ENVIRONMENTAL MANAGEMENT FOR HOTELS

International Tourism Partnership

THE **INDUSTRY GUIDE** TO **SUSTAINABLE** OPERATION

2 ENERGY

First published 1993 | Third edition 2008 | Digital Release 2014

This manual was published in 2014 when Sustainable Hospitality Alliance was known as International Tourism Partnership (ITP), part of Business in the Community (BITC).

The **impacts of climate on tourism** are likely to intensify, particularly under higher global greenhouse gas emission scenarios, and there are compelling reasons to reduce dependence on energy from fossil fuels

2 ENERGY

This section explains the issues associated with our use of energy and why we all need to be more efficient. It shows how you can assess current energy performance in your hotel, the measures you can take to conserve energy across various departments and provides guidelines to help you when considering investment in new equipment.

2.1 THE ISSUES

There are overwhelming reasons why we all need to reduce our overall energy consumption and our dependence on energy derived from fossil fuels. These relate to:

- What we now know about the causes of climate change and its potential global environmental and economic consequences
- Energy demand, security of supply and the likely impact on costs in the future
- Technologies, alternative fuels and techniques for mitigating greenhouse gas (GHG) emissions.

2.1.1 Climate change

a THE EVIDENCE

Over the past 100 years, average global temperatures have risen by 0.7°C. The year 2005 was the hottest on record, 2006 was nearly as warm, and the last decade has seen the eight hottest years ever recorded. Worldwide, glaciers and snowlines are retreating and prolonged droughts are on the increase, sea levels and temperatures are rising, and storms and hurricanes are becoming more frequent and severe.

Scientists and climate experts agree almost universally that the climate changes we are experiencing now are being caused by human (anthropological) intervention and development, largely through emissions of 'greenhouse' gases (GHGs). These include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6). GHGs are released by the burning of fossil fuels to meet demand for energy for power generation and transportation and through activities such as deforestation and agriculture. Carbon dioxide is regarded as the most serious contributor particularly because its emissions are increasing significantly – global CO_2 emissions increased by 70 per cent between 1970 and 2004.

According to the **Intergovernmental Panel on Climate Change (IPCC)**[1] the global atmospheric concentration of CO_2 increased from 278 parts per million (ppm) in dry air before the industrial revolution to 384 ppm today,[2] far more than the natural range of 180–300 ppm observed in ice cores from the last 650,000 years. The situation is being made worse by the extent to which we have depleted the world's forests and woodlands that absorb atmospheric CO_2, and we are only just beginning to understand the role that the world's oceans play in the absorption of CO_2.

b WHAT IF WE DON'T ACT?

Al Gore's film **'An Inconvenient Truth'** released in 2006 forced millions of ordinary people to contemplate (many for the first time) the effects of man-made global warming, now and in the future. The same year **Sir Nicholas Stern** published his **Review on the Economics of Climate Change**[3] which set out the likely costs to tackle climate change issues in clear global economic terms. While it found that all countries will be affected by climate change, it is the poorest who will suffer earliest and most. The report claims that uncontrolled climate change could raise average temperatures by more than 5°C from pre-industrial levels, which would not only transform the physical geography of our planet, but would also have enormous consequences for all life upon it. It calculates that the cost of unabated climate

[1] The IPCC was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP) to assess the scientific, technical and socio-economic information relevant to understanding the risk of human-induced climate change, its potential impacts and options for adaptation and mitigation. It bases its assessment mainly on peer-reviewed and published scientific/technical literature.

[2] **Source:** United Nations Framework Convention on Climate Change (UNFCCC).

[3] The Stern Review on the Economics of Climate Change, November 2006, **www.sternreview.org.uk**

change would amount to at least five per cent of GDP each year and possibly 20 per cent or more. In contrast, it argues that the cost of action to reduce GHG emissions to avoid the worst impacts of climate change could be limited to around one per cent of global GDP each year. This could be achieved through measures such as carbon pricing through taxation, the expansion and linking together of emissions trading schemes around the world, government policies and international co-operation (particularly with developing countries) to encourage the development of low carbon technologies and drought-resistant crops, and educating the global community about how each individual can respond to climate change.

C FINDING SOLUTIONS

Addressing our climate change problems necessitates a global policy response, guided by a common international understanding of the long-term goals for climate policy and strong frameworks for co-operation. Two kinds of measures are essential if we are to reverse the global warming trend. These are 'mitigation' (reducing emissions, particularly in developing countries, or removing them from the atmosphere through 'sinks') and 'adaptation' (including technology such as better flood defences and early warning systems, better risk management and insurance options).

More than 170 states are signatories to the **Kyoto Protocol** which sets legally-binding targets for cutting the greenhouse-gas emissions of industrialised countries by 2012 relative to 1990 levels. The Protocol distinguishes between developed (Annex I) states, which must reduce their greenhouse gas emissions to approximately 5 per cent below their 1990 levels by 2012, and developing (Annex II) countries, which are not subject to these rules. Annex I states can meet their GHG emissions reduction targets through various 'flexible mechanisms' which allow them to purchase reductions from financial exchanges; from projects that reduce emissions in Annex II economies under the **Clean Development Mechanism (CDM)** – for which they receive Certified Emission Reductions (CERs); from other Annex I countries under the **Joint Implementation Scheme (JI)** – for which they receive Emission Reduction Units (ERUs); and from Annex I countries with excess allowances.

One CER or one ERU are equivalent to one 1 metric tonne of CO_2 and are tradable on carbon markets. There are several **emissions trading schemes** in existence with varying degrees of linkage, including the **European Emissions Trading Scheme (ETS)** and the **Chicago Climate Exchange**.

According to the latest science, a decline of 50 per cent against 2000 levels by 2050 would stabilise emissions at around 450ppm CO_2 equivalent in the atmosphere and would correspond to a 2–2.4°C rise in temperatures.[4]

To this end, representatives from 180 nations around the world (including the parties to the United Nations Framework Convention on Climate Change (UNFCCC) and signatories to the Kyoto Protocol) attended the **UN Climate Change Conference** in Bali in December 2007 to negotiate, agree on and co-operate in implementing solutions to stabilise atmospheric GHC concentrations and move towards a low carbon global economy. After a few false starts, countries agreed on a 'roadmap' to launch negotiations toward a global, comprehensive agreement to address climate change. The Bali decision sets out an agenda that frames the discussions that will take place over the next two years and sets a deadline of 2009 to complete the negotiations. Bali also saw an agreement that will allow the Adaptation Fund to fund projects in developing countries that will help people cope with the impacts of climate change over the next four years. Currently worth over USD30 million, the fund is expected to grow to an estimated USD80–300 million by 2012 and will get its resources from a two per cent levy on all transactions of the Clean Development Mechanism. In addition a new programme to scale up investment for the transfer of clean technologies to developing countries was agreed as well as a range of measures to study and assess the issue of deforestation, including finding out how to calculate emissions from deforestation, as well as encouraging demonstration projects that can address the needs of local and indigenous communities.

[4] **Source:** UNFCCC, Fact Sheet: The Need for Mitigation

d HOW TOURISM CONTRIBUTES TO THE PROBLEM

With 846 million international arrivals and some four billion domestic trips in 2006 alone, travel and tourism currently contributes between around four and six per cent of total global greenhouse gas emissions.[5] By 2020 it is estimated that the number of international trips will nearly double to 1.6 billion. The **United Nations World Tourism Organisation (UNWTO)** forecasts that tourism's contribution to CO_2 emissions could grow by 150 per cent in the next 30 years if no mitigation measures are taken.[6] Hotels, as part of that industry, have a key role to play in reducing emissions.

e EFFECTS ON TOURISM

Not only does tourism contribute to the problem, but it is also highly vulnerable to the effects of climate change. Whether it is a winter sports resort, a diving centre or other nature-based destination or a remote holiday island, climate is fundamental to tourism and its impacts on the sector are likely to intensify, particularly under higher global GHG emission scenarios. Significant changes in climate and weather patterns at tourist destinations can compromise the health, safety and comfort of tourists and ultimately affect their travel decisions. Changing demand patterns and tourist flows will impact on tourism businesses and the local communities, as well as sectors that are linked into tourism income such as agriculture, handicrafts and construction. The problem is particularly acute for small island states and developing countries where tourism is the major economic activity and in destinations which rely on a predictable climate, such as the Swiss Alps, the Mediterranean and the Caribbean. It is therefore very much in the hotel industry's interest to be part of the solution. The number of areas where climate change may actually benefit tourism (e.g. the UK and Northern Europe if summer temperatures in Southern Europe continue to climb) is outweighed by the number that will suffer.

f FACING UP TO OUR RESPONSIBILITIES

The fourth **Global Environment Outlook (GEO-4)** released by the **United Nations Environment Program (UNEP)** in October 2007[7] maintains that addressing climate change and global warming have become a question of global justice. For the sake of future generations it is no longer acceptable to generate economic growth at any cost.

UNWTO advocates a strategic focus by the tourism industry and all private and public stakeholders on how destinations affected by climate change can adapt in order to safeguard economic returns and jobs, and on mitigation measures in order to achieve substantial emission reductions. At the same time the industry must maintain its commitment to reducing extreme poverty and fostering sustainable development, as laid out in the **UN Millennium Development Goals (MDGs)**. New technology and financial mechanisms will be very important.

2.1.2 Global energy demand and supply

a DEMAND

According to the **International Energy Agency's World Energy Outlook 2007**, if governments around the world continue with their existing policies, the world's energy needs will be well over 50 per cent higher in 2030 than today.[8] This poses a threat to energy security and oil prices and will accelerate climate change. China and India together would account for 45 per cent of the increase in global primary energy demand as both countries' energy use is set to more than double between 2005 and 2030. Fossil fuels (in the form of oil, gas and coal) continue to dominate the fuel mix, with coal set to grow most rapidly, because of demand from the power-generation sector in China and India. These trends will lead to continued growth in global energy-related emissions of CO_2, from 27 gigatonnes

[5] **Source:** UNEP **www.unep.org/cpi/briefs/2007Oct02.doc**

[6] **Source:** Draft report by UNWTO, UNEP and the WMO entitled 'Climate Change and Tourism: Responding to Global Challenges' for release late 2007.

[7] See **www.unep.org/geo**

[8] **Source:** IEA press release 7 November 2007. See **www.iea.org/textbase/press/pressdetail.asp?PRESS_REL_ID=239**

(Gt) in 2005 to 42 Gt in 2030 – a rise of 57 per cent. China is expected to overtake the United States to become the world's biggest emitter in 2007, while India would become the third-biggest emitter by around 2015.

If, however, governments around the world implement the policies they are considering today (the IEA defines this as an Alternative Policy Scenario), global oil demand would be 14 mb/d lower – a saving equal to the output of the United States, Canada and Mexico combined. The related global CO_2 emissions would level off in the 2020s and reach 34 Gt in 2030 – almost a fifth less – although they would still be at one-quarter above current levels in 2030.

b SECURITY OF SUPPLY

Consuming countries will increasingly rely on imports of oil and gas – much of them coming from the Middle East and Russia. Although production capacity at new fields is expected to increase over the next five years, it is very uncertain whether it will be enough to compensate for the decline in output at existing fields and meet the projected increase in demand. Supply problems in the period to 2015 cannot be ruled out, which would lead to an abrupt escalation in oil prices. In addition, recent years have seen some countries pursuing isolationist or protectionist energy policies which could have severe consequences for the global economy and for global energy security over the longer term. Open, international markets and political stability are important factors in ensuring future security of supply.

2.1.3 Technologies, alternative fuels and mitigation techniques

a ENERGY-EFFICIENCY

At both a global and local level, the cheapest and fastest way to curb demand and emissions growth in the near term is by improving our energy-efficiency; through investment in technology to improve efficiency and through financial mechanisms to support its take-up. For example, tougher efficiency standards for air conditioning systems and refrigerators in India and China alone would, according to the IEA, save the amount of power produced by the Three Gorges Dam in China by 2020. Emissions of local pollutants in both countries, including sulphur-dioxide and nitrous oxides, would also be sharply reduced.

b ALTERNATIVES TO FOSSIL FUELS

Nuclear power generation provides an alternative (albeit a controversial one) to the use of fossil fuels. Whilst not emission-free, it can make a valuable contribution to reducing CO_2 emissions and meeting Kyoto Protocol targets. However, there are a number of problems including the disposal of nuclear wastes which can remain radioactive for millions of years; the fact that the world's resources of uranium are finite; the possible health effects of living close to nuclear plants and the potential consequences of accidents or terrorist attacks. Some countries (Austria for example) have renounced nuclear power altogether or, like Germany and Spain, are planning to phase it out. However, others such as France, the Ukraine and Finland are maintaining or expanding their nuclear energy capacity.

Sustainable energy sourced from alternative, 'renewable' sources (such as the sun, wind, water and waves, biomass, geothermal, ethanol and biodiesel) can substantially reduce GHG emissions and those of other pollutants. Greater availability and take-up will increase the diversity of energy supplies and help to replace diminishing fossil fuel resources over the long term. The growth in demand for renewable energy such as wind power in industrialised countries is leading to economies of scale which will also make it increasingly accessible to the developing world. Governments can use various strategies to make renewable energy more competitive, particularly by removing trade and investment barriers between countries with significant renewable resources.

c MITIGATION TECHNIQUES

In addition to reducing GHG emissions through improved energy-efficiency in industry, buildings and transport, and switching to nuclear power and renewables, it will also be essential to 'mitigate' them as far as possible. This will require the use of mechanisms such as reforestation to reduce CO_2 through photosynthesis and the use of CO_2 capture and storage (CCS). CCS or 'carbon sequestration' is an approach to mitigating global warming by capturing CO_2 from high-emitting sources such as power plants and storing it in geological formations or in the oceans instead of releasing it into the atmosphere. The technology for capturing CO_2 is already commercially available in the oil, gas and chemical industries (for example capturing flue gases for use elsewhere), whilst storage of CO_2 is still a relatively untried concept.

2.2 YOUR ENERGY MANAGEMENT PROGRAMME

An effective energy management programme will help to maintain the profitability of your hotel and should not have an adverse impact upon the comfort or satisfaction of your guests.

2.2.1 Objectives

In striving to become more energy-efficient, your aim will be to:

a PROVIDE A COMFORTABLE INTERNAL ENVIRONMENT

The aim is to create an energy-efficient, comfortable internal environment for guests and staff by cutting waste, not corners. This will help you retain your customer base whilst reducing your costs and your carbon footprint at the same time.

b IMPROVE EFFICIENCY

This requires:

- operators to understand, operate and maintain the hotel's energy-consuming equipment and systems in an energy-efficient manner
- efficient buildings, equipment and systems that consume less energy (and cheaper energy) to accomplish their task.

Energy management is a continuous learning process – there are often enhancements you can make to improve the efficiency of your equipment and the way that you operate it. Regular efficiency measurements should become a standard procedure for major energy consumers such as boilers, chillers, cooling towers and air-handling units.

c ADJUST TO CHANGES IN LOADS

Resources (i.e. staff, equipment and energy use) should be adjusted according to the time of day, day of the week, season, occupancy and weather. This will create tremendous potential for savings.

d OPERATE PROFIT (COST) CENTRES

Those who use the energy must be accountable for it. You will need to install sub-meters and allocate charges to each department according to their consumption. Any independent operators on the hotel's premises should also be re-charged for the energy they use.

e USE PERFORMANCE CRITERIA

You will need to develop and use performance criteria for each department, set targets and continuously monitor results.

f INVEST IN NEW TECHNOLOGY

You should constantly review available technology and assess whether it can help create efficiencies within your own hotel operation.

g SET HIGH STANDARDS FOR NEW PROJECTS

When planning refurbishment, extensions or new buildings it is important that the building is designed for optimum energy-efficiency. Check that the lighting, heating, cooling and total load requirements in kWh per square metre (m^2) comply with state of the art efficiency levels. You must also ensure that the building's mechanical, electrical and plumbing systems are properly commissioned and in perfect working order. Make sure you obtain complete test certificates, balancing reports and completion checklists as unresolved problems and unsatisfactory work can result in higher energy costs and lower standards of guest and staff comfort for the rest of the building's life.

h AVOID SUPERFLUOUS AND WASTEFUL DEVICES

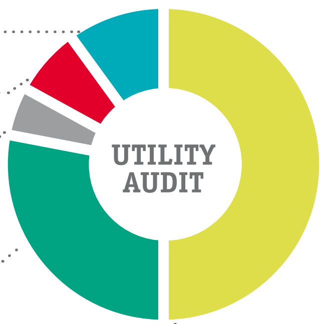
For example avoid purchasing fashionable outdoor bottled gas (LPG) heaters as they use significant amounts of fuel and much of the heat is quickly lost to the surrounding environment.

i PROVIDE ADEQUATE TRAINING

Good training may be the best investment you ever make. If your staff believe that they are playing a key role in your energy achievements and making a positive contribution to the local and global environment it will help build morale. Empower your staff to take decisions by making sure they have the necessary training and knowledge to fulfil their role successfully. This will increase their confidence and job satisfaction, reduce periods of absence and will be reflected in their interaction with each other and with your guests.

FIGURE 2.1 shows a breakdown of typical utility costs (including water) for hotels and is based on data from 300 four and five star hotels with between 150 and 1000 rooms over the period 2000–2007.

Utility	%
Water	10
Gas (kitchen)	7
Fuel (petrol and diesel for vehicles, lawnmowers, equipment)	5
Heating oil or gas for boilers or district heating (steam or hot water)	28
Electricity	50



NOTE: Percentages for individual hotels will vary depending on the country, climate zone, hotel type and facilities.

FIGURE 2.1
Breakdown of typical utility costs for hotels

2.2.2 Your action plan

In order to set (and achieve) relevant and realistic targets you will need to invest time and resources in careful planning, organisation, training and follow-up. The basic steps are as follows:

a Energy audit
Carry out an **energy audit** in the hotel, which will show you where the major energy costs are and where savings can be made. **FIGURE 2.1** gives an indication of the key areas of energy consumption in a typical hotel.

b Compare with benchmarks
Compare your total and departmental **consumption** figures with hotel **industry benchmarks** to determine the potential for energy savings so that you can prepare a summary of opportunities.

c Consider expert advice
Consider seeking the **advice of experts** to help you analyse and evaluate the results and provide recommendations. It is a good idea to ask independent consultants to review the feasibility of major capital expenditure projects.

d Establish realistic goals
Using the energy audit results, **establish realistic goals** for each department and the entire hotel.

e Communicate commitment
Communicate the management's commitment to all employees and explain your objectives and goals clearly to them. Show them the current consumption data, the costs and trends.

f Appoint energy co-ordinator
Appoint an **energy co-ordinator** (someone from your engineering department is likely to be the most appropriate person for this role), define responsibilities within each department and develop an effective communication system.

g Ensure participation
Make sure that the **entire workforce** participates. Capitalise on their knowledge, experience and familiarity with the building as they know it better than anyone else. Encourage them to put forward their ideas and proposals on how to reduce energy consumption.

h Monitoring and targeting
Establish a **monitoring and targeting system**.

i Provide training
Staff must understand how to make prudent use of utilities and how to operate and maintain equipment **for optimum energy-efficiency**.

j Standard operating procedures
Develop **standard operating procedures**, and continue to stimulate motivation by giving **feedback**. Reward success.

k Review supply contracts
Review current energy supply contracts regularly with your providers to ensure that they are charging competitive prices and that you are on the optimum tariff.

2.2.3 Assessing and benchmarking performance

Your energy audit will produce a detailed evaluation of your current energy-efficiency status.

a **FIGURE 2.2** shows the results of a typical energy audit based on the cost for each department of the hotel as a percentage of the total energy costs. The greatest user of energy in this case is the HVAC system.

Area	USD	%
HVAC	217,697	22
Guest Rooms	192,917	19
Others/not metered	140,450	14
Kitchens	124,786	12
Laundry	83,050	8
Pool	80,785	8
Lifts	75,877	8
F&B	60,882	6
Lockers/public toilets	23,556	2

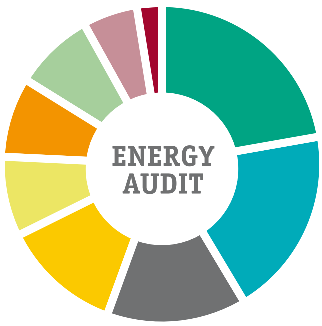


FIGURE 2.2 Typical energy audit by cost

DATA FROM: Fully-metered 300-room hotel in Germany with total annual energy costs of USD1,000,000.

b A useful first step is to **compare your total annual consumption with some benchmark figures** **(SEE FIGURE 2.3)**. To do this, you will need to know the annual consumption of the hotel, the total floor area in square metres (m^2) and the occupancy figures.

Obviously, no two hotels are exactly the same and when comparing your consumption figures with the benchmarks, you will need to apply 'correction factors' or modifiers **(SEE f)** to take account of the local climate and weather conditions as well as occupancy levels and whether the hotel has air-conditioning, an indoor pool, spa facilities or a laundry, each of which will have a significant impact on the total energy use.

c CALCULATE FUEL AND STEAM CONSUMPTION IN kWh PER m^2

You will need to convert the annual fuel oil, gas, district steam or hot water energy into kWh. Your utility provider usually provides a gross figure for the calorific values but you need to bear in mind that around 10 per cent of the gross figure is lost in combustion of gas and five per cent in the case of fuel oil. Use the lower (net) calorific values as shown in **APPENDIX 1** for converting to kWh units.

NATURAL GAS *For cooking, for example*	*43,010* m^3	×	9.3 kWh per litre	=	*400,000* kWh	A
LIGHT FUEL OIL *Boilers*	*182,000* m^3	×	8.3 kWh per litre	=	*1,510,600* kWh	B
DISTRICT HOT WATER *Steam*	*6,650* GJ	×	278 kWh per GJ	=	*1,848,700* kWh	C

TOTAL = A + B + C = *3,759,300* kWh **D**

TOTAL FLOOR AREA = *16,000* m^2 **E**

CONSUMPTION PER m^2 = D ÷ E = *235* kWh per m^2 per year d CALCULATE ELECTRICITY IN kWh PER m² OF FLOOR AREA PER YEAR:

Your electricity bill should already show usage in kWh so it should only be necessary to divide that figure by the total floor area in square metres.

ANNUAL CONSUMPTION = 2,883,000 kWh
for example

CONSUMPTION PER m² = ANNUAL CONSUMPTION ÷ TOTAL FLOOR AREA

= 2,883,000 kWh ÷ 16,000 m²

= 180 kWh per m² per year

e COMPARE YOUR PERFORMANCE AGAINST INDUSTRY BENCHMARKS

FIGURE 2.3 shows benchmark values for electricity and other energy consumption in luxury fully-serviced hotels.

FIGURE 2.3
Benchmark values for electricity and other energy consumption in luxury, fully-serviced hotels[9]

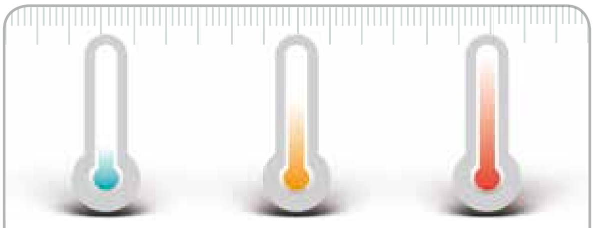
Hotel profile	Climate zone and energy type		Energy consumption (kWh/m² of serviced space) EXCELLENT	SATISFACTORY	HIGH
Luxury serviced hotels	TEMPERATE	Electricity	< 135	< 145	< 170
		Other energy	< 150	< 200	< 240
		TOTAL	< 285	< 345	< 410
	MEDITERRANEAN	Electricity	< 140	< 150	< 175
		Other energy	< 120	< 140	< 170
		TOTAL	< 260	< 290	< 345
	TROPICAL	Electricity	< 190	< 220	< 250
		Other energy	< 80	< 100	< 120
		TOTAL	< 270	< 320	< 370

Benchmark results fall into **three categories**:

EXCELLENT	SATISFACTORY	HIGH
The best that typical hotels could expect to achieve.	The gap between the best that most hotels could expect to achieve and average performance.	The gap between the satisfactory level of performance and high consumption. Consumption greater than this is excessive and illustrates poor resource management practices.

[9] Data in **FIGURES 2.3, 2.5, 2.6 AND 2.7** sourced from the International Tourism Partnership's environmental benchmarking tool, February 2008.

...and are separated into **three climate zones**:



TEMPERATE	MEDITERRANEAN	TROPICAL
Assumes full heating, ventilation and air-conditioning (HVAC) using centrally-controlled electrical chillers).	As per temperate.	Year-round air-conditioning and no heating.

It is important that hotels enter the correct climate zone for their location to achieve the most realistic set of benchmarks. Hotels in the sub-tropics and in cold temperate or glacial environments should select the climate zone that is the nearest match (i.e. sub-tropical hotels should select the tropical climate zone and hotels in cold temperate environments should select temperate environments).

Please refer to **2.2.3.f** overleaf for the appropriate correction or 'modifier' values if your hotel differs from the profile in **FIGURE 2.4** below (for example if it uses absorber chillers, does not have a swimming pool and health club or a laundry, washes more or less laundry, produces more or less covers or operates at a different occupancy level).

The luxury hotel

FIGURE 2.4

THE **LUXURY HOTEL** PROFILE ASSUMES A **FOUR OR FIVE STAR FULLY-SERVICED**[10] HOTEL WITH THE FOLLOWING:

- ✓ 150 to 1000 rooms.
- ✓ An average of 55-100m^2 per room (including public space and back-of-house) with approximately 60 per cent of the total hotel area dedicated to guest bedrooms.
- ✓ Year-round opening, operating at 70 per cent occupancy.
- ✓ 1.2 guests per room.
- ✓ Covers: 2.5 per guest
- ✓ Air-conditioning and heating (see climate zones, left).
- ✓ A laundry producing 6kg/laundry per occupied room (OCRM) per day.
- ✓ A health suite and pool of up to 150m^2 surface area.
- ✓ Gardens of up to 1,000m^2.
- ✓ 1 employee per room.

[10] i.e. with premium services and facilities, regarded as a leading hotel in its region.

f CORRECTION FACTORS FOR LUXURY HOTELS

Depending on the facilities at your hotel you may need to modify the benchmarks in **FIGURE 2.3** so that they are applicable to your specific property, wherever it deviates from the typical profile, using the tables below:

FIGURE 2.5 Benchmarking modifiers for electricity

Electricity	TEMPERATE	MEDITERRANEAN	TROPICAL	
Occupancy	7	8	15	kWh/OCRM *
Laundry	0.12	0.12	0.12	kWh/kg
Covers:				
if electric equipment	3	3	3	kWh/cover
if gas equipment	1	1	1	kWh/cover
If no pool	-3	-3	-3	kWh/m²
No electric chiller	-10	-12	-18	kWh/m²

* OCRM: OCCUPIED ROOM

FIGURE 2.6 Benchmarking modifiers for other energy

Other energy	TEMPERATE	MEDITERRANEAN	TROPICAL	
Occupancy	600	450	0	kWh/OCRM/Yr
Hot water	4.5	4.0	3.5	kWh/guest
Laundry	1.9	1.9	1.9	kWh/kg
Kitchen gas	3	3	3	kWh/cover
Pool heating	10	4	0	kWh/m²
Absorber chiller	60	70	90	kWh/m²

FIGURE 2.7 Benchmarking modifiers for heating energy only

Heating energy — Percentage of total energy used for heating (EXCLUDING KITCHEN USE)

	✓ Laundry ✓ Pool	✓ Laundry ✗ Pool	✗ Laundry ✗ Pool	✗ Laundry ✓ Pool
TEMPERATE				
Electric chillers	50%	55%	70%	65%
Absorber chillers	30%	35%	50%	45%
MEDITERRANEAN				
Electric chillers	40%	45%	60%	55%
Absorber chillers	20%	25%	40%	35%

THE MODIFIERS SHOWN HERE ARE BASED ON 3,100 HEATING DEGREE DAYS IN CENTIGRADE AT A BASE TEMPERATURE OF 15°C. SEE 2.2.3.g FOR MORE INFORMATION.

TROPICAL AND SUB-TROPICAL AREAS WILL HAVE COOLING REQUIREMENTS WHOSE BENCHMARKS CAN BE SIMILARLY WEATHER-NORMALISED USING COOLING DEGREE DAYS.

The following examples show how to use the modifiers to produce more accurate benchmarks for your hotel.

EXAMPLE 1:
ADJUSTING BENCHMARKS ACCORDING TO OCCUPANCY

ACTUAL OCCUPANCY

A **300-room** hotel in a temperate climate zone has an annual occupancy of **88 per cent**. Its total net area is **21,240 m²**

Actual occupancy = 300 × 365 × 0.88 = 96,360 OCRM (A)

TYPICAL OCCUPANCY

The typical profile **(SEE FIGURE 2.4)** assumes **70 per cent** occupancy.

Number of occupied rooms = 300 x 365 x 0.70 = 76,650 OCRM (B)

CORRECTION FACTOR

This hotel has more occupied rooms than the typical hotel for which the benchmarks apply: A – B 19,710 OCRM (C)

On a daily basis, this equals: C ÷ 365 = 54 OCRM (D)

Benchmarks need to be **raised** in order to take into account the higher occupancy as follows:

ELECTRICITY

The modifier value for occupancy in a temperate climate is: 7 kWh/OCRM (E)

FROM **FIGURE 2.5**

REVISED BENCHMARKS

The correction factor for electricity use per m² is therefore calculated as follows: (C × E) ÷ 21,240 m² = 6.5 kWh/m²

HIGHER CONSUMPTION ÷ NET AREA = ADJUSTMENT FACTOR

THEREFORE THE **ELECTRICITY** BENCHMARKS FOR THIS HOTEL SHOULD BE **INCREASED BY** 6.5 THUS:

Electricity	Electricity consumption (kWh/m² of serviced space)		
	EXCELLENT	SATISFACTORY	HIGH
Typical	< 135	< 145	< 170
THIS PROPERTY	< 141.5	< 151.5	< 176.5

OTHER ENERGY

The occupancy modifier for heating energy in a temperate climate: 600 kWh/room/year (F)

FROM **FIGURE 2.6**

REVISED BENCHMARKS

The correction factor is therefore calculated as follows: (D × F) ÷ 21,240 m² = 1.53 kWh/m²

NET AREA = ADJUSTMENT FACTOR

THEREFORE THE BENCHMARKS FOR **OTHER ENERGY** FOR THIS HOTEL SHOULD BE **INCREASED BY** 1.53 THUS:

Other energy	Energy consumption (kWh/m² of serviced space)		
	EXCELLENT	SATISFACTORY	HIGH
Typical	< 150	< 200	< 240
THIS PROPERTY	< 151.53	< 201.53	< 241.53

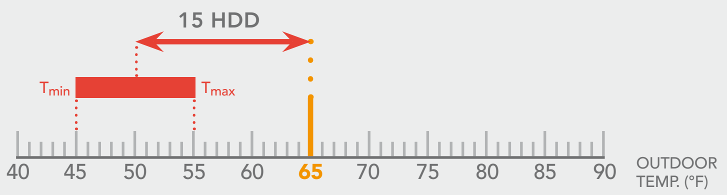
g WEATHER-NORMALISING BENCHMARKS USING DEGREE DAYS

In order to analyse and compare seasonal energy performance year-on-year it is necessary to take weather changes into consideration, since heating and cooling requirements are proportional to the change in the average temperatures during the relevant seasons. In addition, humidity has a major influence on the energy requirements for cooling, as the air conditioner's cooling coils must remove moisture, which is an added load.

This process of 'normalising' or compensating for temperature is done by factoring in the change in the total number of **degree days**. A degree day is a unit of measurement used to estimate the fuel and power requirements for heating and cooling a building. It is equal to a difference of one degree between the outdoor daily average temperature and the reference temperature. Degree days are an indicator of how far the average temperature departs from a human comfort level, called the base. In the US the base is defined as 65°F (18.3°C), in the UK 60°F (15.5°C), and in Germany 68°F (20°C). Experience shows that at an outdoor air temperature of approximately 65°F (18.3°C) no heating or cooling is required. The indoor temperature would then be a comfortable three degrees higher at 21–22°C due to heating loads from people, lighting and equipment.

Each degree of outside average temperature below the base is one **heating degree day (HDD)**, and each degree above the base is one **cooling degree day (CDD)**.

For example, on a typical **winter** day in a **US** hotel:



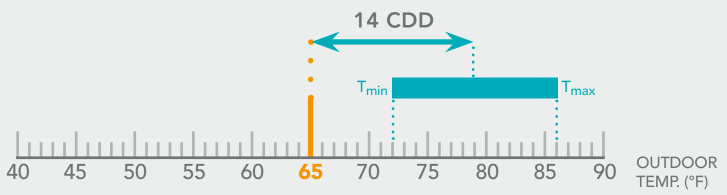
HEATING DEGREE DAYS:

= Difference between **AVERAGE DAILY TEMPERATURE** and **BASE TEMPERATURE**

$$= 65 - \left(\frac{T_{max} + T_{min}}{2}\right) = 65 - \left(\frac{55 + 45}{2}\right)$$

= 15 HDDs

For example, on a typical **summer** day in a **US** hotel:



COOLING DEGREE DAYS:

= Difference between **AVERAGE DAILY TEMPERATURE** and **BASE TEMPERATURE**

$$= \left(\frac{T_{max} + T_{min}}{2}\right) - 65 = \left(\frac{86 + 72}{2}\right) - 65$$

= 14 CDDs

To calculate the number of heating degree days in a month, the outdoor average temperature for each day is subtracted from the reference temperature, and the results for each day are added together, while cooling degree days are calculated vice versa.

Degree days are used by energy managers to:

- identify abnormal seasonal patterns of consumption
- detect exceptional consumption caused by problems/faults
- normalise the performance of different buildings to a common basis for comparison
- verify and quantify the results of energy-saving measures allowing for weather variations
- extrapolate annual consumption from a limited period of monitoring
- set and track fuel budgets.

Simple degree day-based calculations are central to many energy management programmes, but it is essential both to understand the basis and ensure the validity of degree day calculated figures before making decisions based upon them.[11]

You should be able to obtain the degree day figures appropriate for your region from your local meteorological centre or your own building automation system, if available.

The modifiers for heating degree days in **FIGURE 2.7** are based on 3,100 heating degree days in centigrade at a base temperature of 20°C. **EXAMPLE 2** overleaf illustrates how these factors can be applied to your energy consumption data to enable comparisons that are 'weather-normalised', i.e. independent of the prevailing weather.

In the case of cooling degree days calculations you must include daily humidity measurements, which have a major bearing on consumption. This requires not only dry bulb (db) but also wet bulb (wb) temperature measurements.

APPENDICES 2, 3 AND 4 show how to assess current performance for guest rooms, kitchens and laundry.

2.2.4 The energy audit

The energy audit is an essential part of setting up a professional energy-management programme. The objective is to analyse and evaluate the data you collect in order to determine the energy performance of the entire building and its major consumers of energy.

a STEP 1

Collect historical consumption data, costs, utility contracts, relevant hotel statistics, technical data for your equipment and also information on normal local weather patterns.

b STEP 2

You will need to work out where the items that consume energy are within the building (the larger the hotel, the larger the breakdown required). The consumption of all equipment and lighting must be calculated on a fixed daily operating basis. However, because consumption by various items of equipment varies according to their function, the hotel's occupancy and the prevailing weather conditions, you will need to install sub-meters on major items and on departments in order to make an accurate assessment. This will ensure that you get feedback over time on the results of actions taken on individual items and departments.

[11] For more information on degree days, potential problems and how to avoid them, see:
www.energylens.com/articles/degree-days
www.vesma.com/ddd
www.degreedays.net

EXAMPLE 2:
USING HDDs TO WEATHER-NORMALISE ENERGY BENCHMARKS

PARAMETERS

- A hotel in a temperate climate zone has a pool but no laundry
- Chillers are electric
- Net hotel area: **30,000 m²**
- Total energy consumption in 2007/2008 excluding kitchens: **3,450,000 kWh**
- Heating degree days (HDDs) for the season 2007/2008: **3,450** (i.e. **350 more** than the benchmark baseline of **3,100 HDDs** per year **(SEE 2.2.3 g)**
- Heating period: **245 days**

ADJUSTED ENERGY FOR HEATING

The modifier for calculating the percentage of energy used for heating only in this climate zone = 65 % (A)

FROM **FIGURE 2.7**

Applying the modifier gives adjusted energy consumption as follows:

$$3{,}450{,}000\ \text{kWh} \times \text{A} = 2{,}242{,}500\ \text{kWh} \quad \text{(B)}$$

DEGREE DAYS

With **350 more HDDs** than a typical year, dividing this by the heating period (245 days) shows the temperature to have been on average **1.43°C lower** than the baseline over this period. Its effect on energy consumption is calculated as follows:

$$\left(\frac{\text{HDDs}}{\text{baseline}}\right) \times \text{B} = \left(\frac{3{,}450}{3{,}100}\right) \times 2{,}242{,}500\ \text{kWh} = 2{,}495{,}685\ \text{kWh} \quad \text{(C)}$$

Energy consumption for heating has increased by the amount due to the temperature being colder. C − B = 253,185 kWh (D)

BENCHMARK ADJUSTMENT

Calculate the adjustment factor as follows:

$$\left(\frac{\text{increase in consumption}}{\text{net hotel area}}\right) = \frac{\text{D}}{30{,}000\ m^2} = 8.44\ \text{kWh}/m^2$$

THEREFORE THE BENCHMARKS FOR **OTHER ENERGY** FOR THIS HOTEL SHOULD BE **INCREASED BY 8.44** THUS:

Other energy	Energy consumption (kWh/m² of serviced space)		
	EXCELLENT	SATISFACTORY	HIGH
Typical	<150	<200	<240
THIS PROPERTY	<158.44	<208.44	<248.44

2.2.5 Monitoring & targeting (M&T)

a MONITORING

Monitoring is the regular checking of consumption levels by establishing routines for reading utility meters and enables you to check the accuracy of your energy bills. By monitoring at regular intervals, unexpected changes in consumption (perhaps due to the faulty operation of equipment, leaks, poorly-set controls or other sources of waste) can be detected rapidly and corrective actions taken. Regular monitoring also provides a flow of detailed and comprehensive operating information, which is a vital component of good management.

Ideally, you will have installed a system of sub-meters serving different areas or departments of the hotel. Reading these sub-meters on a regular basis, daily or weekly, will help in diagnosing where and why any unexpected consumption occurs. It will also enable you to re-charge energy costs both internally to cost-centres within the hotel and to any independent operators who may be using the hotel premises (such as a shop or hair salon). This will place accountability for energy costs on those who are responsible for usage and will give them a financial incentive to ensure that energy is not wasted.

Meter readings can be taken manually or may be automated. If you record your meter readings on a simple computer spreadsheet it will help to simplify the process of calculating consumption, enable a variety of analyses to be performed and allow you to display the results as graphs or charts, so they can be readily understood by others and become a part of your energy-efficiency communication campaign.

b TARGETING

Targeting is the process of setting targets in order to provide an incentive for reducing waste. In an individual hotel, target consumption figures are generally set with reference to historical consumption levels. If the hotel has been extended, altered, refurbished or has had new facilities added, your targets will need to reflect the anticipated impact of these changes. Correction factors also need to be applied to account for any significant alterations in occupancy and weather conditions.

In a hotel chain or group, targets may be set by reference to the best performer or, more realistically, the worst performers may be compared with the average. Where industry norms are available, these may be used as target values (see, for example the tables for guest rooms, kitchen and laundry in **APPENDICES 2, 3 AND 4**).

An alternative but less common way to set targets is to develop them with reference to theoretical calculations, such as how much heat the building gains and loses, or how much electricity is required for the lighting system to achieve a given level of illumination.

Targets need careful consideration. Setting a realistic target and then actually achieving it will provide positive motivation for staff to continue making progress. If the existing energy-efficiency of the premises is very poor, it may be possible to achieve a 10 per cent or more improvement in the first year through initial 'one-off' changes. However, it is unlikely you will be able to sustain this over time and you should be wary of setting the goals too high. An annual energy reduction of 2–5 per cent of current consumption is typical, and can usually be achieved through good management and care. Annual savings of about five per cent or more may be achievable with good managerial and financial support. Excessively onerous targets may well be dismissed by staff as being unachievable and could undermine your programme.

Remember that wasteful habits can become ingrained and staff may need to have regular 'refresher' training sessions if good practices are to continue.

c M&T SYSTEMS

In its simplest form, monitoring and targeting can be performed manually. This involves reading meters regularly, establishing consumption targets, comparing actual consumption against targets and taking corrective action where necessary.

Computer-based M&T systems can read meters and sub-meters automatically (including those at remote sites), undertake various statistical analyses of the readings and produce regular management reports. It should be remembered, however, that M&T is an adjunct to good management, not a substitute for it.

If M&T systems are to be implemented successfully and their potential benefits achieved, it is essential that:

- operators understand the system fully (rather than relying on outside consultants)
- input consumption data is reliable (and not incomplete or late)
- outputs are displayed in various graphic formats (not just columns of numbers) which are comprehensible to senior managers, energy managers and staff
- reduction targets are realistic (rather than arbitrary, with no adjustments for changes in equipment etc.)
- excess energy use is flagged quickly and investigated rapidly by appropriate staff.

d M&T AND CONTRACT ENERGY MANAGEMENT

It may be appropriate to employ consultants to identify energy-conservation measures for your hotel. Typically, they carry out a site survey and identify 'no-cost', 'low-cost' and capital expenditure measures which will save energy. These will be accompanied by recommendations for training requirements, a schedule for maintenance and future equipment replacement, recommendations for refurbishment and a summary of the anticipated benefits from implementing these measures.

No-cost measures are implemented first, with the consultant advising on appropriate training to improve staff awareness, providing expert guidance and advice and agreeing targets with you. When low-cost and capital projects are implemented, targets should be revised to reflect the expected savings in energy. The consultant may also advise on utility rates and seek rebates from utility suppliers in cases of overcharging.

Consultants should be made responsible for monitoring and comparing consumption against targets, and should provide you with information so that you can assess their effectiveness and performance. Ensure that the data is passed to you and remains yours.

If you plan to enter into a partnership agreement with expert energy consultants, make sure that your hotel's current performance is as good as it can be before you start. It is also important to consider the basis under which their fees are set. If your consultants are to be paid a percentage of the savings achieved, there is a risk that they may identify and correct an area of inefficiency but continue to gain the benefit for several years afterwards. The conditions of engagement should be set up so that they are fair to both parties. Consultants may be paid an agreed percentage of the savings they achieve but, if they are involved in obtaining utility rebates, a one-off fee for this aspect may be more appropriate. Ensure that performance, target setting and remuneration are reviewed annually.

2.2.6 Sub-metering

The installation of sub-meters will deliver the following advantages:

a. You will be able to conduct **accurate energy audits**.
b. The **true efficiencies** of major energy consumers such as chillers, boilers, air-handlers, etc. can be correctly determined.
c. **Inefficiencies and waste** can be traced back to source.
d. Specific departments and consumers can be **compared against benchmarks** for the industry.
e. You will obtain immediate **feedback on the results** of specific energy-conservation measures (ECMs) that would otherwise be lost in the total consumption of the building.
f. Departmental **management accountability** will be enhanced by placing responsibility with the individuals who control and consume the utilities.
g. You will be better able to determine the **feasibility** of capital-investment projects and their resultant true savings after installation.
h. **Better control** of public utility meters and deliveries can be achieved.
i. Equipment designers and energy experts can be provided with **reliable information** for the proper sizing of new or replacement equipment.

2.3 ENERGY CONSERVATION MEASURES (ECMs)

A good way to prioritise your energy conservation programme is to begin with the actions that will reap the greatest savings for the least cost. The following general recommendations are divided into sections relating to cost and return. You will need to evaluate the suitability and feasibility of each measure for your hotel as not all of them may be applicable.

The key area where major energy savings can be made for comparatively little cost (often with a short payback) is in the operation of your Heating, Ventilation and Air-Conditioning (HVAC) system.

2.3.1 Greatest savings at least cost

a MATCH SOURCE TO LOAD

- Operate chillers, boilers, pumps and cooling tower equipment in accordance with **actual loads**. Shut off equipment that is not required for the load. Do not allow simultaneous cooling and heating unless intermediate season conditions dictate (four-pipe systems) and humidity or zone control calls for reheating.
- **Schedule** HVAC equipment and systems according to the time of day, week or holiday operation. Install timers. Shut off individual units in unoccupied areas. Guest rooms can be controlled by housekeeping staff when making up rooms after check-out. Depending on the season, shut off or maintain minimum room temperatures by resetting thermostats.
- Operate **steam boilers** at two pressure levels – at higher pressure during laundry operation and at lower pressure for the kitchen, hot water and heating when the laundry is not operating.
- Use **variable speed** secondary system pumps instead of differential pressure control. Install an inverter to operate pumps in accordance with load. Convert systems with three-way control with bypass return to two-way control and modulate pump operation instead of constant full-volume water flow.
- **Convert constant air volume (CAV)** systems to two-speed or variable frequency-controlled high-efficiency motors. For example in temperate climatic zones, only 40–60 per cent of the air volume required for cooling in summer is required for heating in winter. Reduce kitchen ventilation at times of low activity, for example from 09:00–11:00 and 15:00–19:00 and after 23:00 until 07:00 hours.
- If major equipment must be operated to satisfy **low loads**, disconnect the small load equipment and convert it to self-contained independent operation. For example, for laundry pressing services operating after normal hours, install a separate small steam generator nearby. Have a separate heater for kitchen dishwashers at times when the steam generator is off. When the outside air temperature is less than 16–18°C, and the chiller could be off, use separate self-contained units for cooling internal areas such as shops and front offices.
- Review the **capacity** of central equipment relative to the actual load as oversized equipment operates less efficiently. Successful energy conservation can often result in the existing equipment then becoming too large for the connected load. Consider additional smaller equipment, for example at nights and during intermediate or winter seasons. Although the payback period may be longer, the life expectancy of your major equipment will be extended. An ideal opportunity to do this is when replacing worn-out equipment.
- Heating, cooling and ventilation automatic controls:
  - **Free cooling.** Use up to 100 per cent outside air before you engage mechanical cooling (chillers).

- **Enthalpy** control is usually combined with free cooling controls. Use maximum return air if the heat content makes it more economical than using outside air. However, maintain minimum outside air quantities to maintain comfort levels.
- **Expand fixed set points** to the comfort range. No energy will be consumed between heating and cooling say, the lobby from 21–24°C and 30–60 per cent relative humidity. The coil control valves remain closed.
- **Night setback.** Adjust the temperatures of air-conditioned spaces at night to preset levels.
- **Modulate** chilled and heating water supply temperatures with the outside air temperature. Do not adjust supply temperatures to lower (chilled water) and higher (heating water) levels more than necessary. Aim simply to satisfy the load.
- In **multiple-zone** and **double-deck** systems, reset the supply temperatures to just satisfy the zone with the highest demand. All other zones will then require the least amount of energy.
- Cycle **air-handlers**. Periodically shut off fans to reduce consumption and control peak demand.
- Operate **fans** only when the space is physically occupied. Set the fixed time schedule via timers and/or monitor with motion sensors.
- **Dynamic controls** change the static pressure set points in relation to actual load conditions, for example Terminal Regulated Air Volume (TRAV) systems.
- Vary the quantity of **outside air** in proportion to the number of people. Excessive outside air increases energy consumption considerably. Install air-quality sensors.
- Before you allow physical occupation of air-conditioned spaces, let the **air-handlers** operate on 100 per cent return air to bring the room to the required temperature.
- **Optimise start and stop** schedules of air-handlers by using adaptive control algorithms. The units will automatically start and stop before the end of physical occupation to maintain comfort levels, minimising unnecessarily extended operating times.
- Interface guest room air-conditioners and power supply through a **building automation system.** SEE APPENDIX 5
- Convert constant air volume (CAV) to **variable air volume (VAV)** systems during major renovations.

- Improve **air and water balance** within their respective distribution systems. Unbalanced systems are inefficient and require air handlers, chillers and boilers to run longer and at higher (boilers) and lower (chillers) temperatures than necessary, in addition to causing a loss in comfort. Each supply and return outlet and each coil must receive the required quantity in cubic metres per hour.
- **Investigate and correct** any unsatisfactory heating and cooling performance of plant. Building automation systems cannot improve poor efficiency of inadequately designed, poorly commissioned or badly maintained systems.

b DECREASE HEATING AND COOLING LOAD

LIGHTING

- Decrease lighting levels in general and/or at specified times (using timers).
- Make use of energy-efficient lamps.
- Use light-reflective surfaces and reflection in order to reduce wattage.

GLAZING

- Use reflecting insulating glass.
- Provide shade control on windows, through blinds for example. Close curtains to reduce any unwanted solar gain.

SPECIFIC MODIFICATIONS

- Check for infiltration of outside air in the form of negative pressure, leaking windows and draughts.
- Divert equipment loads from the building loads, for example by using co-generation. SEE APPENDIX 7
- Reduce excessive supply and exhaust air.
- Reduce transmission loads from other heat sources such as the boiler flue.
- Improve insulation of pipes.
- Shut down areas and equipment that are not in use.
- Optimise the use of function areas, for example by not holding a function for 50 people in a function room for 150. Also, if you have an air-conditioning system that serves three function rooms and another that serves two, try to hold two functions in rooms served by the same system to avoid having to operate both systems.

2.3.2 Small to large savings at reasonable cost

The spectrum of modifications and improvements under this category offers wide savings. They can be as simple as:

- Manually resetting temperature controls.
- Changing operating times.
- Closing steam valves to the laundry.
- Adjusting fuel/air ratios on combustion equipment.
- Water treatment to prevent deposits.
- Checking chillers for non-condensables, or for low refrigerant charge.

More expensive modifications include installing major system components to reduce consumption and costs. This is best carried out when replacing obsolete systems or during refurbishment.

a INSTALL SUB-METERS

SEE 2.2.6

b IMPROVE CHILLER EFFICIENCY

- Check cooling capacity at loads of 25 per cent, 50 per cent, 75 per cent and 100 per cent and compare with the equipment design data.
- Reduce head on chiller – use lowest possible condenser and highest possible evaporator pressure to just satisfy load. Automate by installing microprocessor controls.
- You will achieve a one per cent saving for each degree centigrade higher chilled water or lower condenser water temperature.
- Using an absorber chiller economiser reduces the quantity of solution being pumped to the generator at partial loads.
- Keep valves to off-line chillers closed.
- Check regularly for non-condensables in centrifugal chillers and for quality of the vacuum in absorbers.

c IMPROVE COOLING TOWER EFFICIENCY

- Do not run cooling tower cells without fan or bypass condenser water in order to maintain constant temperature. Install two-speed control for fan and cut down fan speed.
- Replace inefficient fill with cellular honeycomb fill to optimise atomisation of water droplets and extend contact time with air.

- Improve air flow – measure amperage and compare with design data; adjust angle of blades.
- Ensure proper water treatment. Biological fouling obstructs fill and causes loss in heat-transfer efficiency.
- Install automatic blow down and use the effluent for irrigation.
- Ensure even water distribution at deck and nozzles.

d IMPROVE BOILER EFFICIENCY

- Check combustion efficiency at loads of 25 per cent, 50 per cent, 75 per cent and 100 per cent. Compare with design data and adjust fuel air ratio if below. Good efficiencies are 82–88 per cent (of net calorific value) and 88–94 per cent for new boilers. Check for draughts and install automatic draught control if excessive. Ensure that burner dampers close when in off-mode to reduce draught losses.
- Check for steam and condensate losses. Steam boilers/generators that also supply laundries should not lose more than 1 litre per kg of processed linen. Add blow down losses (calculate from concentration cycles) to obtain total make-up. Note that one ton of lost steam each day amounts to 80 litres of fuel or approximately 30,000 litres/year, 1 cubic metre of lost condensate amounts to 12 litres of fuel per day or 4,400 litres per year; and 1 cubic metre lost blow-down without heat recovery amounts to 20 litres per day or 7,300 litres of fuel per year.
- Maintain boilers in optimum condition: clean fire and waterside surfaces. Ensure proper water treatment to prevent scale.
- Pre-heat heavy fuel to 80°C.
- Recover flue gas energy. The latent heat content in gas-fired boilers is 11 per cent.
- Close daily steam supply to the laundry, kitchen, etc. after working hours.
- Frequently check steam traps for leaks and also that they are the right type and size.
- Replace obsolete equipment with the latest microprocessor combustion burner controls. Complete combustion results in a blue flame.
- Convert to a closed system, whereby all condensate and flash steam is recovered.

e CHECK AND IMPROVE PUMP, FAN AND MOTOR EFFICIENCY

- Obtain performance curves and compare the actual performance with the design.
- Modify the pump impeller if required.
- Replace burnt motors with a high-efficiency type.

f CHECK THAT CHILLER AND BOILER HEATING COILS USE THE CHEAPEST ENERGY SOURCE

- For example, absorption versus a centrifugal chiller, steam versus electrical heating, gas versus fuel oil, direct versus indirect heating, hot water versus steam.

g INSTALL THERMOSTATIC CONTROLS AND TIME CLOCKS

HVAC controls that can help prevent the waste of fuel and electricity include:

- **Time switches** which ensure that systems operate only when they are needed.
- **Optimum start and stop controllers.** These are connected to internal and external sensors and calculate the optimum time to switch on (to bring the building to optimum temperature in the morning) and off (taking into account the heat stored in the building for example).
- **Weather compensators.** These control the temperature of the water flowing through radiators and adjust it according to the external temperature.
- **Zone controls.** These enable different parts of a building to be heated at different times or to different temperatures, according to factors such as occupancy and solar gain.

- **Room thermostats and thermostatic radiator valves.** These regulate temperatures in the spaces in which they are sited and prevent overheating.
- **Set-back controls.** These reduce temperatures at which heated spaces are maintained overnight or during unoccupied times.

h INSTALL OCCUPANCY-LINKED CONTROLS

- These control part or all of the room lighting, heating or cooling and power outlets serving televisions and kettles (but not mini-bars or outlets that are specifically assigned for guests to use to recharge cell phones, laptop computers and digital cameras whilst they are not in the room).
- Unoccupied rooms can, with appropriate controls, be kept at a set-back temperature which is a few degrees below or above full comfort temperature depending on the season or geographic location. The set-back temperature enables comfortable conditions to be met in a reasonably short time as well as, for example, avoiding the build up of condensation. It also reduces energy/electricity use.

Energy-saving controls. *Clockwise from top right:* thermostatic radiator valve; occupancy sensor; keycard room activation unit; in-room temperature control

ROOM-BASED KEYCARDS AND FOBS

These systems have an energy control unit located near the door in each of the controlled guest rooms into which the guest must place a keycard or key fob in order to be able to operate the controlled services. Key fob systems have a simple fob attached to the room key which must be placed in the control unit. With keycard systems, a credit-card-sized keycard is used by guests both to open the bedroom door and then to operate the energy control unit. The cards are made of plastic and usually contain a magnetic strip so that they can be read electronically.

OCCUPANCY SENSORS

These detect the presence of an occupant, and control services accordingly. Careful selection and design are required if these systems are to be foolproof in use.

CENTRAL SYSTEMS

Central control systems operate the in-room HVAC and/or lighting from the hotel reception. They rely on the key fob being 'parked' in a console at reception when not in use – removing the fob from the console activates the room heating and enables the lights and/or power outlets to be used.

These systems can link the operation of building services with the guest registration system so that when a guest registers, the temperature in the guest's room is brought automatically to full comfort level and electricity is restored to the lighting circuits. An override control in the room must be provided for the use of maids and engineers. Use of mains signalling can reduce wiring requirements.

2.3.3 Moderate to long payback periods

Below is a range of opportunities for applying heat recovery techniques within existing facilities, but you should generally expect a moderate to long payback. Because of the high cost of installing heat exchangers, any system you consider for heat recovery must have a long duty cycle. Full-time use and a correct match of load-to-supply are crucial. Grease and lint in kitchen and laundry exhausts quickly reduce heat-transfer efficiency.

a. Recovery of exhaust air heat can be achieved by using:
   - A runaround system (two heat exchanger coils connected with each other with a pump for transferring energy from the exhaust to preheat/pre-cool outside fresh air. One coil is installed in the exhaust air stream, the other in the fresh make-up air).
   - An energy wheel (a slowly rotating wheel between the exhaust and fresh air channels to transfer lost energy to the fresh air make-up. This can give efficiencies of more than 65 per cent).
   - A regenerator and heat exchanger.
   - A heat pipe (pipes between the two airstreams containing refrigerant, although this is rarely used).
b. Recovery of moisture from indoor swimming pools to heat the pool water or air. This will also reduce ventilation requirements.
c. Reclamation of heat from the chiller condenser circuit.
d. Recovery of heat from condensate or hot water before returning to the utility supplier (good payback potential).
e. Recovery of boiler flue gas energy to heat domestic hot water (circulating secondary return) or to pre-heat boiler make-up water.
f. Recovery of heat and water from refrigeration compressor cooling, which would otherwise be lost to drain.
g. Recovery of flash steam from laundry condensate. Energy from leaking steam traps is also reclaimed (this has good payback potential).
h. Heat pump.
i. Ice storage at off-peak periods reduces electricity peak demand.

2.3.4 High costs and longer payback periods

a. CO-GENERATION

Co-generation is an excellent way to conserve energy because it recovers an additional 25–50 per cent of the energy that would otherwise be lost to the atmosphere (as is the case in most power plants) and uses it to generate hot water and steam (or, in the case of tri-generation, cooling). It can therefore provide a reasonable payback. SEE APPENDIX 7

b. RENEWABLE ENERGY

The reasons for using renewable energy technology are not so much to do with energy conservation but with using non-fossil fuel generated energy that will reduce your overall ‘carbon footprint’ by reducing your CO_2 emissions. Installing alternative, renewable energy technology locally often entails a high initial cost and, depending on the technology, a long payback period.

The principal renewable energy technologies are solar photovoltaic (PV), solar thermal, wind, water, wave, geothermal, biomass, biofuels and energy generated from waste. Not all these technologies lend themselves to (or will be cost-effective for) local application in hotels as they need to have exactly the right climatic or geophysical conditions to work properly. For example, wave power generation is still at an early stage of development and would not be suitable for an individual hotel, whereas solar PV energy is used successfully by many hotels in countries around the world. Energy through wind power is a possibility, and even if the hotel is not sufficiently exposed to justify your own wind turbine, it is increasingly likely that you will be able to purchase electricity generated by large scale wind farms.

An increasing number of hoteliers are installing renewable energy technologies in order to make a contribution towards combating climate change, and because they believe that the payback on the investment comes in from the good publicity it generates. SEE APPENDIX 9

2.4 GUIDELINES FOR AREAS OF MAJOR USE

Initially it is better to concentrate your efforts on areas of major consumption, as the amount of effort required is justified by the saving potential.

2.4.1 Heating, ventilation and air-conditioning (HVAC)

The energy costs for heating, ventilation and air-conditioning (HVAC) equipment can range from 20–50 per cent of the hotel's total energy cost – the lower figure being applicable to smaller unsophisticated hotels in temperate climates and the higher figure to luxury hotels in sub-tropical and tropical countries. The potential for improving energy efficiency is, in most cases, very high, and opportunities fall into the categories described in SECTION 2.3.

a BUILDING CHARACTERISTICS

New buildings, extensions and refurbishments should be designed and built so that the heating and cooling losses will be minimal.

b MATCHING SOURCE TO LOAD

Equipment and systems are designed to satisfy full load conditions both in winter and summer. Their capacity is based on a typical day, with peak outdoor air conditions and maximum loads at the same time. Often design engineers include additional 'safety factors' in their calculations, thus increasing capacity. Sizing of major central equipment such as chillers and boilers is based on the likelihood of simultaneous full load in all areas of the building.

The normal operating mode, however, is partial load, and full load is very seldom required. Equipment operation and capacity for cooling, heating and ventilation should match changing profiles throughout the day and through the seasons without loss in efficiency.

The basic rule is that you shouldn't move any more air, water, steam or refrigerant than is needed to satisfy the load condition.

c DECREASING LOADS

You can decrease the load by:

- reducing the solar load
- reducing the amount and wattage of lighting
- reducing the internal thermal load
- reducing the use of outside air while satisfying fresh-air requirements

- diverting loads to other sources
- peak demand control
- ice storage, which constitutes a shift in load.

d REDUCING SYSTEM COST AND IMPROVING EFFICIENCY

Your aim is to:

- have highly efficient equipment throughout the load range operating at peak efficiency at all times
- be using the cheapest utility source for the requirement
- be on the best available utility rate and tariff.

e RECOVERY OF WASTE ENERGY

Opportunities to recover energy include:

- recovery of energy normally lost to the atmosphere or drain in order to preheat/cool air or water
- heat recovery on exhaust systems
- swimming pool latent heat recovery
- flash steam recovery
- condensate heat recovery
- the use of heat pumps
- condenser water heat recovery
- boiler flue heat recovery.

f OTHER TECHNIQUES

- building automation systems SEE APPENDIX 5
- co-generation and tri-generation SEE APPENDIX 7
- use of alternative energy sources. SEE APPENDICES 8 AND 9

2.4.2 Lighting

Lighting typically accounts for 15–25 per cent of the hotel's electricity consumption and, because it also emits heat, adds to the air-conditioning load. However, with recent advances in lighting, this percentage may look very different in the future. The sector is currently at a pivotal stage as it faces a steady transition from the traditional incandescent and fluorescent technologies to new technologies, such as solid-state technology including light emitting diodes (LEDs). This is primarily driven by the global effort to cut CO_2 emissions, interest in green products on the part of consumers and new lighting solutions that are fast becoming available.

Progression of energy-efficient lighting technologies

a WHAT IS A WATT?

Most people think a watt (W) is a measure of brightness and that a 100 W lamp (the correct term for a light bulb) can light a room whereas a 7 W lamp only works as a nightlight. In fact, the watt is not a measure of light output but of energy. For example, every 40 W lamp uses 40 watts of electricity for each hour of its operation, but the amount of light that 40 watts will give you can vary greatly, depending on the type of lamp.

b WHAT IS A LUMEN?

The lumen is the measure of light output: a 40 W incandescent lamp produces about 450 lumens; a 40 W fluorescent tube produces about 2,150 lumens – nearly five times as much light – all with the same 40 watts of electricity.

c WHAT IS SOLID-STATE LIGHTING?

Solid-state lighting uses chip technology to produce light. This is a different procedure to the traditional filament light (where the tungsten filament is heated up to white heat levels in order to emit light) and the fluorescent light (where a combination of toxic and passive vapours react together to emit light). The most commercial type of solid-state lighting is LED lighting.

ADVANTAGES OF FLUORESCENT OVER INCANDESCENT LAMPS

- ✓ Compact fluorescent lamps (CFLs) both **reduce CO_2 emissions** as they use less energy and **save money** (SEE FIGURE 2.8). They have been available for use in incandescent fixtures for some years. Some countries are planning to phase out the use of incandescents – for example, a 13 W compact fluorescent lamp gives the same light as a 40 W incandescent, lasts about seven times as long and uses 60–70 per cent less energy than its incandescent alternative.
- ✓ Fluorescent lamps need to be **changed only once for every ten times** you need to change an incandescent lamp.

- ✓ Fluorescent lamps **do not get as hot** as incandescent lamps, an important advantage both in terms of internal thermal loads, their suitability for recessed light fixtures and shades with delicate fabrics.

ADVANTAGES OF LEDs

- ✓ **High brightness:** LED technology is moving forward quickly and a 500 lumen single chip white LED is likely to be available in the near future.
- ✓ **High efficiency:** a lumen per watt efficacy of 120+ should also be achievable in the near future.
- ✓ Being solid-state, LED lights are very **robust** and can withstand impact and vibration and variations in operating temperature.
- ✓ LED lights run at **significantly lower running temperatures** than incandescent lights (such as halogens). Most LED lights run at around 60–70° C, compared to over 250°C for halogens. This has significant knock-on **benefits for air-conditioning running costs** and **minimising fire hazards**.
- ✓ **Colour rendition:** LED lights can produce a wide variety of light in all colours – including white. New full-spectral technology allows LED lights to produce a natural white that replicates natural daylight extremely closely.
- ✓ **Health and Safety:** unlike CFLs, LEDs do not contain mercury or other toxic substances and are therefore non-hazardous when it comes to disposal. LEDs do not emit ultra-violet or infra-red rays when lit and present less of a hazard for people with optical sensitivity. Unlike CFLs, LED lights do not flicker.
- ✓ LED lights have a **long life**, typically lasting for 35,000–40,000 hours. If they are left on for an average of 12 hours per day, they have a life of 8–10 years before replacement is required.
- ✓ **Run-up time:** LED lights take a very short time (often immediate) to reach full standard operating condition once they are switched on.

d Below are some commonly encountered terms used in lighting.

C

COLOUR RENDERING INDEX (CRI)
This refers to the colour rendering properties of light with 100 being roughly equal to sunlight. Lamps with a CRI of 80 or above ensure that colours are rendered accurately. This is particularly important where food is being prepared and served.

COLOUR TEMPERATURE (CT)
The warmth or coolness of a light source. Incandescents typically have a CT of 2,700 K. Energy-efficient CFLs are also available in a 2,700 K lamp. The higher the number the 'cooler' the light will appear – over 4,000 K will give a cool appearance. Use lamps with a warm CT for bathrooms.

CONTROL GEAR / ELECTRONIC BALLAST
Light output from fluorescent and other discharge lamps requires control gear to strike and maintain light output. This is known as ballast. High frequency control gear (ballast) eliminates the flicker associated with fluorescent tubes and extends lamp life by 50 per cent.

D

DIFFUSERS OR LOUVRES
Light fittings designed to give an alternative distribution of light.

E

EFFICACY
The measure of a lamp's light output (in lumens) in relation to its power input or electrical consumption (watts), hence lumens per watt (LPW).

I

ILLUMINATION
The distribution of light on a surface.

L

LAMPS
The term used to describe light bulbs.

LIGHT OUTPUT RATIO (LOR)
The amount of light emitted by a luminaire. Choose luminaires with a LOR of 60 per cent or more.

LUMENS
The luminosity provided by a light. A 100 watt incandescent bulb produces around 1,200 lumens.

LUMINAIRE
The light fitting into which the lamp fits.

LUX
The quantity of light incident on a surface, measured in lumens per square metre. The average illuminance required in bedrooms might be 50–100 lux, with 300 at the bed head and desk, and 150 for bathrooms, with additional light at the mirror.

W

WATTAGE
The wattage of a lamp is the number of electricity units (measured in watts) that it burns per operating hour. So, a 100 watt bulb uses 100 watts of electricity for every hour of operation, and a 10 watt light bulb 10 watts.

e LIGHTING DO'S AND DON'TS

- ✓ Reduce lighting levels where possible and **remove unnecessary lamps**.
- ✓ **Split lighting circuits into zones** so that only the parts of the room that need lighting can be illuminated.
- ✓ **Switch off lights** at times when there is **low, or no activity**.
- ✓ **Install switches, timers, dimmers, photocells** and **motion detectors**. Make sure these controls are sited at convenient locations.
- ✓ Make the most of **daylight**.
- ✓ Improve the **reflection** of lamps from walls, ceilings and floors by using lighter, brighter colours.
- ✓ **Clean** light fixtures regularly, especially where grease, lint, dust, humidity and insects can obscure the surface of the lamps over time.
- ✓ Consider your **choice of lampshade** carefully – heavy or dark shades will reduce the amount of light entering the room. Use more translucent shades for guest rooms
- ✓ Make use of **incentive schemes** offered by your national or local government to help with energy efficiency. You may qualify for a free visit by a lighting specialist.

Maximising use of daylight at the **InterContinental Hotel, Paris**

- ✓ **Check** your **building regulations** before commencing a new build or refurbishment as updated versions may impose more stringent lighting efficiency targets.
- ✓ Consider **replacing all the lamps in a lighting system together**. It will save labour, keep lumen levels high, and avoid stress to ballasts through dying lamps. Lamps can lose 20–30 per cent of their light output over their service life.
- ✓ Talk to the **people who will use the area** being lit before embarking on a re-lighting project.
- ✓ Consider the **quality of light** you want for certain areas. CFLs provide a flatter light compared with low-wattage HID sources which have more character and sparkle. LEDs provide a light that is similar to natural daylight.
- ✓ Source lamps from a **reputable manufacturer**. Many of the cheaper imports fail quickly and can be a false economy.
- ✓ Check that your supplier will **take back** old lamps and **dispose of them responsibly** or ensure they are treated as special waste. Nearly all fluorescent lamps contain small amounts of mercury. SEE SECTION 8.5

- ✗ Don't use standard A-type lamps and reflector lamps in **recessed fixtures** as they trap the light. Use a ellipsoidal reflector (type ER) which is designed to project light downwards and is twice as energy-efficient as a parabolic reflector.
- ✓ Check that the **colour rendering index (CRI)** of the lamps is appropriate for their use.
- ✓ Make sure that you have the **relevant instructions** for new lighting systems. Give staff an **induction** session so everyone understands how they work.
- ✓ Ensure that you can **override automatic controls** if necessary under special circumstances – e.g. an event where you might wish to open areas of the hotel out-of-hours.
- ✗ Don't replace lamps in **emergency lights** without first checking the power requirement as it may differ between energy-efficient lamps and battery packs. Test emergency lamps thoroughly after replacement.
- ✓ Check that your **CFLs provide 'instant' light** if this is important. Some lamps flicker or take time to come up to full strength as they switch on.
- ✓ Choose tungsten-halogen **dichroic lamps** with a **glass front cover** as it prevents the build-up of dirt on the reflector. This is a safety requirement for lamps with high pressure capsules.
- ✗ **Don't clean lamps while they are on** as they may shatter.

FIGURE 2.8
Calculating lighting costs (excluding manpower)

HOW TO WORK OUT YOUR LIGHTING COSTS

Step	Description	Calculation	Result	
1	Calculate the amount of energy used by existing incandescent lamps per day	WATTAGE × HOURS OF OPERATION PER DAY =	TOTAL DAILY ENERGY USE (kWh)	A
2	Next, calculate the amount of energy used by existing lamps each year	A × NUMBER OF DAYS OF OPERATION =	ANNUAL ENERGY USE	B
3	Then calculate the cost of electricity used by existing lamps	B × ELECTRICITY COST PER kWh =	TOTAL ELECTRICITY COSTS	C
4	Now calculate the total cost of purchasing lamps over a full year	COST PER UNIT × NUMBER OF UNITS PURCHASED =	COST OF LAMPS	D
5	Then add the total electricity costs to the cost of purchasing lamps per year	C + D =	CURRENT LIGHTING COSTS	

Notes: The total figure will not include the manpower cost of replacing lamps.

To calculate the comparative cost of **energy-efficient lamps**, perform steps 1, 2 and 3, substituting the wattage of existing lamps with that of the proposed energy-efficient varieties and the cost per unit with the cost of energy-efficient replacements. Because energy-efficient lamps can last up to ten times longer than incandescent bulbs you will need to divide the cost of purchasing lamps over a full year (Step 4) by ten before adding it to your energy costs to make a comparison.

SOURCE: greenhotelier

FIGURE 2.9

Comparative efficiency and light output of various lamps

Lamp type	Wattage	Lamp life (hours)	Lumen 120/240 Volts	Lumen/Watt 120/240 Volts	Location
INCANDESCENT	25	2,500	232 / 225	9 / 9	FOR INDOOR USE ONLY
	40	1,500	505 / 420	12 / 10	
	60	1,000	890 / 710	15 / 12	
	75	850	1,210 / 940	16 / 13	
	100	750	1,710 / 1,360	17 / 14	
	150	750	2,850 / 2,150	19 / 14	
COMPACT FLUORESCENT Wattage: lamp only / total (incl. choke)	7 / 12	8,000	400	57	
	9 / 14	8,000	600	67	
	13 / 16	8,000	900	69	
	20 / 24	10,000	1,300 / 1,000	54 / 42	
	30 / 35	10,000	2,360 / 2,000	67 / 57	
	40 / 45	10,000	3,200 / 2,700	71 / 60	
SOLID STATE	2	35,000	14	7	
	3	35,000	60	20	
	4	35,000	170	43	
	6	35,000	91	15	CAN BE USED EXTERNALLY
	9	35,000	145	16	
LOW PRESSURE SODIUM	35 / 44	18,000	4,795	137	
	90 / 113	18,000	12,690	141	
	180 / 225	18,000	32,940	183	
METAL HALIDE (CLEAR)	70 / 92	6,000	5,000	71	
	150 / 197	15,000	11,250	75	
	175 / 210	10,000	14,000	80	

2.4.3 Guest rooms

Guest rooms consume a major proportion of the hotel's energy – on average between 18 and 40 per cent of the total. Consumption for air-conditioning, ventilation and heating changes with weather conditions and occupancy. **APPENDIX 2** shows how to work out the energy consumption of guest rooms and gives benchmarks for comparison.

a HOW CAN SAVINGS BE ACHIEVED?

- **Monitor** and record energy utility consumption for 24 hours on a typical day. **Analyse** hourly consumption to identify where the peaks are during the day and whether there are any leaks.
- During periods of low occupancy, **group the rooms** in which you put your guests relative to the mechanical and electrical systems and shut off unoccupied areas. During the heating season, occupy the rooms on the sunny side of building first, and during the cooling season use the rooms on the opposite side.
- Have maids visit vacated rooms as **early as possible** in order to switch off lights and the TV and to turn down thermostats if these are not all automatically controlled on checkout.
- During **hot or cold weather**, keep curtains, blinds and shades closed to reduce heating and cooling gains and losses.

During the heating season, occupy the rooms on the sunny side of building first, and during the cooling season use the rooms on the opposite side

- Install **thermostatic control valves** on radiators.
- Consider the installation of **key-card systems** to activate power supply to the room and air-conditioning when the guest enters the room.
- See **2.4.1** for advice on **heating, ventilation and air-conditioning** savings.
- See **2.4.2** for advice on **lighting** savings.
- Purchase **integrated digital TVs** which use less energy as they do not require a separate set-top box or need to be left on standby to retain the settings.

2.4.4 Kitchens

Kitchens offer excellent opportunities for achieving energy efficiency that are often largely overlooked. They are traditionally among the least energy-efficient operations in hotels. Large amounts of utilities are wasted, often due to lack of planning at the design stage and excessive use or poor practices. Equipment is turned on in the morning and may be left on for most of the day. Compared with private restaurants, hotel kitchens can use two to three times as much energy to provide the same quantity and quality of food. They can represent 15 per cent or more of the hotel's total energy consumption.

APPENDIX 3 shows how to assess energy consumption for kitchens, and gives benchmarks for comparison.

a KEY AREAS OF CONSUMPTION

The main areas where energy is used in hotel and restaurant kitchens are:

ELECTRICITY
TO POWER EQUIPMENT FOR REQUIREMENTS SUCH AS:

- chilled, frozen and ambient storage and ice-making machines
- cooking (ovens and hobs, microwaves, toasters, deep fat fryers, extractor fans)
- ware-washing (dishes, glasses, utensils, pots and pans)
- water boilers and coffee machines etc
- lighting
- food preparation and food service equipment (peelers, slicers, food processors and hot trolleys)
- waste disposal (waste disposal units, compactors and balers)

ENERGY USED FOR:

- cooking (ovens, grills and hobs may be fuelled by gas, oil, charcoal or electricity)
- hot water provision
- ventilation, filtration and extraction

b DESIGN AND GENERAL OPERATION

- The **design** of the kitchen and restaurant areas will have a major bearing on future operating costs, including space requirements, staffing, maintenance and energy use. Designing the throughput of the kitchen (and all its components) to match the anticipated demand will give the greatest energy efficiency.
- Consider whether the kitchen operation can be **centralised** or whether you can operate fewer kitchens for the same number of outlets. This may also help to reduce the number of staff required.
- Can specific cooking operations from different kitchens be **combined** in order to run less equipment?
- **Compare the cost** of electricity, gas and steam. Gas is often much cheaper than electricity, and in many countries there is an additional penalty for electric peak demand charges. Except for a very few cases, and depending on how the electricity is generated, gas will save about 80 per cent of carbon emissions and energy costs. There is also immediate availability of full heat with gas, so early start-up time is minimised.
- Where electricity is the only power option, investigate sources of **electricity generated by renewable sources** such as wind or solar power.
- Consider installing passive solar panels for **pre-heating** water or photovoltaic panels to produce some of the electricity to heat your water.
- Consider **diverting excess steam** generated from the hotel boilers to run electrical consuming items in the kitchen.
- The kitchen area should be **metered separately** from other departments for electricity, energy and water use so that consumption can be monitored over time and improvements made. In very large kitchens it is advisable to install individual meters on large power-consuming items.

- **Match equipment operation** to your needs. Use only the size of oven that is needed for the job. Use pots and pans of appropriate size for the heating element to prevent under-use. Do not heat up several heating elements if you need only one. An electric range burner should always be smaller than the pot placed on it. Place kettles or pots close together on large heating elements to reduce heat loss. Turn heat to lower levels once boiling point has been reached.
- **Never** place hot or warm food straight into cold rooms or chilling equipment.
- **Frozen food** should be defrosted in refrigerators or cold rooms with positive temperatures. Food will thaw more easily and help to reduce power demand for the refrigerator.

c MAINTENANCE

- Not only will regular routine **checks, maintenance and servicing** according to the manufacturers recommendations ensure that the equipment is operating for optimum energy efficiency, it will also improve safety and reduce problems such as equipment break-down and the inconvenience it can cause.
- Service all cooking appliances at least **twice a year** to ensure greater efficiency and safe operation.
- **Clean** grills and grease filters daily for greater heat transfer. This is also an important fire safety precaution.

d CHILLED, FROZEN AND AMBIENT STORAGE

- Only the **minimum number** of refrigerators should be in operation at any one time. During periods of low occupancy, **consolidate** food storage and switch off units that are unlikely to be used for more than one month.
- **Walk-in chilled stores** usually consist of a chamber with a fan-assisted cooling unit near the door which should switch off automatically when the door is opened. The installation of a buzzer will alert staff to the fact that the door to the chilled store is open.
- When **receiving** frozen and pre-cooled goods, place them immediately into the appropriate storage to avoid warm-up and waste of energy for re-cooling. This is also a food hygiene requirement. Never put hot or warm food into cooling or freezing equipment.
- Keep the **frequency** of chiller and freezer **door openings** to a minimum. The air temperature in the unit can increase by as much as 0.5°C for every second the door is kept open. In older equipment, this will also lead to ice formation and lower energy efficiency. It will also create the need for more frequent defrosting – an energy-intensive operation that should be kept to a minimum.
- The entry of warm air into the cold store can be reduced by using a **plastic strip curtain**, or an air 'curtain' or blower over the door.
- To help prevent frequent door openings of walk-in chillers and freezers, consider installing a **daily working unit**. In this way, the main storage refrigeration need only be used when restocking the working fridge.
- All refrigeration equipment should be **well-insulated** to prevent heat loss or gain.
- **Defrost refrigeration appliances regularly** and check that **door seals** and **gaskets** on all equipment are working properly. Defrost in accordance with the manufacturer's instructions to ensure optimum performance and energy-efficiency.
- Check that **sensors and thermometers** are sited in the warmest part of the cabinet or chamber. Carry out air temperature checks at least once a day and keep records.
- **Storage units** are designed to maintain the temperature of pre-chilled foods and should not be used to chill them. Large volumes of food which are warmer than 4°C above the design temperature of the cabinet or cold room should be rapidly chilled in a purpose-built blast chiller before being placed in the storage cabinet.
- Situate exterior **ice making machines** and cold boxes for drinks under cover or in shaded areas. Automatic shut-down on ice-making equipment will save energy by stopping ice production when the storage bin is full.

- **Thaw food properly** prior to cooking. It takes 0.02kWh to heat one pound (454g) of minced beef from 4.5°C (its thawed temperature) to 60°C, whereas three times the amount of energy would be required to heat it from -18°C (its frozen temperature) to 60°C. Most hygiene regulations stipulate that all meats should be thoroughly defrosted before cooking for food safety reasons.
- Do not store items in front of evaporator coils and fans that will restrict **air circulation**.
- Keep coils free from **ice build-up**. The build up of ice could be due to a lack of refrigerant (caused by a leak), improperly set defrost cycles or overloading of the system through the doors being kept open or being poorly sealed.

e COOKING AND KEEPING FOOD WARM (OVENS, HOBS, GRIDDLES, MICROWAVES)

- Heating equipment should be **clustered together** and away from cooling equipment.
- Turn on cooking equipment **only when required** and switch it off, or at least turn it down, when no longer in use.
- Modern kitchen equipment takes a relatively short time to 'preheat' or come up to operating temperature. Adhere to the **manufacturer's recommendations** to avoid wasting energy. The speed by which the appliance achieves temperature will be affected by ambient temperatures and will differ for tropical and temperate climates.
- Ask staff to assess the **preheat periods** required on older equipment. Even with quite dated equipment, it is unlikely that preheat times will exceed 15 minutes. Once known, staff should be trained to turn all equipment on as required and lower the setting, or switch it off, when not required. Many older equipment models cannot easily be turned on and off so should be set to the lowest setting during periods of idleness, especially if the equipment has a large surface area.
- **Install timers** for cooking operations to shut off equipment automatically at pre-determined times.
- Consider, whenever possible, cooking at **lower temperatures**. In 1992, experiments in Canada proved that cooking meat for five hours at 121°C was up to 50% more energy-efficient than roasting it at 170°C. Cooking at the lower temperature also meant less shrinkage and therefore less loss of nutrients.
- Use a frying pan for a single customer rather than heating up an entire griddle and, where possible, use microwave cooking for **small tasks**, rather than heating up the oven.
- **Match the size** of the pan to the quantity of food to be cooked and choose the right-sized hob to fit the pan. Keep lids on wherever possible. Ensure good contact of pans (i.e. with a flat bottom) for maximum exposure to heat. Keep bottom of pots and pans clean and free from deposits and scale to facilitate good heat transfer.

Match the size of the pan to the quantity of food to be cooked and choose the right-sized hob burner/ring to fit the pan

- Where possible use **steam pressure cookers** – both cooking time and energy consumption are greatly reduced.
- In hard water areas, keep steam ovens, water boilers and kettles **free of lime scale** to ensure they operate efficiently.
- **Load and unload** ovens quickly to avoid unnecessary heat loss.
- **Check all burners** for uneven or yellow flames and adjust them.
- Consider **induction** cooking technologies when installing a new kitchen or refurbishing your existing one. To use induction hobs effectively, you may require new pans as aluminium pans cannot be used. The chef and cooking staff must also be fully trained to use the technology. Although the initial cost of the equipment will be higher, because energy is only used when the pans are placed on the hobs, the energy saved will soon pay for the investment.
- **Combination** (or combi) ovens may be an energy efficient option for some kitchens as they combine several cooking functions in one piece of equipment – dry heat (still or fan-driven) and steam which is injected into the oven when required. They can run off electric, mains gas and liquefied petroleum gas (LPG).
- Using an **'in-the-meat' thermometer** with a gauge outside the oven reduces the heat loss from opening the oven to check on cooking progress.
- **Warming tables** and lamps can be energy-intensive and their use should be kept to a minimum. They should only be pre-heated when required (as should be hot plates and bain-maries). Remember that this equipment is designed to keep hot food at the correct temperature and not to reheat cold food.

f HOT WATER PROVISION

- Use hot water only when it is necessary to maintain **hygiene standards**.
- High efficiency **condensing boilers** are the most efficient. They can convert more than 88 per cent of the fuel used into heat, compared with around 80 per cent for conventional types. These boilers have either a larger or second heat exchanger which captures the heat that would normally escape up the flue from conventional boilers. This reduces the temperature of the flue gases to a point where water vapour produced during combustion is 'condensed out'. They can run on oil, gas and liquefied petroleum gas (LPG) and can operate either as combination boilers, to heat up hot water on demand, or as conventional system boilers, where a separate hot water cylinder is required.
- **Combination boilers** provide instant hot water for hand and equipment washing as required. By separating the hot water and heating systems they enable the heating system to be turned off or down without affecting the supply of hot water.
- Check to see if the amount of **stored hot water** can be reduced. Are there any storage tanks which can be valved-off or pipe runs which can be made shorter? Disconnect any hot water taps which are not required.
- Check **timers and circulation pumps**. If they are not working properly then they may be using more energy than necessary to provide hot water.
- Ensure hot water pipe-work is **well insulated**.

g WARE-WASHING

- Try to run washers only when **full loads** can be processed and select the most economical programme for the job. When the main dishwashing rush is over, turn off the equipment and accumulate dishes until a full load is available or the next rush period occurs.
- Drying cycles on some dish-washers are very energy-intensive. Savings can be made by shortening **drying times** and using the **residual heat** from the machine instead.
- Where **steam** is available for the in-house laundry, use steam-heated (instead of electrical) exchangers for ware-washers.
- Use **softened water** in equipment to prevent the build-up of lime scale and to achieve optimum cleanliness and energy efficiency.
- Shut off the hot water booster for dishwashers and glass-washers automatically via a **solenoid valve** when the equipment is off. Ensure clean heat transfer surfaces.
- Install a **heat-recovery unit** on the dishwasher to recover energy from final rinse cycle.

h HEATING, VENTILATION AND AIR-CONDITIONING (HVAC) AND EXTRACTION

- Consider using **heat recovery** techniques in the air-conditioning plant to pre-heat water.
- Consider the use of **heat exchangers** to stop heat escaping to the atmosphere from heat-generating equipment. Heat recovery is possible on refrigeration and air-conditioning plant, as well as kitchen extraction and ventilation systems.
- Good kitchen ventilation is essential but need not be turned on at full strength at all times. **Variable frequency drives** enable exhaust fans to run at the optimum speed for keeping the kitchen free of cooking fumes and vapours.
- A **sensor-based extractor system** will assess the varying fan requirements throughout the working period (based on steam, smoke and exhaust air temperature) and adjust fan speeds automatically based on continuous assessment of actual cooking activity at each hood workstation. Systems can be retro-fitted to existing hoods in a matter of hours, with little disruption to daily kitchen services.
- **Fans** can be run at 50 per cent or less during low activity hours (9–11am and 2–6pm). At night (11.30pm–6.30am) fans can be run at 30 per cent or even turned off completely, depending on requirements.

i LIGHTING

- Good **light levels** are essential for keeping the kitchen and equipment visibly clean and checking that the food is fresh, appetising, cooked through and attractively presented. However, equal lighting levels do not have to be maintained in areas that are not in use. Turn off lights when leaving an area and in all vacant rooms.
- Ensure that **energy-efficient** lamps and fittings are installed throughout the kitchen area.
- Install **motion detectors** or **occupancy sensors** in store-rooms (especially those that are used infrequently) and in walk-in refrigeration units.
- **Turn off** lights in cold storage rooms – unnecessary lighting not only wastes energy but also increases the cooling load.
- Assign **responsibility** for turning off unnecessary lights and equipment to a member of each shift.

2.4.5 Laundry and dry cleaning

The various cleaning and finishing processes involved in a hotel laundry operation require large amounts of energy and water, while the chemicals used can cause air pollution, toxic waste and sewage problems.

The pattern of energy consumption within the department depends largely on the type of equipment in use and to a lesser extent on the type of textiles (fabrics) being processed. Washing accounts for approximately 35 per cent of the total process energy consumed in a laundry. Drying and finishing account for the rest (65 per cent).

APPENDIX 4 shows how to assess your laundry performance and gives benchmarks for comparison. A benchmark for good total energy performance in a laundry (electricity, light, ventilation and steam) would be 1.9 kWh/kg. **SEE APPENDIX 4 FIGURE 2.15**

FIGURE 2.10 shows the common areas of energy consumption in hotel laundries and how savings can be achieved.

2.4.6 Swimming pools

SEE SECTION 3.3.4

2.4.7 Spas

SEE SECTION 3.3.5

FIGURE 2.10

SOURCES OF ENERGY CONSUMPTION

LAUNDRY AND DRY CLEANING

General laundry operation

- Check that laundry **operating hours** are adapted to the actual needs of operation. Extended operation results in additional energy consumption. If restricted laundry operation is still required alter normal working hours, check if a separate small steam generator can be installed, instead of keeping large steam generators going for the laundry alone.
- Modify laundry operating hours according to the **actual load**. This will be almost directly proportional to occupancy. When occupancy is sufficiently low, check if the laundry operating hours could be reduced or if the laundry could be closed for one or two days.
- Keep a **sufficient stock** of linen so that you are covered for two days' closure over the weekend.
- Operate all equipment **fully loaded** at rated capacity. Utility consumption at partial loads is practically the same.
- Work out a **smooth schedule** of housekeeping to ensure timely flow of used linen being returned in the morning hours, instead of infrequently starting and stopping equipment.
- **Close steam supply** to the laundry at lunchtime and after normal working hours. If work continues during lunch hours, operate the maximum possible pieces of equipment. Always close the steam supply to equipment not in use.
- Immediately **repair** leaks of water, steam and compressed air.
- Once you have evaluated the total operating costs of your laundry, check whether switching to full or partial **outside laundry** services is more economical.

Laundry engineering

- Operate supply and exhaust fans in accordance with **actual operating times**.
- Stop the **compressor** for the laundry when it is not required.
- Maintain **hot water temperature** at 60°C (140°F).
- If separate hot water tanks for the laundry exist, install a **timer** to shut off the primary energy supply to the heat exchanger during off-duty hours. Start-up should be early enough to ensure that the required temperature has been reached by the time staff commence work.
- **Disconnect** the hot water circulating pump if the laundry is located near heat exchangers.
- **Redirect** water that would otherwise be lost to drain from the dry-cleaning machine. It can be used for cooling tower make-up or in the hotel gardens, but not for your domestic water supply.
- Frequently check **steam traps** to ensure they are functioning properly. Do not allow flash steam or live steam from leaking traps to get lost to the atmosphere. Install a flash steam vessel and heat exchanger to recover energy and water.
- Check for steam and condensate losses and **repair leaks** immediately. All condensate must be returned to the condensate tank.
- Ensure that good quality **dry steam** is supplied to the laundry to prevent condensate in equipment at start-up. Poor quality steam often results in steam being bypassed around traps or discharged to drain by laundry staff. Good quality steam is provided by adequate drainage of condensate to return piping within the distribution system.
- All piping should be well **insulated**.
- Watertube steam generators produce poor quality steam. Adequate **separators** must be installed at the main supply header.

Washing machines, washer extractors, tunnel washers, continuous batch washers (CBWs)

- Consider **low temperature** wash formulas. The temperature could be reduced from 85°C to 60°C by using special detergents.
- Consider using **'intermediate extraction'** between rinse operations.
- Check **temperature controls** and thermostats for proper functioning.
- Ensure that machines are **fully loaded** before running them.
- Wash **small quantities** in a small 5 kg machine and iron them by hand.
- Consider the **re-use** of water from previous rinse cycles for washing by installing temporary holding tanks. Chemicals and heating energy will also be saved.

Extractors

- Prolong the **spinning cycle** to achieve final water retention of less than 55 per cent. This will necessitate less energy for drying and the flatwork ironer.

Tumblers and dryers

- Review **tumbler operation time** to prevent over-drying. Consider the installation of a moisture sensor to stop the drying cycle automatically instead of at a pre-set time.
- Ensure proper **loading** to the equipment's rated capacity.
- Check **seals and gaskets** for proper closing and keep the tumbler doors closed after unloading to **retain heat**.
- Use **'non-reverse'** mode for bath linen, which will reduce drying time.
- Run **fewer** tumble dryers constantly instead of keeping them all going intermittently.
- Clean and maintain **lint screens/collectors** regularly and keep **steam coils** free from lint.
- Check the **time-setting** for the 'cool down' cycle.
- Check that **solenoid valves** close steam supply when tumbler is off.
- Consider installation of a **heat recovery** system.
- Consider the use of direct **gas-fired** equipment when replacing obsolete equipment.
- Have gas burners and burner blowers frequently **inspected** to ensure they are operating as efficiently as possible.

Flatwork ironer

- Check that linen has retained the correct **moisture** before feeding into the ironer.
- Operate ironer only at speeds that will enable feeders to feed linen **end-to-end** and ensure that linen dries **in one pass**.
- When feeding a small piece of work, always use **maximum number of lanes**.
- Keep ironer chests free from dirt and deposits, to guarantee maximum **heat transfer**.
- **Wax** ironer once or twice daily to minimise friction.
- Stop the machine during **staff breaks** and shut off the steam supply.
- Adjust dampers on **vacuum** fans for correct vacuum on rolls – excessive suction cools down the roll temperature.
- Check that **roll to chest pressure** is in accordance with the manufacturer's recommendation to guarantee optimum performance in drying.
- **Insulate** ironer chests to prevent unnecessary heat losses.
- Insulate the **steam piping** underneath the ironer.
- Install a **heat shield** (apron) at the front and to the rear side of the ironer.
- Install a **canopy** (hood) above the rolls, to retain the heat and properly vent to atmosphere. This prevents the build-up of heat in the laundry and retains heat inside the irons.
- Consider **heat reclamation** from vented evaporated water (steam) from linen for pre-heating the tumble dryer air supply.

Dry cleaning

- Load machine to its **rated capacity**.
- Turn all equipment off when **not in use**.
- **Re-use** cooling water. Ensure that the water flow stops automatically when machine stops.
- **Check** all seals and gaskets to ensure that no leaks occur.
- **Clean** the still tank regularly.
- **Do not exceed** the manufacturer's recommended steam pressure.
- Keep heating and cooling coils **free from lint and dirt**.

Presses

- **Do not overpad** (by putting a new pad over the old one), as this reduces heat transfer.
- **Shut off** steam supply to equipment that is not in use.

2.5 CAPITAL PROJECTS AND INVESTMENT

Once you have identified the feasibility of projects for investment through your audit, you will need to evaluate the merits of each. You may also have received proposals from various suppliers. Rapid technology developments, particularly in microprocessors, have brought about many new systems that will help you save energy.

2.5.1 Evaluating new technology

Promises for projected savings can sometimes be highly optimistic, so it is as well to have a logical process for validating the efficiency of new technology and assessing realistic savings.

The flow diagram opposite **(FIGURE 2.11)** describes how your overall decision-making process for implementing energy-conservation measures might work.

2.5.2 Simple rules for validating potential savings

- Check out the solidity and reputation of the company/ies that will supply, install and (where relevant) maintain the equipment.
- Where else has the project been successfully implemented? Check any references that you are given yourself. Are the conditions in your hotel similar enough to be able to determine suitability?
- Is there experience of this project being undertaken within the hotel industry? Is it recommended and under what conditions? Check with international hotel organisations, local consultants and government organisations.
- Can genuine savings be verified? The ECM is likely to have an application to a specific system within the hotel, so savings should be related to the actual consumption of that system, not to the total consumption figures for the hotel. For complex systems, you need to ask whether utility consumption was measured before and after the ECM installation. Temporary or permanent sub-meters will have been used for this. Take, for example, key card systems that control power to guest rooms automatically. If the salesperson predicts that by installing a key card system you will achieve a 30 per cent saving in your hotel's total electricity bill, but your energy audit reveals that guest rooms consume just 25 per cent of the hotel's total electricity, it may be that the saving prediction has been exaggerated by the salesperson.

2.5.3 Evaluation procedure

You will need to know:

- The total installed cost of the project.
- Projected annual savings and operating and maintenance cost.
- The project's expected lifetime. (Remember that today's technology may be out of date in two or three years' time.)

DECISION-MAKING PROCESS FOR INVESTMENT IN ENERGY CONSERVATION MEASURES (ECMs)

FIGURE 2.11

Questions to ask when deciding upon capital investment

At each step if the answer is yes, continue.
At any of these stages you may wish or need to seek professional advice

1. **Is it applicable?**
2. **Is it technically feasible?** Seek professional advice if necessary.
3. **Does it conform with legislation or codes of practice, or enable you to meet legislation?**
4. **Will it help improve (or not be detrimental to) comfort, operations, health and safety or food safety?**
5. **Will it help decrease the risk of breakdowns or complications?**
6. **Are the maintenance requirements acceptable and affordable?**
7. **Is it financially feasible?** Include any other benefits at this stage of your evaluation.
8. **Conduct a preliminary evaluation/study.** Seek advice if necessary.
9. **Is the project viable?**
10. **Conduct a detailed engineering study as required.**
11. **Will it affect feasibility and return on investment in view of other ECMs?**
12. **Revise evaluations if necessary.**
13. **Develop the project.** You may need professional advice.
14. **Financing – design development – specifications.**

a CALCULATING THE PAYBACK PERIOD

The simple payback period is calculated by dividing the first cost by the annual savings. For example:

First cost of flash steam recovery unit =	USD 15,000	A
Annual fuel and water savings =	USD 6,000	B
Payback period = A ÷ B =	2.5 years	

Compare the payback period with the expected lifetime of the investment in order to make some rough judgements about repayment potential. Note that a payback period of less than half the lifetime of an investment would generally be considered profitable where the lifetime is 10 years or less.

b RETURN ON INVESTMENT (ROI)

ROI is a superior way of calculating the payback period, because it takes into account the depreciation of the investment over its lifetime. For example:

First cost of flash steam recovery unit =	USD 15,000	A
Annual fuel and water savings =	USD 6,000	B
Estimated lifetime =	10 years	C
Simple payback period = A ÷ B =	2.5 years	
Depreciation charge = A ÷ C =	USD 1,500 per year	E
ROI per cent = $\left(\frac{B - E}{A}\right) \times 100$ =	30 per cent per year	

In most cases, this method is adequate. For larger investments, it is necessary to calculate a second level measure of return which makes an allowance for the value of money over time, generally in the form of a discount factor. Because of possible investment opportunities, money held today is worth more than money held in some future time period. The rate on the best available investment alternative is generally considered to be the appropriate discount rate for evaluating new investment opportunities.

2.6 MORE INFORMATION

2.6.1 Contacts

1. Building Research Establishment (BRE)
   www.bre.co.uk
2. Catering Equipment Suppliers Association
   www.cesa.org.uk
3. Centre for Alternative Technology (CAT)
   www.cat.org.uk
4. Energy Savings Trust
   www.energysavingtrust.org.uk
5. European Renewable Energy Council - EREC
   www.erec.org
6. Institute of Hospitality (IOH)
   www.instituteofhospitality.org
7. International Energy Agency (IEA)
   www.iea.org
8. International Panel on Climate Change (IPCC)
   www.ipcc.ch
9. Regional Institute of Environmental Technology (Asia)
   www.riet.org
10. Renewable Energy Association
    www.r-e-a.net
11. Sustainable Travel International
    www.sustainabletravelinternational.org
12. United Nations Environment Programme (UNEP)
    www.unep.org
13. United Nations Framework Convention on Climate Change (UNFCCC)
    www.unfccc.int
14. United Nations World Tourism Organization (UNWTO)
    www.unwto.org
15. US Environmental Protection Agency (EPA) Energy Star program
    www.energystar.gov
16. World Meteorological Organization (WMO)
    www.wmo.ch

2.6.2 Resources

1. An Inconvenient Truth
   www.takepart.com/an-inconvenient-truth/film
2. Climate Change and Tourism
   www.unwto.org/climate/index.php
3. Climate Change and Tourism: Responding to Global Challenges
   www.unwto.org/media/news/en/pdf/davos_rep_advan_summ_26_09.pdf
4. European Energy Strategy
   http://ec.europa.eu/energy/demand/legislation/buildings_en.htm#Directive
5. Enhanced Capital Allowance Energy Technology List
   etl.decc.gov.uk/etl/site.html
6. EPA ENERGY STAR™ Performance Rating Tool for Hotels
   www.energystar.gov/buildings/sector-specific-resources/hospitality-resources
7. Fuel cells 2000
   www.fuelcells.org
8. Global Environment Outlook
   www.unep.org/geo
9. The Travel Foundation Greener Accommodations Toolkit
   www.thetravelfoundation.org.uk/green_business_tools/greener_accommodations/energy
10. Kyoto Protocol
    http://unfccc.int/kyoto_protocol/items/2830.php
11. LEED certification
    www.usgbc.org/leed/certification
12. A Practical Guide to Good Practice: Managing Environmental and Social Issues in the Accommodations Sector
    www.toinitiative.org
13. Green Hotelier
    www.greenhotelier.org/category/further-reading/
14. The Carbon Trust – hotels and hospitality
    www.carbontrust.com/resources/guides/sector-based-advice/hotels-and-the-hospitality-industry
15. ISO50001 Energy Management
    www.iso.org/iso/home/standards/management-standards/iso50001.htm
16. EcoGreen Hotel
    ecogreenhotel.com/energy_management.php
17. Green Lodging News
    www.greenlodgingnews.com
18. WTTC Leading the Challenge on Climate Change
    www.wttc.org/activities/environment/leading-challenge-climate-change-report/

APPENDIX 1 How to convert energy into kWh units

It is important to use the net calorific value, not the gross calorific value in order to take into account combustion efficiency. The net calorific value for gas is approximately 11 per cent less and for fuel 4–5 per cent less. You may need to check with your supplier to ensure you are using the right figures.

In order to compare hotels with each other, the energy output from the boilers must be used. An annual efficiency of 80 per cent is assumed (relative to the net calorific value).

Kitchens	NATURAL GAS	cubic metre	×	9.3	=	kWh
		cubic feet	×	0.263	=	kWh
		therms	×	29.3	=	kWh
	LIQUID PETROLEUM GAS (LPG)	litres	×	7.0	=	kWh
		kg	×	13.9	=	kWh
Boilers (KITCHEN VALUES × 80 PER CENT)	NATURAL GAS	cubic metre	×	7.44	=	kWh
		cubic feet	×	0.21	=	kWh
		therms	×	23.4	=	kWh
	GAS OIL (35s)	litres	×	8	=	kWh
	LIGHT FUEL OIL (290s)	litres	×	8.3	=	kWh
	MEDIUM FUEL OIL (950s)	litres	×	8.4	=	kWh
	HEAVY FUEL OIL (3500s)	litres	×	8.5	=	kWh
District heating	HOT WATER	GJ	×	278	=	kWh
		MWh	×	1,000	=	kWh
		kcal	×	0.001163	=	kWh
		Gcal	×	1,163	=	kWh
	STEAM	ton	×	698	=	kWh
		kg	×	0.698	=	kWh
		MWh	×	1,000	=	kWh

Conversion factors

SEE ALSO CONVERSION TABLES, SECTION 12.2

1 MWh	=	1,000 kWh	=	3.6 GJ	=	1.4286 tons steam
1 ton steam	=	0.6 Gcal				
1 kcal	=	3.97 BTU				
1 Gcal	=	1,000,000 kcal				
1 therm	=	100,000 BTU				
1 m^3	=	35.3 cubic feet				
1 m^2	=	10.76 square feet				

APPENDIX 2 Guest rooms: Assessing current performance

You will need to know the utility consumption of the guest rooms and their access corridors only, i.e. not other areas of the hotel. You will also need to know the occupancy, including double occupancy, to calculate the number of guests.

STEP 1

Install submeters for electricity and cold and hot water.

Note that hot water is circulating, so you will need to measure on the cold water supply side.

STEP 2

Calculate the energy cost for hot water.

Typical efficiencies of hot water systems are approximately 80–85 per cent. Determine the average incoming cold water temperature and measure the hot water temperature. The required input energy is calculated as follows:

$$\text{QUANTITY} \times \left(\frac{\text{TEMP. DIFFERENCE}}{\text{EFFICIENCY}}\right) = \boxed{\text{Input energy (kWh)}}$$

For example:

$$1{,}000 \text{ litres} \times \left(\frac{60 - 12°C}{0.85}\right) = 56{,}470 \text{ Kcal} = \boxed{65.7 \text{ kWh}} \text{ A}$$

SEE APPENDIX 1 FOR CONVERSIONS

ⓘ One kg low-pressure steam contains 0.698 kWh.

$$\text{REQUIRED STEAM} = \frac{\text{A}}{0.698 \text{ kWh}} = \boxed{94.1 \text{ kg}} \text{ B}$$

ⓘ One litre of fuel oil produces approximately 12kg steam in a boiler at an assumed total annual efficiency of 80 per cent.

$$\text{REQUIRED FUEL} = \frac{\text{B}}{12 \text{ kg}} = \boxed{7.84 \text{ litres}} \text{ C}$$

ⓘ At an assumed cost of **USD 1 per litre** the total energy cost for 1 m^3 of hot water is:

$$\text{USD } 1 \times \text{C} = \boxed{\text{USD } 7.84 \text{ per } m^3 \text{ hot water}}$$

STEP 3

Measure, on a monthly basis, water (hot and cold) and electricity consumption.

This will enable you to calculate the total amounts used, including energy for hot water, and the cost.

STEP 4

Determine the energy consumption per occupied room and water consumption per guest.

STEP 5

Compare the result with the benchmark (FIGURE 2.12) and calculate the difference in percentage and money terms to see how much could be saved.

EXAMPLE 3:

CALCULATING SAVINGS FOR GUEST ROOMS USING ANNUAL CONSUMPTION FIGURES

A five-star, sub-metered, 300-room hotel in a temperate climate with full air-conditioning (fan coils), TV, hairdryer and minibar. Occupancy 70 per cent (double: 25 per cent) = 262 guests in 210 occupied rooms.

	ELECTRICITY	WATER	ENERGY FOR HOT WATER
ANNUAL CONSUMPTION	including corridors and housekeeping storage room (lights, fan coils, TV, minibar, hairdryer) = 600,600 kWh (D)	cold 17,800 m³; hot 9,200 m³; TOTAL = 27,000 m³ (E)	65.7 kWh/m³ × 9,200 m³ (F) = 604,440 kWh (G)
BENCHMARK UNITS	→ kWh/OCRM/year	→ litres/guest/day	→ kWh/guest/year
CONVERSION TO BENCHMARK UNITS	$= \frac{D}{210 \text{ OCRM}}$ = 2,860 kWh/OCRM/yr	$= \frac{E \times 1{,}000}{262 \text{ guests} \times 365}$ = 282 litres/guest/day	$= \frac{G}{262 \text{ guests}}$ = 2,307 kWh/guest/year
RATING FROM FIGURE 2.12	SATISFACTORY Excess of **11.9 per cent** above the benchmark for excellent.	HIGH Excess of **41 per cent** above the benchmark for excellent.	HIGH Excess of **46 per cent** above the benchmark for excellent.

to determine SAVING POTENTIAL

	ELECTRICITY	WATER	ENERGY FOR HOT WATER
ENERGY COSTS	assuming 0.15 USD/kWh	assuming 2.00 USD/m³	assuming 7.84 USD/m³ (from Step 2)
ANNUAL COSTS	= USD 0.15 × D = USD 90,090	= USD 2.00 × E = USD 54,000	= USD 7.84 × F = USD 72,128
SAVING POTENTIAL	11.9% EXCESS $= 90{,}090 - \left(\frac{90{,}090}{1.119}\right)$ = USD 9,581	41% EXCESS $= 54{,}000 - \left(\frac{54{,}000}{1.41}\right)$ = USD 15,702	46% EXCESS $= 72{,}128 - \left(\frac{72{,}128}{1.46}\right)$ = USD 22,725

ANNUAL SAVING POTENTIAL = USD 48,008

NOTES: THIS EXAMPLE EXCLUDES CALCULATIONS FOR HEATING AND COOLING ENERGY. IF SUB-METERS ARE INSTALLED, YOU WILL BE ABLE TO ADD POTENTIAL HEATING AND COOLING ENERGY SAVINGS TO THE TOTAL ANNUAL SAVING POTENTIAL.

COSTS ARE GIVEN FOR THIS EXAMPLE, BUT WILL DIFFER DEPENDING ON LOCAL UTILITY RATES.

Utility consumption	Efficiency rating		
	EXCELLENT	SATISFACTORY	HIGH
Electricity (kWh/OCRM/Yr)	< 2,555	2,555 – 2,920	> 2,920
Energy for hot water (kWh/guest/Yr)	< 1,580	1,580 – 2,000	> 2,000
Energy for heating (kWh/room/Yr)	< 600	600 – 650	> 650
Water (litres per guest per day)	< 200	200 – 250	> 250

NOTE: Data sourced from the International Tourism Partnership's environmental benchmarking tool, February 2008.

FIGURE 2.12
Benchmarks for guest rooms in a temperate climate

APPENDIX 3 Kitchens: Assessing current performance

You will need to know the utility consumption and cost of your kitchens, and the production in covers, including employee meals.

STEP 1 — **Install sub-meters for each utility.**
Gas is often supplied direct to kitchens. Check if any other consumers are supplied from the kitchen lines and deduct usage.

STEP 2 — **Convert energy units to kWh.**

STEP 3 — **Calculate energy consumption per cover on a monthly basis.**
Multiplying factors are given in FIGURE 2.14 to allow you to take into consideration the type of outlet being served.

STEP 4 — **Compare the result with the benchmark (FIGURE 2.13) and calculate the difference in percentage and money to see how much could be saved.**

FIGURE 2.13
Benchmarks for kitchens

Consumption per cover	Efficiency rating		
	EXCELLENT	SATISFACTORY	HIGH
Energy for cooking, dishwashing and cold storage (kWh)	< 3	3 – 4.5	> 4.5
Energy for lighting, ventilation, heating and hot water (kWh)	< 1	1 – 1.5	> 1.5
Water (litres)	< 35	35 – 45	> 45

NOTE: Data sourced from the International Tourism Partnership's environmental benchmarking tool, February 2008.

FIGURE 2.14
Benchmarks for kitchens: multiplying factors

Food service for:	Factor
Chinese restaurant	2.0
A-la-carte restaurant	1.6
Coffee shop	0.8
Banquet	0.7
Staff restaurant	0.5
Snack bar, tea lounge	0.2

NOTE: Data sourced from ITP as above.

EXAMPLE 4:

CALCULATING MONTHLY CONSUMPTION PER COVER AND POTENTIAL SAVINGS

	COOKING, DISHWASHING AND COLD STORAGE		LIGHTING AND VENTILATION	WATER	
	gas	electricity	electricity	cold	hot
MONTHLY CONSUMPTION	4,300 m^3 1 m^3 gas = 9.3 kWh = 39,990 kWh	37,900 kWh	23,550 kWh	730 m^3	410 m^3
				TOTAL = 1,140 m^3	

APPLY MULTIPLYING FACTORS TO COVERS

AVERAGE MONTHLY COVERS AT THIS HOTEL			MULTIPLIER	EQUIVALENT COVERS
Banqueting	9,850	×	0.7	6,895
Coffee shop	7,800	×	0.8	6,240
Luxury restaurant (Rotisserie)	1,800	×	1.6	2,880
Employee meals	4,200	×	0.5	2,100
TOTAL COVERS	23,650			**18,115**

	COOKING, DISHWASHING AND COLD STORAGE	LIGHTING AND VENTILATION	WATER
BENCHMARK UNITS	kWh/cover	kWh/cover	litre/cover
CONVERSION TO BENCHMARK UNITS	$= \frac{39,900 + 37,900}{18,115}$ = 4.3 kWh/cover	$= \frac{23,550}{18,115}$ = 1.3 kWh/cover	$= \frac{1,140 \times 1,000}{18,115}$ = 63 litres/cover
RATING FROM FIGURE 2.13	SATISFACTORY Excess of **43 per cent** above the benchmark for excellent.	SATISFACTORY Excess of **30 per cent** above the benchmark for excellent.	HIGH Excess of **80 per cent** above the benchmark for excellent.

to determine SAVING POTENTIAL

	COOKING, DISHWASHING AND COLD STORAGE	LIGHTING AND VENTILATION	WATER
ENERGY COSTS	assuming 0.8 USD/m^3 gas; assuming 0.15 USD/kWh	assuming 0.15 USD/kWh	assuming 2 USD/m^3 plus 7.84 USD/m^3 to heat
MONTHLY COSTS	= (USD 0.8 × 4,300) + (USD 0.15 x 37,900) = USD 9,125	= USD 0.15 × 23,550 = USD 3,533	= (USD 2 × 1,140) + (USD 7.84 × 410) = USD 5,494
SAVING POTENTIAL	43% EXCESS $= 9,125 - \left(\frac{9,125}{1.43}\right)$ = USD 2,744	30% EXCESS $= 3,533 - \left(\frac{3,533}{1.30}\right)$ = USD 815	80% EXCESS $= 5,494 - \left(\frac{5,494}{1.80}\right)$ = USD 2,441

MONTHLY SAVING POTENTIAL = USD 6,000

ANNUAL SAVING POTENTIAL = USD 72,000 (ASSUMING SIMILAR FIGURES FOR THE REST OF THE YEAR)

APPENDIX 4

Laundry: Assessing current performance

You will need to know the utility consumption and cost of your laundry, and the total daily production in kg of linen, including dry cleaning, uniforms, outside services, etc.

STEP 1 **Install sub-meters for each utility.**
Check if any other consumers are supplied from the laundry lines and deduct.

STEP 2 **Convert energy units to kWh.**

STEP 3 **Calculate, on a monthly basis, energy consumption per kg.**

STEP 4 **Compare the results with the benchmarks in FIGURE 2.15 and calculate the difference in percentage and money to see how much could be saved.**

FIGURE 2.15
Benchmarks for laundries

Consumption per kg linen	Efficiency rating		
	EXCELLENT	SATISFACTORY	HIGH
Electricity equipment only (kWh)	< 0.12	0.12 – 0.16	> 0.16
Electricity including light, ventilation (kWh)	< 0.19	0.19 – 0.28	> 0.28
Steam (kWh) 1 kg = 0.67 kWh	< 1.9	1.9 – 2.0	> 2.0
Total energy requirement (kWh)	< 2.2	2.2 – 2.5	> 2.5
Water (litres) without recovery	< 25	25 – 30	> 30
Water (litres) with recovery*	< 12	12 – 18	> 18

* WATER CONSUMPTION WITH RECOVERY MEANS WASHING MACHINES THAT RE-USE WATER FROM SPECIFIC CYCLES AGAIN VIA TEMPORARY STORAGE TANKS. TUNNEL WASHERS ARE EQUALLY EFFICIENT.

NOTE: Data sourced from the International Tourism Partnership's environmental benchmarking tool, February 2008.

EXAMPLE 5:

CALCULATING CONSUMPTION IN LAUNDRIES AND POTENTIAL SAVINGS

The following example of **consumption per kg per month** illustrates how wasteful an inefficient laundry operation can be:

	ELECTRICITY EQUIPMENT	ELECTRICITY	STEAM	WATER (without recovery system)
MONTHLY CONSUMPTION	= 7,560 kWh	including lights, ventilation, air compressor = 14,175 kWh	= 165,375 kg	cold 887 m³, hot 436 m³ = 1,323 m³
LAUNDRY PRODUCTION	47,250 kg/month			
BENCHMARK UNITS	➔ kWh/kg	➔ kWh/kg	➔ kWh/kg	➔ litres/kg
CONVERSION TO BENCHMARK UNITS	$= \frac{7,560}{47,250}$ = 0.16 kWh/kg	$= \frac{14,175}{47,250}$ = 0.30 kWh/kg	$= \frac{165,375 \times 0.698}{47,250}$ = 2.44 kWh/kg	$= \frac{1,323 \times 1,000}{47,250}$ = 28 litres/kg
RATING FROM FIGURE 2.15	SATISFACTORY Excess of **33 per cent** above the benchmark for excellent.	HIGH Excess of **58 per cent** above the benchmark for excellent.	HIGH Excess of **28 per cent** above the benchmark for excellent.	SATISFACTORY Excess of **12 per cent** above the benchmark for excellent.

to determine SAVING POTENTIAL

	ELECTRICITY EQUIPMENT	ELECTRICITY	STEAM	WATER
ENERGY COSTS	assuming 0.15 USD/kWh		assuming 1 USD/litre oil (1 litre oil gives 12 kg steam)	assuming 2 USD/m³ plus 7.84 USD/m³ to heat
MONTHLY COST	= USD 0.15 × 7,560 = USD 1,134	= USD 0.15 × 14,175 = USD 2,126	$= \text{USD } 1 \times \left(\frac{165,375}{12}\right)$ = USD 13,781	= (USD 2 × 1,323) + (USD 7.84 × 436) = USD 6,064
SAVING POTENTIAL	33% EXCESS $= 1,134 - \left(\frac{1,134}{1.33}\right)$ = USD 281	58% EXCESS $= 2,126 - \left(\frac{2,126}{1.58}\right)$ = USD 780	28% EXCESS $= 13,781 - \left(\frac{13,781}{1.28}\right)$ = USD 3,014	12% EXCESS $= 6,064 - \left(\frac{6,064}{1.12}\right)$ = USD 649

MONTHLY SAVING POTENTIAL = USD 4,724

ANNUAL SAVING POTENTIAL = USD 56,688 (ASSUMING SIMILAR PRODUCTION)

APPENDIX 5 Building automation systems

Reliable and cost-effective building automation systems have become more and more sophisticated over the past 20 years. The rapid progress in microprocessor technology and its application to the control of building plants have provided dramatically improved system performance and monitoring capability from a central computer. Comfort improvements are considerable.

These systems mainly control heating, ventilation and air-conditioning (HVAC) systems, but can also be put to other useful purposes. Major functions are:

1. Automatic control of temperature, relative humidity and pressure.
2. Automating equipment operation.
3. Graphic display of system schematics and real time values.
4. Raising of alarms in case of equipment malfunctioning or exceeding set limits.
5. Trend logs: maintaining historical data of important parameters including temperatures, pressures and operating times.
6. Recording utility consumption and providing automatic reports and analyses.
7. Electricity peak demand control and other energy management functions.
8. Remote monitoring of the entire system via intranet or WiFi.

Building automation systems allow for control strategies that were practically impossible before. Changes are made through software, and their flexibility permits the design of programmes tailored for the hotel needs. Larger hotels with HVAC control problems, high energy bills and poor alarm systems are excellent candidates for this technology. However, these systems require knowledgeable people to manage them. It is vital to ensure that the person responsible receives full and comprehensive training before using such systems.

APPENDIX 6 Chillers

WHAT ARE CHILLERS?

Most large and medium-sized hotels are cooled by chillers. Building chiller systems are designed to cool and control humidity to create a comfortable indoor climate and provide a more productive environment for guests, employees and other tenants. They form the heart of the building's air-conditioning system.

HOW DO THEY WORK?

A chiller is basically a compressor and expansion valve for creating a pressure difference together with two heat exchangers for transferring heat to lower temperatures. It uses two basic principles: a) as liquid evaporates it looses heat, and b) heat always flows from a higher to a lower temperature.

Cooling is usually supplied to air-conditioning systems by chilled water. The water is pumped around the system, picking up heat from the air handling units etc. and having the heat taken away by the chillers. In all chillers, cooling is provided by making a refrigerant boil (thus absorbing that heat) in an 'evaporator'. The heat then has to be disposed of, and there are two different chiller technologies which achieve this – either 'vapour compression' or 'absorption cooling'.

a **Vapour compression or centrifugal chillers** are the most widely-used type (**SEE FIGURE 2.16**). The refrigerant vapour that has cooled the chilled water is drawn away by a compressor and raised to a higher pressure. Because the pressure is now higher, the refrigerant will condense and give up its heat at a higher temperature – in a condenser. This means that the heat can now be given up to the atmosphere, and the pressure required is actually determined by the atmospheric temperature. The condenser may be mounted on the chiller so that the heat can be passed to a water circuit and then to the atmosphere through a cooling tower. Sometimes the refrigerant goes directly to an external condenser (an evaporative condenser or a dry-air condenser). Refrigerant from the condenser passes through a pressure restriction (usually an expansion valve) so that it returns to the lower pressure ready to cool the chilled water again.

b **Absorption chillers** (**FIGURE 2.16**) have a refrigerant that boils at low pressure to remove heat from the chilled water in exactly the same way. The condenser is also very similar, except that most absorption chillers are a standard package with the condenser mounted within the unit and the heat must be taken away by a water loop to a cooling tower or dry-air water cooler. The difference occurs in the way the pressure change is achieved. In absorption cooling, the refrigerant vapour is dissolved in a liquid, which is then raised to the higher pressure by a pump rather than a compressor – using much less energy. The refrigerant then has to be separated from the liquid, and this is done by using an external heat source (hot water, steam or gas) to distil the gas from the liquid. The hot refrigerant gas then goes off to the condenser as before, and the liquid absorbent is recycled for further use.

More common in the US and Asia than in Europe, absorption chillers have the advantage that they use less electricity for their operation and that they are quieter than vapour compression chillers. However, they do consume heat as well as electricity, so the total energy use can be higher. The chillers themselves are quiet, but the cooling towers or dry-air coolers are larger and can also be a source of noise. Absorption chillers are most applicable when the heat is available at very low cost, where excess heat is available from say, a Combined Heat and Power (CHP) plant or where electricity supplies are limited.

HOW DO THEY IMPACT ON THE ENVIRONMENT?

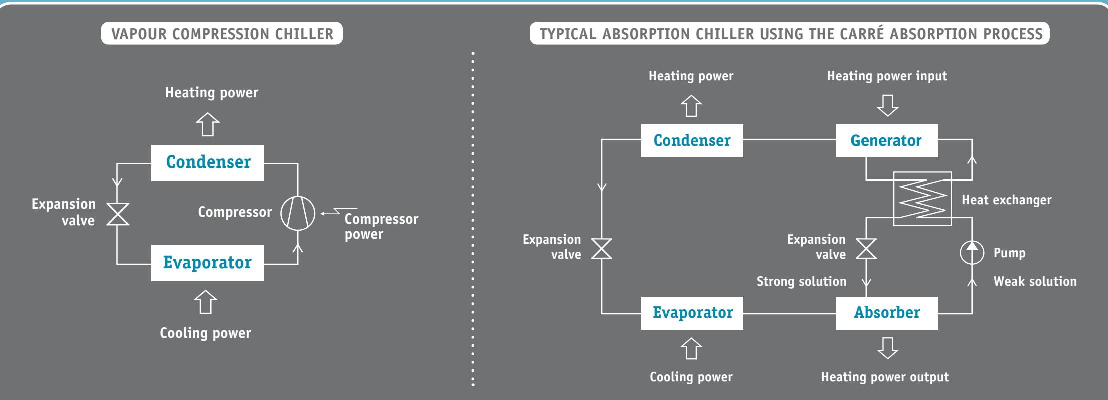
The principal environmental impacts of chillers are the emissions of greenhouse gases (i.e. CO_2) from the power used and any emissions of the refrigerant they contain. However there are other issues such as noise and vibration, air quality and even the raw materials and processes used to manufacture the chiller.

1. ENERGY USE

Depending on your geographical location, air-conditioning accounts for between 10 and 40 per cent of the total energy used in a medium or large hotel so it makes sense to ensure that your equipment is as energy-efficient as possible and also that it is maintained correctly to ensure optimum performance.

FIGURE 2.16

Illustrating different chiller technologies



SOURCE: ACHIEVING THE DESIRED INDOOR CLIMATE: ENERGY EFFICIENCY ASPECTS OF SYSTEM DESIGN. THE COMMTECH GROUP

In new buildings, the right choice and the proper commissioning of the air conditioning system are vital. The best modern chillers use around 30 per cent or less electricity compared with those available 20 years ago, although efficiencies vary widely, even from the same manufacturer. State-of-the art building automation systems further reduce operating and maintenance costs by constantly monitoring and controlling building operations and notifying managers of small problems before they become costly. They also provide a higher level of guest comfort.

If you are currently using technology that is outdated, consider replacing it with a new energy-efficient chiller. It should be able to pay for itself in electricity savings, improved reliability and lower maintenance costs in as little as five years.

A chiller's efficiency is defined by its **Coefficient of Performance (COP)**. COP is the relation between the cooling output in kWh and the energy input to operate it in kWh. The higher the COP, the more energy efficient the chiller. In UK operating conditions, the most popular chillers are air-cooled and offer a COP of around 2.5, while some standard high-efficiency models are available with a COP of up to 3.2.

In addition to the COP, an important consideration in selecting a chiller for a hotel application is whether it offers **heat recovery**. The heat is normally wasted through being rejected to the atmosphere, but this need not be the case as the heat can be recovered and used to pre-heat water for heating and domestic use – such as for boilers or the laundry.

The heat recovery option on a chiller can add 10–15 per cent to the purchase price; however, this would quickly be recouped through the energy cost saved on the water heating. In addition, the chiller fans do not need to operate continually to reject the heat and this could make the chiller operation itself more energy-efficient (by increasing the COP). It also helps to eliminate open cooling towers, thereby reducing water consumption and the risk of contamination.

A 'desuperheater' is a less costly heat recovery system that is built into the chiller and can provide heat at 60°C, although in much smaller quantities.

Building energy consumption can be significantly reduced at the time of chiller replacement through **other cooling system improvements**. These can include the use of variable speed drives on fans and pumps, improved cooling towers, evaporative coolers, and improved controls. Always aim to use the generated heat elsewhere in the building.

You can also **reduce the cooling load** with lighting system retrofits, better insulation, and new windows. Reducing cooling load and improving cooling system efficiency will enable you to downsize the new chiller, thereby cutting capital cost and increasing overall operating efficiency. Comprehensive projects along these lines are known as 'integrated chiller retrofits'.

Decisions to replace chillers or reduce cooling loads through different measures should be made as part of an overall in-house energy management programme and/or with specialist advice on energy optimisation.

2. REFRIGERANT

SEE SECTION 5.3.8

3. BACTERIOLOGICAL CONTAMINATION

SEE SECTION 5.2.5

4. NOISE

SEE SECTION 5.4

5. SIZE

The size of the equipment is dependent on the hotel's peak cooling needs. Reducing those needs by taking energy efficiency measures will also reduce the size of the chiller. The new generation of chillers are smaller than ever before. This not only frees up space back-of-house, but requires fewer resources to produce and transport them.

ISSUES TO CONSIDER

1. EXISTING SYSTEMS

a. Focus on maintaining the equipment's **peak performance** and **minimal refrigerant emissions**. Any refrigerant is environmentally safe so long as it is never emitted, and all refrigerants require careful handling to avoid worker exposure. The goal of near-zero refrigerant emissions is possible with new equipment, modern refrigerant monitoring technology, and a proper maintenance programme. Computerised controls and building automation systems can cost-effectively sustain and document the performance of the chiller plant.

   The most **energy-efficient new chillers** will reduce electricity generation and associated greenhouse gas emissions by up to 50 per cent or more compared with the older chillers they replace. Leaking equipment frequently operates undercharged, requiring additional energy to achieve the same cooling.

b. **Reducing your cooling needs** lessens the operating time for the chillers, in some cases with lower peak demand. This will reduce your operating costs and increase the life of the equipment.

2. CHOOSING NEW EQUIPMENT

a. When investigating new chiller systems, insist that financial calculations consider both **partial and full-load** operation, that the performance of the equipment based on **alternative refrigerants** is compared, and that available **energy efficiency options** are considered, including variable speed motor drives, heat recovery, and free-cooling which uses cold outside temperatures instead of chillers for cooling at certain times of the year. Select the investment with the best LCCP with emissions minimised.

b. For **smaller buildings**, new screw chiller technologies with high full and part-load energy efficiency are replacing existing centrifugal chillers primarily in the smaller tonnage ranges. These chillers are ideal for buildings with highly variable daily cooling loads.

c. In many countries, **financing** for integrated chiller retrofits may be available from regional or national energy authorities, electricity utilities, equipment suppliers, and commercial lenders. Building owners around the world have saved millions of dollars in electricity bills by upgrading air conditioning chiller installations and through concurrent investments to reduce building cooling load.

d. Make sure you have already implemented ways to **lower your cooling needs**. This will enable you to install a smaller chiller, which will require less capital outlay and will have lower operating costs. Lower cooling costs will also increase the building's resale and rental value.

APPENDIX 7 Co-generation

Co-generation or combined heat and power generation (CHP) is on-site power generation which makes use of the simultaneous production of electricity and heat. It can also be harnessed to provide cooling, in a process known as tri-generation or CCHP (combined cooling, heating and power generation). In order to maximise the benefits of CHP, systems should be based according to the heat demand of the application. CHP systems are used in individual buildings, factories and cities served by district heat/cooling. Because the heat is utilised, the efficiency of cogeneration plant can reach 90 per cent or more, and the energy savings can range between 15 and 40 per cent when compared against the supply of electricity and heat from conventional power stations and boilers.

In a typical co-generation project, an engine fuelled by natural gas, diesel or light oil, or a reciprocating engine (motor with pistons) is used to drive a generator, and the heat that is rejected from the engine is used for producing hot water and winter heating, etc. The savings result from the electricity produced and the simultaneous use of free heat energy, which would otherwise have been lost to the atmosphere. The load on the hotel's boiler or district heat source is reduced, and, in many cases, this increased efficiency enables on-site power to compete economically with utility power.

To improve the thermal efficiency of an on-site energy system, most of the rejected heat must be recovered and put to useful purposes. The most convenient source of this recoverable heat is the rejected heat to the jacket water or cooling system. The other source of recoverable heat is the exhaust.

SEE FIGURE 2.17

FEASIBILITY: IS IT SUITABLE FOR YOUR HOTEL?

In general, internal-use co-generation projects are best sited at hotels with electric and thermal load throughout the year and where electric and thermal loads are co-incident on both a daily and seasonal basis. The closer the match between simultaneous power and heat requirements, the greater will be the system's efficiency.

You will need to determine the **technical feasibility** of such a system, which is based on compatibility between the CHP system and the hotel's mechanical and electrical systems, and the **economic feasibility**, based on cost and possible savings.

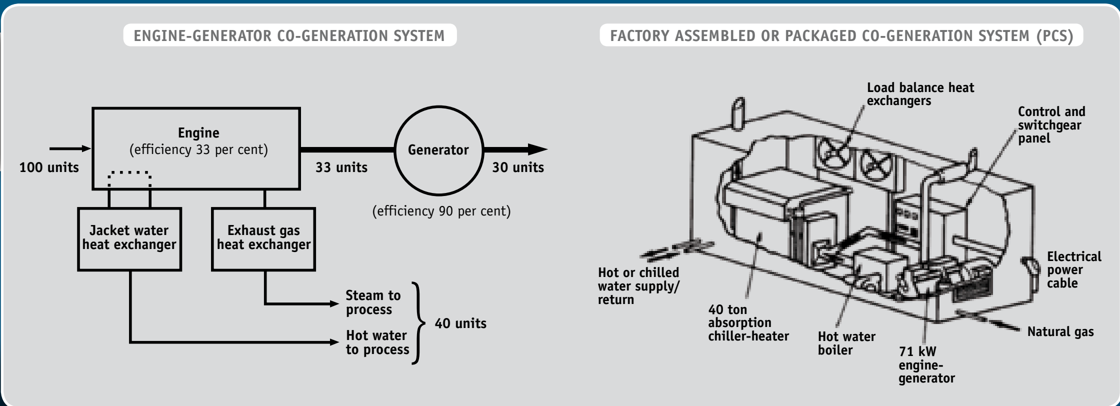
The first questions to be answered are:

1. Is the plant permitted by local authorities?
2. Does the plant create an internal problem, such as noise or emissions that may re-enter the hotel?
3. Is there adequate space for the equipment?
4. Is there sufficient thermal demand for the heat produced by the CHP plant?
5. Does the local power company encourage the use of on-site power generation? Some utility companies may view it as direct loss of revenue.
6. How does the cost of fuel/gas/diesel relate to the cost of purchased power? What is the likely development?
7. Can reliable maintenance be guaranteed and at what cost?
8. How will the plant be financed? Who will own and operate the plant?
9. Are there any tax incentives or exemptions available for installing such a system?

The analysis for technical and economic feasibility is extremely important, as co-generation systems that produce significant savings in one hotel may be completely inappropriate for another one.

FIGURE 2.17

Types of co-generation systems



APPENDIX 8 Fuel cells

A fuel cell is an electrochemical device that combines hydrogen and oxygen to produce electricity, with water and heat as its by-product. As long as fuel is supplied, the fuel cell will continue to generate power. Since the conversion of the fuel to energy takes place through an electrochemical process and without the need for combustion, the process is clean, quiet and very efficient – two to three times more efficient than burning fuel.

If hydrogen is used, the only waste product is hot water, making fuel cells suitable for certain forms of co-generation. Currently the hydrogen is not commercially available from renewable sources and has to be created from carbon-based fuels, so fuel cells are not totally CO_2 emission-free. However, if natural gas is used to create the hydrogen, fuel cells are appreciably lower in emissions than conventional boilers.

In addition to low or zero emissions, benefits include high efficiency and reliability, multi-fuel capability, siting flexibility, durability, and ease of maintenance. Fuel cells can also be 'scaled up' and can be stacked until the desired power output is reached.

A number of larger hotels, particularly in the US, have installed fuel cells and have greatly reduced both their energy costs and their CO_2 emissions as a result.

SEE CASE STUDY 11.2.12

APPENDIX 9 Renewable energy technologies

Renewable energy makes use of the energy flows that occur naturally and continuously in the environment, such as energy from the sun, wind, waves or tides for example. In a world concerned with the impact of its CO_2 and other emissions, renewable energy offers a sustainable, low or no-carbon alternative to fossil-fuel generated energy without the inherent problems of nuclear power generation.

Renewable energy is still at a comparatively early stage of development, but the market is developing rapidly and these technologies have become more affordable in recent years. By 2004, renewables accounted for 13.1 per cent of the world's total primary energy supply (nearly 80 per cent of which was combustible renewables and waste and 16.7 per cent hydro power).[12]

The use of some renewable technologies (such as wind and solar power) has grown proportionally faster than any other electricity supply technology. In the past 20 years, the wind energy industry has grown from producing small machines for remote power applications into a modern, multi-billion dollar industry supplying grid-connected power. Consequently, the cost of wind-generated electricity has dropped seven-fold, making it competitive with most fossil fuel technologies in locations with a good wind resource. Since 1971 the use of wind power has grown by 48 per cent and solar by 28 per cent.

Some forms of renewable energy are more efficient than others, for example, hydro-plants convert around 90 per cent of the potential energy of the running water into electrical energy whilst solar PV cells are currently around 10–15 per cent efficient.

RENEWABLE ENERGY IN HOTELS

When combined with energy-efficient practices, the purchase of 'green' electricity from generating companies that use renewable energy sources can help to significantly lower the overall carbon footprint of your hotel. Some renewable technologies also lend themselves to application on-site, enabling hotels to generate their own renewable power. The benefits not only include the potential for lower energy bills but also the opportunity to be seen to be committed to more sustainable operation. Many governments now provide financial incentives or 'tax-breaks' for companies wishing to invest in their own renewable energy projects.

Renewable energy technologies that are most likely to be suitable for local application by hotels – given the right climatic and geophysical conditions are:

a) **Solar** – capturing and harnessing the sun's energy in one of three main ways:
   - **passive** solar design so that a building's form and fabric captures or avoids the sun's energy and reduces the need for artificial light and heating
   - **active** or **solar thermal** conversion of solar radiation into heat (e.g. to heat water) which can be used directly or stored. Fluid beneath the solar panel's dark surface absorbs the sun's heat and transfers it to a heat exchanger
   - **solar photovoltaic (PV)** panels containing solar cells which convert daylight into electricity.

b) **Wind** – using local wind turbines to convert the kinetic energy in the wind into electrical energy.

c) **Geothermal** – using either:
   - **geothermal energy** from deep within the earth, transferred using water in the form of steam, hot springs, or geothermal reservoirs.
   - **ground-source heat** (typically a fairly constant 10–20°C) at a shallow depth. This can be increased to 40–50°C with the use of heat pumps and is suitable for low-temperature heating systems such as under-floor systems and radiant panels. The pumps can also extract heat to provide cooling.

d) **Hydro** – electrical energy using the flow of water through a turbine with a generator. Derived from water flowing in rivers, or from man-made installations where water flows from a high-level reservoir down through a tunnel and away from the dam. There can be serious social and environmental implications in damming rivers for large-scale hydroelectric plants, but smaller systems and 'in-line' hydro using the flow of the river can be very suitable for hotels.

e) **Biomass** – using plant matter or other biological material either as a solid fuel, or converting it into liquid or gaseous forms to produce electric power, heat or fuels.

[12] **Source:** Renewables in Global Energy Supply fact sheet, International Energy Agency, January 2007 **www.iea.org/textbase/papers/2006/renewable_factsheet.pdf**

APPENDIX 9
.../continued

APPLICATIONS

Hotels can apply these technologies in the following ways:

a Natural or 'passive' design

How a building is oriented can make a great difference to its energy use, operating costs and the comfort of its occupants over its lifetime. The main passive design techniques hotels can use for new buildings, extensions and refurbishment are:

- **Passive solar** for heating or cooling – where the building envelope either takes advantage of the sun's heat to reduce the need for mechanical heating, or shields the building to lessen dependence on other cooling systems.
- **Natural daylight** – by maximising the amount of light entering the building it is possible to reduce the amount of electric lighting required. In hotter climates it may be necessary to shade the building and prevent light entering during the day.
- **Natural ventilation** – using the natural flow of air across the building to provide ventilation, cooling and a comfortable indoor environment. This can reduce or obviate the need for air-conditioning especially when combined with careful shading and appropriate use of vegetation.

All these techniques can be optimised by the use of intelligent systems that help the building respond automatically to external conditions.

Resorts in remote locations (particularly on islands) where there is no grid-supplied electricity often rely on diesel generators. In hot countries, the lack of insulation quickly lifts the temperature inside rooms, requiring considerable use of electrical power for air-conditioning to keep it at a comfortable level. Effective passive design techniques combined with the use of fans can eliminate the need for air conditioning. Combining these techniques with locally-generated renewable energy can considerably lower operating costs.

b Purchasing green electricity

It is worth checking with your utility company how it generates its electricity, and possibly changing suppliers to one that generates electricity from renewables. Increased demand provides a powerful incentive for these companies to invest further in renewable electricity generation.

Not only can you use green electricity inside the hotel, but you can also use it elsewhere in the resort such as for powering and recharging electric carts to provide a renewable alternative to cars for getting around the resort.

c Biomass

There are three forms of biomass fuel:

- **Solid** – for example wood, in log form or compacted into pellets made from sawdust and other wood waste, used in boilers. Wood chip biomass is widely used as a fuel source in Europe and so long as regrowth and replanting take place, it is regarded as being CO_2 neutral since the emissions equate to the CO_2 absorbed by the timber while it is growing.
- **Liquid** – either biodiesel produced from the oil of crops such as oilseed rape, sunflowers and soybeans, and from waste cooking oils; or bioethanol made from starch plants (such as corn, wheat and cassava), sugar plants (beet and cane) and cellulose plants (trees). Liquid biomass is used for boilers or vehicles.
- **Gas (biogas or digester gas)** – the methane created by the anaerobic conversion of crops, food or animal waste can be used in boilers or vehicles. It can reduce CO_2 emissions by around 95 per cent compared with diesel, as well as creating 80 per cent lower nitrous oxide emissions and zero particulate emissions.[13]

d On-site generation

Some renewable energy technologies are suitable for application locally in a scaled-down form, making them suitable for use either at individual hotels and resorts or entire destinations, depending on the prevailing climatic and physical conditions. FIGURE 2.18 shows the renewable technologies that are the most appropriate on a small-scale. In some locations, it may be possible to use a mix of technologies (such as solar and wind).

If there is sufficient space, you may wish to consider allowing an energy company to install renewable generating equipment such as a wind turbine at your property. This would enable you to negotiate a long term supply agreement, without having to make the investment yourself.

[13] Source: Energy Savings Trust: www.energysavingtrust.org.uk/fleet/technology/alternativefuels/biogas/

APPENDIX 9
.../continued

FIGURE 2.18
On-site renewable technologies most suitable for hotels

Technology	Suitable for	Advantages
Biomass	Small, medium and large hotels and offices. Can be combined with CHP generation	CO_2-neutral. Low-emission combustion, even in very small appliances. Can be retrofitted to replace oil or solid fuel boilers. Transportation is cost-effective and storage is safe and convenient
Solar thermal	Heating or cooling accommodation of all sizes. Also used for desalination	Modern solar thermal systems work in both daylight and sunlight. Relatively short payback period. Vacuum tubes are more effective for heating water than flat plate collectors, particularly in cloudy conditions
Solar photo voltaic (PV)	Properties of all sizes. Heating, cooling and powering water pumps. PV panels may require planning permission	Good for remote locations where delivering fuel is difficult or expensive. Ideal for cooling as the peak demand coincides with peak solar radiation. Near silent operation. Visible demonstration of commitment to renewable energy
Wind power	Locations with sufficient wind speeds and space for safe operation. Generally requires planning permission	Technology developments have made wind power increasingly affordable and effective. Visible demonstration of commitment to renewable energy
Small scale hydro	Hotels or resorts with streams running through or near property. Requires an abstraction license	Potentially one of the most efficient and cost effective power sources, given the right site
Geothermal – ground source heat pumps	New buildings, particularly for underfloor heating. Retrofitting is best undertaken during major refurbishment	Constant source of heat 365 days a year. Typically three to five times more efficient than electric heating and twice as efficient as gas boilers
Geothermal	Any size of property	Cheap, reliable source of hot water, heat and electricity

EXAMPLE 6

ASSESSING THE VIABILITY OF SOLAR PV ENERGY

The photovoltaic (PV) process converts sunlight directly into electricity. PV equipment has no moving parts, requires minimal maintenance and the electricity is generated with no emissions and no noise.

A PV cell consists of two or more thin layers of semi-conducting material, most commonly silicon. When the cell is exposed to light, electrical charges are generated which can be conducted away by metal contacts as direct current (DC).

The electrical output from a single cell is small, so multiple cells have to be connected together to provide a useful output. The cells are encapsulated (usually behind glass) to form a weatherproof module or panel. These panels can be connected together to provide coverage for sufficient solar exposure.

The energy output of solar PV panels is normally measured in peak Watts (Wp). A 100 Wp panel will produce a maximum of 100 W in peak conditions (i.e. 1 kW per m^2 of solar irradiation) which is the equivalent of a sunny mid-summer day in the tropics or a temperate zone. Typically a 1 kWp array will produce 750 kWh/year.

To calculate whether solar PV technology is viable you need to evaluate:

1. The likely average efficiency of the panels in your climatic zone.
2. What you are currently paying for your electricity in kWh.
3. Whether those costs are likely to go up or down in the future.
4. How many panels you would require and what the installation cost would be.
5. The payback time versus the expected life of the equipment.
6. You will then need to consider whether the payback period exceeds the life of the equipment and to take depreciation into account.

APPENDIX 10 Carbon offsetting[14] and The Hotel Carbon Measurement Initiative

Carbon offsetting has become popular in recent years, particularly with consumers in western countries who are concerned about reducing the negative effects of their energy-intensive lifestyles and economies on the environment and who wish to reduce their carbon 'footprint'.

Various sectors within the travel and tourism industry have been enthusiastic in embracing the concept and an increasing number of hotels around the world now claim that they are 'carbon neutral' by offsetting their emissions. Where businesses have made every effort to reduce CO_2 emissions through an energy management programme, offsetting can help them feel more comfortable about the remaining emissions that are unavoidable.

WHAT IS CARBON OFFSETTING?

a. Offsetting is a means through which greenhouse gas emissions (GHGs) can be mitigated or 'offset' and its use has become widespread since the mid-2000s. Many travellers now offset the GHG emissions from their personal air travel for example.

b. The early method of offsetting carbon was simply to plant trees, but more sophisticated offsets now include support for renewable energy and energy conservation projects in developing countries and even offsets in methane capture projects.

c. The concept of paying for emission reductions to be made somewhere else is similar to that of emissions trading. Whilst emissions trading is regulated by a strict formal and legal framework, carbon offsets generally refer to voluntary acts by individuals or companies that are arranged by commercial or not-for-profit carbon-offset providers. The quantity and varying quality of available schemes has proved controversial, but some formal standards for voluntary carbon offsets are now beginning to emerge. With so many schemes and very little in the way of verification, those who wish to offset their CO_2 emissions should use a provider with a good reputation.

d. The Kyoto Protocol established a Clean Development Mechanism (CDM) which validates and measures carbon offset projects to ensure that the benefits they claim are authentic and that they are genuinely 'additional' activities that would not otherwise be undertaken. Organisations that have difficulties in meeting their emissions quota are able to offset by buying CDM-approved Certified Emissions Reductions. The CDM encourages projects that involve, for example, sustainable power generation, changes in land use, and forestry, although not all trading countries allow their companies to buy all types of credit.

THE HOTEL CARBON MEASUREMENT INITIATIVE

Hotels wishing to calculate their carbon footprint are recommended to use the Hotel Carbon Measurement Initiative (HCMI).

Developed by the International Tourism Partnership, World Travel & Tourism Council, KPMG and 23 global hotel companies, HCMI is a methodology and tool which enables hotels to measure and report on the carbon footprint of a guest stay or meeting / event in a consistent way.

Increasingly corporate customers are asking for the carbon footprint of their stay or events they organise through their RFPs. Now, thanks to HCMI, over 17,000 hotels worldwide are able to provide this information to customers in a consistent fashion, and the number is steadily increasing.

To request a free copy of the methodology and Excel calculation tool, email:

info@hotelcarboninitiative.org

[14] Much of the information in this appendix has been sourced from the Carbon Trust website. See **www.carbontrust.co.uk**