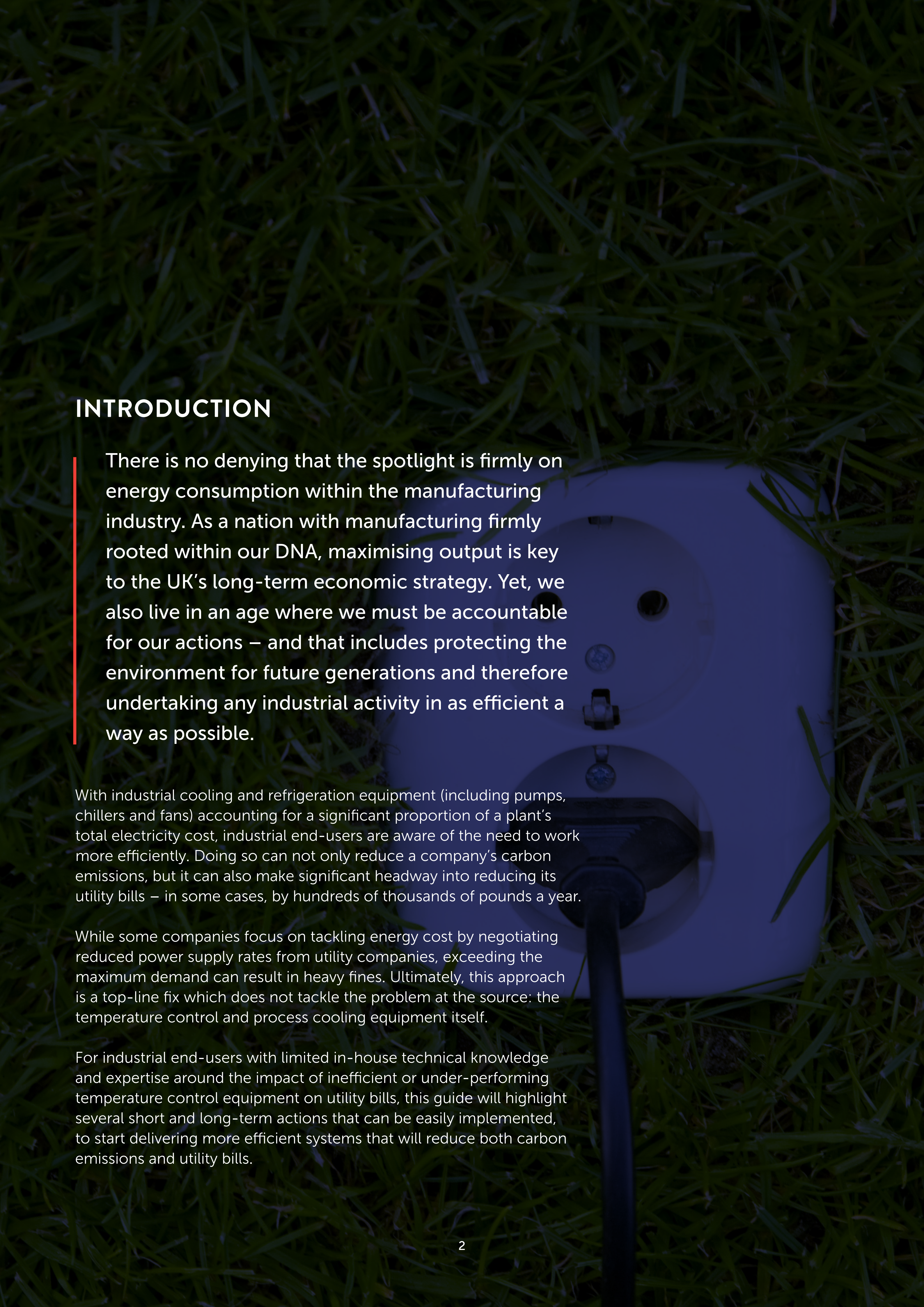
HOW TO REDUCE YOUR ENERGY COSTS

A guide to temperature control efficiencies

ics cool energy



INTRODUCTION

There is no denying that the spotlight is firmly on energy consumption within the manufacturing industry. As a nation with manufacturing firmly rooted within our DNA, maximising output is key to the UK's long-term economic strategy. Yet, we also live in an age where we must be accountable for our actions – and that includes protecting the environment for future generations and therefore undertaking any industrial activity in as efficient a way as possible.

With industrial cooling and refrigeration equipment (including pumps, chillers and fans) accounting for a significant proportion of a plant's total electricity cost, industrial end-users are aware of the need to work more efficiently. Doing so can not only reduce a company's carbon emissions, but it can also make significant headway into reducing its utility bills – in some cases, by hundreds of thousands of pounds a year.

While some companies focus on tackling energy cost by negotiating reduced power supply rates from utility companies, exceeding the maximum demand can result in heavy fines. Ultimately, this approach is a top-line fix which does not tackle the problem at the source: the temperature control and process cooling equipment itself.

For industrial end-users with limited in-house technical knowledge and expertise around the impact of inefficient or under-performing temperature control equipment on utility bills, this guide will highlight several short and long-term actions that can be easily implemented, to start delivering more efficient systems that will reduce both carbon emissions and utility bills.

FREE COOLING
(STANDALONE AND INTEGRATED)

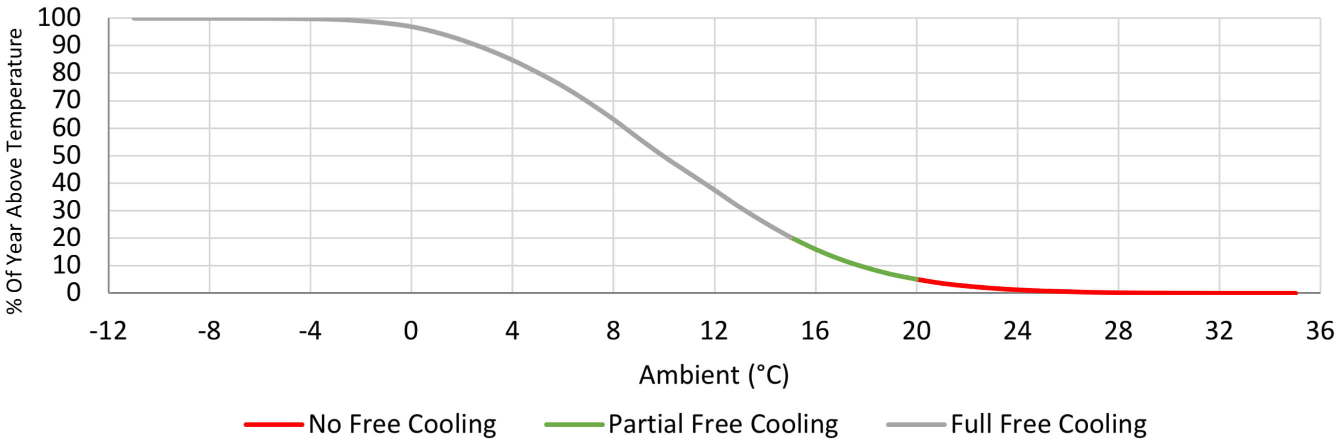
> There's a common perception that you don't get anything in life for free. While that may be true in most scenarios, what many industrial end-users may not be aware of is that the UK's mild climate can pave the way for significant energy savings in process cooling applications.

Known as 'free cooling', the concept uses ambient air to reduce the energy consumed by a cooling circuit, and therefore reduces the electrical power load of that system.

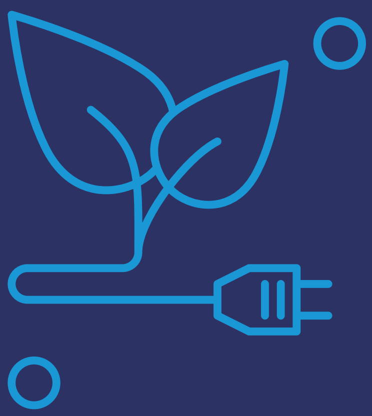
With the average UK monthly temperature below 15°C for eight months of the year, free cooling represents a viable option for making significant energy savings for process end users throughout the year.

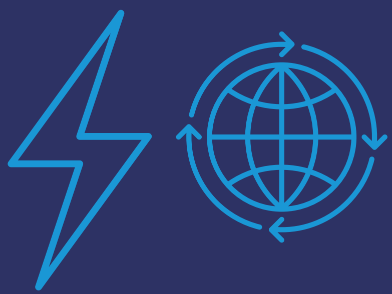
To put the issue into context, the below graph illustrates the percentage of the year that free cooling could be achieved when using an Air-Cooled Chiller with a 257kW capacity (when operating over a typical working day).

WORKING DAY OPERATION (8AM-6PM)



However, even existing free cooling systems can be fine-tuned to make even greater savings. For example, if an operating system is above 10°C, raising the temperature by an extra 1°C won't affect the operation, but will enable a more efficient design as the operating temperature is closer to the ambient air temperature, which makes free cooling a more viable option for providing the bulk of the cooling required.





Free cooling can be achieved in one of two ways, either by integrating a free cooling coil into an existing chiller installation, or as a standalone (sometimes referred to as a bolt-on) unit. Standalone and integrated free cooling offer many benefits depending on the application and the site in question.

STANDALONE FREE COOLING

Standalone units require a significant amount of space given the footprint of the equipment (which would typically require two units), and the need to allow air to circulate around the units. The increased footprint means a larger surface area, which can allow better part loading to be achieved – akin to a 70% saving on running costs a year. What's more, they have the capacity to provide 100% free cooling at a higher ambient air temperature than integrated free cooling chillers.

INTEGRATED FREE COOLING

Integrated free cooling units are a viable option for existing sites which may not have the available floorspace to accommodate standalone units. Integrated free cooling is suitable for any system with a capacity of 100kW and above and provides an ideal solution for sites with limited available footprint. A particularly pertinent solution for multi-megawatt projects where a standalone system on that scale would require significant floorspace to accommodate the necessary equipment.

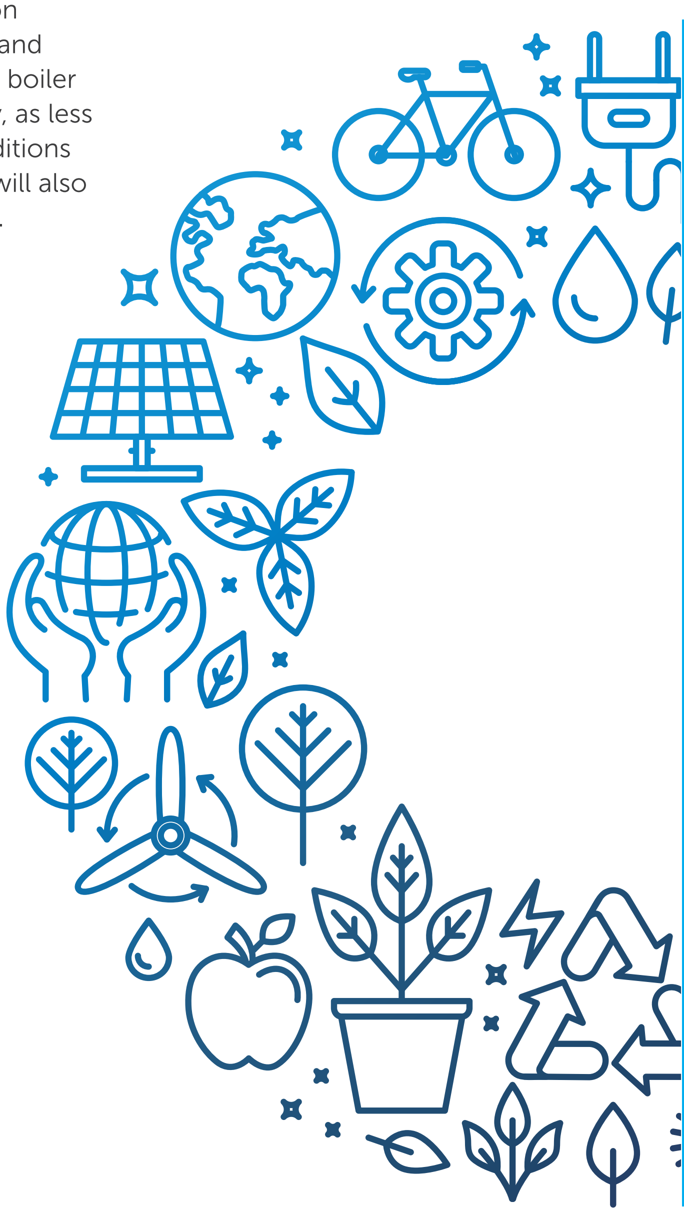
Capital expenditure may put some industrial end-users off investing in free cooling systems; however, most systems offer a pay-back period of just 18-24 months. If you consider the average operational life of a cooling system is at least seven years, incorporating some form of free cooling into an industrial cooling system is likely to result in a minimum of five years of permanent savings.

HEAT RECOVERY

One innovative way that industrial end-users can make further efficiency savings on their process temperature control equipment is to proactively recycle waste heat from the hot discharge refrigerant. It can be re-used for other processes which require heat, such as pre-heating for a secondary process, or a HVAC requirement, such as space heating, hot water production, prewarming for a boiler or a drying process.

Purchasing equipment which is designed to facilitate heat recovery is one option to increase the overall energy efficiency of a system. A second option is retrofitting an existing chiller with a heat recovery section which will also increase a systems efficiency, although consideration should be given to the age and condition of the plant as well as its thermal output and load profile.

The starting point for the consideration of a retrofit would be around 250kW. Heat recovery modifications reduce energy consumption of the cooling source, as there is a decreased heat load to cool and contribute to a reduction of associated running costs for a site’s boiler or other plant, as it will not be required to run at full load. Finally, as less heat is expelled into the atmosphere, not only will working conditions be more tolerable – particularly in the warmer months – but it will also contribute to improving a company’s environmental credentials.



COMPONENT SELECTION (NEW PROJECTS AND RETROFIT UPGRADES)

CHILLER COMPONENTS

> From an energy usage point of view, a chiller can be one of the most energy-intensive pieces of equipment to run. They are effectively comprised of two halves – high pressure and low pressure, and the closer those two sides are to each other, the more efficient the chiller.

However, the quality of the components that make up a chiller can go a long way to improving the efficiency of a unit over the course of its operational life. The key components within a chiller that will impact performance and energy consumption are:

1) PUMPS

Pumps are one of the biggest users of energy in any cooling application – not just chillers, but cooling towers too.

Variable speed pumps are key to matching the flow of the system to the required capacity. They avoid wasted power and energy compared to traditional on/off pumps and have the potential to save up to 50% on pump energy. What's more, the cost and power output savings are magnified on larger systems with pumps greater in capacity than 15kW.

2) HEAT EXCHANGER (SHELL & TUBE)

Shell and tube heat exchangers are typically not much more expensive than brazed plate heat exchangers but offer greater efficiency and are ideal for process end-users as they can cope with higher operating temperatures and pressures.

Using a heat exchanger with multiple 'passes', such as a two or four-pass model, is likely to be much more efficient than single pass or two-part variants. The 'pass' refers to the number of times the heat transfer fluid is required to pass through the heat exchanger to reach the desired temperature. However, they are not compatible for all models. Crucially they can be retrofitted to existing chillers.

3) COMPRESSORS

The compressor is another area of a chiller that can be responsible for a significant volume of energy consumption. Many high-efficiency compressors are available as part of both new installations and retrofit upgrades to a chiller.

Inverter-driven scroll and screw compressors, as well as turbocor compressors, with built-in Variable Speed Drives can offer huge energy savings of 50-60% compared to standard models. What's more, a -3°C difference in operating temperature between screw and turbocor compressors can lead to energy savings of circa 56%.

4) CONDENSERS

Micro-channel condensers, while not able to reduce energy consumption directly, can reduce the volume of refrigerant needed which will take further cost out of the system and promote a more environmentally-friendly operation. They are also crucial to helping equipment comply with the latest requirements of both the F-Gas legislation and Ecodesign Directive.

5) ELECTRONIC EXPANSION VALVES

While electronic expansion valves (EEVs) are not yet standard on most chillers, they are much more efficient than mechanical equivalents as they are able to operate on a lower pressure ratio without impacting the functionality of the chiller.

What's more, EEVs have the potential to save circa 12% energy a year compared to mechanical valves. Again, they can easily be retrofitted onto an existing chiller, and can justify the extra capital expenditure in the long-term given the swift payback period they offer.

6) EC FANS

EC (Electronically Commutated) fans operate using a DC motor rather than an AC motor, which in turn not only offers a much more efficient fan performance, but also noise levels that can be 4-5 dba lower.

Engineers are often put-off by the investment in EC fans given the number of fans that can be found on a chiller. However, with a payback period of just 6-12 months, industrial end-users can start to make permanent energy savings from just the second year. If variable fan speed control is added, a further 12-14% energy savings can be made compared to standard on/off fan speed control.

BOILER COMPONENTS

While industrial cooling remains a major challenge for process end-users, the scope of a temperature control system can extend to industrial boilers – particularly in winter when systems are put under greater pressure. Legislation is driving the use of more energy-efficient condensing boilers, as they make use of not only sensible heat but also latent heat to drive further system efficiencies.

As with a chiller, there are several boiler components than can contribute to a unit's overall efficiency performance:

1) COMBUSTION NOZZLE (OIL FIRED)

In oil-fired units, the combustion nozzle needs to be matched to the type of oil (otherwise known as the medium) which is combusted. Failing to correctly match the oil to the combustion nozzle can lead to poor performance, as it will not break up the fuel into the smallest possible droplets. This is essential to the boiler's efficiency, as the smaller the oil droplets, the more efficient the boiler. From a maintenance perspective, the nozzle also needs to be regularly cleaned to maximise performance.

2) HEAT EXCHANGER

As with a chiller, the same efficiency arguments relating to heat exchangers can be applied to boilers; and using multi-pass heat exchangers where possible, will undoubtedly result in a much more efficient system than one which employs single-pass heat exchangers.

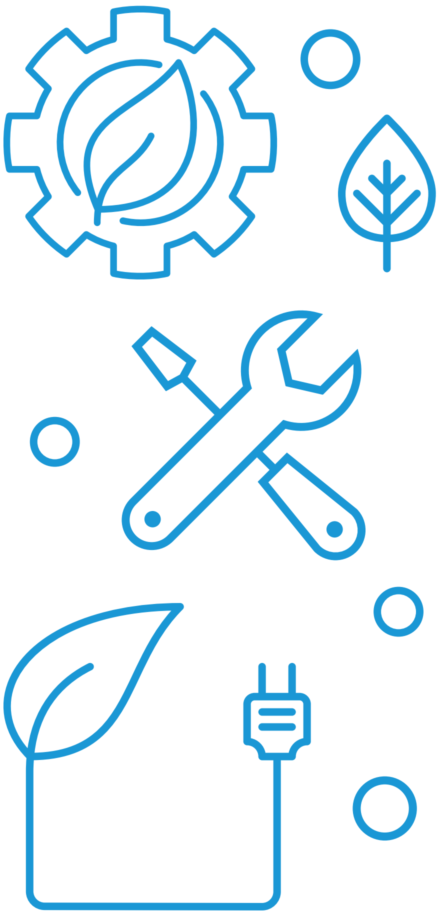
3) PIPEWORK AND DUCTING

Pipework is another good example of how an efficient installation can lead to long-term energy savings. First and foremost, ensuring the system is as short as possible – avoiding any unnecessary diversions in or around buildings – will help to keep heat loss to a minimum. Secondly, insulating the pipework can also work towards reducing heat loss.

Likewise, as air is not a particularly efficient heat transfer medium, keeping the length of any ducting to a minimum will limit any heat loss. Again, adding an extra layer of insulation to the ducting will help to reduce energy wastage through escaped heat.

MAINTENANCE

> It goes without saying that keeping on top of maintenance – particularly when it comes to adopting a proactive rather than reactive approach – will go a long way to ensuring an industrial temperature control system can perform at its most efficient for as long as possible.



Planned Preventative Maintenance (PPM) programs should be familiar to most industrial process managers and will ensure all equipment is regularly checked with any red flags addressed as soon as possible, rather than accepting run-to-failure as the norm.

For chillers, undertaking regular system water quality checks, coupled with the implementation of an effective water treatment programme, will ensure that system components continue to operate efficiently. Failing to do so will limit the efficiency of the heat transfer fluid and could also present a significant contamination risk.

Regularly cleaning a chiller's condenser is another good example of how efficiency improvements can be made. Condensers have the potential to block up on a weekly basis, especially in environments with high dust or particle presence, such as industrial bakeries or composite subcontractors.

If the condensing temperature goes down, so too does the power input, therefore failing to regularly maintain them can have a huge effect on efficiency. Thankfully, it's a simple procedure to undertake, and keeping them clean will dramatically improve efficiency.

Finally, while not strictly falling into the maintenance bracket, end-users may not be aware that by reducing a chiller's condensing temperature by just 1°C can lead to

4% energy savings per chiller.

It may not seem huge in the context, but over the course of the year, the financial savings can add up to a welcome sum.

First and foremost, keeping the internal elements of a boiler system as clean as possible is essential, as any build-up of mineral deposits can quickly hamper overall system efficiency. Likewise, regular cleaning of the chimney can minimise the volume of soot found in the combustion chamber.

A build of just 0.5mm is equal to a

7%

decrease in efficiency.

Another factor to consider as part of a robust boiler maintenance programme is to check the burner is correctly commissioned, as this can ensure a balanced combustion and reduce the amount of unburnt fuel.

For industrial applications which may only require seasonal temperature control support, hiring a boiler as part of a fixed-term contract is an excellent way of managing commissioning, installation and maintenance in one packaged cost.

REFRIGERANT TYPE

> While refrigerant selection is often governed by either the application, the industry of operation or the equipment manufacturer, when end-users have the option, another low-maintenance way of reducing operating costs and improving the efficiency of a system is through selecting a low GWP refrigerant.

While smaller chillers have traditionally not been able to accommodate the components needed to realise the benefits of more efficient refrigerants, intensive R&D from manufacturers has seen the emergence of models which can now overcome these issues for end-users looking for efficient cooling from a small footprint.

Specifically, newer models can incorporate screw compressors, meaning they can operate using the likes of R513A which is both non-flammable, and benefits from a much lower GWP value than its predecessor R134A. With an ability to cool to -8°C, it can both compete with ammonia, and be used in food processing applications. It is also one of the most efficient refrigerants for medium pressure applications, with a COP of 8.2.

As such, while legislation is set to continue to dominate refrigerant production level with the continued move away from HFCs, end-users are now in a better position to make a more informed choice. This can help them base specification on factors such as refrigerant efficiency, rather than solely on application or industry.

POWER FACTOR CORRECTION

A small but often overlooked element that will be relevant to all industrial end-users is power factor correction. It is a measure of how effectively electrical power is converted into useful output. Most industrial sites have power factor correction on switchboards and correct to a power factor of 0.95.

With a chiller, compressor efficiencies average a power factor of around 0.86, however some are operating with a power factor as low as 0.81-0.82. As such, the electricity a site is paying for is not being used as efficiently as possible. By targeting such areas with lower power factors, and correcting them to as close to 0.95, industrial end-users will reduce on-going running current, and in turn, on-going power bills.

FINAL THOUGHTS

Ultimately, given the process-heavy nature of the UK's industrial landscape, getting a firm grip of a plant's temperature control systems can quickly result in a reduction of energy consumption and consequently, utility bills.

From upgrading the internal elements of a chiller to factoring free cooling into a new-build installation, there are a wide variety of tips and techniques end-users can adopt to start taking back control of their site's energy consumption and improving profitability.

However, to get a true picture of all areas that need to be addressed, by far and away the most comprehensive solution is to undertake an energy analysis audit. This can be carried out by a temperature control partner with good technical knowledge of your applications and temperature control equipment. There are basic and more comprehensive ways that this can be undertaken – through monitoring conditions and demands on a given day or over a 12-month period, either way, you should be provided with clarity on any underperforming areas that can be targeted to improve energy efficiency and reduce your overall costs.

For industrial end-users keen to factor any equipment upgrades into financial planning, or make energy savings on existing temperature control equipment, energy analysis audits from ICS Cool Energy can include anticipated cost and saving projections across a variety of equipment and locality scenarios. This can help decision makers to balance capital expenditure – or packaged hire costs – with payback periods, to ultimately find a solution which is right for their applications and business.

While industrial temperature control is a necessary element of nearly all manufacturing applications, it does not have to be a necessary evil. Significant long-term energy savings are there for the taking – all it requires is a proactive mindset and a desire for change.

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