8 – Energy efficiency in swimming pools

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The range of pool facilities is vast, from the smallest spa pool to a large Olympic sized facility. While all of these have quite different energy costs, the
heating and treating of water in all swimming pools makes consumption patterns similar.

This guide has been developed to help pool managers and operators ensure that energy is managed efficiently in their swimming pools. With the complex range of associated building services and their considerable energy demand, it is important that opportunities for both carbon and cost savings are highlighted.

All of the technologies discussed in this guide can yield significant savings. This guidance will also help you to:

- Assess the potential for carbon savings and indicate key areas for improvement
- Raise awareness of carbon emissions amongst staff and motivate them to reduce waste
- Appraise the overall energy performance of a swimming pool.

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Why reduce your carbon footprint?

- Save money and increase profits
- Provide better conditions for staff and pool users
- Help combat climate change by cutting carbon emissions
- Help meet local and national sustainability targets
- Attract more customers by demonstrating a social responsibility forreducing carbon emissions.

Energy consumption
Swimming pool water needs to be continually heated in order to overcome the cooling effect of evaporation and maintain comfortable temperatures.
It must also be continuously filtered and treated, so it is not surprising that pools are significant users of energy. Pool halls and changing areas are typically kept warmer than other spaces as pool users are wet and wear less clothing. Moreover, bathers consume large volumes of shower water, which adds to the overall energy consumption of pool facilities. Using energy efficiently can save up to 25% of overall operating costs of a typical swimming pool. Implementing good energy management techniques can minimise consumption without lowering the standard of service to users.
In order to achieve the greatest savings potential, pool hall managers should know where the majority of their energy is being consumed. Typical common areas for attention within a swimming pool are:

- Space heating and ventilation
- Water heating and treatment
- Lighting
- Motors and drives (particularly for pool pumps and filtration equipment).

In each of the key consumption areas, there are three main opportunities to save energy:

Control – all energy-consuming equipment should be controlled carefully to give the required conditions and switched off when not required.
Maintenance – a number of energy efficiency measures can be carried out as part of routine maintenance for little or no extra cost.
Refurbishment – energy saving measures taken when planning major building refurbishment can be extremely cost-effective.

In most swimming pools, energy is supplied in two forms: fossil fuel (gas, oil, coal or LPG) and electricity. For the majority of sites, space heating and hot water is supplied by fossil fuel. However, some facilities only have access to electricity or use it more extensively. Electricity is also used for lighting, electrical equipment, fans and pumps.

Reducing electricity consumption should take a high priority in an energy efficiency plan as it has higher cost and carbon emissions per kWh used than most fossil fuels. Moreover, most electricity wastage is within the control of end users and can be minimised through good energy management and increased awareness

Energy benchmarking
Benchmarking allows a pool manager to compare energy performance with other similar pool buildings across the UK and, over time, with their own previous performance. Calculating a benchmark based on energy consumption per unit of floor area of a pool hall allows direct comparison with other facilities, giving managers an idea of how energy efficient their pool is. The most recent benchmark figures for swimming pools were published in 2001 in the Carbon Trust publication Energy use in sports and recreation buildings (ECG078). Although these figures are a little dated, they can still be used as a rough guide to performance relative to other organisations. There are lots of opportunities for saving energy and, therefore, money and carbon emissions. Many of these require little or no cost, although others require some investment. The following section gives details of opportunities relevant to all pools.

Pool halls – space heating and ventilation
Space heating and ventilation accounts for a large proportion of energy use in pool halls – which means that there are big opportunities to make savings. However, it is important to ensure that the primary functions of the heating, ventilation and air conditioning system are not compromised
Ventilating and heating pool halls can be rather complex and it is essential to manage these services correctly. The control of evaporation from the water is a function not normally encountered in standard heating, ventilation and air conditioning (HVAC) systems, and can therefore be misunderstood by designers and operators.

The ventilation system is normally the primary (or only) means of:

- Controlling the pool hall air quality, temperature and humidity so as to reduce evaporation from the pool and prevent condensation (and, potentially, corrosion damage).
- Maintaining comfortable environmental conditions for different occupants.
- Removing contaminants from the air.

Comfort requirements
Maintaining satisfactory environmental conditions in the pool hall and all other areas of the building is crucial to the comfort of bathers, lifeguards, staff and spectators. It is also essential if the pool is to operate successfully over its working life.

In addition to the fact that pool users are wet and wearing less clothing, they will also experience evaporation as they dry, which gives a cooling effect. As a result, higher than usual air temperatures need to be maintained. Evaporation also depends on the relative humidity in the air, but bathers are relatively tolerant of changes in humidity provided that air movement is minimised, for instance, by avoiding draughts.

Heating and ventilation of the pool hall has to account for a wide range of factors such as the number of bathers, water temperature, insulation of the pool hall and integration with the building structure. Air and water temperature should be set relative to each other to optimise user comfort and minimise evaporation from the pool water. Above all, humidity and moisture content in the pool hall needs to be controlled to avoid condensation.

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Air movement
A pool hall air circulation system needs to distribute air effectively so that:

- Comfortable temperatures are provided for occupants
- Air movement is controlled so it does not produce uncomfortable draughts
- Smells produced by water treatment are removed/reduced
- Evaporation and condensation is minimised.

There are three locations within the pool hall where these issues should be addressed and each one is examined in more detail below. These are: the pool surface, the poolside and other areas, such as upper walls and the ceiling void.

Pool surface
The key elements to be addressed at the pool surface are to remove contaminants if they could affect bathers, to provide bathers with oxygen for respiration and to control evaporation.

- Remove contaminants – sometimes unpleasant to smell, the odours caused by the water treatment process can be an irritant to eyes, nose and respiratory system and unhealthy. While pools need and effective ventilation system to remove contaminants, the first line of action is to control the water treatment process itself. Follow the guidance given by PWTAG.
- Respiration – bathers need to be able to breathe comfortably; however, as in other spaces, this requirement is usually met adequately by air diffusion within the pool hall. Special consideration may have to be given to pools where competitive swimmers exercise.
- Evaporation control – air movement at the pool surface encourages evaporation to occur. Therefore, it is better to avoid deliberate air movement such as directing air onto the pool from jets built into the ductwork if other comfort requirements can be met without constantly

refreshing the air at the pool surface. Angle jets towards the sides of the pool hall away from the surface of the water. One proposed way of moving air comes from Germany where they create a zone someway above the pool surface of dry warm air that acts to draw air from the water surface in a gentle yet effective way without causing unusual evaporation

Poolside
The comfort of the bather (before entering and after leaving the pool) and on the poolside staff is the key elements to be addressed at the poolside. Most of the people who use the pool hall will be wet, so the poolside temperature should be adjusted accordingly. This can be assisted, for example, by redirecting any grilles and jets near the poolside to avoid any direct air flow from the ventilation system.

Staff should also be discouraged from opening doors or windows, which creates draughts. Discourage poolside staff from opening emergency escape doors for their own personal comfort. If localised cooling is required, increased air movement can provide this, such as through simple overhead fans. Use controls to avoid increasing air movement at the pool surface or around wet bathers.

Temperatures elsewhere in the swimming pool building, such as café areas, the foyer, administration offices and plant rooms should be appropriate for the activities taking place

Other areas in the pool building
Outside air normally has much less moisture in it than pool hall air as it has a lower temperature. Mixing outside air with pool hall air can reduce overall humidity

The key elements to be addressed in other areas of the pool hall are protecting the pool hall structure from condensation and providing comfort to non-swimmers.

One solution to both problems is to provide separate airflows for the pool and other areas to minimise mixing between areas. In a new pool building, the airflow could be directed upwards from a slot at the foot of the walls in 'laminar flow', so that it mixes as little as possible with the bulk of air in the hall. For existing pool buildings, inlet grilles and jets can be repositioned so that drier air entering the pool hall can be pointed towards the sides of the building rather than down on to the pool.

Comfort for spectators can be improved by having a similar arrangement to direct drier incoming air over them. It may also be appropriate to blow drier air into ceiling voids to ensure that condensation does not occur on hidden parts of the structure.

These approaches that separate air flow within the space have clear advantages over a traditional system in which all the air flows are mixed, demanding that all air in the pool hall be brought down to the limiting moisture content demanded for structural protection.

Controlling condensation
As air temperature increases, it can hold more moisture in the form of invisible water vapour. Pool hall temperatures can hold more moisture than air at ordinary room temperatures, causing condensation to occur as the warmer, moist air moves over cooler surfaces.

Condensation is rarely an issue in most buildings and even then is predominantly a cosmetic problem which can be caught before it does too much damage.

Swimming pools, however, have additional complications. For example, the condensate may contain aggressive chemicals from the water treatment process or there may be a suspended ceiling concealing the structure, so that damage may occur unnoticed.

There are two ways to avoid this happening:

- Insulate the cold surface on which condensation might occur so that the surface temperature is always above the dew point. The 'dew point' refers to the temperature at which the air is saturated with water vapour, corresponding to 100% relative humidity – as the air temperature falls towards dew point this is when condensation occurs. The insulation should preferably be located outside the structure so that the whole of it remains warm.
- Reduce the moisture in the air so that the relative humidity is less than 100% when it contacts the cold surface.

Safety first
Condensation-related damage can occur out of sight and pool roofs have been known to collapse due to undetected corrosion. Invariably the cause is Stress Corrosion Cracking of stainless steel. It is important to carry out regular preventive checks and always consult a qualified specialist where necessary

Controlling humidity
Regardless of whether air flow patterns have been arranged to reduce evaporation, it is important to control moisture condensing on cold surfaces by
limiting humidity. The alternative methods of dehumidification are:

- To dilute the air close to surfaces which are prone to condensation with dry air from outside the building
- To directly dehumidify the air.

Dilution
Outside air normally has much less moisture in it than pool hall air as it has a lower temperature. Mixing outside air with pool hall air can reduce overall humidity. The outside air has to be heated up to the pool hall temperature to make it comfortable for bathers, which uses energy. To make room for this incoming air, the air already in the pool hall must be

extracted. Pool hall air has a high temperature and also contains the latent heat of the moisture evaporated from the pool so it can be wasteful. However, some of this energy can be captured and returned to the pool hall, thus achieving savings (see the heat recovery section). The volume of incoming air used to dilute the pool hall air can be reduced to the minimum consistent with avoiding condensation by using variable speed fans.

Direct dehumidification
This approach strips moisture out of the air within the pool hall system, rather than simply diluting it with outside air. In this way, the heat required to
maintain conditions in the pool hall is reduced to what is needed to replace direct losses through the building structure and the heat needed to warm fresh air needed for respiration.

The two main ways to achieve this are through the use of a dehumidifying heat pump or a desiccant wheel.

The cost effectiveness of both options needs to be evaluated carefully in life cycle terms. In either case they need to be able to cope with the corrosive air they have to handle, which can considerably reduce plant lifespan if not addressed. In addition, both options need to be controlled to achieve the correct function, and the control regime must be understood by plant operators as direct dehumidification is a radically different approach from that traditionally employed.

Dehumidifying heat pumps
A dehumidifying heat pump consists of an electrically driven heat pump where air from the pool hall passes over the evaporator or cold coil. Moisture condenses out of the air at the same time as it is cooled and the water is run to drains (or can be stored for cleaning or toilet flushing). The air is then
reheated by passing it over the condenser or hot coil of the heat pump. Thus the air is dehumidified and returned to the pool hall at the right comfort temperature.

The considerable latent heat in the air being dehumidified produces a surplus that can be used to heat the pool. This can make up for the cooling effect caused by surface water evaporation from the pool in ordinary use. The recycling of otherwise wasted energy from the latent heat of the air used to heat the pool water makes this system highly energy efficient.

If the pool already has a heat pump dehumidification system installed, make sure that:

- The controls are set up as recommended by the original installer
- Recovered heat is returned to both pool hall air and pool water
- The dehumidified air returns to the pool hall and is not exhausted to outside
- Cooling coils are clear from blockages or corrosion so that air flow through them is not impeded

Desiccant wheels
A desiccant wheel passes air from the pool hall through a disc comprising a hygroscopic honeycomb matrix which absorbs the moisture. Thus the air is dehumidified and returned to the pool hall without much change in temperature. The disc rotates and a separate hot (usually gas-fired) stream of air is passed through it to remove the moisture and recharge the wheel ready for its next pass through the pool hall extract air-stream. The hot air is
discharged from the building with the water vapour.

A plate heat exchanger or run-around coils can be used to recover some of this waste heat, to preheat incoming fresh air to the pool hall.

If the pool already has a desiccant wheel dehumidification system installed, make sure that:

- The controls are set up as recommended by the original installer to reduce the humidity only to that level required to avoid condensation on the structure
- The hygroscopic material is still actively absorbing moisture
- Heating of the hygroscopic material is limited to the amount needed to regenerate it, in order to avoid waste.

Although humidification control (using dehumidifiers for example) can control pool hall humidity conditions, this does not replace the need for adequate ventilation to control air quality.

Ventilation rates and controls
The ideal ventilation rate for a pool hall varies in accordance with a number of factors such as the number of bathers, evaporation rate and water quality at any given time. A recommended guideline figure of 10 litres of ventilation air per second, per square metre of total pool hall area (water area plus all wet surrounds) is acceptable for a wide range of pool complexes. This normally results in an overall total of approximately 4–6 air changes per hour depending on the height of the pool hall.

Ideally, the speed of the ventilation fans should be controlled using variable speed drives (VSDs) linked to a dew point sensor. This optimises the speed of the fans to keep the moisture content of the air in the pool hall just above the dew point at which condensation occurs. Place the sensor so as to avoid condensation on the worst ‘cold bridge’ in the structure. A cold bridge is formed where the thermal insulation barrier is breached, leaving a bridge that short-circuits the thermal insulation and results in a colder surface than the surrounding area. In a pool building, this will usually be a window frame or structural steel. As an alternative to dew point sensors, a relative humidity sensor can be employed to control the air supply. It should be reset depending on the outside temperature. When the outside temperature is below freezing, for example, the relative humidity required to avoid internal condensation will be lower than in milder weather or summer. Note that these sensors require frequent recalibration.

Heat recovery

Heating the supply air is generally one of the major consumption areas for a pool building. Providing a simple heat exchange device, such as a plate heat exchanger or run-around coils, can optimise energy efficiency by reclaiming large amounts of lost energy from the exhaust air.

Fit heat exchangers with a bypass in the ductwork for occasions when heat recovery is not required. However, make periodic checks to ensure that they are not permanently bypassed and normally operate in the ‘heat recovery’ position.

Plate heat exchangers
Plate heat exchangers consist of glass, metal or plastic plates arranged in a stack with the exhaust air and incoming air flowing in the adjacent channels. Heat transfers from the outgoing air from the pool hall (which is warm and moist) through the plates to the cold incoming air. They are cheap and free from mechanical problems, although a limit on their application is that the incoming and outgoing air ducts must be adjacent to each other. If grease and grime are allowed to build up on the plates this will lead to a substantial reduction in their effectiveness, so the heat exchanger should be maintained in accordance with manufacturers’ specifications. If the plates are made of metal, chlorinated air can attack them. Inspect for signs of corrosion at least once a year.

Rotary heat exchangers
Rotary heat exchangers or ‘thermal wheels’ are honeycomb meshes that slowly rotate and alternately pass through the outgoing warm air stream (where they absorb heat) and then through the incoming cool air (where they release heat). They can save considerable energy, although their application again depends on the incoming and outgoing air ducts being adjacent to each other. The honeycomb mesh has to be chosen carefully to be compatible with the moist, chemically aggressive condition of the pool hall air extract.

Rotary heat exchangers have particular maintenance requirements associated with their drive and seal mechanisms yet are very effective and popular. Where the wheel is easily visible, a daily check should be made to confirm that it is rotating at the manufacturer’s recommended rate. In addition, check every six months that:

- The wheel is rotating at the correct speed
- The bearings are lubricated
- The seals are in good condition
- There are no signs of corrosion
- The honeycomb mesh is clean.

It is important that rotary heat exchangers are inspected. If they stop rotating and become blocked, ventilation will be significantly reduced which could lead to condensation in the building structure with serious consequences.

Run-around coils
In this device, two pipe coils are connected by a pumped water circuit. One coil is placed in the extract duct to pick up waste heat, the other in the

supply duct to pre-heat incoming air. The advantage of this system is that the two ducts do not have to be adjacent and so it can be retrofitted to an existing ductwork installation. If heat recovery is not required, the pump can be turned off.

The disadvantage of this system is that it is not as effective as other heat recovery methods owing to heat losses from pipework between the two coils and the energy used to drive the pump.

Note
All heat recovery devices should be carefully evaluated over the projected life cycle of the building services installation. They may save heat energy (usually fossil fuel) but increase electricity usage in the fan motor, which is more carbon intensive

Other considerations

Choice of heat source
When undertaking refurbishment, specify high efficiency condensing boilers or consider installing combined heat and power (CHP). This is covered later.

Ductwork and dampers
Ductwork should be checked annually to ensure that:

- It is internally clean and free of leaks, especially at duct junctions
- Insulation is sound
- Flexible connections between ducts and fans or other plant are not taut or split. If dust is found, this may indicate leaks or loose panels elsewhere, or failure of filters, and should be investigated. It is essential to either remove or protect any sensors when ductwork is cleaned.

Dampers are used to control whether air is routed through one duct or another, the proportion of fresh to re-circulated air, and the emergency cut off
to stop air movement in case of fire. Checks should be conducted to ensure:

- They are operating correctly in accordance with the control strategy (at some pools they have been found to be operating in the opposite direction to that intended)
- They are lubricated regularly to avoid being jammed in one position.

Correct control
Make sure appropriate time and temperature control regimes are in operation and consider interlocked controls so that heating and cooling cannot operate at the same time. It is essential to understand the consequences before changing any temperature or humidity settings in order to avoid damaging the building fabric. Always consult a qualified technician.

Pool water – heating and treatment
Water heating is essential for efficient operation of the pool, showers and other facilities in a pool building. Since the pool water itself is re-circulated

continuously, it needs to be disinfected. Although the chemical treatment of pool water is not considered in this guide, its quality and the associated processes do have energy consumption implications

Pool water heating
The heating of pool water is a relatively simple operation which is generally carried out by the introduction of a heat exchanger to transfer heat from the primary heating system, sometimes via heat recovery systems, to the pool water. The heater is typically sized, based on raising the pool water temperature by 0.5°C per hour (to adjust temperature and 'make good' heat lost by, for example, evaporation and backwashing).

If a pool is being heated from cold, the rate must be no more than 0.25°C per hour, otherwise the expansion of materials may cause problems to the pool structure or lining. Correctly specified and operated controls are the key to efficient pool heating.

Ideal water and air temperatures
There has been a consistent trend towards higher water temperatures in recent years to increase pool custom. Currently, main pool temperatures tend to be set around 29–30°C. Some pools do need to be this warm, for instance when catering for parents and toddlers or for rehabilitation purposes. However, operators tempted to increase temperatures should bear in mind that this creates a number of problems.
For example:

- Microorganisms multiply faster – up to twice as fast for a rise of 10 degrees C;
- Bathers get hotter – limiting serious swimming and increasing sweat and grease in the water;
- Increased perspiration will add to the levels of ammonia and urea in the pool, producing more combined chlorine. Chlorine demand will increase simply to maintain free chlorine levels;
- Raised urea levels will increase the production of irritant nitrogen trichloride. This will need to be dealt with;
- Dissolved gases become less soluble – more bad smells (chloramines) and potentially harmful trihalomethanes; and pH value rises as carbon dioxide escapes;
- Energy costs, direct and indirect, are higher – whatever efficiency or conservation methods are used;
- Air temperatures, which are linked to those of the water, rise too – making the atmosphere less comfortable for staff and others (as can the higher moisture levels); and
- There is more moisture in the pool atmosphere, even when relative humidity is controlled at the same level – with a risk of condensation and possibly corrosion and deterioration of the building fabric, structure and equipment

With an increasingly wide variety of pool activities taking place, and with operators attempting to introduce more flexibility into pool operation programming, it is difficult to select a single appropriate or optimum operating temperature for any particular pool. The large volumes of water involved make it impossible to vary water temperatures to a great extent in any one area. This means that selection and accurate control of the optimum water temperature for each pool is essential.

The air temperature in the pool hall should be similar to the water temperature – ideally 1°C above. This helps reduce evaporation and convection of heat at the pool surface. It also makes it more comfortable for bathers leaving the pool. Air temperatures of 30°C or more should generally be avoided.

Recommended water temperatures
Competitive swimming and diving, fitness swimming, training
26ºC to 28ºC
Recreational swimming, adult teaching
27ºC to 29ºC
Leisure waters
28ºC to 30º
Children's teaching
29ºC to 31ºC
Babies, young children, disabled and infirm
30ºC to 32ºC
Hydrotherapy
30ºC to 35ºC
Spa pools
30ºC to 40ºC

Evaporation
There is a direct link between the energy consumption of ventilation systems and evaporation of water vapour from the pool. The amount of heat energy in the pool which is lost to evaporation depends on the air conditions immediately above the pool. This energy, together with a small amount of heat loss through conduction and radiation, represents a major part of the energy exchange from the pool to the pool hall air. Controlling this is therefore key to saving energy. The rate of evaporation from the pool depends on the difference between the moisture content of the air at the water surface, the moisture in the air just above the surface and also the air velocity. If the air above the surface can be as stationary as possible, it will become saturated and evaporation will be minimised. If the air moves, however, drier air will enter the space immediately above the pool, the moisture difference will increase and evaporation will increase. Thus the key to reducing evaporation is to minimise the air movement immediately above the pool. This will inevitably conflict with bathing activity in the area, so some evaporation will always take place when the pool is occupied. This is why the pool hall air must be continually heated even after it has been warmed up, to maintain bather comfort. There must be some movement of air from the water surface for this is needed to remove the potentially harmful chloramines and trihalomethanes that are a natural consequence of pool water disinfection. The key is to encourage a natural flow of air from the relatively wet air at the water surface to a drier area of heated air someway, perhaps 3m above the water surface.

Evaporation is also increased if the water is sprayed or agitated by water features such as wave machines or flumes, because the surface area is increased. To prevent wastage, limit the use of water features, rather than operating them continuously. As well as reducing evaporation, this will also reduce pumping energy and provide a more varied swimming environment. When the pool is unoccupied it may still be necessary to run the pool ventilation system to maintain environmental conditions within the pool hall to prevent condensation.

Pool covers
The use of pool covers out of hours reduces the evaporation rate from the pool surface and can save significant amounts of energy in swimming pools.

- The lower evaporation rate reduces the energy needed to keep the pool water heated to the required temperature and the resulting reduction in energy use is significant.
- The reduced evaporation lessens the need for high ventilation rates and air heating in the pool hall can be reduced or shut off. This allows the air circulation system to be shut off, or turned down to a very low rate, when the covers are on.

In practice, some water may get on to the top of the pool cover and there may be some evaporation at the sides where the cover does not quite fit. There may also be some residual moisture in the air after the cover has been deployed so it may still be necessary to run the ventilation system at a low setting. Nevertheless, an effective pool cover will reduce the need for dehumidification out of hours and therefore substantially reduce energy consumption. Even where covers do not match the shape of a free form pool, they are still worthwhile: evaporation is still reduced in proportion to the area covered and hence yields energy and cost savings

A wide variety of covers is available, including motorised models which can be withdrawn to the side or bottom of the pool to minimise the labour input at changeover. When selecting a suitable cover, consider the following factors:

- Resistance to water treatment chemicals and UV light
- Strong and durable materials and construction
- Good insulation properties and suitable fitting
- Storage ability and ease of use
- Safety requirements for staff and pool users.

Pool covers also provide additional benefits in terms of building maintenance. A reduction in pool hall humidity and condensation can help to prolong the life of the structure and reduce building maintenance.

It is important to train staff to use covers properly – and regularly – in order to achieve maximum energy savings. Ensure staff and lifeguards have adequate safety training to ensure that they know what to do should anybody become trapped on top of or underneath a cover.

Did you know?
Insulated pool covers are one of the most cost effective investments

available to swimming pool managers. Typical savings can be 10–30% of total pool energy use with a payback period of 18 months to three years.

Backwashing filters and dilution

Backwashing refers to a process where the flow of the pool water through the filter is reversed to flush out the accumulated debris, such as dead microorganisms, skin cells, and dirt in the filter.

Dilution with fresh water

Disinfection and filtration will not remove all pollutants in swimming pool water. Indeed, there are some complex byproducts that will largely resist both processes. So the design of a swimming pool should recognise the need to dilute the pool water with fresh water. Dilution limits the build-up of pollutants from bathers and elsewhere, the byproducts of disinfection, and various other dissolved chemicals.

To some extent, dilution is effected through the replacement of water used in backwashing. But filter backwashing is often not frequent enough (although it will be at least weekly) to keep the concentration of unwanted pollutants at an acceptably low level. And some pollutants can be reduced only by dilution. If dilution is inadequate, bather discomfort can result. PWTAG recommend pool operators replace pool water as a regular part of their water treatment regime, at a rate of 30 litres per bather. This is mandatory in some European countries. As well as making bathing (and the pool hall atmosphere generally) more comfortable, proper dilution can help protect the fabric of the building by reducing the level of contaminants in the air above the pool.

Although 30 litres per bather might seem an intimidating amount of water, operators are likely to be diluting already by as much as half of that just by backwashing. Fresh water should, ideally, be metered to allow accurate measurement and monitoring of dilution rates; and added gradually throughout opening hours, derived from bather throughput. Diluting up to 30 litres per bather clearly has practical implications in terms of how water is removed and the fresh water added, heated etc. But if it leads pool managers to undertake a comprehensive audit of water, energy and effluent costs, then that is another real benefit. Managers should at the same time evaluate the dilution that can be introduced by pre-swim showering with pool water. And it may be worthwhile to recycle some of the water drained from the pool into a grey water system for toilets etc.

The water used in dilution must be reheated, as must the fresh water used to replace that used to backwash the filters. This will have to be heated up from the mains supply to the comfort temperature of the pool, requiring energy input from the boiler or other heat generator.

It is important to maintain an appropriate interval between consecutive backwashes of a pool filter to reduce energy and water consumption. Backwashing is very costly in both water and energy terms so any reductions in this area will lead to significant cost savings. Although energy can be saved by minimising the water quantity used in backwashing and dilution, take special care to avoid compromising water quality and safety.

The interval between backwashes will depend on the type of pool, the type of filter and the degree of usage. Some filters in spa pools for example require backwashing daily. All swimming pool medium rate sand filters should be backwashed at least once a week or more frequently at busy periods according to pressure drop across a filter.

In all situations where heated water is being discharged to waste then it is worth exploring potential energy saving by reclaiming the heat from the discharge water and applying this to heat either the pool water or hot water supply. In some circumstances, where sewers are unable to take large sudden outflows of water, for backwashing, say, the pool must store the water and discharge it at a slow rate. In this case, this creates an opportunity for energy to be saved by applying water to water heat recovery to preheat incoming water which enters the building at approximately the same rate as this discharge. Any heat exchangers used in this way should be capable of being dismantled to allow periodic cleaning.

Showers

Pollution of the pool water, for example through sweat, urea, bacteria and dirt is a big issue for pool operators. A build up of pollution can be reduced by encouraging bathers to shower and use the toilet before entering the pool. While this may increase shower water heating, it reduces the need for disinfection and will improve the pool water quality. Moreover, there are ways to lessen the effect of the extra hot water demand. For example, reduce the quantity used by bathers by introducing push button controls instead of conventional taps, so that they are not left running.

During refurbishment projects, install a dedicated hot water heater for showers rather than storage calorifiers which are prone to energy losses. Make sure that the insulation is intact and at the required thickness in hot water storage systems.

Explore solar water heating potential

Solar water heating can be very effective for showers and for heating pool water. Modern systems are relatively easy to connect to a conventional heating system. Unglazed solar collectors perform well in summer and are generally the cheapest to buy and install. Glazed collectors provide more energy in spring and autumn and can give a substantial contribution to pool heating throughout the year, with the remainder provided by a conventional heating system.

Combined heat and power

Combined heat and power (CHP) is the on-site generation of electricity and the utilisation of the heat that is a by-product of the generation process. It saves energy and reduces carbon emissions by making the engine’s heat, which would normally be wasted, available as hot water. It could therefore substantially reduce a swimming pool’s electricity requirement from the mains supply. It will increase gas use to some extent because CHP produces hot water with less efficiency than a boiler. For larger swimming pools, CHP can offer an economical method of providing heat and power which is less environmentally harmful than conventional methods.

To gain maximum benefit from CHP, the system needs be in operation for as many hours of the year as possible. With year-round requirements for electricity and hot water, swimming pools can be well suited to using CHP although the economics depend on the relative prices of purchased gas and displaced electricity. Use proprietary CHP sizing software to find out whether it is worthwhile. An expert should thoroughly investigate the site and carry out a complete financial and technical appraisal.

Did you know?
In an appropriate application, CHP can reduce energy bills by around 20–30%, provided the unit is designed to meet the building's seasonal demands for electricity and heating. Even better, good quality CHP qualifies for Enhanced Capital Allowances and the fuel input is exempt from the climate change levy (CCL). Contact the Carbon Trust for more information.

Top tip
Ensure pipework is checked regularly for leaks. A leaky pipe costs money for the water and heat being wasted. To reduce energy losses, also make sure that pipework is properly insulated. Regularly check the condition of insulation and replace if it is damp or worn

Effective maintenance for heating plant
Have boilers serviced regularly by a reputable firm. Gas-fired boilers, which are most common in sport and recreation facilities, should be serviced once a year; oil boilers twice a year. A regularly serviced boiler can save as much as 10% on annual heating costs.

Insulate boilers, hot water tanks, pipes and valves to prevent heat escaping. Payback can usually be expected within a few months of installation, with additional savings in subsequent years.

Lighting
Lighting accounts for up to 16% of the total energy costs in an indoor pool hall. There are many simple and inexpensive ways to reduce the energy consumption and costs associated with lighting without compromising internal comfort levels As well as selecting energy efficient light sources, there are a number of important design issues to consider when lighting a swimming pool.
These include:

- Minimising reflected glare from light fittings off the pool surface
- Ease of maintenance when replacing bulbs and cleaning fittings
- Sourcing light fittings that resist corrosion
- The colour performance of lamps.

Some key efficiency measures are outlined below. More detailed information relating to lighting and controls is available in the Lighting technology overview (CTV021) available from the Carbon Trust

Choose efficient replacements
When a lamp fails, it presents a useful opportunity to substitute a more efficient lamp type. Lighting technology progresses quickly and alternatives

should be investigated, especially when refurbishment is being undertaken. Consider the substitutes outlined below and avoid automatically replacing like with like

Replace standard lamps
Replace standard incandescent tungsten filament lamps with compact fluorescent lamps (CFLs) that last up to eight times longer than their tungsten counterparts, which means less time spent replacing them. They have a similar light output to tungsten bulbs and use only 20–25% of the energy.

Replace T12 tubes with T8 and T5 tubes
All 38mm diameter (T12) fluorescent tubes can be replaced with slimmer, 26mm diameter (T8) tubes. When replacing luminaires – the light fitting – consider those that will take the more efficient T5 fluorescent tubes. Always specify tubes with a triphosphor coating – this will be stated on the packaging.

Consider long-life lamps
If lights are placed in difficult areas to reach, for example directly over the centre of the pool, choose long-life lamps such as metal halides and sodium lamps. Metal halide lamps can be used in the pool area and in other areas where the colour rendering properties of high pressure sodium lamps are not suitable.

Consult a lighting specialist
For new build or refurbishment projects, consult a lighting designer or dedicated lighting specialist. In most cases, a qualified designer will be able to identify savings whilst maximising the quality and aesthetics of the final result. When commissioning a designer, it is important to work through the actual requirements of the finished design and ask them to specifically consider:

- The safety and comfort of staff and pool users
- The pool hall architecture and layout of the building
- How the design can help to achieve the lighting requirements, including any specialist needs such as lighting for swimming or diving competitions
- How the use of daylight can be maximised including utilising suitable controls
- The costs of installing and operating the system including maintenance costs and ease of access
- The most energy efficient design possible – make sure that low energy options are specified from the outset

Daylighting
Most swimming pools have good levels of natural daylighting from windows or roof lights. In many cases, there will be sufficient daylight to allow some artificial lighting to be switched off during the day. Appoint a staff member to ensure this occurs and, if necessary, change the switching arrangement so

that selected lights can be turned off separately using appropriate daylighting controls.

Cleaning windows and skylights regularly will allow maximum daylight to enter the pool hall and significantly reduce the need for electric lighting. Clean glass is particularly important for urban swimming pools where high levels of pollution can cause a film of dirt to settle on windows and particularly roof lights.

Motors and pumps
Motors, fans and pumps are used widely throughout the pool building for water treatment and ventilation systems. Collectively, they are responsible for more than 25% of the energy costs in swimming pools so making motors and pumps more efficient will yield significant savings.

Switch-off policy
There are many motors in the average pool hall and they are usually hidden within machinery. So motors tend to be ignored or left running even when they are doing no useful work. Develop procedures to ensure that ‘idle’ motors and pumps are switched off when not in operation. This may involve devising a switch-off procedure and placing instructions in visible locations around the building. The procedure should also take into account the maximum number of ‘starts’ allowed for each motor.

Clean components
Motors should be kept clean and free of dust and other contaminants. Pay particular attention to motors situated in the corrosive atmosphere of pool water treatment areas or those in dirty or dusty environments. Consider putting a preventive maintenance plan in action to address this issue.

Correct motor sizing – over-sizing leads to inefficiency
A smaller motor running at a higher loading will be more efficient than a larger, partially loaded motor and it will consume less energy. For example, swapping a single 10kW motor running at 25% loading for a 2.5kW motor running at full load could save around £70 per year.

High efficiency motors
High efficiency motors (HEMs) rarely cost more, but use between 3–5% less energy. They also qualify for 100% tax relief under the Enhanced Capital Allowance scheme. HEMs make a good replacement option for an existing failed motor.

Variable speed drives
In applications where a motor is required to serve a variety of load conditions, such as varying supply and extract volumes to remove moisture in a pool hall, consider installing a variable speed drive. These devices can alter the speed of a motor, enabling the motor to operate efficiently in a range of different conditions.

Action checklist
Existing systems

- Ensure air temperature is set at 1°C above water temperature to avoid convection air movement
- Control ventilation rates with a dew point sensor to the minimum rate consistent with avoiding condensation
- If existing control is by humidistat, reset each season according to the outside temperature
- If ventilation volume is set at 'full' or controlled manually or by timer, investigate how to link this with humidity levels as an alternative option
- Reposition supply air outlets so that drier supply air entering the pool hall is pointed towards the building structure rather than down on to the
 surface of the pool water
- Keep doors closed between areas with different temperatures and humidity
- Provide localised cooling for staff using overhead fans and discourage staff from opening doors and windows if they are hot
- Conduct regular pool backwashing and clean the pool filters to maintain good quality clean water
- Benchmark separately for fossil fuels and electricity to show potential for savings
- Inspect system components such as fans, coils and pumps for corrosion and clean or replace if necessary
- Provide heating, lighting and hot water only to occupied areas
- Inspect heat recovery devices and air filters once a month and clean or replace if necessary
- Walk around the premises at different times of the day and during different seasons to see how energy is being used. Develop an action plan for making savings

Refurbishment and capital expenditure

- Fit pool covers to minimise evaporation and ensure staff are trained to use them properly
- Consider fitting variable speed drives on pumps and fans
- Explore solar water heating potential
- Replace ageing conventional boilers with high efficiency condensing boilers
- Consider combined heat and power; evaluate the economics including maintenance and plant replacement costs
- Consider ventilation heat recovery and waste water heat recovery
- Evaluate options for using heat pumps for dehumidification and utilising the recovered energy for pool heating
- Investigate installing additional insulation and consider insulating any existing cold bridges

The main material in this guidance has in been provided from "Swimming pools – A deeper look at energy efficiency 2008″ with kind permission from the Carbon Trust. Supplemented as appropriate to reflect ISRM policy and current best practice.