by Neil Bradley, Stuart McLeod and Bobby McHale

Energy Efficiency Opportunities in Lighting and Lighting Controls

Eliminating energy waste through energy efficiency is something that everyone who looks after energy in their organisation or for their clients is striving for. When it comes to different technologies, there is an endless list of options to consider at every stage. We will be looking at different technologies in each issue of The EMA Magazine this year and asking those with experience in these areas for their thoughts and useful tips.

In this issue, we will focus on Energy Efficiency Opportunities in Lighting and Lighting Controls. The quality of artificial light is a significant influencer on productivity and wellbeing within the workplace. At the same time lighting can be a large contributor to a company's energy cost and significantly, also one of the areas generating most waste. We have asked three energy management professionals who gave their views in this area.

Neil Bradley, Energy and Environment Engineer at Cardiff Metropolitan University

Cardiff Metropolitan University is home to just over 1,100 staff, around 11,000 students and 54 buildings. It consists of offices, teaching spaces, laboratories, sports facilities, and residential blocks. Across the academic estate alone, there are around 10,000 light fittings - or 10,000 energy saving opportunities, as I view them.

Our motto is 'the most valuable possession is knowledge.' And this accurately reflects my path of continual learning to achieve energy efficient lighting across the University. Although this is unlikely to steal-the-show for pioneering building innovation, it's a critical path towards decarbonising our buildings.

I have found, time and time again, that collaboration, stakeholder engagement and importantly, challenging industry norms, is crucial to achieving the right solution.

With this in mind, this article tries to cover some of the key, and perhaps less obvious, energy efficiency opportunities available in delivering cost effective retrofit LED lighting improvements. These stem from the lessons I have learned on my journey so far – one that continues to challenge me!

The most surprising energy efficiency opportunity

Don't always follow the guidelines to the letter. I am going to start by controversially veering off the beaten track. Lighting designs are typically created using popular software systems such as Dialux or Relux. This modelling software for lighting upgrades provides a useful tool and starting point for developing an initial lighting design for a specific area or building... but it should be used with caution. Under current guidelines, the requirement for high task illuminance uniformity factors (e.g. 0.6 - 0.8) and targeted illuminance levels often results, in my experience, in 'excess illumination' of spaces resulting in wasted energy. This inevitably translates into additional costs associated with surplus LED fittings, controls integration and wiring.

This task-based approach together with high uniformity factors can result in a lighting scheme that lacks contrast or ambience. And also provides too much light (and glare) in office and learning environments where many tasks are now self-illuminating via PCs. This not only adds to the expense of the installation but also increases the energy demand.

My advice is don't be afraid to challenge the lighting designs based on your knowledge of how you would like an entire space to be illuminated. Apply your own knowledge of that space and how it is used - how the existing lights perform, daylight influence and the aspect, the heights of the ceilings, the colour of the walls and desks and the levels of reflectance - rather than relying solely on the software to dictate this based on formulas. If you focus on achieving more dynamic lighting schemes which aim to create ambient lighting suited to the tasks undertaken, this not only delivers savings in energy

from streamlining the installation, but reduces capital expense, labour and maintenance.

As an example, we recently undertook a full refurbishment in one of our existing buildings. Within a large open-plan area the lighting design stipulated that a total of 16qty, 25W suspended downlights should be installed to achieve the desired illuminance levels. This was to compliment the continuous perimeter lighting installed all the way round the space.

Although there was an absence of adequate daylight, I had concerns regarding the quantity of fittings and the logistics of installing them in, and between, the existing suspended architectural ceiling panels. I requested a trial install of 1 fitting in situ and it was decided (following consultation with stakeholders) that based on the general use of the space, the presence of large touch screens on the walls, PCs and the existing perimeter lighting, a total of 4 downlights was sufficient to create a more dynamic, learning environment. This resulted in cost savings on the project budget and the avoidance of re-stocking charges for the return of surplus light fittings to the supplier.

The no cost energy efficiency opportunity

Engage with your stakeholders. Although not always essential in many lighting upgrades, this particularly applies in buildings with multi-use areas where lighting requires a flexibility of control to achieve the correct illuminance for specific activities (e.g. sports halls, bars, hospitality areas etc).

Recently, the aging BMS controlled lighting system in the University's sports arena was becoming increasingly unreliable, leading to operational challenges for staff. Engagement with stakeholders revealed that lighting requirements had evolved over the years and the inherent complexity of the existing system was now unfit for purpose, too time consuming to operate and confusing. It was agreed that a simple wall mounted multi-gang, switch plate would be preferred, removing any obvious points of failure (no software requirements), with labelled switch banks that were simple to operate.

This engagement with the building users resulted in a controls lighting upgrade investment that cost a fraction of the like-for-like BMS, software and controller driven solution. It also achieved a reduction in energy from improved bank switching (where applicable) and prevented overnight wasted energy from lights remaining on. Having local control also provides the staff with an enhanced responsibility and ownership for the area. This ensures that the close down procedure includes switching off the lighting in the main arena, providing further cost savings.

In conjunction with these works, discussions also led to the appraisal of the existing light fittings and ultimately the disconnection of 35 highbay flood lights at 2kw each. These were installed as part of the construction of the building back in 1999 but were no longer needed based on current day to day activities and events.

As part of energy monitoring regimes, energy metering on the building main electric meter serves to flag up any issue with lights remaining on which are then communicated to staff.

The low cost energy efficiency opportunity

Join the dots. Until recently, all lighting retrofits I have undertaken have required upgrades to the existing emergency lighting. This has been courtesy of integrated emergency light fittings which require the replacement of the fitting and the integrated emergency luminaire and battery packs.

This is not only expensive but limits the location of the emergency fittings based on the luminaire locations in the ceiling. I have since moved to separating the emergency light (and in some cases separating the emergency wiring circuit) from the luminaires

in all upgrades. Instead, we now install DOT LED emergency non-maintained downlights consuming only 3W in operation and powered by AA batteries in comparison to the standard 'size D' batteries used in integrated luminaires. This, in itself drastically reduces the footprint of the battery pack, which may be beneficial if there is limited space above the ceiling. These unobtrusive, flush mounted fittings are very small and discreet, more energy efficient, simpler and cheaper to install and work equally well in plasterboard ceilings and suspended ceiling types. They are also considerably cheaper to purchase and provide the added flexibility for routine testing in daytime hours.

As University spaces are occupied for long periods during the day, with traditional integrated emergency lighting (which switch off all luminaires when the test is carried out) the programme of routine emergency light testing would have to be undertaken at night. With the DOT LED luminaires, as standalone fittings they can be tested at any time without disruption to the lighting in the space as they do not impact on the operation of the lighting scheme in anyway. This has also generated savings in reduced labour costs.

Ultimately, if a luminaire now fails it can be replaced independently of the emergency lighting (that was previously integrated into the fitting) at a much lower cost. If you have a range of luminaires from different manufacturers in the same space, this type of system makes replacing them much simpler.

Lastly, in my experience I have found that for capital works, this type of emergency lighting system is simpler to specify in lighting designs and easier to review and cross reference during installation and snagging as the DOT LED fittings are easily identifiable.

The most common energy efficiency opportunity

Audit, sleep, repeat. It might sound obvious but carrying out an initial audit of the existing lighting schemes within your organisation is integral to developing a robust business case, prioritising programmes of work, completing the relevant information required for tendering lighting projects and understanding the types of lighting systems you have in place.

In addition, this information is integral to applications for loan finance schemes such as Salix. Yes, it can be time consuming and if your organisation is large, your building stock diverse and widespread, in many cases you will discover a plethora of different lighting installations.

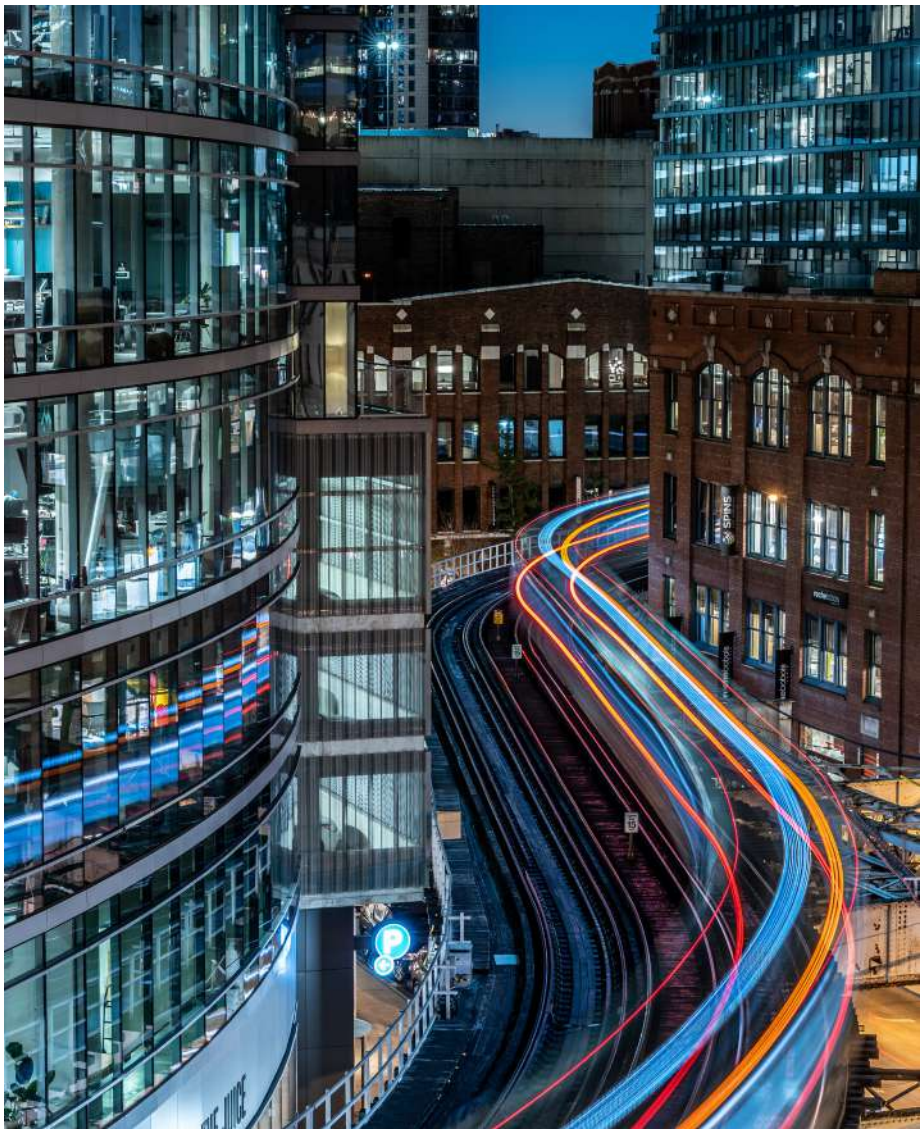
At this point, when it comes to carrying out the work, revisit each installation to fully understand the type of lighting, controls, wiring and components used to prevent any surprises during the install stage. This information is critical for establishing the proposed upgrade solution that delivers the greatest benefits in energy, cost and carbon and ultimately repayment periods on the investment.

A common issue we have in relation to upgrading old downlights in plasterboard ceilings - found typically in lecture theatres and large teaching spaces - are that existing fluorescent lamps and halogen lamps are considerably larger in diameter than the modern LED equivalent at the required lumen output.

Ceiling hole diameters of circa 240mm are not uncommon and this provides a challenge in finding a suitable LED alternative. Fortunately, we are able to manufacture bespoke laser cut infill rings onsite through our Art and Design Laboratory to act as a reducer to provide a fixing which overcomes this.

The most overlooked energy efficiency opportunity

You can't rely on people switching the lights off. Develop a controls specification and strategy and stick to it. The integration of controls to



lighting systems are not new, but in my experience can sometimes be considered as a 'nice to have' rather than a critical system element for providing flexible lighting solutions that save energy whilst prolonging the life of the luminaires.

Lighting controls may be perceived as a complex, unwanted addition to a lighting scheme. However, modern systems are quite the contrary. University spaces are often re-modelled to accommodate new courses or teaching requirements and I increasingly specify prefabricated plug and play-lighting connection and control systems (such as Flex 7 or Klik). These have the added benefit of speed and ease of installation of both LED fittings and sensors and go hand-in-hand with the flexibility to adapt to future building needs.

Similarly, traditional plug and play sensors have now evolved to offer improved functionality and DALI integration similar to networked intelligent control systems but in a simpler, more affordable package. Albeit without some of the bells and whistles.

Virtually all of the University's lighting systems are controlled by standalone ceiling mounted sensors that can be modified by a handheld infra-red programming tool. This innovation allows the adjustment of sensitivity, delay on-and-off times, daylight integration, testing, DALI, dimming and so on, without the network expense. This has proven invaluable when office or teaching spaces are repurposed or change occupation and different lighting requirements are provided or simply to make day to day adjustments.

Top tip

Don't be afraid to ask for help. In a world of increasing automation and the emergence of IoT, don't lose sight of the basic function of an energy efficient lighting system and how it operates. Fundamentally, any lighting system will only be as effective as the installation allows.

As energy managers, we are motivated by delivering savings, achieving the highest lumen output for the lowest circuit watt (lm/cctW) and maximising efficiencies through integrated controls systems. However, our judgements and rationale can often be clouded by the above and at the expense of what can realistically be achieved.

Developing good working relationships with project managers, electricians and wholesalers, building managers and staff provide key sounding boards for overcoming challenges, seeking cost effective solutions, fostering collective ownership of the project and ultimately delivering the most energy efficient solution.

I have regularly found that it is not uncommon for a lighting design on paper to be fraught with unforeseen practical challenges on-the-ground. However, in my experience, learning to ask for help and listening to others cultivates a collaborative ethos within the team to overcome the challenges presented.

Ultimately, the knowledge and combined experience of the electricians and wholesalers are invaluable to achieving the end result.

Stuart McLeod, Project Manager at Oaksmere Design

The most surprising energy efficiency opportunity

Save yourself from surprises further down the line, by ensuring all unserviceable fittings at the time of survey have been documented, along with the wattages of fittings currently installed. Project teams often operate independently from maintenance teams, particularly when maintenance is outsourced to an outside agency. Not only will you not realise the benefit of replacing an unserviceable fitting with a serviceable LED, but replacement fittings may be more efficient than those originally specified for the building.

While it is best practice to survey in person, pressures to achieve short paybacks may mean that shorter surveys are carried out that rely on original drawings that do not truly reflect reality. Situations may also arise, where it is not clear who is responsible for certain aspects of lighting, this is particularly true of retail parks that have undergone changes in ownership and building upgrades over the years. In this instance, it is particularly important to ensure all lighting fed from the site is captured during the survey so that opportunities are not missed.

Finally, when replacing fittings operated by a local switch with integrated microwave sensors, you need to consider factors such as glass panels and the volume of traffic passing the room. If the sensors are overly sensitive, you may end up with the lighting illuminated almost permanently and therefore consuming more energy than it was previously.

The no cost energy efficiency opportunity

Engagement with onsite management teams and building occupants. Engagement from the start of the project and in the weeks following project completion helps to identify and rectify issues. Operational teams have the most intimate knowledge of their workplace and are likely to identify problems and potential solutions that project teams are unaware of. Early engagement also helps to minimise any disruption that can occur while contractors are on site and helps to communicate the expected cost minimising and productivity benefits that are often a feature of improved work environments.

The low cost energy efficiency opportunity

When carrying out an LED upgrade, be sure to fully assess the current lighting arrangement. For example, as operational patterns change over time, a site could start seeing more activity during a night shift and therefore need improved lighting levels in a previously unused area. If the configuration is not set up for

this, members of staff may need to override lighting to carry out their work safely and effectively. If this is picked up early, it might be possible to move additional existing fittings on to the 24hr circuit so that it is no longer necessary to override the lighting. While this will marginally increase consumption, there will be a net benefit from removing the requirement to override the lighting in the first place. In this instance there would be a marginal increase in labour to change fittings from one circuit to another, but it would not incur the cost of additional fittings. Likewise, the same exercise could be carried out at a site that is not currently undergoing an upgrade, but again the cost incurred would be for labour rather than new fittings and additional wiring.

The most common energy efficiency opportunity

As lighting quality deteriorates over time and LED technology improves, it may be possible to achieve required lux levels with fewer fittings, although the cost of other components such as a replacement ceiling tiles need to be considered. Similarly, can microwave sensors be fitted in rooms that are currently operated via a local switch that is often left on?

The most overlooked energy efficiency opportunity

While current and ongoing maintenance costs are not always included in simple payback calculations, there are nonetheless indirect benefits that arise from newly installed lighting in the years immediately following an upgrade to lighting or controls.

Tracking these benefits, such as those that arise from a reallocation of maintenance resources to other building services, would help to understand more fully the benefits of lighting upgrades.

Finally, while most project and energy managers will anticipate unforeseen problems, they are by their very nature unknowns. Therefore, contingency plans must be in place for dealing with issues, such as faulty emergency lighting, damaged electrical circuits or ceiling tiles, which can increase costs without providing additional savings.

Top tip

While achieving energy savings is often at the forefront of decision making, lighting in buildings is provided to perform a function for the building's occupants therefore, this must be at the centre of decision making. If the lighting configuration does not perform for the building's occupants, this will inevitably lead to conflict and possibly energy wasting behaviours.

Bobby McHale, Estates and Facilities Data Analyst at Manchester University NHS Foundation Trust

The no cost energy efficiency opportunity

Behaviour Change. Staff behaviours can have a large impact on energy consumption, behaviour change can save energy from lighting through education and persuasion. This can be done through stickers and posters around fittings, or communication between peers of the benefits.

At Manchester University NHS Foundation Trust (MFT) we have a staff engagement programme called Green Rewards, and through small incentives of points and prizes over 750 staff members have actively reported switching off lights and equipment in their workspaces, a useful nudge for positive energy saving habits. A study titled "Intervening to change behaviour and save energy in the workplace: A systematic review of available evidence" prompted results showing the latter reduced the percentage of lighting being left on from 51% to 17% - saving power through persuasion!

The most common energy efficiency opportunity

LED lighting upgrade. Lighting technology has progressed rapidly over the past decade, with Light Emitting Diode (LED) lighting at the forefront of this. LEDs can save between 25% and 80% on electricity consumption, they provide high quality light and less maintenance due to a much longer life span.

Remember it is important to undertake a lumen method calculation beforehand, lighting systems tend to be excessive, a lumen calculation will most likely allow for a reduction in the number of fittings. With prices coming down and return on investments decreasing, they are becoming a no brainer.

The most overlooked energy efficiency opportunity

Ensuring external lighting controls are appropriate and well maintained. Most external lighting systems will include light level sensors as to ensure energy is not wasted in broad daylight, an often overlooked aspect of these systems would be the maintenance of the sensors. External sensors, and sensors located in areas like car parks can quickly become soiled by exhaust fumes and leaves or damaged due to battling the elements. This would result in a lower level of light being detected meaning the control thinks it's darker than it is and therefore switches the light on. A programme of maintenance and cleaning of these sensors will allow them to work as they should and save energy.

The most surprising energy efficiency opportunity

Lights which aren't just lights. With the introduction of smart lighting in recent years, light fittings are becoming more intelligent with integrated occupancy and even temperature sensors. These extra sensors, and the ability to communicate with other building services such as a building management system allows for extra energy savings through other energy profiles such as heating and cooling.

The low cost energy efficiency opportunity

Incorporating a daylight sensor with existing occupancy sensors. With many organisations requiring certain lux levels to comply with the relevant standards, lighting designs can be created under the impression there is no natural light available. In a hospital corridor for example, adequate lighting levels is required 24/7. With frequent footfall, occupancy sensors alone would mean lighting being on at all times in areas where natural daylight would suffice. A project completed at Manchester University NHS Foundation Trust (MFT) produced results of 70% energy reduction through LED and occupancy sensors, whilst these are positive results it was found that this reduction increased to 91% with the installation of a daylight sensor alongside it. It is important to always maximise the opportunities.

Top tip

Shout about your results. Staff are more interested than ever in how they can 'do their bit', communications around the positive results of interventions displayed in everyday terms such as cost savings will raise awareness and involvement; resulting in further energy savings.

by Andy Watson, Samuel Arje and Bruno Valerio

Energy Efficiency Opportunities in HVAC

Eliminating energy waste through energy efficiency is something that everyone who looks after energy in their organisation or for their clients is striving for. When it comes to different technologies, there is an endless list of options to consider at every stage. We are looking at different technologies in each issue of The EMA Magazine this year and asking those with experience in these areas for their thoughts and useful tips.

In this issue, we will focus on Energy Efficiency Opportunities in HVAC and we have asked three energy management professionals who gave their views in this area.

Andy Watson CEng CIBSE EI, Executive Director at Sim Energy Ltd

Heating Ventilation and Air Conditioning (HVAC) usually represents a high proportion of a building's energy load, often more than 50% of the aggregate electricity and gas usage. The provision of HVAC is essential to allow occupants to work or reside in relative comfort but due to the fact that its provision is largely invisible (compared to, say, lighting), it is often ignored when it is left switched on even when not required or oversupplying to demands.

For the energy conservation professional this then presents a range of opportunities to make energy savings without resorting to expensive technical upgrades or untested widgets. Here is a selection of some of them.

The most surprising energy efficiency opportunity

Fans, often one of the larger electricity loads in an HVAC system, follow what is called the cubic power law. This means that the electricity power used by the fan has a relationship to the fan speed by a power of three. For example, if you reduce the fan speed by 50% then the approximate resultant fan power is reduced to: 50% x 50% x 50% = 12.5%.

That means an approximate 87.5% reduction in electrical power. The catch is that fan pressure is reduced according to a square relationship to fan speed so simply running two fans at 50% may not be enough to overcome the system pressure. Nevertheless, finding ways to reduce fan speed will yield significant savings. These methods include CO2 sensing speed control, elimination of leaks, removal of obstructions in the ductwork and airstream etc.

Many energy solutions suppliers have recommended and installed

variable speed drives (VSDs) to clients in the past with a promise to reduce their fan energy costs by 40%. This is a good step forwards, however the first step should be to properly calculate, understand and control your air demand so that a VSD can be automatically controlled, and this kind of energy project optimised.

The no cost energy efficiency opportunity

It would be odd to suggest anything not relating to the Building Management System (BMS) at this stage. Providing one considers manual expertise on the BMS to be relatively free (an on-site energy manager and BMS maintainer should be able to do this) then focussing on BMS optimisation will yield the shortest paybacks on an HVAC system. Optimisation tasks include:

1. A regular review of time schedules so that the building has enough time to reach the required temperature before occupancy begins but also allowing for the thermal mass and air volume to take some of the demands and the end of the occupancy and shut down HVAC equipment before everyone leaves the building (assuming that occupancy follows a particular schedule). A rough but good first estimate is that if a building takes 1 hour to "warm up" then it takes about 2 hours to "cool down" so you can gain an hour a day of not having the HVAC switched on in many cases. In many cases however, energy experts often find HVAC systems running 24/7 when the building occupancy has nothing like this kind of demand.

2. Optimisation of temperature/humidity setpoints to provide relatively good control of tempered air. Typically, temperatures between 20-22°C will keep most people happy though this does not account for everyone - sometimes some people will have to wear jumpers while others wear short-sleeved shirts, that's just human nature and the facilities manager should not react to every single request to increase or decrease the building temperature.

3. Review of Low Temperature Hot Water (LTHW) and Chilled Water (CHW) temperatures to ensure that while keeping setpoints away from Legionella danger zones, that temperatures are not too hot or cold. The temperature of the service water in comparison to the ambient air dictates the amount of energy wasted through conduction through the pipework and insulation. A rule of thumb is that a one degree relaxation in temperature setpoints will yield a 2% saving in boiler gas usage and a 3% saving in chiller usage. Furthermore, relaxing setpoints will increase the asset life of chillers and boilers if they are prevented from "hunting" due to poor demand control.

The low cost energy efficiency opportunity

Installers love to insulate straight runs of pipe: it is easy and it looks great when completed. And they hate fitting insulation over complex shapes such as joints, valves, sensors etc. However, there is more heat radiated and lost from complex shapes than from simple straight pipework. Fitting metallic and fibreglass insulation around these shapes can be tiresome and expensive hence removable jackets are easily and cheaply available to purchase and fit. If access is needed to the ancillaries beneath then the jackets can be quickly and easily removed.

The most common energy efficiency opportunity

It is difficult to imagine a common good approach to HVAC savings though there is a surprisingly high number of cases where instead of some good old-fashioned engineering science has been applied, that some kind of miracle widget has been invested in. Some of these widgets may work, many do not and if they do then the energy savings yield is often too small to be interesting or the payback period extremely long. It is recommended to always work through the solid engineering techniques before investing in something new and relatively unproved.

The most overlooked energy efficiency opportunity

Many HVAC systems have their fans or pumps arranged in a duty/standby parallel arrangement. Often maintainers will cycle these facilities (i.e. switch over which unit is in duty and which in standby) in the belief that this will improve service reliability (in fact this operational strategy is the one most likely to result in simultaneous failure both duty and standby units).

Based on the cubic power law described above, there have been multiple cases where running both duty and standby units simultaneously (using VSDs) has resulted in significant energy savings as well as extending equipment life. This arrangement can be set up with pressure or flow sensors to run up one of the units to 100% of the desired demand if the other fails. I have overseen this improvement at a number of sites with a minimum of 11% electrical saving and a maximum of 36%. If the fans or pumps are already fitted with VSDs then this usually requires a very small amount of controls upgrades to enable this opportunity.

Top Tip

Always examine your actual system demands first! Does the chilled water temperature really need to be at 6°C when the return temperature is only 7°C? Does all the HVAC have to run at 100% during the occupied period? Is half of the building empty during most of the day?

Typically, HVAC systems are designed to provide for full occupancy at the most extreme of external conditions and then with another 10-20% comfort allowance on top of that. If you are not operating with those conditions then almost certainly you do not need to be running your HVAC at full supply.

Author's Profile:

Andy has worked and studied in the energy field since 1997 and holds a BEng (Hons) in Energy Engineering as well as Chartered Engineer status. He has been consulting for Sim Energy Ltd since 2006 and has worked for a range of high profile clients in developing carbon and energy mitigation strategies and initiatives. His main focus in the field of energy conservation is using consumption data analysis to develop and optimise solutions.

Sam Arje, Senior Energy Consultant and EnCO Practitioner at TEAM Energy

The most surprising energy efficiency opportunity

Avoiding conflict between heating and cooling units is critical when improving the energy efficiency of a building. To ensure this, a dead band of at least 3°C must be set. This dead band represents a comfortable building temperature for staff when neither cooling nor heating is required. Many buildings have just 1°C between the two, which is not enough to guarantee that both heating and cooling are not operating simultaneously.

The no cost energy efficiency opportunity

Educating the workforce to understand the importance of energy efficiency. This will have benefits beyond energy efficiency opportunities for HVAC but by inspiring colleagues to think sustainably will motivate them to be more careful when using HVAC systems.

The immediate benefit is cost saving, and although this seems to benefit the business rather than the employees in the short term, bigger savings means more money within the business to be allocated in different areas.

Demonstrate the business's position on energy management and the ambition to be a greener, more energy efficient business. In the current climate, customers, suppliers, and future staff respect businesses who are taking climate change seriously so making positive change is great for the company reputation. Most importantly, energy efficient operations drive down energy usage and therefore carbon emissions, which is essential when considering the UK's net zero target and, for environmental pollution in the local community. This should help them get on board to support your HVAC energy efficiency initiatives.

The low cost energy efficiency opportunity

The nature of a business will determine how its building is used and the ideal temperature it should operate at. Managing the temperature in accordance with the building use can minimise wastage, drive down costs, reduce carbon emissions and enhance overall user comfort. Therefore, it is important to manage HVAC centrally rather than allowing building users access to the controls. Temperature control panels or thermostatic radiator valves could be protected by codes or keys that only limited people have access to.

Additionally, a Building Management System (BMS) can boost the efficiency of an HVAC system by monitoring a building's humidity and ventilation as well as making it easy to schedule the system to work at different temperatures on specific days and at specific times.

Central temperature and time-based controls will help you to run your operations at the optimal temperature. You may make a bigger impact by utilising zonal controls which are more effective

where there are multiple uses and required temperatures in different areas.

You could also install placebo controls which look and feel like actual temperature control panels or dials, so users can seemingly adjust settings without affecting your settings. These placebo controls are not connected to the HVAC system so any changes that the user implements on the controls do not affect the building's optimal settings. Studies have found that often this is enough to make the user believe the heating or cooling has changed in their environment.

The most common energy efficiency opportunity

A physical inspection of areas around the building will help you understand whether your HVAC system is operating in the best circumstances. Whatever type of building you have, conditioned air is precious so take measures to ensure that roof, wall, and floor insulation is up to standard.

Pipes, ducts, and outlets are also usual suspects for energy loss that can get overlooked. Gaps in windows and doors need to be repaired to improve HVAC efficiency and ensure that external doors are not left open. Where doors are operated by motion sensors, adjust the settings to limit the time they are open for. And, most obvious of all, encourage staff to not be tempted to open windows when the heating is on.

The most overlooked energy efficiency opportunity

It is easy to forget the thermostatic settings that run in the background. Check that they are still suitable for the building's operating hours and occupation levels. These are changes that have affected most organisations in the current climate. If there is a control panel, use it as it is meant to be used; adjust time bands, ensure the settings are adapting for seasonality, building use and UK time zone changes. Also check that the dates and times are correct on all control panels.

Additionally, check the building's temperature sensors, establish that they are calibrated and operating correctly so that the internal heating system switches on and off to suit your organisation's operating hours. Also check that the sensors are located appropriately, particularly if there have been any changes to the building layouts.

Top tip

Engaging and influencing staff to form sustainable and efficient habits can make a big impact on your building's overall energy consumption. It is impossible to make everyone 100% comfortable in a building, but if everyone amends settings to suit themselves, the building is likely to be less comfortable for most and it will never be efficient. Encourage colleagues to adjust their behaviours so they can support the overall energy strategy and avoid inadvertently wasting energy.

It is worth trying to influence organisational dress code to allow staff to dress appropriately for the weather conditions and for their own comfort, suggesting that staff wear layers that they can add or remove accordingly.

Not everyone approaches energy use in the same way, so investing in training to coach colleagues to become more energy conscious and change their habits will be worthwhile.

Author's Profile:

Sam is Senior Energy Consultant at TEAM Energy. He is an award-winning Energy Manager with strong experience of implementing energy projects. He is an EMA ESOS Lead Assessor and EnCO Practitioner and specialises in Energy Compliance.

Bruno Valerio, SMaRT hub Energy Analyst at Arcus FM

Introduction

It is known that 160 million buildings in the European Union use over 40% of Europe's energy and create over 40% of carbon dioxide emissions. In the United Kingdom, direct greenhouse gas (GHG) emissions from buildings were 87 Mt CO2e in 2019, accounting for 17% of the country's GHG emissions. These emissions are mainly the result of burning fossil fuels for heating. Buildings are responsible for 59% of UK electricity consumption, equivalent to a further 31 Mt CO_2e of indirect emissions.

Therefore, the best practices of sustainable building design, efficient energy management policies, and systems optimisation lead to a significant reduction in energy consumption in buildings, driving the country towards its target of bringing all greenhouse gas emissions to net-zero by 2050.

In retail food stores/buildings, for instance, HVAC electricity consumption accounts for figures between 15% - 25% of total building usage, depending on the heating system design, geographic location of the store, and controls. This type of buildings would also have gas as a fuel type mainly consumed for HVAC purposes, in the event of having their heating & ventilation units gas-fired.

Energy metering systems allow building occupiers, owners, and managers to learn, manage, benchmark, and improve the buildings' energy performance and ultimately reduce its consumption and subsequent carbon equivalent emissions, by closely monitoring the various equipment circuits & energy loads. In this topic, HVAC sub-metering data is vital for those keen to analyse the building profile, understand internal & external variables affecting consumption & energy conservation in HVAC systems, whilst anticipating trends and detecting anomalies driving the buildings' energy consumption upwards. The below points represent real case studies of remote energy investigations of HVAC systems.

The most surprising energy efficiency opportunity

Think energy benchmarking and volume of heated spaces. Energy benchmarks are expressed in terms of delivered energy used per unit of floor area (kWh/m2), for both electrical and fossil fuel energy use. For instance, according to CIBSE Energy Benchmarks TM46 document, the fossil thermal typical benchmark for supermarkets is set at 105 kWh/m2/yr, whereas the electrical benchmark is 400 kWh/m2/yr.

As much as they guide those seeking to understand whether their buildings are or not within the expected consumption intervals, this document failed to consider the differences in thermal energy consumption in the cold and warm months.

Remote energy HVAC assessment in retail food buildings should consider the analysis of building dimensions and other main systems, such as lighting and refrigeration. The over usage of one will affect the performance of others and vice-versa.

A particular case of long investigations for a supermarket flagged with excessive HVAC gas consumption has brought up new examples of how one building system can push the other to consume more energy. The investigated supermarket had been within expected energy usage ranges but suddenly seen its gas consumption going through the roof for no apparent reason.

Once the HVAC control strategy had been confirmed to be correct, an engineer has attended the site to investigate the HVAC system operation hoping to determine what could be driving gas consumption massively up. It has been noted that all heating & ventilation units had been working perfectly and in accordance to the customer's specifications.

However, it has also been noted that the buildings had recently had a lighting investment. The steep increase in gas consumption followed a LED refit not only because these type of bulbs emit less heat but also, and more importantly, the previously dropped ceiling holding the older lighting system had been removed which has almost doubled the heated space and, therefore, heating demand. The HVAC system was

eventually replaced by a more efficient alternative to match the new heating requirements.

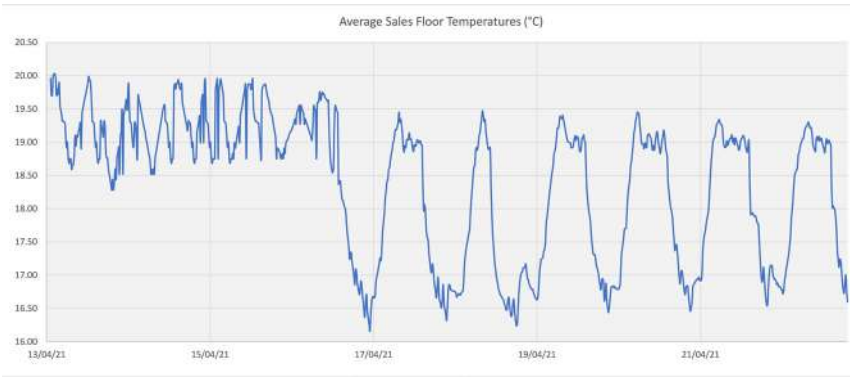
Although energy benchmarks add valuable information regarding the typical energy use assessment for a certain building type/sector, it is advised to analyse other parameters that would help to identify energy efficiency opportunities in HVAC.

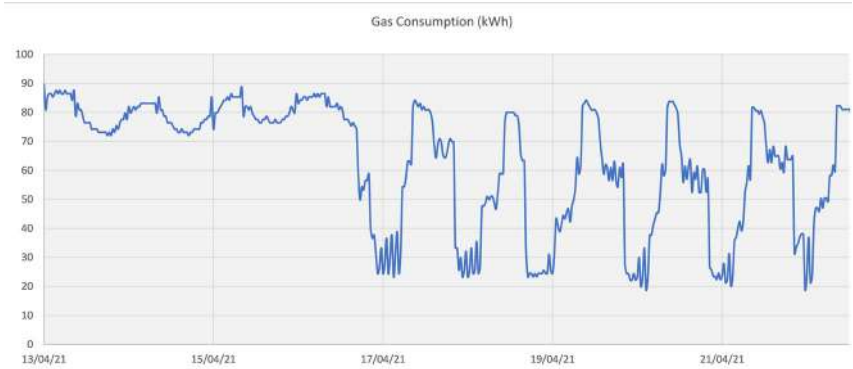
The no cost energy efficiency opportunity

Set energy alerts. One of the key steps of building optimisation is the extensive remote analysis exercise, which could be taken as a first assessment before an on-site energy HVAC audit or purely to ensure these systems run smoothly from an operation & energy efficiency point of view, and in line with the Federation of European HVAC Association's (REHVA) guidelines.

An analysis of metering data does highlight what is very likely to be missed during on-site audits. The better the data granularity available the higher the chances of spotting anomalies. The combination of energy metering data with telemetry data as well as site operating hours provides an efficient and no-cost way to spot anomalies that could progressively become asset problems or simply detect tiny deviations to the expected building HVAC energy consumption profile. As a result, small and quick remote adjustments could easily result in achieving energy savings by simply resetting BMS systems to specifications. Such a task could be carried out by adjusting BMS parameters in line with core operating hours, building occupancy demands, and/or seasonal weather factors.

The below pictures represent the reduction of a retail building sales floor temperatures following the BMS remote adjustments and the direct gas consumption drop, respectively.





As per this adjustment, not only has a gas reduction been achieved, but also the HVAC electricity consumption is likely to have reduced. Furthermore, in food retail buildings, we often witness indirect refrigeration energy savings too, depending on how much the heat load is eased upon these systems.

As BMS systems automatically run all year round, they help reduce business costs and lower carbon emissions by requiring little maintenance and assuring building thermal comfort, achieving superb savings at no cost. If the building's energy tariffs are also known and the BMS systems are capable of adjusting settings in a relatively quick period, then an even bigger energy-saving opportunity can arise.

Peak tariff management represents a real advantage where, for example, the reduction of major HVAC units' motors speed or even their temporary shutdown occurs during high energy tariff events (such as Triads) avoiding, at times, the payment of astronomical energy bills.

The low cost energy efficiency opportunity

Explore maintenance visits. HVAC systems, like any other building systems, do require regular maintenance. Ultimately, this contributes to fewer repair costs, avoiding major asset issues, increase

equipment lifespan and indoor air quality as well energy efficiency.

Planned preventive maintenance (PPM) visits play a vital part in identifying poor asset performance and retaining these at the desired level of quality. Therefore, including HVAC energy checks in these visits does help pinpoint essential equipment components that could potentially be outdated or requiring replacement.

Frequently, sites with excessive gas and HVAC electricity consumption do show some sort of overused asset parts, particularly on occasions where the BMS strategy has been reviewed and set to specification. For instance, the replacement of an Air Handling Unit (AHU) filter and/or door curtains have saved significant amounts of energy in food retail buildings, not to mention the health & safety benefits that come with it.

To make the most of PPM visits and adequately plan these according to each building's demands, geographical location, and/or season, could add great benefits by minimising the HVAC system energy consumption and extending its lifespan.

The most common & overlooked energy efficiency opportunity

Review settings. Particularly during the winter months, HVAC systems seem to stretch their capabilities and require pre-winter maintenance checks followed by permanent energy performance monitoring. By doing so, not only do we ensure consumption is within expected ranges but also building thermal comfort is delivered.

Thus, and as previously mentioned, the correlation between telemetry data (building temperatures, AHU supply temperatures, heating demand, etc) and energy metering provides a great remote overview of sites' energy & thermal performance.

Commonly, retail food supermarkets are flagged with excessive HVAC & gas consumption. Several factors contribute to this but perhaps the requirement to run systems above standard specifications and longer than core operating hours represents the main drivers for such a fuel consumption increase.

Despite BMS systems running automatically, faults do occur causing for example, loss of communications to sites and leaving the major HVAC units running flat out. Settings need to be reviewed once communications issues are rectified and/or according to building operations' demands.

Furthermore, ensure settings are also reviewed post-on-site works as these could easily be misleading HVAC units to run harder than needed (quite often unnoticeably until energy consumption starts climbing) and most importantly, that the BMS strategy is in line with the building's demands. This could provide quick wins, not requiring site attendance and maintaining sites within their energy budgets.

Top tip

There are no equal buildings. Be mindful of the fact that each building is a different case scenario as its energy demands, fabric properties, installation type, or simply BMS control strategy may well be different from its most similar site. Consequently, the search for energy efficiency opportunities, particularly from a remote perspective, does require deep investigations, merging several layers of data that would normally pay off the invested time.

As faults do normally occur, the trick is to closely monitor, continuously assess energy and asset performance and, if possible, work with live data to predict rather than react. Owners and tenants also carry out investment programs and on-site works which require energy baselines to be adapted and any BMS strategy amended accordingly.

Adopt a bespoke Energy Management Policy which, coupled with a proactive colleague and staff behaviour, becomes vital to follow good practices and helpful in spotting anomalies. Invest in replacement of inefficient systems by low carbon technologies to minimise fuel consumption and GHG emissions.

Lastly, keep your eyes wide open and rigorously pay attention to detail (i.e. on data) as it does make a clear difference. The planet thanks us for any energy efficiency improvements.

Author's Profile:

Bruno is passionate about Energy & Environment and working towards the net-zero target. Awarded with a Master's degree in Energy & Bioenergy, he joined Arcus in 2015 to perform energy consultancy, analysis, management, and monitoring for our customers, supporting them to reduce their energy consumption and carbon footprint.

by Madeleine Harris,
Commercial Energy Analyst at Dŵr Cymru Welsh Water

Energy Efficiency Opportunities in Data and Reporting

Dwr Cymru Welsh Water is the 4th largest company in Wales. We serve most of Wales and Herefordshire through an extensive asset base of over 56,500km of clean water mains and sewers, over 800 wastewater treatment works and 92 reservoirs.

The day-to-day job for a lot of my colleagues in our in-house energy team is spent travelling all across Wales, helping to build and maintain our physical assets to ensure we deliver the greenest, cleanest and most efficient energy services we possibly can.

While I am no stranger to a hard hat and safety boots, I help create value from arguably one of the biggest assets a company can have in the 21st century, right from my desk at home – our data.

During my time at Dwr Cymru, I have been involved in quite a few energy projects involving data, from automating an anaerobic digestion plant's SCADA system, to creating and implementing the financial budget through our team's favourite new data modelling tool, Power BI. I have always been drawn to these sort of projects, not just because I feel as though numeracy is my mother tongue, but because I truly believe that understanding energy habits is the first and most important step in order to achieve energy efficiency, and this can be achieved through communicating the data we harness. So, I would like to share a bit of insight regarding this, from my recent project of creating the power budget for next year.

The most surprising energy efficiency opportunity

This is not surprising in the sense that it is unexpected, but such that this efficiency rarely comes without causing a bit of shock or a few challenges along the way: behavioural change. It is a big challenge for our team as we reach our limits of optimising through replacing inefficient bits of equipment for efficient ones. We know the scope for further efficiencies has to be driven by behavioural changes to reduce consumption, which is not as easy to implement. Culture change causing a massive headache for organisations is hardly news. While new technologies and ways of working become widely available, encouraging the uptake of these new changes require individuals to make choices where benefits may come to fruition in the long term, so are often overlooked.

TRIAD season is a perfect example of this. Each year, to try and catch the 3 highest half hourly periods of highest recorded UK electricity demand during the winter period, the energy team calls multiple TRIADS. These short-notice changes in consumption can be very disruptive to many areas of the business but is required to save us paying extremely high costs for our power.

The transfer of control and accountability is very welcome when we have achieved savings from efficiency projects or consumption reductions. However, the idea of new challenges or ways of working in the

form of new projects and reduced budget targets can often cause a bit of tension, and sometimes a bit of push-back. Despite super-conservative project delivery dates and months of data to prove consistent reductions in consumption for some sites, we found some of our customers reluctant to accept a saving target in their budgets for next year. Sometimes new ideas may clash with short-term decision making or have an element of uncertainty – it is natural for people to stray from the accountability of something uncertain. People resist change when they believe they will lose something or fear they will not be able to adapt to these new challenges, and the consequences of this.

However, as a team we assure others through the provision of data, and our communication around it. We celebrate organisational successes through our reports, particularly during Triad Season, to achieve consistent buy-in from all areas of the business, which can be hard to achieve when some business results are disappointing. My adaptable colleagues are active participants in any changes we may suggest; we realise that for behaviours to change, we really do need to lead by example to ensure we are all singing from the same hymn sheet. We promote our reports, show others how to use them and proudly take on any queries or feedback that comes our way. We take the time to hear people out, take on board worries and concerns, and we make everyone else part of our story. You would never find someone in our team saying, "That's not my job", the kind of attitude needed to lead change.

The no cost energy efficiency opportunity

We were always taught 'Good manners cost nothing, but are priceless', and I have found this has certainly applied to my recent projects, making good manners and engagement my "No Cost" efficiency opportunity. Although it seems like something obvious, it can often be overlooked as we do not always audit our style of communication, or it is not something we are always aware of. To deliver on efficiency projects, good rapport and engagement with the team taking on the efficiencies is crucial – no one will be motivated to deliver things that are just being demanded of them with no explanation. We achieve things together through collaboration.

After submitting the budget, I engaged with stakeholders about their year to date performance and prospective budgets. I was really delighted to see that after being presented with data about certain sites, our customers were able to pinpoint the reasons why the performance of certain assets were different from expected, and they were keen to go and discuss this more with their teams to find more answers. We provide the data and the visuals, but ultimately catchment managers and our operational colleagues are the ones who provide the narrative and the answers! Good communication and engagement of the data we present to other teams then creates the perfect environment for problem solving and driving efficiencies.

The low cost energy efficiency opportunity

This can be 'low cost' depending on what tools and skills you have, but from my own personal experience the provision of transparent, user friendly data is my "Low Cost" efficiency. Power BI, a business insight platform created by Microsoft, has had increasing prevalence in my team over the past couple of years.

Caban Coch Dam in high spill

We have worked on building our own knowledge and skills of the platform via connecting our various data sources to create energy insight reports that we have made available online for anyone in the business. We continue to improve and provide new reports as we understand our customers' needs more and more.

We realise that our customers value our honest and transparent practises when it comes to data provision. By not hiding anything we are able to build strong relationships with our customers on solid grounds, trust and respect. It demonstrates our confidence in the data, and our accountability for it. Some stakeholders felt that energy consumption is somewhat out of their control, probably due to lack of visibility of energy consumption itself.

When provided visuals based on data, the trends spark interest and the cogs begin to turn. By making our reports and data easily accessible, individuals are empowered to investigate their own initiatives freely, to make data-driven decisions which helps drives efficiencies. It enables control and accountability to pass through from our team to theirs. People are more motivated to make changes when they have control and have the access to right information to do so.

The most common energy efficiency opportunity

As we enter the age of Big Data, it goes without saying that the most common efficiency in data and reporting is the collection of quality data first place. Data undoubtedly helps us to make better decisions, solve problems, understand performance, improve processes, and understand our customers, to name a few. Like any asset, data must be maintained to a high standard to be efficient, because you cannot use the data to solve problems or make decisions if it is not truly reflective of the situation to begin with.

It became apparent from the discussions with our customers that we still have work to do with the quality of our data. Even the little things such as an MPAN belonging to a wrong area, or certain sites allocated too much or too little budget all work against the objective of making a budget as reflective as possible. It is important to note that organisations change all the time, and data should be maintained to reflect this so it can continue being an asset, otherwise it may start to cause inefficiencies. Make your data credible.

The most overlooked energy efficiency opportunity

I would not say this aspect is overlooked, but perhaps the 'Story' of the data and reporting is sometimes neglected because we are often focused on the data itself. Unfortunately, if we cannot tell a compelling story, the message is likely to be misunderstood, and we will not see any change. At that point, what was the point of collecting the data in the first place? We are under the illusion that more data is better, but this runs the risk of having more than you know what to do with, which could lead to inefficiencies. We collect data to help us create a picture and to tell a story, but this could be difficult and arduous if you are bogged down by a lot of useless information. So being mindful of whether the data you are collecting is for a specific reason or not can help mitigate this risk.

While collecting data is one thing, being able to extract value from it is another which requires a lot of skill. This is where the story telling aspect comes in. We particularly like Power BI because of the user-friendly visuals we can create from the data we model, which help us enlighten our customers about data insights that they would not see just from looking at a set of data (unless they were robots).

Graphs and visuals allow people to spot trends, patterns, and abnormalities and create easily digestible data which fuels stakeholder empowerment. It is also worth getting clued up on which graphs best represent the story you are trying to tell, to aid this. This alone is not enough, though. There is then the narrative behind the data and visuals. As humans, we love stories. We need narrative to explain the bigger picture beyond the visuals!

My Top Tip

You do not need a degree in computer science to get started with data modelling and reporting – anyone can do it! My team's skills in Power BI are self-taught and we grow our knowledge through sharing sessions, with other parts of the business. New technologies become available all the time so it is important to share and to keep up to date!

Author's Profile:

Madeleine is a Commercial Energy Analyst at Dwr Cymru Welsh Water. She has been in this role for a year now after starting it as the final placement on her graduate scheme at the University of Surrey. Madeleine background is Maths and Economics, but she has a keen passion for all things green.