PEEK
A sustainable concept.

Energy Efficiency

in Thai Hotels

A Practical Guide

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

UNWTO • OMT • IOHBTO

adelphi research

IIEC

Energy Efficiency in Thai Hotels

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Introduction

1. Introduction

This Energy Efficiency Handbook provides practical guidance on using energy more efficiently in your organization and significantly reducing energy costs. In particular, this includes low- and no-cost measures that can be realized immediately or over a short period of time without high cost investment. In addition, some innovative measures for refurbishment activities and new built facilities are presented.

The handbook not only focuses on energy efficiency measures in all major energy consuming areas of your hotel but also on the application of renewable energy technologies (e.g. solar water heating, heat pumps, photovoltaic etc.). This handbook also provides information on the importance and functionality of energy management systems.

Overall, it is an energy-related guideline on how you can achieve considerable cost advantages whilst fulfilling the highest comfort levels for your guests and improving the environmental situation of your hotel.

This handbook has been issued as part of the "Program for Energy Efficiency in Kho Khao" (PEEK). PEEK is a project financed by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety under the International Climate Protection Initiative. The initiative supports climate protection projects worldwide in developing, newly industrializing and transition countries in order to contribute effectively to emission reductions and adaptation to climate change. On the island of Kho Khao in the province of Phang-Nga, energy efficiency measures are implemented in hotels as part of the PEEK project in order to significantly reduce green house gas emissions from tourism on the island. The experiences from the PEEK project have been incorporated into this handbook to benefit other hotels in Thailand.

Content & style:

The handbook provides a summary of practical instructions addressed to hotel management and operational staff on improving energy performance and reducing operating costs. It provides ready-to-use energy efficiency measures for most important energy consumption areas in your hotel -- especially low cost measures for cooling (air conditioning and refrigeration), cooking, water heating, lighting and ventilation. A wide range of energy efficiency measures are listed for each of the main technical areas in the form of collected best practice examples - easy to understand and with calculation examples.

The handbook encourages the active participation of all hotel staff in energy saving measures by offering information about the importance of energy efficiency for each operational area. It points out the meaning and technical relation of energy saving measures to their immediate work sphere and clarifies the effects of their behavior on energy consumption. It aims to raise staff awareness so that everybody can contribute actively to the process of energy conservation.

The handbook also highlights energy saving potentials and explains technical processes visually, through drawings and charts. With this information you can train your staff and give them the basic technical knowledge on how to save energy. Checklists for the different operational areas add to the implementation process.

Structure:

This Energy Efficiency Handbook is divided into the following five chapters:

Chapter 1: Introduction
Chapter 2: Climate Change and Tourism
Chapter 3: Energy Management
Chapter 4: Energy Efficiency Measures
Chapter 5: Checklists

Chapter one sets out the aim of this handbook, describes content, style and structure, and depicts the target groups.

Chapter two explains the greenhouse gas effect and global warming. It describes the twofold relationship between climate change and tourism and why energy efficiency and renewable energy matter.

Chapter three provides an introduction into energy management. It explains how you can measure energy consumption regularly and reduce energy costs in your hotel in a structured way. Managers will learn about operating an energy management system and be equipped to assess the overall energy situation in their hotel.

Chapter four represents the core of this handbook. It provides a collection of best practice examples for different technical areas such as refrigeration, air conditioning, ventilation, water heating, lighting, and building. These include immediate measures as well as different technical solutions.

Chapter five provides exemplary checklists *for those operational areas of a hotel that tend to be energy intensive. These checklists can be distributed* to the staff of the relevant operational areas in order to assess the current energy situation and realize energy efficiency measures. Checklists for office areas can also be used by maintenance staff for public /community buildings.

Target group:

This handbook can be used by Thai hotels of all sizes and standards.
The most important target groups within a hotel are:

- Hotel management as decision makers,
- Engineering and maintenance staff with insight into technical maintenance tasks,
- Staff of different operational areas in your hotel.

Management staff in communities / public buildings can also make use of this handbook.

The chapters are structured to address the following target groups in particular:

Chapter	Target groups
1	Hotel management; management staff in communities
2	All readers
3	Hotel management; management staff in communities; engineering staff with managerial background
4, 5	Engineering and maintenance staff; staff of different operational areas

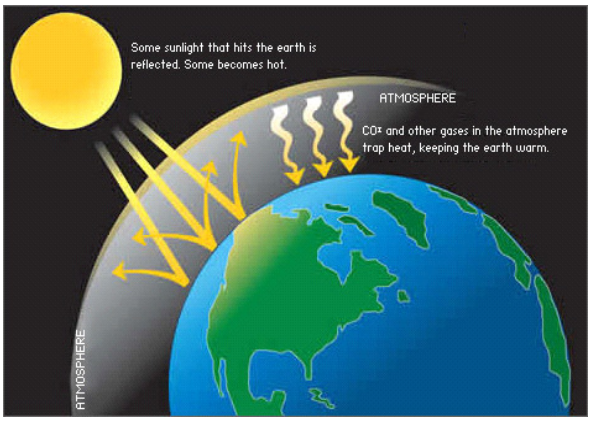
Climate Change and Tourism

2.1 Greenhouse Effect

Almost 100% of the observed temperature increase over the last 50 years has been due to the increase of greenhouse gas concentrations in the atmosphere, such as water vapor, carbon dioxide (CO2), methane and ozone. Greenhouse gases are those gases that contribute to the greenhouse effect:

Sunlight reaches the Earth. Parts of solar radiation are absorbed and warm the earth and most of the rest is radiated back to the atmosphere. Some of these longer wavelengths are absorbed by greenhouse gases in the atmosphere before they are lost to space. This absorption warms the atmosphere. These greenhouse gases act like a mirror and reflect back to the Earth some of the heat energy which would otherwise be lost to space. This process of heat energy being reflected back by the atmosphere is called the "greenhouse effect".

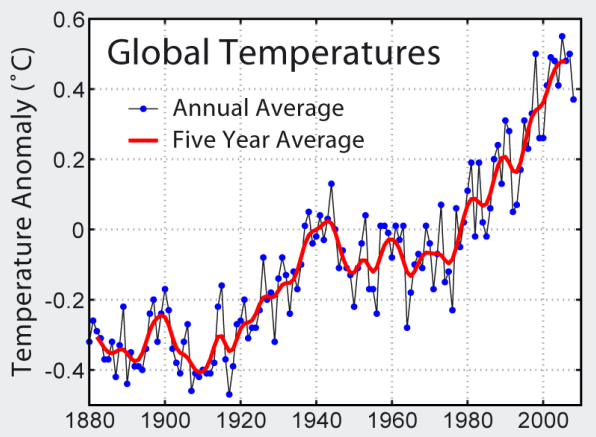
The Greenhouse Effect



Source: US department of Energy Efficiency and Renewable Energy

The largest contributing source of greenhouse gas is the burning of fossil fuels like coal, gas and oil, which lead to the emission of carbon dioxide. The rise of the concentration of greenhouse gases like CO2 leads to a rising temperature on the earth as can be seen in the following chart:

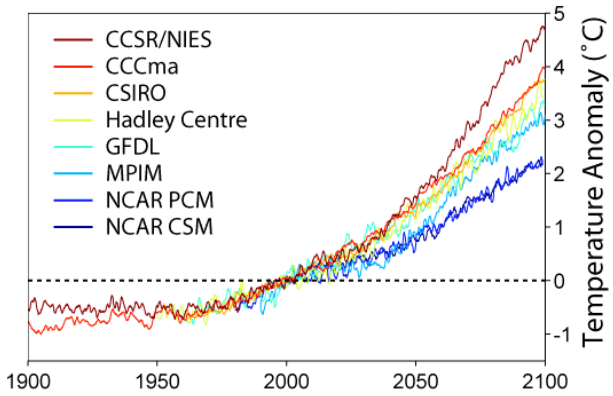
Global Temperatures



Source: IPCC 2007

There are studies undertaken by different research institutes on how global temperature will develop over the next years. Because of the long period of time and difficulty of modeling systems the results vary widely. But all of the studies mention that temperature will rise in this century.

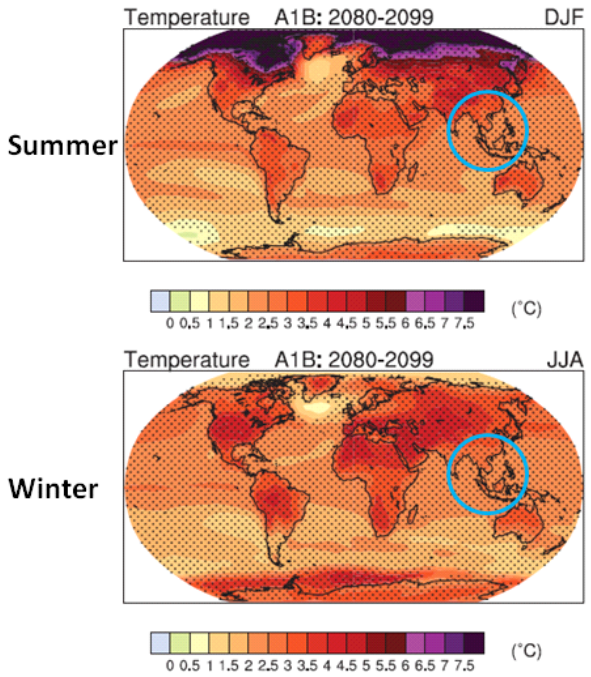
Global Warming Projections



Source: IPCC 2007

The world map below shows a potential change in worldwide temperature and its distribution in the years 2080-2099. The relevant geographic area for Thailand is highlighted with a blue circle.

Global Warming



Source: IPCC 2007

2.2 Relation between Tourism and Global Warming

The relation between climate change and tourism is twofold: climate change impacts tourism and tourism impacts climate change in return.

To take concerted action against climate change the UNWTO jointly with the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO), with the support of the World Economic Forum (WEF) and the Swiss Government convened the Second International Conference on Climate Change and Tourism.

The tourism industry is responsible for 4 to 6 percent of CO2 emissions worldwide. Use of non-renewable energy from oil and gas leads to an increase in CO2 concentration in the atmosphere. Additionally, the consumption of electrical energy affects CO2 output because the energy is generated mostly from non-renewable fuels like coal or gas. Emissions of CO2 start with the transport of tourists. Airplanes need kerosene, trains need electricity and taxis need fuel.

Furthermore, the welcome drink with ice made in the ice machine, the hot shower and the air conditioned rooms all consume energy. So every form of tourism and all aspects thereof, affect climate change.

On the other hand the climate change also affects the tourism industry.

Due to rising global temperatures parts of glaciers and the arctic will melt, or have already begun to do so. This leads to rising sea levels, which will concern Thailand, and in particular its long coastal area. The changing temperatures can also lead to an increase in extreme weather conditions such as storms or heavy rainfall.

So what can we do?

The best thing you can do is try to keep the CO2 emissions down to minimum and to spend as little energy as possible. Another positive side effect is that you will not only save emissions but also a lot of money. The following chapters show how this can be undertaken.

Energy Management

3.1 Introduction to Energy Management

Energy management involves paying attention to energy consumption and costs at the structural level of your organization.

When energy management is integrated into the daily practice of your hotel, you create an instrument with which your energy efficiency can be improved continually. This in turn reduces your energy costs.

Energy management can be seen from three perspectives:

The organization

Energy management is embedded in the operations and organizational structure of your hotel. Important aspects of this are planning, monitoring, information provision, management and recording responsibilities.

The technology

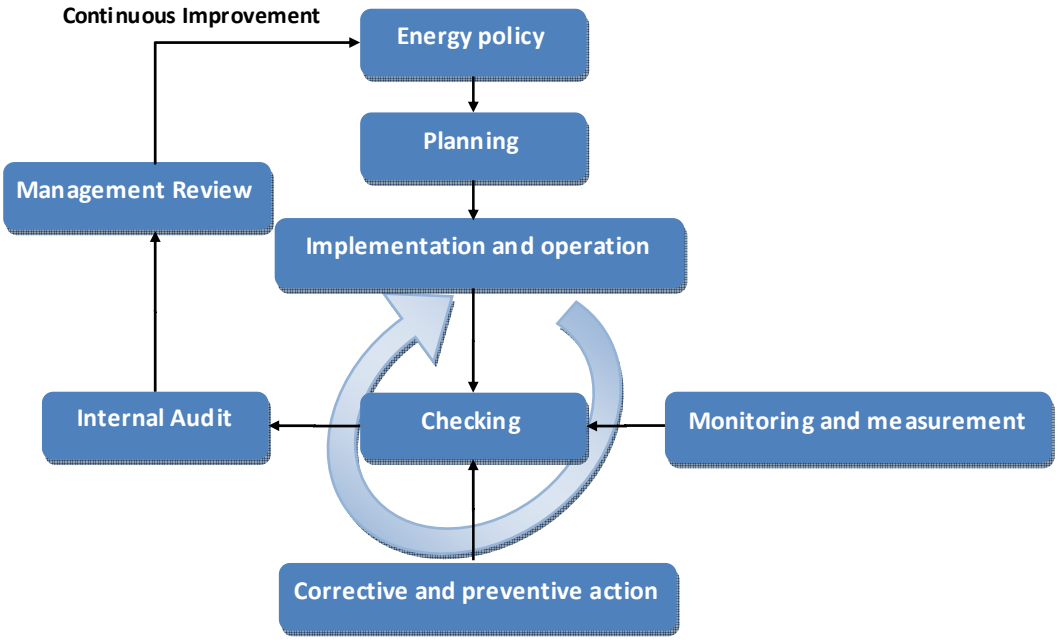
The approach to energy management depends on the processes and operating conditions of your hotel. Technical measures are always included – from generating and use of energy to the provision of information.

The behavior

Energy management also takes social factors of your hotel operations into account, such as management style, attitude and behavior of employees and the organizational structure of your hotel business.

Energy management is based on the concept of continual improvement: The Plan-Do-Check-Act cycle. It ensures that your hotel continually passes through the cycle of developing an energy policy, implementing actions, and checking results, on the basis of which new policy is made. In practice, this means that you map out energy flows at a certain point in time, identify the relevant energy aspects and subsequently take action. The analysis of your hotel's energy consumption must be done regularly in order to keep insights up to date and to adapt measures to changes. Even if the implemented measures work, continuing to use the cycle can provide further benefits and improvements.

Energy Management



Source: modified from DIN EN 16001:2009

Generally, the energy management can be part of your hotel management system, your ISO 9001 or ISO 14001 system. These ISO standards are also based on a process of continuous improvement – if you have already implemented them at your hotel it should be even easier to start your energy management system.

Internationally, there is currently a trend to introduce separate standards for energy management systems (e.g. EN 16001 in Europe or ISO 50001 worldwide). These in turn are based on integration into existing management systems.

Whether the energy management system works, depends on the organization's willingness to manage energy consumption and energy costs.

3.2 Responsibility of Top Management

The secret of successfully introducing an energy management is the commitment of employers. Regardless of the size of your hotel, the success of your energy efficiency measures will depend on the motivation and commitment of your employees. They are the users and thus best positioned to save energy. Including your guests in your efforts completes your energy management.

In order to successfully implement an energy management system at your hotel, it is therefore important that persons at the highest level be committed to and responsible for it – i.e. the top management of the hotel. For example, the managing director should include the managers of the operational areas (such as kitchen, rooms, spa & pool, restaurant etc.) into the energy management team.

3.3 Getting Started

Starting and introducing an energy efficiency management in your hotel requires you to:

- Communicate to all staff the key aims of your energy efficiency program and your commitment to energy efficiency.
- Nominate an energy manager for your hotel.
- Encourage staff to think about energy efficiency and the ways in which they can make more efficient use of energy at work.
- Develop and encourage staff to take ownership of key action points that are relevant to their workplace.

First of all you have to clarify key objectives for implementing an energy efficiency system:

- Empower your hotel to make the best use of energy, thus reducing emissions of global warming gases .
- Identify the key action points of immediate relevance for reducing energy costs in your business and at the same time improving safety, quality and costumers comfort.
- Make a commitment to reduce the energy consumption year-by-year by using energy more efficiently, whilst maintaining standards of guest comfort.

Each one of the employees can make a contribution. However small an issue may seem (turning down air conditioner for example), they soon add up to large savings in energy consumption, greenhouse gas emissions and cost. Each and every staff in each area of the operation can contribute towards reducing energy consumption. Switch-off is a simple no-cost action that everyone can take.

What are the main steps?

- Train and motivate your staff to keep energy consumptions low.
- Start monitoring energy consumption throughout your operation and set your own targets for reduction.
- Keep up-to-date with the latest grants and loans available for new technology.
- Stay informed about of best practices and how others are achieving energy savings.
- Research the most energy efficient and appropriate plant and equipment when replacing the old or making new investments.

3.4 Identify your consumption

An average Thai hotel uses three energy sources: Electricity, gas (bottles of LPG) and Diesel (for the generator).

3.4.1 Diesel

What is the monthly diesel consumption? If there is a meter installed it is easy to measure. Just detract the last meter reading from the new meter reading. If there is no meter installed you can infer the monthly consumption from the purchase of diesel. Another possibility is to mark the fill level of the diesel tank. In the next month you can see the change of the fill level. If there is a scale you can easily detract the last level from the new level. If there is no scale you can multiply the change of the height with the area of the tank and get the change of the content.

3.4.2 Gas

How much do you consume per month? Just count the gas bottles you need per month. The content in kg is written on the bottles. If you use different sizes of bottles be sure that your count is accurate.

3.4.3 Electricity

Calculating the electrical energy consumption is a bit more complex. There are 3 types of costs in the electrical bill: The electrical work, the power demand and the service fee.

The electrical power demand
This is the maximum power you need during one month. If you have 30 air conditioners with 1 kW power each and they are all running at the same time you have a max. power demand of 30kW. The unit of the power demand is **kW.** Each kW of the max. power demand is charged with 70 to 210 THB each month, depending on the voltage of your connection power. Only the max. demand of the peak hours is used for the calculation of the max. power demand.

The electrical energy
This is what the electrical meter shows. If an air conditioner with 1kW power runs for 1 hour you have to pay for 1 kWh. The unit is **kWh.** There are different prices if you use it during peak (Mon. – Fri. 09.00 a.m.–10.00 p.m.) or off peak times (Mon.–Fri. 10.00 p.m. – 09.00 a.m. and Sat. -Sun. and holidays).

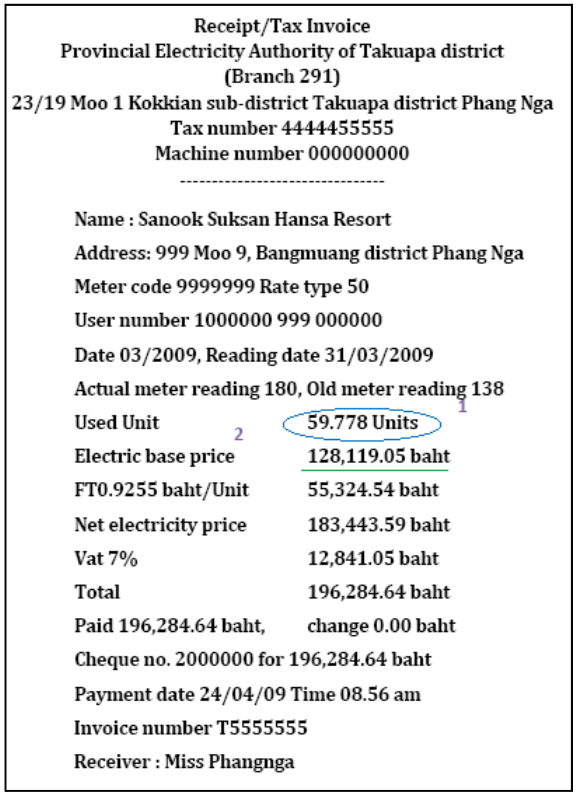
Peak time consumption is more expensive and costs twice as much as during off peak times.

Service fee
This is a service charge for delivering the electricity. It is fixed (in August 2009 it was 228 THB per month).

Normally, there are two bills from the Provincial Electricity Authority **[**PEA]. One is the receipt. The receipt shows only your overall consumption and how much you have to pay. The other bill is the invoice. In the invoice you can see all details like peak, off peak, holiday consumption and the power demand. If you do not receive an invoice you can ask for it at PEA or your local electricity provider.

Receipt:

- The purple numbers 1 & 2 in the receipt come from 1 & 2 in the invoice
- The blue circle of unit consumption comes from the blue circle in the invoice
- In the receipt only peak electricity (kWh) is shown without a decimal.
- PEA calculates the price from peak (kW) together with off peak and holiday (unit), as shown on the invoice on the next page:



Receipt/Tax Invoice
Provincial Electricity Authority of Takuapa district
(Branch 291)
23/19 Moo 1 Kokkian sub-district Takuapa district Phang Nga
Tax number 4444455555
Machine number 000000000

Name : Sanook Suksan Hansa Resort
Address: 999 Moo 9, Bangmuang district Phang Nga
Meter code 9999999 Rate type 50
User number 1000000 999 000000
Date 03/2009, Reading date 31/03/2009
Actual meter reading 180, Old meter reading 138

Used Unit	59.778 Units
Electric base price	128,119.05 baht
FT0.9255 baht/Unit	55,324.54 baht
Net electricity price	183,443.59 baht
Vat 7%	12,841.05 baht
Total	196,284.64 baht

Paid 196,284.64 baht, change 0.00 baht
Cheque no. 2000000 for 196,284.64 baht
Payment date 24/04/09 Time 08.56 am
Invoice number T5555555
Receiver : Miss Phangnga

INVOICE

No. T5555555

Subject: Electricity invoice

Dear Sanook Suksan Hansa Resort

Provincial Electricity Authority wishes to charge electricity of March 2009 as the followings:

Electricity Code	User Code	Meter code	Rate	Pressure	Multiplier	Actual Reading date
11-05-2-01	999-000000	9999999		22-23	600	31/03/09

	Actual meter reading	Old Meter reading	Kwh/unit/kv	Total(Baht)
Peak Electricity (Kilowatts)	1.446 1.198 1.377	1.212 0.998 1.154	140.40 120.00 133.80	18663.37
	1	2		
Electricity price (Unit)	180,470 117,200 144,450	138,340 86,670 114,480	25278.00 16518.00 17982.00	68124.21 41103.30

Production FT(Baht/Unit)	0.9907
Bulk FT(Baht/Unit)	-0.0241
Distribution FT(Baht/Unit)	-0.0411
Total FT (Baht/Unit)	0.9255
Units multiplying FT	59778.00
Total FT price(Baht)	55324.54

	Price(Baht)
Electrical base price	123119.05
Electrical price +FT	183443.59 0.00
Net electrical price	183443.55
Vat 7%	12841.05
Total	196284.64

	Production system(Baht)	Bulk system	Distribution system(Baht)
Peak Electrical price Electrical price Electrical support price	91386.30	17841.21	18663.37
FT price	59222.06	-1440.65	-2456.87

Total: One hundred ninety six thousand two hundred eighty four point sixty four

Please pay within: April 21, 2009

Remark

Please proceed the payment within the due date

Best regards,

The receipt date of the invoice .....

Sign.....

Sign.....(user)

Tel.....

Power demand

Look at the purple square on the invoice – this is the max. power demand (kW)
PEA uses only information for peak times to calculate the price.

Power demand	column 1	column 2	column 3	column 4
P = peak	actual meter reading	old meter reading	max. power demand (actual meter reading – old meter reading) x size of transformer (green circle)	Cost max. power demand (max. power demand x price/kW)
OP = off peak	actual meter reading	old meter reading	max. power demand (actual meter reading – old meter reading) x size of transformer (green circle)	no effect on the price
H = holiday	actual meter reading	old meter reading	max. power demand (actual meter reading – old meter reading) x size of transformer (green circle)	no effect on the price

Electrical energy

Look at the blue square in the invoice – this is the electric energy (kWh).

Electrical energy	column 1	column 2	column 3	column 4
P = peak	actual meter reading	old meter reading	Peak consumption (actual meter reading – old meter reading) x size of transformer (green circle)	price electrical work peak (peak consumption x peak price)
OP = off peak	actual meter reading	old meter reading	off peak consumption (actual meter reading – old meter reading) x size of transformer (green circle)	price electrical work off peak (off peak consumption x off peak price)
H = holiday	actual meter reading	old meter reading	holiday consumption (actual meter reading – old meter reading) x size of transformer (green circle)	price electrical work holiday (off peak consumption x off peak price)

The service fee is 228.17 (Fixed).

The green underlined price is the electrical base price.

FT price

In the orange square on the invoice is the calculation with the FT price. The FT price is an additional charge fixed by the government. The FT price is connected to the world oil price.

Total Price

Look at the red square in the invoice – this is the total price.

1. line	Electrical base price
2. line	Electrical base price + FT
3. line	Power factor
4. line	Total price
5. line	VAT
6. line	Net price

3.5 Collect Data

You can now write down the consumption of the different energy sources. Then you can find out how many room-days you had in the specific month and write it down. For example, if you rented 4 rooms out for 25 days then you had 100 room-days.

Then you have to calculate. Divide the electrical, gas and diesel costs by the room-days. In this way you get the different energy costs per booking. Now you can compare the results of the different month and see how your energy saving measures affects your energy consumption.

The template overleaf can assist you with your monthly and yearly calculation.

Year:	January	February	March	April	May	June	July	August	September	October	November	December
Electrical energy consumption [kWh]												
Electrical energy costs [THB]												
Gas consumption [kg]												
Gas costs [THB]												
Diesel consumption [l]												
Diesel costs [THB]												
Room-days												
Calculate ratios												
$\frac{\text{Electrical costs}}{\text{Room - days}}$												
$\frac{\text{Gas costs}}{\text{Room - days}}$												
$\frac{\text{Diesel costs}}{\text{Room - days}}$												
$\frac{\text{Oveall Energy costs}}{\text{Room - days}}$												

Energy Efficiency Measures

4.1 Introduction

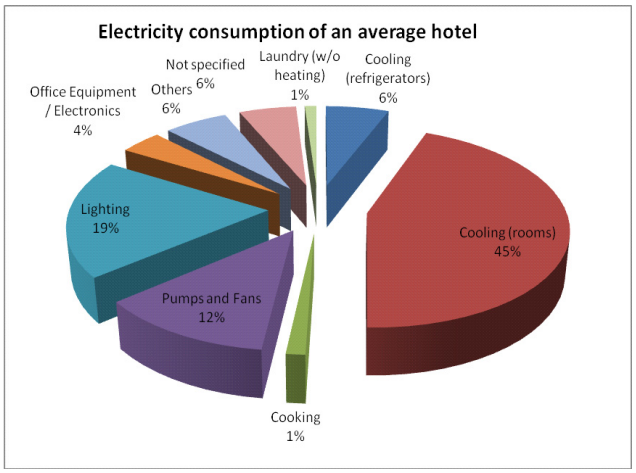
Energy costs make up a large portion of a hotel's total expenses.

In the light of rising energy prices and increasing global warming it is worth taking a look at energy efficiency measures. Many of these measures can be implemented with or without low investment costs.

Measures implying higher costs are usually amortized quickly through the savings of energy costs.

An average hotel needs gas mainly for cooking and partially for hot water. Electrical energy is required mainly for cooling (air-conditioning and refrigeration), lighting and ventilation as shown in the pie chart below.

Electrical Consumption



Source: own Energy Audit

4.1.1 Energy

The average price for 1 kWh amounts to between 2.7 and 3.5 THB in 2008.

The prices of electric energy sway depending on:

- Time of consumption
- Size of the transformer
- FT charge

The prices for electricity are higher in peak times (Mon. –Fri. 09.00 a.m. – 10.00 p.m.) and cheaper during off peak times (Mon. – Fri. 10.00 p.m. – 09.00 a.m.; Sat. Sun. and official holidays).

The FT charge is the additional expenditure which is altered by the oil price. PEA will calculate by using the ratio of cost of production that is increased on the period.

For further information take a look at the homepage of the Provincial Electricity Authority **http://www.pea.co.th**

For example:
The electrical energy costs of a small resort with 25 bungalow-apartments, a pool, an open lobby and a restaurant area with a small kitchen are about 30.000 to 45.000 THB/month during the peak season.

A resort with 62 deluxe rooms in six 2- and 3-story buildings, and 16 spacious villas, cocktail bar, 2 restaurants, health center and a swimming pool would have to pay 300.000 to 400.000 THB/month for electricity.

Natural gas is normally used for cooking and water heating. The gas is delivered in bottles.

The average price for bottled LPG amounts to 18.33 THB for one kg gas or 1.43 THB for one kWh.

4.1.2 Energy Label

Thai Energy Label

Source: Electricity Generating Authority of Thailand

An important instrument for assistance in using energy saving measures is the Thailand Energy Label. This Energy Label is easy to understand. The energy efficiency is rated from 1 - low to 5- excellent. The label also shows consumers the average energy consumption per year (kWh/ year) and the average electricity price per year (Baht/year).
In the following chapters energy use by the main technical groups of use is therefore explained:

- Refrigeration
- Air conditioning
- Ventilation
- Water heating
- Lighting
- Building

4.2 Refrigeration

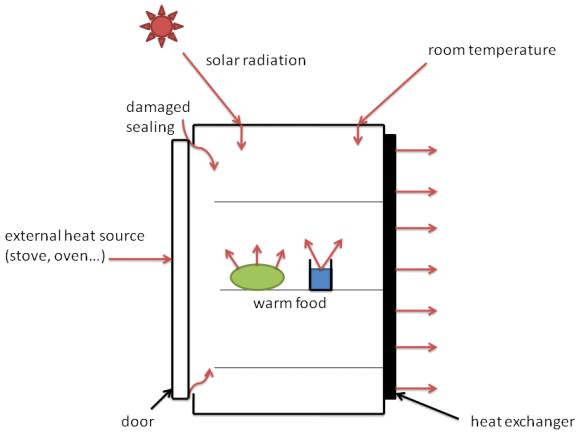
4.2.1 Importance

Refrigeration is an essential element in the world of hospitality. Refrigeration equipment is used for gastronomic purposes everywhere and is one of major consumers of electricity. In many hospitality establishments, refrigeration is badly used, poorly managed and maintained. There is usually good scope for achieving worthwhile savings in consumption and costs. As it can be seen in the diagram above this sector consumes about 6 % of the total electrical energy.

4.2.2 Principle

Almost all refrigerator equipment works in the same way. It transfers the heat from the inside to the outside. Therefore it consumes electrical power. The more heat it has to transfer out the more energy it consumes.

Heat Transfer of a Refrigerator



Source: Adelphi

There are several types of cooling equipment for different cooling tasks.

4.2.2.1 Refrigerator

The temperature inside the refrigerator is in the range of 2°C to 8°C. The refrigerator is use for almost every cooling task.

Refrigerator

Source: IIEC

4.2.2.2 Freezer

The freezer usually works with temperatures about -18°C. This temperature assures the freshness of the food for a long time period. Chest freezers are more energy efficient than uprights. Units with self-closing devices or alarm devices to ensure that doors are not left opened.

Freezer

Source: IIEC

4.2.2.3 Mini bar

The mini bar is a small refrigerator inside the guestroom to provide the guests with cold drinks and snacks at all time. Mini bars not only needs electric energy but also heat up the guest room and lead to higher electrical consumption of the air conditioner.

Mini bar

Source: IIEC

4.2.3 Energy Saving Measures

4.2.3.1 Avoid external heat

Do not put warm food inside the refrigerator because the heat has to be transported out by the use of electrical energy. Avoid external heat flows towards the refrigerator from the sun or other equipment like ovens and stoves. Keep the refrigerator away from hot equipment and direct solar radiation. Place the refrigerator in a cool and shady room. To save energy it is important that the temperature settings are correct for the content. Beware of over-cooling. Only 5°C below the required temperature can add 10-20% on the running costs.

4.2.3.2 Avoid air influx

It is also essential to keep the air influx to a minimum. Keep freezing rooms and freezer doors opening times to a minimum. The air temperature in the unit can increase by as much as 0.5 °C for every second the door is kept open. In older equipment, this will also lead to ice formation and lower energy efficiency. Frequent openings will also mean more frequent defrosting, again, a very energy intensive operation that should also be kept to a minimum. Check the sealing. If the sealing is in bad condition and does not close tightly, repair or replace it. To prevent frequent door openings, consider a daily working unit, into which the day's or shift's requirements can be stored. In this way, the main storage refrigeration need only be used when re-stocking the working fridge. Take a look at the closure mechanism. Does it work properly? Are the doors closed tightly? If not, repair it immediately because otherwise warm air will flow constantly inside the refrigerator and lead to high energy costs.

4.2.3.3 Ensure proper ventilation

To ensure a high efficiency, the cooling mechanism needs to transport the heat from the inside to the outside without any problems. Therefore, it is essential to provide good ventilation at the place where the heat outlet is. In general it is located at the back of the equipment. Clean aggregates, grid and condensers. Blocked condensers will increase operating costs by up to 5%.

4.2.3.4 Turn off

Refrigeration should be organized so that only a minimum number of refrigerators will be operated at any time. During periods of low occupancy, switch off units that are unlikely to be used for more than one week. Also switch of the mini bar in non-occupied rooms.

4.2.3.5 Buy new equipment

Due to the large operation hours of refrigeration plants and the huge amount of energy that can be saved, the investments can be profitable in short periods of time. Plants that are older than

10 years should be replaced. The new technical generation of equipment could be up to 30% cheaper to run. Buy the most energy efficient equipment. The equipment is labeled with the Thailand Energy Label from class 1 (low efficiency) to 5 (high efficiency). The additional costs of the purchase will be repaid very fast by the saved energy costs.

If you want to be sure about how much savings can be made install an electricity meter and measure the consumption of your equipment. After some days you can calculate the yearly consumption. Compare your yearly consumption with the consumption of the new equipment. The yearly consumption of the new equipment is written on the Thailand energy label.

4.3 Air Condition

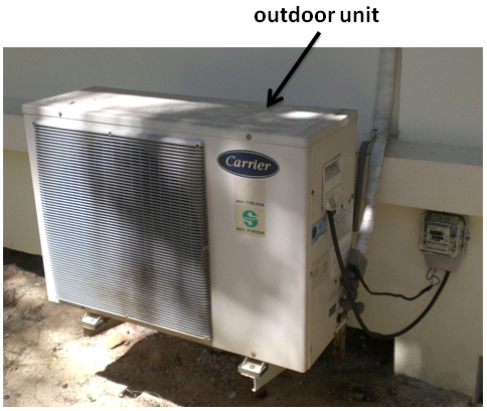
4.3.1 Importance

Air conditioning is one of the largest source of energy costs. Often up to 50% of the energy demand is used for air conditioning. Hotels can reduce the energy consumed by operating existing equipment more effectively and identifying the best type of air conditioning unit for their property. It is important to integrate some general principles into day-to-day management processes to reduce costs. You have to work with your maintenance manager to establish a routine maintenance program.

4.3.2 Principal

Air conditioning refers to the cooling and dehumidification of indoor air for thermal comfort. The average air condition equipment consists of an indoor and an outdoor unit. The indoor unit circulates and cools the room air. The outdoor unit transmits the heat to its surrounding ambiance.

Outdoor Unit

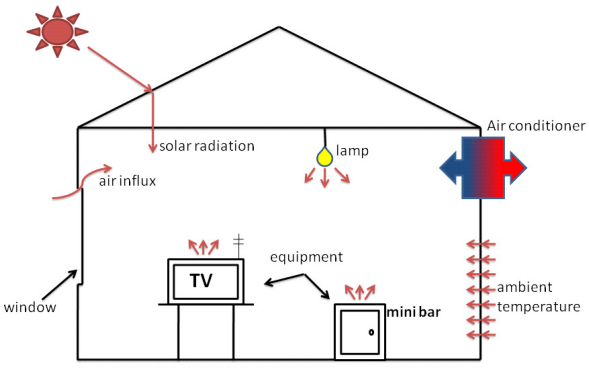


Source: Adelphi

Indoor Unit

Source: Adelphi

Air Conditioned Room



Source: Adelphi

4.3.3 Energy Saving Measures

4.3.3.1 Guests

Many hotel guests from cooler climate zones (e.g. Europeans) are not used to air conditioning. For their comfort and for energy reasons it would be a benefit if they were able to lower or turn off the air conditioner. Also, many guests from cooler climate zones prefer to sleep without air conditioning. To improve their comfort without air-conditioning, beds should be covered with thin blankets by default and extra comforters should be offered additionally, e.g. stored in the closets. Inform your guests about your climate protection efforts through energy efficiency measures when they check into your hotel. That way they can appreciate these measures.

4.3.3.2 Organization

Book guests into blocks where possible – i.e. rooms next to each other to cool one part of the building through the rooms and achieve one temperature level in a concentrated part of the building. Unoccupied offices, guest function or store rooms do not require air conditioning. Also adjust thermostats in unused areas and watch out that furniture or drapes are not placed in front of air conditioners as this will impair their effectiveness.

Ensure that air conditioners are only operating with windows closed. If windows are frequently open, when air conditioning units are operating, explore fitting automatic cut-off switches. If that is not possible, inform the guests through signs. Check if large windows, which have a high solar radiation, are supplied with curtains to avoid high air conditioning consumption and guest discomfort from excessive light or overheating. Also avoid over-cooling the building. This is expensive. Ensure that temperatures match recommended temperature standards as closely as possible. Increasing the temperature by 1°C reduces the energy consumption by 6%.

4.3.3.3 Technical

Before investing in any air conditioning unit or additional capacity, ensure that it is really necessary. In some cases, ceiling fans can be used to supplement air conditioning units, especially when combined with other and often cheaper measures like outside window shades and/or solar film and shading plants. Fans use only a fraction of the energy that air conditioning units use and often provide higher levels of guest comfort. When you choose to purchase an air conditioner buy the most energy efficient equipment being aware of the right efficiency class. The Thailand Energy Label (5 = efficient) and the COP (coefficient of performance = the higher the better) are indications for efficiency.

Cooling systems are prone to reductions in operational efficiency over time. Well maintained installations are the most energy efficient. Inspect and clean the air conditioner continuously. Dirty condensers can reduce efficiency by as much as 15%. Check the air filter inside the indoor unit. Also proper ventilation for the outside unit must be assured.

Decrease the energy consumption of the other equipments in the air conditioned rooms. All energy usage inside the room turns into heat and must be brought out by the air conditioner. Also try to avoid direct solar radiation. Heat ,that does not reach the room needs no air conditioning power. Install sunblind's or plant trees in front of big windows. Indoor sunblind's can save 25% and outside ones 75% of air conditioning energy.

The standard chillers produce cold with electrical energy. But there are also absorption chillers available. These chillers use hot water to produce cold. Hot water in turn can be produced for free via solar collectors. So if you use a central chiller it is worth taking a closer look at this option.

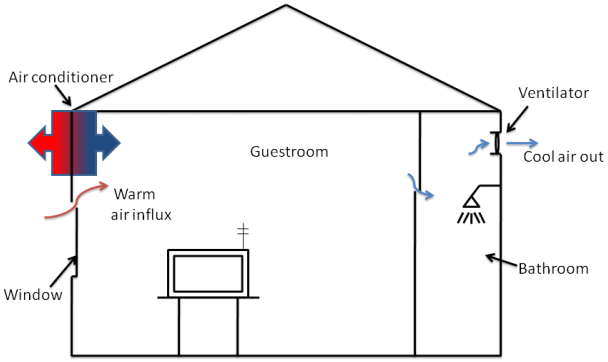
4.4 Ventilation

4.4.1 Importance

Although ventilation is not the highest consumer of energy it is worth to take a closer look. Ventilation needs energy for itself and also carries out the cooled air and leads to higher consumption of the air conditioning process. Therefore savings in ventilation are beneficial for the energy balance of the entire air conditioning system.

4.4.2 Principal

Ventilation in a Guestroom



Source: Adelphi

Ventilation is often in use in bathrooms and toilets. The ventilator transports used air out and fresh air stream in.

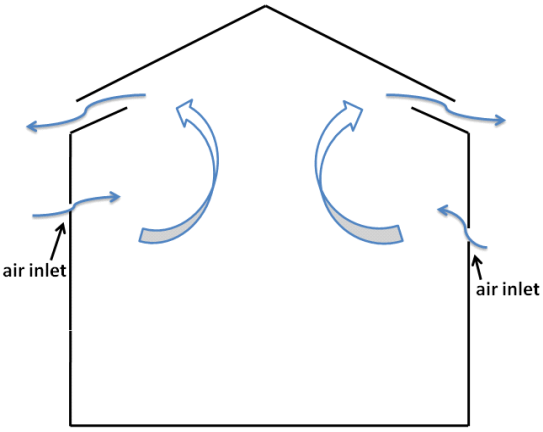
4.4.3 Energy Saving Measures

Ventilation in the bathrooms and the toilets is only necessary when these rooms are occupied. The installation of movement sensors reduces the operating time of the ventilation. In bathrooms and rarely used rooms ventilation will only work if someone is inside. It is also possible to combine the ventilation with the light fixtures.

Ventilation should be regulated according to occupancy levels. The amount of ventilation needed in a half-full area will be less than that required by a facility working at full capacity. By regulating the levels according to the actual need, large energy savings can be achieved.

In rooms and buildings without air conditioning you should think about the possibility of natural ventilation. Natural ventilation can secure a comfortable indoor temperature without any use of energy.

Natural Ventilation



Source: Adelphi

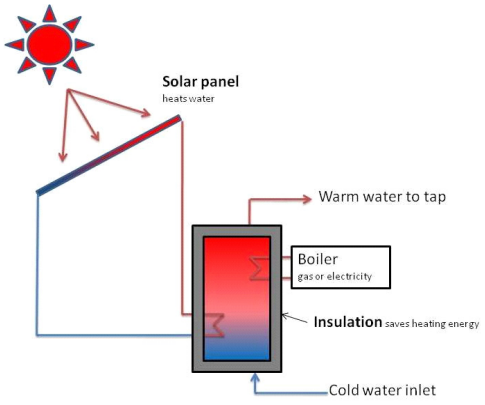
4.5. Water Heating

4.5.1 Importance

Water heating is a key part of energy consumption at all hotels. The heat boiler is a large energy user in hospitality business. Small changes here can save a lot of energy and money, so you should take a closer look. Guests take a shower every day and the pool needs warm water. Also, in the kitchen a lot of hot water is used.

4.5.2 Principle

Water Heating

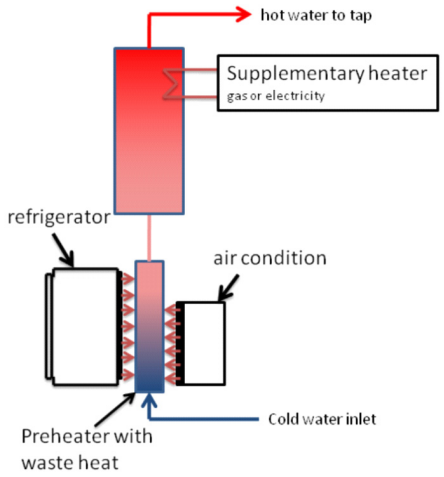


Source: Adelphi

It is possible to heat the water by using various kinds of heat sources. For example gas, electricity, solar, biomass or waste heat. Warm water can be generated centrally in big boilers or

with small boilers, on demand. Central boilers are more efficient but need circulation to provide all consumers with hot water all the time.

Waste Heat Recovery



Source: Adelphi

If a choice exists between using natural gas or electricity, especially at time of purchasing equipment, choose gas. Gas will save energy costs and reduce carbon emissions by a similar amount. Use solar thermal systems or heat-recovery systems from all heat-generating installations, such as refrigeration and air conditioning. The climate with high solar radiation and high temperatures is perfect for solar water heating. In Thailand the annual solar radiation is about 1.800kWh/m². Waste heat also can be used to pre-heat water. Where this is feasible, not only can it reduce energy consumption, but it could also reduce boiler capacity. Another option is to install heat pumps. Heat pumps heat up the water very efficiently. Therefore they need only 25% of energy, compared with a standard electrical boiler.

4.5.3 Energy Saving Measures

4.5.3.1 Boiler

Excessive heating of hot water is wasteful. The optimum temperature for stored hot water is 60°C which is adequate to kill Legionella bacteria and is sufficiently warm for guests and staff. Therefore, ensure that thermostats are set at a level that guards against legionnaire's disease while also avoiding overheating water. Also provide the hot water needed, using the least amount of boiler capacity and check time and temperature settings of all electric panel and storage heaters.

Where hot water needs to be transferred a long way from the main boiler to reach staff quarters and public toilets, the installation of heat-on-demand water heaters should be taken into consideration. Furthermore, think about if hot water in remote areas is really necessary.

When choosing a new boiler, you should consider that you will spend far more on the energy used to power it over its lifetime than on the initial capital investment. Thus an additional investment at the time of purchase in the most efficient boiler will pay back relatively quickly. Adequate insulation of hot water tanks and hot water pipes with modern foam coat is very important and saves a lot of money and energy.

Maintain the boiler by an annual service (a poorly maintained boiler may use 15% more energy than one that is served annually).

4.5.3.2 Washing and Cleaning

Thermostats on hot water heaters and washing water temperature settings should be set to appropriate temperatures and checked regularly. Ensure that the lowest possible washing temperatures are selected. A 40°C washing is adequate for most lightly soiled fabrics and is significantly more energy efficient than washing at temperatures of 60°C. Some of the newer generation of washing detergents can facilitate washing at even lower temperatures (some are effective in cold water) offering further energy savings.

Many modern cleaning fluids, washing detergents and products do not require hot water. If you use cold water you can save a lot of money without having a disadvantage.

4.5.3.3 Kitchen

Dish washers should only be used when full loads can be processed.

Use preheated water.

Power drying cycles on some dishwashers are very energy intensive. Energy savings can be made by shortening the drying times and using the residual heat from the machine to dry the dishes.

Also never use running hot water to defrost foods. Take them out of the freezer on time.

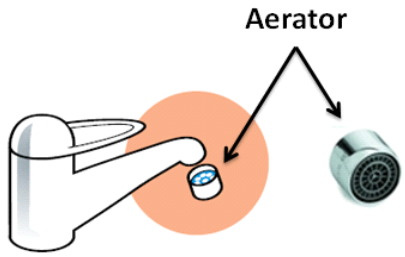
4.5.3.4 Pool

Because of the high thermal capacity of water, even the smallest rise (0.5 °C) in the pool temperature will increase energy consumption. The temperature of pre-swim-showers should be set at 2 °C above pool temperatures and post-swim/exercise showers at 40 °C.

4.5.3.5 Guest rooms

Fit aerators or flow restrictors on all basin taps, but especially on hot water outlets. These are easily fitted to pipes or taps and can reduce consumption without diminishing the service to the customer. Replace conventional showerheads with water efficient showerheads. These appliances will reduce the flow of water in showers from 15-18 litres/minute to 8-10 litres/ minute.

Aerator



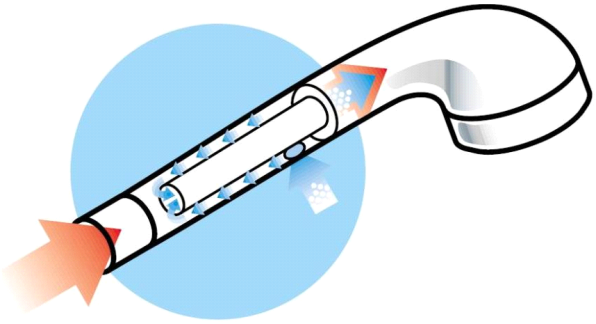
Source: Adelphi

4.6. Lighting

4.6.1 Importance

Lighting is an important cost factor. About 20% of the total electrical consumption is used for lighting. Good lighting is essential for costumers' satisfaction as well as for health and safety of staff and visitors. With modern technology, lighting energy costs can be reduced dramatically by use of energy efficient lamps and controllers. The pay-back period for lighting conversion is short, usually well under two years. Converting to energy efficient and effective lighting is one of the most cost-effective measures available to hospitality businesses.

Water Efficient Shower



Source: Adelphi

4.6.2 Types of Lighting

Type	Compact fluorescent lamp (CFL)	Fluorescent lamp	Incandescent lamp	Halogen lamp	LED
					
Light efficiency [Lumen/Watt]	35 - 85	50 - 110	4 - 16	10 - 25	8 - 30
Lifetime [h]	8.000 – 15.000	9.000 – 77.000	1.000	1.500 – 5.000	Up to 100.000

(Types of lighting)

4.6.3 Energy Saving Measures

4.6.3.1 Avoid the need of light

One of the best and easiest measures to save energy is simple to avoid the need for artificial light.

Use natural light wherever possible and comfortable. Place desks close to windows or under skylights. It is also important to ensure that all windows are cleaned regularly. Only clean windows let the whole natural light in. It is also a benefit if you use bright colors in all interior rooms. These colors reflect the light and lead to brighter rooms. Provide guests and staff with desk lamps or independently operated task lights and avoid the need to fully illuminate the whole room when only a part of space is in use.

4.6.3.2 Clean the lights

Keep light fixtures and fittings clean. A regular cleaning routine for external lighting is equally if not more important than a routine for cleaning internal lights. Moss, lichen and environmental pollutants can all rapidly build up on lights and reduce their effectiveness by as much as 50%.

4.6.3.3 Switch off

Switch off lights in vacant rooms. Ensure that "switch off" policies are in place and operating. Inform your guests about these policies. Timing controls can be used to reduce night time lighting, for example, by switching off selected lights along corridor areas and in remote garden areas. Photocells and motion detectors are very effective in areas such as public toilets where the user cannot be expected to turn the lights on and off. However, sensors must be placed to turn lights on as soon as the customer enters the area and, to ensure that the customer does not enter a completely dark room.

4.6.3.4 Change types of lights

Exchange conventional incandescent lamps with compact fluorescent lamp (CFL) in all places where the light is on for more than a few minutes. This measure easily saves 80% of costs and energy. Also efficient lamps have the added advantage of a longer life span thus requiring less replacement and maintenance.

Cost of Lighting

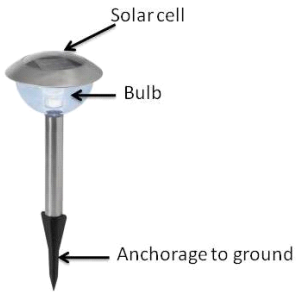
	Incandescent light bulb 	Compact fluorescent lamp 
Power	60 Watt	11 Watt
Lifetime	1000 h	10 000 h
Daily operating hours	4	4
Yearly energy consumption	87.6 kWh	16.1 kWh
Yearly energy costs (3 THB/kWh)	262.8 THB	48.3 THB
Savings/year (1 bulb)		214.5 THB 71.5kWh 80%
Savings/year (100 bulbs)		21450 THB

Source: Adelphi

An average energy bulb starts at a price of 100 THB. The price rises with higher performance, longer lifetime or different shape.

You can also use solar lamps to light paths. These lamps have solar panels on the top and can produce light without consuming external energy.

Solar Lamp



Source: Adelphi

Exchange old fluorescent lamp (diameter T12 = 38.1mm; T8 = 25.4mm) and the magnetic ballast with new fluorescent lamp (diameter T5 = 15,9mm) and electronic ballast. There are special replacement sets available.

Take a look at the "T5 Retrofit Program" of the Electricity Generating Authority of Thailand and the Thailand Ministry of Energy.

http://www.egat.co.th/en/images/stories/pdf/eng-t5_3.pdf

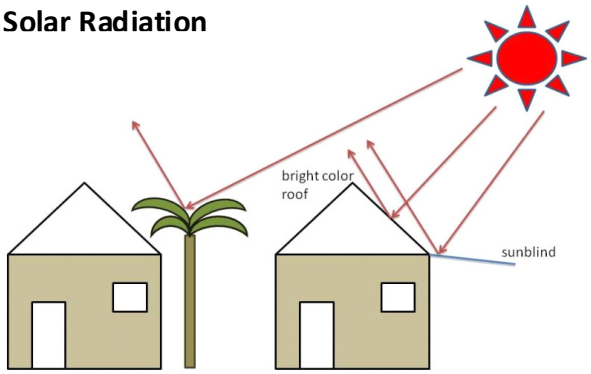
4.7. Building

4.7.1 Importance

Significant savings in energy costs can be made by integrating energy efficiency considerations if you are planning to refurbish any part of your property or build new facilities.

4.7.2 Energy Saving Measures

Solar Radiation

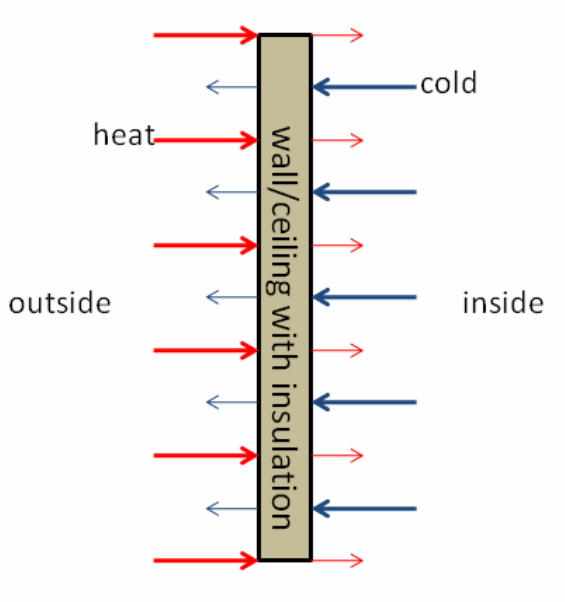


Source: Adelphi

Use light colors for walls and ceilings (for example, paint wooden roofs in a bright color). Light colors reflect the solar radiation and lead to lower air conditioning consumption. Buildings with large south or south west facing glazed areas, may suffer from excessive heat and light gain during the summer months. Trees and shrubs planted carefully in external areas can help guard against solar gain and reduce the need for costly air conditioning by providing attractive shading. Also an outside sunblind can help saving energy. An outside located sunblind can save up to 75% and an inside sunblind 25% of energy. Also check the sealing of the doors and windows to ensure air tightness. This will lead to higher comfort and reduce energy costs.

Insulation is a key issue for all hotels, even those with existing energy management programs. Effective insulation can be cheaply installed during the construction and refurbishment of hotels. If you are planning to refurbish, you should bear in mind that significant savings in energy costs can be made by integrating efficient insulating materials and building design considerations into your plans. It is worth increasing insulation levels for walls, ceilings and roofs above the regulatory standard. Effective use of insulation and design as a part of a refurbishment program can reduce energy costs as much as 50%.

Insulation



Source: Adelphi

Insulation separates the hot outside conditions from the air conditioned indoor climate. A thicker insulation layer and a lower thermal conductivity (k or Lambda λ) of the insulation lead to a lower heat exchange and energy savings.

In general, consider maximum use of natural resources such as solar energy, natural light or ventilation and avail of most energy efficient new equipment and technologies .

Insulation material	Thermal conductivity k [W/(m*K)]
Fiber glass	0.03 – 0.045
Mineral or rock wool	0.045
Cellulose	0.04
Vermiculite	0.06 – 0.07
Polyurethane foam	0.02
Elastomeric foam	0.033
Polystyrene foam	0.035

5. Checklists:

Hand out the checklist to the responsible persons for the following areas: Guest room, facility management, kitchen and restaurant, laundry.

5.1 Guest rooms / room service

	Check	If YES	If NO	Action	Done
guest room - room service - guest room - room service	Are the sealings of the doors and windows of the air conditioned rooms in a good state?	☐ OK	→	Repair or replace them	☐ OK
	How old is the mini bar? Less than 5 years?	☐ OK	→	Think about buying new equipment (inform management)	☐ OK
	Is the mini bar off if the room is vacant?	☐ OK	→	Turn it off	☐ OK
	Is the inside of the mini bar free of ice?	☐ OK	→	Remove ice	☐ OK
	Is the heat exchanger at the back of the mini bar clean?	☐ OK	→	Clean it	☐ OK
	Is good ventilation behind the mini bar assured?	☐ OK	→	Assure good ventilation by move the mini bar a bit further or making slots behind the mini bar	☐ OK
	Is the air filter of the air conditioner clean?	☐ OK	→	Clean or replace the filter	☐ OK
	Are the guests able to lower or turn of the air conditioner in their rooms?	☐ OK	→	Give the guests the possibility to adjust the temperature	☐ OK
	Are the air conditioned rooms sealed against outside air influx? Check doors and windows	☐ OK	→	Seal doors, windows and repair holes	☐ OK
	Do the guests have access to thin blankets?	☐ OK	→	Provide the guests with thin blankets so that they can lower or turn off the air conditioner overnight	☐ OK
	Are there aerators or flow restrictors installed at the tap?	☐ OK	→	Install aerators or flow restrictors	☐ OK
	Are water efficient shower heads installed?	☐ OK	→	Install water efficient shower heads	☐ OK

	Check	If YES	If NO	Action	Done
guest room - room service	 Are all incandescent light bulbs replaced?	☐ OK	→	Replace incandescent light bulbs with compact fluorescent lamps (CFL) 	☐ OK
	Does all hot water needs have a short way to the boiler?	☐ OK	→	Think about installing a heat-on-demand water heater	☐ OK
	Are the boilers shut down during periods of seasonal closure?	☐ OK	→	Shut down the not required boilers	☐ OK
	Are all lights in vacant rooms switched off?	☐ OK	→	Switch them off. Ensure that “switch off” policies are in place and operating	☐ OK
	Do you have desk lamps or independently operated task lights?	☐ OK	→	Install small task lights to avoid the fully illumination	☐ OK

5.2 Facility Management

	Check	If YES	If NO	Action	Done
Facility Management - Facility Management	Are the sealings of the doors and windows of the air conditioned rooms in a good state?	☐ OK	→	Repair or replace them	☐ OK
	How old is the refrigeration equipment and the mini bar? Less than 5 years?	☐ OK	→	Think about buying new equipment	☐ OK
	Is the temperature in the air conditioned rooms 23°C or higher? Use a thermometer to be sure	☐ OK	→	Adjust temperature to 23°C or higher	☐ OK
	Is the air filter of the air conditioner clean?	☐ OK	→	Clean or replace the filter	☐ OK
	Is the air conditioner only operating with windows closed?	☐ OK	→	Close windows. Give your staff instructions to do so. If the windows continue to be left open install an automatic cut-off that switches off the air conditioner when windows are open	☐ OK
	Are the air conditioned rooms protected from direct solar radiation?	☐ OK	→	Protect the rooms from direct solar radiation with sunblind or trees	☐ OK
	Is the warm water boiler temperature 60 °C?	☐ OK	→	Adjust temperature to 60°C	☐ OK
	Are there aerators or flow restrictors installed at the tap?	☐ OK	→	Install aerators or flow restrictors	☐ OK
	Are water efficient shower heads installed?	☐ OK	→	Install water efficient shower heads	☐ OK
	Does all hot water needs have a short way to the boiler?	☐ OK	→	Think about installing a heat-on-demand water heater	☐ OK
	Are the boilers shut down during periods of seasonal closure?	☐ OK	→	Shut down the not required boilers	☐ OK
	Do you use solar energy, heat pumps or heat recovery to heat water?	☐ OK	→	Install a energy efficient or renewable energies system if possible	☐ OK

	Check	If YES	If NO	Action	Done
Facility Management	Don´t you use electric energy to heat water?	☐ OK	→	Try to switch to solar heating or gas if possible	☐ OK
	Do the boilers have a adequate insulation?	☐ OK	→	Insulate the boiler	☐ OK
	Are the external lights are clean?	☐ OK	→	Clean them	☐ OK
	 Are all incandescent light bulbs replaced?	☐ OK	→	Replace incandescent light bulbs with compact fluorescent lamps (CFL) 	☐ OK
	Are the lights in public toilets only on when they are needed?	☐ OK	→	Install a movement sensor (inform the facility management)	☐ OK
	Is the outdoor light (partly) switched off after 1 a.m.?	☐ OK	→	Switch off the outdoor light (partly) if it is not needed. Install a time controller	☐ OK

5.3 Restaurant and kitchen

	Check	If YES	If NO	Action	Done
Restaurant and kitchen	Check the load of the refrigerator. Is it fully loaded?	☐ OK	→	Try to rearrange the food in one refrigerator and switch off the other. If the refrigerator is too big think about buying a smaller one.	☐ OK
	Ensure that the temperature settings are correct for the contents?	☐ OK	→	Adjust temperature properly	☐ OK
	Is the refrigerator located in shady and cool place?	☐ OK	→	Provide shadow or rearrange the refrigerator to a cooler place	☐ OK
	Are all heat sources far away from the refrigerator?	☐ OK	→	Try to place the heat source and the refrigerator as far away from each other as possible	☐ OK
	Are the aggregates, grid and condensers clean?	☐ OK	→	Clean the aggregates, grids and condensers	☐ OK
	Are the insulation and the gaskets in good condition?	☐ OK	→	Repair or replace them	☐ OK
	Is the inside of the refrigerator free of ice?	☐ OK	→	Remove ice and check for the reasons of ice building	☐ OK
	How old is the refrigeration equipment and the mini bar? Less than 5 years?	☐ OK	→	Think about buying new equipment	☐ OK
	Is the temperature in the air conditioned rooms 23°C or higher? Use a thermometer to be sure	☐ OK	→	Adjust temperature to 23°C or higher	☐ OK
	Is the air filter of the air conditioner clean?	☐ OK	→	Clean or replace the filter	☐ OK

	Check	If YES	If NO	Action	Done
Restaurant and kitchen	Is the air conditioner only operating with windows closed?	☐ OK	→	Close windows. Give your staff instructions to do so. If the windows are left open furthermore, install an automatic cut-off that switch off the air conditioner while windows are open	☐ OK
	Are the air conditioned rooms protected from direct solar radiation?	☐ OK	→	Protect the rooms from direct solar radiation with sunblind or trees	☐ OK
	Are the dishwashers only running with full load?	☐ OK	→	Run dishwashers only with full load if possible	☐ OK
	 Are all incandescent light bulbs replaced?	☐ OK	→	Replace incandescent light bulbs with compact fluorescent lamps (CFL) 	☐ OK
	Do the boilers have a adequate insulation?	☐ OK	→	Insulate the boiler	☐ OK
	Are the lights in public toilets only on when they are needed?	☐ OK	→	Install a movement sensor (inform the facility management)	☐ OK

5.4 Laundry

	Check	If YES	If NO	Action	Done
Laundry	Does the washing machine only run with full load?	☐ OK	→	Run washing machine only with full load if possible	☐ OK
	 Are all incandescent light bulbs replaced?	☐ OK	→	Replace incandescent light bulbs with compact fluorescent lamps (CFL) 	☐ OK
	Do you wash with the lowest possible temperature?	☐ OK	→	Try to wash with lower temperature. A 40°C washing is adequate for most lightly soiled fabrics and is significantly more energy efficient	☐ OK

Renewable energy

6.1 Introduction

Renewable energy is energy generated from natural resources that are renewable (naturally replenished). About 18 percent of total global energy consumption is made up of renewable sources. The biggest part comes from traditional biomass, which in most cases means burning wood for heating and cooking. Hydroelectricity is the second largest renewable source of global energy consumption. Other renewable energies like biomass (wood, waste, ethanol), wind and solar power are growing steadily.

Useful information on renewable energies
www.dede.go.th and www.eppo.go.th

Thailand has implemented a fairly ambitious renewable energy policy, which sets the target for modern renewable energy deployment at 9.5 percent of total energy consumption by 2011. There are attractive benefits for electricity generated from different renewable technologies, resulting in rapid increase in the use of biomass for heat and power. The biofuel industry has also grown rapidly. In the last 3 years bioethanol production has jumped to about 1 million litres/day and biodiesel to 1.2 million litres/day. The biomass and biofuel removes the greenhouse gas CO2 from the atmosphere while growing and binds the carbon in the biomass. The carbon is released into the atmosphere when burning the biomass or biofuel. This means no additional CO2 is emitted.

Unlike fossil fuels, modern renewable energies do not emit CO2 into the atmosphere and do not affect global warming. Furthermore, they are free of charge. So it is worth to check the possibility of using renewable energies at your hotel business.

There are different options in Thailand for using renewable energies in hotel business.

6.2 Technology

6.2.1 Solar Thermal

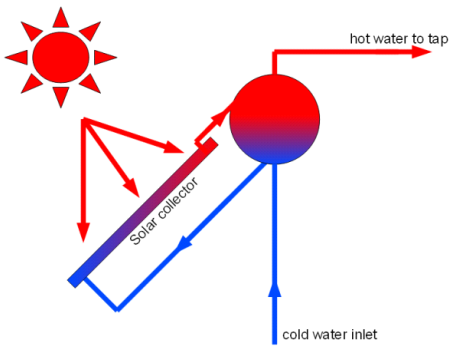
Solar thermal systems utilize the heat of the sun for heating purposes. Solar collectors capture the sun radiation and turn them into useful heat. In hotel business it is used for water heating. Due to the large demand of hot water in hotel business, this system can fit perfectly. Moreover the sun radiation in Thailand, is compared to the global average, very high.

This photo shows a typical solar water heating system. The cold water inlet is on the bottom of the hot water storage tank. Due to the thermal circulation there are no additional pumps needed. This system is very cost efficient and reliable and can provide free hot water without much investments and construction work.

Solar Water Heater

Source: Stan Zurek

Solar Water Heater



Source: Adelphi

6.2.2 Solar Cells

Solar cells convert the solar radiation directly into electricity by using the photovoltaic effect. The photovoltaic effect refers to photons of light knocking electrons into a higher state of energy to create electricity. These systems are high-end technology and therefore they are relatively expensive and often not feasible for hotels.

Solar Cells

Source: BMU, Bernd Wenzel (IFNE)

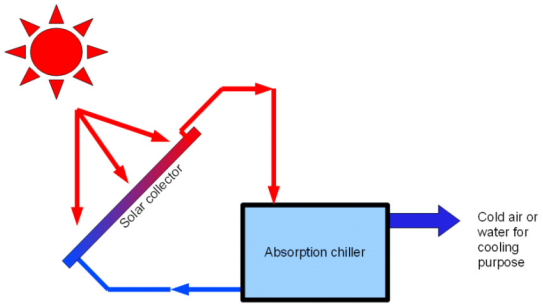
Solar cells convert the solar radiation directly into electricity by using the photovoltaic effect. The photovoltaic effect refers to photons of light knocking electrons into a higher state of energy to create electricity. These systems are high-end technology and therefore they are relatively expensive and often not feasible for hotels.

They can, however, be useful for remote buildings. The energy-self-sufficient buildings do not need a connection to the grid and therefore they can save a lot of costs.

6.2.3 Solar Cooling

Solar cooling is based on solar thermal systems in combination with absorption chillers. Unlike conventional chillers the absorption chillers use heat to generate cool air or water.

Absorption Chiller



Source: Adelphi

The advantage of this system is that the demand of cooling energy and the production of the energy therefore (solar heated hot water) are at the same time (e.g. at noon you need the most cooling power and also get the most hot water from the thermal solar system).

Solar cooling is more efficient with central cooling systems than with small decentralized air conditions systems. Although the adsorption chillers are more expensive than conventional chillers and the solar collectors are also not cheap a solar cooling system with central water heating can provide you with free cooling and water heating for years.

6.2.4 Biomass

Biomass is one of the most important sources of renewable energy in Thailand. Extracting energy from biomass is still practiced in a traditional way in rural areas. Direct combustion has been the most important process of converting biomass to other useful types of energy. The most common forms of biomass in Thailand are bagasse from sugar cane, Paddy husk, wooden chips and parts of the oil palm. Because of the closed CO2 cycle there is no additional CO2 emitted.

Biomass

Source: BMU, H. G. Oed

In hotels with central water heating, cheap biomass can replace the expensive gas or electricity. If you have a source of biomass nearby and you do not suffer of space shortage you should think about this option and talk to your heating engineer.

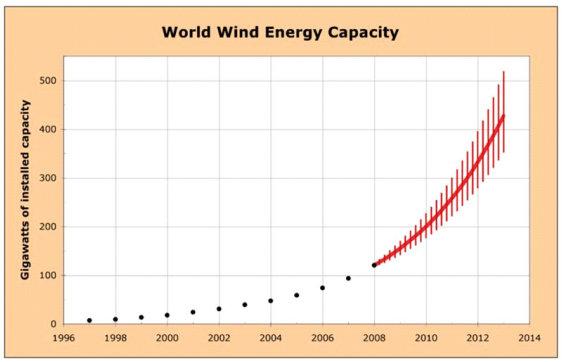
6.2.5 Biogas

Biogas is produces when organic materials are decomposed anaerobically in the absence of oxygen. Sewage, kitchen-waste and most organic materials can be decomposed in biogas plants to produce biogas. Biogas is an inflammable, clean and efficient gas which can use for cooking, heating or as fuel replacement in power generators.

6.2.6 Wind Power

Wind power is the conversion of the energy of the wind into electrical energy through wind turbines. It is one of the fastest growing and economically efficient sources of renewable energies.

Wind Power



Source: World Wide Energy Association, Loren Cobb

There is considerable potential for large scale wind energy in Thailand, especially in the central and western regions.

The normal size of wind turbines is very large (1MW—5MW) but there are also some small types (1kW—50kW) available for commercial use.

Although the installation of the wind turbine will be no financial gain, but shows your guests your interests in environmental protection.

Small Wind Turbine

Source: Glogger

Basic Calculations

7.1 Payback Period

7.1.1 Calculation

The payback period is a calculation method which is easy to use. This tool indicates the economic efficiency of investments in energy efficiency measures. This calculation can be undertaken by the hotel owner or the technical staff – i.e. the person responsible for the buildings and machines budget.

The **payback period** is the amount of time an energy efficiency measure needs to cover its costs.

$$payback\ period = \frac{total\ investment}{yearly\ cost\ savings}$$

First you have to identify the current **yearly consumption** of your existing (old) technologies. This can be done through measurements or estimations. If you undertake measurements only for a certain time period (in days) you have to calculate the yearly consumption as follows:

$$yearly\ energy\ consumption = \frac{consumption\ (period)}{period} \times 365\ days$$

Now this must be compared with the yearly consumption of the new equipment. This is written on the energy label.

The **yearly energy saving** is the difference of the old yearly energy consumption and the new energy consumption.

old yearly energy consumption - new yearly energy consumption

= yearly energy savings

The yearly energy savings have to be transferred into **yearly cost savings** by multiplication with the energy costs. The energy costs are depending on the source of energy. The electrical costs are written on the electrical bill. The electrical price currently (Nov. 2009) ranges from **2.7 THB to 3.5 THB per kWh**.

The cost for gas in bottles (LPG) is **1.8 THB per kWh**

$$yearly\ cost\ savings = yearly\ energy\ savings \times price\ per\ kWh$$

With the required cost of investment and the annual cost savings the payback period can easily be calculated. This method shows if it is worth to replace old working equipment with new efficient equipment. If the old equipment must be replaced anyhow and there are different possible options for new equipment the payback time can also help with the decision:

$$payback\ time = \frac{price\ of\ product\ A - price\ of\ product\ B}{[energy\ consumption\ (product\ B) - energy\ consumption\ (product\ A)] \times energy\ price}$$

7.1.2 Example

Replacement of a refrigerator:

To identify the consumption there are plug-in electrical meters available. These meters can plug between the electrical socket and the plug and display the energy consumption. After 5 whole days the meter reading is 10 kWh. With the formula the yearly energy consumption is calculated.

The **payback period** is the amount of time an energy efficiency measure needs to cover its costs.

$$yearly\ energy\ consumption = \frac{10\ kWh}{5\ days} \times 365\ days = \mathbf{730\ kWh}$$

The yearly energy consumption is written on the energy label of the new refrigerator. In this example it is **420 kWh** per year.

$$yearly\ energy\ saving = 730\ kWh - 420\ kWh = \mathbf{310\ kWh}$$

The price of the electrical energy is shown on the electricity bill and in this example 3.5 THB per kWh.

$$yearly\ cost\ savings = 310\ kWh \times 3.5\ \frac{THB}{kWh} = \mathbf{1085\ THB}$$

The investment costs for a new refrigerator are 7500 THB.

$$payback\ period = \frac{7500\ THB}{1085\ THB} = \mathbf{6.9\ Years}$$

7.1.3 Typical Payback Periods

The savings and costs vary according to the application. The following table shows typical values of payback times for Thai hotels.

Measure	Payback time
Roof and wall insulation	5 – 15 years
Solar water heating system	5 – 12 years
Heat recovery	3 – 12 years
Compact fluorescent bulb	0,5 – 3 years
Install variable frequency drives on motors and pumps	2 – 5 years
Efficient shower heads	0,5 – 2 years
Aerator	0,5 – 3 years
Energy efficient refrigerator	5 – 12 years
Movement sensor	1 – 5 years
Energy efficient air condition	3 – 10 years

7.2 Other Calculation Methods

The payback period is a static calculation. Therefore it is a fast and easy method to get an overview of the investments profitability. Beside this method there are other, more complex calculation techniques available, which are shown briefly here.

$$NPV = -Investment + \left(yearly\ savings \times \frac{(1+i)^T - 1}{(1+i)^T \times i}\right)$$

7.2.1 Net Present Value (NPV)

The NPV shows how much an investment is worth at the present time. It also considers the interest rate.

$$NPV = -300\ THB + \left(200\ THB \times \frac{(1+0.05)^3 - 1}{(1+0.05)^3 \times 0.05}\right) = \mathbf{245\ THB}$$

i = interest rate in decimal digit (5% = 0.05)
T = lifetime (years)

Example: An energy saving light bulb with a lifespan of 3 years costs 300 THB. This lamp saves electricity worth 200THB every year. The interest rate is 5% = 0.05.

This means the bulb is worth 245 THB now. All investments with a NPV > 0 are economically reasonable.

7.2.2 Annuity

The annuity is the yearly costs of an investment with the interest rate involved. The annuity can check against the yearly savings. So I can be seen if an investment should be made.

$$Annuity = Investment \times \frac{i \times (1+i)^T}{(1+i)^T - 1}$$

i = interest rate in decimal digit (5% = 0.05)
T = lifetime (years)

Example: With the example above we have investments of 300THB, 3 years lifespan, 200THB yearly savings and 5% = 0.05 interest rate.

$$Annuity = 300\ THB \times \frac{0.05 \times (1+0.05)^3}{(1+0.05)^3 - 1} = \mathbf{110\ THB}$$

Now we compare the yearly savings with the yearly costs (annuity)

$$yearly\ earnings = 200\ THB - 110\ THB = \mathbf{90\ THB}$$

This method shows that yearly earnings of 90 THB can be made.

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