Efficient Air Conditioning

EarthCheck

Providing clients with comfortable, climate controlled facilities is an important feature of many tourism operations. Air conditioning units and systems are commonly used to achieve space heating and cooling as well as to condition the air by removing dust and dirt and adjusting the humidity. The use of air conditioners varies significantly within the tourism sector and depends greatly on climate and for some sectors such as hotels, air conditioning can contribute up to 50% of their overall energy use[1].

How does an air conditioner work?

To understand how best to operate an air conditioning unit or system efficiently it is important to know how they work. Air conditioners use a refrigerant that absorbs heat (within **evaporator coils**) from air in the space needing to be cooled. The warm refrigerant then flows to a **compressor** that increases the pressure of this warm gas. The warm, pressurised refrigerant then circulates to the **condenser coils** where the pressure is reduced and the gas cools by releasing heat to the outside air or water flowing over the condenser coils. The cooled refrigerant then flows back to the evaporator where the cycle starts again. In reverse cycle systems (also known as heat pumps) the refrigerant cycle is reversed and the heat is extracted from the outside air and released into the air conditioned space for heating purposes.

Types of air conditioning systems

The components of air conditioning systems are either housed in a **single unit** that is typically installed into a wall or window that opens to the outside or come as packaged or central systems. In a **packaged split system** the condenser and compressor are located outside (to reduce the noise typically made by single units) and have lines connecting them to indoor evaporators. **Packaged ducted systems** are similar but have the compressor, condenser and evaporator located outside and air is simply ducted throughout the building. **Central plant systems** have multiple packaged units that are usually housed in a dedicated room with an outside condenser that is air or water cooled (using cooling towers). Central plant systems are typically used by large tourism operations wanting 100 kW cooling capacity or more[2].

Is your air conditioning unit or system energy efficient?

What is the energy efficiency rating of your system?

While energy efficient air conditioning units or systems are typically more expensive to purchase, the energy savings generally give a short payback period[3]. If your air conditioning system is over 10 years old the power savings made from replacing it with an energy efficient model is often highly cost effective. Most central and ductless air conditioning systems will have an energy efficiency rating calculated by dividing the system's cooling or heating output by its power consumption throughout the season and is based on your countries standard load and climate. This is known as the **Seasonal Energy Efficiency Ratio (SEER)**. Older systems often have a SEER of 6 or less while the minimum in most countries is now 13 or more. The SEER of systems can reach as high as 20 making them 3 times more efficient than older models! Single units are rated by an **Energy Efficiency Ratio (EER)** which is calculated in the same way as the SEER but on 'peak days' (the hottest days specific to the country of operation). Again in most countries an EER of 13 or more is desirable.

Is your unit or system correctly sized and located?

Air conditioning service providers should always perform a cooling or heat load calculation to determine proper sizing. An undersized air conditioning system will be inefficient while an oversized system will cool or heat an area quickly but will then cycle on and off resulting in higher operating and maintenance costs to add to the initial higher capital costs.

In determining the location of your unit or system is important to ensure:

- Efficient condenser heat exchange by providing adequate air flow and locating condenser coils in a cool, shaded area. Air

Case Study:

The Taj Residency Hotel
Bangalore, India

The Taj Residency Hotel increased the efficiency of its air conditioning compressor by 20% by replacing an old reciprocating plant, which was continually cycling on and off, with a new screw compressor that operates more efficiently at part loads.

Other actions taken:

Installing Variable Frequency Drive starters on motors of the air handling unit and chiller secondary pumps so they can operate over many speeds as opposed to a single or two-speed motor starter.

Ensuring heat exchanged across the air conditioners condenser coils is efficient by de-scaling them regularly and closely monitoring the levels of dissolved solids in the chilled water.

Heat absorbed by the air-conditioning refrigerant is expelled to chilled water from the cooling tower that flows over the air conditioners condenser coils.

Monitoring the temperature of chilled water in and out of the condenser by the Building Management System, helped to assess the load on the air conditioning plant.

Replacing pumps used for air conditioning and building plumbing with high efficiency pumps that adjust their performance (i.e. speed) with demand **saving about 250-300 kWh per day.**

should be able to flow freely around the condenser and not be obstructed.
- Optimum temperature settings are maintained by locating the thermostat away from heat sources such as windows and providing adequate supply ducts for cool air and return ducts for warm air.
- Heat loss is reduced by minimising piping and ducts.
- Internal and external noise is considered and minimised.
- Adequate space is provided for maintenance.

Is your unit or system suitable for your operating conditions?

It is important to consider air conditioning energy efficiency under different operating conditions. If your air conditioning system will be operating for long periods, during which time the cooling or heating requirements (or load) will vary considerably, the system's compressors should be able to operate effectively at part loads. Sites with existing compressors operating inefficiently at part loads could investigate the viability of replacing the compressor or installing a **Variable Speed Drive (VSD)** that will adjust the compressor's motor speed to continually match the load.

Are your air conditioning ducts insulated and not leaking air?

If your air conditioning ducts are located in ceilings or basements which are not air conditioned, they may be at risk of undetected air leaks, drawing in dust, pollen and losing heat or cool air through their walls. This combination of leaks and heat conduction losses means that a great deal of your air conditioning energy consumption is being wasted.

Check for leaks by visually inspecting duct connections and piping for leaking air, water, rust, rips or breaks and connections or joints that have come apart. Feel around connections and joints for cool air escaping. If you are concerned leaks may be significant, contract your service provider to conduct a more precise leak test using pressure and air flow monitoring to determine the size of any leaks and their location.

Insulate ducts - existing poorly insulated ducts can be wrapped in duct wrap. Newer ducts will often come with an R (resistance) insulation rating. In addition to saving energy, insulation will help maintain a constant temperature, reduce noise levels and prevent condensation.

Is your building designed to reduce the loss of heated or cooled air and solar gain?

While ventilation is important, windows and doors can allow drafts into and air leaks out of, air conditioned areas increasing the amount of energy consumed for cooling or heating.

Check for, and seal, any leaks along windows and door frames using sealants, foam or rubber strips, brush strips, screw-on external doors or compression threshold strips (extruded aluminium section fitted with a rubber seal). Seal floor gaps and don't forget other room penetrations such as around electrical outlets or mounted air conditioners that are externally mounted. Ensure seals are regularly maintained and not degraded.

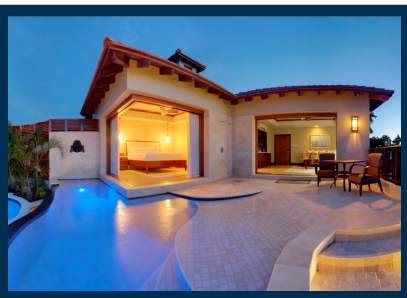
Keep in mind some ventilation is important to maintain sufficient air turn over for spaces to remove contaminants, odours, water and carbon dioxide.

Reduce building heat gain by:

- Retrofitting single pane windows with multiple window panes that put a seal of air or gas between the panes of glass acting as an insulator.
- Covering the window with a reflective pane or a transparent low-emissivity (low-e) coating that reflects heat while still allowing light to transfer through the glass.
- Ensuring all windows have internal curtains and blinds or external awnings to reflect sunlight and reduce solar ingress into air conditioned spaces.
- Installing air curtains or automatic closing doors to minimise loss of cool air from areas that must be kept open or have high traffic.
- Investigating natural landscaping options to help reduce heat input by providing shade. Try planting deciduous trees or vines that will provide shade during summer while allowing light in through winter.
- Installing roof, wall and floor insulation to help keep heat in during winter and prevent heat entering during summer. Insulation works in different ways with some trapping air within their bulky structure while others reflect radiant heat away.

Did you know?

Insulation is given an R-value or U-rating. The higher the R value the more resistant the insulation is to heat flow. In some cases a U-rating may be used which measures the transfer of heat through the material rather than the resistance to heat transfer.



Case Study:

The Sandals Regency La Toc Golf Resort and Spa in St Lucia, West Indies

Sandals Regency La Toc Golf Resort and Spa installed air curtains on their entertainment desk, jewellery store and boutique whose front doors remain open constantly to attract customers.

Actions taken:

Air curtains are powered by a fan that forces air from the top of the door to the bottom to create an invisible barrier that prevents around 75-85% of air conditioned air exiting, if they are well designed and correctly installed. They also have the additional benefits of keeping out dust and insects.[4]

Are you operating your air conditioning unit or system efficiently?

Can you switch off your air conditioning in areas that are not occupied?

Air conditioning left operating in areas not in use is of concern for tourism operations, especially where guests have full operational control, which can result in systems being left running for prolonged periods of time, often with doors and windows left open.

Some operators designate specific **air conditioning zones** whereby unoccupied areas are 'zoned off'. This can be achieved by **training housekeeping staff** and requesting guests to switch off air conditioning in rooms not in use. Alternatively, automated systems can be used that are linked to thermostats which can block the air flow to zoned areas and maintain corrects temperature in occupied areas.

Larger accommodation operations often use an automated **Building Management System (BMS).** BMS's can control guest rooms as well as common spaces such as offices, restaurants and conference rooms that that require a system to respond quickly to a range of thermal comfort requirements.

BMS's allow for full manipulation of temperature settings and the operation of air conditioning from the reception desk. This gives the system a longer time to reach comfortable conditions and eliminates false set offs which can occur with sensors. Most BMS's includes functions to track the operation and conditions in rooms which can be used to assist management with understanding the benefits of other changes or additions to room control.

Other options include:

- **electronic access cards** for guest rooms that automatically turn off the room's air conditioning when guests exit a room. Energy can also be saved by shortening the time it takes for control circuits to turn it off after guests leave the room.
- **sensors** that sense heat (infrared), movement or carbon dioxide levels emitted occupants to determine when to cycle air conditioning on and off.
- **balcony and door switches** to temporarily turn the air conditioning off when the door is open.

Case Study:

The Alto Hotel, Melbourne, Australia

The Alto Hotel installed split system air conditioning units in all guest rooms. The units use inverter and movement sensor technology. The invertors continually adjust the capacity of the air conditioning systems, rather than on/off control, making the units 35% more efficient, and movement sensors reduce the air conditioning cycles when there is no-one in the room.

Other actions taken:

Energy consumption for heating and cooling has also been reduced by:

- Using layers of floor covering to improve insulation including a 5mm layer of recycled car tyres
- Using heat reflection in glass doors
- Double glazing 95% of all windows
- Energy efficient compact fluorescent or LED light globes on 95% of lights
- Using energy saving key-tags which switch off power to the room (and air conditioning) when unoccupied

Are air conditioning thermostats set for optimal energy savings?

Thermostats set at 24–25°C in summer and 17-19°C in winter provide optimal comfort and energy savings. Consider conducting trials adjusting the thermostat settings on your air conditioning system. For every 1°C (1.8F) decrease in the temperature set point you can make during winter it may be possible to reduce energy use by 15%. Similarly in summer every 1°C (1.8F) increase will decrease energy use by 10%[5].

Remember if your system vents have adjustable louvers, make sure they are directed towards the ceiling when cooling and down towards the floor when heating as cool air falls and hot air rises.

Do you turn off heat generating equipment when cooling?

Remove any unnecessary heat generating equipment from air conditioned spaces and turn off heat generating equipment and lighting, especially halogen down lights, when they are not needed to reduce cooling requirements.

Do you clean and maintain your air conditioning systems?

As a working machine, air conditioning systems require regular cleaning and maintenance by a suitably qualified member of staff or air conditioning service provider. Make sure the following maintenance is carried out as a minimum:

- clean and inspect the evaporators to ensure efficient heat transfer
- clean and inspect the condenser coils of dirt and debris that may block air flow
- clean and inspect fins and straighten if necessary
- check refrigerant levels and recharge if levels are low (leak detectors can be used to locate a leak)
- clean and inspect the air vents and air ducts (seal any leaks)
- check oil and belts of compressor motor
- check the thermostats are recording the correct temperatures
- check the system's electric control sequence and electric terminals[6]

Service provider contracts

Discuss the option of incorporating energy and water performance requirements into your service provider contracts. This will provide an incentive to contractors to ensure your system is operating efficiently, saving you money and reducing your environmental impacts.

Cooling or heating alternatives

Evaporative coolers draw outside air through a wet pad and then blow it through a building, forcing hot internal air out through vents or windows. They work better in hot, dry climates as they add humidity to the air. While they consume considerably more water and require more maintenance, they can use four times less electricity to operate[7].

Combined Heat and Power Systems (CHP) produce power (usually electricity) and heat in a single operation. A CHP can produce electricity on site using a wide range of energy streams such waste heat, solar, biogas, LPG, natural gas, coal and oil[8]. Heat is also recovered from the hot exhaust gas (from fuel or biogas turbines) or steam (from boiler driven steam turbines) and then used for heating water as well as for space heating and cooling. This type of technology is especially viable in areas where electricity rates are high but fuel costs low.

Fans create air movement which evaporates moisture from the skin providing a cooling effect. Fans used in conjunction with air conditioning can decrease the temperature as much as 4°C potentially resulting in lower air conditioning requirements[9].

Natural ventilation replaces warm air inside a building with cooler air from outside using natural differences in pressure and temperature. Take advantage of natural convection flows and allow for the direct flow of air. If natural ventilation is not sufficient due to the building's design, aspect or location warm air can be extracted using exhaust fans so cooler outside air can then be drawn in through windows.

References

[1] Bohdanowicz P. and Martinac I., 2002, Thermal Comfort and Energy Saving in the Hotel Industry ***http://www.greenthehotels.com/eng/BohdanowiczMartinacKansas2002.pdf***

[2] SEAV, 2004, Refrigerated Air Conditioning Systems ***www.seav.vic.gov.au/manufacturing/sustainable_manufacturing/resource.asp?action=show_resource&resourcetype=2&resourceid=21***

[3] Australian Department of the Environment, Water, Heritage and the Arts, 2007, Tips for Choosing an Efficient Air Conditioner ***www.energyrating.gov.au/acl.html***

[4] 2VV, 2009, Why invest in an air curtain?, Accessed Jan 2010: ***http://www.2vv.cz/index.actuality.php?view=101***

[5] SEAV, 2004, HVAC Tips ***http://www.seav.vic.gov.au/manufacturing/sustainable_manufacturing/resource.asp?action=show_resource&resourcetype=2&resourceid=46***

[6] US Department of Energy, 1999, Energy Efficient Air Conditioning ***www.pueblo.gsa.gov/cic_text/housing/aircond/aircond.htm***

[7] California Energy Commission, 2006, Evaporative Cooling, ***www.consumerenergycenter.org/home/heating_cooling/evaporative.html***

[8] Energy Conservation Systems, 2009, Greener Air Conditioning ***http://www.ecsaustralia.com/aircon.php***

[9] Engineering Extension, 2001, Space Heating and Cooling, ***www.engext.ksu.edu/ees/henergy/space/air.html#fans***