Development of Criteria and Benchmarks

for Green Hotels in Thailand—Phase I

Submitted to

Council of State Governments/
United States-Asia Environmental Partnership

International Sustainable Development Foundation
U.S. Department of Energy APEC Program
State of Oregon Office of Energy
City of Portland's Office of Sustainable Development
Portland General Electric's Green Building Services
Thailand Environment Institute

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PREFACE

The Oregon Economic and Community Development Department is grateful to the Council of State Governments/US-Asia Environmental Partnership in making the funding possible to this study***, Development of Criteria and Benchmarks for Green Hotels in Thailand—Phase I.***

Tourism is Thailand's key industry and hotels are prime consumers of energy and water, and they also generate significant waste. Hotel owners and managers are increasingly aware that if they do it right, good sustainable practices will yield financial benefits.

The state of Oregon is the recognized leader in the U.S. in promoting sustainable development. It is known as a "world class' provider of innovative and cost-effective environmental solutions. We are pleased to have this opportunity to share our expertise with Thailand, while also learning more from Thai hotels at the same time.

The goal of this study is to assist the Thai hotel industry in conducting their business operations more efficiently, and reducing operating costs—particularly in energy, water and solid waste—while also improving the local and global environment. With cooperation from a number of Thai hotels, our survey and study has been accomplished. It is our hope that this report, resulting from our research and analysis, will be useful for hotels owners, engineers, businesses to pursue many of the innovative ideas presented in this report.

We would like to thank all the parties involved, particularly Mr. Jack Kneeland, Director of US-AEP Thailand, for his guidance and continued support. Special thanks go to Dr. Duangjai Intarapravich Bloyd and her team, both in the U.S. and Thailand—notably the Thailand Environment Institute—for their countless hours of service in conducting this study and putting this report together.

This project, which is the first phase of a multi-phase activity, represents a partnership of government, non-government organizations, and the private sector both in Thailand and Oregon, working together to establish relationships in the green hotel best practices. We are confident that new, long-term business and governmental relationships will grow out of this project and produce positive, sustainable results.

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September 9, 2002

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The views expressed in this study are those of the study team alone and should not be considered to represent the official positions of the Council of State Governments, US-AEP or U.S. Department of Energy.

Chapter 1

Introduction

1.1 Background

Hotels are prime candidates for the development of "green" criteria and resource conservation benchmarks. Hotels are major commercial sector consumers of energy and water, and generate significant amounts of solid waste and wastewater. Because hotels operate twenty-four hours a day, they are particularly sensitive to savings that can accrue from the efficient use of energy and other resources. In addition, their high visibility makes them appropriate candidates to demonstrate the benefits of adopting sustainable practices. Due to the international nature of the industry, the hospitality sector can play an important role with its ability to share successful conservation practices across countries. Hotel owners in Thailand are increasingly aware that good environmental practices and financial performance are not conflicting goals but, are in fact, mutually supportive when conducted through an integrated approach. An increasing number of hotels are incorporating environmentally friendly goals into their operations. However, there is a lack of appropriate numerical benchmarks to guide Thai hotel owners and managers toward the best practices for hotels regarding energy savings, resource consumption and waste minimization.

At present, through its Green Leaf Certification Program, the Green Leaf Foundation has taken the lead role in promoting environmental awareness to hotels in Thailand. The foundation offers "Green Leaf" awards to hotels according to the level of their environmental achievements in resource management and efficiency. The foundation has developed a checklist for conducting environmental assessments and audits of hotels. The assessment has standardized grading to evaluate each operation's efficiency in regard to environmental management. The work of the Green Leaf Foundation has undoubtedly motivated Thai hotels to move toward better environmental practices. The evaluation for Green Leaf Certification, however, is not based on measurable criteria with quantifiable benchmarks for energy savings and environmental management. Several other countries have also developed benchmarking programs to guide hotels' environmental performance. However, due to the differences, for example, in building codes, regulations and business practices between Thailand and the countries that have designed these certification systems, these programs may not be completely appropriate for Thai hotels.

So that hotel owners and managers may work more effectively toward improving their energy and environmental performance, numerical guidelines should be established for Thai hoteliers. This study is designed to be the first step of a multi-phased activity that will lead to the development of environmental evaluation criteria and benchmarks that are based on international best practices and that also reflect Thailand's economic, financial and environmental conditions.

In recognition of the importance of Thailand's hotel industry, and the expertise of the team undertaking this study, the Council of State Governments/United States-Asia Environmental Partnership (US-AEP) provided financial support to the State of Oregon Economic and Community Development Department (OECDD) to conduct this study. Under the leadership of OECDD, the study was conducted as a joint effort by the International Sustainable Development Foundation, the U.S. Department of Energy's Asia-Pacific Economic Cooperation (APEC) Program, the State of Oregon Office of Energy, the City of Portland's Office of Sustainable Development, the Green Building Services of Portland General Electric, and the Thailand Environment Institute.

1.2 Objective of the Study

This study is the first phase of the "Development of Criteria and Benchmarks for Green Hotels in Thailand" project which will identify appropriate best practices and potential energy, water and waste management projects for Thai hotels. The information and lessons learned from this study will be used in the next phase of this project to develop customized criteria and benchmarks for the Thai hotel industry's environmental performance.

The study is designed to benefit two major audiences—Thai hoteliers and U.S. businesses. The Thai hoteliers are the direct beneficiary of this study since the study provides information and recommendations that will help them conduct their business operations more efficiently, reduce operating costs, enhance employee morale and productivity, and improve their public and "brand" image through their leadership as environmental stewards. A large-scale adoption of the energy and environmental best practices by the Thai hotel industry will benefit Thailand by reducing oil imports, increasing energy security and reducing negative environmental impacts. Finally, such practices will benefit the global environment by incrementally reducing the production of greenhouse gases through reduced energy consumption.

It is hoped that this project will also lead to future technology cooperation between Oregon and other U.S. companies and Thai hotels. The U.S. is a leader in the areas of energy, water and waste management. For example, the U.S. is a major exporter of the advanced control systems which are the key to managing energy consumption. Similarly, due to strict water and solid waste disposal regulations in the U.S., the U.S. is a world leader in producing equipment used in water and solid waste management. Thus, in the key focus areas of this study, the U.S. has an opportunity to demonstrate to the Thai hotel industry and to other Thai commercial and service sectors, the effectiveness of their advanced technologies. Therefore, the indirect co-beneficiaries of this study will be Oregon and other U.S. companies with expertise in managing water, wastewater, solid and hazardous waste, in cleaner industrial production, clean energy and energy-efficient equipment.

1.3 Project Approach

The project was composed of four main tasks: information gathering, a country visit, data analysis and synthesis, and presentation of recommendations to participating hotels.

Information Gathering. The information on various hotel certification programs and best practices of international "green" hotels was reviewed and assessed. The information on hotel certification programs will be useful for the Thai hotels as they consider joining international certification programs to attract more foreign tourists. The best practices and projects implemented by international "green" hotels provide examples of various "green" projects that reduce hotel operating costs. They also demonstrate industry leaders' recognition of the link between responsible stewardship and financial self-interest.

Country Visit. To understand the current energy and environmental practices, technologies, and problems associated with Thai hotels, the team visited eleven Thai hotels and interviewed hotel owners and managers. Of the hotels visited, eight agreed to participate in the study and to provide more detailed information on their current practices, energy and water consumption, and solid waste management. The participating hotels also agreed to make their best efforts to implement the projects recommended by this study.

The team also visited various other stakeholders associated with the hotels' management, resource consumption and waste production including the electric utility and potential funding agencies. This was done to learn about related government policies and to explore possible funding sources for Thai hotels.

Data Analysis and Synthesis. The information gathered on the country visit and from the participating hotels was analyzed and synthesized. Potential projects for all Thai hotels and potential projects for each participating hotel were then identified.

Presentation of Recommendations. The final report and recommendations are to be presented to the participating hotels at a CSG/US-AEP sponsored project summary workshop. The workshop has been scheduled for September 23, 2002 at the Imperial Queen's Park Hotel in Bangkok, Thailand.

1.4 Organization of the Report

The report is composed of six chapters. Chapter 1 is an introduction which reviews the project background, objectives and approaches. Chapter 2 reviews the various existing hotel certification programs. These include national programs such as the Green Leaf Program in Thailand, the United Kingdom's Green Tourism Business Scheme, Costa Rica's Certification for Sustainable Tourism, Canada's Green Leaf Eco-Rating Program, the United States' Leadership in Energy and Environmental Design and ENERGY STAR programs, and the Nordic countries' Nordic Swan Label program. The report also reviews two international programs—ECOTEL and Green Globe 21, and the

International Hotels Environment Initiative of The Prince of Wales International Business Leaders Forum.

Chapter 3 reviews best practices and projects implemented by hotels in the United States and internationally. These are actual projects that have proven successful in helping hotels improve their energy and water conservation and waste management. Some of the projects may not be applicable to Thai hotels at present due to differences in cost structures and/or government policies. However, they demonstrate the strong commitment of hotels around the world to conducting business in an environmentally friendly manner—one that protects the local and global environment while reducing operating costs and increasing revenue.

Chapter 4 provides case studies of the eight Thai hotels selected to demonstrate current practices of energy, water and solid waste management in the Thai hotel industry. These participating hotels shared with us the energy and environmental problems they encounter, and their need to improve performance in energy efficiency, water conservation and waste management.

Based on the information gathered from the participating Thai hotels, potential conservation projects are suggested and presented in Chapter 5. These are projects considered the most feasible for Thai hotels to implement and to have the greatest potential benefit for improving the hotels' environmental management, and for reducing their operating costs. Suggested potential projects are in the areas of ventilation and air conditioning systems, lighting systems, energy management and control systems, waste heat recovery, laundry wastewater recycling and heat recovery systems, solar water heaters, water-saving equipment, ozone laundry systems, water purification, wastewater treatment, building shell improvements, and building recommissioning.

Recommendations and conclusions are presented in Chapter 6. Recommendations are made for the participating Thai hotels for potential projects and potential sources of funding, and for the Thai Hotel Association as well as the US-AEP as a combined effort to promote Thailand's "green" hotel industry. The Chapter also discusses the next steps of the project.

Chapter 2

International Certification Programs

There are currently many national and international hotel and tourism certification programs. This chapter reviews some of the programs that have gained a positive reputation and are well respected. The national certification programs reviewed include the Green Leaf Program in Thailand; the Green Tourism Business Scheme in Scotland; the Certification for Sustainable Tourism in Costa Rica; Green Leaf Eco-Rating Program in Canada; the LEED for Existing Buildings and the ENERGY STAR™ programs in the U.S.; and the Nordic countries' Nordic Swan Label program. The international certification programs include the ECOTEL and the Green Globe 21, which offer certification to hotels around the world. The chapter also reviews the International Hotels Environment Initiative (IHEI) which, although not a certification program, has raised awareness of responsible business practices throughout the hotel industry.

2.1 Green Leaf Program[1]

The Green Leaf Foundation was established in Thailand in 1995 by the Board of Environmental Promotion of Tourism Activities (BEPTA). BEPTA consists of the Tourism Authority of Thailand, Thai Hotels Association, United Nations Environment Program, Electricity Generating Authority of Thailand, the Thai Association for the Development of Environmental Quality, and the Metropolitan Waterworks Authority. The foundation receives sponsorship and support from government, non-government, international, academic and private organizations. BEPTA established the Green Leaf Program to help implement environmental practices and set guidelines for hotels in Thailand, as well as to certify Thai hotels according to their level of efficiency in managing energy, environment and natural resources.

From one to five Green Leaves are awarded to each hotel depending on the hotel's achievements in environmental management and resource efficiency. The Green Leaf audit is conducted and re-assessed every two years.

The Green Leaf program's manual features three types of questionnaires: a screening questionnaire, a qualifying questionnaire and a grading questionnaire. The questions cover all areas of hotel operation (i.e., guestrooms, restaurants, kitchen, laundry, landscape, various staff training activities, and community relations). The hotels are audited on the basis of environmental policies and standards, waste management, energy and water efficiency, purchasing, indoor air quality, air and noise pollution, water quality, storage and management of fuel, gas and toxic waste, ecosystem impact and community cooperation. Each hotel receives a set of questionnaires to conduct its own environmental audit. This audit is then verified by a team of independent personnel, international organizations and invited guests who report to the BEPTA with their findings. The Green Leaves are then awarded to the hotel based on its performance.

[1] http://www.hotelthailand.com/greenleaf/

At present, 64 hotels have qualified as Thai Green Leaf hotels. Of the sixty-four, only six hotels have received five Green Leaves. Those include the Sofitel Central Plaza, Dusit Resort Pattaya, Evason Hua-Hin Resort and Spa, Grand Hyatt Erawan Bangkok, Le Meridien Phuket, and Bangkok Mariott Resort and Spa. Two of the five Green Leaves hotels, the Sofitel Central Plaza and the Dusit Resort Pattaya, participated in this study.

2.2 Green Tourism Business Scheme[2]

The Green Tourism Business Scheme **(**GTBS) is an accreditation scheme for Scottish tourism businesses. The GTBS was launched in 1998 by the department of Quality Assurance at the Scottish Tourist Board. This program promotes sustainable tourism and provides environmental advice to Scottish tourism businesses and visitors to help them reduce their environmental impacts.

The GTBS offers awards not only for hotels, but also for other tourism businesses such as hostels, guesthouses, bed & breakfasts, holiday parks, restaurants/cafés, self-catering and visitor attractions. Businesses eligible to join GTBS must belong to one of Visit Scotland's Quality Assurance Schemes. The GTBS works with both visitors and businesses. Its website provides information to tourists and encourages them to stay at "green" accommodations and to visit "green" tourism attractions.

The cost of participating in GTBS includes a joining fee and an annual membership fee. Joining fees range from ƒ88.13 to ƒ235 (US$138 to $369), and annual membership fees range from ƒ29.38 to ƒ176.25 (US$46 to $277) depending on the size and type of businesses. The joining fee is a one-time payment which covers the initial site assessment, plaque, certificate, free listing on the GTBS website and a membership package (e.g., technical information, list of green suppliers, information on financial support for environmental measures, list of useful contacts and websites). Annual membership cost includes free access to a member area website, telephone and email support, a regular newsletter and a repeat audit.

There are three levels of GTBS awards: Bronze (for businesses with *good basic* environmental practices), Silver (for businesses with *very good* environmental practices), and Gold (for businesses with *excellent* environmental practices). Each business is assessed on how much it is reducing its environmental impact in relation to its size and type. In order to gain any award, a hotel must complete satisfactorily the measures in the compulsory section. These cover minimal environmental standards and compliance with environmental legislation. In addition, GTBS has a list of environmental criteria that a business must satisfy. These environmental criteria cover good practices on management, communication, energy, water, waste, purchasing, transport, and wildlife and landscape. An application for the award is assessed by an independent environmental auditor. The business members of GTBS are audited once every two years.

[2] http://www.green-business.co.uk

At present GTBS has about 214 members consisting of holiday parks, hotels, guesthouses, B&B's and youth hotels.

2.3 Certification for Sustainable Tourism[3]

The Certification for Sustainable Tourism (CST) was developed by the Costa Rican Tourism Institute and the Costa Rican National Accreditation Commission. The program has been designed for all types of companies in the Costa Rican tourism industry. However, in its first stage, CST is only being applied to the lodge and hotel sectors. Participation in the program is voluntary and is open to all hotels, inns, bed & breakfast services and cabins, without restriction on location or size. Enrollment in the program and the initial evaluation are offered at no cost to participating companies.

CST has set best practice guidelines to evaluate the level of sustainability of a tourism business in four general areas including:

- Physical-biological environment: Evaluates the interaction between the company and its surrounding natural habitat (e.g., gardens, natural areas, and protection of flora and fauna).
- Hotel facilities: Evaluates the management policies and the operational systems within the company and its infrastructure (e.g., water consumption, energy consumption, general supply consumption, and waste management).
- Customers: Evaluates the interaction between the company and its clients in terms of how many it allows, and whether it invites clients to contribute actively to the company's policies of sustainability (e.g., communication and involvement, customer feedback measurement).
- Socio-economic environment: Evaluates the interaction of the company with the local communities and the population in general (e.g., contribution to public health, direct and indirect economic benefits for local communities).

These four general areas are divided into twenty general descriptors that represent sources of positive/negative impacts generated by the hotel activities. For each general descriptor a set of questions, totaling 153 questions, was designed to evaluate the hotel performance. Each question evaluates a specific standard or condition with which a hotel needs to comply. The questions are weighted by their relevance on a scale of one to three, three being most important.

The CST uses six sustainability levels from zero to five to classify a hotel. The sustainability level assigned to a hotel depends on its percentage of compliance with the standards established by the categorized questionnaires. Achieving Level 1 of a category means that the firm has taken the first step on the process of sustainability. The higher levels correspond to more advanced stages that peak at Level 5, which means that the company is considered outstanding in terms of sustainability.

[3] http://www.turismo-sostenible.co.cr/EN/sobreCST/about-cst.shtml

Level of Sustainability	Minimum percentage of compliance for all four evaluation areas
0	<20
1	20-39
2	40-59
3	60-79
4	80-94
5	>94

In terms of sustainability, the degree of fulfillment signified by each Level corresponds to the different aspects mentioned. For example, to achieve a Level 3 category, it is necessary to complete at least 60% of the established conditions for the four areas evaluated.

The CST offers a series of incentives that will increase benefits in direct proportion to a company's increased rating. As the rating increases, the company will receive more benefits. Benefits include national and international publicity and promotion, training for its personnel, and priority participation in various world tourism fairs and events.

Currently, 57 hotels are members of CST. Of the total, 20 hotels are classified in Level 1, 19 hotels in Level 2, 13 hotels in Level 3 and 5 hotels in Level 4. Presently, no hotel has achieved Level 5 of the program.

2.4 ENERGY STAR™ [4]

ENERGY STAR™ is the symbol for energy efficiency in the United States. The program was established in 1992 by the U.S. Environmental Protection Agency (USEPA). Over 800 office buildings and schools across the country have earned the ENERGY STAR™ label. In 2002, the USEPA extended its program to hotels. A new tool has been designed to help hotels benchmark their energy performance against others on a nationwide scale of 0 to 100. Using the ENERGY STAR™ website, hotels will be able to analyze the energy performance of their buildings, set goals for improvement, and track their progress online using the interactive Portfolio Manager.

The ENERGY STAR™ for hospitality is a voluntary labeling scheme based on an online application and assessment. The program has been designed for buildings that rent overnight accommodations on a room or suite basis, with a bath/shower and other facilities in most guestrooms. Hotel/motel categories currently eligible for benchmarking include economy, mid-scale, upscale, and upper upscale. Resort and extended stay categories are not eligible for benchmarking at this time.

Hotels and motels must meet certain eligibility criteria to be eligible to use the online Portfolio Manager. Those eligible criteria include:

[4] http://www.energystar.gov

- The gross building area must be greater than or equal to 5,000 square feet.[5]
- The hotel/motel must contain at least 20 guestrooms.
- The building must have been occupied for at least 11 of the last 12 months.
- The building has 50% or more of its gross square footage designated as hotel/motel space.
- The building has less than 10% of its gross square footage as secondary space designated as computer data center space.
- The average annual hotel/motel occupancy rate must be greater than 45%.

To assess building energy performance, hotels must enter information about a building's physical characteristics, operating characteristics, and energy consumption to the online Portfolio Manager, which then calculates the hotel's score. The energy performance of a hotel is rated on a scale from 0 to 100. A score of 50 is regarded as average for the hotel industry. A hotel that scores 75 or higher with a healthy and productive indoor air environment that is consistent with industry standards, is eligible to receive the ENERGY STAR™ Label. To apply for the ENERGY STAR™ label, the hotel must complete an application letter and an official Statement of Energy Performance, which must be validated by a professional engineer. Without this professional validation, the application is considered void. The professional engineer is required to verify that all data entered about the hotel are accurate and must visit the hotel to verify that it conforms to current industry standards for indoor environments (e.g., temperature and humidity, illumination, outside air ventilation, control of indoor air pollutants).

Members of the Energy Star™ program include the Hilton Hotel Corporation, the La Quinta chain and the Columbus Hospitality Group.[6]

2.5 LEED for Existing Buildings[7]

The U.S. Green Building Council (USGBC) is a non-profit, consensus-based coalition representing the building industry in the United States. USGBC developed the Leadership in Energy & Environmental Design (LEED) Green Building Rating System for new construction and major renovations to promote sustainable design, construction, and operation practices in buildings in the U.S. LEED for Existing Buildings (LEED-EB) was designed recently to complement the LEED Green Building Rating System Version 2.0. The objective of LEED-EB is to encourage and support building owners in their efforts to operate their buildings in a sustainable way over the long term. LEED-EB is applicable to existing buildings that are seeking LEED Certification for the first time as well as to projects previously certified under LEED standards for new construction.

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[5] Total square footage includes floor areas of all supporting functions, such as food facilities, laundry facilities, exercise rooms, health club/spas, lobbies, elevator shafts and stairways.

[6] See http://yosemite.epa.gov/Estar/business.nsf/webmenus/Hospitality to learn more about their success stories.

[7] http://www.usgbc.org

LEED-EB is a set of performance standards for the sustainable operation of existing buildings. It includes building operations and upgrades of systems and/or processes in existing buildings where these upgrades do not significantly change the interior or exterior surfaces of the building. LEED-EB addresses whole-building cleaning/maintenance issues, energy efficiency performance, water efficiency performance, recycling programs and supporting facilities, exterior maintenance programs, and systems upgrades to improve building energy, water, indoor air quality, and lighting performance.

Using the blueprint established in LEED 2.0, LEED-EB evaluates "greenness" in five categories using a rating system with a maximum score of 71 points plus 5 extra points for innovation in operations and upgrade. The five categories are: Sustainable Sites (16 points), Water Efficiency (5 points), Energy and Atmosphere (22 points), Materials and Resources (10 points), and Indoor Environmental Quality (18 points).

As with LEED 2.0, LEED-EB offers four levels of recognition. The four levels are based on a point system. Buildings that achieve 41% (28 to 35 points) of the 71 points available are awarded a LEED Certified plaque. LEED Certified Silver requires 50% (36 to 42 points), LEED Certified Gold requires 60% (43 to 56 points) and LEED Certified Platinum requires 80% (57+ points). Five bonus points recognizing design and process innovation are also available to projects attempting certification.

In preparation for the public launch of LEED-EB, the USGBC is currently conducting a pilot test of rating criteria on a select sample of projects. The pilot test will run officially through January 2003. During the pilot phase the LEED-EB program is limited to a selected group of projects forming a representative sample of the broad range of facilities that will seek LEED certification when LEED-EB is officially launched. For this important phase of the development process, building size, location, as well as occupancy type and industry sector will be reviewed to assemble a final group of pilot projects. The deadline for project submission was March 31st, 2002. The selected participants are obliged to pay a $2000 fee for the certification of a single building. Fees for multiple buildings are negotiable.

2.6 Green Leaf™ Eco-Rating[8]

The Green Leaf™ Eco-Rating program was established by Terra Choice Environmental Services and was officially launched by the Hotel Association of Canada (HAC) in February 1998. It is a graduated rating system designed to identify hotels committed to improving their financial and environmental performance. The program is targeted at the Canadian hotel industry. The Government of Canada's Hotel Directory for Canadian Government Employees lists only Green Leaf certified hotels as lodging to be used on business travel by federal employees.

[8] http://www.terrachoice.ca/hotelwebsite/indexcanada.htm

Any property, with either full or limited services, can participate in the program. Annual participation fees vary depending on the size of facility, ranging from Canadian $250 to $600 (US$160 to$383).

The program has an audit checklist that covers all key aspects of eco-efficiency and includes all areas of guest services, grounds maintenance, water and energy use, management strategies, purchasing policies and practices. The checklist completed by the hotel applicant is evaluated and rated based on a scale from 0 to 100 points. Given that the size and comparative significance of sub-facilities may vary considerably among hotels, three evaluation options have been established for each sub-facility area, such as restaurants/food services, conference and meeting facilities, pool and spa facilities, and grounds maintenance and operations.

The program's rating system provides a designation from one Green Leaf to five Green Leaves. The Green Leaves are awarded depending on the environmental achievements of the hotel: one for a minimum commitment to a set of environmental principles, and two through five for results in applying those principles. The criteria for each of the five Green Leaf™ levels are:

- One Leaf (more than 15 points): The hotel has identified and initiated measures to improve environmental performance in areas such as energy use, water conservation and waste reduction.
- Two Leaves (more than 35 points): The hotel has moved beyond awareness of sound environmental practice and achieved real results in reducing the environmental impacts of its operations.
- Three Leaves (more than 55 points): The hotel has shown excellent progress in environmental performance in all areas of its facility's operations and management.
- Four Leaves (more than 75 points): The hotel has shown national industry leadership in terms of environmental performance for both hotel management and facilities.
- Five Leaves (more than 90 points): The hotel is serving as a world leader in environmental performance, and continually introduces new policies and practices for others in the industry.

The eco-rating score is verified by Terra Choice Environmental Services. The verification involves a hotel visit to confirm the reported level. Random "spot audits" may also be conducted at any time to confirm continued performance at reported levels.

Currently, 139 hotels in Canada have been awarded the Green Leaf.[9] Of the total, only two hotels have five leaves—the Aurum Lodge and the Fairmont Chateau Lake Louise, both located in the province of Alberta.

[9] For a list of participating hotels with contact addresses according to Canadian provinces, see http://www.terrachoice.ca/hotelwebsite/indexcanada.htm

2.7 Nordic Swan Label[10]

Nordic Swan is a voluntary, seal-of-approval certification program established in 1989 by the Nordic Council of Ministers as an attempt to unify the emerging eco-labeling programs that existed throughout the Nordic Countries. The participants in the program are Finland, Iceland, Norway, Sweden and Denmark.[11] The program is managed by the Nordic Ecolabelling Board, which maintains a secretariat and a committee or board in every member country. The Nordic Swan Label is an independent label which guarantees a certain environmental standard. The products that satisfy strict environmental requirements are allowed to display the Nordic Swan Label.

The Nordic Swan Label has now been introduced to the hotel trade, with the aim of promoting sustainable development in the hotel sector. The environmental program of a hotel with the Swan Label covers seven important areas: energy, water, the use of chemicals, consumables and raw materials, finishing and fixtures, waste management and transportation. As an independent body, the Swan organization checks that the hotel meets demanding environmental standards. The Nordic Swan Label is an acknowledgement that these standards are achieved.

Hotels eligible to apply for the Swan Label are those that offer their guests rooms that include beds with bed linen, towels and access to a shower/bath. They are also responsible for cleaning the rooms. These amenities must be included in the basic price. In addition, breakfast must be available. Either a written application or an electronic application, Excel format, can be sent to one of the five national secretariats. The Excel application is free.

The Nordic Ecolabelling Board has set a list of environmental requirements in the form of obligatory requirements, points requirements and environmental management requirements. To receive a Swan Label, a hotel must at least:

- satisfy two out of four limit values (explained below)
- meet all obligatory requirements
- meet 45% of points requirements within the Operations and Maintenance area
- meet 65% of all required points.

The limit values are energy consumption, water consumption, chemical products and waste management. In order for the limit values to be used by different types of hotels, the hotels are divided into different classes according to specific parameters (e.g., occupancy rate, presence of a pool, size of total area). The limit value for energy also takes into consideration the hotel's geographic location. The list of obligatory and points requirements evaluates a specific standard or condition with which a hotel needs to comply to receive between one and three points according to the relevance of the point requirement. The requirements are divided into 13 categories:

[10] Nordic Ecolabelling, *Swan Labelling of Hotels*, Draft 2002-02-18.

[11] Denmark joined the Nordic Swan Program in 1997.

1. Operation and maintenance
2. Consumer goods
3. Fittings and other equipment
4. Guest rooms
5. Kitchen and dining room
6. Cleaning and laundry
7. Waste
8. Transport
9. Official requirements, safety and hygiene
10. Extra requirements for hotels with restaurants
11. Extra requirements for hotels with conference facilities
12. Extra requirements for hotels with spa, pool and similar facilities
13. Extra requirements for hotels with gardens

In addition to the above requirements, to receive a Swan Label, a hotel must also comply with Swan's environmental management requirements, such as having its own environmental policy and action plan, a training program for staff, a guest information policy and an annual self-assessment. Before the hotel can be granted a Label, an inspection visit must take place so Nordic Ecolabelling can assure itself that the requirements are truly satisfied.

2.8 ECOTEL[12]

The ECOTEL® Certification is managed by HVS Eco Services, a division of HVS International, a leading global hotel consulting and appraisal firm which is based in the U.S. The ECOTEL® Certification is only awarded to hotels and resorts. The ECOTEL ® Certification is widely regarded as one of the hospitality industry's most challenging tests of environmental responsibility. Certification evaluations are based on stringent criteria developed in 1994 by HVS International and hospitality and environmental experts from the Rocky Mountain Institute, the Ecotourism Society, and Cornell University's School of Hotel Administration.

ECOTEL offers five Globe Awards—each representing one of the cornerstones of environmental responsibility. The five Globe Awards are Environmental Commitment, Solid Waste Management, Energy Management, Water Conservation and Preservation, and Employee Environmental Education. When a hotelier applies for the ECOTEL® Certification, he or she must determine the Globe awards from which to apply. The minimum number of awards a hotel may apply for is two, and one of the Globes must be the Environmental Commitment award.

The ECOTEL® Certification is based on a three-level mathematical scoring system called the Numerical Rating System (NRS). The NRS scoring begins with the "Primary Criteria." Each Globe award has a set of "Primary Criteria" related to that award. To apply for ECOTEL® Certification, a hotel must submit proof that all of the "Primary Criteria" of that Globe award are satisfied in every department of the operation. For any

[12] http://www.hvsecoservices.com/ECOTEL.htm

other Globe award applied for, all of the "Primary Criteria" of the Environmental Commitment award must also be satisfied. When this proof is received and deemed satisfactory, an inspection is scheduled. The inspection date may be set within a time period of, for example, two weeks, but the exact date and time may not be announced to the hotel.

The second level of scoring is called the "Secondary Criteria." Each of these items has a specific point value assigned to it. Secondary scoring is calculated as a percentage score of points awarded above a baseline score. Each department or functional area of the hotel (e.g., main restaurant kitchen, banquet kitchen, room service kitchen, front desk and office area, executive office areas) is inspected and scored individually. A percentage score is calculated for each department inspected, and to be awarded the certification, each department must score above a set level. If any department scores below that level, but above a minimum threshold, the Tertiary Criteria can boost that department's score so that the hotel may achieve the award. The Secondary Criteria forms are given to the applicant hotel before inspection so that the hotel may self-inspect prior to the actual inspection. Lists of Tertiary Criteria are not provided prior to inspection. The ECOTEL program encourages the hotel to generate its own ideas and initiatives to give the environmental efforts individual identity.

The Tertiary Criteria are most easily described as a bonus system. The hotel receives bonus points for existing environmental programs – not part of the Primary Criteria – that are considered to be above ordinary levels of environmental responsibility. An example of such a program in the solid waste management category comes from a hotel in Latin America that collects cigarette butts and soaks them in solution to draw out chemicals, which are then used as pest-repellent for the fruits and vegetables grown on-site.

Hotels that achieve the Globes qualify as ECOTEL®-certified hotels and are part of 'the collection' for a period of two years, as long as standards are maintained in all daily operations. Members must agree to unannounced inspections anytime during their two-year membership period. If the hotel falls short of achieving certified status, the HVS International inspection team will prepare an action plan to help the management make the necessary changes and prepare for re-inspection.

More than 500 hotels have applied for ECOTEL® Certification over the last five years. However, only 36 hotels have received the certification. Members of ECOTEL include twenty-three hotels in Latin America (Belize, Guatemala, Honduras, and Costa Rica), seven hotels in North America (U.S. and Mexico) and six hotels in Asia (India and Japan).

Of the total certified hotels, at present there are only three hotels that carry five ECOTEL® Certification Globe Awards.[13] Those include the Benjamin Hotel in New

[13] Arco Iris (Santa Elena de Monteverde, Costa Rica) formerly received five ECOTEL Certification Globe Awards; re-certification is currently pending.

York, USA, the Lapa Rios Hotel in Puerto Jimenez, Costa Rica, and the Hilton Tokyo Bay in Tokyo, Japan.

2.9 Green Globe 21[14]

Green Globe is a global travel and tourism certification program. It was started in 1994 by the World Travel and Tourism Council (WTTC), a private tourism industry association. The WTTC established Green Globe as its environmental program. Green Globe is designed to achieve environmental, social and cultural improvements globally, nationally and locally. It is a private company which includes an international advisory council, and seeks peer review of its standards and supporting technical information.

Green Globe is managed globally by four joint venture partners: Green Globe Ltd. in the U.K.; Green Globe Asia Pacific in Australia; the Caribbean Alliance for Sustainable Tourism (CAST) in Puerto Rico; and Green Globe 21 Africa in South Africa. Each of these partners has different roles and functions within the organization. Green Globe Ltd. is responsible for global policy and marketing, while Green Globe Asia Pacific oversees development of Green Globe products, and CAST handles Caribbean and South America.[15] There are also strategic alliances that include Societe Generale de Surveillance (SGS), Anglo Japanese Registrars (AJA), BM Trada, WTTC, the Tourism Industry Association of New Zealand, and the Ecotourism Association of Australia. These partners and alliances make it possible for Green Globe to operate on a global scale.

Green Globe has enhanced its standards to reflect changing needs and attitudes in the global community. Green Leaf, a program developed by the Pacific Asia Travel Association (PATA), recently merged with the enhanced Green Globe standard to form Green Globe 21.

The Green Globe 21 standard addresses the following issues:

- Greenhouse Gas Reduction
- Improvement of Energy Efficiency
- Air Quality Protection
- Noise Control
- Wastewater Management
- Improved Community Relations
- Respect for Cultural Heritage
- Enhanced Social Performance
- Nature and Wildlife Conservation
- Good Land Management
- Ecosystem Conservation

[14] http://www.greenglobe21.com

[15] Green Globe 21 Africa is the most recent partner and its role is not clear.

Green Globe 21 has three levels of membership for companies, communities and consumers consisting of Affiliate, Benchmarking and Certified members. Affiliate members, those at the first level of membership, are offered a whole range of support and information sources to enable them to gain official recognition as environmentally sound and to support and share their eco-conscious beliefs and practices.

Benchmarking members are those at the second level of Green Globe 21 membership. Benchmarking members have access to the Green Globe 21 website, which provides them with information on benchmarking. They receive a sustainability assessment and are assisted in their progress toward their next step on the Green Globe 21 pathway, which is Certification.

Certified members are those who have their performance independently assessed and audited. Audits take place regularly to ensure that performance levels are maintained or improved. The Certified members hold a premier position on the Green Globe 21 website.

Company members of Green Globe 21 include airlines, airports, attractions, car rental companies, caravan/RV parks, convention centers, cruise boats, exhibition halls, golf courses, hotels, marinas, micro-businesses, railways, restaurants, and tour operators. Community members include cities, destinations, protected areas, resorts, and rural locations. The membership fees depend on the applicant's sector, size of business, location, and the type of membership—Affiliate, Benchmarking or Certified.

There are thirteen Green Globe 21 members operating in the U.S.—mostly as Affiliate companies. There are five Green Globe 21 members operating in Thailand including East West Siam Ltd., Siam Inter-continental Bangkok, Siam Safari, Srifa Bakery Ltd., and Thai Asia Travel Co. Ltd. The Siam Inter-continental Bangkok is a Certified company while the other Thai members are Affiliate companies.

2.10 International Hotels Environment Initiative [16]

The International Hotels Environment Initiative (IHEI) is a program of The Prince of Wales International Business Leaders Forum, an educational charity with its headquarters in London, U.K. It is a global environmental program, established in 1992 by international hotel industry leaders to promote environmental progress in small, medium and large hotels worldwide. The Council of the IHEI was formed by CEOs and senior executives from eleven international hotel chains to provide the program with leadership and funding. IHEI initiatives have raised awareness of responsible business practices among the international hotel industry, tour operators, government bodies, trade and business media, academia, consumers, and suppliers to the hospitality industry.

[16] http://www.ihei.org/csr/csrwebassist.nsf/content/f1c2a3b4.html and http://www.un.org/esa/sustdev/viaprofiles/IHEI.html

With the cooperation and active participation of hotels and related organizations around the world, the Initiative provides practical guidance for the industry on how to improve environmental performance, and how this contributes to successful business operations. The IHEI promotes examples of good environmental practice throughout the industry with its quarterly publication *Green Hotelier*.

The IHEI represents over sixty-eight brands with 11,200 hotels in 110 countries on six continents and almost two million hotel rooms. The IHEI International Council is comprised of Accor, Carlson Hotels & Resorts, Fairmont Hotels & Resorts, Four Seasons Hotels & Resorts, Hilton International, Marco Polo Hotels, Marriott International, Inc., Radisson SAS Hotels & Resorts, Six Continent Hotels, Starwood Hotels & Resorts Worldwide Inc., The Taj Group of Hotels, and TUI Beteiligungsgesellschaft mbH. Other associate members and partners include Turtle Island, CH2M Hill, the Association of the Brazilian Hotel Industry (ABIH), the Caribbean Alliance for Sustainable Tourism (CAST), Small Luxury Hotels (SLH) and The Association of the Hotel, Restaurant and Tourism Industry in Denmark (HORESTA).

The IHEI is *not* a certification program. Yet building on the experience of its member hotels, IHEI has developed guidelines for all hotels to benchmark their environmental performance. In partnership with the World Wildlife Fund in the U.K.,[17] and supported by Biffaward,[18] in 2001 IHEI launched a new internet-based environmental benchmarking tool designed to help hotels around the world make substantial cost savings, while improving environmental performance.[19]

Hotels can use the IHEI benchmarks to monitor their energy management, fresh water consumption, waste management, wastewater quality, purchasing programs, community relations and biodiversity improvements. With the IHEI benchmarks an individual hotel management team can compare its environmental performance with that of hotels with similar facilities in three major climate zones and design a program to reduce costs and environmental impact. All individual hotel data remains confidential.

Access to the private part of the online benchmarking tool is available at an annual fee of £120 (about US$188).

[17] http://www.wwf-uk.org/core/index.asp

[18] A multi-million pound environment fund which utilizes landfill tax credits donated by Biffa Waste Services, see http://www.biffaward.org/

[19] The online-based benchmarking tool can be accessed at: http:// www.benchmarkhotel.com.

2.11 Conclusion

There are not many differences among the criteria on which these certification programs grant their awards, although some programs have more detailed guidelines than others. A greater difference is in the level of inspection standards; some are much more rigorous than others. All certification programs reviewed here are voluntary. Some programs are national programs that attempt to promote sustainable development and to set standards for the hotels in their countries. Some are international programs offering awards worldwide. Some offer awards only to the hotel industry while others also include travel and tourism businesses.

The main benefit of being a member of a well-respected certification program is that the certification can provide a powerful marketing advantage and enhance sales for a hotel. It is definitely valuable for a hotel to join the Thai Green Leaf program because it helps improve the hotel's image while motivating the hotel to achieve the next level of the program's award. It also provides connections to information about best practices within Thailand, and to local companies which have demonstrated successful projects based on Thai examples. In addition to being a member of the Thai Green Leaf program, a Thai hotel should also consider participating in an international certification program for the broad exposure afforded by such international recognition.

It is clear that "green" hospitality is a growing business sector. To remain competitive in the international arena, Thailand needs to participate aggressively and be at the forefront of the "green" movement.

Chapter 3

International Best Practices of Green Hotels

Hotels around the world are increasingly aware of the importance of being "green" for many reasons, including a positive hotel image, marketing advantages, and cost savings. This chapter reviews fourteen examples in eleven countries and describes some of the best green hotel practices and cost-saving projects on energy, water and waste management. Together, these examples show how successful businesses throughout the world can also be good corporate citizens.

3.1 Saunders Hotel Group—USA[20]

The Boston-based Saunders Hotel Group has spent the last decade converting their hotels into environmentally responsible operations. Tedd Saunders, the Executive Vice President of the Group, originally pursued these changes for their cost-saving potential, but inadvertently tapped into a new market segment with unexpected customer and brand loyalty. Saunders started tracking comment cards and feedback from his sales team at the Park Plaza Hotel in Boston, which he owned until 1996. Based on this feedback, Saunders traced about $2 million in convention business alone from groups who became interested in the hotel when they learned about its environmental program. The energy efficient renovations also increased the building's value when the hotel was later sold.

Glazing

The Boston Park Plaza replaced and installed over 1,600 insulated-glass, operable windows for its 977 rooms at a cost of $1.2 million. Savings in energy costs were projected at $75 per room on an annual basis, and the payback period was calculated at 10 years.

Heat Recovery from Wastewater

The Boston Park Plaza has installed a $90,000 water filtration system that allows reuse of grey water and captures the heat from wastewater. Wastewater heat recovery is a technique that can recover up to 60% of the energy used to heat water by preheating incoming cold water with recovered heat that is transferred via a heat exchanger unit. Under ideal conditions, recovering that heat may actually double the efficiency of a conventional water heater, and will possibly produce ancillary environmental benefits by reducing the temperature of the wastewater stream and avoid potential thermal pollution.[21]

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[20] Nancy Nachman-Hunt, "The Greening of Business Travel," *LOHAS Insights*, May- June 2001, Natural Business Communication, Boulder, CO, and Alex Wilson, et al. *Green Development: Integrating Ecology and Real Estate*, New York: John Wiley & Sons, Inc, 1998. It is also available on the website at http://www.climateneutral.com/pages/press.html

[21] "Energy Solutions Resources: Water/ Wastewater – General." *Energy Ideas Clearinghouse (EIC)* , April 9, 2002, see

Low-Flow Showerheads

The Saunders Group installed low-flow showerheads at the Boston Park Plaza. Combined with the above-mentioned wastewater filtration system, the hotel reduced its water consumption by 65%–saving $45,000 annually.[22] Low-flow showerheads can save a hotel 10 gallons of water for every five minute shower, which, assuming 100 people shower each day and the cost of water and sewage is 1 cent per gallon, translates to over $3,600 in annual savings.[23]

Reducing Materials Flow

Park Plaza eliminated the use of two million shampoo bottles per year by purchasing such products in bulk.[24] The hotel also implemented various recycling measures that saved $67,900 after the 1994 renovation.

3.2 Inter Continental Sydney – Australia[25]

The Hotel Inter Continental Sydney is a five-star hotel near Circular Quay. The hotel was constructed so as to preserve the facade of the nineteenth century Treasury building located on the site. Since opening in 1985, hotel management has been sensitive to environmental issues. In early 1991, a decision was made to formalize an environmental policy. A group of staff was selected by the Hotel Inter Continental Group to develop environmentally responsible procedures for all member hotels. The group's efforts resulted in the publication of a comprehensive Environmental Procedures Manual.

Lighting

Lighting levels, hours of operation and light intensity in the hotel were reviewed. Various "uplighters" were found to be too bright, so the 150-watt globes were changed to 100 watt. Similarly, the service areas underwent lux testing. Removing one fluorescent tube from each fitting maintained necessary lighting levels. These changes resulted in substantial annual savings.

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http://www.energyideas.org/energy_solutions/res_details.cfm?resourceID=488&category=Water%20%2F%20Wastewater&subcategory=%20General

[22] Alex Wilson, et al. *Green Development: Integrating Ecology and Real Estate*, New York: John Wiley & Sons, Inc, 1998

[23] "Hotel/ Motel Waste Reduction: Facilities Management," North Carolina Division of Pollution Prevention and Environmental Assistance (DPPEA).

[24] Alex Wilson, et al. *Green Development: Integrating Ecology and Real Estate*, New York: John Wiley & Sons, Inc, 1998

[25] http://www.emcentre.com/unepweb/tec_case/hotel_55/house/h1.htm

Air Conditioning

Air conditioning use contributed considerably to energy waste. A variety of measures were taken to overcome the problem. Those included reviewing cooling demands and controls, activating master controls to regulate heat throughout the building, and reducing air conditioning temperatures in unoccupied guestrooms.

Water Temperature Adjustment

Water temperatures were found to be too high throughout the building. In the laundry, linen cleaning was conducted at 96 C. A new process was implemented which required water temperatures of 60 C. By lowering hot water tank temperatures, the hotel was able to save large amounts of energy.

Building Management System and Sub-Metering

A Building Management System (BMS) was installed to fine-tune the comfort conditions and further minimize waste. The BMS has also helped create considerable payroll savings because maintenance is based on actual use of services rather than time schedules. Over 50 sub-meters were installed in 1989 for electricity, gas and water, to monitor where energy was actually consumed. This investment was recovered in less than 12 months. Most of these meters have now been connected to the BMS and to a data migration package.

Low-Flow Fixtures

Guestroom showers were using too much water, so shower restrictors were installed. These reduced water consumption from 22 to 12 liters per minute.

Laundry Water Reclaiming Unit

The laundry was using excessive water, so a laundry water reclaiming unit was installed to collect water from the rinse cycles and re-use it for the first wash.

Recycling Efforts

The environmental committee conducted a waste management audit and developed an action plan for recycling. Paper and stationery was an area for significant cost savings. All offices now have boxes for recyclable paper collection. A private contractor collects the fully used paper for recycling while the re-usable paper is re-used internally for photocopying, notepads or stationery. When required, paper is shredded for packaging. Waste removal was another expensive area for the hotel which required three collections a week. In 1992, the hotel purchased a cardboard bailer at a cost of $5,000. The cardboard is now compacted in half-cubic meter bales and secured with string, greatly reducing its bulk. The number of weekly collections of garbage required has been reduced from three to two. Savings for the hotel were in excess of $25,000 per year.

Wine is consumed in substantial quantities at the hotel creating over 6,000 corks every month for disposal. The hotel now donates all corks to the war veteran's village, which then recycles them into cricket balls, car gaskets and floor tiles. The veteran's village uses the proceeds to purchase items such as wheel chairs and a lifting hoist for patients.

Purchasing Requirements to Reduce Material Waste

A purchasing policy was implemented to improve the hotel's environmental performance. Price and quality are still primary considerations, but suppliers are also requested to reduce excess packaging, use biodegradable or recyclable products, and to provide environmentally preferred products wherever possible.

Composting

A small worm farm was established to help compost kitchen scraps. The worms are kept in recycled Styrofoam boxes and fed with "green" kitchen scraps. The liquid waste from the worms or "worm tea" is used to fertilize an herb garden on the roof of the hotel. The herbs are grown free of chemicals and are used to garnish and flavor the restaurant's dishes. In the summer, approximately 40% of the restaurant's herbs are supplied by this herb garden.

Because of its progressive environmental policies that resulted in reduced electricity and gas consumption, the hotel has reduced its carbon dioxide emissions by 1,581,749 kilograms annually. The hotel now discharges 24,950 cubic meters less wastewater each year. The resulting dollar savings equal $279,588. This figure was calculated prior to the Australian energy deregulation. Energy deregulation has contributed to further savings of $250,000 per annum.

3.3 Nikko Hotel – Hong Kong[26]

The 17-floor Nikko Hotel in Hong Kong is situated on the waterfront of the Victoria Harbour next to the shopping area of Kowloon. Nikko Hotel developed an extensive energy and water conservation program that has yielded impressive results, and it is recognized as a leader in environmental innovation. The hotel is a sponsor of the Hong Kong Annual Business and Industry Environment Conference. The hotel also participates in tree-planting efforts and fund-raising activities for environmental charities. In addition, Nikko Hotel and the Hong Kong Polytechnic University have published "A Guide to Energy and Water Conservation in Hotels," a practical guide for managers and engineering staff based on the experience gained from auditing hotels in Hong Kong.

Water Control System

The hotel installed a calibrated water control system called the Platypus System in June 1995. The core element of this system is a compact valve, which is inserted into the

[26] http://www.emcentre.com/unepweb/tec_case/hotel_55/process/p2.htm

hydraulic system to control the flow and temperature balance of each tap or shower. The correct type and size of valve is chosen for each tap or shower, depending on required water temperature, pressure and flow rate. This system significantly reduces water consumption. Between July 1995 and June 1996, despite an average occupancy increase of 4% over the previous year, water consumption per guest decreased by an average of 13%, resulting in HK$13,000 (US$1,688) saved per month. The hotel also decreased its use of hot water by an average of 4%, or 2,000 liters per month. This amounts to savings of approximately HK$5,600 (US$724) in fuel costs. Taking into account both the water and energy saved, the payback period for the Platypus System is estimated to be 30 months.

Keycard System

The hotel estimated that approximately a third of its guests forgot to turn off the master switch controlling electrical units when leaving the room. The hotel installed a keycard-controlled master switch to replace the button, which automatically turns off all electrical units when rooms are vacant. This brings a savings of US$0.30 per day per room. Switches cost US$21 per unit. The payback period is 70 days.

Temperature Monitoring

Daily thermometer readings ensure that indoor temperatures are maintained at 20 C in summer and at 21-22 C in winter. In addition, the hot water boilers are switched off between 1.00 a.m. and 5.00 a.m. Water temperature has been reduced from 60 C to 55 C - hot enough for personal use and to prevent Legionella growth. The hotel has also installed control technologies that maintain the correct ratio of gas and air in the kitchen stoves. The hotel works with the Hong Kong & China Gas Company to ensure that all gas equipment is adjusted in accordance with the company's specifications. In 1995, the combined electrical and fuel oil saving measures brought the hotel a 6% reduction in electricity costs, and over a 9% reduction in fuel oil costs which translated into savings of about US$66,000. The readjustment of gas equipment resulted in reducing consumption by 11% and associated costs by 6% each year.

Staff Awareness and Training

The hotel recognized that conservation efforts would not be effective unless the staff was properly informed. Consequently all staff are trained to apply good housekeeping measures during their daily tasks—turning off equipment when not in use, closing curtains in unoccupied bedrooms to reduce heat transfer, using equipment according to manufacturers' specifications, and reporting leaks and other defects. Special training is given to engineering and maintenance staffs, who are actively involved in improving the operating efficiency of all equipment. The government's "Guidelines for Energy Efficiency" is distributed to all staff.

Metering and Audit

An extensive program to monitor energy and water use, as well as indoor air quality, is in place. Meters have been placed on all outlets. The information is being used to build a database which will enable the hotel to prioritize future activities. Since 1992, the hotel has had a partnership with Hong Kong Polytechnic University in which the hotel's environmental program is used as a practical study program for final year students of the university's Department of Building Services. The students, with assistance from the hotel maintenance and engineering staff, monitor and audit the hotel's water and energy consumption and indoor air quality.

3.4 Budapest Hilton – Hungary[27]

The Budapest Hilton accommodates over 100,000 guests annually. Located in the historic Castle district of Budapest, it incorporates the remains of a Dominican church and cloister from the 13th century that are classified by UNESCO's World Heritage Program.

The Budapest Hilton has pioneered innovative recycling and conservation measures for the hospitality industry in Hungary. When it began in 1994, recycling in Hungary was still limited and expensive. Subsequently, twelve hotels in Budapest started recycling office paper, then newspapers and cardboard and later, glass bottles. The Hilton also encouraged its staff to participate and be involved in its environmental programs. The hotel distributed the money won from the Environmental Prize of the Hotel Association of Hungary amongst its employees who demonstrated a strong environmental commitment. The Budapest Hilton's general manager has organized several environmental training workshops for members of the Hotel Association of Hungary. He has also published a booklet entitled "The Green Road to Tourism."

Energy Efficient Light Bulbs

The Hilton changed its light bulbs to energy efficient models, which reduced the energy bill by 13%, saving US$40,000 per year.

Waste Management

Waste paper, metal cans and glasses are collected, separated, and sold for recycling. The hotel bought a waste compactor in 1995 to reduce waste volumes. In 1994 and 1995, through recycling initiatives and compacting non-recyclable waste, the Budapest Hilton reduced its overall waste volumes by more than 30%. The waste compactor cost US$10,000. However, using the waste compactor, waste collection fees were reduced by US$10,000 in 1995, thus recouping the investment in the waste compactor in only one year.

[27] http://www.emcentre.com/unepweb/tec_case/hotel_55/recovery/r1.htm

In addition to the proper disposal of waste, the hotel's collective waste management program helps to overcome problems pertaining to limited storage space of other Budapest hotels. Savings are made on waste collection fees as trucks collect waste from several hotels in one round. Collectively, the program is reported to save participating hotels around US$70,000 per annum.

3.5 Hotel Guestline Days – India[28]

The Hotel Guestline Days in Tirupati, India, is owned and managed by Mahindra & Mahindra Ltd., in affiliation with Days Inn Inc., USA. Tirupati lies at the foot of the Tirumala hills in Chittar District, Andhra Pradesh. It is a pilgrim center which receives an average of 30,000 visitors a day, thus creating a large year round clientele for the hotel. Corporate environmental commitment is part of Guestline Days' mission statement —"To construct and manage our properties in a manner that preserves and enhances the environment and serves the public interest." To realize this mission, the hotel has implemented a number of energy- and water-saving measures.

The hotel's commitment has provided environmental and economic benefits. The hotel recycles 150,000 liters of water per day, which equals Rs.55,480 (US$1,585) per year in water costs. The hotel estimated that its energy saving measures collectively save about 2,815 kW per year which equals Rs.84,315 (US$ 2,409). The newspapers, bottles, crates and cans sold to scrap dealers for recycling generates Rs.1,500 (US$ 43) per month.

Radiant Barrier Systems

The ceiling on the hotel's top floor is lined with a 75mm thick layer of expanded polystyrene which acts as a heat insulator, keeps the indoor temperature at a lower level and brings down air-conditioning costs.

Capturing Air Conditioning Condensation

Condensation from the air conditioning unit, the laundry and health club is fed back into the main boiler. As this water is already heated, the boiler operates at lower capacity and consumes less fuel.

Glazing

Sun control films have been added to all windows in public areas receiving direct sunlight, reducing the hotel's air conditioning load and related costs. Energy saving light bulbs are equipped with dimmers in all public areas.

Grey Water Recapture

Rainwater is collected and used for many purposes. In an untreated form it is used to flush toilets. Water which has been filtered, chlorinated and passed through an ultra-

[28] http://www.emcentre.com/unepweb/tec_case/

violet filter is used for cooking and drinking. In addition, waste water, from flushing and bathing, and from the kitchen and laundry is collected in grit chambers where grease is separated. The heavy particles sink to the bottom of the chamber and are removed at regular intervals. The water then flows to an aeration tank where bleaching powder, ferric chloride and copper sulfate are added. It then passes through a multi-layer filter before it is stored and used in the hotel garden and fountains. Excess grey water is used on local agricultural land.

Hydro-Pneumatic System to Reduce Flushing

A hydro-pneumatic ring system has been introduced to regulate flushing waste. The system operates through control valves in each toilet, and has reduced the quantity of water per flush from 12 to 8 liters. This results in a savings of 365,000 liters of water each year.

Biodegradable Utensils

Plastic plates and cups have been replaced by disposable containers made with biodegradable leaf and plant materials.

Composting

All wet garbage (mainly food waste from the kitchen) is composted and used as fertilizer. Excess compost is sold to local farmers, some of whom supply the hotel with fruits and vegetables. Revenue form this practice is estimated at Rs. 1,369 (US$39) per month.

Materials Reuse and Recycling

The air-conditioning units use reusable filters. Stationery and promotional materials use recycled paper, while old envelopes are reused for internal correspondence. Leftover juices and wines are used to make vinegar, which is used as a cleaning agent. Wooden crates, used for packaging when the hotel was built in 1991, were reused to build barriers around saplings planted along the road leading to the hotel. Newspapers, bottles, crates and cans that are not taken away by suppliers are sold to scrap dealers for recycling. Old linen is converted into cleaning cloths.

Purchasing Requirements to Reduce Materials Waste

Guestline Days makes a conscious effort to use suppliers who buy back their packing for reuse and recycling. Preference is given to local products. Efforts are made to reduce items that require long distance transportation which causes pollution. All wine and spirits served are made in India.

Guest and Staff Participation

On-going environmental initiatives among staff include an awareness program on vehicle emissions, which has encouraged the staff to car-pool and use bicycles. Guests can also hire bicycles from the hotel. In addition, a letter inviting guests to "Save the Planet" is included in the general information package in all rooms. It outlines the Guestline Days environmental policy and asks guests to cooperate through actions such as using less water and turning-off the power supply master switch when leaving the room. A "Water shame" notice is placed in all guestrooms reminding guests to save water. On the guest questionnaire, visitors have commended the hotel for its environmental efforts.

3.6 Inter Continental Nairobi – Kenya[29]

The Inter Continental Nairobi successfully implemented energy conservation measures that not only saved them money, but also made them a model for other hotels in Africa. In response to the overwhelming interest in the hotel's experience, the Regional Chief Engineer has compiled two environmental information booklets designed for non-engineers: "Energy Conservation and Awareness and Environmental auditing" and "Environmental Management for Small and Medium Sized Hotels in Developing Countries." He observed that while most hoteliers recognize the importance of environmental management, many fail to act not only because they lack the necessary capital, but also because they lack technical knowledge. The booklets were developed to improve hoteliers' understanding of environmental issues and provide practical suggestions for simple, low-cost measures to improve environmental performance. They were disseminated to over 50 small and medium sized hotels and to other Inter-Continental Hotels in Kenya and Africa, and were sent in place of a traditional Christmas card.

Heat Recapture from Laundry Steamer

Flash steam was escaping from the boiler due to excess steam in the laundry condenser. The hotel therefore considered installing a flash steam heat exchange unit to use this otherwise wasted energy to heat water. However, as the hotel's 20 years old water chillers were being replaced, the hotel decided to remove the condenser from the discarded chillers and reuse it for the heat exchange unit, a move which resulted in substantial cost savings. Water now enters the heat exchanger at 25 C where it is heated to 38 C. It is then pumped into the central water heater where it needs to be heated only another 12 C to reach 50 C, whereas before, water was heated directly in the heater from 25 C to 50 C. Thus the boiler now operates at 50% capacity, and uses less energy. By saving on the cost of a new heat exchanger (US$40,000) and using the heat exchanger recovered from the water chillers, the only cost incurred was US$2,000 for installation and modifications. Fuel consumption is now reduced by 24,000 gallons (90,909 liters) per year, which amounts to annual savings of US$34,000.

[29] http://www.emcentre.com/unepweb/tec_case/hotel_55/process/p4.htm

Cooling Towers

The cooling towers of the water-chilled air-conditioning system have been replaced by ones which operate on two-speed motors and fans. The temperature of the water entering the cooling towers is gauged automatically so when cooling demand falls and the water temperature is low, the motor operates at a lower speed. An automatic water treatment device used to remove limestone and Legionella bacteria has also been installed. As the new two speed motors in the air conditioning cooling towers operate at a lower speed, approximately 8,000 kWh of electricity is saved each month. This equates to a reduction of US$8,400 in energy costs per annum. In addition, the noise level of the towers has been reduced by 60 percent.

Capacitor Bank

When receiving power from the national grid, the hotel had been registering significant losses in voltage due to the high reactive power content. A capacitor bank was installed which improved the incoming power factor from 0.8 to 0.99. This brought major savings in electricity costs through reduced surcharges. The capacitor bank was purchased for US$28,500. The increased power factor achieved energy savings of US$1,700 per month or US$20,400 per annum. The return on investment was 18 months.

3.7 Sanga Säby Conference and Study Center – Sweden[30]

Sanga Säby Conference and Study Center was established as a center for agricultural research over 50 years ago by the National Swedish Farmers Union. It is located on Lake Mälaren, on Färingo Island, 35 km from Stockholm, Sweden. Today the Sanga Säby Conference and Study Center is a separate company affiliated with the Farmers Union. Conference participants make up a large share of its market.

Environmental activities at Sanga Säby began with an internal environmental audit undertaken by students of the local high school who continue to monitor and report bi-annually on the center's environmental progress. To ensure full co-operation and participation, all staff members were involved in formulating Sanga Säby's environmental policy and action program. Training is an important priority. The Center’s pay scale includes environmental performance-related bonuses for all staff.

Sanga Säby is often invited to make presentations on its environmental work at the conferences and meetings it hosts. In 1995, 62% of the guests were introduced to the Center's environmental program through such presentations. Sanga Säby reports that occupancy has risen by almost 10% per annum since 1993 and attributes this primarily to its environmental activities.

[30] http://www.emcentre.com/unepweb/tec_case/

Alternative Energy for Heating and Cooling

Sixty-seven percent of the entire facility is heated and cooled using marine and geothermal energy. Supplementary energy is generated through boilers fuelled by rapeseed methyl esters (RME), or rapeseed oil. All electricity used by the center is produced from renewable sources. Solar panels have been installed on the roof of the sauna/relaxing area. These panels provide most of the energy for heating and hot water in the sauna and swimming pool.

Alternative Energy for Transportation

In early 1995, Sanga Säby, in association with the Swedish Ethanol Development Foundation, acquired Sweden's first RME-powered car. Today all vehicles and tractors at Sanga Säby operate on RME. Lawn movers are operated on solar energy and rapeseed oil.

Conservation Strategies

Low energy light bulbs and fluorescent lights are used whenever possible. Motion detectors turn off lights when conference rooms are empty. All guestrooms are fitted with individual thermostats. Time relay control systems reduce indoor temperatures at night in all guestrooms and public areas. Weather-strips on windows and doors are checked annually and replaced as needed.

Water-Saving Devices

All water outlets have been fitted with water-saving nozzles and all public restrooms furnished with urine-separating toilets. Through these water-saving devices, Sanga Säby estimates that the volume of water consumption has dropped by 40%, which equals savings between US$1,506 and $1,807.

Reuse and Recycling

A waste separation program ensures the separation of paper, aluminum, organic waste from kitchen and garden, glass, batteries and other hazardous waste substances. Wastewater from the kitchen goes through a special cycle where fats enter a separating tank before reaching the sewage plant for further treatment. Disposable items are used only for picnics and excursions. Plastic items have been replaced with starch-based biodegradable materials and cardboard. Individual portion packs have been replaced by larger bulk packs. The hotel’s delivery system ensures that all packing is taken back for recycling. All delivery trucks are fuelled with rapeseed oil. Because of waste-saving measures, waste volumes were estimated to have fallen by 60% in 1995.

3.8 Scandic Hotels – Scandinavia[31]

Scandic is presently Scandinavia's largest hotel chain. Scandic Hotels operates three and four star hotels throughout Europe. The Scandic chain consists of approximately 130 full service hotels located downtown or in the outskirts of cities close to airports and major routes. Most of the hotels are located in Scandinavia, but Scandic also operates hotels in Germany, the Netherlands, Belgium, Austria and the United Kingdom. The company's goal is to be recognized as the most resource-efficient company in the hotel industry and operate in an ecologically sustainable fashion.

Scandic began integrating sustainability into its business practices in 1993. In 1994 it contacted a Swedish environmental foundation known as The Natural Step to provide the company with guidance in reducing environmental impacts. Scandic also developed several programs/products, which were introduced throughout the chain, namely the Scandic Soap & Shampoo Program, the Recyclable Hotel Room, and a program for reducing the unnecessary use of chemicals. The hotel chain's environmental programs have reduced its chemical effluent by 30 tons annually.

Scandic is a partner in The Challenge—a program to facilitate dialogue and co-operation on continuous environmental management and improvement. It takes environmental management very seriously and requires quarterly reporting on environmental performance from all Scandic Hotels. A 14-point index was developed to create benchmarks and assist progress monitoring within each property and throughout the chain.

Scandic's commitment to environmental excellence has paid off. The market surveys in 1995 indicated that the environmental program strongly enhanced Scandic Hotels' corporate image.

Conservation Efforts

Rooms have individual thermostatically controlled heating. The lighting is provided through low energy light bulbs. Metal parts in fittings have been replaced with wood. Shades are made of reinforced material, lacquered aluminum or recyclable plastic.

Recyclable Guest Rooms

The "recyclable room" in which 97% of the construction materials are recyclable or biodegradable, was first tried out in 1994 and is now being introduced to all Scandic hotels. Approximately 2,000 rooms are being retrofitted each year. By 1999, approximately 25% of Scandic hotels in the Nordic region had been converted (that's over 4,200 rooms). The contents of all materials, parts and design elements in the environmental rooms are labeled so that the durability of each part can be assessed and so that they can be effectively re-used. Lacquers and paints used are water based, UV lacquer or powder lacquered materials. While the cost of fitting an environmental room

[31] http://www.emcentre.com/unepweb/tec_case/hotel_55/material/m2.htm

is 10% higher than a conventional Scandic hotel room, Scandic does not consider this to be an additional cost as each part of the room can be reused. For every 1,000 rooms built or retrofitted, the consumption of non-renewable resources is reduced by 10 tons of metal and 60 tons of plastic. Scandic reports that the market response to the environmental rooms is very positive. These rooms are always the first to be booked.

Use of Rapidly Renewable Products

All timbers used are from Nordic trees carrying a sustainable felling stamp. Floors are either wooden or laid with wall-to-wall carpets. Cupboards and panels are made of wooden boards with a veneer of Nordic alder. Armchairs and sofas have wooden frames with steel springs, are upholstered with cotton or wool and reinforced with leather for durability. Accessories made of wood include baggage racks, frames and hooks for bed and paintings, and coat hangers.

3.9 Royal Meridien Phuket Yacht Club – Thailand[32]

The Phuket Yacht Club is a Royal Meridien Resort located on Nai Harn Beach, Phuket, Thailand. The hotel's environmental committee was convinced that environmental sustainability could only be achieved through programs that increase environmental awareness, that stress the urgency of action given the present state of the environment, and that develop the notion of environmental stewardship—a positive and caring attitude towards the environment.

The Phuket Yacht Club's main focus was to change people's attitudes, starting with the Yacht Club staff, then widening the range of influence to include the village communities of Phuket and the rest of Thailand. The Club has issued an environmental action checklist for all hotels in Phuket. There are 65 actions listed under front office, housekeeping, laundry, restaurants, room service and bars, kitchen, stewarding, waste management, maintenance and engineering, and overall performance.

Energy Conservation

The Club maintains hot water at 50 C to ensure minimum use of energy for water heating. It starts the refrigeration defrost cycles during off-peak demand periods to keep costs down. Curtains and blinds are closed to reduce external solar heat transfer. A reflective roof was installed above the walk-in fridge to reduce energy consumption. The hotel estimates that the energy-saving measures save 6% in electricity costs per month, which equates to 26,400 Baht (US$1,056).

Wastewater Reuse

Wastewater from the hotel goes through a treatment process using the BIO-BAC system, which treats the water biologically. Treated water is then used in the gardens. The hotel

[32] http://www.emcentre.com/unepweb/tec_case/hotel_55/process/p5.htm

estimates that it saves 70 m^3 of water per day or 1,750 Baht (US$70) in high season and 40 m^3 of water and 1,000 Baht (US$40) per day in low season from recycling water.

Guest Participation

Cards in bathrooms inform guests that "Water is a precious commodity on our island and your co-operation in conserving this valuable resource during your stay with us will be greatly appreciated." Guests are invited to reuse towels. Because of the water conservation cards in bathrooms, laundry loads (especially towels) have been reduced by 25 percent.

Recycling

Paper, cardboard boxes, plastic, metal, aluminum cans, organic waste, cooking oil and glass waste are collected, separated, stored (when required) and sold for recycling or reuse. Over 1,000 kg of newspapers are recycled each month, and every day five 26-gallon containers of organic waste are sent to a local pig farm. Although the annual revenue earned from the recycling of waste is insignificant (around 800-1,200 Baht or US$32-48), the hotel believes that it is an important program for raising staff awareness of the importance of recycling.

Staff Participation

All job descriptions include an environmental section. Staff members are required to "protect the environment and be economical as possible with resources and materials used in the job, including electricity, paper and water." General environmental workshops are held every Saturday. Special training is given on maintenance to ensure that all equipment is regularly cleaned and serviced to avoid spills, odors and leaks, and to ensure maximum operating efficiency.

3.10 Habitat Suites – USA[33]

The Habitat Suites Hotel in Austin, Texas has gained a reputation as a “safe haven from toxic chemicals and environmental ills that travelers must endure in ordinary hotels."

Its environmental program stresses environmentally sound housekeeping. All advertising emphasizes Habitat Suites’ commitment to being a "green" hotel. The hotel has an increasing number of visitors who suffer from environmental allergies and illnesses. It is a popular venue for meetings on environmental awareness and conservation. Among its other environmentally sensitive features, in addition to a traditional breakfast menu, which is 100% organic and additive- and preservative-free, the hotel also offers a macrobiotic breakfast.

[33] http://www.emcentre.com/unepweb/tec_case/hotel_55/material/m1.htm

Energy Reduction Measures

To minimize the use of electricity, the hotel maintains refrigerator temperatures at 38 F (3 C) and its freezer at 5 F (-15 C). Motion sensors turn the lights on and off in guest laundry rooms and public restrooms. The pool water circulation pump operates only during peak hours (10 a.m. -10 p.m.). The hotel realizes that excess water heating is energy and cost intensive, and thus maintains hot water at temperatures sufficient for its applications—125 F (52 C) in guestrooms and 140 F (60 C) in the laundry. Fifteen energy-efficient air-conditioning units have been installed and the hotel plans to gradually replace all A/C units with energy efficient ones.

Water Saving Measures

Aerators have been fitted to sinks and showerheads, reducing water flow from 2.1 to 5 gallons (8 to 19 liters) per minute. Water-saving toilets have been installed in all suites and staff toilets; these use 1.5 gallons (6 liters) per flush, as opposed to the normal 3.5 gallons (13 liters). Bed linens and towels are changed only upon request. Water-saving sprinklers in irrigation outlets are estimated to save 500 gallons (1,893 liters) a day. Native plant species that require less water are used for landscaping. Washing machines are programmed for low water usage. The combined water-conservation measures bring the hotel an estimated savings of US$9,000 in annual water costs.

Non-Toxic Sterilization of Swimming Pool

Instead of chlorine, a nontoxic copper and silver ionization system is used to sterilize the swimming pool and spa. This involves passing a low alternating direct current (6-12 volts) between copper and silver electrodes which are fitted into the circulation system of the pool and spa. The current releases virus-killing copper and silver ions which are carried into the pool and spa with the returning water. This system provides good residual protection, is unaffected by UV or heat and these ions cannot be absorbed through the skin. Thus, the use of chlorine has been eliminated and the use of other maintenance chemicals has been reduced by 50%. Ionization is non-corrosive to the equipment and the pool and spa surface and greatly improves water quality.

Refurbishing Measures

Chlorofluorocarbons (CFCs) were recovered from all discarded equipment. Newly purchased equpiment uses established CFC alternatives. Aluminum window frames were removed and a reflective roof cover added to avoid heat transfer. Only water-based paints were used and carpets were laid with no adhesives. Fire extinguishers are refillable and halon-free.

3.11 Bali Inter-Continental Resort—Indonesia[34]

The Bali Intercontinental Resort is located in idyllic and unspoiled surroundings on Jimbaran Beach—a white sand beach which is reputedly the best in Bali. The hotel prides itself on the fact that environmental ethics are central to its business. The hotel was one of the driving forces behind the development of the Indonesian hotel industry's eco-rating system. With a mission to reduce the environmental impact of the resort, the Bali Inter-Continental has implemented several energy and water conservation measures. The conservation projects at the hotel have resulted in savings of 10.3% in energy consumption and 4.3% in water consumption. The hotel has also made a commitment to local communities and ecosystem conservation. In 1999 the hotel launched a project to preserve the island's sea turtle population from extinction by purchasing turtles eggs at local markets, hatching them and releasing the young turtles into the ocean.

Energy Efficiency Measures

Wherever possible, energy efficient lamps are used throughout the resort to reduce power consumption. Sub-meters have been installed for utilities in various sections in the hotel complex, and each of these departments is charged for their usage. This makes all employees aware of usage and thus helps to control consumption.

Waste Management

All grey water in the hotel is recycled and used for topping up decorative ponds, for cooling towers and irrigation. Lubricating oil from the generators is collected and recycled. Housekeeping trolleys have been modified to sort waste from the guestrooms for recycling. A compost project to recycle the hotel organic waste has been set up with support from a grant from the World Bank. Bulk purchasing is used to reduce packaging. For example, the bulk purchase of yogurt eliminated the discarding of approximately 5,400 small plastic containers every month.

Resource Conservation

All amenities in the guestrooms and all kitchen and laundry detergents are environmentally friendly. Whenever practically possible, the purchasing department tries to purchase environmentally friendly products.

3.12 Inter Continental Miami – USA[35]

The Hotel Inter Continental Miami is a 34-story property located in Florida, USA. The Inter Continental Miami is a member of the Florida Department of Transportation's "Keep Florida Beautiful" program. The hotel has participated in numerous regional and local environmental campaigns such as the Earth Day anniversary festivities, the U.S.

[34] http://www.ggasiapacific.com.au/casestudies/

[35] http://www.emcentre.com/unepweb/tec_case/hotel_55/process/p10.htm

Conference of Mayors' National Paper Recycling Project and the Buy Recycled Business Alliance.

Energy Efficiency Program

The hotel has implemented the Florida Power and Light's Energy Efficiency Program. Motion sensors have been installed in all meeting rooms. Air conditioner filters are changed once a month instead of every two months. Temperatures in corridors and elevators are adjusted. Variable speed drives are used on all electric motors. Timers are fitted on all energy equipment. Incandescent lights have been replaced with single florescent lamps. The light wattage has been reduced from 40 to 34 watts in renovated guestrooms. The air-conditioning system has been retrofitted with an automatic thermostat system. Collectively, the energy-saving actions save an estimated 400,000 kWh of energy annually, which amounts to $2,400.

Hotel Supplier and Purchase Policy and Coordination

The hotel has adopted a policy to purchase environmentally sensitive products, e.g., items that are recyclable or biodegradable, and made from recycled materials. Suppliers are asked to provide information on the environmental sensitivity of their products, and to suggest alternatives for toxic and heavy resource consuming items. All suppliers are asked to take responsibility for their packaging. Suppliers must take back wooden crates and pallets that were previously left on the hotel loading dock or to pay for their disposal. The hotel encourages cooperation and dialogue with suppliers through its annual Vendors Summit which serves as a forum to inform suppliers of its commitment to resource conservation and pollution prevention, and to encourage suppliers to employ environmentally sound practices in the production and distribution of their products.

Waste Management Effort

The hotel has set up the "Inter-Cycle" initiative for waste management. The hotel has a "green" team to coordinate this effort. The team includes all department heads and a representative from the hotel's environmental consultants. To coordinate the collection of recyclables, the special post of "Mr. Inter-Cycle" was created. Monthly competitions are organized to select the "recycler of the month" and the "recycling department of the month". A regular waste management audit is performed with assistance from an environmental consultant. This is followed by an annual cost benefit analysis of the entire "Inter-Cycle" initiative. Monitoring checklists are used to determine whether each item the hotel uses can be better re-used or recycled. Each department must maintain a record of its waste output. Waste collection and recycling programs have been set up for paper, PET (Poly Ethylene Terephthalate) and HDPE (High Density Polyethylene) plastics, cardboard, glass, batteries, used florescent lamps, motor and kitchen oils, scrap metal, Styrofoam and aluminium.

Other re-use initiatives include donating edible left-over food to food banks, collection of guest amenities (e.g., soaps and lotions) by the Miami Rescue Mission, donating old

furniture to local charities, old sheeting reused as laundry bags (to replace plastic bags), old electrical appliances re-sold to suppliers, replanting Christmas trees to be reused the following year, batteries and fluorescent lamps recycled through the Florida state program, reusing containers for storing and holding cleaning liquids, photocopying on both sides of paper, and compacting non-recyclable waste in a 30 m^3 compactor.

Before "Inter-Cycle" began, the hotel generated 1,420 tons of waste annually and disposal costs amounted to $85,000. Since 1992 with "Inter-Cycle" up and running, over 30 items and 45% of the hotel's waste stream are recovered and recycled. The disposal volumes have fallen to 679 tons and disposal costs are down to $31,000 per annum—with garbage collection just once a week, instead of every other day.

3.13 Sheraton Auckland Hotel & Tower—New Zealand[36]

The Sheraton is located in the central business district of Auckland. It is a five star hotel with 410 guestrooms. The hotel offers the largest conference facilities of any hotel in New Zealand.

Reducing Energy Use in the Laundry

There is a very high demand on hotel laundry facilities. Vast quantities of energy, and chemicals are consumed, and waste generated in daily laundry washing and drying. The hotel has implemented several measures to reduce energy use in its laundry. First, the water temperature has been reduced from 85 C to 60 C. Over the first three months the reduction in wash temperature saved the hotel $2,000 in energy costs while achieving the same quality of wash. Washing machines are run only when fully loaded. A domestic size washing machine and drier have also been installed in the laundry to accommodate off-peak washes required by guests. To ensure maximum reduction in water, washing machines use high-speed spins prior to sheets being dried. In addition, sheets are dried using a gas-fired roller press system. The benefits from the project include reduced energy costs, reduced atmospheric pollution resulting from reduced energy consumption, lower consumption of wash chemicals per kilogram of clean laundry and overall reduction in the hotel's wastewater pollution load and wastewater discharge costs.

3.14 Aurum Lodge—Canada[37]

Aurum Lodge is located in Alberta, Canada. The lodge offers a destination resort, which incorporates environmental thinking throughout its design, construction and management. The Aurum Lodge Project was started in 1999 with the objective of becoming a true eco-tourism operation. The extra investments for environmental features represented about 30% of the overall building cost, with payback in dollar terms estimated at around 20 years. However, many benefits are not directly accountable in monetary terms—for example, reduced pollution, no noise, raw material and resources conserved and intact

[36] http://www.arc.govt.nz/arc/index.cfm?B5339CFB-2588-4611-9EDB-9DD63CC0F7E5

[37] http://www.aurumlodge.com

ecosystem conservation. Aurum Lodge has earned a five Green Leaf Eco-Rating from the Hotel Association of Canada. The hotel is one of the only two hotels in Canada that have received this rating.

Energy Conservation Measures

The Aurum Lodge generates all its own electricity via a diesel/PV/battery hybrid power system. To reduce the amount of energy used, Aurum Lodge has installed high efficiency lighting and appliances, and thus has a minimal generator run time (on average less than 2 hours a day). The Lodge also installed a high-efficiency boiler and masonry storage heater.

Heat Retention

The Lodge retains energy through high insulation with a double wall system to reduce radiant and conductive heat loss, air-locks, recessed low-E windows, a thermal storage mass in the basement and a heat storage tank. In addition, heat is recovered from exhaust air and water.

Renewable Energy

More than 50% of electricity used in the hotel is produced by photovoltaics. Solar collectors are used for space and water heating. Wood is used for heating and cooking. A heat storage tank collects heat from different heat sources, of which three use renewable energy (sun or wood). The building is optimized for passive solar heating with good surface to volume ratio and proper window sizing. On a sunny winter day (-10 C), passive solar design, solar collectors and in-floor heating are all that is required to maintain a constant temperature in the building.

3.15 Conclusion

Tourism is one of the world's largest industry and the hospitality sector is an important component of this growing industry. Increasingly, the hospitality sector is realizing that its very success depends upon a clean and scenic environment. A growing number of hotels are realizing that environmental and economic goals can and must be achieved simultaneously. By operating in a more environmentally responsible fashion, the hospitality sector can demonstrate leadership in ecological sustainability while enhancing competitiveness through cost-effective operation and facility improvements. The best practices and cost saving projects reviewed in this chapter are only a few examples of green projects implemented by hotels around the world. These examples show that “green” related savings are available to all hotels, regardless of country or climate region. In establishing the Thai based Green Leaf Program, the Thai hotel association has taken an important first step in greening the Thai hospitality industry. It is hoped that lessons learned from the reviewed international hotels will benefit Thai hotels and encourage them to make an even stronger move toward environmental friendly practices and a sustainable future.

Chapter 4

Case Studies of the Thai Hotels

There are eight hotels participating in this project as case studies. The participating hotels include:

- Amari Watergate, Bangkok
- Imperial Queen's Park, Bangkok
- Novotel Lotus, Bangkok
- Royal Princess Larn Luang, Bangkok
- Sofitel Central Plaza, Bangkok
- Ao Prao Resort, Rayong Province
- Dusit Resort Pattaya, Cholburi Province
- Regent Cha-Am Beach Resort, Phetchaburi Province

These eight hotels represent the diversity of Thai hotels and thus are good case studies for the project. They are located in different parts of the country—inside Bangkok and in coastal area outside Bangkok. They are different types of hotels and serve different clienteles—five are business-oriented hotels and three are resort hotels. They vary in size, from small to large. The hotels also have different management structures, which will certainly influence their decision-making on environmental improvement projects. The hotels in this project include those run by a hotel management company, a single owner, and a large hotel chain.

These participating hotels realize that being environmentally friendly is important to improving their image, reducing operating costs, and to providing local and global environmental benefits. Most of these hotels are practicing good energy and water conservation and solid waste management, and they are willing to share how these good practices are implemented. The participating hotels are randomly re-named, and hereafter will be referred to as Hotel 1, Hotel 2,… Hotel 8.

This chapter reviews these hotels' energy and water consumption, ventilation and air conditioning systems, lighting systems, wastewater treatment, solid waste management and current practices. This information will help us understand these hotels' current performance and to some extent, that of the Thai hotel industry. The participating hotels' basic characteristics are also presented as part of the background information.

4.1 Characteristics of the Participating Hotels

Table 4.1 compares the basic characteristics of the participating hotels. The eight hotels vary in size. They range from less than 100 guestrooms with a total floor area about 3,000 m^2 to more than 1,200 guestrooms with a total floor area over 76,000 m^2. Building styles vary and include a low-rise resort, self-contained cottages, and a tall building with 37 floors. Average occupancy rates in 2001 ranged from 38% to 85 percent.

Table 4.1: Characteristics of the Participating Hotels

	Number of Floors	Total Floor Areas (m^2)	Number of Guestrooms	Average Occupancy Rates (%)	Number of Conference Rooms	Number of Restaurants	Number of Kitchens
Hotel 1	6	56,571	700	51	8	6	7
Hotel 2	37	76,371	1,287	60	30	6	7
Hotel 3	9	46,850	464	68	8	3	3
Hotel 4	36	58,000	577	85	11	5	7
Hotel 5	29	21,226	224	60	3	4	4
Hotel 6	26	43,004	598	74	12	6	8
Hotel 7	6	9,510	168	57	4	4	3
Hotel 8	1	2,968	62	38	1	2	2

4.2 Energy Consumption

As shown in Table 4.2, energy used in the hotels includes electricity, diesel, fuel oil, LPG and benzene. Electricity is mainly used for lighting and cooling systems. Diesel is used for back-up electricity generation or (in case of Hotel 4) for boilers. Fuel oil is mainly used for boilers, while LPG is used for cooking.

Table 4.2: Average Monthly Energy Consumption in 2001 (Original units)

	Electricity (kWh/month)	Diesel (liter/month)	Fuel Oil (liter/month)	LPG (kg/month)	Benzene (liter/month)
Hotel 1	736,643	67	27,533[1/]	1,332	23
Hotel 2	1,590,500	n/a	70,741[2/]	0 n/a	n/a
Hotel 3	555,973	31	35,000	7,544	n/a
Hotel 4	1,152,000	41,676	n/a	9,840	n/a
Hotel 5	388,250	n/a	19,952	n/a	n/a
Hotel 6	1,219,871	n/a	45,565	n/a	n/a
Hotel 7	280,123	n/a	n/a	7,162	n/a
Hotel 8	n/a	23,906	n/a	n/a	n/a

Notes: 1/ Including both fuel oil grade A and grade C
2/ Data for May 2002
"n/a" means either the hotel did not use that energy or the hotel used that energy but the data was not available.

Table 4.3 compares energy use in the same units—10^6 Btu. From this table it is clear that electricity is the main form of energy consumed in these hotels, representing on average, 70% of the hotels' total energy consumption. Hotel 8 uses diesel to generate its own electricity and thus has relatively high diesel consumption. Hotel 8 does not record its annual electricity consumption.

Table 4.3: Average Monthly Energy Consumption in 2001 (10^6 Btu)

	Electricity	Diesel	Fuel Oil	LPG	Benzene
Hotel 1	2,512.0	2.3	1,038.0 [1/]	63.4	0.7
Hotel 2	5,423.6	n/a	2,666.9 [2/]	n/a	n/a
Hotel 3	1,895.9	1.1	1,319.5	359.3	n/a
Hotel 4	3,928.3	1,438.7	n/a	468.7	n/a
Hotel 5	1,323.9	n/a	752.2	n/a	n/a
Hotel 6	4,159.8	n/a	1,717.8	n/a	n/a
Hotel 7	955.2	n/a	n/a	341.1	n/a
Hotel 8	n/a	825.2	n/a	n/a	n/a

***Notes**:* 1/ Including both fuel oil grade A and grade C
2/ Data for May 2002
"n/a" means either the hotel did not use that energy or the hotel used that energy but the data was not available.

Table 4.4 shows an estimate of the hotels' total energy costs in 2001. Energy costs, especially electricity, represent a high percentage of the hotels' total annual operating costs. Working toward greater energy efficiency could reduce the hotels' operating costs as much as 35 percent.

Table 4.4: Total Cost of Energy in 2001 (thousand bahts)

	Electricity	Diesel	Fuel Oil	LPG	Benzene
Hotel 1	20,782	10	2,568 [1/]	175	2
Hotel 2	46,407	n/a	6,952 [2/]	n/a	n/a
Hotel 3	15,664	5	3,458	1,102	n/a
Hotel 4	33,345	6,259	n/a	1,225	n/a
Hotel 5	11,167	n/a	1,759	n/a	n/a
Hotel 6	30,963	n/a	4,454	n/a	n/a
Hotel 7	8,794	n/a	n/a	878	n/a
Hotel 8	n/a	3,729	n/a	n/a	n/a

Notes: 1/ Including both fuel oil grade A and grade C
2/ Data for May 2002
"n/a" means either the hotel did not use that energy or the hotel used that energy but the data was not available.

To compare the efficiency of electricity consumption among the hotels, the average electricity consumption per m^2 of total floor area was calculated. Table 4.5 and Figure 4.1 show that electricity consumption per floor area in 2001 ranged from 11.87 kWh/m^2 in Hotel 3 to 29.46 kWh/m^2 in Hotel 7.

Table 4.5: Average Monthly Electricity Consumption per m^2 of Total Floor Area (kWh/m^2)

Hotel 1	Hotel 2	Hotel 3	Hotel 4	Hotel 5	Hotel 6	Hotel 7
13.02	20.83	11.87	19.86	18.29	28.37	29.46

Note: Hotel 8 was not included here since the electricity consumption data is not available.

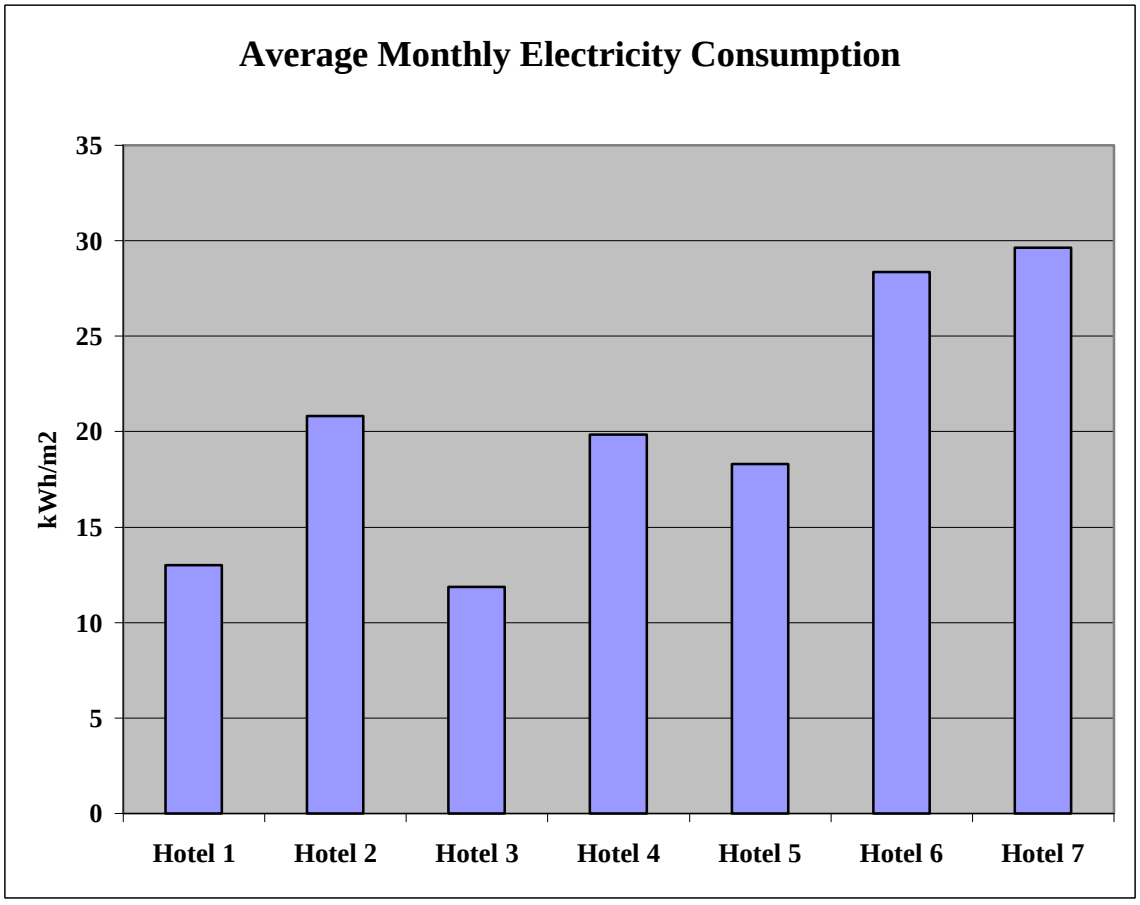

Figure 4.1: Average Monthly Electricity Consumption per m^2 of Total Floor Area

Table 4.6 compares the average energy consumption per m^2 of total floor area of the participating hotels. Hotel 1 consumes energy at approximately 63.93 Btu/m^2—which is less than any other participating hotel. Hotels 6, 7 and 8 have the highest rate of energy consumption. Hotel 8 shows the highest energy consumption per floor area of all the participating hotels. Its energy consumption is double that of Hotel 7, the second largest energy consumer among the hotels.

Table 4.6: Average Monthly Energy Consumption per m^2 of Total Floor Area (10^3 Btu/m^2)

Hotel 1	Hotel 2	Hotel 3	Hotel 4	Hotel 5	Hotel 6	Hotel 7	Hotel 8
63.93	89.39	76.32	100.61	97.81	136.67	136.31	278.04

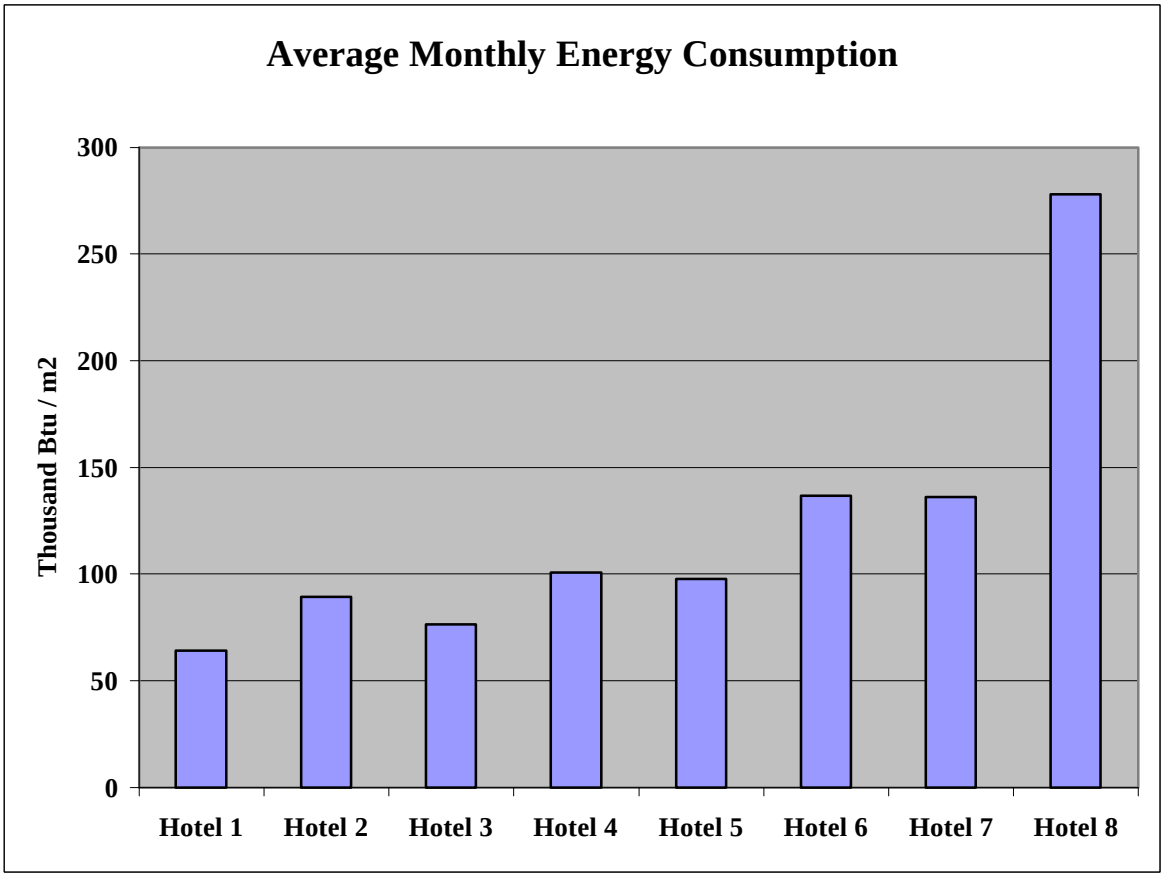

Figure 4.2: Average Monthly Energy Consumption per m^2 of Total Floor Area

4.3 Mechanical and Lighting Systems

Ventilation and Air Conditioning Systems

The VAC systems in these hotels are a combination of central chilled-water cooling systems and split-type air conditioners. Centrifugal chillers are used in the large hotels and reciprocating chiller and screw chillers are used in the smaller hotels. Central station air handling units are widely used in public areas and conference rooms as are terminal units such as fan coil units in guestrooms and corridors. Split-type air conditioners are used in areas such as offices or individual cottages. The reported capacities of the hotels' air conditioners are between 12,000 Btu/hour and 38,000 Btu/hour.

Water Heating Equipment

The main method for water heating in these hotels is with steam from boilers. The capacities of the boilers vary from 1 ton to 10 tons. The main fuel used for boilers is fuel oil (e.g., grades A and C)—although one hotel uses diesel. Electric water heaters are also used in self-contained hotel units. Two hotels use solar water heaters and report successful energy savings.

Waste heat recovery systems are being used in some hotels. Those systems include heat reclaimed from split-type air-conditioners, from chillers and from laundries—all of which is used for water heating.

Lighting

The hotels use a variety of lighting. Most commonly used are incandescent lamps, including conventional incandescent lamps, Philinear and tungsten lamps. Energy efficient lamps, including fluorescent lamps, compact fluorescent lamps (including PL, PL-S, PL-C and PLE), SL and high-pressure sodium (HPD), are increasingly taking the place of inefficient ones.

4.4 Water Consumption

In 2001, the participating hotels' water consumption ranged from an average of 1,873 m^3 per month for a small hotel like Hotel 8, to an average of 36,952 m^3 per month in a large hotel like Hotel 2 (see Table 4.7). The hotels pay for water at different rates depending on their locations (inside or outside Bangkok) and water sources (i.e., tap water, surface water and raw water from an irrigation canal).

Table 4.7: Water Consumption of the Hotels in 2001

	Total Consumption (m^3)	Average Monthly Consumption (m^3/month)	Total Cost (000 baht)	Average Price (baht/m^3)
Hotel 1	397,462	33,122	1,590	4.00
Hotel 2	443,424	36,952	6,651	15.00
Hotel 3	170,365	14,197	2,555	19.38
Hotel 4	246,440	20,537	3,898	15.82
Hotel 5	82,709	6,892	1,310	15.83
Hotel 6	241,156	20,096	3,593	14.90
Hotel 7	68,017	5,668	1,077	15.83
Hotel 8	22,475	1,873	672	29.90

The average water consumption per occupied room was calculated (as shown in Table 4.8) to compare the water consumption among the hotels. The consumption was compared per occupied room instead of total rooms to account for variation in annual room occupied rates. Hotel 4 had the lowest average water consumption per occupied

room (1.37 m^3). Hotel 1 and Hotel 8 are the highest water consumption per occupied room (3.17 m^3 and 3.08 m^3, respectively).

Table 4.8: Average Daily Water Consumption per Occupied Rooms
(m^3 per occupied room)

Hotel 1	Hotel 2	Hotel 3	Hotel 4	Hotel 5	Hotel 6	Hotel 7	Hotel 8
3.17	1.64	1.50	1.37	1.69	1.47	1.96	3.08

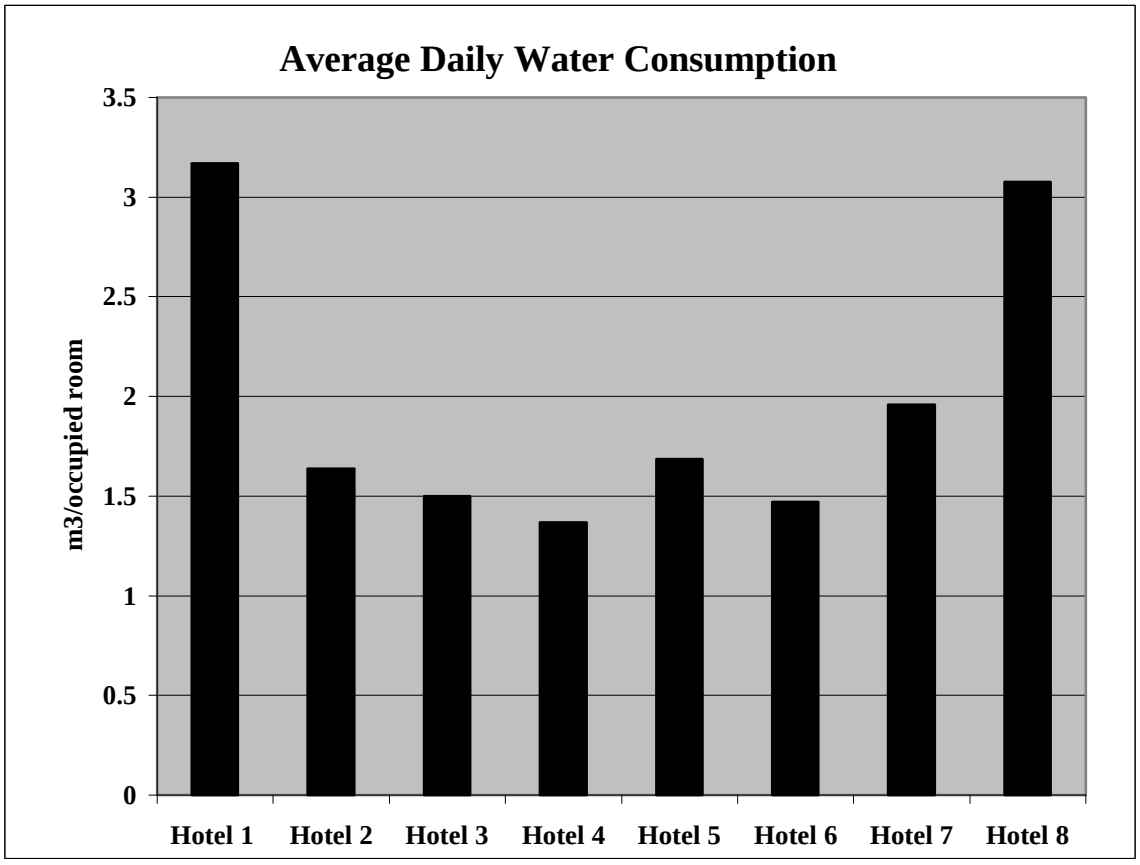

Figure 4.3: Average Daily Water Consumption per Occupied Room

4.5 Wastewater Treatment

All Thai hotels have wastewater treatment plants on site since they are required to treat wastewater to specified standards before discharging it into the municipal sewer system. Most of the hotels reported no problems with their wastewater treatment. They reported that the quality of their treated wastewater meets government standards for hotel effluent for their particular hotel category (Type A, B or C hotel). Two hotels, however, reported problems with insufficient treatment capacities and limited space in which to expand their plant capacities. Where space limitation is not an issue, the hotels usually recycle water

and reuse the treated water in gardens, in fountains or for staff toilets. Two hotels mentioned problems with the odor and color of their treated wastewater which stops them from re-using the treated wastewater. The wastewater treatment system being used in most hotels is an activated sludge system. One hotel uses aeration with chlorination.

4.6 Solid Waste Management

Solid waste collection fees in Thailand are minimal. In most cases, the hotels pay a fixed amount each month for any amount of solid waste. Therefore, there is no financial incentive for reducing solid waste. However, all the participating hotels recycle some of their solid waste. Some hotels have solid waste separation plants. One hotel separates metal, glass and bottles on each floor. Items such as plastics, glass, metal, newspaper, cardboard, aluminum are collected and sold to recycling companies. Food waste is sold to pig farms or used to make fertilizer. Money from selling recycled products is put in an employee fund for employees' welfare and other such services.

4.7 Current Practices

To learn more about their current practices and the potential for improvement, a survey regarding current practices on energy, water and solid waste was developed and sent to the participating hotels. Questions in the survey were drawn from guidelines and criteria used by various hotel certification programs (especially ECOTEL). Table 4.9 compares the answers to the survey questions. An answer of "Yes" indicates current good practices. An answer of "No" indicates that a hotel's performance in a specific area could be improved and operating costs thus lowered.

Table 4.9: Comparison of the Current Practices of the Participating Hotels

Feature	Hotel 1	Hotel 2	Hotel 3	Hotel 4	Hotel 5	Hotel 6	Hotel 7	Hotel 8
General								
Green Team exists to operate and maintain good energy/ environmental practices	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**No**
Green Team is chaired by a senior hotel manager and with representatives from every department	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**n/a**
Education on waste management, energy and water conservation for all staff members	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Energy								
Conduct an energy audit	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**No**
Meter & monitor energy consumption	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**No**	**No**
Presence of an electricity demand meter	**No**	**Y**	**Y**	**n/a**	**Y**	**Y**	**No**	**No**
Turn off / power down air conditioning system during periods of inactivity (i.e., late at night) in the main areas such as lobby and restaurants	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**No**
Turn off / power down air conditioning system and lights during periods of inactivity in *the conference areas and meeting rooms* (e.g., through the use of timers and/ or occupancy sensors)	**No**	**No**	**Y**	Y	**Y**	**Y**	**Y**	**No**
Turn off / power down air conditioning system and lights during periods of inactivity in *the office/ employee areas* (e.g., through the use of timers and/ or occupancy sensors)	**No**	**No**	**Y**	**Y**	**No**	**No**	**Y**	**No**
Turn off / power down air conditioning system and lights during periods of inactivity in *the guest rooms* (e.g., through the use of timers, occupancy sensors, and / or keycard controller mechanism)	**No**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Strict cleaning of crystals, glass, lights and walls	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**No**	**Y**
Eliminate anything that could restrict natural lighting	**Y**	**No**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Use lighting controls	**Y**	**Y**	**Y**	**Y**	**Y**	**No**	**Y**	**No**
Evaluate overall lighting needs for applicability of reducing bulb wattage	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**No**
Turn off lights and the television left on by guests after leaving rooms	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Turn off office equipment when it is not in use for long periods	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**

Table 4.9 (Continued)

Feature	Hotel 1	Hotel 2	Hotel 3	Hotel 4	Hotel 5	Hotel6	Hotel 7	Hotel 8
Open curtains when cleaning guestrooms (to utilize natural daylight while cleaning) and close the curtains when room cleaning is finished (to minimize heat gain to room)	Y	Y	Y	Y	Y	Y	Y	Y
Use mechanical timing devices to control recreation equipment such as saunas, hot tubs and steam rooms	No	Y	Y	Y	Y	Y	No	Y
Use energy efficient lamps and lighting fixtures	Y	Y	Y	Y	Y	Y	Y	Y
Ensure that the building envelope, including roof, windows, wall and other exterior surfaces are in proper condition to promote energy efficiency	Y	Y	Y	Y	Y	Y	Y	Y
Ensure good ventilation in kitchen areas to promote overall energy efficiency and efficient operation of the equipment in the space	No	Y	Y	Y	Y	Y	Y	Y
Place heat producing equipment such as ovens away from refrigeration units in the kitchen	Y	Y	Y	Y	Y	Y	Y	Y
Lower water temperature for laundry	Y	Y	Y	Y	Y	Y	No	No
Use washable towels/roller towels instead of hot air dryers	Y	Y	No	Y	Y	Y	Y	No
Recover heat from ventilation, refrigeration machines or wastewater for water heating	Y	No	No	No	No	No	Y	No
Use tankless water heating system to provide hot water for guests	No	Y	No	Y	No	Y	No	Y
Set temperature on hot water tanks at lowest acceptable level	Y	Y	Y	Y	Y	Y	Y	No
Use solar water heating (or other alternative energy)	Y	No	No	No	No	No	No	Y
Regularly dust refrigerator coils on mini-bars	Y	Y	Y	Y	Y	Y	No	Y
Water								
Conduct a water consumption audit	Y	Y	Y	Y	Y	Y	Y	Y
Meter & monitor water consumption	Y	Y	Y	Y	Y	Y	Y	Y
Educate hotel staff to check for, and report, leaks and drips	Y	Y	Y	Y	Y	Y	Y	Y
Install, where possible, water conserving plumbing fixtures in combination with ultra high efficiency or dry fixtures	Y	Y	Y	Y	No	Y	Y	No
Use highly water efficient equipment (e.g., dishwashers, laundry, cooling towers)	No	Y	No	Y	No	Y	Y	Y

Table 4.9 (Continued)

Feature	Hotel 1	Hotel 2	Hotel 3	Hotel 4	Hotel 5	Hotel 6	Hotel 7	Hotel 8
Use sensor-driven (infrared or ultrasonic) faucets and urinals	Y	Y	No	No	No	Y	Y	No
Use recycled or storm water or municipal grey water if available for VAC process make-up water	Y	Y	No	No	No	No	No	Y
Limit the use of potable water for landscape irrigation	Y	Y	Y	Y	Y	Y	Y	Y
Use a system for capturing rain or recycled site water for irrigation	Y	Y	Y	Y	Y	No	No	Y
Decrease the use of potable water for sewage conveyance by utilizing grey and/or black water systems	No	Y	No	No	Y	No	No	No
Utilize a system that recirculates and reuses water	Y	Y	Y	No	Y	No	No	Y
Use waterless urinals	No	No	No	No	No	No	No	No
Use dual flush toilet	No	No	No	Y	No	No	No	No
Use self-closing taps (percussion taps)	Y	Y	No	No	Y	Y	Y	No
Install filtration systems that recover heat and recycle water	No	No	No	No	Y	No	No	No
Recover wastewater from guestroom sinks and showers for treatment and ultimate reuse on-site for irrigation, public toilets, and cooling towers	Y	Y	No	No	Y	No	No	No
Use low-flow faucets (such as at 5.7 liters per minute) in public restroms and guestrooms	No	Y	Y	Y	No	Y	Y	No
Use low-flow showerheads (such as at 9.5 liters per minute or less) in guestrooms, recreation and employee areas.	No	Y	Y	Y	No	No	Y	No
Use low-flow toilets (such as 6 liters per flush) in guestrooms and public toilets	No	Y	No	No	No	Y	No	Y
Give guests who stay longer than one night the option to reuse sheets and linens in their rooms	Y	Y	No	No	Y	No	No	Y
Use mechanical timing devices and mechanical moisture monitoring devices to control irrigation equipment	No	No	No	No	No	No	No	No
Check landscaping irrigation system pressures periodically to properly maintain the system and to check for leaks	Y	No	No	No	No	No	No	No
Whenever possible, clean ground surfaces in recreation areas by means other than hosing down	Y	No	No	Y	No	No	No	No
Grow drought tolerate plants	n/a	Y	No	Y	No	Y	Y	Y

Table 4.9 (Continued)

Feature	Hotel 1	Hotel 2	Hotel 3	Hotel 4	Hotel 5	Hotel 6	Hotel 7	Hotel 8
Solid Waste								
Conduct a waste audit to understand waste source components. Identify recyclable materials	Y	Y	Y	Y	Y	No	n/a	Y
Look at largest quantities of waste and find ways to prevent their generation	Y	Y	Y	Y	Y	Y	Y	Y
Reduce packaging waste by purchasing in bulk and concentrates, and returning packaging when possible	Y	Y	Y	Y	No	No	Y	Y
Use compactor to reduce waste volumes	No	No	No	No	No	No	No	No
Use email instead of paper when possible	Y	Y	Y	Y	Y	Y	Y	Y
Avoid the use of paper cup covers and coasters in rooms	No	Y	No	No	No	No	No	Y
Keep promotional materials throughout the hotel to a minimum to reduce waste	Y	Y	Y	Y	Y	Y	No	No
Display events to guests through a zero-waste system, using electronic message boards or black boards	No	No	No	Y	No	No	No	No
Newspapers delivered to guests upon request only	Y	Y	Y	Y	Y	No	Y	Y
Return newspapers not needed for guests or used by the hotel to distributors	Y	Y	Y	Y	Y	Y	Y	Y
Collect and recode room keys	No	No	No	Y	Y	Y	No	Y
Provide messages to guests via a paperless system	No	No	No	No	No	Y	Y	No
Coordinate purchasing efforts between the different areas of the hotel so purchasing can be in bulk	Y	Y	Y	Y	Y	Y	Y	Y
Provide guests with partial room service option	Y	Y	Y	Y	No	No	Y	No
Use large roll tissue in public restrooms	No	No	No	Y	No	Y	No	Y
Supply amenities (e.g., soap, shampoo) in refillable bulk dispensers	Y	Y	Y	Y	Y	Y	Y	Y
Analyze and adjust amenity sizes to ensure that they are not offered in excessive amounts (or offer amenities in bulk from dispensers if practical)	Y	No	Y	Y	Y	Y	Y	Y
Use refillable condiment jars and refilled from bulk containers	Y	Y	Y	Y	Y	Y	Y	Y
Use cleaners from refillable pump spray bottles	Y	No	Y	Y	Y	Y	Y	No
Serve drinks from dispenser units or pitchers - not in individual bottles or cans	Y	Y	Y	Y	Y	Y	Y	Y
Donate leftover food, amenities and other “extras” to local shelters or other recipients	Y	Y	Y	Y	Y	Y	Y	No

Table 4.9 (Continued)

Feature	Hotel 1	Hotel 2	Hotel 3	Hotel 4	Hotel 5	Hotel 6	Hotel 7	Hotel 8
Use central display boards for memos	Y	Y	Y	Y	Y	Y	Y	No
Reduce the use of paper towels and plastic wraps	Y	Y	Y	Y	Y	No	No	No
Repair and reuse products instead of buying new ones	Y	Y	Y	Y	Y	Y	Y	Y
Make an effort to purchase reusable materials	Y	Y	Y	Y	Y	Y	Y	Y
Use old towels and linens for cleaning	Y	Y	Y	Y	Y	Y	Y	Y
Use both side of office paper before recycling it	Y	Y	Y	Y	Y	Y	Y	Y
Reuse notepads, pen and pencils	Y	Y	Y	Y	Y	Y	Y	Y
Reuse unopened condiments	Y	Y	Y	Y	Y	Y	Y	Y
Do not use disposable plates and utensils for room service	Y	Y	Y	Y	Y	No	Y	Y
Use glasses rather than paper cups in guestrooms and for employees	Y	Y	Y	Y	Y	Y	Y	Y
Use reusable products instead of disposable products. Use disposable tableware (i.e., plates, bowls, spoons, forks, knives, drinking cups) only for take out and pool food service where safety is a concern	Y	Y	Y	Y	Y	Y	No	Y
Do not use paper tray mats or paper napkin rings	n/a	Y	Y	Y	Y	Y	No	Y
Use washable tasting spoons in the kitchen	Y	Y	Y	Y	Y	Y	Y	Y
Use durable menus	Y	Y	Y	Y	No	Y	Y	Y
Cover recipes to make them durable	Y	Y	Y	Y	Y	Y	Y	Y
Use a dry erase board or chalkboard instead of paper to display the menu	n/a	No	Y	Y	No	No	No	No
Replace amenities only if opened by a guest	Y	Y	Y	Y	Y	Y	Y	Y
When a new amenity is provided for a guest, the original is left for the guest to use if product remains	Y	No	Y	Y	Y	No	Y	Y
Use a “waste exchange” or “material exchange” to find users for valuable wastes	Y	Y	Y	Y	Y	Y	Y	No
Recycle all recyclable materials	Y	Y	Y	Y	Y	Y	Y	Y
Recycle office paper	Y	Y	No	Y	Y	Y	Y	Y
Collect fryer oil for recycling	Y	Y	No	Y	No	Y	No	No
Use recycled paper, i.e., for general printing, guest communications, and internal communications	Y	Y	No	No	Y	No	Y	Y

Table 4.9 (Continued)

Feature	Hotel 1	Hotel 2	Hotel 3	Hotel 4	Hotel 5	Hotel 6	Hotel 7	Hotel 8
Provide adequate size recycling bins, distribute them properly to ensure that all guestroom waste is recycled	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Label recycling bins properly	**No**	**Y**	**No**	**Y**	**Y**	**No**	**No**	**No**
Provide recycling bins for guests to recycle materials in their rooms (i.e., begin with paper, bottles, cans, plastics and cardboard)	**No**	**No**	**No**	**No**	**No**	**No**	**No**	**Y**
Use ceramic mugs and durable glasses and cups	**Y**	**Y**	**Y**	**No**	**Y**	**Y**	**Y**	**Y**
Refill or recycle computer ribbons and/or toner cartridges	**No**	**Y**	**No**	**Y**	**Y**	**No**	**No**	**Y**
Compost waste food for sales or give away to a pig farm	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**
Set up a collection center and train all employees on the materials to be recycled and the collection center	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**	**Y**

Note: Y refers to the answer "Yes," and n/a refers to "unavailability of the data from the hotels."

4.8 Conclusion

This chapter provides case studies of eight Thai hotels, examining their current practices of energy and water consumption, and solid waste disposal. The hotels were chosen to represent a range of size, location, clientele, and management structure. The information was collected through site visits, a questionnaire, a survey, and follow-up communications in response to the questionnaire and survey answers. The information collected provides the basis for suggested projects to improve hotel practices associated with energy, water, and solid waste.

The information collected showed that the hotels varied widely in their use of energy and water. When energy use was looked at on the basis of Btu per square meter of floor area in Table 4.6, a range of 64-278 Btu/m^2 was seen. Thus the least energy-efficient hotel used about 4.3 times more energy than the most energy-efficient hotel. When water consumption per occupied room was examined in Table 4.8, a range of 1.37-3.17 m^3/occupied room was seen. Thus the least water-efficient hotel used about 2.3 times more than the most water-efficient hotel. With the exception of Hotel 8, which ranked eighth (least efficient) in energy use and seventh (next to least efficient) in water use, no clear correlation was seen between the hotels' water and energy use. The wide variation in both energy and water consumption points to the potential for energy and water conservation projects in all the hotels studied.

In terms of energy consumption, the fact that all the hotels used large quantities of liquid fuels (primarily to heat water) indicates a great potential for solar water heating in Thailand. Solar thermal collectors have been shown to be cost effective in climates similar to Thailand's in both urban and resort settings.

A review of responses to the current practices questionnaire given in Table 4.9 shows that all the hotels generally have good practices in the areas of energy, water, and solid waste. However, the questionnaire did identify potential areas for all of the hotels to improve in each of the categories examined.

Overall, the information collected from the eight Thai hotels provides the basis for recommending potential changes in energy, water, and solid waste practices that will improve the hotels' environmental and economic performance. The information collected also shows that Thai hotels generally have a strong current commitment to good environmental stewardship.

Chapter 5

Potential Projects for the Thai Hotels

This chapter reviews the projects which have a great potential to help Thai hotels improve their use of energy and water. These projects are identified based on information received from the participating hotels about their current practices, and their energy and water consumption. The potential projects are classified here under ventilation and cooling systems, lighting systems, energy management and control systems, waste heat recovery, laundry wastewater recycling and heat recovery systems, solar water heaters, water purification for drinking, water-saving equipment, ozone laundry systems, wastewater treatment, building shell, and building re-commissioning. Some of these projects are inexpensive, easily implemented with very short payback periods while others require greater capital investment which will be paid-off in the long run. These projects have been used successfully in hotels around the world and with proper implementation and maintenance could also be successful in Thailand.

It should be noted that the order of potential measures presented in this chapter generally follows their share of total energy use. That is, ventilation and cooling systems comsume the most energy, followed by lighting. The order is not meant to suggest the optimum sequence of adoption, which is very dependent on the specific situation of a given hotel. In general, it is recommended that hotels examine those measures that reduce load, such as those related to the building shell, prior to implementing those measures that have to do with system efficiency and controls. When the measures are viewed in this manner, lighting becomes important since its optimization both reduces load (by reducing heat) and increases system efficiency.

This chapter does not include any solid waste management projects because they do not seem to have a significant application for Thai hotels, since there is less incentive to implement such projects as solid waste collection fees in Thailand are minimal.

5.1 Ventilation and Cooling Systems

Ventilation and cooling (VAC) systems are generally the hotel sector‘s single most important use of energy. It accounts for 50% or more of most Thai hotels‘ total energy use. Proper sizing, selection, installation, maintenance and use are essential to cost-effective operation and to lowering overall air conditioning costs, and could help Thai hotels significantly lower their energy costs.

Air conditioner efficiency is rated in terms of the cooling effect per power use (i.e., how many Btu per hour are removed for each watt of power drawn). For room air conditioners, this efficiency rating is the Energy Efficiency Ratio (EER) and for central air conditioners, it is the Seasonal Energy Efficiency Ratio (SEER). The higher the EER and SEER, the more energy efficient the system. New air conditioners are more energy efficient than older ones. Although new air conditioners with higher EER and SEER cost more, the higher initial costs of energy-efficient air conditioners will be repaid several

times during the appliance's life span. The air conditioners now recommended are those with an EER greater than 10 or SEER greater than 12. Room air conditioners have lower overall energy efficiency than central air conditioning systems, but they are generally a more cost-effective approach for applications with cooling loads of less than 100 kWR (kilowatts of refrigeration).

The measures with a high potential for overall system performance improvement for central air conditioning systems include:

- Chiller replacement
- Optimizing cooling tower performance
- Utilizing variable air volume systems
- Utilizing dehumidifying heat pipes
- Utilizing electric variable speed air conditioning
- Utilizing electronic adjustable-speed drives

Chiller Replacement

A hotel may consider replacing the existing chillers if they are:

- inefficient,
- inappropriate for the cooling load,
- oversized, or
- using refrigerants with ozone-destroying cholorofluorocarbons (CFC).

Older chillers can be quite inefficient (higher energy consumption rate) when compared to new ones. For example, an old reciprocating chiller has an average efficiency of 0.90 – 1.2, or higher, kW/ton while a new reciprocating chiller has an average efficiency of 0.78 – 0.85 kW/ton. As another example, the average efficiency rate of new centrifugal chiller is 0.56 – 0.70 kW/ton as compared to the 0.70 – 0.80, or higher, kW/ton rate of an old one.[38] Therefore, in some cases, because of significantly reduced operating costs due to higher effiency (i.e., lower energy consumption rate), replacing an old chiller with a new unit can have a relatively short payback period.

The type of chiller selected for a particular installation should be appropriate to the cooling load it will serve. For example, a centrifugal chiller is more suitable to large constant loads while a reciprocating chiller responds better to variable loads.[39] Using an inappropriate chiller results in energy waste.

Many existing chillers are oversized. This makes a system cost more than necessary and leads to substantial energy loss from excessive cycling. Careful attention to appropriate sizing is critical to achieving maximum energy savings.[40]

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[38] http://tristate.apogee.net/cool/cfsc.htm

[39] *Energy Efficiency Reference for Asian Use*, Asian Development Bank, 1997, p. 131.

[40] ASHRAE publishes the *Cooling and Heating Load Calculation Manual*, see http://www.ashrae.org

Continuing to operate chillers containing CFCs exposes the owner to the high cost of obtaining this refrigerant from a dwindling reclaimed supply. Converting existing chillers to a non-CFC refrigerant usually results in some loss in cooling capacity. However, replacing the equipment with a new chiller using non-CFC refrigerants will require a substantial capital outlay. Good candidates for "early retirement" are CFC-based chillers with poor efficiencies or histories of high maintenance costs. Assuming a U.S. electricity cost of $0.06/kWh, replacing a 500-ton CFC chiller (0.85 kW/ton efficiency) with an efficient (0.56 kW/ton) non-CFC chiller can save $17,000/year. In some cases, savings from demand charges may almost double this figure.[41]

Two important issues regarding chiller replacement are worth mentioning:

- In some cases, replacing a single chiller with two or more small chillers to meet varying load requirements could be cost-effective. "Parallel staging" of multiple chillers is a common method of meeting peak loads in larger installations. For many typical facilities, sizing one chiller to one-third and another chiller to two-thirds of the peak load enables the system to meet most cooling conditions at relatively high part-load efficiencies.[42]

  Selecting the number and size of each chiller in a multi-chiller installation is a trade-off between capital investment and on-going operating costs. Using the minimum number of chillers of the largest possible capacity is the lowest capital cost option. However, the most energy efficient configuration requires several chillers of different sizes (and possibly compressor types) to ensure that each chiller operates as fully loaded as possible at all times. The overall capital cost for the central cooling plant will increase, but the operating cost will decrease. In large-scale installations, feasibility studies are recommended to determine the optimum chiller configuration.[43]

- Significant energy savings can be achieved by combining chiller replacement with other energy conservation measures that reduce the hotel's cooling load or increase the efficiency of the cooling system.[44] Examples of cooling system efficiency improvements include control system upgrades and increased cooling tower capacity. Cooling load reduction measures include tightening the building envelope and lighting system retrofits. The additional cost of such measures can be offset significantly by the savings from the downsized chiller they make possible.[45]

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[41] http://www.eren.doe.gov/femp/procurement/pdfs/le_chiller.pdf

[42] http://www.eren.doe.gov/femp/procurement/pdfs/le_chiller.pdf

[43] *Energy Efficiency Reference for Asian Use*, Asian Development Bank, 1997, p 131.

[44] http://www.eren.doe.gov/femp/procurement/pdfs/le_chiller.pdf

[45] Lawrence Berkeley National Laboratory' s "Cool $ense" project provides guidance on integrated chiller retrofits, see http://ateam.lbl.gov/coolsense/

Optimizing Cooling Tower Performance[46]

Proper maintenance of cooling towers can significantly reduce energy expenditure for chillers. An improperly maintained cooling tower will produce warmer cooling water resulting in condenser temperatures 5 to 10 F higher than a properly maintained cooling tower. The increased condenser temperature lowers the chiller's efficiency, wastes energy and increases costs. For each degree increase in the condenser temperature, the chiller will consume 2.5 to 3.5% more energy.

The recommended daily/weekly cooling tower maintenance schedules include:

- Test water sample for proper concentration of dissolved solids. Adjust bleed water flow as needed.
- Measure the water treatment chemical residue in the circulating water. Maintain the residue level recommended by the water treatment specialist.
- Check the strainer on the bottom of the collection basin. Clean as needed.
- Operate the make-up water float switch manually to ensure proper operation.
- Inspect all moving parts such as drive shafts, pulleys, and belts.
- Check for excessive vibration in motors, fans, and pumps.
- Manually test the vibration limit switch by jarring it.
- Look for oil leaks in gearboxes.
- Check for structural deterioration, loose connectors, water leaks, and openings in the casing.

The recommended periodic cooling tower maintenance schedules include:

- Check the distribution spray nozzles to ensure even distribution over the fill.
- Check the distribution basin for corrosion, leaks, and sediment.
- Operate flow control valves through their range of travel and re-set for even water flow through the fill.
- Remove any sludge from the collection basin and check for corrosion that could develop into leaks.
- Check the drift eliminators, air intake louvers, and fill for scale build-up. Clean as needed.
- Look for damaged or out-of-place fill elements.
- Inspect motor supports, fan blades, and other mechanical parts for excessive wear or cracks.
- Lubricate bearings and bushings. Check the level of oil in the gearbox. Add oil as needed.
- Adjust belts and pulleys.
- Make sure there is proper clearance between the fan blades and the shroud.
- Check for excessive vertical or rotational free play in the gearbox output shaft to the fan.

[46] http://www.es.wapa.gov/pubs/briefs/cooling/tb_cool.cfm

The recommended annual cooling tower maintenance schedules include:

- Check the casing, basin, and piping for corrosion and decay. Prime and paint any welded repairs with a corrosion- resistant coating.
- Properly seal all cracks, holes, gaps, and door access panels.
- Remove dust, scale, and algae from the fill, basin, and distribution spray nozzles to maintain proper water flow.

Variable Air Volume Systems[47]

For a large building with many different air conditioned spaces, an air handling unit (AHU) is assigned to serve similar loads in several zones. The use of a variable air volume system (VAV) is more energy efficient than a constant volume system.

Because each AHU has to serve several zones and since each zone may have slightly different cooling needs, the air conditioning supplied to each zone must vary. In a constant air volume system, the fans in an AHU always operate at the same speed and the quantity of air supplied remains essentially constant despite changes in the cooling load. Therefore, to satisfy a zone's cooling requirement, the temperature of the air supplied to the zone must vary (using terminal reheat or dual ducts). Adjusting the temperatures of the air supply to various zones requires heat and therefore additional energy consumption.

In contrast, the VAV systems allow the quantity of air supplied to each zone by AHU to be varied. In principle this allows a zone's cooling load to be met with air supplied at a constant temperature which saves the energy otherwise needed to heat the air supply.

Dehumidifying Heat Pipes[48]

The heat pipe is a new technology which is ideally suited for hot and humid environments like those existing in Thailand. In hot, humid climates, in order to make a room comfortable an air conditioner must lower the indoor humidity level as well as air temperature. If an air conditioner fails to lower the humidity adequately, the air will be cool but uncomfortably damp. This problem is likely to occur with inappropriately sized air conditioners. Large unit air conditioners quickly cool the air but cycle off before they can properly dehumidify it. The dehumidifying heat pipe addresses this problem. It is a device that enables an air conditioner to dehumidify better but still cool the air efficiently. The dehumidifying heat pipe does not need additional electricity to operate. In addition, it is proven that when used on outside air ventilation units, the dehumidifying heat pipe can help reduce the required chiller capacity by up to 30% by precooling the incoming air before it reaches the cooling coil. In addition, the space cooling achieved with a heat

[47] *Energy Efficiency Reference for Asian Use*, Asian Development Bank, 1997, pp 112-113.

[48] http://www.eren.doe.gov/consumerinfo/refbriefs/bd2.html

pipe occurs at a lower sensible heat ratio (SHR) than is possible with a conventional cooling coil alone.[49]

Most models of heat pumps and air-conditioners can be retrofitted with dehumidifying heat pipes.

Electric Variable Speed Air Conditioning[50]

Variable-speed central air conditioners use electronically commutated motors (ECMs), which are more efficient than the induction motors used in a single-speed system. ECM speeds can be varied to make the cooling system's capacity more precisely match a hotel's load. Cycling losses, associated with a system that is continually turned off and on to meet hotel load conditions, are thus reduced. Unlike induction motors, ECMs retain their efficiency at low speeds, thereby reducing energy use at low-load conditions. A variable-speed A/C system uses approximately 40% less energy than a standard single-speed A/C system.

Electronic Adjustable-Speed Drives

Electronic Adjustable-Speed Drives (ASDs), also known as Variable Speed Drives and Variable Frequency Drives, are currently the dominant motor speed-control technology. ASDs can significantly improve the efficiency of alternating current (AC) motors in applications with highly variable loads. ASDs save energy by matching motor speed (and electricity used) to load. ASDs control the current/voltage fed to the motor through power semiconductor switches. Normally, electronic ASDs convert the fixed-frequency power supply (50 or 60 Hz), first to a DC supply and then to a continuously variable frequency/variable voltage. ASDs are thus able to change the speed of AC motors continuously.

Electronic ASDs have no moving parts (sometimes with the exception of a cooling fan), offering high reliability and efficiency, and low maintenance requirements. In addition, since ASDs are not bulky and have flexible positioning requirements, they are easy to retrofit.

As for room air conditioners, old systems primarily use reciprocating compressors and constant air volume distribution. New systems are much more energy efficient. The new technologies include the use of variable air volume, variable refrigerant volume and adjustable variable speed drive.[51]

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[49] *Energy Efficiency Reference for Asian Use*, Asian Development Bank, 1997, pp 139-141.

[50] James McMahon, Gregory J. Rosenquist, J.D. Lutz, Stanley H. Boghosian, and Leslie Shown, "Energy Efficient Technologies: Appliances, Heat Pumps, and Air Conditioning", in *CRC Handbook of Energy Efficiency*, eds. Frank Kreith and Ronald E. West, Massachusetts: CRC Press, Inc., 1997, p 437.

[51] *Energy Efficiency Reference for Asian Use*, Asian Development Bank, 1997, p 149.

- Variable Air Volume (VAV) distribution systems are used in some packaged units.[52] These help reduce cooling capacity and power input in response to part load conditions.
- Variable refrigerant volume (VRV) used in split systems can reduce power input by over 25 percent.[53] Rather than using chilled water as a cooling medium, VRV systems pump refrigerant directly. When installed in a modular configuration, only those spaces requiring air conditioning will receive cooling while the system can be shut down completely in rooms not requiring air conditioning.
- Adjustable variable speed drive controlling the compressor in split systems can further improve energy efficiency by matching the speed of the compressor motor to the refrigeration requirements at part cooling load conditions.

5.2 Lighting Systems

Lighting is a hotel's second largest energy-using system after its cooling system, and is probably the easiest and most cost-effective area in which to reduce energy costs. The use of more energy efficient lighting can contribute significantly to reducing a hotel's energy bills. In addition, because the lighting system is a major source of internal heat, an efficient lighting system can also help reduce the load on the hotel's cooling system. The following techniques are suggested to achieve a safe, comfortable lighting system with minimal energy waste:[54]

- Using natural daylight to the fullest extent possible.
- Matching lighting levels to the visual requirements of the tasks undertaken in the space.
- Choosing the most efficient lamp and ballast for the application.
- Using efficient light fixtures (reflectors, shielding, housing).
- Installing and maintaining the systems properly.
- Installing devices to automatically control switching.

Efficient Lamps and Ballasts

The energy efficiency of light sources and associated control gear (e.g., ballasts and starters) can be increased as much as 75% by using high efficiency tubular fluorescent lamps, compact fluorescent lamps, electronic or low loss ballasts and high intensity discharge lamps. These lighting technologies are best suited to specific types of applications, where energy savings can be maximized and the overall quality of the lighting system improved.

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[52] A packaged unit has air-cooled condenser, compressor and evaporation packed together in one unit.

[53] A split system has air-cooled condenser and compressor located in an outdoor unit separating from the indoor evaporator.

[54] *Energy Efficiency Reference for Asian Use*, Asian Development Bank, 1997, p 173.

High Efficiency Tubular Fluorescent Lamps

Fluorescent lamps are ideally suited to general lighting applications and any general lighting installation which requires minimal glare, even light distribution and long (often continuous) hours of use. The old, common fluorescent lamp for commercial lightings is the 1.5-inch diameter T12 cool-white fluorescent lamps. The new standards for low power consumption, low life-cycle cost and illumination that more closely resembles natural light are the high-efficiency 1-inch diameter T8 fluorescent lamps. The T8 lamps offer a higher efficacy (lumen per watt) rating than T12. The 32-watt T8 lamps produce similar levels of light as the older 40-watt T12 lamps, and have become the most popular choice for new installations.

The newest entry into the lighting market is the 0.5-inch diameter T5 fluorescent lamps. T5 lamps are straight tube lamps with a high efficacy. Standard T5 lamps have light output and efficiency comparable to T8/electronic ballast systems. High output T5 lamps have significantly higher light output—a 1-lamp high output T5 cross-section can replace a 2-lamp T8 cross-section. A T5 lamp is about 3.5 times more expensive than a T8 lamp. However, it offers several advantages for new luminaries used in either retrofit or new construction projects, including better optical control, more aesthetically pleasing luminaries and higher peak operating temperature. Similar to T8, T5 are available in nominal 2′, 3′, 4′, and 5′ lengths.[55]

Compact Fluorescent Lamps (CFLs)

CFLs are currently manufactured in many different shapes, sizes, wattages, and color characteristics and are designed to fit into normal incandescent lamp sockets. A CFL works much like a conventional fluorescent lamp. It works with either magnetic or electronic ballasts and can be permanently attached to the tube (integral) or removable (modular). While the integral models have the lowest initial cost, modular models are clearly the most economical in the long run. The integral ballast has a screw-in base, so it is a direct replacement for standard incandescent lamps. The modular ballast has a lamp with two or four pins on the bottom that plugs into a socket. Therefore, for modular ballast, the lamp can be replaced when it fails without having to replace the ballast (for which a life expectancy is about five times longer than the lamp). Modular ballasts can be hard-wired within a fixture or enclosed within a screw-in base.

Fluorescent lamps produce four times as much light per wattage of energy consumed than incandescent lamps. This means a 100 W incandescent lamp can be replaced with about 25 W of CFL. Fluorescent lamps can also last eight to ten times longer than incandescent lamps.[56] The long life of fluorescent lamps means that maintenance costs are lower than that of incandescent lamps. If a Thai hotel replaces a 100-watt incandescent lamp which

[55] http://www.pge.com/003_save_energy/003b_bus/pdf/t5.pdf

[56] http://www.ase.org/programs/lighting.htm

is operating for 3,000 hours each year with a 25 watt CFL, the payback period will be less than six months.[57]

However, a study revealed that early burnout of CFLs accounted for 22% of the complaints received about the product. Factors which can affect the life of CFLs are[58]

- Use of instant-start electronic ballast instead of rapid-start electronic ballast. Instant-start electronic ballasts have greater potential to shorten lamp life compared to rapid-start electronic ballasts because they do not preheat cathodes.
- Lamp ambient temperature. Although lamp ambient temperature has only secondary effects on lamp life compared to lamp starting, it directly affects ballast life and lamp lumen output.
- Operation cycle. Lamp life is shortened when lamps are operated on shorter cycles. CFLs are most cost effective and efficient in areas where lights are on for long periods.

Dimmable CFLs can save additional energy. The use of dimmable CFLs is increasing due to improved product availability and reliability. The color rendition of many models is similar to that of incandescent lamps. Dimmable CFLs are available for both integral and modular ballasts. Most use electronic, rapid start ballasts. Dimming can be achieved gradually, without flicker, and without changes in color or temperature. Some types of ballasts and controls utilize low voltage wiring to regulate the dimming, while some simply reduce the power to the ballast. It is important that the lamp and dimming system be compatible.

Electronic or Low Loss Ballasts for Fluorescent Lamps

Ballasts are available commercially in two types: electromagnetic or electronic. Conventional electromagnetic ballasts consume 9 to 12 W of input power. A 36 W tubular fluorescent lamp requires a total input power of 45 W. Comparatively, "low loss" electromagnetic ballasts consume 5 W of input power. Thus when a low loss ballast is used with a 36 W fluorescent lamp, only 41 W of total input power is consumed, yielding a 10% increase in efficiency over conventional ballasts. In most cases low loss ballasts can be used as a direct substitute for conventional ballasts and thus can be installed in both new and existing lighting systems. Since a low loss ballast costs 2 to 3 times more than a conventional ballast, it is generally not cost-effective to replace conventional ballasts, which are working, with low loss ballast. The recommended approach is that at a minimum hotels should gradually replace conventional ballasts with low loss ballast as

[57] The calculation is based on the following information: cost of a 25 watt compact fluorescent lamp (Phillips) is 260 baht, cost of a 100 watt incandescent lamp (Philips) is 15 baht and average cost of electricity is 2.3031 baht/kWh (an average of the participating hotels' reported average electricity prices).

[58] Conan O´Rourke and Mariana G. Figueiro, *Long-Term Performance of Screwbase Compact Fluorescent Lamps*, Illuminating Engineering Society of North America 2000 Annual Conference: Proceedings. IESNA: New York, NY. 369-381.

the conventional ballasts fail. However, the best approach is to utilize lighting capital funds to replace old fixtures with new electronically ballasted T8 or T5 systems.

Electronic ballasts are a more recent product, and more energy efficient than low loss ballasts. Generally, electronic ballasts cost more than electromagnetic ballasts, but they produce more light for each watt, run cooler and last longer. Most electronic ballasts also have several other advantages over electromagnetic ballasts, including:

- reduced noise or "hum" and no lamp flicker,
- improved lamp life,
- high power factor (0.98 or higher) and good tolerance to supply voltage and frequency fluctuations,
- reduced heat losses which influences air conditioning energy consumption and sizing, and
- easy control of light output and power consumption for use with external sensors and controls.

High Intensity Discharge (HID) Lamps

HID lamps are energy efficient and should replace high-wattage incandescent fixtures used in high-ceiling applications. There are three main types of HID lamps: metal halide (MH), high pressure sodium (HPS) and mercury vapour (MV). HID lamps have longer average rated life and greater light output than the incandescent lamps used on high ceilings. MH fixtures provide pleasing, white light for lobbies, ballrooms and service areas, and are more efficient than MV lamps often used in these applications. HPS lamps are highly efficient systems for security purposes in street lighting and parking lots. The simple payback period for replacing a 500-watt tungsten halogen incandescent lamp which is operating for 3,000 hours per year with 150-watt MH lamp is proven to be only about 1.3 years.[59]

Efficient Light Fixtures

The lighting fixture is normally made up of the following components:

- Lamp(s) and lamp-holders or sockets,
- A reflector to direct the light to the desired area,
- Shielding to control the distribution of light output and reduce glare, and
- Housing (also called the troffer) to contain the above elements and ballast or control gear.

The most effective efficiency improvement for fluorescent fixtures is to retrofit them with high efficiency reflectors. Retrofitting with an efficient reflector can improve a fixture's energy efficiency by more than 15 percent. Delamping is a common efficiency feature

[59] The calculation is based on the following information: cost of a 150 watt metal halide (Lamzini) is 3,500 baht, cost of a 500 watt tungsten halogen incandescent lamp (Delight) is 380 baht, input power for a ballast with the 150 watt MH lamp is 12 watt, and average cost of electricity is 2.3031 (an average of the participating hotels' reported average electricity prices).

after the retrofitting of reflectors. Delamping will increase energy savings and also help reduce capital and maintenance costs since number of lamp failures will decrease.

Old lamp fixtures should be retrofitted at the same time as incandescent bulbs are replaced with CFLs, or installation of an integral reflector for use with a CFL. Using conventional incandescent lamp fixtures with CFLs can lead to poor system performance as incandescent lamp reflectors are usually designed for a point source of light rather than a long distributed light source.

Lighting Control Devices

Lighting control devices such as occupancy sensors and daylight control can increase hotel energy savings.

Occupancy Sensors

Occupancy sensors are light switching devices that respond to the presence and absence of people in the sensor's view. Lights will be on when movement is detected and off after specified periods of non-activation. These are applicable in areas such as meeting rooms, offices, public restrooms and guestrooms, and can save as much as 35% to 45% on an energy bill.

Daylight control

Daylight control devices help save energy by reducing the amount of artificial light when sufficient daylight is available. A daylight (photoelectric) sensor is used to determine the level of light in a space and signals a controller to either turn off one or more lamps, or dim the lighting levels until the specified room lighting level is achieved. Daylight control is suitable in areas where daylight can penetrate significantly into spaces such as offices with windows, and lobbies or other general areas with atrium or skylights.

Dimming control of lighting contributes to energy savings by continuously reducing (or increasing) artificial light in a room in response to the sensor input. Dimming may also increase lamp life as the lamp is not "stressed" by high starting and operating voltages. Existing lighting systems can be retrofitted with dimming controls, which are available for fluorescent, HID and incandescent lamps.

General recommendations for lighting retrofits are as following:[60]

- Replace all incandescent lamps that are in use for more than 3,000 hours per year with fluorescent lamps or CFLs.[61]

[60] http://www.ase.org/programs/lighting.htm

[61] A 2,000 hour threshold may be more appropriate in the case of Thailand due to the A/C savings in a climate that imposes cooling on the building for most of the year.

- Replace incandescent lamps with halogen lamps in appropriate spotlight and decorative lighting applications.[62]
- Replace incandescent fixtures with more efficient fixture systems.
- Replace low-wattage incandescent fixtures with fluorescent fixtures (that incorporate electronic ballasts and reflectors) in offices, and in recreational and some parking lot areas.
- Replace high-wattage, incandescent fixtures used in high-ceiling applications with MH and HPS fixtures.
- Replace incandescent exit signs with corresponding light-emitting diode (LED) lamps or fixtures.[63]
- Upgrade T12 fluorescent lamp and magnetic ballast systems to T8 lamps and electronic ballasts.
- Incorporate occupancy sensors in applicable spaces such as meeting rooms, offices, support spaces, public restrooms and guestrooms.
- Perform group relamping in public areas, that is, replace all old lamps and ballasts with new efficient models at all once, to minimize maintenance needs and costs.

5.3 Energy Management and Control Systems[64]

An Energy Management and Control System (EMCS) is the most effective means to control building systems and services. Although the components of services like lighting and VAC may be designed for energy efficiency, if poorly controlled, they will waste energy and not provide a comfortable environment. Control problems such as unnecessary use of equipment after occupancy times, simultaneous heating and cooling of building zones, and operation of equipment at less than optimal loading are common and often go undetected since building systems are very complicated. Correcting these control malfunctions will greatly improve energy efficiency of building services and thus reduce operating costs.

The two key concepts underlying the operation and utility of an EMCS are monitoring (gathering information related to how equipment or building services are operating) and control (changing an operation or responding to an operational change). Numerous available EMCS softwares provide various monitoring and control functions. Some of those most often encountered in the hotel industry include:

[62] Halogen, though not as efficient as CFLs, are almost two times more efficient than incandescent lamps, last two to four times longer, and pay for themselves in about three years. Halogen lamps can be used instead of CFLs where color render is critical and where operating hours are short. Halogen lamps are also easily dimmable.

[63] Exit signs use incandescent lamps consume approximately 30 to 50 watt per sign. Exit signs that use more energy-efficient light sources like LEDs consume about 4 watt per sign and thus save 80% in operating and energy cost per year.

[64] *Energy Efficiency Reference for Asian Use*, Asian Development Bank, 1997, pp 316-319.

Time Schedule

Air conditioners, lighting and other electrical equipment can be programmed to switch on and off according to a predetermined schedule in order to operate only when needed. This can result in as much as a 20-25% reduction in total energy costs.

Optimum Start/Stop

A VAC plant with time control is normally set to start early enough in the day to make conditions comfortable at occupancy times in the hottest, most humid weather. Therefore, on milder days, the equipment will start one to two hours earlier than necessary. In contrast, an EMCS can be used to sense outdoor temperature and start the equipment just long enough before a building is occupied to produce comfortable conditions at that time. Thus, under the right climate conditions, the A/C can be shut down early, leaving only the ventilation fan operating.

Chiller Optimization

This control function has several features. First, it optimizes a staggered "on" and "off" schedule of multiple chillers to provide the combination that meets the hotel cooling load with the lowest power input. Second, it adjusts the condenser water supply temperature according to the ambient wet-bulb temperature to achieve the highest possible setting. In addition, it will reset the chilled water supply temperature upward under light cooling load conditions. However, care must be taken to ensure that building humidity does not increase. It is estimated that maximizing chiller efficiency can save between 10% to 20% of the chiller's compressor energy use.

Load Based Re-set

This control system will monitor temperatures in occupied areas. It will allow supplied air temperatures and volumes to be re-set and controlled to optimize occupant comfort and avoid energy waste by over cooling supply air. Savings are generally about 5% to 10% of chiller compressor energy use.

Lighting Controls

Occupancy sensors can be used to meet the lighting needs of occupants in places such as conference areas or storerooms. Where dimmable lamp controls have been installed, the amount of artificial light provided can be regulated according to the amount of natural daylight available. Savings vary from site to site but lighting costs can be reduced by up to 40 percent.

Demand Control

An EMCS can be used to reduce peak demand of electricity and produce a more even load profile by temporarily shedding loads for brief periods until peak demand abates.

Recording of Conditions

A record of temperatures, flows, etc. is kept enabling the examination of conditions over a period of time. If any building conditions exceed pre-specified limits, instantaneous alarms will come on to alert building operators to act. This can produce an accurate profile of key building operating parameters and allow a reduction in operating times of equipment such as fans, pumps and chillers.

Centralized Monitoring and Trending

With an EMCS, the energy use of key building components (such as chillers, fans, pumps, and lighting) and operating parameters (such as temperatures and flow rates) are centrally monitored. Statistical analysis allows long-term trends to be established for various building services and energy use targets to be set. A drop in the desired/optimum performance of a building system can alert operators of the need for immediate maintenance. While this function does not lead directly to energy cost savings, it does give building managers the tools required to monitor and control energy inefficiencies.

The Novotel Lotus Hotel in Thailand, one of the hotels participating in this project, has installed an energy management system and reported that the system helps reduce its electricity bill about 100,000 baht a month or 1.2 million baht a year. The Novotel spent 10 million baht on the system and thus it will be repaid in ten years. As another example, the Double Tree Hotel in Sacramento, California has installed an EMCS for its HVAC system. The system helped reduce annual energy use by 11% in 2001. Therefore, the hotel was able to hold electricity cost increases to 2.5% despite a 15% average increase in the electricity rates in California.[65]

5.4 Waste Heat Recovery

Waste heat recovery systems are a technology that takes heat from where it is unwanted to where it is needed. Waste heat, if captured properly, can substitute for a portion of fuel otherwise required for space cooling or water heating. Heat recovery devices such as heat exchangers or heat pumps can increase energy efficiency, reduce energy consumption, and reduce operating costs. In a hotel with a high hot water requirement, using recovered heat to heat or preheat water is very cost-effective.

Heat Recovery from Air-Conditioning Units

Air conditioning units are designed to remove heat from interior spaces and transfer it to the ambient (outside) air. Condenser heat may be transferred directly into the air, as it is in most conventional air source units, or into water circulating from a cooling tower and then to the ambient air via the cooling tower. While this heat is of a "low grade variety," it still represents wasted energy that can be reclaimed in a usable form. The best and most obvious use for such recovered heat is for water heating. In areas that have high cooling loads, significant heat can be reclaimed and used to heat water. With a heat

[65] http://www.consumerenergycenter.org/enhancedautomation/case_studies/CS6_Doubletree.pdf

recovery device, air conditioners operate more efficiently and energy used to heat water can be significantly reduced.[66]

The Regent Cha-Am Beach Resort in Thailand has installed 16 sets of heat recovery devices at the Regent Chalet to reclaim waste heat from its existing split type air conditioners. The project was implemented in 2000. The equipment included a water storage unit (100-liter capacity), a 1,000-watt heater, a thermostat control, a safety valve and two sets of piping at a cost of 15,000-20,000 baht per set. The system can heat 100 liters of water to 70 C in one hour while an air conditioner is running, thus reducing electricity used to heat water. The constraint is that the system only works when the air conditioner is running. Thus, the hotel needs an electric water heater as a back up for the winter when air conditioners are not in use.

On a larger scale, Half Moon Resort in Jamaica has installed heat exchangers to heat water with waste heat reclaimed from its central air-cooled condenser, chilled-water cooling system. The cooling system consists of three 100-ton dual compressor chillers. The hotel has a diesel fired boiler system to produce steam and hot water. However, the boiler system was unable to cope with peak demands for hot water. This resulted in guest complaints and excessive water consumption. The problem was solved by installing a heat exchanger on each chiller compressor discharge line, a hot water circulation loop between the heat exchangers, and a 3,000-gallon hot water storage tank. The system has helped improve daily hot water delivery by producing approximately 8,000 to 12,000 gallons (about 30,000 to 45,000 liters) of hot water at 135 F per day. The improvements were immediately recognized: water consumption was reduced by approximately 15%, diesel fuel consumption was reduced by 30%, guest complaints regarding hot water temperature were virtually eliminated, and electricity consumption was reduced by approximately 5 percent.[67]

Heat Recovery from Boilers

The energy that goes up a boiler stack with the flue gases can be captured with air-to-air heat exchangers, and used for preheating boiler feedwater or space cooling via an absorption chiller. In general, cost effective recovery of energy from flue gases can only be achieved in medium to large capacity systems—boilers with a heat output of at least 5 to 10 MW.[68]

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[66] http://www.agen.ufl.edu/~fees/pubs/eh126.html

[67] http://www.idrc.ca/industry/jamaica_e9.html

[68] *Energy Efficiency Reference for Asian Use*, Asian Development Bank, 1997, p 264.

Heat Recovery from Ventilation[69]

Ventilation heat recovery systems are based on heat pump technology. A heat pump is a device that extracts heat from a source, concentrates it, and transfers it elsewhere at a higher temperature. Heat pumps can provide important temperature amplification, which simple heat exchangers cannot. In a hotel, heat pumps can take warm, moist air such as that from laundries or kitchen and transfer it at a higher temperature to heat water or to other areas of the hotel. This system provides mechanical ventilation as well as heat. The temperature of fluids from which commercial heat pumps extract heat ranges from 10 C to 51.5 C. Where exhaust stack (kitchen or laundry/dryer) temperatures are higher than 177 C, a flue gas heat exchanger can recover the waste heat.

Solid Waste Incinerators[70]

Hotels with over 1,000 pounds (454 kilograms) per day of burnable solid waste can recover high and medium temperature heat from specially designed incinerators. The heat can be used to regenerate the lithium bromide used in absorption cooling, for steam production, space heating or hot water heating.

It is important to note that the cost effectiveness of installing heat reclamation technologies depends on three key parameters: quantity (how much waste heat is generated), quality (what the temperature of the waste heat is) and availability (the heat is obtainable at the times that it is required).[71] A systematic study of available waste heat sources and identification of the opportunities for its use are needed to determine whether the potential savings in fuel costs outweigh the capital cost of installing heat reclamation technologies.[72]

5.5 Laundry Wastewater Recycling and Heat Recovery System

Water, energy and cost savings can be achieved in a commercial laundry such as that in a hotel with a wastewater recycling and heat recovery system. This system helps reduce water use and sewage discharge by recycling water that would otherwise go into the municipal sewage system.

This system saves energy for water heating since the recycled water has a higher temperature than fresh water. The system also cuts water treatment chemical costs because the recycled water has already been treated with soaps and conditioners. Several hotels in the U.S. are using this system successfully and achieving cost savings. Those

[69] http://www.eren.doe.gov/consumerinfo/refbriefs/ea4.html

[70] http://www.eren.doe.gov/consumerinfo/refbriefs/ea4.html

[71] If the time at which a heat source is available does not match the time at which the process or service requiring the heat needs, the energy can be stored using thermal storage system.

[72] *Energy Efficiency Reference for Asian Use*, Asian Development Bank, 1997, p 272.

hotel include, among others, the Boston Park Plaza in Massachusetts, Hilton Disneyworld in Florida, Hyatt Regency Maui in Hawaii, San Francisco Hilton in California, Red Lion La Posada in Arizona, Marriott Central Laundry in California, and Red Lion Central Laundry in Oregon.

In 1995, the Hospitality Industry Forum on Energy Conservation—an industry consortium organized by the U.S. Department of Energy (U.S. DOE) to help the Technology Introduction Partnerships (TIPs) program increase market adoption of advanced, energy-efficient technologies—identified the laundry wastewater recycling and heat recovery project as a top priority. With financial assistance from the U.S. DOE, the project was demonstrated at the Red Lion Central Laundry in Portland, Oregon. It evaluated the water, energy and cost savings resulting from installation of the wastewater recycling and heat recovery system. The pre- and post-project energy and water use was monitored by the Pacific Northwest National Laboratory, one of the U.S. DOE's national laboratories.[73]

The Red Lion Central Laundry serves seven Red Lion facilities in the Portland metropolitan area. The laundry washes up to 25,000 lbs. of laundry per day and used to dump an average of 55,000 gallons of water a day into the City of Portland's sewer system. The laundry is housed in a 17, 000-sq. ft. building and contains six commercial-sized washing machines, five dryers, two irons, two presses, and a steam tunnel. The laundry operates between 16 to 24 hours a day, 6 to 7 days a week.

The wastewater recycling and heat recovery system selected for this project is a micro-filtration unit (MFU), manufactured by Wastewater Resource, Inc.[74] The system uses a series of filters and a membrane to filter suspended solids and oils from laundry wastewater that would otherwise be discharged to the sewer, and recycles the water for reuse and heat recovery. The old system continuously heated 52 F city water to 150 F and dumped it after a single use. The new system recycles 110 F laundry wastewater through a mechanical shaker screen, a pressurized stainless steel strainer, and then into the submicron membrane filter. Together, the filters remove particulates to 0.5 microns. The filtered water is then heated by the existing gas steam boiler to 150 F and run back through the washers.

The project was monitored for about five months. Energy savings were measured by performing a thermal energy balance around the washing machines. Water savings were calculated by metering volumetric flow rates.[75] After five months, the MFU had provided a 52% savings in water consumption and a 44% savings in energy used to heat

[73] T.F. Garlick, M.A. Halverson, and M.R. Ledbetter (Program Manager), *Wastewater Recycling and Heat Reclamation Project, Red Lion Central Laundry, Portland, Oregon.* A Project of the Hospitality Industry Forum on Energy Conservation. Prepared for the U.S. Department of Energy under Contract DE-AC06-76RLO 1830, Pacific Northwest National Laboratory, Richland, Washington 99352, July 1996.

[74] See http://www.h2oreuse.com/whathow.html.

[75] Chemical savings were not analyzed in the study.

water. The performance measurements indicated monthly savings of approximately $3,400 on waste, sewage, and energy (natural gas), which would result in a payback of 4.1 years. However it was also found that the MFU installed in the project was oversized by 65%, making the capital investment much larger than needed. If the unit was sized properly, the payback for the project would be 2.7 years. The payback for similar installations throughout the U.S. is estimated to range from 1.2 to 2.7 years, depending on initial system cost, daily consumption, and local utility rates.

5.6 Solar Water Heaters

Solar water heaters are one of the simplest and most commercially viable solar systems for residential and industrial use. Hotels require large quantities of hot water for bathing, washing, cleaning, etc. Solar water heaters can be used to meet some of these demands and to reduce energy costs. The systems may have high initial costs but fuel costs are free. Therefore, in nearly all cases, the initial costs are recovered through substantial fuel savings over the system's lifetime.[76] In addition to economic benefits, solar water heaters do not produce carbon dioxide, any other air pollution, or waste that is created when water is heated by electricity or fossil fuels.

Most solar water heaters are composed of two features—a collector and a storage tank. Various designs of solar water-heating systems are available from different manufacturers.[77] The system design of solar water heaters can be classified as passive or active, and as direct (also called open loop) or indirect (also called closed loop).[78] Passive systems operate without pumps and controls, and can be more reliable, more durable, easier to maintain, longer lasting and less expensive to operate than active systems. Active solar heaters incorporate pumps and controls to move heat-transfer fluids from the collectors to the storage tanks. A direct solar water-heating system circulates water through collectors and heats the water directly, while an indirect solar water-heating system heats (antifreeze) fluid in the collectors and circulates the hot fluid around the stored water to heat the water.

The Regent Cha-Am Beach Resort in Thailand installed passive design, closed loop solar water heaters in 1997 at the Regent Chalet, in cottage units of the Regent Cha-Am property. A total of 14 sets of solar water heaters from the Sola Hart have been installed at an investment cost between 47,000–50,000 baht per system. The hotel reports

[76] http://www.eren.doe.gov/solarbuildings/moreinfo.html

[77] The Solar Rating and Certification Corporation (SRCC) provides a benchmark for comparing the performance of some solar water heating systems. It also offers a directory of certified solar water heating systems from various manufactures, see http://www.solar-rating.org/DIRECTORIES/OG300DIRFULL_20020405.PDF.

SRRC is a non-profit organization located in Florida, USA. It was found in 1980 with the primary purpose is the development and implementation of certification programs and national rating standards for solar energy equipment, see http://www.solar-rating.org/

[78] http://www.eren.doe.gov/erec/factsheets/watheath.html

successful use of the system resulting in reduced water heating energy costs. The hotel has electric heaters as a back up, but they are rarely used since the solar heaters usually provide enough hot water except during some periods in the rainy season. The payback period of the project was about five years (assuming 50% occupancy rate).

5.7 Water Saving Equipment

If water efficiency practices are integrated into everyday operations and water-efficient equipment installed, a 30 % reduction in water consumption in a hotel is possible with no loss of comfort to guests.[79] While water efficiency measures should begin with operations that use the most water, such as cooling, cleaning, rinsing and heating, many hotels overlook easy improvements that can be made in so-called domestic water devices, such as showers, faucets, toilets, urinals, and water taps.

Low-Flow Showerheads

The U.S. hotel industry has estimated that each guest takes one 10-minute shower per day. An old conventional showerhead uses 4-8 gallons (15–30 liters) of water per minute, which brings the use of water per guest per day to between 40-80 gallons (150 – 300 liters)—just for one shower. New, efficient, low-flow showerheads use only 2.5 gallons (9.5 liters) per minute or less, and thus can reduce the use of water by more than half without sacrificing the "feel" of the shower. At the same time the hotel can save the energy that would have been used to heat those extra gallons of water. A showerhead produced by Energy Technology Laboratories (ETL) and used by a casino hotel in Nevada uses only 1.5 gallons (5.7 liters) per minute, further reducing water use and energy by approximately 40% when compared to the 2.5 gallons (9.5 liters) per minute model, and by 70% when compared to an older 5 gallons (19 liters) per minute model.[80]

Low-flow showerheads are engineered to provide a spray pattern that compensates for less water flowing through the shower. Thus they conserve water while providing the sensation of a high-flow showerhead. A low-flow showerhead is not the same as a flow restrictor. A flow restrictor simply cuts back the flow without compensating for pressure. Therefore, inserting a flow restrictor reduces water use but results in an unsatisfactory shower. On the other hand, a low-flow showerhead is designed to deliver fewer liters of water per minute but with the same pressure as a traditional showerhead.

There are a variety of low-flow showerheads available, including hand-held and designer models. Many are equipped with a push-button shut-off valve, which allows the user to interrupt the water flow while soaping up, saving even more. Temporary cut-off valves usually are attached to, or incorporated into, the showerheads. The water can be reactivated at the previous temperature without any need to re-adjust hot and cold water

[79] http://www.epa.gov/OW-OWM.html/water-efficiency/hotels.pdf

[80] http://homeenergy.org/archive/hem.dis.anl.gov/eehem/98/980717.html

valves. Most new showerheads also feature three spray functions so a hotel guest can vary the flow delivery between mist, spray and jet settings to suit any preference.

Replacing a conventional showerhead with a low-flow model is usually a very quick and simple job. A variety of adapters is readily available that can be fitted to most standard shower arms, including the swivel-type. The products in U.S. vary in price, from $3 to $48. Good single-setting showerheads can be purchased for less than $10.

The Small Tourism Enterprise Project (STEP), founded by the Organization of American States (OAS) to support and assist small Caribbean hotels, calculated the impact of using inefficient showerheads in guestrooms. A 50-room hotel with 70% occupancy and guestroom showerheads that consume 15 liters per minute can waste approximately 2.5 million liters of water and 65,100 kWh of energy per year. At an average water cost of 0.23 cent per liter, and an average electricity cost of $0.10/kWh, these inefficient showerheads would add $13,500 to the hotel's annual utility costs. If the hotel decided to replace its inefficient showerheads with new low-flow showerheads (with an estimated cost of $30 each), it would spend $1,500 and recover this investment in less than two months.[81]

Low-Flow Faucets & Faucet Aerators

Inefficient faucets in guestrooms, public restrooms and kitchens waste large amounts of water. These conventional faucets have a flow rate of 2-5 gallons (7.6 - 19 liters) per minute and should be replaced with more efficient models that use 1.5 gallons (5.7 liters) per minutes in restrooms, and 2.5 gallons (9.5 liters) per minute in kitchens.[82]

When replacing public restroom faucets, the following options should be considered: [83]

- *Low-flow faucets with metered valves* that deliver a preset amount of water and gradually shut off,
- *Low-flow self-closing faucets* that are spring-loaded to shut off a few seconds after the user triggers it, and
- *Low-flow faucets with infrared and ultrasonic sensors* that activate the water flow when they detect an object. The flow stops immediately when the object is removed, and automatically resets after each use.

A faucet can be retrofitted by adding an aerator to reduce the water flow through faucet. An aerator combines air with water as it comes out of the tap creating an effective spray pattern. It can reduce water usage by about 20% to 40%. Aerator models are available

[81] http://www.caribbeaninnkeeper.com/files/Water%20Conservation%20Toolkit%20-%20Final%20Draft%20version%203.pdf

[82] *Water Efficiency Program for Hotels and Motels*, Florida Energy Extension Service, University of Florida.

[83] *Water Efficiency Program for Hotels and Motels*, Florida Energy Extension Service, University of Florida.

with various water-flow rates ranging from 0.5 to 2.5 gallons (1.9-9.5 liters) per minute. Different flows from different faucets may be desirable. The 0.5-1.0 gallons (1.9–3.8 liters) per minute aerators are recommended for staff hand washing sinks; 1.5-2.0 gallons (5.7–7.6 liters) per minute aerators are recommended for guestrooms, and 2.2–2.5 gallons (8.3-9.5 liters) per minute tamper-proof aerators should be used in kitchens bars, and laundries to ensure that the flow of water is sufficient to wash and rinse dishes.[84] Low-flow faucet aerators usually cost $5 -$10, are easy to install, and typically yield a payback within a few months.

Another technology applicable to both guestrooms and public restrooms is ceramic valving. This technology requires no maintenance, while providing drip-free operation for extraordinary long time periods. Ceramic valves can withstand high temperatures, constant wear, hard water, and any unexpected debris in the line.

In assessing a 30-room Caribbean hotel, the Small Tourism Enterprise Project studied the impact of using efficient faucet aerators in guestrooms. The assessment revealed that 67% of its guestroom faucet aerators were either damaged or missing and allowed the faucets to produce flows of up to 5.5 gallons (20.8 liters) per minute. By installing 1.5 gallons (5.7 liters) per minute aerators in all guestrooms, the hotel could reduce its water consumption by more than 39,000 gallon (850,000 liters) per year and save $2,400 per year. This measure required approximately $200 investment and therefore offered a payback period of only 5 weeks.[85]

Ultra-Low-Flow Toilets

Low-flow toilets use less water than conventional models which were not designed to save water. The earliest toilets used about 10 gallons (38 liters) of water per flush. Today, a conventional toilet uses about 4.5 gallons (17 liters) of water per flush. More efficient low-flow toilets now use about 3 gallons (11 liters) per flush while ultra-low-flow toilets, developed most recently, use only about 1.6 gallons (6 liters) per flush.

If an old hotel is using conventional toilet with water flow rate of 4.5 gallons (17 liters) per flush, and it flushes four times a day for one guest in an occupied room, it will consume about 18 gallons (68 liters) per day per room. The hotel could save 11.6 gallons (44 liters) of water per room or 1,160 gallons (4,400 liters) for every 100 occupied rooms in one day—if using 1.6 gallons (6 liters) per flush ultra low-flow toilets.

There are three major types of toilets in use. Those include gravity flow, flush valve and pressurized tank toilets.

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[84] http://www.caribbeaninnkeeper.com/files/Water%20Conservation%20Toolkit%20-%20Final%20Draft%20version%203.pdf

[85] http://www.caribbeaninnkeeper.com/files/Water%20Conservation%20Toolkit%20-%20Final%20Draft%20version%203.pdf

Gravity Flow Toilets

Gravity flow toilets are the most common type of toilet used in hotels built prior to 1970. In these toilets, a rubber stopper releases water from the tank, and gravity forces the water and waste in the bowl through the trap. The old model of gravity flow toilets consumes 5-7 gallons (19-26.5 liters) per flush. A newer model, low-flow gravity toilet uses 3.5 gallons (13 liters) per flush while the most recent, ultra-low flow gravity toilets consume only 1.6 gallons (6 liters) per flush. Replacing older gravity flow toilets with the ultra low flow 1.6 gallons per flush models will provide the most water savings. Most 1.6 gallons per flush toilet replacements will offer a payback period of less than four years.

Retrofit options for gravity flow toilets are available in the U.S. for less than $20. Displacement devices, including bags or bottles, can reduce water flow by approximately 0.75 gallons (2.8 liters) per flush. They function by displacing flush water stored in the tank. The devices are inexpensive and easy to install, but do require regular maintenance.[86]

Toilet dams are flexible inserts placed in a toilet tank to keep 0.5-1.0 gallon (1.9-3.8 liters) out of each flush cycle. Dams will last five to six years. A plumber should be consulted before installing such devices. Early closure flapper valves can also be used to replace the existing flush valve in the tank. These devices are inexpensive and usually can be installed in ten to fifteen minutes, barring other problems with the toilet mechanisms. These valves are adjustable to optimize performance and can save 0.5-2 gallons (1.9-7.6 liters) per flush.

Flush Valve (Flushometer) Toilets

Flush valve, or flushometer, toilets are tankless but have a valve that is attached to a pressurized water supply pipe. When the valve is activated, the connecting pipe supplies sufficient water to flush the toilet. The most effective water-saving option for a flush valve toilet is a replacement of inefficient units with 1.6 gallons (6 liters) per flush ultra low valve toilet. It is important to note that both the low-flow valves and the toilet bowls should be replaced simultaneously. A 1.6 gallons per flush valve must be used with an appropriately designed 1.6 gallons per flush bowl, or the unit will not perform adequately.

The retrofit options of flush valves can be made to reduce water use.

- *Valve inserts* are available and can reduce flush volumes by 0.5-1.0 gallon (1.9–3.8 liters) per flush. Some of these devices consist of plastic orifices, perforated with holes in a wheel and spoke pattern.
- *Infrared and ultrasonic sensors* automatically activate flushing. They are the most expensive retrofits for flush valve toilets. However, they are considered

[86] Bricks or other friable objects should never be used as displacement devices becausethey will break into pieces and cause plumbing problems. In addition, granular contaminants can prevent proper closure of the flapper and damage flow valves.

dependable in controlling the amount of water used in flushing. Infrared sensors emit an infrared light beam to detect motion, while ultrasonic sensors are activated by high frequency sound waves to detect motion.

- *Dual flush adapters* adjust the system to use two flushes—a standard flush for solids removal and a second, modified smaller flush for liquid and paper. Dual flush adapters can save between 0.6-1.2 gallons (2.3-4.5 liters) per flush.

Pressurized Tank Toilets

The most modern and effectively designed toilet currently on the market is the pressurized tank toilet. These units perform very well at removing waste at a low-flow water rate of 1.6 gallons (6 liters) per flush. These toilets use water line pressure to compress air in a specially sealed tank. When flushed, the compressed air greatly increases the flush water force.

Dual Flush Toilets

An option for low-flow toilets is dual flush toilets. The dual flush toilets provide two different volumes of flushing. While most standard toilets flush approximately 4.5-5 gallons (17-19 liters) of water each and every time, the dual flush toilet gives the user the choice between a reduced 1.5 gallons (6 liters) flush suitable for clearing liquids and a regular full flush for clearing solids. This technology is mandated in the building codes of Australia and Singapore.

Waterless Urinal

The typical water consumption for a urinal is 2-3 gallons (7.6-11.4 liters) per flush. New federal standards in the United States require all urinals to use not more than 1.0 gallon (3.8 liters) per flush.

Conventional urinals can have a flushometer valve or water tanks for both wash-down and trough urinals. Conventional urinals flush periodically in order to remove urine and debris from the bowl. This flushing process helps to reduce malodor and bacterial growth by removing the nutrient such as the uric acid in urine, which the bacteria feed upon. Flush mechanisms are generally one of two types. The first type is simply a valve connecting the building's main water supply to the urinal. Whenever the flush valve is opened, water passes directly to the urinal bowl and flushes the urine down the waste outlet pipe. For greater efficiency in this type of flush mechanism, infrared or ultrasound sensor controls should be installed to automatically flush and help eliminate unnecessary double flushing.

The second flush mechanism is siphonic jet urinal. It consists of a cistern above the urinal bowl containing a siphon mechanism. Water gradually fills the cistern from the main water supply. Once the water reaches the top of the siphon it pours through using gravity, and the siphoning effect empties the cistern down the flush pipe into the bowl, flushing the urine down the waste outlet pipe. The flush will be a regular and constant

process as the cistern continually empties and fills. Water efficiency options in siphonic jet urinals include repairing leaks, replacing the rubber diaphragm periodically, and adjusting or retrofitting flushometer valves. In addition, a timer should be installed to control the removal of collected wastes and to stop the flow of water when that area of the hotel is closed.[87]

Waterless urinals do not have a water connection. They consist of a bowl with a water repellant coating and a trap with a special liquid seal. In waterless urinals, the biodegradable liquid takes the place of water to provide flushing action. Figures quoted by the UK Environment Agency claim that a single flushing urinal can use as much as 65,000 liters of water in a year.[88] With this in mind it is clear that any urinal or related device which can significantly reduce water consumption is beneficial. In addition to water savings, advantages of the waterless urinals include reduced maintenance and improved hygiene.

Maintenance savings have become a significant selling point of waterless urinals. The average annual savings in maintenance costs in the U.S. range from $80 to $120 per urinal.[89] These savings come from eliminating the mechanical components: there aren't any valves to clog or break. The deposits on pipes that plumbers refer to as "urine salts" should not occur with waterless urinals. These deposits apparently result when urea causes calcium carbonate to precipitate out of hard water, not from the urine itself. Also, because gallons of water are not being flushed down the urinal drain, eliminating the possibility of overflow if the drain becomes clogged. Moreover, in a new washroom, the installation of a waterless urinal is less complex and saves money given the absence of flush apparatus and related plumbing and pipe work.

The third major benefit of waterless urinals is improved hygiene. Bacteria, the primary concern in bathrooms, need a moist environment to survive. Waterless urinals are designed to dry out between uses, so do not provide as hospitable an environment for bacteria as do conventional (wet) urinals and sinks. Users also report less urine smell than with conventional urinals.

However, in waterless urinals, debris accumulation can be a problem since there is no regular flush to move cigarette ends, chewing gum, etc. away from the bowl. In addition, malodor can be a problem if the waterless urinal is not carefully and thoroughly maintained with appropriate cleaning products.

Waterless urinals cost between $478 and $600. Conventional urinals cost about the same, or a little more (depending on the flush valves specified). Therefore, for new construction, waterless urinals offer an immediate payback. In replacement situations,

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[87] *Water Efficiency Program for Hotels and Motels*, Florida Energy Extension Service, University of Florida.

[88] http://www.ri-research.com/health/newsandt/Watrless/watrless.htm

[89] http://www.buildinggreen.com/products/waterless.html

the payback should be from one to three years, depending on the existing urinal models, water cost, maintenance cost, and usage.

The Waterless Company,[90] in Del Mar, California, and Falcon Waterfree Technologies,[91] in Los Angeles, California, are the leading manufacturers of waterless urinals in the United States. Both sell patented waterless urinal systems.

Percussion Taps (Self-Closing Taps)

A tap left running can quickly waste a considerable amount of water and energy, and possibly cause damage by flooding. Percussion taps are taps that require pressure to be turned on, and automatically turn off when not in use. They are a reliable non-concussive cartridge that reduces water consumption. The taps can be set to operate for a few seconds only. This reduces water usage by eliminating dripping and taps being left on, sometimes for long periods. The taps also reduce the flow of water so that less water is used for each washing event. Fitting percussion (push) taps on all washbasins can reduce water use by 50 percent.[92] Self-closing or percussion taps can be supplied as kits which simply fit onto existing standard taps without disturbing existing pipe work connections. They are available with either individual water temperature regulators or with pre-mixed water. Protection against scalding can also be provided with a hot water limit stop. There is a wide range of percussion taps (i.e., push-button and lever-operated) that can be used for showers or wash basins. Percussion or self-closing taps can waste water if they jam in the 'on' position, so they must be inspected and maintained regularly.

5.8 Ozone Laundry Systems

Ozone laundry systems are rapidly gaining international acceptance over conventional methods because of the overall benefits they provide with considerably reduced washing and drying cycle times, chemical use, water and energy consumption, wastewater discharge, and their ability to keep garments whiter, cleaner and softer.

Ozone is created when air is exposed to ultraviolet light, lightening or man-made high voltage electric arcs. This process causes some of the oxygen (O_2) molecules to fracture into two separate oxygen (O) atoms. These atoms then combine with other O_2, forming a molecule of ozone—consisting of a group of three oxygen atoms (O_3). Ozone is very reactive and is nature's way of destroying pollutants and cleaning the atmosphere. Ozone is highly unstable, a property which makes ozone a very powerful oxidizing, cleaning and bleaching agent.

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[90] http://www.waterless.com

[91] http://www.falconwaterfree.com

[92] http://www.envirowise.gov.uk/envirowise/envirowise.nsf/Site+Setup/$First?OpenDocument&RURL=MBEN4PBHPL&RType=Page

Ozone laundry systems use an ozone generator, which is usually integrated with existing equipment. Compressed air is forced through a high voltage electrical arc, which converts oxygen molecules into ozone gas. The ozone is then dissolved in cold laundry wash water where it exerts its powerful cleaning action.[93] Because it is so reactive, ozone readily attaches itself to fatty and other soils that bind dirt to clothing, destroying them rapidly. As one of the strongest known oxidizing agents, ozone is capable of breaking down virtually any organic soil into innocuous compounds such as carbon dioxide and water. Being a gas in solution, ozone penetrates and opens individual garment fibers, allowing faster cleaning and bleaching of garments using fewer chemicals.[94] In addition, ozone is totally biodegradable; when it completes its function, it reverts rapidly back to oxygen, leaving no chemical residues behind.[95]

Ozone attacks most organic soils and kills bacteria 3200 times faster than chlorine bleach. When used in laundry wash water, ozone allows for shorter wash cycles resulting in significant energy and water/sewage surcharge savings. The time to complete a wash and dry cycle can be reduced by 15 - 20 percent. If this means ten minutes less per load, and there are six loads per day processed by that equipment, the daily operation for that load factor could be reduced by one hour.[96] Because of its powerful oxidation properties ozone dissolves soil on contact and does so at ambient water temperatures, instead of at conventional wash temperatures of 140-160 F; this drastically reduces heating costs. Some estimates indicate that using an ozone laundry system can reduce fuel consumption by 80 percent. [97]

Other advantages of the ozone laundry system include: [98]

- Quicker cycle times increase the productivity per machine, per hour. Labor savings, estimated at 20%, can also be realized through shortened wash and dry times made possible by reduced chemical use and handling.
- Ozone is also recognized for its powerful pollutant destruction capabilities in laundry wastewater and therefore in the purification of wastewater.
- Due to the reduced cycle time coupled with the elimination of chlorine and hot water, the life of the garment is often increased. Unlike chlorine with a long garment residual time that may be detrimental to fabrics, all traces of ozone are instantly eliminated.

[93] Ozone works best in cold water because hot water breaks ozone down before it can perform as intended.

[94] The EPA and FDA have acknowledged that ozone is capable of reducing pathogenic bacterial levels on garments by 99.9992%.

[95] http://www.schiff-consulting.com/Ozone_in_laundry_washing.html

[96] http://www.envirocleanse.com/How%20It%20Works.htm

[97] http://www.schiff-consulting.com/Ozone_in_laundry_washing.html

[98] http://www.schiff-consulting.com/Ozone_in_laundry_washing.html and http://www.envirocleanse.com/key_product_features.htm

- Using cold water, the laundry area is cooler to work in. With virtually no chemical residual in the linen, laundry workers experience less hand chapping. Also, less linen damage helps to reduce irritating levels of airborne lint.

Some of reported disadvantages of the ozone laundry system should be acknowledged. Those include:[99]

- Ozone is highly toxic and hazardous requiring special handling.
- Oil based stains, like make-up, are more difficult to remove.
- The system has high up-front costs, and may not be cost effective for hotels with less than 100 rooms.
- The system may deteriorate materials such as rubber fittings, gaskets, and certain kinds of metals.
- Ozone injection laundry systems are relatively new and somewhat complex. These systems may not function perfectly when first installed and may require some adjustment to match each individual hotel's needs. Therefore, it is important to find an ozone installation and service company with an adequate local support network that can help with maintenance and problems after sales.

The Days Inn in Orlando, Florida, has installed an ozone laundry system. Prior to the installation of the system, the hotel had hot and cold water meters installed on the washing machines. After operating the ozone system for two months, the hotel calculated a 98% savings in hot water and a 30% savings in water and sewer charges. Other benefits included a 25% faster wash cycle and a 15% overall faster drying time.[100]

One of the participating Thai hotels is in the process of installing an ozone laundry system. The hotel has estimated that the total cost of the system is 5.26 million baht. The cost of using the laundry ozone system is estimated at 0.70 baht per kg of laundry as compared to 1.50 baht per kg. The simple payback is expected in 3 years.

5.9 Water Purification for Drinking

One of the participating hotels in the project is an island resort hotel. The hotel has no source of fresh water and must buy all water from the mainland for drinking and other uses. It is likely that the hotel could save money by purifying raw water to drinking water quality on site instead of buying bottled water from the mainland. The recommended methods for such water purification are membrane filtration and activated carbon filtration.

[99] http://www.socalodging.com/Newsletter/News0201.htm

[100] http://www.socalodging.com/Newsletter/News0201.htm. Moreover, EnviroCleanse Systems, Inc., offers at http://www.envirocleanse.com/laundry_market_segment_examples.htm some further saving examples, including a 1700 Room City Center Hotel, 150 Room Select Service Hotel and a 400 Room Full Service Hotel

Membrane Filtration[101]

Membrane filtration can remove various contaminants including bacteria, viruses and dissolved organics to make water safe for drinking. The membrane technique is recognized by the U.S. Environmental Protection Agency as a "best available technology" for treating water to meet the U.S. Safe Drinking Water Act standards.

There are various types of membrane processes. The membrane process commonly employed in drinking water applications uses pressure as its driving force. There are four categories of pressure-driven membrane process: microfiltration (MF), ultrafiltration (UF), nanofiltration (NF) and reverse osmosis (RO). MF and UF are low-pressure membrane processes and can remove larger contaminants. NF and RO operate at significantly higher pressures than MF and UF, and are typically used to remove dissolved contaminants including both inorganic and organic compounds. Which membrane filtration process is the best for this Thai hotel depends on the quality of the raw water to be purified. The hotel must have its feedwater tested to determine the membrane filtration most appropriate for its water purification.

The RO membrane process requires the greatest operating pressure, and can remove solids as small as salts. Therefore RO is used to produce drinking water from seawater.[102] Thus the hotel, which is located on the island, may choose to use RO for desalinating drinking water. RO is the most commonly used method for drinking water purification—especially for island-type resorts and for facilities in remote areas.[103]

Activated Carbon Filtration [104]

Activated carbon (AC) filtration is recognized by the U.S. Water Quality Association as an acceptable method to meet U.S. Environmental Protection Agency National Drinking Water Standards for certain drinking water contaminants. It is most effective in removing organic contaminants such as volatile organic compounds, pesticides and benzene. Organic chemicals are often responsible for taste, odor and color problems, and AC filtration can generally be used to solve those problems. AC filtration will also

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[101] *Membrane Processes Design Guide* , CH2 M Hill 2001, Internal document.

[102] Reverse Osmosis is a method of separating water from dissolved salts by passing feedwater through a semipermeable membrane at a pressure greater than the osmotic pressure caused by the dissolved salt. For more details on RO, see http://www.pall.com/applicat/water/fundamentals.asp.

[103] Examples of the hotels using reverse osmosis system are the Laguna Beach Resort, Utila Bay Islands, Honduras (see http://www.utila.com), the Hawaiian Island Resort, Hawaii, USA (see http://www.solardesign.com/project-mgt.html), the Jaguar Paw Jungle Resort, Belize (see http://www.jaguarpaw.com/), and the Pittstown Point Landings Resort, Crooked Island (see http://www.pittstownpointlandings.com/)

[104] http://www.ext.nodak.edu/extpubs/h2oqual/watsys/ae1029w.htm and http://www.msue.msu.edu/msue/imp/modwq/wq239201.html

remove chlorine and some heavy metals. However, AC filtration does not remove microbes, sodium, nitrates, fluoride, or hardness.

Instead of buying bottled water for drinking (which is very costly) and fresh water for other uses, the Thai island resort hotel may be able to save money by purifying fresh water to make it safe for drinking by using chlorination in combination with AC filtration. Chlorination will kill bacteria and germs that are harmful to human health, and AC filtration will remove organic contaminants and the taste of chlorine. However, because AC filtration effectively removes only a limited number of contaminants, analysis of each fresh water supply provided for filtration is important to determine if the AC filtration can produce safe drinking water.

Both membrane and AC filters have a limited lifetime and need to be replaced regularly to ensure effective treatment.

5.10 Wastewater Treatment

Wastewater treatment is a multi-stage process that reduces or removes organic matter, solids, nutrients, disease-causing organisms and other pollutants from wastewater before it can be re-used or discharged to a body of water. The treatments include several stages: *preliminary treatment* which screens out large debris such as large food particles, gravel, toys, sticks etc.; *primary treatment*—the second step in separating suspended solids and grease from wastewater; and *secondary treatment*—a biological treatment process that removes dissolved organic matter from wastewater. The wastewater can be further treated in a *final treatment* step by adding chlorine or by using ultraviolet light to remove disease-causing organisms before the water is discharged. In addition, *advance treatment* can be utilized (and maybe necessary in some treatment systems) to remove nutrients from wastewater. In the advance treatment, chemicals can be added to help settle or strip out phosphorus or nitrogen. Some examples of nutrient-removal systems include coagulate addition for phosphorus removal, and air stripping for ammonia removal.[105]

As required by Thai law, all hotels must treat their own wastewater to meet specified standards (these vary depending on a hotel's size) before it is discharged to the central sewage systems.[106]

Therefore, all Thai hotels have wastewater treatment plants on site. To meet these standards, treatment is generally conducted to the secondary treatment stage. Most Thai hotels treat their wastewater using activated sludge. One participating hotel uses aeration. Both activated sludge and aeration are examples of suspended film systems—

[105] http://ohioline.osu.edu/aex-fact/0768.html

[106] The Thai "Hotel Effluent Standards" vary among three types of hotels—Types A, B and C. Type A hotels are hotels with 200 rooms or more, Type B hotels are the ones with at least 60 rooms but not more than 200 rooms and Type C hotels are the ones with less than 60 rooms. Type A hotels have most stringent effluent standards with strict law enforcement. For more information, see http://www.pcd.go.th/.

one of the three methods commonly used to accomplish secondary treatment. The other methods of secondary treatment are fixed film systems and lagoon systems. Activated sludge systems are highly efficient and require little land area. However, this system requires technically skilled operators and maintenance personnel.[107]

Currently there are two fees in Thailand for discharging wastewater. If hotels can pretreat their wastewater to exceed government standards, they pay a much lower discharge fee than if the wastewater treatment merely meets the standards. Most of the participating Thai hotels are able to treat their wastewater to meet current government standards. However, improved treatment could save the hotels money. Two hotels have raised the issue of land limitation, which prevents them from expanding and thereby improving their wastewater treatment system's capacity. It is very important to note that proper operation and regular maintenance of the system are essential to efficient wastewater treatments. The quality of the treated water could be improved significantly, and more wastewater could be treated at the existing plants, if these systems are operated at their maximum designed potential. Therefore, the hotels should study the system manuals to ensure that the system is running as designed. It is likely that many existing problems with current treatment systems could be solved simply by changing operational procedures.

Two technologies are available that could be adopted to solve the problem of limited land in which to expand wastewater treatment capacities: membrane filtration and step feed. These are both techniques for secondary treatment, and could be added to the existing plants without additional land. In addition, this study reviews two new technologies, namely BacGen and Living Machines. These two technologies may be of interest to Thai hotels because of their energy and environmental characteristics.

Membrane Filtration

Membrane process techniques are widely accepted for water treatment. Interest in membrane technology is growing because of the introduction of thin film composite membranes that operate at substantially lower pressure (and lower cost) than standard cellulosic media. In addition, given the increases in the cost of treating wastewater for discharge, and constantly rising cost of fresh water, it is often less costly to process wastewater for recycling and reuse than to treat it for discharge and purchase additional fresh water.

For the Thai hotels where space limitation prevents expanding wastewater treatment capacities, membrane filtration can be used to help increase the capacity of an existing system by 200-300 percent. Membrane filtration installed in an existing aeration tank will trap impurities, remove contaminants, and increase the flow of water from the aeration tank. Water treated by membrane filtration is clean enough for recycling or reuse. As mentioned in section 5.9, there are various types of membrane filtration techniques which can remove different sized contaminants. Further analysis is needed to

[107] http://www.oas.org/usde/publications/Unit/oea59e/ch25.htm#TopOfPage

determine which membrane filtration is appropriate and what the investment costs will be for each specific plant.[108]

Step Feed

The step feed or step aeration process is a technique that allows entry of wastewater at two or more points along the length of the aeration basin. An existing plug-flow reactor can be modified for step feed simply by dividing the basin into compartments and redirecting the flow so that each compartment, except the last one, receives wastewater input. This arrangement results in a more uniform oxygen uptake rate throughout the basin. Modifying a plug-flow reactor to step feed is low cost and can help increase the existing system's capacity by 20-30 percent.

BacGen Technologies[109]

BacGen is operated by BacGen Technologies, a U.S. company located in Seattle, Washington. BacGen is designed to optimize the processing and energy use of wastewater facilities. BacGen shows that wastewater facilities can be designed and operated for both maximum treatment performance and energy conservation.

BacGen technologies can be used at facilities that process wastewater volumes of 10 million gallons or less per day. BacGen promotes the use of process-controls that optimize electricity use in small to mid-sized wastewater treatment plants—both aerated lagoon and activated sludge plants. Appropriately adjusted controls can provide additional benefits by helping plants comply with water quality regulations and better manage sludge accumulation, chlorination and de-chlorination, effluent ammonia and odors. Through a combination of improved plant operation and process expertise, sophisticated monitoring, controls, and software technologies, BacGen can significantly conserve energy, reduce operating and capital expenses, and optimize the performance of wastewater treatment facilities.

With the BacGen technology, various monitoring instruments are installed to analyze and model each plant's system processes. Using data gathered on 160 different operating parameters, software-driven models are built for each facility's load characteristics and performance. The plant's existing processes are then optimized on a real-time basis to improve performance and energy efficiency. Process-control systems are used so systems can be automated as much as possible. The process-control systems allow the hotel's facility staff to observe and pinpoint the optimised levels of aeration needed at any given time. The hotel staff will be trained to program the system for precise aeration delivery and basin mixing, and advised on related process issues such as retention times, waste and return rates, nutrient removal, disinfection and pumping strategies.

[108] There are three leading US membrane manufacturers including Zenon (http://www.zenonenv.com/), Pall Corporation (http://www.pall.com/applicat/water/), and US Filter (http://www.water.usfilter.com/index.html). The Thai hotels could contact these manufacturers for further information.

[109] http://www.bacgen.com and http://www.nwalliance.org/projects/projectoverview.asp?PID=43 and http://www.nwalliance.org/resources/news/winter2002.pdf

Since 1998 BacGen systems have been implemented at 23 western U.S. municipal wastewater and fresh water facilities. Each of these facilities has seen significant energy savings ranging from 17-91 percent. In some facilities, BacGen has provided additional benefits by significantly reducing algae growth, increasing treatment capacity, and providing outstanding and consistent treatment quality. An additional 116 facilities are now under contract for process optimisation design and/or full system implementation of the BacGen technology.

Living Machines®

Another wastewater treatment technology worth mentioning here that is currently used in the U.S. is called Living Machines®, designed and operated by Living Machines, Inc.[110] A Living Machine® system extends the sewage treatment concept to include a full range of plants and other organisms. The "machine" is a contained ecosystem made up of thousands of selected species of living organisms. These organisms are housed in a casing or structure, frequently a series of cylinders, made up of lightweight and sometimes light-transmitting materials. The developers claim that the technology can treat wastewater to advanced treatment standards without the use of chemicals by using solar-powered greenhouse-based technology. The technology also claims to be cost effective, to reduce air pollution and to require minimal maintenance. However, in 1994 the U.S. Environmental Protection Agency undertook an independent evaluation of the technology that included performance and cost considerations, and found some conflicts with these claims.[111] Nevertheless, Living Machines® are aesthetically pleasing and could significantly enhance public acceptance for the wastewater treatment process.

Because this technology depends on plants and solar energy for treatment, it requires large surface areas. The technology may not be appropriate for general applications such as buildings or hotels, and may be better suited for sites wishing to demonstrate an example of sustainable wastewater treatment or for environmental education purposes. Examples of Living Machine® sites include the 80,000-gallon per day wastewater treatment system in the town of South Burlington, Vermont, and the 200,000-gallon per day system installed for Master Foods in Wyong, Australia. Another Living Machine® can be found at Ethel M Chocolates in Las Vegas, Nevada. At the Ethel M facility, up to 32,000 gallons of highly concentrated wastewater are diverted each day from conventional waste treatment channels into a Living Machine® where it is filtered, cleaned and re-used to irrigate their world-famous cactus garden.[112] The first example of a Living Machine® in the Pacific Northwest is at Clatsop Community College in Astoria, Oregon. The facility was installed in September 2001 and treats 2,400 gallons per day and is the operational sewage treatment plant for the campus. Treatment components

[110] http://www.livingmachines.com

[111] Sherwood C. Reed, et.al, "An Evaluation of the "Living Machine" Wastewater Treatment Concept" in *Water Environment Federation's Annual Conference and Exposition (WEFTEC) Proceedings*, October 1996.

[112] http://www.bfi.org/news/livingMachines.htm and http://www.livingmachines.com/htm/studies.htm

include a series of ecological habitats, a constructed wetland and a UV disinfection unit. System monitoring and operational maintenance take about one hour a day, and plant maintenance requires about thirty minutes a day. Processed water from the plant exceeds water quality standards.[113]

5.11 Building Shell

Recommended building shell improvement measures include the use of high-efficiency windows, caulking and weather-stripping.

High-Efficiency Windows

Double pane and even triple pane windows are most beneficial in areas with long heating seasons (cold climates). The use of argon, kryton and other inert gases between the panes do not increase the insulating valve of the window per se. They delay the onset of convective currents between the panes when the indoor-outdoor temperature differential is high (e.g., greater than 40 F)—the conditions which do not exist in Thailand. For a hot and humid climate like Thailand, preventing solar gain is the most important consideration and thus the use of low-emissivity glazing and spectrally selective coatings discussed below are recommended for Thai hotels.

Low-Emissivity Glazing

A standard double-pane helps less in warm climates. But, unlike single pane, a double-pane window can have a special coating applied to it, which greatly reduces heat gain from the hot sun. This coating is called low-emissivity (low-e). More than any other single improvement, the invention and commercial development of low-e coatings in the 1980s revolutionized window technology. Low-e glazings have special coatings that reduce heat transfer through windows. The coatings are thin, almost invisible metal oxide or semiconductor films that are placed directly on one or more surfaces of glass, or on plastic films between two or more panes. The coatings typically face air spaces within windows and reduce heat flow between the panes of glass.[114]

A variety of low-e windows are now available for different climate zones and different applications in any particular location. For a hot climate like Thailand, low-e windows with low heat gain coefficients (SHGCs) are appropriate.[115]

Low-e films are applied in either soft or hard coats. Soft-coat low-e films degrade when exposed to air and moisture, are easily damaged, and have a limited shelf life. Therefore,

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[113] http://www.clatsopcollege.com/livingmachine/mainframe.html

[114] http://www.aceee.org/consumerguide/windo.htm

[115] While people in warm climate want low-e windows with low solar heat gain coefficients (SHGCs), people in cold climates want low-e windows with high SHGCs (above 0.70). See http://www.energyhawk.com/heat/heat6.php

low-e films are carefully applied by manufacturers in insulated multiple-pane windows. Hard low-e coatings, on the other hand, are more durable and can be used in add-on (retrofit) applications. However, the energy performance of hard-coat low-e films is slightly poorer than that of soft-coat films. Windows manufactured with low-e films typically cost about 10% to 15% more than regular windows, but they reduce energy loss by as much as 30% to 50 percent.

Retrofit low-e window films are also widely available and easy to apply. These films are inexpensive compared to total window replacements, last 10 to 15 years without peeling, save energy, reduce fabric fading, and increase comfort.

A low-e coating is virtually invisible from the inside, but most brands tend to give windows a semi-mirrored appearance from the outside. [116]

Spectrally Selective Coatings

Spectrally selective (optical) coatings are considered to be the next generation of low-e technologies. These coatings filter out from 40% to 70% of the heat normally transmitted through clear glass, while allowing the full amount of light to be transmitted. Spectrally selective coatings can be applied to various types of tinted glass to produce "customized" glazing systems which can increase or decrease solar gains depending on the desired aesthetic and climatic effects. Computer simulations have shown that advanced glazings with spectrally selective coatings can reduce the electric space-cooling requirements of new homes in hot climates by more than 40 percent.

Caulk and Weather Stripping [117]

Warmed or air-conditioned air mixes with outside air through gaps in a building's thermal envelope—exterior walls, windows, doors, roof, and floors. Such air leaks can waste large amounts of energy. Most experts agree that caulking and weather- stripping any gaps will pay for itself in energy savings within one or two years. Both weather-stripping and caulking are considered economical, do-it-yourself jobs.[118] However, these two weatherization techniques cannot take the place of proper insulation throughout the building.

Because caulking and weather-stripping limit indoor-outdoor air circulation, a hotel should first assess its indoor air quality. Some buildings contain dust, mold, carbon dioxide, and other indoor air contaminants. Sealing air leaks in these buildings without proper ventilation can also seal in indoor air pollutants. Therefore, any plan to tighten the

[116] http://www.care2.com/channels/solutions/consumer_guides/137 and http://www.eren.doe.gov/erec/factsheets/windows.html

[117] http://www.eren.doe.gov/erec/factsheets/weatherize.html

[118] For tips on applying caulk, see http://www.leeric.lsu.edu/energy/caulking/#interior

thermal envelope of a building should be accompanied by an assessment of the building's ventilation needs.

In checking for gaps, a hotel should look at areas where different materials meet, such as between brick and wood siding, between foundation and walls, and between the chimney and siding. The following also must be inspected for any cracks and gaps that could cause air leaks:

- Door and window frames
- Mail chutes
- Electrical and gas service entrances
- Cable TV and phone lines
- Outdoor water faucets
- Where dryer vents pass through walls
- Bricks, siding, stucco, and foundation
- Air conditioners
- Vents and fans.

Caulking

In addition to plugging air leaks, caulking can also prevent water damage inside and outside a building when applied around faucets, ceiling fixtures, water pipes, drains, bathtubs and other plumbing fixtures.

Caulk forms a flexible seal for cracks, gaps, or joints less than one quarter-inch wide. Most caulking compounds come in disposable cartridges that fit in half-barrel caulking guns. Caulking compounds can also be found in aerosol cans, squeeze tubes, and in ropes for small jobs or special applications. Caulking compounds also vary in strength, properties, and prices. High-quality caulking compounds with a long life expectancy are generally the most expensive. Caulking compounds are either water-based or solvent-based. Water-based caulking compounds can be cleaned with water before curing. Solvent-based compounds must be cleaned up with solvents.

Weather-Stripping

Weather-stripping can seal leaks around movable joints, such as windows or doors. A hotel should choose the type of weather-stripping that will withstand the friction, weather, temperature changes, and wear and tear associated with its location. For example, when applied to a door bottom or threshold, weather stripping could drag on carpet or erode as a result of foot traffic. Weather stripping in a window sash must accommodate the sliding of panes—up and down, sideways or out. The weather-stripping a hotel chooses should seal well when the door or window is closed while allowing it to open freely.

Weather-stripping may be purchased by the foot or in handy kits complete with the seal and fasteners for a single door or window. Durability has to be taken into account when comparing costs. Some weather seals are surface mounted and are visible, while others

are concealed when the door or window is closed. Weather strips come in a variety of materials.[119]

5.12 Building Re-commissioning

Building commissioning is a way to ensure that the energy systems in a new facility perform according to their originally intended design. Building re-commissioning "tunes-up" the energy systems in an existing facility so that they perform as well as possible. Most facilities do not operate as efficiently as they could. With re-commissioning, the energy systems are analyzed for proper operation and for improvements. Re-commissioning can save energy costs and improve the comfort in existing buildings. Recent studies have shown that tune-ups of buildings can result in savings of 5 to 15% with paybacks in less than two years.[120] In the U.S., buildings with the best potential for quick re-commissioning payback are those that are energy intensive, with an annual total energy cost greater than \$2 per ft^2 (or \$21.5 per m^2).[121] This number should be significantly lower for Thailand where energy costs are similar to those in the U.S. but the labor costs associated with building re-commissioning are less.

5.13 Conclusion

Energy costs are a large portion of hotels' total operating costs. Using energy more efficiently can thus save a significant amount of the hotel's costs. The Florida Solar Energy Center (FSEC), a research institute of the University of Central Florida, has worked with the hotel industry in the Caribbean to help reduce energy consumption, and to encourage the use of renewable energy. A recent FSEC audit of energy consumption in Caribbean hotels (where the climate is similar to Thailand) revealed that approximately 20% savings could be gained by replacing older, less efficient 8 EER A/C units with newer 10 EER A/C units; up to 75% of lighting energy costs could be reduced by switching incandescent light bulbs to energy efficient fluorescent bulbs; a minimum of 15% in air conditioning costs could be saved by installing a radiant barrier system; and 95% or more of the electricity used to heat water could be saved by using solar water heaters.[122]

Energy is needed to move water from the municipal water system to the hotel and its guestrooms, as it is to move wastewater for treatment. Significant amounts of energy are also required in a wastewater treatment process. More efficient water consumption thus

[119] http://www.ianr.unl.edu/pubs/consumered/heg157.htm and http://www.leeric.lsu.edu/energy/caulking/#interior

[120] http://www.beengineering.com/building_recom.htm

[121] http://www.aepi.army.mil/aweec/B%2010%20New%20Energy%20Tech/ 03_B10%20Herron.ppt

[122] "Energy Saving for Typical Caribbean Hotels." RETEC International. 9 April 2002. <http://www.fsec.ucf.edu/Ed/INTERNAT/typ_savings.htm>

contributes not only to lower water costs, but also lower energy, wastewater treatment and discharge costs.

There are a range of savings and conservation opportunities available for Thai hotels, particularly in the area of energy and water consumption, and related activities. This study has shown that while there are some general measures which are applicable to many hotels, often the measures which have the potential to provide large savings, such as modifying VAC systems or wastewater treatment facilities, require significant site-specific analysis before proper investment strategies can be determined. Such detailed analyses are beyond the scope of this study.

Chapter 6

Recommendations and Conclusions

Based on the lessons learned from the best practices of international "green" hotels, and information collected in this study about the participating Thai hotels' current practices, recommendations have been developed for these hotels regarding the potential implementation of highly effective conservation projects, and possible funding sources for these projects. Recommendations for the Thai Hotel Association and the United States-Asia Environmental Partnership (US-AEP) are also made as a combined effort to promote Thailand's "green" hotel industry. This chapter also discusses the project's next steps and presents the report's overall conclusion.

6.1 Recommendations to the Participating Hotels

Potential Projects

Most of the participating hotels now practice good energy and water conservation and waste management. However, all the hotels still have significant areas in which to improve their existing performance. All the hotels should immediately adopt the no-cost projects (i.e., changes in current practices) mentioned in Table 4.9, and implement additional low-cost projects when ready. Feasibility studies (cost-benefit analyses) should be conducted for additional projects that require significant capital investment.

Table 6.1 lists specific potential projects to which each participating hotel should pay close attention. When implemented appropriately all of these projects have successfully reduced costs for U.S. and international hotels. In Table 6.1 where there is no mark for a hotel, it means that the corresponding project has been implemented there, or that the particular project is not applicable to that hotel. It should be noted that the recommendations presented in Table 6.1 are based on the general information received from the hotels and from visits to those hotels and not based on detailed technical and economic analyses—since it is beyond the scope of this study. The recommendations thus are not conclusive—particularly for projects requiring major retrofits. For retrofits which require a large capital investment, further technical and economic analyses should be conducted. The recommendations made here are simply to draw the hotels' attention to specific projects considered to have a high potential for reducing hotel operating costs.

Table 6.1: Potential Projects for Specific Hotels

Project	Hotel 1	Hotel 2	Hotel 3	Hotel 4	Hotel 5	Hotel 6	Hotel 7	Hotel 8
Energy								
Set up a hotel "green" team								X
Conduct an energy audit								X
Meter and monitor energy consumption							X	X
Install electricity demand meters	X			X			X	X
Use mechanical lighting controls						X		X
Increase use of CFLs						X		X
Use Dimmable CFLs (i.e., in restaurants)	X	X	X	X	X	X	X	X
Caulk between windows								X
Stop air infiltrations to guestrooms								X
Install bathroom ventilation fans								X
Install efficient room air conditioners	X							X
Install balcony A/C switch	X							
Use heat recovery from air-conditioning units, ventilation and boilers	X	X	X	X	X	X	X	
Use solid wastes incinerators	X		X					X
Use solar water heater		X	X	X	X	X	X	
Implement Energy Management Systems	X	X	X	X		X	X	
Implement building re-commissioning						X	X	X
Water								
Use water conserving plumbing fixtures					X			X
Use highly efficient water equipment (e.g., dishwasher, laundry, cooling tower, etc.)	X		X		X			
Use low-flow showerheads	X				X	X		X
Use low-flow faucets/ faucet aerators	X				X			X
Use sensor-driven (infrared or ultrasonic) faucets and urinals			X	X	X			X
Use waterless urinals	X	X	X	X	X	X	X	X
Use ultra low-flow toilets	X		X	X	X		X	
Use dual flush toilet	X	X	X		X	X	X	X
Use self-closing taps			X	X				X
Use purification technology for drinking water								X
Use ozone laundry system	X	X	X	X	X		X	

Table 6.1 (Continued)

Project	Hotel 1	Hotel 2	Hotel 3	Hotel 4	Hotel 5	Hotel 6	Hotel 7	Hotel 8
Wastewater								
Using step feed technology for wastewater treatment							**X**	
Using membrane technology for wastewater treatment								**X**
Use laundry water recycling and waste heat recovery	**X**	**X**	**X**	**X**		**X**	**X**	**X**

Potential Sources of Funding

As described below there are several potential funding sources available to hotels for energy conservation and environmental improvement projects.

Fund for Building Chiller Replacement

The Building Chiller Replacement Project is being carried out by the Industrial Finance Corporation of Thailand. Funding for the project comes from the Thai government in the amount of US$4.975 million in form of zero interest loans from the Multilateral Fund for the Implementation of the Montreal Protocol and Global Environmental Facility. The objectives of the project are to help Thailand improve its energy efficiency, to reduce greenhouse gas emissions in the building chiller sector, and to reduce consumption of ozone depleting substances (ODS). Specifically, this project is designed to establish conditions that will facilitate early replacement of energy-inefficient CFC chillers with highly energy-efficient non-CFC chillers, and thus demonstrate actual energy savings from the replacement of 20-24 energy-inefficient, CFC chillers throughout the project.

The technical criteria for participating in the project are as follows:

- Existing chillers must be centrifugal chillers and use CFCs as the refrigerant.
- New chillers will be non-CFC, screw or centrifugal chillers.
- Power consumption of new chillers should be less than 0.63 kW/refrigerant ton (RT).
- The cooling capacity of existing chillers should be greater than 250 RT.
- The existing chillers shall be disposed of properly following the Thai Department of Industrial Works "*Codes of Good Practices*."

After the initial commissioning date, project participants will be charged monthly on the outstanding loans at a 4.5% p.a. interest rate, with a 48-month payback period. The amount of monthly payments will depend on expected energy savings.

The project offers several advantages including no required letter of credit, no currency risk, a guarantee on technical short-fall, and a two-year warranty on equipment maintenance in addition to a one-year manufacturer's warranty. Seven chiller suppliers are currently enrolled in the project, and project participants must choose from among these companies' products.

As of April 2002, four participants (which have a total of six chillers to replace) have been approved at total capacity of 2,950 RT, and a total estimated cost of 37.2 million baht.

Environmental Fund

The Environmental Fund was established by the Thai government to comply with the Enhancement and Conservation of National Environmental Quality ACT B.E. 2535, and to encourage investment and operation of the Environmental Protection Program. The Krung Thai Bank and the Industrial Finance Corporation of Thailand are the loan executing agencies of the Environmental Fund. The Fund is available to all industrial sectors, including hotels, hospitals and municipalities. Projects eligible for Environmental Fund loans are those that contribute to environmental protection system. Projects such as the construction of wastewater treatment plants, air pollution control systems, waste management and cleaner technology systems (i.e., recycling projects) that the hotels may need are among the eligible projects for the Fund. Specific terms and conditions are required for the loan (e.g., the maximum loan must not exceed 20% of the business's fixed assets; total loan periods may not exceed seven years, etc). The interest rates for the loans are between 1.5% – 3% depending on the type of projects. No hotels have yet requested loans from the Environmental Fund.

Revolving Fund for Energy Conservation

The Revolving Fund for Energy Conservation (RFEC) is a new fund established in 2001, and is still in its initial design stage. It was established by the Thai Department of Energy Development and Promotion (DEDP) with 2 billion baht (US$46.5 million) from the Energy Conservation Fund. The purpose of the RFEC is to stimulate and develop a financial market for energy efficiency and conservation projects. To encourage commercial banks and financial institutions to offer loans for energy efficiency and energy conservation projects, the RFEC has made funds available at 0% interest for ten years. Banks can withdraw money from the RFEC to issue loans for energy efficiency and energy conservation projects (at a maximum of 50 million baht per loan) with a maximum interest charge of 4% to cover risks and administrative costs.

In general, it has been very difficult to borrow money from commercial banks to finance energy efficiency improvements. Project financing is also clearly the main barrier faced by Energy Services Companies (ESCOs) in Thailand. The availability of the low-interest loans from the RFEC will thus make it easier for hotels to finance energy efficiency projects.

Energy Services Companies and Energy Performance Contracting Services

Energy performance contracting services and Energy Services Companies (ESCOs) have been used widely throughout the U.S. and Europe for nearly a decade to finance energy efficiency projects. An ESCO will identify and evaluate energy and cost-saving opportunities, arrange project financing, and maintain the installed equipment. In most cases an ESCO will offer energy performance contracting services with compensation based on the level of savings generated by the project. With ESCOs, hotels can overcome several major barriers to the implementation of energy-saving projects, including lack of technical expertise and financing.

The ESCO concept is relatively new in Thailand. The Electricity Generating Authority of Thailand (EGAT) initiated the first Thai ESCO project in 1998. It was a pilot project funded by a $600,000 grant from the Global Environmental Facility. Currently, the Energy Conservation and Entrepreneurs Association (ECEA) is implementing an ESCO project in Thailand with financial support from DEDP. Three hotels are participating in the project, including the Sofitel Central Plaza Hotel, the Imperial Queen's Park Hotel and Mae-Nam Hotel. The ESCO involved in this ECEA project is the Excellent Energy International Co. Ltd. They are now in the first phase of the project. The second phase is currently being designed and will offer an opportunity for other hotels to join the project.

Tax Reduction Program

While not a source of funding, the tax reduction program offered by the DEDP can help hotels reduce the cost of new energy-efficiency projects and equipment. The hotels can apply to the DEDP for a reduction in import taxes on qualifying energy efficient equipment and materials. Materials and equipment eligible for such tax reduction are waste heat recovery equipment, equipment fueled by renewable energy, or equipment that supplements or replaces existing less energy-efficient equipment.

The import tax reduction privilege can also be granted to hotels that import equipment and materials for environmental protection and conservation activities including wastewater, air and solid waste treatment, and for research, analysis and monitoring for environmental protection.

The program has some restrictions. For example, the energy efficient equipment and materials eligible for the tax reduction must be suitable for use in hotels with 80 or more rooms; the price of the equipment (including insurance and transportation expenditures) must be greater than 400,000 baht; the equipment must be new (not second-hand); and equipment of equivalent quality must not be produced in Thailand.

6.2 Recommendations to the Thai Hotel Association

Be a "Green" Information Gateway

Regular energy-efficiency training sessions are provided by EGAT, and monthly

meetings are sponsored by the Hotel Chief Engineer Association. However, we learned that all hotels do not know about these events and thus do not participate. The Thai Hotel Associations (THA) should adopt the role of being the "green" information gateway for member hotels and thus provide information about special events and trainings to its members. Technologies related to energy, water and waste are continuously changing. Much information about these technologies is available through the Internet, including that provided by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy,[123] U.S. Environmental Protection Agency's Water Use Efficiency Program,[124] American Council for an Energy-Efficient Economy,[125] Florida Solar Energy Center,[126] Solar Energy Industries Association,[127] Energy Star Program,[128] and Alliance to Save Energy.[129] Subscribtions to publications like *Green Hotelier* is one method of obtaining current and new information.[130] The THA should set up a mechanism to provide and update information on "green" hotels' best practices, sustainable products and "green" technologies, and distribute these to its members regularly.

Provide International Outreach

The THA should vigorously advertise Thai "green" hotels to international tourism and hotel organizations. According to a survey conducted by the Travel Industry Association of America (TIA), 85% of travelers would prefer to stay at "green" properties if given a choice.[131] The THA should add to its website a section on Thai "green" hotels, and include information about the Green Leaf Award (one Green Leaf hotel category to five Green Leaves hotel category) and other international awards or recognition the hotels may receive. This information will attract "green" tourists from around the world and it would provide a good incentive for Thai hotels to improve their practices and compete with each other for international recognition as environmentally friendly hotels.

[123] http://www.eren.doe.gov/

[124] http://www.epa.gov/OW-OWM.html/water-efficiency/

[125] http://www.aceee.org/progpage.htm

[126] http://www.fsec.ucf.edu/

[127] http://www.seia.org/

[128] www.energystar.gov

[129] http://www.ase.org/

[130] The annual subscription (4 issues) fee for the *Green Hotelier* is US$40. For more information, see http://www.ihei.org/HOTELIER/hotelier.nsf/content/b1e2.html

[131] http://www.tia.org/ and http://www.state.ga.us/dnr/p2ad/swissotel.html

6.3 Recommendations to the US-AEP

Work with the Thai Government

It is clear that numerous issues important to hotel energy efficiency, water conservation and waste management are in the government domain. Some important issues to be raised with the Thai government include low waste collection fees, lack of incentive programs for energy efficiency and water conservation in the hotel sector, and lenient enforcement of existing wastewater treatment regulations. Just as this report has reviewed "best practices" from the international hotel perspective, the Thai government would benefit from a "best practices" report presented from the regulatory perspective. The U.S. Environmental Protection Agency (U.S. EPA) could be a partner with US-AEP in such a program which could be an extension of their current bilateral activities with the Thai government.

The Thai government has been implementing programs to encourage increased use of energy efficient products. These programs include the DEDP's import tax reduction program and establishment of the RFEC as mentioned earlier. However, all of these programs require time-consuming paperwork involving numerous forms and applications. This "overhead" could be reduced with incentives that would provide benefits directly to hotels through mechanisms such as income tax credits, sales tax exemptions, or accelerated depreciation. The US-AEP could provide the Thai government with examples of lessons learned and practical models from the applications of such fiscal policies applied to energy efficiency in the U.S.

Eliminate Language Barrier

The language barrier is one of the underestimated constraints in doing businesses in Asia. Energy efficiency systems and technologies, water-saving products, and other "green" technologies are relatively new in the Thai market. The systems and technologies are complicated and the language barrier makes them more difficult for a hotel's technical staff to understand. To sell such new systems or products in Thailand, American companies must provide all information about their products and technologies—including system manuals, etc.—in Thai. Large U.S. companies may have the resources to translate their product catalogues into Thai, but small- and medium-sized U.S. businesses may not—or may not realize the importance of this translation. US-AEP could help smaller companies get involved in the Thai "green" hotel industry by providing financial support for small and medium sized companies to translate reports on their successful "green" projects into Thai. These case studies could then be placed on the THA website for wide dissemination to the Thai hotel community. Based on the level of interest, additional technical information could be translated and provided to interested hotels.

Support International Trainings and Tours

The Florida Solar Energy Center (FSEC) has established a hotel energy certification program with the Caribbean Action for Sustainable Tourism (CAST) organization to provide detailed training on energy and water conservation for Caribbean hotels. The program has been successful and has helped Caribbean hotels save energy and reduce operating costs. The US-AEP could help develop a program to share successful experiences from this Caribbean program with the Thai hotel industry which operates in a similar climate. Several hotels also expressed their interest in visiting model "green" hotels and buildings in the U.S. Financial support, in the form of cost sharing provided by US-AEP, would be helpful in making such training and tours available for Thai hotels.

Identify A Local Partner

This study is an important first step in stimulating interest among the participating hotels in U.S. "green" technologies. All of the participating hotels have expressed interest in joining the next phase of the project—which involves a detailed cost-benefit analysis of a specific environmental improvement system to be implemented in a particular hotel. Some hotels have mentioned that they were willing to share costs of the detailed analysis of the systems with government or private sector entities. In order to continue this project and expand the work to additional hotels, a strong, capable local partner is needed. The US-AEP in Thailand should identify such a local partner to follow up on this initial project, and to act as an intermediary between the Thai hotels and U.S. companies. While promoting the Thai "green" hotel industry, in the long run this will also support U.S. "green" technologies.

6.4 Project Next Steps

This study is designed as the first phase of multi-part activity of the *Development of Criteria and Benchmarks for Green Hotels in Thailand* project. In this first phase of the project, areas are identified for Thai hotels' performance improvement on energy, water and solid waste management. In particular, specific projects considered capable of improving an individual hotel's energy and environmental performance have been identified. To recommend the best retrofit improvements for an individual hotel, the specific situation of each hotel must be considered, and a detailed cost-benefit analysis of such a project performed.

The information and knowledge gained in this phase of the project will be useful in the next phase for which activities will include:

- Selecting a few recommended projects in each category (i.e., energy, water, and wastewater) for further detailed cost-benefit analysis, and estimation of the projects' payback periods based on Thai cost structures and economic conditions.
- Proposing such cost-effective projects to those participating hotels interested in implementing these projects.
- Implementing the project, monitoring the operations and evaluating the results.

- Developing energy and water consumption benchmarking based on the project's costs and operating conditions.

6.5 Conclusions

Tourism is one of the largest and fastest-growing sectors of the global economy. Travel and tourism activities accounted for about $3.6 trillion of economic activity in 2000, or approximately 11% of the total gross world product.[132] The number of international tourist arrivals has increased nearly 28 times since 1950, reaching 698 million in 2000. This number is expected to double—or reach 1.6 billion by 2020.[133] Asia-Pacific destinations are expected to dominate economic growth in the travel and tourism industry over the next few years. Economic research on tourism produced by the World Travel & Tourism Council shows that although the travel and tourism industry in the Asia-Pacific region has suffered badly due to the global impact of the September 11 event—with a cumulative loss of 5.7% in travel and tourism demand and the loss of 4.4 million job-equivalents in years 2001 and 2002, the industry is expected to rebound in 2003 with a massive growth rate of 6 percent. In the coming decade, countries in the Asia-Pacific region, especially India and China, are expected to outperform other countries as international tourist destinations.[134]

Because they help determine the destinations for tourists and influence their clients' choice of services, tour operators and travel agents have played a major role in steering international tourism toward greater sustainability. Several of the Thai hotels participating in this study mentioned that it was not Thai regulations—since they don't normally exist—but pressure from tour operators that made them become more environmentally conscious. Many tour companies are setting up professional guide accreditation programs and investing in extensive training to ensure that their guides adhere to sound environmental practices.[135]

To compete in the international tourism business and enhance their marketability, it is necessary for Thai hotels to make a strong commitment to environmental friendly operations. These good practices will also lower a hotel's operating costs, reduce environmental impacts and increase customer and employee satisfaction.

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[132] World Travel & Tourism Council (WTTC), "Tourism Satellite Accounting Confirms Travel and Tourism as World's Foremost Economic Activity," Press release (London: May 11, 2000).

[133] Rosa Songel, "Statistics and Economic Measurement of Tourism," World Tourism Organization (WTO) as cited by Lisa Mastny, "Traveling Light: New Paths for International Tourism", *World Watch Paper* # 159, December 2001, p. 6.

[134] A press release from World Travel & Tourism Council, April 16, 2002, see http://www.wttc.org/resourceCentre/mediaCentre/releases/020416%20Asia-Pacific%20Destinations%20Dominant.asp

[135] Thomas B. Lawrence and Deborah Wickins, "Managing Legitimacy in Ecotourism," *Tourism Management*, vol. 18, No. 5 (1997), p. 313, as cited by Lisa Mastny, "Traveling Light: New Paths for International Tourism", *World Watch Paper* # 159, December 2001, p. 53.

Opportunities for reduced operating costs and improved performance exist through a hotel's energy efficiency and water conservation practices, environmentally preferable purchasing, material substitutions and through procedural improvements. This study identifies a number of promising projects for the Thai hotel industry that can reduce operating costs and improve the local environment. However it is beyond the scope of this study to identify specific cost-effective projects for each participating hotel.

Although this study focuses on the Thai hotel industry, we hope that the study will also benefit hotels in other countries, especially those with a similar level of economic development and climate conditions as Thailand. The lessons learned from this study provide the first step for the design of benchmarks for energy, water and waste management appropriate to Thailand's economic, social and environmental conditions.