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.

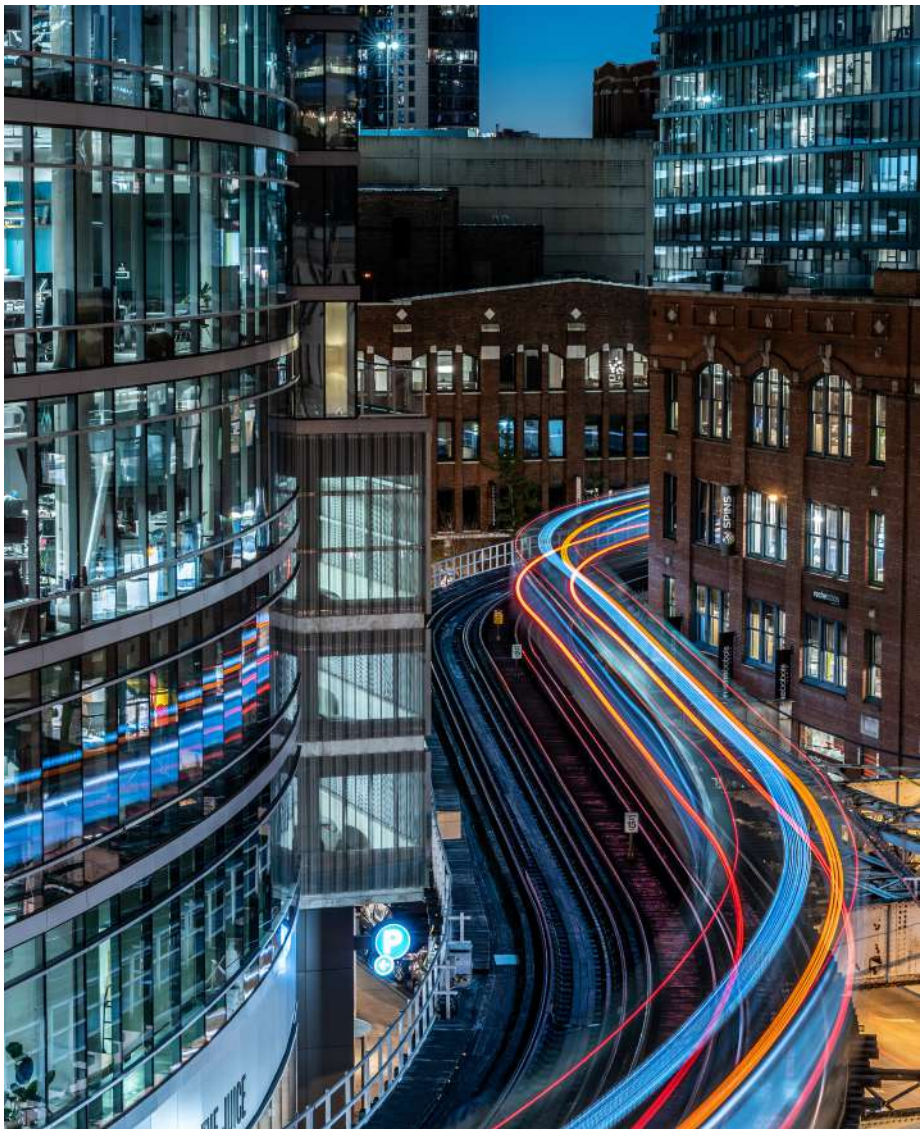
At this point, when it comes to carrying out the work, revisit each installation to fully understand the type of lighting, controls, wiring and components used to prevent any surprises during the install stage. This information is critical for establishing the proposed upgrade solution that delivers 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.