.00/day X 1, 320 days) - (P9, 000.00 + P 4, 300 + P5, 160)

= P48, 860.00

NS2= P48, 860 for 5 years (P37.01/day)

3. With heat insulating film, heat sensor device and special lubricating oil (NS3):

NS3= (GS3 X estimated life span) - material cost

Estimated life of heat insulating film and heat sensor device will last for 5 years and lubricating oil will last for 10 years. Assumed the room

studied will be used for 5 days a week and there only 22 days in a month.

So, estimated life span in days is given by;

Estimated life span in days= 10 years X 12 months/year X 22 days/ month

= 2640 days approximately

So,

NS3 = (P66.00/dayX2640days)-[P9, 000(2) +P4, 300(2) +P5, 160(2) +P7, 740]

= P129, 580.00

NS3= P129, 580.00 for ten years (P49.08/day)

Investment retrieval period

1. with heat insulating film (RP1):

RP1= material cost /net savings per day

= (P 14, 160 / P21.27 per day)

= 665.73 days

= 666 days

RP1= 666 days

2. with heat insulating film and heat sensor device (RP2):

RP2= material cost/ net savings per day

= P18, 460 / P37.01 per day

= 498.78days

=498.78 days

RP2= 498.78 days

3. with heat insulating film, heat sensor device and lubricating oil (RP3):

RP3= material cost / net savings per day

= P44, 660/ P49.08/day

= 909.94 days

= 910 days

RP3= 910 days

Interpretation

Table 4.8 shows the cost of each method, its estimated life span, gross savings, net saving and the investment retrieval period.

METHODS	Cost	Estimated life span	Daily Savings		Investment retrieval period
			Gross	Net	
Heat insulation	P14,160	5 years	P32.00	P21.27	666 days
Heat insulation and heat sensor controlling system	P18, 460	5 years	P51.00	P31.01	498.78 days
Heat insulation, heat sensor controlling system and oil lubrication	P44, 660	5- 10 years	P66.00	P49.08	910 days

Table 4.8. Summary of results

Based on the table above, using the first method which is the heat insulation, it cost Php14, 160 that will last for 5 years. It will give a net savings of Php21.27/day and supposing the studied room will only be used five days a week the investment of Php14, 160 will be retrieved in just 666 days.

Using the second method which are the heat insulation and heat sensor controlling system it cost Php18, 460 and will last for 5 years. It will give a net savings of Php31.01/day and the investment of Php18, 460 will be retrieved in 498.78 days.

The third method which is the combination of heat insulation, heat sensor controlling system and the oil lubrication will cost P44, 660 and it will for 10 years. It will give a net savings for P49.08/day and the acquiring cost of P46, 660 will be retrieved in 910 days.

CHAPTER V

Conclusions and Recommendations

Conclusions

Based on the result of the study, the researchers concluded that;

1. All three methods give a savings in the energy consumptions of the air- conditioner.
2. The third method gives the highest reduction of energy consumption and the first method gives the lowest reduction of energy consumption as wells as their costs.
3. The third method is more expensive than the other two and the first method is the least expensive among the three methods.
4. The second method has the cost that is easily be retrieved. It can only be retrieved in just 1 and a half year
5. In terms of net savings, the third method will give the highest savings the first method gives the least.
6. The energy consumption in each day varies depending on the number of people inside the room ventilated by the air- conditioner, how often the room was opened and closed, and the weather condition.

Recommendations

Based on the result of the study, it is recommended to use the E- SHIELD insulating film, heat sensor device and ARTIKOOL™ lubricating oil together save energy consumption. Aside from its energy consumption reduction, it will give a net saving that is remarkable. And its cost will be retrieved in a time shorter than its estimated life span.

For further study using these methods, the following are recommended:

1. To achieve accurate results the following parameters should be monitored;

   a. Outside environment temperature

   b. Weather condition

   c. Number of people goes in and out the room

2. It is also recommended to use a non-automatic air-conditioner so that the heat sensor will only be the one to control the rising and falling of the room temperature.

3. Since the EFERGY meter can also determine the CO_2 emission, it is recommended to monitor the CO_2 emission so that its effect to the environment will be known.

4. The researchers also recommended doing the study in a longer period of time to have a more accurate and more reliable data

results. The data gathering could be done in a month or even in a year per stage. The total energy consumption per month could be the data used to differentiate the energy consumption per stage.

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APPENDIX A

Efergy Meter Reading Without the Devices

TIME	DAY 1: OCTOBER 8, 2008	
	READING	CONSUMPTION(KWH)
8AM	553	0
9AM	556	3
1OAM	558	5
11AM	560	7
12NN	563	10
1PM	569	16
2PM	571	18
3PM	574	21
4PM	577	24
5PM	579	26
TOTAL		**26**

TIME	DAY 2: OCTOBER 9, 2008	
	READING	CONSUMPTION(KWH)
8AM	584	0
9AM	589	5
1OAM	593	9
11AM	596	12
12NN	598	14
1PM	602	18
2PM	607	23
3PM	610	26
4PM	613	29
5PM	615	31
TOTAL		**31**

TIME	DAY 3: OCTOBER 10, 2008	
	READING	CONSUMPTION(KWH)
8AM	618	0
9AM	620	2
1OAM	623	5
11AM	627	9
12NN	630	12
1PM	634	16
2PM	639	21
3PM	644	26
4PM	647	29
5PM	649	31
TOTAL		**31**

TIME	DAY 4: OCTOBER 13, 2008	
	READING	CONSUMPTION(KWH)
8AM	702	0
9AM	707	5
1OAM	709	7
11AM	712	10
12NN	714	12
1PM	717	15
2PM	720	18
3PM	722	20
4PM	725	23
5PM	727	25
TOTAL		**25**

TIME	DAY 5: OCTOBER 21, 2008	
	READING	CONSUMPTION(KWH)
8AM	992	0
9AM	994	2
1OAM	997	5
11AM	999	7
12NN	002	10
1PM	004	12
2PM	007	15
3PM	009	17
4PM	011	19
5PM	013	21
TOTAL		**21**

APPENDIX B

Efergy Meter Reading with Heat Insulator

TIME	DAY 1: DECEMBER 09, 2008	
	READING	CONSUMPTION(KWH)
8AM	885	0
9AM	887	2
1OAM	889	4
11AM	892	7
12NN	894	9
1PM	897	12
2PM	899	14
3PM	902	17
4PM	904	19
5PM	906	21
TOTAL		**21**

TIME	DAY 2: DECEMBER 10, 2008	
	READING	CONSUMPTION(KWH)
8AM	906	0
9AM	907	1
1OAM	908	2
11AM	910	4
12NN	912	6
1PM	915	9
2PM	918	12
3PM	921	15
4PM	924	18
5PM	926	20
TOTAL		**20**

TIME	DAY 3: DECEMBER 11, 2008	
	READING	CONSUMPTION(KWH)
8AM	927	0
9AM	929	2
1OAM	931	4
11AM	934	7
12NN	937	10
1PM	939	12
2PM	941	14
3PM	943	16
4PM	944	17
5PM	945	18
TOTAL		**18**

TIME	DAY 4: DECEMBER 12, 2008	
	READING	CONSUMPTION(KWH)
8AM	945	0
9AM	948	3
1OAM	951	6
11AM	953	8
12NN	955	10
1PM	957	12
2PM	959	14
3PM	961	16
4PM	964	19
5PM	966	21
TOTAL		**21**

TIME	DAY 5: DECEMBER 15, 2008	
	READING	CONSUMPTION(KWH)
8AM	968	0
9AM	970	2
1OAM	973	5
11AM	975	7
12NN	979	11
1PM	981	13
2PM	984	16
3PM	986	18
4PM	988	20
5PM	990	22
TOTAL		**22**

APPENDIX C

Efergy Meter Reading with Heat Insulator and Heat Sensor Device

TIME	DAY 1: JANUARY 19, 2009	
	READING	CONSUMPTION(KWH)
8AM	724	0
9AM	726	2
1OAM	727	3
11AM	730	6
12NN	731	7
1PM	733	9
2PM	735	11
3PM	738	14
4PM	739	15
5PM	741	17
TOTAL		**17**

TIME	DAY 2: JANUARY 21, 2009	
	READING	CONSUMPTION(KWH)
8AM	756	0
9AM	758	2
1OAM	760	4
11AM	762	6
12NN	765	9
1PM	769	13
2PM	771	15
3PM	772	16
4PM	774	18
5PM	775	19
TOTAL		**19**

TIME	DAY 3: JANUARY 22, 2009	
	READING	CONSUMPTION(KWH)
8AM	775	0
9AM	777	2
1OAM	778	3
11AM	780	5
12NN	782	7
1PM	784	9
2PM	786	11
3PM	788	13
4PM	789	14
5PM	791	16
TOTAL		**16**

TIME	DAY 4: JANUARY 29, 2009	
	READING	CONSUMPTION(KWH)
8AM	841	0
9AM	843	2
1OAM	844	3
11AM	846	5
12NN	849	8
1PM	851	10
2PM	851	10
3PM	853	12
4PM	855	14
5PM	856	15
TOTAL		**15**

TIME	DAY 5: JANUARY 30, 2009	
	READING	CONSUMPTION(KWH)
8AM	856	0
9AM	859	3
1OAM	860	4
11AM	862	6
12NN	863	7
1PM	864	8
2PM	866	10
3PM	868	12
4PM	870	14
5PM	872	16
TOTAL		**16**

APPENDIX D

Efergy Meter Reading with Heat Insulator, Heat Sensor Device and Lubricating Oil

TIME	DAY 1: FEBRUARY 10, 2009	
	READING	CONSUMPTION
8AM	244	0
9AM	246	2
1OAM	247	3
11AM	249	5
12NN	250	6
1PM	252	8
2PM	254	10
3PM	255	11
4PM	256	12
5PM	257	13
TOTAL		**13**

TIME	DAY 2: FEBRUARY 11, 2009	
	READING	CONSUMPTION
8AM	262	0
9AM	263	1
1OAM	265	3
11AM	267	5
12NN	269	7
1PM	271	9
2PM	273	11
3PM	275	13
4PM	277	15
5PM	279	17
TOTAL		**17**

TIME	DAY 3: FEBRUARY 12, 2009	
	READING	CONSUMPTION
8AM	281	0
9AM	282	1
1OAM	283	2
11AM	283	2
12NN	284	3
1PM	285	4
2PM	286	5
3PM	288	7
4PM	290	9
5PM	291	10
TOTAL		**10**

TIME	DAY 4: FEBRUARY 13, 2009	
	READING	CONSUMPTION
8AM	294	0
9AM	296	2
1OAM	299	5
11AM	301	7
12NN	302	8
1PM	302	8
2PM	303	9
3PM	303	9
4PM	303	9
5PM	305	11
TOTAL		**11**

TIME	DAY 5: FEBRUARY 16, 2009	
	READING	CONSUMPTION
8AM	308	0
9AM	309	1
1OAM	311	3
11AM	312	4
12NN	315	7
1PM	316	8
2PM	317	9
3PM	320	12
4PM	323	15
5PM	325	17
TOTAL		**17**

APPENDIX E

Picture of Device Installation Set-up

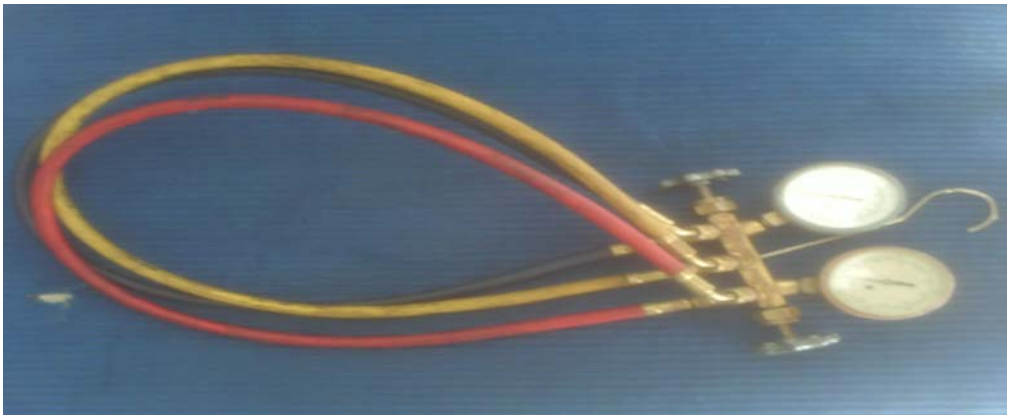
Window with E- SHIELD insulating film

Air- conditioner with the heat sensor device

Application of ARTIKOOL™ lubricating oil

air- conditioner breaker with the EFERGY meter and transmitter

Humidity tester



Oil injector pump gauge

ARTIKOOL™ lubricating oil

TRANE Air- conditioner Compressor

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