CIBSE JOURNAL

Build Perform

December 2021 www.cibsejournal.com

ORKNEY'S HEAT ISLANDS

How one Scottish council is decarbonising its building stock by switching to heat pumps

MAX FORDHAM ON PERFECTING PASSIVHAUS

EMBEDDING INDOOR AIR QUALITY IN BUILDING DESIGN

NIGEL BANKS: WHAT UPFRONT CARBON MEANS FOR ENGINEERS

Lighting Special


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Avoiding electric shock

If the UK is to decarbonise buildings by switching from gas to electric, there are some serious challenges to address regarding Grid capacity. Currently, peak gas demand is four times that of peak electricity. A huge investment in the Grid will be necessary to take on this additional load and also provide power for the nation s electric vehicles.

There is also the issue of ramp rate . This is the sharp uplift in energy demand during busy periods, such as first thing in the morning. While the gas grid can accommodate uplifts of up to 120GW, the current uplift on the electricity grid is only 5 10GW.

CIBSE s new guidance, TM67, spells out some key challenges of electrification as we move to net zero, and explains how technology and digitisation will help the transition. It reiterates the importance of demand reduction something that was rather tucked away in the government s *Heat and Building Strategy*. Tony Day is chair of the TM67 Working Group and, on page 57, he explains how the guide will evolve to promote best practice as we understand more about designing and operating electric buildings.

Max Fordham understands the importance of minimising heating loads in building designs. It has been using the fabric first Passivhaus design approach since 2013, and, for the past two years, has won the CIBSE Building Performance Award for residential project of the year. The contrast between its two award winning projects demonstrates how Passivhaus can work at different scales. The 2020 accolade was for the large Agar Grove estate regeneration project, completed in 2018, while founder Max Fordham s own single dwelling was recognised in the 2021 awards.

On page 20, Max Fordham s Gwilym Still describes what the practice has learned from the Passivhaus process and how it has refined its designs based on knowledge gleaned from previous schemes. One of its most recent Passivhaus projects has been the all electric retrofit of the Entopia building for the Cambridge Institute for Sustainability Leadership. With the focus on minimising embodied carbon, retrofits such as this will soon be commonplace, and consultants will spend more time on the moisture risk of insulating old buildings than selecting new materials.

Embodied energy is also addressed in TM66, which features in our Lighting Special on page 44. It s not just designers who will have to focus on reuse; manufacturers also have a crucial role in designing components that can be disassembled and used again.

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CONTRIBUTORS

Hywel Davies
What can be expected from the government on energy and buildings following COP26

Nigel Banks
What upfront carbon means for building services design and the specification of renewables

Jill Entwistle
SLL has published new guides on the circular economy and illuminating the night-time environment

Tim Dwyer
December's CPD explores the drivers for good-quality ventilation in schools and other education facilities

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IN BRIEF

ASHRAE opens net zero HQ

ASHRAE has formally opened its new global headquarters building, after a $20m renovation to demonstrate the economic viability of a fully net zero energy operation.

The 66,700ft² building, situated in 11 acres of land at 180 Technology Parkway, Peachtree Corners, Georgia, took 10 months to renovate and was completed at the height of the Covid 19 pandemic.

The society s treasurer, Ginger Scoggins, said: We decided ASHRAE could make the greatest impact by showing others how to renovate an existing building with net zero energy as the focus, using our own standards and guidelines. ASHRAE is making net zero the new norm in sustainable design and construction.

Graeme Fox elected IoR president

Graeme Fox will be the next president of the Institute of Refrigeration (IoR), having been announced as the winner of the members vote at the IoR AGM. He will take over from current president Mike Creamer next year.

A chartered engineer, Fox ran his own air conditioning contracting business before being appointed head of technical at F Gas register Refcom in 2016. He became BESA head of technical last year.

An IoR Fellow and president of AREA, the European contractors body, from 2010 14, Fox is currently working with the United Nations on a refrigerant drivers licence scheme to help developing nations establish safety and competency criteria for refrigerant handling.

Arup to drop fossil fuel work

Consultancy committed to achieving net zero across global operations by 2030

The consultancy Arup will not take on paid work linked to the extraction, refinement or transportation of hydrocarbon-based fuels from next April.

It says all future energy commissions will focus entirely on low carbon solutions, including wind, solar, hydroelectric and hydrogen projects.

Arup's future projects will focus on wind and solar solutions

Last year, the engineering giant announced a commitment to achieve net zero across its global operations by 2030, and this new commitment addresses the emissions from its client work across thousands of projects in 140 countries.

It has also committed to carrying out whole life-cycle carbon assessments for all its buildings projects – new and retrofit – from next year, adding that this would produce fresh data on the scale and source of whole life-cycle carbon emissions.

The company's group chair, Alan Belfield, said: 'Whole life-cycle carbon assessment is the next step that must be taken to unlock decarbonisation of the built environment at scale.

'Our commitment to undertaking whole life-cycle carbon assessment for all of our buildings work means that, for the first time, we will have the data to share with our clients, and with industry partners, about the precise actions to be taken to decarbonise buildings – new or existing – most effectively.'

Two years of growth ahead predicted

Market analysts Glenigan forecast that 2021 will turn out to be a year of strong growth across the construction and related sectors.

The total value of underlying construction project starts is expected to reach £54.2bn, which will be a rise of 11% on last year, but still 8% lower than pre-pandemic levels recorded in 2019. Growth will be less dramatic over the next two years, but Glenigan is still forecasting an increase of 7% next year and a further 5% in 2023. This will push the value of project starts up to £61bn, which would be 3% higher than the level recorded in 2019.

Weaker private-sector investment will influence the industry's performance from 2021-23, and weak real-earnings growth – along with labour shortages and disruption to the supply chain from post-Brexit customs regulations – will also slow things down. 'We expect supply-side issues to temper the pace of growth,' said Glenigan economics director Allan Wilén. 'Near-term availability and cost of materials are set to be the greatest constraint on industry growth. These are anticipated to ease during 2022, while labour availability and wages are expected to be growing supply-side constraints.'

Prime Minister 'tinged with disappointment' by COP26 deal

Johnson gave climate conference overall score of 'six out of 10'


Prime Minister Boris Johnson at COP26

Prime Minister Boris Johnson has admitted that the final deal signed by delegates to the COP26 climate conference in Glasgow could have been stronger and more ambitious, but claimed the summit was still a success.

In his closing address, he said he was 'tinged with disappointment' that the Glasgow Climate Pact, supported by more than 190 nations, did not go further, but claimed real progress had been made in several crucial areas.

He gave the gathering an overall score of 'six out of 10' and expressed optimism that 'for the first time, humanity is genuinely equipping ourselves with the equipment we need to halt anthropogenic climate change altogether'.

However, analysis by scientists at Climate Action Tracker indicates the world is still on course for 2.4°C of warming by 2100, despite the global actions agreed at the conference. They accused the governments of a 'massive credibility, action and commitment gap' at COP26, estimating that, in 2030, global greenhouse gas emissions will still be around twice as high as they need to be to keep the world on track for the 1.5°C rise agreed at the Paris conference in 2015.

Johnson said individual governments could not be forced into action, but added that promises now needed to be 'delivered and not diluted'.

Poor housing costs NHS £1.4bn a year

The impact on people's health of poor housing in the UK is costing the NHS £1.4bn a year, with excess cold the biggest problem, according to a new report from the Building Research Establishment (BRE).

Excessive cold costs the NHS £857m per year, and 11% of England's homes (2.6 million) have at least one 'category one' hazard, so are considered 'poor quality' and potentially hazardous to occupants.

The report says 75,000 homes are suffering from serious damp, costing the NHS £38m, but BRE says there are many more homes with less serious damp that still affect people's health. It has calculated the cost to remedy all category one hazards in English homes to be £9.8bn, and that the cost of mitigating risks associated with damp, for example, would be paid back in healthcare savings in seven years.

BRE points out that there are 'societal costs' associated with poor housing – such as those linked to long-term care, mental health and poorer educational achievement – and its report suggests the wider annual cost could be as high as £18.5bn.

Social housing must have smoke alarms

Smoke alarms must be fitted in all rented accommodation, under new rules announced by Housing Minister Eddie Hughes MP last month.

The consultation, launched alongside the Social Housing White Paper last year, extends requirements for alarms in social and private rented homes and through Building Regulations.

Smoke alarms will be mandatory in all social rented homes and carbon monoxide alarms will be mandatory in rooms with a fixed combustion appliance (excluding gas cookers) in private and social rented homes. Carbon monoxide alarms will be mandatory upon the installation of any heating appliance (excluding gas cookers) in all tenures through Building Regulations. Finally, landlords will be expected to repair or replace faulty alarms.

CIBSE technical director Hywel Davies said: This is a welcome addition to existing safety measures in rented homes. Any CIBSE member specifying or installing combustion appliances in any dwelling should already specify an alarm, regardless of tenure, as good practice.

New homes to have electric car chargers

New homes and buildings in England will have to have electric vehicle charge points installed from next year, the Prime Minister has said.

According to the government, the move will result in 145,000 being installed across the country each year. New build supermarkets and workplaces, and buildings undergoing major renovations, will also come within the new law.

About 10% of cars sold in 2020 were electric, and the Competition and Markets Authority says the country could need 10 times the current 25,000 charge points before 2030.

CLC warns of looming product-testing crisis

Failure to assess products in time could damage ambitions for housebuilding, building safety and net zero

A shortage of testing capacity could mean crucial construction products will no longer be available to the UK market from January 2023, according to the Construction Leadership Council (CLC).

The UK is due to drop the European CE Mark in just over a year, in favour of the new UK Conformity Assessed (UKCA) mark for product compliance. However, a shortage of UK-based test facilities is causing alarm across the construction sector.

The CLC has written an open letter to government ministers pointing out that a failure to assess products in time for the new deadline could damage their ambitions for housebuilding, infrastructure, building safety and net zero.

'The inability to certify radiators in the UK, for instance, could delay the construction of more than 150,000 homes in a single year, and will delay the switch to low carbon heating,' the CLC wrote.

The UKCA mark deadline has already been pushed back to January 2023, but most industry observers say this will not avert the looming crisis. The CLC wants greater flexibility, more investment in testing capability, and for some tests to be done overseas.


Housebuilding could be hit by a lack of product-testing facilities

Infrastructure plan to prioritise green projects

Projects to support the development of carbon-reducing sectors, such as hydrogen and heat pumps, will 'sit at the heart' of the National Infrastructure Commission's (NIC's) advice to government about future investment.

The NIC said it would focus on tackling 'unanswered questions' around the net zero transition, such as defining the limits of heat pumps for home heating, the role of hydrogen in heat, and the future of the gas grid. It has produced a report that prepares the way for the UK's second National Infrastructure Assessment in 2023, which encourages all industries to make better use of digital technologies to cut costs and improve efficiency and resilience.

The report says there has been limited progress on the transition to low carbon heating for homes because of a 'stop start' approach to energy efficiency policy. The 2023 assessment will set out costed policy recommendations to government for investment in infrastructure over the next 10 to 30 years. The NIC will 'explicitly' consider the affordability of the investment, and how costs and savings will be spread between consumers and taxpayers.

‘No excuse’ for poorly ventilated buildings

Professor Cath Noakes calls for accreditation for the ventilation sector

One of the government’s top scientific advisers has called for a concerted programme of ventilation improvements in buildings, including professional accreditation for contractors.

Professor Cath Noakes said the Covid-19 pandemic had increased understanding of how disease is transmitted around indoor spaces and raised public awareness of the importance of mechanical ventilation.

Speaking at the Building Engineering Services Association (BESA) National Conference, she said: ‘[I] never thought I would see the day when the Prime Minister and the chief scientific officer were talking about ventilation.’

Noakes, who is one of two engineer members of the government’s Scientific Advisory Group for Emergencies, said the pandemic had exposed systemic failings in how we design and retrofit buildings, and added that we should pay far more attention to the impact of poor ventilation on human health and productivity.

‘Many of our buildings are under-ventilated and there is no excuse for it,’ said Noakes, who is professor of environmental engineering for buildings at the University of Leeds, and an expert in fluid dynamics. ‘We know buildings improve health and that poor indoor air quality reduces productivity by up to 9% – that’s half a working day a week.’

She told the conference that it is important that ventilation contractors are included in wider discussions because of their practical knowledge, and called for professional accreditation for the ventilation sector, similar to that for the gas and electricity professions.

Better evaluation of systems in use is also needed, Noakes said, to assess whether they were delivering what occupants need, had been installed and commissioned correctly, and were being adequately maintained. It was now clear, she added ‘that it is very hard to naturally ventilate buildings adequately in winter’.

Studies focus on school ventilation

As much as 40% of primary school buildings lack adequate ventilation to combat the spread of disease, including Covid-19, according to a study by Coventry University.

The research, led by PhD student Sepideh Korsavi, concluded that this was less to do with the design of the buildings and was largely because teachers were reluctant to open windows or doors.

In 32 naturally ventilated classrooms, 805 children were monitored during cold and warm seasons. The study suggested that a classroom with high potential for natural ventilation did not necessarily provide adequate air quality because that relied on windows and doors being opened appropriately.

Korsavi recommended the use of windows at two different heights to meet the needs of both teachers and children. ‘Well-designed, naturally ventilated schools that are operated effectively by school occupants can increase ventilation rates and reduce the risk of spreading Covid,’ she said.

The researchers also recommended schools follow recent CIBSE guidance that reinforces the need for good ventilation to reduce occupants’ exposure to airborne pathogens, including Covid-19.

Meanwhile, 30 primary schools in Bradford are the focus of a £1.85m trial run by the University of Leeds, which studies the effectiveness of air cleaners in reducing the spread of Covid-19.

Two different approaches using portable or wall-mounted devices are being tested: one uses a high-efficiency particulate air filter and the other cycles the air through an enclosed unit, where it is exposed to an ultraviolet (UV) germicidal light in a bid to ‘inactivate’ the virus.

IN BRIEF

Material price rises hit 40 year record

The price of building and engineering materials is rising at a faster rate than at any time in the past four decades, according to the latest Building Cost Information Service Materials Cost Index from the Royal Institution of Chartered Surveyors (RICS).

Steel and timber suffered the highest price hikes between January and September, and RICS analysts say the rises will continue well into next year. The cost of materials in constructing a three bedroom, semi detached house increased by 14% or approximately £7,300 between January and September, said the index s director, James Fiske, who added that labour shortages would become the significant driver for overall construction cost increases next year.

Alliance calls for retrofit push

The engineering services alliance Actuate UK wants industry and the government to work together to tackle the challenge of retrofitting and decarbonising existing buildings.

BSRIA s Michelle Agha Hossein told a built environment session at the COP26 climate conference in Glasgow that the UK has the least energy efficient housing stock in Europe, and around 28 million homes would need to be retrofitted to keep net zero plans on track.

Retrofitting will not only have environmental benefits, but also social gains, as we must ensure decarbonising buildings will optimise occupant safety, health and comfort, she said.

Manly Trust celebrates 30 years

The Manly Trust, which supports charities working with young people and promoting engineering careers, is 30 years old this month.

Founded in 1991 by former CIBSE President Graham Manly, in memory of his father, Alfred, it has so far provided more than £1.5m of funding to 130 charities and causes.

Since its foundation, the trust has been run by Manly s wife, Margaret, but she is now stepping down from the board, leaving David Manly, David Montgomery, Tim Dwyer and Ewen Rose as trustees.

Team MS Lighting Design won the 2021 Peer Prize

Lighters compete in annual competition

The Society of Light and Lighting s Ready Steady Light (SLL) event, held in partnership with Rose Bruford College, took place in October.

The annual competition sees teams compete to design and set up temporary exterior installations with limited equipment in three hours. Teams were tasked with lighting their site in its natural state with the equipment provided.

While the lighting community has worked to overcome the challenges presented by the pandemic, new starters may have missed the crucial interaction of getting to work alongside colleagues in a shared space. As such, the SLL felt it was more important than ever to provide design practices, students and lighting professionals with an opportunity to have fun and work together, with the added element of some friendly competition.

Three awards were up for grabs, with a panel of judges deciding the winners of the SLL Technical and Artistic Awards, supported by the IALD; the Peer Prize was decided by the contestants.

Team Michael Grubb Studio won the 2021 Technical Award. Team Franklite won the 2021 Artistic Award, and Team MS Lighting Design won the 2021 Peer Prize.

Further support and equipment are provided by Lee Filters, Light Collective, Signify, White Light, Whitecroft and Zumtobel Group.

Students enrolled in Rose Bruford College s Lighting and Design BA course support the event, giving them the opportunity to see lighting professionals working in this unique environment.

Technical research recognised with awards

Last awarded in 1999, the Dufton and Barker medals have been reinstated

Four technical papers covering a diverse range of issues of industry-wide interest have been recognised with awards by CIBSE.

The papers – covering energy and indoor environmental quality in schools; Passivhaus in tropical climates; daylight and overheating in low-energy design; and the effect of boiler oversizing on efficiency – were published in 2020 in CIBSE's *Building Services Research and Technical Journal (BSER&T)*.

Joining the Napier Shaw and Carter Bronze Medal awards for technical papers are the newly reinstated Dufton Medal and Barker Medal – last awarded in 1999 – to allow more high-quality papers to be recognised. The Dufton Silver and Napier Shaw Bronze Medals are awarded for papers relating to fundamental research. The Barker Silver and Carter Bronze Medals are awarded to papers on application of research in practice.

The Dufton Silver Medal for 2021 goes to *Balancing daylight and overheating in low-energy design using CIBSE improved weather files* by Eleonora Brembilla, Christina J Hopfe, John Mardaljevic, Anastasia Mylona and Eirini Mantesi. This considers the requirements to balance the light available in a space so as to reduce overheating risk, using the CIBSE weather files.

Eleonora Brembilla

Anastasia Mylona

The Napier Shaw Bronze Medal is awarded to Roy Candra Sigalingging, David Chow and Steve Sharples for *Applying the Passivhaus standard to a terraced house in a hot and humid tropical climate: Evaluation of comfort and energy performance*, which considers how the Passivhaus approach can be adapted and adopted to this climate.

The Barker Silver Medal is awarded to *Building performance evaluation: Balancing energy and indoor environmental quality in a UK school building* by Nishesh Jain, Esfand Burman, Craig Robertson, Samuel Stamp, Clive Shrubsole, Francesco Aletta, Edward Barrett, Tin Oberman, Jian Kang, Peter Raynham, D Mumovic and Mike Davies. It has been cited in 10 papers – one of the highest levels of citation in *BSER&T*.

The Carter Bronze Medal goes to George Bennett and Cliff Elwell for *Effect of boiler oversizing on efficiency: a dynamic simulation study*. It looks at the impact of a traditional tendency to oversize boilers on the efficiency in everyday conditions, which has an impact on comfort and energy use.

The awards will be presented at the CIBSE President's Awards dinner in February.

CIBSE members can read the *BSER&T Journal* and *Lighting Research and Technology (LR&T) Journal* as part of their membership at **www.cibse.org/knowledge**

Journal scores highly in survey

A recent readership survey has revealed strong ongoing support for *CIBSE Journal*.

More than **90%** of respondents rated the *Journal* as 'excellent' or 'good'. When asked to rate the technical coverage, **87%** rated it as excellent or good. Case studies, technical articles and CPD rated highest when asked to rate different sections, however, all sections rated highly.

There was also feedback on how long people spend reading each edition: **42%** said 30-60 minutes with **26%** taking more than an hour over the monthly magazine, **37%** of respondents said they accessed the *Journal* online, with **23%** reading both the online and print edition, and **39%** reading the print edition.

The website received positive feedback, with **78%** rating it as either excellent or good, while **93%** of those who accessed *CIBSE Journal* webinars rated them as interesting/informative.

The *Journal* podcast series was also positively reviewed with **88%** of those who had listened rating them as interesting/informative. A large number of respondents were not aware or had not listened to them, so we will be doing more to promote these to a wider audience.

Thank you to the **450** people who responded to the reader survey in October.

From left: Jake Lenahan, CIBSE YEN North West chair; Laura Whatmough, CIBSE YEN North West events co-ordinator; Matthew Lowe, CIBSE North West social secretary; and Will Harrop, CIBSE North West chair, at the YEN National Ball

YEN: Helping CIBSE through pandemic

Global YEN chair Rebecca Michaelsen gives an update on recent YEN activities

A great deal of change has taken place for everyone through the global pandemic in the past few years, and this is true of both CIBSE and the Young Engineers Network (YEN).

Initially, YEN looked to online events and focused on networking, as there was a great deal of CIBSE technical content on offer. As 'online event fatigue' set in, YEN refocused its efforts on bridging the gap for engineers coming into industry, initially targeting early-career engineers who may not have been able to get site experience. This led to an 18-month project, in collaboration with Arup and Jones Engineering, producing a video on the New Children's Hospital in Ireland, which can be accessed at **bit.ly/CJDec21YEN** It is a fantastic tool providing detail into engineers' involvement in a project. The enthusiasm of those involved will help promote our field.

YEN also collaborated on a CIBSE project to generate educational outreach videos explaining building services. These provide our CIBSE and YEN volunteers involved in education a resource to help promote the industry. You can find the videos on the CIBSE YouTube channel at **bit.ly/CJDec21YEN2**

CIBSE YEN also collaborated with the equivalent ASHRAE group on a joint Leadership Weekend, where YEN members had an opportunity to strengthen their leadership skills, managing up and working within a team.

David Mather, who attended the course, said: 'It was a fantastic opportunity to network with enthusiastic young engineers around the world. The need to adapt teamwork to hybrid working is critical for success going forward. The weekend left me inspired to focus on my role in team dynamics, both in person, and via online communication.'

In other news, the YEN National Ball took place in Manchester on 15 October, after a two-year break. It was great to see full tables and so many sponsors in attendance. Thank you to CIBSE North West and CIBSE North West YEN for organising and hosting the ball.

Finally, YEN has been helping its regional committees with events throughout the pandemic. I want to not only thank everyone involved in the projects above, but everyone volunteering with YEN. Without your help, CIBSE would not be where it is today.

With the YEN volunteers who have stepped up during this difficult time, the future of CIBSE is looking bright. To get involved in your region email **YEN@CIBSE.org**

Celebrating young engineers at SoPHE dinner

The Society of Public Health Engineers (SoPHE) was back and bigger than ever with its first in a series of live events last month – its 17th annual dinner in London.

At a larger venue, the Royal Lancaster London, new chair Peter White hosted a record 35 tables at the biggest SoPHE event to date – hopefully, a sign of better days to come after the Covid-19 pandemic.

As well as being the premier networking event for the public health engineering industry, the dinner's highlight is always the presentation of the Young Engineers award. This year, it was organised with the help of the SoPHE Plumbing Centre of Excellence (as featured in October's edition of *CIBSE Journal*) and took the form of a Young Engineers training day at New City College, Havering.

The aspiring engineers at the training day were involved in exhibitions and practical CPD sessions with various pipework materials, fittings and valves manufacturers. This was followed by the competition itself, with individuals completing various pipework challenges and putting their theoretical knowledge into practice.

Selecting finalists was no easy task as the standard of work was excellent, so the judges decided to make three awards. All three finalists were invited to attend the annual dinner to celebrate their successes. Congratulations to Annabella Conmee of Arup and George Fall of ChapmanBDSP who were awarded joint first place, and Charlie Hill of Troup Bywaters + Anders who was third.

Following tradition, a sought-after Honorary Fellowship was awarded to Linda Dulieu for her exceptional contribution to public health engineering. During a career spanning almost 40 years, Dulieu has championed SoPHE from its inception and inspired and mentored several generations of talented young engineers.

Closing the dinner, Miguel Garcia, SoPHE Industrial Group chair, presented a donation of £1,000 from the table sponsors to the charity Village by Village, which works to introduce public health initiatives and enhance lives in villages across West Africa.

If you missed your chance to attend the annual dinner, the next SoPHE event – a technical conference at the Institute of Physics – will be on 24 March.

From left: Sanjay Modasia, SoPHE Contractors Group chair; joint winners George Fall and Annabella Conmee; and Peter White, SoPHE chair

New members, fellows and associates

FELLOWS

Chu, Chi Pan Benny
Kowloon, Hong Kong

MEMBER

Au, Ka Man
Hong Kong, Hong Kong

Au, Kwok Wun
Tseung Kwan O, Hong Kong

Bhaskaran, Vijayanand
Sharjah, United Arab Emirates

Chen, Chun Tat
Kowloon, Hong Kong

Cheng, Kai Yip Kenneth
Hong Kong, Hong Kong

Chiang, Yan Yi
Shatin, Hong Kong

Cleary, Luke
Perth, Australia

Colledge, Nicholas Justin
Manchester, United Kingdom

Connick, Owen
Coulsdon, United Kingdom

Coronel, Nestor
Dubai, United Arab Emirates

Elliott, Christopher
Castlehill, Australia

Fleming, Adam
Clongriffin, Ireland

Fong, Yim Kit
Hong Kong, Hong Kong

Frati, Davide
London, United Kingdom

Greene, Aoife
Dublin, Ireland

Harris, Andrew
Sharjah, United Arab Emirates

Hayes, Conor
Dripsey, Ireland

He, Ping
Kowloon Tong, Hong Kong

Ho, Ming Sang
Kwai Tsing, Hong Kong

Huang, Xinyan
Kowloon, Hong Kong

Ip, Kwok Fai
Hong Kong, Hong Kong

Ko, Tsun Ho
Hong Kong, Hong Kong

Kwit, Yik Leung
Tsuen Wan, Hong Kong

Lai, Kwok Wai
Diamond Hill, Hong Kong

Lam, Wai Yan
Sham Shui Po, Hong Kong

Lau, Ka Kui William
Shum Shui Po, Hong Kong

Lau, Wun Ying
Chai Wan, Hong Kong

Leung, Yuk Wo
Shatin, Hong Kong

Liang, Tsz Chung
Sheung Shui, Hong Kong

Lim, Shin Tarn
Singapore, Republic of Singapore

Mattappilly, Vinoj
Doha, Qatar

Ngai, Shun Wai
Hong Kong, Hong Kong

Paravaikkarasu, Raman
Hong Kong, Hong Kong

Quadri, Mohammed Fayyaz Ahmed
Ras Al Khaimah, United Arab Emirates

Qureshi, Harris Farooq
Karachi, Pakistan

Sehrawat, Ashwani
Blessington Wicklow, Ireland

Shan Bai, Alex
Sydney, Australia

Szeto, Ka Wai
Ngau Tau Kok, Hong Kong

Talarska, Marta
St Leonards, Australia

Tsang, Po Choi
Kowloon, Hong Kong

Tsang, Po Choi
Kowloon, Hong Kong

Tsang, Sin Fai
Tseung Kwan O, Hong Kong

Tse, Ming Fung
Sha Tin, Hong Kong

Wasi, Mohammed Abdul
Dubai, United Arab Emirates

Wong, Chung Yin
Hong Kong, Hong Kong

Wong, Kin Wa
Tin Shui Wai, Hong Kong

Wong, Kin Wa Rico
Shatin, Hong Kong

Wong, Lung Tim Eric
Macau, Macao

Wong, Man Tsun
Tai Po, Hong Kong

Wong, Wing Yan
Wong Tai Sin, Hong Kong

Yip, Tak Shing
Kwai Chung, Hong Kong

Yip, Pui Kwan
Tuen Mun, Hong Kong

ASSOCIATE

Rowley, David
Cannock, United Kingdom

Unnikrishnan, Aswadev
Manama, Bahrain

LICENTIATE

Baker, Callan
London, United Kingdom

Blackie, David
Chessington, United Kingdom

Brewer, Stephen
Hull, United Kingdom

Brooks, Rumaysa
Hackney, United Kingdom

Clelland, Ewan
Gateshead, United Kingdom

Davidson, Adam
Newcastle upon Tyne, United Kingdom

Dooley, Stephanie
Bristol, United Kingdom

Doran, Adam
Kent, United Kingdom

Dove, Martyn
Nottingham, United Kingdom

Hajduczek, Tom
Colchester, United Kingdom

Hawcroft, Wayne
Burton on Trent, United Kingdom

Hunter, Joshua
Wyton On The Hill, United Kingdom

Kataria, Reiss
West Bromwich, United Kingdom

Keenan, Callum
Hull, United Kingdom

Knight, Grace Agnes Peta
Epsom, United Kingdom

Kohl, Terence
London, United Kingdom

Mason, David
Sutton Coldfield, United Kingdom

Miselbach, Samuel
London, United Kingdom

Mountain, Joshua
London, United Kingdom

Charging forward

Hard on the heels of COP26, the government is set to make a flurry of announcements about energy and buildings, to press ahead with decarbonising our homes and offices. Hywel Davies sets out what can be expected

The CBI, late last month, played host to both Boris Johnson and Sir Kier Starmer, with Sir Kier emphasising the need to invest in technical and vocational skills. The Prime Minister, supported by a flurry of press briefings, set out plans for electric vehicle (EV) charging points to be required in the Building Regulations.[1] As coverage of the speech focused on other aspects, it is worth a closer look at the details of the government response to the consultation on EV charging.[2]

The new regulations are intended to support up to 145,000 new charging points each year, to expand the EV charging network and provide reliable, accessible and usable facilities nationwide.

As a result, every new home with a parking space within the site, and every residential building undergoing renovation that will have more than 10 parking spaces, will be required to install charging points for each space allocated to a home, and cable routes to any other spaces. New and refurbished non residential buildings will also be required to provide at least one full charge point and cable routes to 20% of spaces.

It is vital that designers focus on reducing operational energy demands and users costs

This is not the only area of Building Regulations activity that can be expected this month. There is an expectation that the latest changes to Parts F and L of the Building Regulations will also be issued, supplemented by new requirements on overheating. It is anticipated that this package will come into force next summer.

These changes are the first step towards the promised Future Homes Standard and Future Buildings Standard, which are intended to be put in place in 2025. They will drive an increase in the electrical supply requirements to new buildings, with the need to supply charge points and the growing number of heat pumps.

CIBSE has just published guidance on the implications of this trend. *Electrification of buildings for net zero*, CIBSE TM67,[3] gives initial guidance on design and operation of building electrical services (see page 57). It aims to raise understanding and knowledge of the implications of this drive to net zero carbon emissions among all engineers involved in the design of buildings, to stimulate appropriate design responses.

Increased electrification of buildings will have significant implications for the design and operation of, and the technical services systems installed in, buildings. As electricity currently costs users much more than fossil fuels, there is a risk of large increases in energy bills without well considered design. So, it is vital that building designers focus on reducing operational energy demands and users costs.

One reason for the high price of electricity is the cost of Grid decarbonisation, which may be reallocated in future but that does not diminish the need for efficient design. Electrification of transport and heat will require significant new capacity, the cost of which will be borne on electricity bills, so it is vital to renew the focus on delivering efficient and effective services systems for buildings.

We face a significant set of changes over the next few years in relation to building energy and emissions. Meanwhile, we have the ongoing programme of building safety reform.

In a special evidence session on building safety on 22 November,[4] Dame Judith Hackitt acknowledged the progress being made by leading players in construction and called on others to start preparing now for the new regime, and not wait for the legislation or to be told what to do. Sir Ken Knight emphasised the far reaching nature of the reforms and that they apply to all buildings, not just those classed as higher risk in the bill.

With new Building Regulations and a new regulatory regime, there is a great deal to look ahead to for all *Journal* readers. The new year will bring plenty of fresh challenges and topics for your continuing professional development CIBSE will be busy providing guidance and events, as well as the *Journal*, to support you.

References:

1 PM speech at the CBI conference, 22 November 2021 **bit.ly/CJDec21HD1**

2 Consultation response: EV charge points in residential and non-residential buildings, Department for Transport, 21 November, **bit.ly/CJDec21HD2**

3 TM67 *Electrification of buildings for net zero*, CIBSE **bit.ly/CJDec21HD3**

4 Housing, Communities and Local Government Committee, Monday 22 November 2021, **bit.ly/CJDec21HD4**

DR HYWEL DAVIES
is technical director at CIBSE
www.cibse.org

We need to focus on short term emissions

Aiming for net zero carbon in new homes means rethinking the upfront carbon in building services engineering. Ilke Homes' Nigel Banks looks at what this means for engineering design if targets are to be met

NIGEL BANKS is R&D director at ilke Homes. The modular housebuilder has committed to only build zero carbon homes – with zero energy bills, at zero additional cost – by 2030, while reducing the whole-life emissions of its products by 75%.

What is clear from COP26 is that we all need to deliver significant emissions reductions this decade. As designers, this means understanding better the emissions resulting from our designs and, potentially, challenging some of our preconceived ideas of what delivers low carbon or zero carbon buildings.

Having looked at what this means in new homes recognising that re use of existing structures is also critical my initial analysis of what produces the lowest emissions in the short term , over the next 20 years (upfront emissions, plus 20 years of operational emissions), gave me some surprises.

I felt it would be useful to share these initial findings, which I m sure many of you will instinctively think are incorrect but I invite you to run the numbers yourselves and really challenge yourself on what will save carbon emissions in the next 20 years.

Use heat pumps

Hopefully, everyone is aware that the electricity Grid has significantly decarbonised and that a grid connected heat pump delivers very low and, increasingly, close to zero carbon heat (see Figure 1). We can t continue burning natural gas, and green or blue hydrogen won t be here in any scale in the next decade (or two). Heat pumps, however, have a huge knock on impact on how much extra upfront carbon we should spend to save heat, as saving heat energy won t save much carbon in the 20 years of using a heat pump.

> Heat pumps have a huge impact on how much extra upfront carbon we should spend to save heat

Don t go too far on fabric

For example, a U0.8W m^{-2} K^{-1} triple glazed window has higher upfront emissions than a U1.2W m^{-2} K^{-1} double glazed window. With a gas boiler, this upfront carbon pays back in two years but in an air source heat pump (ASHP) heated new home, it never pays back (Figure 2a). There is also a limit on how far to go with wall insulation. Adding 60mm of mineral wool to an externally insulated wall improves the U value from 0.18 to 0.15, but this upfront carbon never pays back with ASHP. However, the upfront carbon pays back in 14 years with a gas boiler (see Figure 2b).

National Grid history and future energy scenarios for the carbon intensity of electricity generation (gCO_2/KWh)

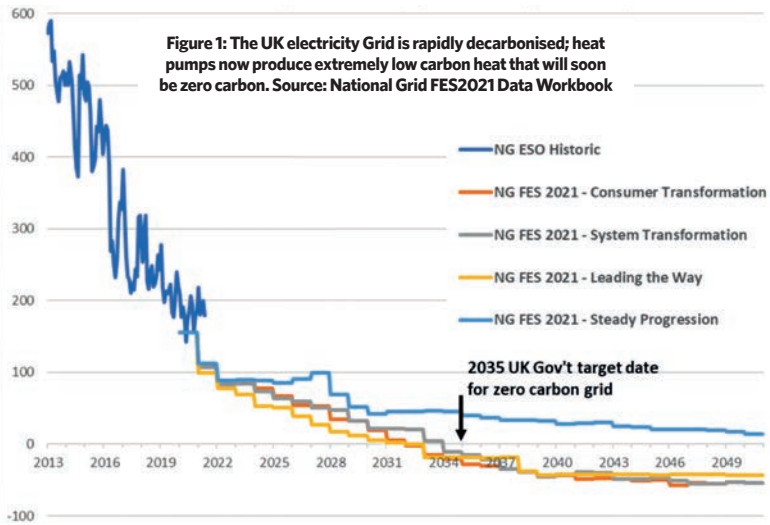


Figure 1: The UK electricity Grid is rapidly decarbonised; heat pumps now produce extremely low carbon heat that will soon be zero carbon. Source: National Grid FES2021 Data Workbook

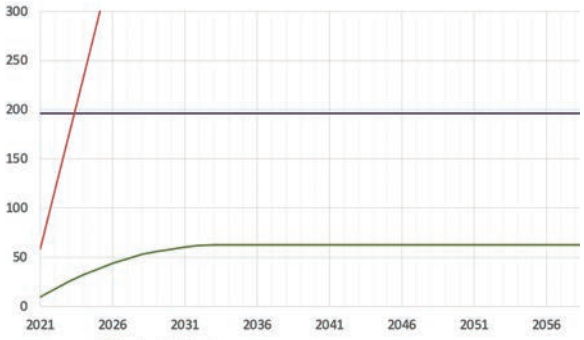
Bio based materials may not help

The chart in Figure 3, from a recent IStructE paper, really helped me understand why sequestered carbon from bio based materials is not included in upfront carbon. Cutting down a tree adds to emissions today, and it is the tree that replaces the one cut down that gradually sequesters carbon. Trees typically have a 50 year harvesting cycle, so other bio based materials with a faster, or annual, harvesting cycle (hemp, straw) may be more helpful in the short term.

Don t connect to gas CHP district heating

unless you know the heat you get is already below 0.04kgCO_2e/kWh. Gas combined heat and power led heat networks are now worse than natural gas boiler heated ones. Not many heat networks will use heat pumps this decade and even if they do, the network losses may mean a local heat pump is lower carbon, especially if there is a lot of new pipework to lay (upfront carbon) to connect you up.

Whole-life carbon – double (U1.3) vs triple (UO.8) glazing in natural gas and heat pump (COP2.7) heated new home in UK



Additional embodied carbon
Cumulative operational carbon saving (Gas Boiler SAP10.1)
Cumulative operational carbon saving (ASHP, NG FES 2021 system transformation to zero carbon)

Whole-life carbon – 120mm mineral wool externally insulated wall (UO.18) vs 180mm (U0.15) in natural gas and heat pump (COP2.7) heated new home in UK

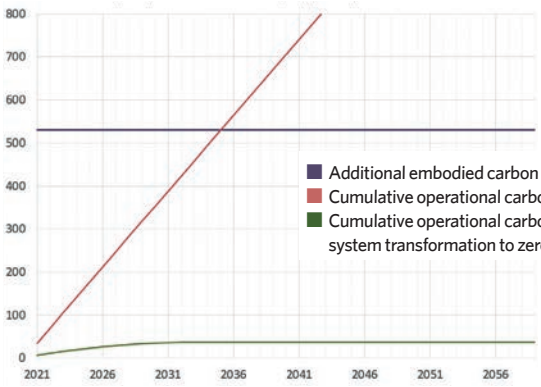


Figure 2a & 2b: The carbon payback of the additional embodied carbon of triple glazing (a) and higher wall insulation levels (b) with gas boilers and heat pumps. Source: Own calculations

Solar needs to be in roof to help

Unless solar PV is replacing high embodied carbon finishes, such as concrete or clay tiles, they are likely to increase emissions because of their relatively high upfront carbon and because the energy they are now offsetting is much lower carbon.

Batteries don t help much either

specifically, on carbon emissions. They have a high upfront carbon footprint and waste electricity (around 10% per charge, with a typical round trip efficiency of 90%). However, they are enabling more renewables onto the Grid, ,can make heat pumps much cheaper to run, and can slightly reduce emissions by moving your electricity use to the night, when electricity is cheaper on a smart or Economy 7 tariff and, generally, 10 30% lower carbon. Spending £3 5,000 on a domestic battery can lower bills by as much as £500 per year, significantly more than if spending about the same on upgrading windows from double to triple glazed, which results in a £10 30 per year saving (depending on tariff/heat source).

Keep it simple

Simple building forms, MEP systems and controls usually mean less upfront carbon, and they are less likely to go wrong although a means of measuring performance to know if things have gone wrong is probably a form of upfront carbon that is well worth including!

Stay up to date

The data on upfront carbon will evolve as the Grid evolves, so we need to stay alert to changes. For example, if a zero carbon glassworks opens, triple glazing makes sense again from a carbon footprint perspective.

The short term emissions numbers with heat pump heating really changed my thoughts, and is now influencing our upcoming designs.

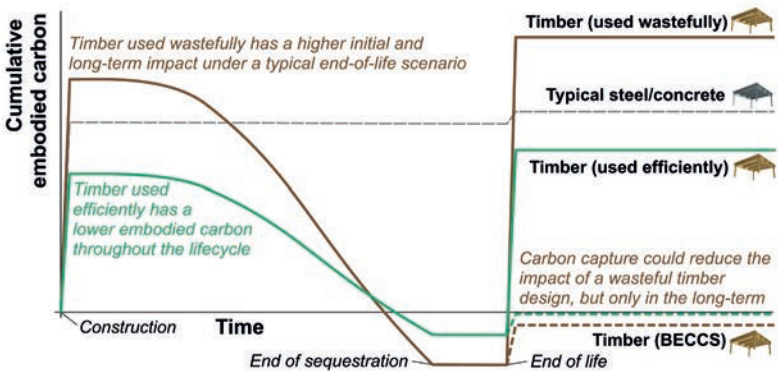


Figure 3: The upfront carbon of timber is not negative, and can be higher than steel or concrete buildings. Source: Hawkins, Timber and carbon sequestration, *The Structural Engineer*, Jan 2021, bit.ly/CJDec21NB1

BACK TO REALITY

With the CIBSE Building Performance Awards returning to London in 2022, the cream of the building services industry will again be able to celebrate in front of their peers. **Alex Smith** reports from the judging process that, last month, selected shortlists for the 14 awards

Despite the disruption caused by Covid 19, judges last month selected a highly impressive shortlist of projects, products and companies for the 2022 CIBSE Building Performance Awards.

The judges met online to decide which companies should feature on the 14 award shortlists. Winners of each category, as well as the Overall Carbon Champion, will be announced on Thursday 24 February, at the Park Plaza Westminster Bridge in London.

There is a special Project of the Year category for healthcare, to recognise the increased awareness of air quality and hygiene in the built environment. This follows last year s special CIBSE Covid 19 Achievement Award, which marked the building services industry s tremendous response to the pandemic.

There are Project of the Year categories for the retail/leisure sector and for public use buildings. Entries to the Building Performance Awards have to include information on energy use with building performance, although the judges noted that the pandemic meant this data could not always be included this year.

Focus on Covid was a marked feature of the judging for these awards, partly because buildings weren t occupied, so it was difficult to obtain the data necessary, said Jon Belfield.

The judges were impressed with how the entries for the Facilities Management Award had embraced the challenge of the past 12 months, while also balancing the need for increasingly sustainable buildings. There were a lot of good entries of a high standard, they said. It is clear from the level of entries

The winners will be announced in February, at London's Park Plaza Westminster Bridge

> There is Project of the Year category for healthcare, to recognise increased awareness of air quality in the built environment

that progressive facilities management is adapting to climate change and now really focusing on building performance.

Not surprisingly, the category for Product or Innovation of the Year Air Quality was dominated by products that focused on providing air cleaning technologies to address the pandemic.

The judging panel noted that many of the applicants focused on adapting existing technologies to address new threats and they commended this approach.

In the Wellbeing category for Product and Innovation, the judging panel was pleased to note that, across a diverse range of entries, there was a focus on iterative improvements in the design to refine performance, and that this was based on feedback and testing.

The judges were impressed by the large amount of entries for the Thermal Comfort product category, reflecting the importance of the sector in reducing building energy consumption.

However, the judges did say they would have liked to have seen a bigger focus on test data, and more information on embodied carbon, which they said could be based on CIBSE s guidance *TM65 Embodied carbon in building services*.

For the Learning and Development Award, the judges noted how online learning was increasing accessibility to continued professional development. They saw a wide range of initiatives among the entries and were impressed by how entrants had embraced the challenges of the past 12 months .

In the Collaboration Award, the judging panel said they were keen to see teams doing more than was normally expected of them in their role, and disturbing normal practice . Sally Godber said that collaboration was having the courage to question other people in the team.

If you ve always done something in a particular way, you must be more willing to question what s going on that s outside your sphere of expertise. That s where the interesting ideas come from, she said.

Among the entries, judges saw good evidence of collaboration happening across multiple organisations, and not just internally, and added that long term collaboration was much more prevalent than short term project collaboration.

In the Building Performance Consultancy of the Year category (over 300 employees), the judges praised the very high standard of entries. They praised how entrants had developed new ways to maintain collaboration for virtual teams and were pleased to see a strong response across the board to the challenges of diversity and inclusion. They also praised the consistent reporting of carbon emissions and the consultants clear roadmaps to net zero.

In the Consultancy of the Year category for companies with fewer than 50 employees, the judging panel were gratified to see that submissions were honest about what worked well and what sometimes pulled up short .

This is the professional conversation we need so best practice can be improved and shared, and it was great to see this across the CIBSE Building Performance Awards entries, said Belfield.

The way lessons learned were incorporated into future projects was also praised by Belfield. Occupier feedback is such an important feedback loop for success, and seeing engagement with this occupier feedback in the award entries, to make changes and tune the buildings, was very positive, he said.

Hopefully, this will ensure the journey to net zero is owned by everyone designers, installers and occupiers. CJ

For more information about the CIBSE Building Performance awards and to book a table at the event in the Park Plaza Westminster Bridge, London visit **www.cibse.org/building-performance-awards**

THE JUDGES

1 **Mel Allwood,** associate director, Arup
2 **Will Arnold,** head of climate action, Institution of Structural Engineers
3 **Nick Buckingham,** UK MD, Colt International
4 **Emma Bushell,** sustainability manager, Lewisham Council
5 **Hywel Davies,** technical director, CIBSE
6 **Tim Dwyer,** technical editor, *CIBSE Journal*
7 **Sally Godber,** director, Warm
8 **Louise Hamot,** global lead of life-cycle research, Elementa
9 **Susan Hone-Brookes,** director of sustainability, ChapmanBDSP
10 **Jeff House,** head of external affairs, Baxi Heating
11 **Lucinda Lay,** Energy and sustainability team, Mitie
12 **Helen Newman,** head of sustainability consultancy, CBRE
13 **Ted Pilbeam,** building services and sustainability director, VolkerFitzpatrick
14 **Mike Powers,** FCIBSE, director, Clancy Consulting
15 **Isabelle Smith,** associate director, Net Zero Buildings and Cities lead, Atkins
16 **David Stevens,** vice-chair, CIBSE Facilities Management Group
17 **Ed Wealend,** head of research and innovation, Cundall

Not pictured: **Jon Belfield,** managing director, InTandem Systems
Darren Coppins, chartered engineer and director, Built Physics
Anastasia Mylona, head of research, CIBSE
Craig Robertson, associate and head of sustainability, Allford Hall Architects

CIBSE BUILDING PERFORMANCE AWARDS 2022

Join us for the Awards Celebration on Thursday 24 February 2022 at Park Plaza Westminster Bridge, London

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- FairHeat
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- Lawler Consulting
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BUILDING PERFORMANCE CONSULTANCY (51–300 EMPLOYEES)

Sponsored by: Airflow

- AESG
- Max Fordham

BUILDING PERFORMANCE CONSULTANCY (OVER 300 EMPLOYEES)

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- AECOM
- Buro Happold
- Elementa Consulting

COLLABORATION

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- Aviva UK & Ireland Portfolio – Aviva
- BBC Central Square – AECOM
- Belgrave House – BNP Paribas Real Estate
- Echo Court – FairHeat
- Southern House – Arup

FACILITIES MANAGEMENT

Sponsored by: Gratte Brothers

- Aviva UK & Ireland Portfolio – Aviva
- Cityplaza – Swire Properties
- Legal & General Investment Management TBPE – Hoare Lea
- KAUST New Housing Project (KNHP) - Oasis Buildings – King Abdullah University of Science and Technology
- Southern House – Arup

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CONGRATULATIONS TO OUR

LEARNING AND DEVELOPMENT

Sponsored by: SfS a division of Exyte Hargreaves

- BEEP Student Camp – Indo-Swiss Building Energy Efficiency Project (Indo-Swiss BEEP), Bureau of Energy Efficiency, Govt. of India, Swiss Agency for Development & Cooperation
- BetaTalk – NJV BetaTeach/BetaTalk
- Light4Health – University of Wolverhampton
- Low Energy Cooling and Ventilation for Indian Residences (LECaVIR) – CEPT Research and Development Foundation, CEPT University
- Ventilation Hygiene Cleaning Training – Overclean

PRODUCT OR INNOVATION – THERMAL COMFORT

- BMSN1 bGrid Multi Sensor Node – bGrid
- Closing the Performance Gap – Knauf Insulation & Knauf Energy Solutions
- 'DB Series' Underfloor Heating Manifold – Giacomini UK
- ROCKLAP Pipe Supports – ROCKWOOL UK

PRODUCT OR INNOVATION – WELLBEING

Sponsored by: Tamlite Lighting

- Eco-Duo – Water Kinetics
- IEQ Dashboard – Demand Logic

PRODUCT OR INNOVATION – AIR QUALITY

- Deltri + – Systemair
- Invisivent – Renson
- UV-C Upper Air Disinfection Luminaires – Signify

PROJECT OF THE YEAR

Sponsored by: Crane Fluid Systems

- Active Office – SPECIFIC, Swansea University and Naked Energy
- Clatterbridge Cancer Centre – AECOM
- Jewish Care Wohl Court, Hendon – Max Fordham
- McDonald's Global Flagship - Buena Vista - Net Zero Energy – Cyclone Energy Group
- St John's College, Oxford, Library and Study Centre – Max Fordham

BUILDING PERFORMANCE ENGINEER OF THE YEAR

Sponsored by: Ideal Heating

- Mike Burton, Director – AECOM
- Catherine McCarthy, Senior Mechanical Engineer – Buro Happold

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@CIBSEAwards #BPA2022

Max Fordham has been designing Passivhaus projects for nine years, including two very different housing projects that won the residential CIBSE Building Performance Award in consecutive years. **Gwilym Still** chronicles the development of Passivhaus at the practice, and explains why it is integral to Max Fordham s net zero strategy

PERFECTING PASSIVHAUS

Passivhaus provides a way of designing and delivering high thermal comfort, low operational energy buildings, with rigorous quality control baked in. It has been tried, tested and proved over 30 years and, in the past few years, we have seen a dramatic growth in interest in the method of building.

With COP26 focusing our minds on the climate emergency, this is a good time to reflect on our experience of using Passivhaus and the drivers behind its growth.

Agar Grove Estate

Max Fordham s first Passivhaus project was the multi residential London Agar Grove Estate redevelopment, which started in 2013. The initial brief wasn t for Passivhaus but, as a client, Camden was keen on the quality aspect of Passivhaus and on using it as a way to address fuel poverty.

Phase 1a was completed in 2018, Phase 1b in 2021, and 1c is on site now. The post completion monitoring of 1a has shown Passivhaus delivering occupant comfort and enjoyment, and has been recognised in a range of awards including Residential Project of the Year at the 2020 CIBSE Building Performance Awards **bit.ly/CJDec21PH**

As a phased development, it is interesting to see which aspects of the scheme have changed from one phase to another, and which have remained the same. The general primary structure and airtightness approach have been consistent between phases, and we ve worked to avoid very thick wall build ups, which with a masonry weather skin led to expensive brick hangers providing vertical support to brickwork and significant thermal bridging from them.

The energy system has shifted from a gas fired, low temperature heat network scheme with heat interface units on 1a and 1b, to an all electric ambient loop system for 1c, with water source heat pumps in each apartment.

Max Fordham s house

The large scale Agar Grove was followed by a project on the opposite end of the size spectrum: our founder Max Fordham s house, also in Camden,[1] which won the same CIBSE award, but in 2021 (Windows of opportunity , *CIBSE Journal*, September 2019, **bit.ly/CJDec21HP2**).

Max had worked on very low energy housing before, and wanted to deliver an all electric building with very low or no heating demand. The building features insulated shutters to reduce heat loss at night, and domestic hot water produced by an air source heat pump, with the air intake in a sun trap so the local microclimate raises the air temperature and helps improve performance.

It had a good summer comfort stress test in the summer of 2019, with peak external temperatures rising to 36 C, and the internal temperature not going above 27 C. It has the same radial microbore pipework arrangement for domestic hot water seen on many Passivhaus schemes.

Street-facing elevation of Max's house – the modest appearance belies the low-energy design

Left: The south elevation of Agar Grove, showing the balcony, which provides private amenity space and solar shading for summer comfort

Two external characters, one low-energy approach: the Villa building (above top) and the Stephen Taylor building (above bottom) share the same low carbon cross-laminated timber (CLT) primary structure, all-electric energy system, and Passivhaus construction quality. The Villa building has a brick façade to complement the arts and crafts context it sits within, while the Stephen Taylor building has a precast concrete and brick façade, in response to the modernist architecture seen elsewhere in Cambridge.

Cranmer Road, King s College

The practice s next Passivhaus project was Cranmer Road, in Cambridge, for King s College, which needed to provide additional accommodation for graduate students and wanted to create a sense of community.

A site with two existing buildings was a good match, and the two new buildings and landscape design have created shared facilities for the entire site. The choice to go for Passivhaus was informed by a life cycle costing exercise. This showed a payback of around 25 years, significantly shorter than the design life of the building, and less than the length of time King s College normally holds buildings for. Passivhaus also allowed an all electric project, which was attractive to the college with the ongoing decarbonisation of the grid.

The combination of the low heating demands of Passivhaus and the all electric, distributed hot water scheme meant minimal plant space was needed, which created an additional student bedroom within the same footprint. It is the first large Passivhaus project in Cambridge and was the first Passivhaus scheme for several members of the design team.

In contrast to Agar Grove, the primary structure is cross laminated timber (CLT), which gave a low carbon skeleton to the building and, being inherently airtight, acted as the primary airtightness line a strategy we are using for several other projects in Cambridge.

The measured peak heating loss is around 8W·m^{-2}, below the Passivhaus limit, and a post occupancy evaluation survey has shown positive feedback from the students. The post occupancy »

» evaluation has also shown domestic hot water usage patterns exceeding the default figures in the Passivhaus energy model, so we re using figures informed by real world usage on future schemes.

Croft Gardens, King s College

Cranmer Road was followed by another project for King s College: Croft Gardens. This offers additional accommodation for graduates and fellows through an ensemble of four buildings on one site. It s kept the same CLT primary structure, and initial airtightness tests have been excellent.

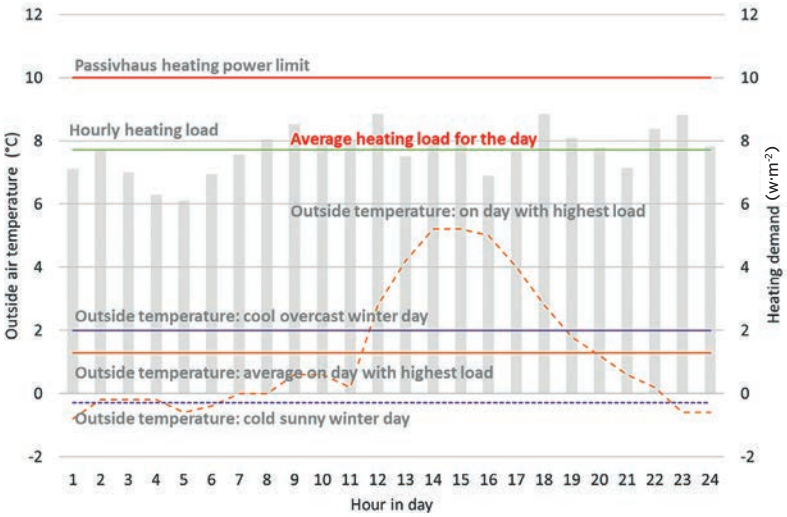
The ventilation approach is similar to Cranmer, with a cascade system for the buildings without en suites (fresh air is supplied to bedrooms, transferred through circulation spaces, and extracted from toilets, showers, kitchens and store rooms), and balanced ventilation at each room for the en suites, with dedicated units ventilating the kitchens. The three building typologies and ventilation strategies are being delivered using a number of the same ventilation units, so maintenance and holding spares is simpler for the college.

Feedback from Cranmer Road showed some students had unlocked and overridden the temperature controls for their rooms*, so we re providing an alternative interface, intended to provide some occupant control, but without profligate energy use.

**Space-heating controls at Cranmer Road are child-proof, but not, it turns out, Cambridge graduate-proof!*

Lucy Cavendish College

Lucy Cavendish College had an exciting brief for its new student accommodation, including making



Data from the day with the highest measured space heating load, showing an average 8W·m^{-2} when external temperatures were between the two weather conditions against which Passivhaus tests

it highly accessible and sustainable. This was a good reminder that while low environmental impact is a key part of designing for a climate emergency, buildings need to be used, useful and enjoyed to be truly sustainable. Passivhaus wasn t explicitly asked for, but we proposed it as a way of contributing to their net zero carbon aspirations, combined with the Max Fordham sustainability matrix as a way of addressing wider sustainability that falls outside Passivhaus s remit.

We ve shared the Passivhaus designer role with architects RH Partnership, and worked with some previous collaborators, including Smith and Wallwork structural engineers. The scheme has common elements with some other Cambridge Passivhaus projects: CLT primary structure, brick weather skin, space heating and domestic hot water from heat pumps. The differences have also given us some interesting pieces of design with which to engage: a hung tile fa ade at first floor and above, and different ground conditions. For both, the design detailing have been developed to be buildable and minimise

A view looking north across the Croft Gardens site, showing two apartment buildings framing a shared landscape, which is integrated with the surface-water drainage strategy

thermal bridging. The project is currently on site with Bidwells as the project manager and SDC as the main contractor. It has just completed its first interim air test, with a permeability of 0.12m³·h⁻¹·m⁻², and 0.065 air changes per hour (ach), significantly better than the Passivhaus limit of 0.6 ach (all at 50Pa).

Entopia Building

This project for the Cambridge Institute for Sustainability Leadership offers an interesting counterpoint to other Cambridge projects: it s an office building, instead of residential, and a deep retrofit and refurbishment rather than new build.

These differences mean there has been more focus on moisture risk because it s internally insulated and uses bio based insulation materials and on thermal bridging, as the existing structure penetrates the internal insulation line in a number of places. Other elements are consistent: it s all electric; has domestic hot water systems designed to be simple and to minimise distribution losses; and there has been a consistent focus on working with the client team to understand and minimise the energy use of client fit out items, from kettles to photocopiers.

Along with Passivhaus, it s targeting Breeam Outstanding and Well Gold, adopting a circular economy approach, and focusing on using bio based materials. While, in many ways, it is an exceptional project for 2021, we hope it will become the norm for retrofit in the years to come.

These are only a selection of the Passivhaus projects we are working on, with others including schools, archives, swimming pools and healthcare centres. Many of these are driven by clients, who are responding to the climate emergency and using Passivhaus as a key element of that response. While it is excellent at what it does, it is only one ingredient in our net zero recipe. CJ

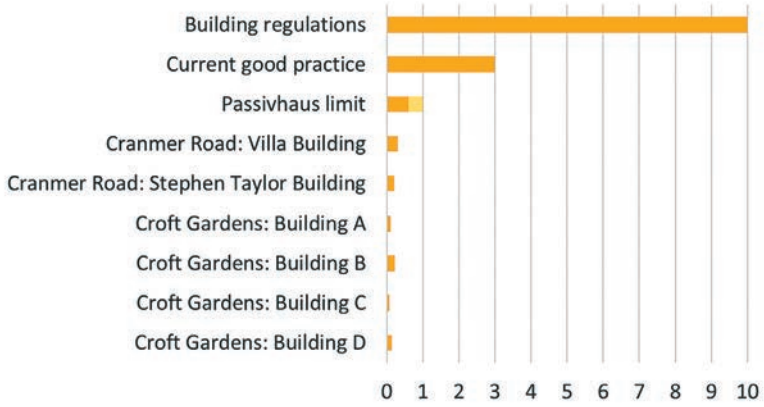
GWILYM STILL is Passivhaus leader at Max Fordham

References:

1 www.maxfordham.com/projects/max-fordham-house

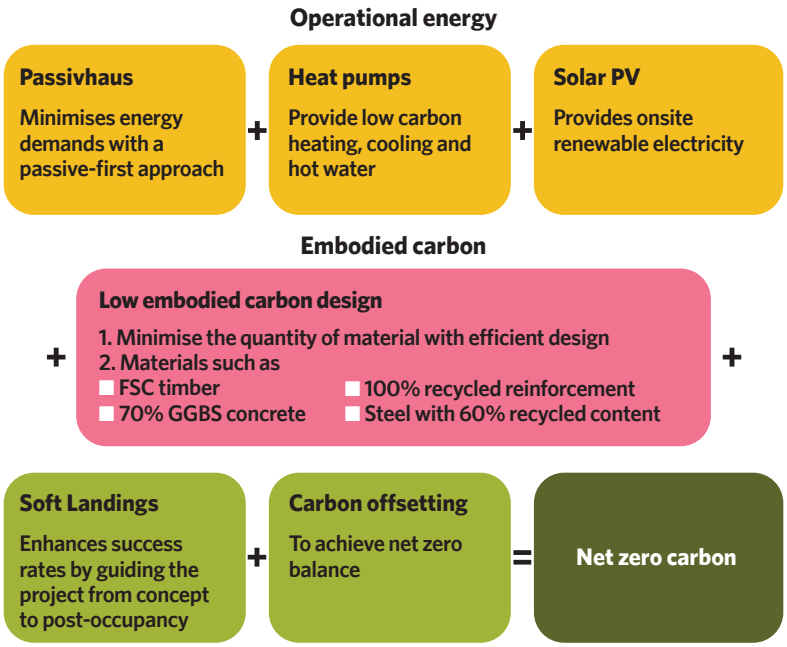
Cambridge's Entopia building project exterior will be similar to the original

Air permeability: m³·h⁻¹ per m² at 50 Pa (building regs metric)



Airtightness tests for Cranmer Road (at completion) and Croft Gardens' initial air tests (airtight envelope completed, prior to first fix), showing figures consistently below the Passivhaus limit, and significantly lower than Building Regulations and current good practice. The Passivhaus limit uses a different metric (0.6 ach at 50 Pa), so the chart shows a typical range of equivalent permeabilities

Lucy Cavendish College, currently on site



The Max Fordham net zero recipe – the firm's approach to net zero carbon on most projects

BREATHING SPACE

New guidance designed to assess and improve indoor air quality has been published by the Institute of Air Quality Management, with input from CIBSE. Co authors **Emma Gibbons** and **Chris Rush** explain how a new assessment approach aims to identify issues affecting air quality

In the UK, there is little legislation to protect the public from indoor exposure to air pollution, despite the existence of legal limits relating to outdoor exposure to air pollution and occupational exposure.

The Institute of Air Quality Management (IAQM) has published new guidance on indoor air quality (IAQ) to fill some of these gaps in legislation and guidance. CIBSE has endorsed the final publication and its members contributed to the writing of the guidance. The IAQM was keen to involve and have the endorsement of CIBSE, given the integral role that ventilation plays in IAQ.

The document provides guidance on assessment, monitoring, modelling and mitigation of IAQ, and is set out in sections relating to typical project stages.

Assessment criteria are summarised and a new assessment approach is proposed, and there is also context for the guidance and a reflection on why IAQ is important.

The summarised assessment criteria are based on a review of existing air quality standards in legislation and guidance, and a consideration of the likely length of exposure for the people being considered.

The assessment approach requires input from all those involved in the design, construction or operation of a building, and the method can be applied to proposed, new or existing buildings.

It is considered that an IAQ assessment will be needed for any building where there are internal sources of pollution, or where there is ingress of ambient (outdoor) pollutants, and where there are people in the building who could be exposed to those air pollutants. In some cases, assessment may be required for non human receptors, such as in a data centre.

The assessment approach requires input from all those involved in the design, construction or operation of a building

Elements to consider during an assessment include pollutant sources, building activities (equipment and cleaning, and so on) and the building design.

Aspects of the building design that can have an effect on IAQ include: the materials used; room volume; the ventilation strategy (including, for mechanical ventilation, the hours of operation, recirculation, and air change rate); effectiveness of air distribution and airflow; the capacity of a room; and the heating/cooling strategy of the building.

Air quality input should be provided at every RIBA stage, and an example of how air quality can input into a project at different RIBA stages is outlined.

THE FOUR STAGES OF ASSESSMENT

The proposed assessment method involves the following stages:

- **Stage 1 – Scoping study. To review all available information, identify pollutants of concern and possible receptors, and determine whether a more detailed assessment is required.**
- **Stage 2 – Assessment. This stage can be a simpler approach, by which the likely risk of exposure and potential magnitude of harm is identified, or a more detailed approach, which may involve monitoring and/or modelling.**
- **Stage 3 – Consideration of mitigation and improvement opportunities.**
- **Stage 4 – Reporting.**

Indoor air quality can have a negative impact on people's wellbeing and productivity

Detailed chapters on monitoring, modelling and mitigation/improvement opportunities are provided, and there are a number of detailed case studies to offer examples and add context (see case study, Office HQ indoor air quality).

The mitigation strategy outlined in the guidance focuses on a hierarchy of measures for removing and reducing sources of air pollutants, and protecting receptors as much as possible from the outset.

The guidance can help to inform professionals in all areas of the construction industry and open dialogue on the topic of IAQ. Greater understanding and early collaboration will be key to improving IAQ for the future. **CJ**

EMMA GIBBONS is a PhD student at UCL, and a member of the CIBSE Air Quality working group

CHRIS RUSH is air quality group lead at Hoare Lea, and a member of the CIBSE Air Quality working group

OFFICE HQ INDOOR AIR QUALITY

The environmental quality of a second-floor central London office was assessed after complaints of 'stuffiness' in both the summer and winter. The office had been occupied for several years, with the initial fit-out and commissioning conducted in 2007. There was found to be a general perceived negative impact on productivity because of the environmental conditions, as well as reported negative health effects and a sense that the design of the workplace did not make the employees feel valued.

Quantitative environmental monitoring of representative office areas was conducted over a one-month period, using space utilisation and indoor environmental quality (IEQ) sensors measuring total volatile organic compounds (TVOCs), CO_2, temperature, humidity and PM2.5 concentrations in 10 zones numbered 2.01 to 2.10. These data were used in conjunction with qualitative data from Building User Surveys (BUS) to understand the performance of the space.

Following the IEQ monitoring, an initial desktop study of the existing ventilation systems indicated that – based on the occupancy density – there was insufficient ventilation to meet the British Council for Offices recommended supply rate of 12L·s^{-1} per person, which affected the northern side of the office because of its higher occupancy density.

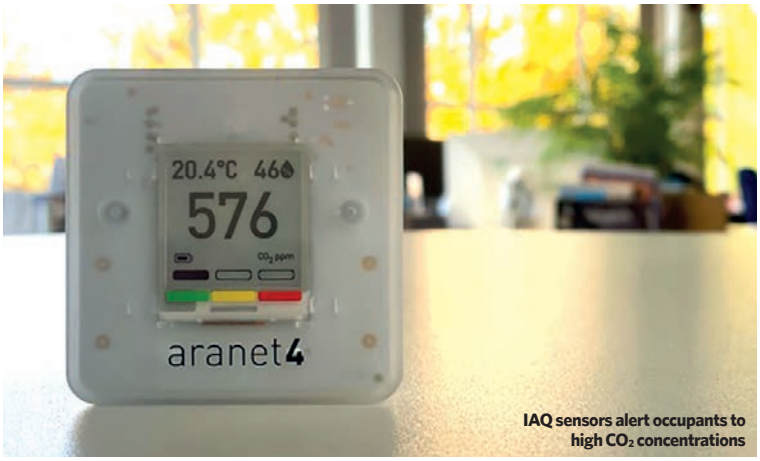
Most spaces did not meet the Building Regulation minimum standard air supply rate – the higher rate of 10L·s^{-1} per person or 1L s^{-1}·m^{-2} (floor area); current good practice performance for a new modern office building would typically achieve 14-16L·s^{-1}. This underperformance was confirmed by the IEQ and BUS data. The clearest indication was from the recorded concentrations of CO_2, which significantly exceeded the good-practice threshold of 1,000ppm, peaking at more than 1,600ppm.

Another reason for the reported 'stuffiness' of the office areas was low relative humidity (RH). Good-practice RH is between 40% and 60%, whereas the IEQ sensors measured RH below this range for 60% of the time, and below 30% RH for 25% of the time. These low RHs were unusual for the time of year and warranted further investigation. Beyond drying out the skin, eyes and nose, low humidity increases the rate of transmission of viruses, such as influenza, and may have a direct impact on absenteeism. Recent studies have shown that these low RHs can also affect occupant wellbeing and productivity.

TVOCs were observed to be high in areas with high CO_2 concentrations. They are often brought into the space by users and, as such, are a function of occupancy and the amount of fresh air delivered to the space. Increased ventilation (or reduced occupancy) in these areas will bring concentrations down. A number of zones indicated spikes in VOCs, and a steady increase over the weekend when occupancy was significantly reduced. This was probably because of VOCs being emitted in the office from cleaning activities.

PM2.5 measurements were found to be very low across all sensors, with very slight increases in a couple of meeting rooms. This was expected, as external (ambient) concentrations were relatively low, and the bag filters installed on the ventilation system should remove most of the particulate matter from the supply air when concentrations are elevated outside.

At the end of the investigation, it was recommended that a detailed review of the ventilation system be commissioned, to understand whether more ventilation could be supplied to the floor via the existing air handling units, or how additional local ventilation units could be incorporated to supplement the existing supplies. It was also recommended to increase humidity by introducing humidification to the mechanical plant and/or introducing a significant number of plants (greenery) into the office space.



IAQ sensors alert occupants to high CO_2 concentrations

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CIBSE to publish guide on non domestic heat pumps

BEIS commissions AM17 guidance for large heat pump installations

CIBSE is working with Arup to produce new guidance on heat pumps in large non-domestic buildings.

AM17 has been commissioned by the Department for Business, Energy and Industrial Strategy (BEIS) and will be available for free to designers, installers and consumers. It aims to ensure that heat pump installations follow best practice and are delivered safely, legally and to a high quality.

The project will:

- Produce new guidance for large heat pump installations in both new and retrofit non-domestic buildings
- Contribute towards delivering high-quality design, installation, commissioning, operation and maintenance of heat pumps
- Increase awareness of common issues in delivering effective systems in larger buildings, and seek to reduce instances of ineffective systems.

Twin water source Star heat pumps installed at Queens Quay, Glasgow

Arup – which developed CIBSE AM16: *Heat pump installations in multi-unit residential buildings* – will be the technical author, under the direction of the CIBSE technical team. The CIBSE team will be supported by a steering group comprising developers, landlords, occupiers, designers, installers, operators, manufacturers and other specialists. Dr Hywel Davies, CIBSE technical director, said: 'We are delighted to be appointed to lead this project, which aligns with our drive to link knowledge development and best practice to support the technical improvement and through-life performance of low carbon commercial and industrial buildings.'

Mike Edwards, associate director at Arup said: 'Heat pumps will play a crucial role in the UK's net zero carbon transition. We are very pleased to... lead the authoring of this best practice guidance, continuing our strong working relationship with CIBSE and other industry partners.'

Building analytics software used to optimise 1960s London office

Mace is using Demand Logic's building analytics software to optimise energy use at HYLO, a refurbished 1960s, 29-storey office tower in London. The scheme has ground-floor retail space and more than 23,000m^2 of high-end office space

The software tool delivers live data intelligence on how a building is operating. It monitors the heating, ventilation and air conditioning systems, utility meters, and internal environmental sensors for temperature, CO_2, air quality, humidity and occupancy.

Mace is using the software for fault detection when commissioning, and it could also use the software for energy and carbon reduction, improved facilities management/maintenance; or to focus on comfort, wellbeing and productivity. The software gives a holistic analysis of the HVAC systems and highlights common faults in major plant and small equipment. Mace can use this data to optimise control of the MEP systems, to ensure energy use is minimised. Once the scheme is up and running, property and facilities managers can use the live operational data to prioritise actions that fix faults, reduce energy and improve comfort.

Chris Connelly, operations director of Mace MEP, said: 'The introduction of Demand Logic on HYLO is providing our team with interpreted data to allow inefficient control of the MEP to be identified and remedied during commissioning.'

BlocPower helps city on road to net zero

The city of Ithaca, in New York State, USA, is working with Brooklyn-based climate tech start-up BlocPower to electrify and decarbonise its building stock.

BlocPower's proposal is to install air source heat pumps paired with supporting energy efficiency upgrades. At the same time, it will make financing green energy upgrades affordable by providing low-cost loans to building owners, which they will pay back through energy cost savings as a result of the scheme.

For buildings that qualify, and where owners have signed an Energy Services Agreement, BlocPower will oversee the project, handle maintenance and guarantee system performance for 15 years.

The initiative is the first step in Ithaca's plan to become carbon neutral by 2030, and BlocPower estimates the improvements will cut the city's current 400,000 tons (362,000 tonnes) of CO_2 emissions by 40%. The programme will also create 400 new green construction, technology and management jobs.

Heat pumps supply new Dublin hotel

A new hotel that uses air source and water source heat pumps has opened in Dublin.

The 137-room, nine-floor Wren Urban Nest uses 100% renewable energy, and the design of the building's hot water, heating and cooling system is based on a combination of air source and water-to-water heat pumps. Its ventilation system captures 81% of rejected heat using a thermal wheel, which also heats the incoming fresh air for free.

The hotel also uses thermal gains from the path of the sun. Heat gained on the east elevation in the mornings is extracted and used to warm rooms on the west elevation, and the process is reversed in the afternoons.

BDP delivered the architectural, civil and structural, and mechanical and electrical engineering design.

Wren Urban Nest in Dublin

HEAT ISLANDS

Orkney Islands Council has been installing heat pumps in schools and public buildings for more than 15 years in a bid to decarbonise heating and end reliance on oil. **Andy Pearson** looks at the lessons learnt and how a smart electric grid could soon take advantage of the relentless winds that batter the Islands

Alistair Morton, energy and utilities officer for Orkney Islands Council

The Scottish government published its *Heat in Buildings Strategy* in October. Similar to that published in England, the document has identified the contribution heat pumps will make, as a tried and tested measure , to Scotland s fight against climate change.

Scotland is ahead of the rest of UK when it comes to installing small scale renewable schemes, with the remote Orkney Islands leading the way. According to MCS, the certification body for renewables, one in five properties on the Islands has some form of small scale renewables.

More impressively, for the past 12 years Orkney Islands Council has been pioneering the use of large scale renewables through its commitment to heating council buildings, including offices, schools and care homes, using heat pumps. In that time, the council and its consultants have completed 16 schemes, and gained valuable experience of how best to use heat pumps on both new build and retrofit projects.

Necessity has driven the Islands to embrace electric heat pump technology. Orkney is off the gas grid, so we can heat our buildings with either electricity or oil fired boilers, says Alistair Morton, energy and utilities officer for Orkney Islands Council, and the person responsible for implementing the council s Carbon Management Plan. Because of the council s commitment to reduce carbon emissions, we ve been going down the heat pump route for all our new build properties for over a decade, he adds.

The council s first venture using ground source heat pumps (GSHPs) was on two new build care homes: the relatively small development on the island of Westray, and Smiddybrae House in Dounby, on the Orkney mainland. Both were designed with back up oil fired boilers because no one trusted the heat pumps to deliver , Morton recalls.

Following on from the care homes, the council then opted to use ground source heat pumps on a series of larger, new build schools projects: Kirkwall Grammar School (including an attached theatre and fitness centre); Stromness Primary School; and Papdale Halls of Residence. Unusually for Orkney,

One thing we have learnt is the importance of thermal testing the ground to ensure we design the ground array based on actual data

in addition to heat pumps the schools also incorporate liquified petroleum gas (LPG) boilers to provide high grade heat for the hot water coils in air handling units, and to top up the temperature of the hot water systems.

LPG was used in preference to oil because the council was aiming for a Breeam rating of Excellent. The success of the schools project subsequently resulted in GSHPs being used on The Pickaquoy Centre for sport and leisure. More recently, the council has installed a seawater heat pump to take heat from the sea at the adjacent harbour, to heat its new offices and public library in Stromness.

The key lesson the council has learnt from its GSHP rollout has been the need to test the thermal response of the ground. The

Necessity has driven the Orkney Islands to embrace electric heat pump technology

Smiddybrae House care home project was one of its initial GSHP schemes. Rule of thumb calculations were used to determine the number of boreholes needed for the scheme.

However, after two years of continuous use it became apparent the array was too small when so much heat had been taken from the ground that it had started to freeze, causing frost heave. Now, thermal response tests are carried out as part of the scheme design.

One of the main things we have learnt is the importance of thermal testing the ground to ensure we design the ground array based on actual data, Morton explains.

In contrast to Smiddybrae, on Hamnavoe House care home, in Stromness, the ground array initially appeared to be generating too much heat. According to Morton, this was because the heat pump s output had been worked out based on the depleted conditions found in the boreholes at the end of their 20 year design life. We d sized the heat pump based on water entering the array at 5°C, returning at 0°C, when in fact it was going out at 5°C and returning at 8°C, he says. Ensuring we sized the plant for the initial borehole output was a learning point,

The council is also hoping that, by the time the scheme has been running for 20 years, heat pump technology will have evolved to the point where it will be able to replace the current units with heat pumps that will work effectively at the depleted, lower temperatures of the boreholes with a good coefficient of performance. We want these boreholes to last for 50 years, Morton says.

Monitoring installations has also become more sophisticated over time. Morton admits the initial schemes had insufficient meters and sensors. Newer projects, particularly those installed under the Renewable Heat Incentive initiative, have heat meters and sensors. The council is also monitoring performance of the ground loop.

Alongside ground source and sea source heat pumps, the council has used air source heat pumps (ASHP) with limited success on a couple of housing schemes. There s a lot of salty water in the wind, so we have to be very careful with the spec for air source heat pumps; we get the pumps and coils treated for maritime conditions, but it s the external casing that we ve found soon corrodes and falls to bits, exposing the nice shiny heat pumps, says Morton. The first batch [of ASHPs] we put in had to be replaced within a couple of years because of case corrosion. »

CASE STUDY: RETROFITTING HEAT PUMPS IN SANDAY COMMUNITY SCHOOL

Sanday Community School is a junior high school catering for pupils aged three to 16 years. It also serves as a community centre, with facilities such as a meeting room, swimming pool and fitness centre for use by pupils and local residents.

Built in the 1960s, the 2,000m² school incorporated a poorly insulated flat roof and large areas of floor-to-ceiling, single-glazed, steel-framed windows. An LTHW radiator system, run from two 250kW oil-fired boilers, kept the school warm using generously sized radiators to offset the heat losses through the large expanses of single glazing.

Over time, the thermal performance of the school's envelope has been gradually improved. The flat roof was covered in a thick layer of insulation that was then hidden beneath what Morton describes as a 'crinkly tin' pitched roof, complete with a ventilated roof void. The windows were also replaced with semi-glazed panels featuring an insulated-panel lower section and a double-glazed unit above. Insulation was also added to the brick cavity walls.

By 2010, the oil-fired boilers, operating at 82°C/71°C, were on their last legs and the decision was taken to replace them with heat pumps. To keep the heating system running while they were installed, a new plantroom, incorporating a pre-insulated 10,000-litre thermal store, was constructed at the school before the oil boilers were decommissioned.

The building's improved insulation meant the initial radiator design was now significantly oversized and they were able to reuse the original radiator system and pipework with the 50°C/35°C flow and return temperatures. The large thermal store enabled the buildings to heat up in one-third of the time previously taken by the oil boilers.

Sanday heat pump

» In addition to promoting corrosion, the wind also draws heat from the buildings. Orkney s temperate maritime climate means that temperatures average 5°C in winter and 15°C in summer as a result of the warm Gulf Stream. The Islands relatively consistent temperatures are accompanied by almost continuous wind, which averages 7m·s[1] (13.5 knots) over a year.

The wind strips the heat out of the buildings, so we have to design them with minimal envelope penetrations, says Morton. Extract fans can really cause problems, so, in new builds, we put in centralised MVHR units with one intake and exhaust.

The relentless wind is the reason Orkney is dotted with wind farms, which result in it annually exporting more electricity than it consumes. Interconnectors transfer the wind generated power to the mainland grid. Bizarrely, this is then sold back to the Islanders with a surcharge of 2p per unit. We end up paying 2p per unit more for electricity than the rest of the country, Morton explains.

He admits that, if Orkney did have access to the gas grid, he probably wouldn t be using heat pumps for most schemes, because the cost of electricity would make them uneconomic. Most of the time, we propose heat pumps on the basis of lower carbon emissions, but the bottom line is that, currently, electricity is at least three times more expensive than oil, he says.

Another frustration for Islanders is that insufficient grid capacity means that, when the wind is blowing hard, wind turbines have to be shut down to limit electricity generation. It is a situation that is set to change under the ReFlex project, which will develop an electricity smart grid.

Under the scheme, electric vehicle chargers will be switched on, and heat pumps will top up heating systems in public buildings and homes with cheap electricity when the grid starts to become overloaded. This will enable the turbines to keep running.

Meanwhile, the project currently occupying Morton is the refurbishment of the heat pump system at Smiddybrae House, the council s first heat pump scheme. This involves the installation of a new borehole array and replacement of the heat pumps. And, 12 years after the heat pumps were first installed in the care home, the council has removed the oil fired boiler backup. We re now confident we can meet 100% of the heat load using heat pumps, says Morton. CJ

■ The Scottish Net Zero Public Sector Buildings Standard is a voluntary standard to support public bodies in meeting their net zero commitments for their new-build and major refurbished infrastructure projects.

The Islands' relatively consistent temperatures are accompanied by almost continuous wind

Heat pump council projects

Site		Tech	Capacity kW	RHI	Installed	New build/ retrofit	Notes
Smiddybrae House	Care home	GSHP	230	Yes	2020	New build	1
Kalisgarth	Care home	GSHP	36		2006	New build	2
Stromness Pool	Swimming pool	GSHP	32		2007	Retrofit	3
Glaitness Primary School	School	GSHP	72		2007	Retrofit	
The Pickaquoy Centre	Campsite amenity block	ASHP	32		2008	New build	
Stromness Community Centre	Community centre	ASHP	80		2009	Retrofit	
Braeburn Court	Care home	GSHP	12		2010	New build	
Warehouse Building	Library/ Community space	SSHP	40		2012	New build	4
Stromness Primary School	School	GSHP	154	Yes	2012	New build	5
Children's House	Residential care	GSHP	35	Yes	2013	New build	
Sanday Junior High School	School/pool	GSHP	120	Yes	2013	Retrofit	
Kirkwall Grammar School	School	GSHP	756	Yes	2013	New build	6
The Pickaquoy Centre	Swimming pool	GSHP	380	Yes	2013	New build	7
Papdale Halls of Residence	Student accommodation	GSHP	253	Yes	2013	New build	8
Evie Primary School	School	GSHP	113	Yes	2016	New build	
Hamnavoe House	Care home	GSHP	302	Yes	2019	New build	
Kirkwall Care Home	Care home	GSHP	390		2022	New build	9
St Andrews Primary	School	GSHP	330		2022	Retrofit	10
OIC housing stock	94 installations	ASHP	Various			Mostly retrofit	
OIC housing stock	171 installations	EAHP	Various			New build	
OIC housing stock	41 installations	GSHP	Various			Mostly retrofit	

Notes
1 Replacement of original HP/oil boiler system installed 2006 **2** Oil boiler backup **3** HP does pool water to allow boiler to be switched off out of hours **4** Sea source heat pump **5** LPG boiler backup **6** LPG boiler backup **7** Oil boiler backup **8** LPG boiler backup **9** Water-to-water heat pump for DHW (start on site Q1 2022) **10** Water-to-water heat pump for DHW (on site)

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EYES ON ENERGY

Building Performance Awards winner Carbon Intelligence has helped its clients save more than 17,000 tonnes CO_2e from 2019 to 2010, while readying buildings for safe reoccupation following the pandemic lockdowns. **Andy Pearson** finds out how its data platform uses non invasive technology to monitor and manage building energy use

Above: Carbon Intelligence has identified £100,000 of savings per year at Liverpool One's retail estate

'We're a team of strategists, technologists and engineers who believe in business as the solution to a zero carbon world. That's what Carbon Intelligence declared on its entry to the 2021 CIBSE Building Performance Awards, at which it won the Building Performance Consultancy (51 300 employees) accolade. As such, the business works with organisations to help them achieve their sustainability, energy and carbon reduction goals.

Over the past decade, Carbon Intelligence has assisted predominantly commercial real estate organisations to understand and optimise their building performance strategies, which, it claims, has helped clients save more than £7m and 17,000 tonnes of CO_2e from 2019 to 2020.

Carbon Intelligence's approach to sustainability is underpinned by its six dimensions framework, which is recognised by the World Business Council for Sustainable Development. This framework is the lens through which it delivers its services including those of building performance and optimisation which, it says, ensures an integrated approach to setting and delivering credible net zero and environmental, social and governance targets. Carbon Intelligence's approach is to work with businesses as a trusted partner and adviser, integrating our team to become an extension of theirs'.

CIBSE TM22 *Energy assessment and reporting methodology* is a key document for the firm. Its engineers have extensive training in its use, and the document is employed as a model for energy audits, to better understand building energy use.

Using secure, non invasive technology, Carbon Intelligence gathers data across

its clients building portfolios. Its data platform, Adapt, is then used to enable clients including Aviva, BNP Paribas Real Estate and JLL to monitor and manage their energy use and air quality, plus a range of performance indicators, across their portfolios.

Adapt is ISO 27001 *Information Security Management* certified, to ensure the security of assets and all energy saving data adheres to the International Performance Measurement and Verification Protocol.

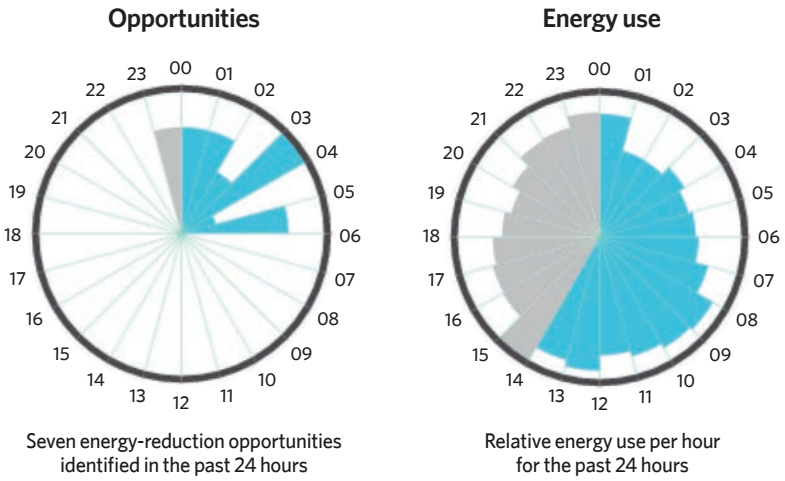
It allows data to be collated, verified for accuracy and analysed for insight, diagnostics and reporting. The platforms machine learning capabilities also help build performance benchmarks, and can highlight anomalies and potential problems, and alert site teams and engineers to carry out essential fixes. Adapt currently services more than 45,000 buildings in 60 countries.

According to Carbon Intelligence, its approach to building performance has the ability to review against design to bridge the performance gap between operation and design . It can also be used to create industry benchmarks, so clients can assess performance across multiple assets and against their peers and the industry as a whole.

Smart building technology and Carbon Intelligence s innovative approach to building management has enabled its clients to respond to the Covid 19 lockdowns, and the subsequent challenge of readying buildings for reoccupation. By remotely monitoring and managing their buildings, some of its clients were able to reduce their energy use by more than 70% during lockdown, with corresponding cost and carbon savings.

The same smart building technology was equally useful in helping businesses to manage a safe and successful reoccupation of the workplace after lockdown, by ensuring offices are running efficiently to minimise Covid 19 transmission and give the workforce confidence to return. Its monitoring dashboard shows CO_2, temperature and humidity levels in real time, to provide reassurance (see Safety with numbers: using data to make workplaces Covid secure , *CIBSE Journal*, October 2020).

Adapt has enabled Clifford Chance HQ to monitor and manage its energy use



IoT hardware monitors the environment to improve comfort and identify energy-savings opportunities, as above

The smart building technology was useful in helping businesses to manage a safe and successful reoccupation of the workplace after lockdown

Carbon Intelligence contributes to various industry bodies, including the UK Green Building Council (UKGBC) and Advancing Net Zero framework, which, it says,helps define how sustainability should shape the built environment going forward and ensure that net zero remains a core influence over industry decision making .

In partnership with UKGBC, the Carbon Intelligence team has contributed to numerous technical guides and committees, including: *Advancing net zero building framework*; *Guide to Scope 3 reporting in commercial real estate*; and the Renewable Energy Procurement and Carbon Offsetting Task Group.

More recently, the organisation has published a white paper on *Net zero for commercial real estate*, setting out its working definition of net zero and how it thinks the industry needs to respond to achieve it.

As an organisation, Carbon Intelligence walks the walk with its main office in Londons Regent Street, a space it has occupied since 2016. For its fit out, the organisation focused on sustainability and staff wellbeing. Sensors monitor air quality and wellbeing related data, which is displayed on screens for staff and guests to view. This allows it to proactively manage its working environment, such as set times for air conditioning to coincide with peak temperatures in meeting rooms and alerts for high CO_2 levels. More widely, it has sensors that monitor fans and heating elements.

The numerous sensors have been beneficial for office reoccupation during Covid. Data combined with alerts has allowed Carbon Intelligence to identify areas of poor ventilation and potentially poor air quality, and to take action to correct these to minimise virus spread.

Carbon Intelligence was described by the BPA judges as being ahead of its time in its service to clients . **CJ**

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Joining the circle

The lighting industry is far from being truly circular. Energy efficient LEDs have, paradoxically, led to a profligacy of use and the inability to replace just a lamp, rather than an entire integrated fixture. Products are not repaired, repurposed or reused at the end of life. The vast majority of lighting is sent to landfill. Even for products complying with the Waste from Electrical and Electronic Equipment Directive, only 7.5% are recovered.

CIBSE SLL TM66 is one of three new tools produced by the Society of Light and Lighting (SLL) to address the problem (page 44). The resources are aimed at the whole supply chain. Manufacturers can use the Circular Economy Assessment Method to assess the cradle-to-cradle performance of luminaires, while specifiers have a tool that helps them ask suppliers key questions.

The SLL has also published its first full-blown guide to avoiding light pollution in outdoor environments (page 46). Perhaps the starting point needs to be: should something be lit in the first place? This is also being asked in interior lighting design. An atmospheric office project by BDP (page 38) exemplifies the latest thinking, with an emphasis on dark as well as light.

Jill Entwistle, editor of the *CIBSE Journal* Lighting Special

CONTENTS

A beacon for change

During COP26, countries, world leaders, communities and businesses came together to discuss how they can attempt to reverse the environmental issues that grip our planet. With the built environment making up 40% of the UK's total carbon footprint, the installation of more energy efficient LED lighting could have a sizeable impact. As we continue to develop new technologies and shift to new ways of thinking, should we be encouraging customers to consider lighting as more central to the design of buildings, new and old?

The recently published TM66 suggests, we must all assess and report on not only our commercial performance, but also our environmental impact. Increasingly visible effects of man-made climate change and the questions over energy and resource scarcity have made the move towards a circular economy more relevant now than ever before.

Greater commitments to sustainability and the environment are crucial to maintain a healthy planet. As consultants and industry experts, we should embrace sustainable practices such as designing away waste, maximising value and ensuring that materials remain within the 'cycle', as these are key to achieving environmental targets and a circular economy.

Another key way to achieve net zero is to specify products that are manufactured and designed close to home. The lighting industry should be a beacon for change – do we really need legislation to tell us to do the right thing?

Let's 'reduce, reuse, recycle, recover' together.

DEBBIE-SUE FARRELL, head of wellbeing and manager of marketing at Tamlite Lighting

Black to the future

There has been a shift to lower light levels and use of darkness in the workplace, according to BDP s Colin Ball, who cites the refurbished London office building LDN W as a prime example

There has been much discussion and research in recent years on productivity and concentration in the workplace, and how brighter ceilings and cooler temperatures improve people's wellbeing. The Well Standard defines this in terms of quantifiable melanopic lux ratios, which can be translated very simply: our eye/brain system evolved to be awake during daylight hours and to contemplate around a warm fire, before sleeping in darkness.

Over the past few years, we have noticed a gradual shift in the approach to lighting. The bright spaces, dramatic use of colour and showpieces of previous decades have evolved into a more subdued, warm glow – a form of lighting that is perhaps encapsulated by *hygge*, the Danish word for the calmness of feeling the moment.

This sense of creating an inviting glow from within depends on darkness to frame it, and on allowing that warmth to glow out. Clients and users have responded quite dramatically to schemes where we have used darkness as an energy-saving device to meet carbon zero or exemplar targets. This involves fully exploiting daylight where it is available and only using artificial light to balance contrast. What has been interesting is that, when these daylight spaces are allowed to darken down, our clients do not want them brighter. Instead, they appreciated the warm 'business class' mood of their interiors.

Whether for leisure or work, the greater use of screens increases the amount of time each day that we stare into the cool, blue, strobing light that keeps us

Vertical and horizontal surfaces are illuminated according to the tasks taking place

The office's unique colour palette of black with black meant standard lighting could not be used

stimulated and concentrated. The need to balance this is also growing – future places for work and leisure need to offer quieter, warmer, darker spaces as an alternative.

The following BDP project – LDN-W, an office development in London EC2 – is a good example of this trend, and reflects the way in which it is possible to incorporate a darkness element into a lighting scheme successfully.

A newly refurbished office building, LDN-W comprises 12 floors of Cat A office accommodation, a reconfigured, semi-public ground floor with innovative structural glazing, a new façade at street level, and a rooftop terrace with impressive views across the city.

On a general level, vertical and horizontal surfaces are illuminated according to the specific tasks taking place, supplying the building users with a comfortable and safe environment that is easy to navigate. Lighting is appropriate for the character and function of each space within a coherent, rationalised illumination system of lit effect and lamp types. This enables good passive security and maintenance, while also maximising lamp life and minimising energy consumption.

However, the unique palette of black with black, with more black throughout,

Timing occupants as they entered the foyer was essential to the success of the scheme

meant that standard lighting could not be used. Any light on a black finish only reveals scratches and dust. The scheme intentionally adds angles of light up to the threshold of perceived visual tolerance, to narrow the occupant's iris, making the black finishes rich and dark in lustre, but by using contrast instead of light.

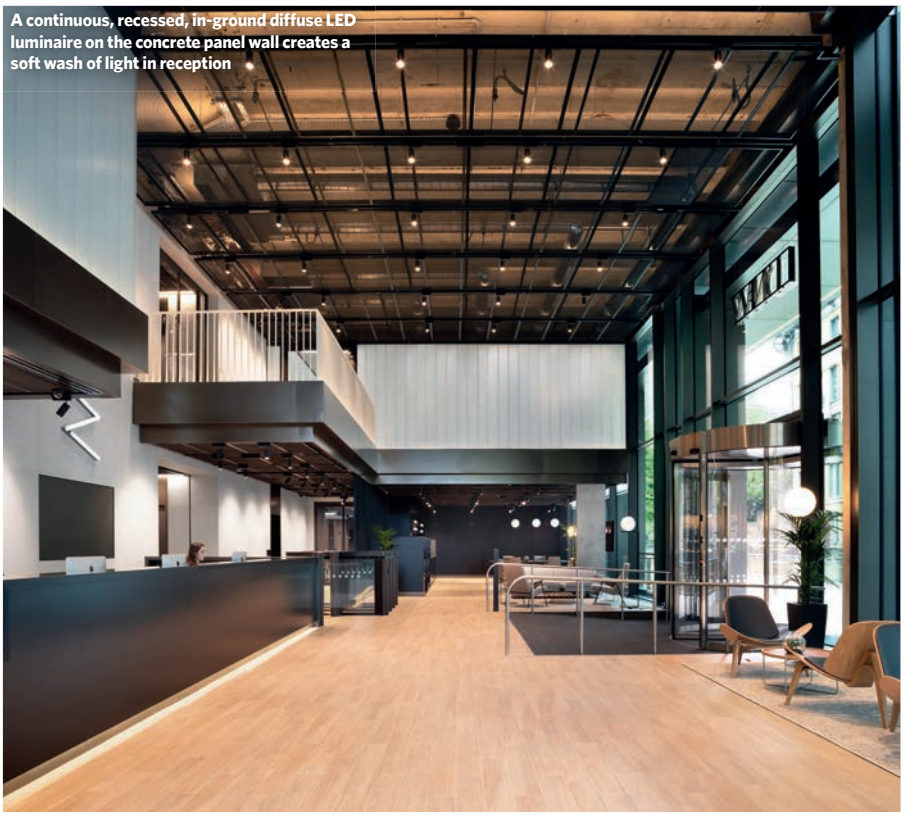
The backlighting to the ceiling in the ground-floor foyer produces a warm upward wash to the fine-finished concrete behind the mesh. This produces a high-level wash, achieving a bright daylit ceiling while maintaining the presence of the black mesh as a translucent layer.

This technique works if the relationship between neighbouring materials is carefully managed so that floor, ceiling and wall finishes involve at least one matt, warm pale material to provide a diffuse reflector to the rest of the space.

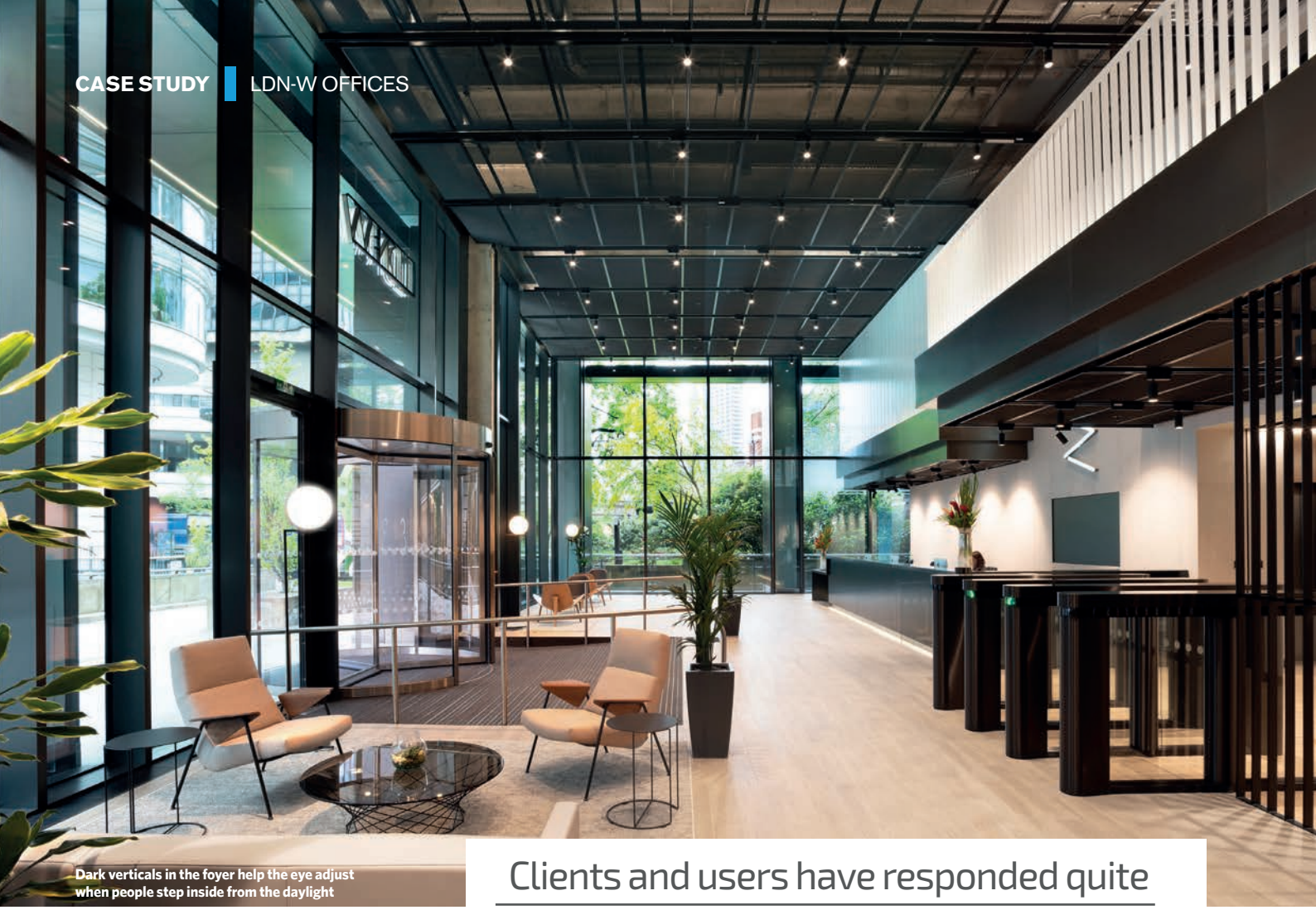
The end result still produces a lit interior without glare or spill light affecting the quality of the blackness of the space. The room may appear black, yet you can read in any location and clearly see your companions throughout the space. It uses a cost-effective, sustainable and energy efficient control system based on presence detection for any area outside the ground-floor foyer.

Lighting inside the main entrance, reception and cafe area is provided by high-level LED spotlights mounted on runs of track with a continuous, indirect LED light source. The track is suspended between the panels of expanded mesh ceiling, within an exposed slot, at a height that allows the spotlight head to project below the underside level of the ceiling. This produces an indirect wash of light to the existing concrete coffer ceiling.

An integrated, diffuse LED striplight at the front of the reception desk – and a continuous, recessed, in-ground diffuse LED luminaire on the concrete panel wall behind – create a soft wash of light. »



A continuous, recessed, in-ground diffuse LED luminaire on the concrete panel wall creates a soft wash of light in reception



Dark verticals in the foyer help the eye adjust when people step inside from the daylight

Clients and users have responded quite dramatically to schemes where we have used darkness as an energy saving device to meet carbon zero or exemplar targets

» Suspended LED feature pendants give direct lighting to the bar and create a visual focal point for customers. Floor-standing LED feature lighting provides low-level lighting to the cafe seating area for a more relaxed and informal ambience.

Continuous, direct, diffuse LED lines of light run around the entire perimeter of the lift lobby and circulation space. Luminaires are either suspended or surface-fixed, flush-recessed to the underside of the black, expanded mesh ceiling. Adjacent to the lift doors, deep-recessed LED downlights, mounted within a black profile system, produce pools of accent light on the timber floor.

Timing occupants as they entered the foyer was essential to the success of the scheme. At the height of summer, occupants can step quickly into the building from daylight levels of 20,000 lux or more, potentially posing a problem for adjusting their eyes as they enter an interior with such radically dark finishes.

However, the intentionally dark verticals speed the eye's adjustment to the lower interior levels. Once the occupant is in the interior space, the light is concentrated on the pale wall finishes to comfortably bring the eye's focus to the lower light level, a process that can take up to two minutes. As the vertical black walls facing the daylight are five times brighter than the interior white walls, it is the pale walls away from the daylight that alleviate the transition. In other words, we are using a staged luminance transition to keep the eye comfortable as it adjusts over that two minutes.

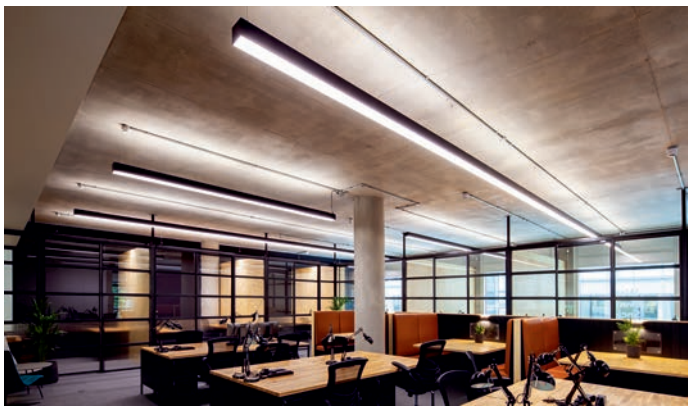
The balancing of contrast and focus to reflected light to any black finishes continues through each landlord space, into the toilet suites.

Task-focused light uses diffuse reflection to bring good facial modelling to mirror reflections. Lighting above the wash basin comes from a surface-mounted, flush-recessed line of LED light with opal diffuser, providing a soft lit effect, while indirect LED cove lighting detail gives vertical illumination above the mirror.

In all places, we understood the occupants' eyes and direction of view, such that the lighting is as much about the balance and placing of black or pale finishes as it is about a standard approach to light levels. CJ

COLIN BALL is lighting director at BDP



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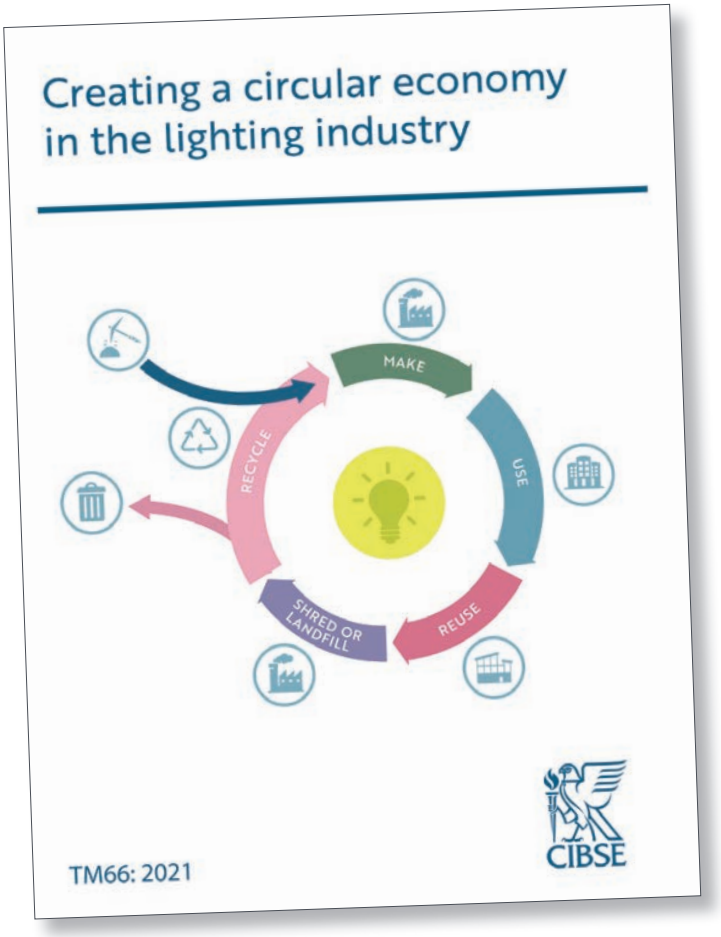
Virtuous circle

Action is urgently needed to promote the circular economy in the lighting industry. Bob Bohannon describes three tools developed by SLL to reduce embodied carbon and save natural resources



Without definition or action, the government's Build Back Better mantra is just a slogan. The first question we should ask is what does better look like in terms of lighting when we are being tasked with delivering net zero carbon buildings?

With a renewed focus on any building service that consumes energy, will lighting quality again be under pressure? To avoid taking a blinkered, energy-only approach, we need to understand and communicate all the aspects that make up better (lighting) in a net zero carbon building.

Perhaps we should adapt the excellent 'right light, right place, right time' mantra (originated by dpa lighting) for our new net zero, life-cycle aware, wellbeing-based age. It might usefully become 'minimum energy, minimum resource, maximum comfort'. This article focuses on 'minimum resource' and looks at the embodied resources that are used to build the luminaire.

The old joke about how many (fill in your stereotype) does it take to change a light bulb doesn't work any more. The LED and the driver are often integral to the fitting, so if one fails you have to replace the whole thing – you can't repair it and extend its life, even if you wanted to.

LEDs are more energy efficient and part of our green jobs revolution, which is driving economic growth – but it is not the whole story. The huge growth of LED lighting has brought its own problems. Consider the hospitality sector, for example, which is the focus of ever more wonderful lighting designs. While each individual luminaire is likely to be fairly energy efficient, there are now many more of these fittings, which are replacing conventionally lamped fittings and are common.

You may reasonably think we recycle the fittings ripped out before a hospitality or retail refit. The WEEE directive came into force in 2003, so equipment less than 19 years old has to bear the crossed-out wheelie bin mark, meaning it can be recycled. But I present you with an inconvenient truth: the vast majority of lighting or lighting with this mark is sent to landfill, with only 7.5% estimated to be recovered under WEEE. These go to a grandly named Approved Authorised Waste Treatment Centre, but any value in your old luminaire is literally shredded to recover metals – a process that needs energy inputs to melt them down for reuse.

We have to make better use of the resources embodied in our lighting equipment. An unthinking linear economy of Take (resources from the environment), Make (products in factories), Waste (dispose of products into the natural environment) is no longer acceptable.

Part of the problem is that we measure economic growth in terms of sales revenue, not environmental impact. Adopting the circular economy is the process of maximising resource usage, and maintaining lighting assets at their highest value – in other words, ensuring luminaires are effective for as long as possible.

We need practical action right now. This will most likely take the form of legislation, supplier innovation, specifier or client-led demand, the dissemination of practical knowledge and the adoption of assessment methods. To help the lighting industry adopt a more circular approach, the SLL has created a suite of three tools for manufacturers, specifiers and clients.

The first tool in the suite is the forthcoming CIBSE SLL TM66 Technical Memorandum *Creating a circular economy in the lighting industry*. It describes the background to the circular economy in general, including the drivers behind

ON-DEMAND WEBINAR

Watch *Delivering the circular economy for the lighting industry* at bit.ly/CJDec21Circ The webinar was organised by SLL and CIBSE Home Counties South West.

Chairs: Hakeem Makanju, CIBSE HCSW chair; David Mooney, SLL representative, HCSW; Speakers: Bob Bohannon, FSLL, immediate past president; Kristina Allison, CEng MCIBSE MSLL, chair, SLL education committee; Roger Sexton, FSLL, business development, Stoane Lighting; Tim Bowes, MSLL, head of lighting application, Whitecroft Lighting.

Aluminium recycling: scrap material in a crucible (left and centre); pendant reflector from recycled aluminium (right)

its adoption. Most importantly, it gives guidance on how the circular economy affects each sector of the industry, what opportunities it may bring them, and what to do next.

Alongside TM66 is CIBSE SLL's Circular Economy Assessment Method for Manufacturing (CEAM-Make), which allows manufacturers (or specifiers, if they so wish) to assess the performance of their luminaire and its supporting ecosystem in terms of its circular economy performance.

The products are given a rating out of four, and the objective is to move as many products and manufacturers from 'zero to hero' (four) as quickly as possible by giving them the detailed issues to consider. The assessment method is comprehensive, covering product design, manufacturing, materials and supporting ecosystem.

The CEAM-Make may be a bit too in-depth for a busy specifier to use every time they need to choose between luminaires, or in the transition period when manufacturers have not fully completed their CEAM-Make assessments. So, the third part of the suite of tools is the SLL's CEAM-Specify, which is a specifier support tool. You could think of it as a triage tool that provides the most important questions to ask a manufacturer.

A team is already convening to build another tool, CEAM-Manage, which looks at how to maintain a circular project through the design phase and after completion in the facilities management phase.

All the tools in the suite have been created in full consultation with manufacturers, product designers, lighting designers and end users. They will be updated continually, and the hope is that they will deliver the practical know-how to ensure carbon isn't just minimised in a product's operational performance, but also throughout its whole life-cycle. **CJ**

- Immediate SLL past president **Bob Bohannon**, MSc, FSLL, MIET, is a lighting designer and head of policy and academy at the Lighting Industry Association. He led the team on TM66: *Creating a circular economy in the lighting industry* and the CEAM Assessment methods, with SLL education committee chair **Kristina Allison** as project manager, and support from **Andrew Bissell**, **Sophie Parry**, **Anastasia Mylona**, **Simon Fisher**, **Roger Sexton**, **Mark Ridler**, **Tim Bowes** and **Tom Ruddell**, among others.
- TM66 received the highest accolade, Platinum, at the Build Back Better Awards 2021, along with a Build Back Better Green rating. TM66 is available at **www.cibse.org/knowledge**

Multiple fixing holes to allow for alternative components

CIRCULAR QUESTIONS

This basic, five-point guide is a starting point to establishing that specification is on the right path:

1. **Ask your lighting supplier about the circular economy performance of their products. If they don't know what you are talking about, don't have buy-in from their management, or just talk about WEEE recycling, find a better supplier.**
2. **Ensure that light fittings can be upgraded and repurposed, and that the LED or driver can be changed out later in life. If the fitting is glued together, it's going to struggle to be remanufactured or maintained – in a nutshell, use screws not glue.**
3. **Ask what life-cycle/circular economy accreditation your supplier has – for example, the upcoming CIBSE/SLL Circular Economy Assessment Method (CEAM).**
4. **Make sure that lighting assets are bought for the long term and that burning hours can be monitored. Then ensure they can be maintained when needed, upgraded or remanufactured. Don't think throw and replace. Think value not price.**
5. **Those responsible in-house should engage with the ecosystem of new services, build relationships and think local. They should ask how fittings in their new project will be maintained in five or 10 years? It might be an onsite service; it might be a UK/EU-based facility – it's unlikely to happen 6,000 miles away.**

Refurbishment of a halogen installation to LED, demonstrating the circular economy in action

Dark matters

The SLL has published its first, full blown lighting guide on illumination and the night time environment. Co author Benedict Cadbury summarises the new *LG 21: Guide to protecting the night time environment*, following a summary by Jill Entwistle

According to the 2016 World Atlas of Artificial Night Sky Brightness, 80% of the world's population live under skyglow. In the US and Europe, 99% of the public can't experience a natural night.

'For three billion years, life on Earth existed in a rhythm of light and dark that was created solely by the illumination of the sun, moon and stars,' says the International Dark-Sky Association. 'Now, artificial lights overpower the darkness and our cities glow at night, disrupting the natural day-night pattern and shifting the delicate balance of our environment.'

Not only have we lost the stars, or the greater number of them, but we are damaging the ecosystem and wildlife, harming human health through the disruption of our circadian rhythms, and squandering energy. The sources are many and various: building exterior and interior lighting; advertising signs; security lights; street lights; and illuminated sporting venues.

Obtrusive light

A great deal of outdoor lighting used at night is inefficient, overly bright, poorly directed, inadequately shielded, and even unnecessary. 'This is an area where guidance is indispensable,' says Benedict Cadbury, who has finalised the SLL's first extensive lighting guide in this area, a work substantially completed by former SLL president Liz Peck before her untimely death at the beginning of 2021.

Until now, the SLL *Guide to limiting obtrusive light*, written by Peter Boyce and published in 2012, was the only guidance available. 'Nine years on, it is time to expand this into a full lighting guide, with additional material relating to LED light sources, and consideration of how light can affect human and animal circadian systems,' says Cadbury, who, here, summarises key points from *LG 21: Guide to protecting the night-time environment*.

Lighting for nature

Liz Peck worked with Bob Bohannon on the award-winning scheme for the Iron Bridge at Telford. In terms of light pollution, this guide could almost have formed a checklist for the project: skyglow; obtrusive light; bat flyways; fish; visitor views; extending the economic day of Ironbridge; curfews; luminance-based design; spectral reflectance and light-source spectral radiation; daytime appearance; glare mitigation through positioning, aiming and louvres; and, finally, an overall lighting impact assessment – all have been included.

Electric light is capable of being harmful not only to humans, but animal and plant species. For humans, glare and flicker are obvious problems. First, flicker does not have to be visible to have an effect; second, many LED lights that operate satisfactorily on full power produce increasing flicker as the driver dims the light source. So, if lights are planned to be dimmed in use – for example, with daylight-linking – the flicker factor/ flicker index needs to be ascertained at 50% and 25% output, as well as 100%.

Skyglow might not, at first, be thought of as bad for health, but if it means that city

London's Piccadilly Circus: the sources of light pollution and skyglow are many and various, including building exterior and interior lighting, advertising signs, shop windows and street lights

centre dwellers sleep less well because of the lack of complete darkness outside, this clearly has an implication for their wellbeing.

More than half the world's species are nocturnal, so exterior illumination in or near their habitats can cause problems, particularly if it is in operation throughout the hours of darkness. Bats are at the top of the list, but nocturnal birds – such as owls – suffer; small mammals, such as mice and shrews, rely on darkness to avoid predators.

A significant number of animals and birds are protected in the UK; the Appendix of the guide lists 101 vertebrates in this category. Disturbance of any of these species is illegal, so lighting designers need to consider carefully the effect of an exterior lighting scheme – not just on neighbouring properties, but also on native wildlife. This is especially pertinent on the edge of a built-up area or a greenfield site in the countryside.

Blue light is of particular interest when considering circadian entrainment and the negative effects of electric light on wildlife. In the past, street lights were generally monochromatic sodium; now, LED street lights – generally 4,000K-5,000K – contain a good deal of blue light. A 4,000K LED source typically has a blue-light content of around 33%, whereas a warmer, 2,700K light source has 16%. Blue-rich white light disturbs nocturnal creatures more than warmer, narrow-waveband sources, so it is essential to consider the spectral distribution of a light source in assessing its impact on the natural environment.

The first question has to be whether or not the lighting is necessary or justifiable. Much of it is, indeed, necessary – for example, for safety of movement, security, or work, such as loading vehicles. The next category is 'desirable' – for instance, to extend the economic day of a town centre, lengthen the time that leisure facilities can be used, or illuminate landmarks. At this point, the lighting designer and client must make a realistic assessment of the negative effects to weigh against the benefits.

> It is far more effective to light a few well chosen focal points rather than flood the whole space with uniform illuminance

There is a tendency to think that more or brighter lighting is better. If a private client or hotel asks for a garden to be lit, it is far more effective to light a few well-chosen focal points rather than flood the whole space with uniform illuminance. Of course, safety considerations mean that steps and the edges of any water features need accent lighting, but this can be local and discreet.

There is no reason to exclude external lighting altogether. Clients frequently want features lit on winter evenings, which might mean 4-9pm. A lighting impact assessment might well conclude that, with a curfew at 9pm, the entire scheme would be acceptable, whereas – if it was to run to midnight – a restriction on the number of luminaires and/or their lumen output would have to be imposed. The guide offers practical advice and useful suggestions, drawn from the author's extensive experience. Good-practice examples are given and there is a checklist of considerations before a lighting scheme is submitted for planning permission.

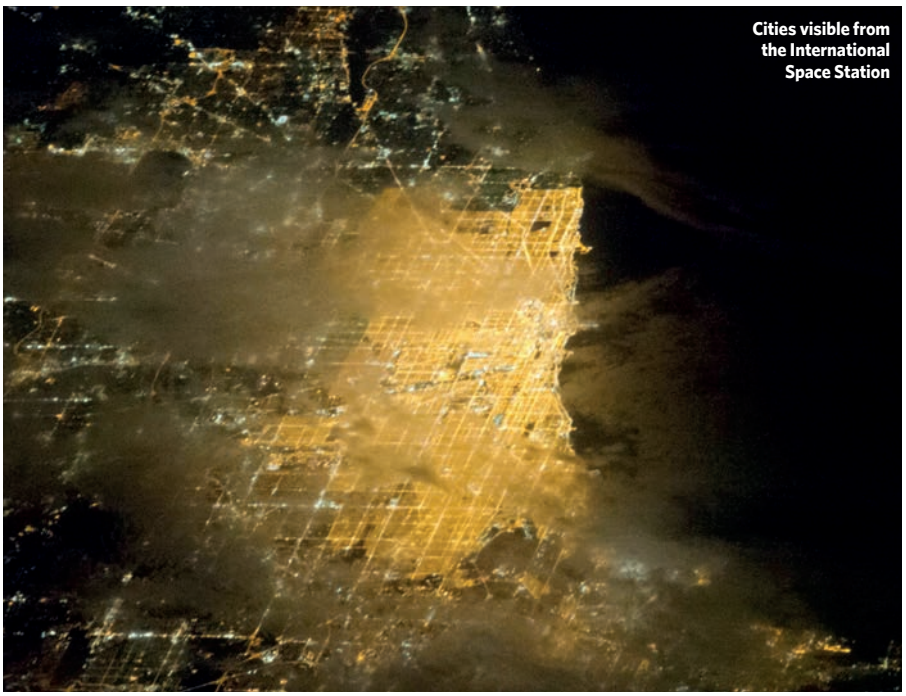
Humans are a diurnal species, but we have the tools to turn night into day. The power to use these tools should be employed wisely. Not every building needs lighting, not every surface needs to be lit, and we should be cognisant of the impact of any light that escapes the confines of our projects. **CJ**

Lighting Guide 21: Guide to protecting the night-time environment, primarily written by Liz Peck and finalised by Benedict Cadbury, is now available at **www.cibse.org/knowledge**

References:

1 2016 World Atlas of Artificial Night Sky Brightness, Falchi *et al*, Sci Adv, Jakob Grothe/NPS contractor, Matthew Price/CIRES

BENEDICT CADBURY is a lighting design consultant at Lampholder Lighting Design



Cities visible from the International Space Station

More than half the world's species are nocturnal and affected by exterior illumination in or near their habitats

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Improving air quality for education

This module explores the drivers for good-quality ventilation in schools and other education facilities

One of the many areas that has excited popular interest as a result of concerns raised around internal air quality during the Covid 19 pandemic is the importance of providing suitable ventilation for schools, colleges and universities. However, the need for appropriate ventilation has been a long standing issue, and the justification goes far beyond diluting the potential presence of SARS CoV 2 in the classroom. This article will focus specifically on the drivers for good quality ventilation in schools although the messages are equally appropriate for all places of learning.

Indoor environmental quality (IEQ) is dependent on an amalgam of factors, and when assessing strategies and options for ventilation it cannot be considered in isolation. CIBSE TM57[1] *Integrated school design* describes the four interrelated factors for successful environmental design of school buildings as daylight, thermal comfort, low and zero carbon energy, and ventilation. TM57 covers all these areas in some detail, and emphasises that building form and thermal mass underpin successful strategies for daylight, ventilation and energy. While recognising the interdependence of all the factors for a successful internal environment, this article will specifically consider ventilation.

The cocktail of contaminants that make up the internal environment has been discussed frequently (including in the first section of CPD 180 in *CIBSE Journal* June 2021) with the key chemical contaminants (in Europe) being[2] carbon monoxide (CO) and nitrogen dioxide (NO_2), and the volatile organic compounds (VOCs) formaldehyde, benzene and naphthalene. With potentially lesser significance, but highly dependent on exposure levels, are CO_2, bacteria and viruses, particulate matter (PM2.5, PM1.0 and ultrafine particles) and, in some locations, gases such as radon. It is important to note that CO_2, which has a concentration of just over 410ppm in outdoor air, is used both as a marker or proxy for estimating the actual ventilation rates in buildings, as well as being a potential contaminant that is being exhaled by occupants. This article relates to CO_2 as a contaminant.

CIBSE Technical Memorandum TM40 *Health and wellbeing in building services* notes that, in general, exposure to air pollutants can have both acute and chronic health effects, from mild to severe and occupants are unlikely to even be aware of the contaminants in the air that they are breathing. The likelihood and severity of the impact of contaminants on humans depends on age, any pre existing medical conditions and individual sensitivity. In schools, there are often pollutants generated from the building and various materials used in the teaching spaces, together with local complications such as mould, asbestos and radon. A recent review paper produced by Swegon, *Air quality and ventilation in schools*,[3] reiterates the much voiced opinion that classroom ventilation rates are directly associated with students academic achievements,[4] with a poor quality indoor environment thought to cause discomfort, distract attention and reduce motivation.

Much of the potential contamination in the teaching rooms can emanate from the space itself, but will be dependent on the situation. For example, the presence of materials that emit VOCs which can include adhesives, insulation, wall boards, furniture, carpets and fabrics have been widely implicated in »

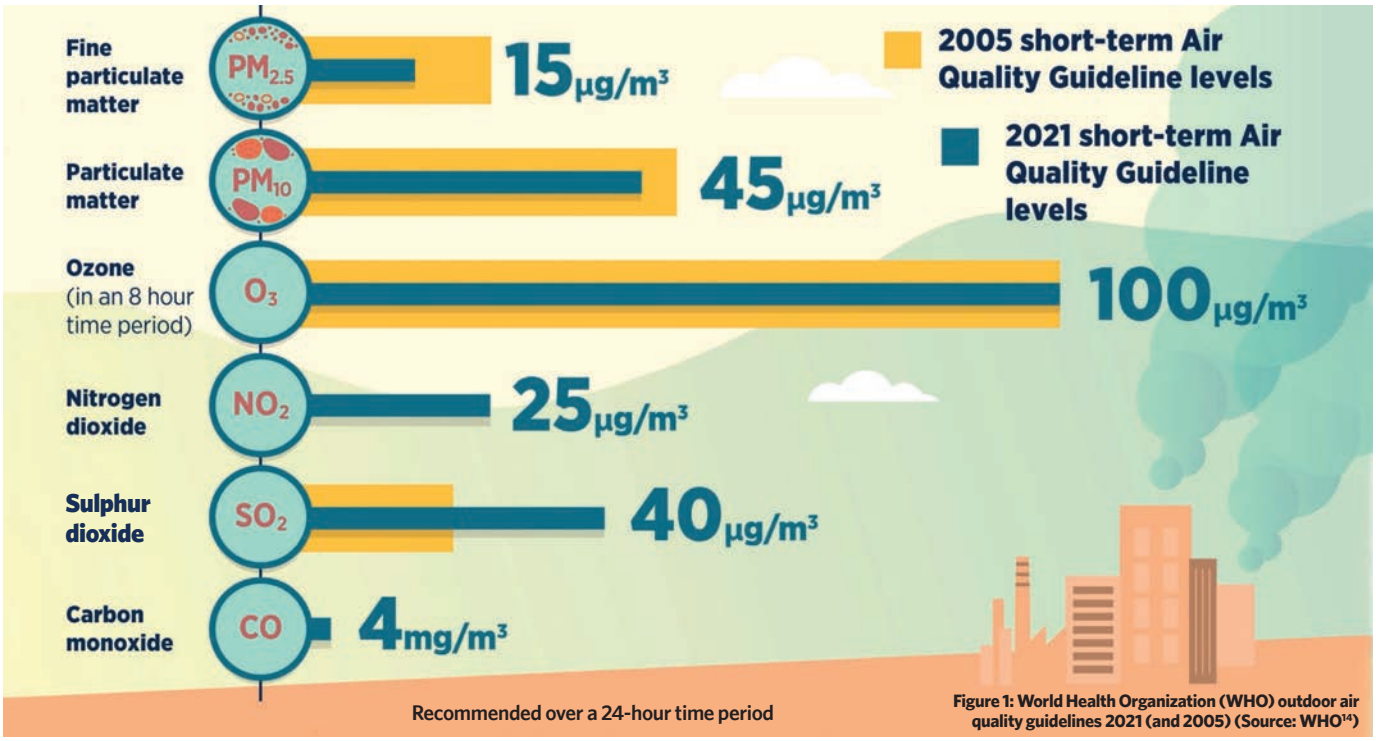

Figure 1: World Health Organization (WHO) outdoor air quality guidelines 2021 (and 2005) (Source: WHO[14])

» adversely affecting occupants. Levels of CO_2 will primarily depend on the occupants. The Swegon review paper notes that a child aged seven to nine years old will produce half the amount of CO_2 compared with a teenager this will make a significant difference when assessing the accumulating CO_2 levels in the internal environment. A recent research review by Fisk,[5] which considered research across the world, indicates time average CO_2 values in surveyed classrooms ranged from 1,400ppm to 5,200ppm (in studies where 20 or more classrooms where investigated). This is illustrated, categorised by type of ventilation system, in Figure 2. Fisk notes that concentrations of CO_2 do not appear to be systematically higher or lower in naturally ventilated classrooms relative to mechanically ventilated classrooms . His review reports that studies found average or median ventilation rates to be in the range of 3L s^{1} to 5L s^{1} per person, with one average as low as 1L s^{1} per person, and he concludes that there is a widespread failure to provide the minimum amount of ventilation specified in standards for classrooms .

Adverse effects have been reported for elevated CO_2 levels in classrooms, including decreased satisfaction with indoor air quality (IAQ),[6] students experiencing greater fatigue and impaired attention span, and lower levels of focus among university students during lectures.

The link between ventilation and achievement was observed in a study by Toyinbo *et al*,[7] where preliminary analyses indicated statistically significant poorer results in mathematics tests in schools where the ventilation rate was lower than 6L s^{1} per person. Toyinbo also links lower ventilation rates to more missed school days caused by respiratory infections. Lower ventilation rates may lead[8] to increased asthmatic symptoms, and the risk of viral infections through the concentration of bioaerosols emitted from the occupants. Carrion Matta[9] noted research that indicated that high indoor concentrations of PM2.5 have been associated with asthma and cognitive impairment. The levels of particulates in the indoor air were determined as being strongly related to the outdoor air quality (rather than resulting from activities in the space itself) and were typically worse when ventilation rates were higher. This can pose a difficult compromise in locations with poor outdoor air quality and will increase the dependence on air cleaning devices, such as particulate filters.

In the US, Haverinen Shaughnessy observed[10] a link between ventilation rates and performance on standardised tests in maths and reading for nine to 10 year olds, estimating that each 1L s^{1} per person increase in ventilation rate was associated with a mean increase of 0.5% in maths scores. A UK study[11] by Clements Croome *et al* indicates that pupils performance is increased by a very significant 15% in various tasks when ventilation rates in teaching spaces are increased from 0.7 1L s^{1} per person to 6 8L s^{1}. Fisk s review[5] indicates similar improvements in performance with increased ventilation rates ranging from a few per cent up to as high as 15%.

Recently, Wargocki *et al*[12] reviewed data from published studies to derive systematic relationships between learning outcomes and air quality in classrooms, which predict that reducing CO_2 concentration in classrooms (from the typically higher values as illustrated in Figure 2) to 900 1,000ppm would significantly improve performance in school tasks, concentration and daily attendance. In terms of ventilation rates, these results suggest that increasing ventilation rates from 2L s^{1} to 7.5L s^{1} per person will improve pupils performance in national tests by 5%, and children s daily attendance by 1.5%. Notably, Wargocki concludes that the results provide a strong incentive for improving classroom air quality, and this might be assessed as part of cost benefit analyses in systems design and operation.

As classrooms are typically densely occupied spaces with a common rule of thumb being between 2m^2 and 4m^2 floor area per student TM57 notes that the ventilation rates required to maintain good IAQ are high in winter and even higher in summer. It is noted, in this pre Covid publication, that the wider interest in IAQ of educational buildings is underpinned by the rising incidence of asthma and respiratory disease among children.

In urban applications, the outdoor air may not be necessarily fresh (see panel, Fresh air?) but, practically, to maintain a good indoor environment, the school

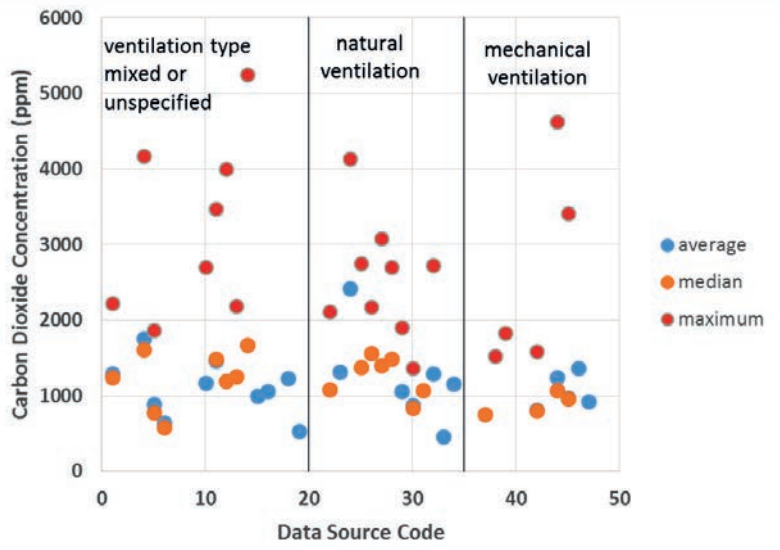

Figure 2: Time average carbon dioxide concentrations in classrooms (measured in classrooms from studies with 20 or more classrooms) (Source: Fisk[5])

building needs to have an air replacement system employing adventitious and/or controlled air movement. Outdoor air may be introduced by infiltration (through a leaky building envelope), airing (manual operation of openings such as windows and doors) and controlled ventilation (natural, mechanical or hybrid). TM57 highlights that the ventilation should always be available, and that this should include secure night ventilation. Typically, the ventilation solution must provide adequate IAQ that, while minimising heating requirements, should also be configured and integrated to reduce the potential risks of overheating in an energy efficient way and be able meet the need for summer cooling. The authors of TM57 note that common complaints in new schools are that they are stuffy, suffer from overheating, and are under ventilated .

Current regulatory frameworks focus on CO_2 concentrations as an indication of air quality, as it is a useful metric that can be used to estimate ventilation rates, the dilution of pollutants from indoor sources, and the improvement of perceived IAQ. The recently introduced BS EN 16798 1[13] gives three methods (in section 6.3.2) of determining minimum ventilation rates for non residential buildings such as schools to provide a satisfactory IAQ. Each method provides calculation constants (in Annex B3) based on four categories of indoor environmental quality I, II, III and IV (high to low). Calculation in the three methods is based on simple, steady state conditions.

Method one is established on perceived air quality and is provided by the sum of empirically derived, tabulated ventilation rates, based on the number of occupants plus an area based rate (to allow for pollution from the building and the systems). Method two provides a simple formula for the dilution of a contaminant in the air through the introduction of outdoor air. Practically, this would be used to determine the ventilation required to dilute the level of CO_2, based on steady state ventilation (regardless of other contaminants). This requires careful consideration to ensure systems are designed appropriately, as the guesstimates of occupant CO_2 emissions appear to be highly variable. The example data provided in the standard is based on CO_2 emissions of 23.3L h^{-1} per person for a kindergarten it is challenging to find peer reviewed estimates. Method three is based on pre defined ventilation airflow rates (based either on occupant numbers or room area), and is probably the least useful although possibly the simplest method when assessing teaching spaces. It is probably included in the standard as a catch all method to allow application of the standard where local regulations have specific designated ventilation rates. For worked examples, a reliable reference with extended and corrected data and explanations is the interpretation document PD CEN/TR 16798 2:2019.[23]

The recommendations for IAQ, published by WHO,[24] CIBSE, ASHRAE and, in the UK, Building Bulletin 101[25] typically set limiting values of average daily CO_2 concentration to between around 1,000ppm and 1,500ppm, with various restrictions of acceptable peak values. For a category II application, which might be considered appropriate for a teaching space, BS EN 16798 1 suggests a level of 800ppm.

Natural ventilation would always be the preferred option, but constraints of location, occupant density and building configuration will often make this technically challenging to achieve in an energy or cost efficient way or just simply impossible. For example, as reported[26] by Jain *et al*, relating to a study of a London school campus, monitoring indicated increased levels of traffic related pollutants during the heating season, and that this suggests activated carbon filters or other measures are required (in addition to particle filters) that could be coupled with ventilation controls to balance the requirement for fresh air to create a healthier environment while ensuring energy efficiency.

Ventilation is a key component of successful school design and operation. As with most subdisciplines within building services engineering, there is no single solution for how the ventilation should be best achieved. The key deliverable is the quality of the air that is being inhaled by the building occupant. Whether that is assessed by real time monitoring for example, by measuring levels of CO_2 to provide demand led ventilation or by attempting to meet prescriptive minimum ventilation rates, current evidence indicates that, in many cases, ventilation is inadequate and, in all likelihood, may be adversely impacting the wellbeing and performance of the students.

Turn to page 52 for further reading and references. »

'FRESH' AIR?

The quality of outdoor air – which is often referred to in building services as 'fresh' air – will have a significant influence on the ability to ventilate. The World Health Organization (WHO) guidelines[14] for outdoor air quality are becoming more stringent, as illustrated in Figure 1. Outdoor air quality has shown general improvement[15] over recent years, particularly in the 'western' world,[16] as a result of various regulatory and technological measures, with the exception of ground-level ozone,[17] which – as well as increasing in warm weather – perversely increases as nitrogen dioxide (NO_2) levels reduce.[18] However, a changing climate has increased the prevalence of wildfires[19] with their associated particulate matter, wind-carried dust,[20] and uncertainties in ozone levels[21] that can have potentially significant health impacts[22] on building occupants if transferred into the internal space.

Module 189

December 2021

» **1. Which CIBSE TM would probably be of most use when considering holistic design of schools?**

- ☐ A TM 23
- ☐ B TM 37
- ☐ C TM 40
- ☐ D TM 45
- ☐ E TM 57

2. Which of the following air contaminants was not identified in the article as being significant in European internal environments?

- ☐ A Carbon monoxide
- ☐ B Formaldehyde
- ☐ C Nitrogen dioxide
- ☐ D Particulate matter
- ☐ E Sulphur dioxide

3. What is the lowest average ventilation rate discovered by Fisk s research review?

- ☐ A 1L s ^{1} per person
- ☐ B 3L s ^{1} per person
- ☐ C 5L s ^{1} per person
- ☐ D 7L s ^{1} per person
- ☐ E 9L s ^{1} per person

4. By how much have the WHO outdoor air quality guidelines changed in 2021, compared with 2005, on the recommended limit on exposure to ozone (in an eight hour time period)?

- ☐ A Approximately 25% reduction
- ☐ B Approximately 10% reduction
- ☐ C No change
- ☐ D Approximately 10% increase
- ☐ E Approximately 25% increase

5. Across the standards referred to in the article, what is the typical limiting value of average daily internal CO_2 levels?

- ☐ A 410ppm
- ☐ B Below 500ppm
- ☐ C Below 750ppm
- ☐ D Between 1,000ppm and 1,500ppm
- ☐ E Not exceeding 2,000ppm

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Further reading:

The freely downloadable BB101 *Guidelines on ventilation, thermal comfort and indoor air quality in schools* is based on UK requirements, but provides comprehensive guidance that is widely applicable. CIBSE TM57 *Integrated school design* provides very accessible guidance for all members of the design team to bring their understanding of all aspects of building design and performance to influence a more informed design. It also provides a gateway to the myriad of other documents that will provide further knowledge and understanding of this topic. A recent paper by Khovalyg *et al* provides a useful comparison of standards in a *Critical review of standards for indoor thermal environment and air quality* – **doi.org/10.1016/j.enbuild.2020.109819**

References:

1 CIBSE TM57 *Integrated school design*
2 The INDEX project , **bit.ly/CJDec21CPD11**
3 *Air quality and ventilation in schools*, Swegon, 2021.
4 Haverinen-Shaughnessy, U, *et al*, **bit.ly/CJDec21CPD12**
5 Fisk ,W J, **bit.ly/CJDec21CPD19**
6 Chatzidiakou, L, *et al*, **bit.ly/CJDec21CPD20**
7 Toyinbo, O, *et al*, **bit.ly/CJDec21CPD13**
8 Chatzidiakou, L, *et al*, **bit.ly/CJDec21CPD21**
9 Carrion-Matta, A, *et al*, **bit.ly/CJDec21CPD22**
10 Haverinen-Shaughnessy, U, *et al*, **bit.ly/CJDec21CPD14**
11 Clements-Croome, D J, *et al*, **bit.ly/CJDec21CPD23**
12 Wargocki, P, *et al*, **bit.ly/CJDec21CPD24**
13 BS EN 16798-1, BSI
14 *WHO global air quality guidelines*
15 Emissions of air pollutants, **bit.ly/CJDec21CPD1**
16 Air Quality Historical Data Platform, **bit.ly/CJDec21CPD18**
17 Concentrations of ozone, **bit.ly/CJDec21CPD2**
18 Lockdown and ozone levels, **bit.ly/CJDec21CPD3**
19 Hirschlag, A, **bit.ly/CJDec21CPD4**
20 Milford, C, **bit.ly/CJDec21CDP5**
21 Ozone threat from climate change, **bit.ly/CJDec21CPD6**
22 Graham, A, *et al*, **bit.ly/CJDec21CPD10**
23 PD CEN/TR 16798-2:2019 BSI
24 Selected Pollutants, WHO, **bit.ly/CJDec21CPD15**
25 Building Bulletin 101, **bit.ly/CJDec21CPD16**
26 Jain, N, *et al*, **bit.ly/CJDec21CPD17**

Please see online version of this article for full references

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*'Lifetime' represents anticipated lifetime of equipment and is 15 years maximum.
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Product of the month

Spirotech to acquire EDER

Integration will provide synergy benefits and growth opportunities

Spirotech is acquiring the Austrian family business EDER for its technology, knowledge and experience in the field of pressurisation in HVAC installations.

Pressurisation in installations is essential for controlling the quality of the system water and, as a result, for optimising the performance and lifespan.

The two family businesses have been working together for more than a decade. As of 1 January 2022, all pressurisation activities and the employees of EDER Heizung (service provision) and Anton EDER (production and sales) will become part of Spirotech.

The acquisition means Spirotech will strengthen its range of solutions for improving system water quality. This will enable all customers and partners in the HVAC sector to benefit through its global sales network.

The complementary product portfolio, increase in scale and integration of both

organisations will also provide interesting synergy benefits and growth opportunities.

The acquisition will enable EDER to have better access to the global market and to continue its business activities.

EDER sales director Alfred Eder said: 'We chose Spirotech based on our experiences during a decade of collaboration. Like EDER, Spirotech is a family business in which quality provision has been paramount for more than 65 years and where the knowledge and experience of all employees is seen as an important distinguishing asset.'

Spirotech Operations will be responsible for the development, manufacturing and supply chain of the expansion and pressurisation products, while EDER Sales and Service will become part of the Spirotech DACH sales team at Spirotech Commercial.

Hans Jacobs, chief operating officer for Spirotech, added: 'Combining the knowledge and experience of Spirotech and EDER with innovation and the delivery of quality products and services enables us to provide future-proof solutions better and faster.

'The production of the Spirotech range will remain located in Helmond, in the Netherlands, and will be expanded here in the coming years so that we can continue to meet the expected market growth. In addition, we have already purchased additional land in Leisach in Austria to enable us to expand our production capacity for the expected increase in demand for pressurisation products.'

Visit: www.spirotech.com

Priority Demand Valve from Aquatech Pressmain ›

Aquatech's Fire Priority Demand Valve is designed to be fitted to the domestic water branch of any combined domestic water and sprinkler system. In a fire, it stops the domestic water flow, preserving supply for the sprinklers.

It is fitted with battery close and break tank level interlock to meet the requirements of new BS9251:2021.

Visit www.aquatechpressmain.co.uk or sales@aqpm.co.uk

Aliaxis launches new HDPE drainage CPD ›

Aliaxis UK has launched a new CPD – 'The Benefits of HDPE Drainage Systems' – designed to provide best practice advice on specifying and installing Marley high-density polyethylene (HDPE) soil and waste systems.

The CPD explores the background of soil drainage building standards, the drainage systems available, and the benefits of HDPE.

Approved by CIBSE, it also includes considerations when specifying HDPE drainage and information on Aliaxis UK's Marley range of HDPE products.

Visit www.marleypd.co.uk

‹ Service growth at Condair

Humidity control specialist Condair has appointed Ryan Mooney as a humidifier service engineer to provide an even more efficient response time to its customers in the London region. Mooney has many years' experience in the building services and environmental control sectors.

Tony Tullett, service director at Condair, said: 'We are very happy to welcome Ryan to the Condair service team and are proud to be expanding our nationwide network of engineers to 18.'

Visit www.condair.co.uk

Luceco s sweet lighting success

Luceco has recently supplied exterior amenity lighting to the famous village of Bournville. More than 90 Viva-City Pro street lanterns were chosen to illuminate the streets, some with the columns boasting the purple livery of the 'glass and a half' chocolate bar that became the most-popular chocolate consumed in Britain.

Viva-City Pro is a modular, slimline, performance LED street lantern offering a choice of optics. Manufactured from high-pressure die-cast aluminium, the luminaire is IP66 and IK10 rated. It has an efficacy of up to 141 Llm/W and can produce up to 24,000 luminaire lumens at 4,000K with a CRI >70. The range offers 15W–180W power options with 2,062–24,741 luminaire lumens respectively and an operational working life of 100,000 hours.

This celebrated confectionery manufacturer has been inspiring a nation of chocolate lovers for nearly 200 years – a truly sweet success!

Call 01952 238100, email Uk.sales@luceco.com or visit www.luceco.com/uk

Breathing Buildings offers CIBSE approved CPD on school ventilation

Breathing Buildings, a UK provider of controlled, hybrid ventilation systems, is offering a CIBSE-approved CPD on meeting the requirements of BB101: *Guidelines on ventilation, thermal comfort and indoor air quality in schools* and TM52: *The limits of thermal comfort; avoiding overheating*.

This course – delivered by one of the company's experienced ventilation experts – is particularly timely with the current focus on schools and ventilation to improve indoor air quality and help mitigate Covid-19 transmission.

Call +44 (0) 1223 450 060 or email info@breathingbuildings.com

Mitsubishi Electric to stock s MEX range

Mitsubishi Electric is pleased to announce that it is now stocking the entire range of s-MEXT high-precision CRAC (closed room air conditioning) units.

The s-MEXT-G00 DX is a high-precision CRAC unit that connects directly to Mitsubishi Electric's Mr Slim R32 Power Inverter outdoor unit, creating a full inverter split system designed according to the best quality standards. The s-MEXT comes with a three-year warranty across the entire range. All sizes from 6kW to 42kW capacity are available from stock within 48 hours.

The units operate at high levels of energy efficiency and incorporate full Mitsubishi Electric inverter technology and EC plug fans. The s-MEXT contain a small footprint with pipe runs up to 100m, making the s-MEXT an ideal air conditioning unit for all IT cooling needs.

The units are available in both upflow and downflow variants and are perfect for applications where high, sensible cooling and close control of temperature and humidity are required, such as enterprise data centres.

Visit https://les.mitsubishielectric.co.uk/products/it cooling/mitsubishi electric close control systems/s mext dx close control system

From heat pumps to horse power

Pump Technology has developed an optional new control panel for use with its dual pump systems.

Rather than just a single high-level alarm, the additional logic of two, volt-free signals enable the BMS to recognise if either pump fails. In the unlikely event of both pumps failing, then a third common signal will indicate to the BMS to activate the incoming water feed solenoids.

Call 0118 9821 555 or visit www.pumptechnology.co.uk

Creating healthy spaces in buildings this winter

Ventilation specialist Vent-Axia has launched its PureAir Room air purifier to cleanse the air, remove harmful particles, neutralise bad smells and remove pollen and other allergens.

The need for air purification is especially warranted in schools because of the extensive disruption to education caused by lockdowns. Many schools are now using CO_2 monitors, and the government is running air purifier trials to help improve IAQ and reduce Covid transmission. However, hotels and offices can benefit from the same technology to tackle indoor air pollution.

Call +44 (0)344 856 0590 or visit www.vent axia.com/airpurifiers

Downloads from Domus Ventilation

Domus Ventilation, manufacturer of mechanical ventilation systems, is pleased to announce that its full range of Revit building information modelling (BIM) files can now be downloaded directly from its website free of charge.

The Domus Ventilation BIM library features an extensive array of products, including energy-saving, whole-house mechanical ventilation with heat recovery (MVHR) appliances, as well as award-winning Radial semi-rigid duct systems, and its full range of rigid ducting and accessories.

Email vent.info@domusventilation.co.uk or visit www.domusventilation.co.uk

Vent Axia wins at *H&V News* Awards

Vent-Axia has won the 'Domestic Ventilation Product of the Year' award at the *H&V News* Awards for the second year running. This year, the company scooped the award for its 'Lo-Carbon Multivent MEV Family' – a new range of mechanical extract ventilation (MEV) and decentralised MEV (dMEV) designed to help housebuilders meet the Future Homes Standard.

Joe Tse, product manager at Vent-Axia said the company was delighted to have won again.

Visit www.vent axia.com

Elco supplies advanced heating for schools and leisure

Elco Heating Solutions has delivered three Trigon XL 500 boilers to the Ponteland Schools and Leisure complex in Northumberland.

The boilers were chosen because they achieve impressive low NO_x emissions by utilising a commercially proven premix-burner system, which includes a fully modulating, water-cooled cold-flame burner. This is combined with an optimised combustion system and stainless steel heat exchanger to provide a reliable and robust lifetime performance.

Visit www.elco.co.uk

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Tony Day

Electric dreams

CIBSE's new guidance *TM67 Electrification of buildings for net zero* aims to engage building services engineers in the transition from gas to electric heating. Working group chair Tony Day explains how the guide intends to fill the knowledge gaps in this rapidly evolving area

The ability of building services engineers to make a successful transition from gas to electric in the projects they design and operate will determine whether the net zero targets necessary to prevent catastrophic global warming will be met. *TM67 Electrification of buildings for net zero* provides a blueprint for that transition, highlighting the challenges, risks and solutions of moving from gas heating to electric heat pumps in a way that is affordable for everyone. Tony Day explains the aims of the guide (available free to CIBSE members at **www.cibse.org/knowledge**) and how it will evolve in the future.

Why are we talking about electrification now?

Electricity is driving us much closer to the net zero buildings goal, and the carbon intensity of the National Grid has fallen from 529gCO_2/kWh in 2013 to 181 in 2020. With the government s *Heat and Buildings Strategy* confirming that hydrogen is going to be way down the track, electric heat pumps will be the primary way of decarbonising heat.

What is the aim of TM67?

To raise awareness of emerging opportunities and challenges through electrification. It highlights the role of electrification in designing net zero buildings and points out key challenges at generation, network and building level.

The guide presents the latest thinking on system design and operation, and highlights existing guidance. Its focus is on the UK, where high heat demand is mostly met by natural gas, but it will be applicable elsewhere.

Buildings are going to have to be zero carbon for their lifetimes. We have to ask what that will look like, and what we have to do to respond to that need. TM67 doesn t have all the answers, but it asks all the questions.

What are the challenges of electrification?

Electrification brings significant challenges. The 200GW of heat demand in the UK is currently four times greater than electrical peak demand, and we have to transfer all that demand to electricity. If we are going to use heat pumps, we could bring peak demand down by a factor of two to three, but we will still end up doubling electricity demand.

There is also the challenge of providing huge additional loads at peak times. The electricity grid has an uplift of 5 15GW between 5am and 8am, while the gas grid has around 100 115GW of uplift. Those rates would be severely challenging for the electricity network.

We can t just transfer heat from the gas grid to the electricity grid with impunity. We have to do that in a managed, structured way, and the risk and the responsibilities for doing that are going to have to be well understood.

The car will be part of the energy network, but building services engineers don t have much experience of managing EV fleets and integrating charging points into buildings. It will have to be costed and managed.

How will costs be controlled?

We must make sure we don t push the cost to the end user. The costs of a heat pump are significant if you also have to upgrade the building fabric and install storage. We need to be smarter about getting retrofit available at the right cost. We must also focus on reducing energy to keep the bills low. We need to be monitoring and managing heat pumps coefficient of performance. If we allow performance to degenerate too much, heat pumps will be less financially attractive and carbon targets will be breached. Performance monitoring will be really important.

Who will be responsible for the infrastructure?

It s not fit and forget; there will be a lifetime of responsibility for these systems and we may need third party aggregators to manage some of the complexity. Responsibility will be right across the supply chain, and the CIBSE community has to understand what that supply chain looks like and where the complexities arise.

What next?

CIBSE is pulling together best practice and filling in the knowledge gaps as they become apparent. This working group is not over now; this document is the start, and I m hoping that TM67 becomes part of a series by which we fill in those gaps.

EVENTS

NATIONAL EVENTS AND CONFERENCES

SLL Young Lighter 2021 Finals
16 December
The four finalists will each deliver a 15-minute presentation outlining their entry submission, before the judges announce the 2021 Society of Light and Lighting Young Lighter of the Year. The winner will receive £1,000 and a trophy.

The four finalists are: Maria Englezou, María Teresa Aguilar Carrasco, Remedios María López Lovillo, and Verity Rose. For more information and to register for the event, visit **bit.ly/CJDec21SLL**

CIBSE REGIONS AND GROUP EVENTS

Check the website for up-to-date information on regions and groups meetings, webinars and podcasts; visit **www.cibse.org/events**

Joint Christmas Technical Event: HCNE and Spaces: Building Regs
7 December
Presentation by Hywel Davies, CIBSE technical director, covering Building Regulation Part L, the Building Safety Bill and the Golden Thread.

South West: Cladding challenges: an industry perspective legal
7 December
With speaker Tom Weld, from Burges Salmon, providing insight into what can go wrong and the implications for those involved in cladding disputes.

Merseyside & North Wales: 2021 Heat pumps: a year in review and plans for the future
9 December
With speaker Laura Bishop, chair of the Ground Source Heat Pump Association, and director Infinitas Design.

CIBSE Scotland: Chain of infection a reservoir of organisms
14 December, online
Pete Tyson, of the Water Hygiene Centre, will present details on the background to legionella and Pseudomonas aeruginosa, including those who are most susceptible, favourable conditions, and control strategies.

SLL and East Midlands: Webinar Finding darkness with the light
11 January
Exploring the role of responsible outdoor lighting design in confronting the global loss of the night, with speaker Dr John Barentine, principal consultant at Dark Sky Consulting.

CIBSE JOURNAL PODCASTS

In the latest *CIBSE Journal* podcast – 'How heat pumps are changing the future', sponsored by Mitsubishi Electric – consultants and industry experts discuss how heat pumps are transforming heating and cooling.

All *CIBSE Journal* podcasts are available on the CIBSE Soundcloud – at **soundcloud.com/build2perform** – Apple Podcasts and Spotify.

LIVE ONLINE TRAINING COURSES

CIBSE training courses have been reformatted to work online, with a live trainer, meaning you can expect the same interaction and participation as you would in a classroom setting. Upcoming courses:

Heat networks code of practice (CP1)
6-7 December

Mechanical services explained
7-9 December

The importance of energy efficient buildings
9 December

Below ground building drainage
9 December

Electrical services explained
14-16 December

Low carbon consultant design
14-16 December

Emergency lighting to comply with fire safety
15 December

Overview of IET wiring regulations (18th edition)
15 December

Design of ductwork systems
16 December

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STUDENT WEBINARS

14 December
Student webinar for those looking for more information about CIBSE membership. The focus is on the benefits of membership, including resources, societies, events and awards. Each webinar will also include a Q&A.

For details and to register, visit **bit.ly/CJDec21Briefing**

CIBSE JOURNAL WEBINARS

Water source heat pumps and ultra low heat networks for the multi residential sector
This webinar, sponsored by Mitsubishi Electric and now available on demand, explores the future of ultra-low heat technology with multi-residential apartments.

To register for this, and to access all other *Journal* webinars on demand, visit **www.cibsejournal.com/cpd/webinars**

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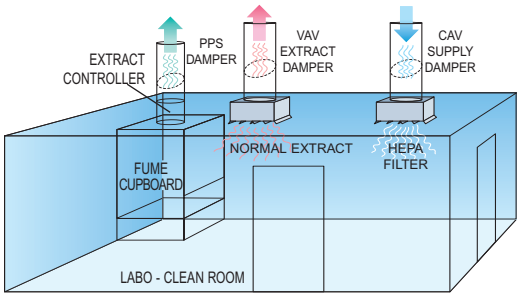

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