cibse Journal

September 2024
www.cibsejournal.com

The magazine of the Chartered Institution of Building Services Engineers

Game changer

Creative teamwork is building an era-defining stadium for Everton FC

The AI revolution in building services

Visualising whole life carbon

How Inkling redefined corporate success

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League leading

Everton Football Club, one of the 12 founding members of the English Football League, will soon boast one of the best stadiums in world football. The 52,888-capacity ground at Bramley-Moore Dock in Liverpool will be completed later this year, ready for the 2025/26 season.

The arena has been designed with the fans in mind with its steeply raked terraces putting the Everton faithful close to the action wherever they sit. The huge Eastern Terrace in particular will be the envy of rival teams. Builders on the project are already likening it to Borussia Dortmund's famous Yellow Wall.

Just as impressive as the stadium's design is its environmental credentials. The all-electric complex features a host of renewable features, and the consultants and contractor Laing O'Rourke have worked closely to reduce predicted energy loads and minimise whole life carbon, in order to reduce the amount of HVAC equipment needed to service the stadium. Most of it was built off site in the factory and Buro Happold made sure its designs were optimised for the contractor's blueprint for manufacture and assembly process.

A single BIM version of the stadium was created using models from all disciplines, and clashes were identified and eliminated at an early stage. As a result, construction has been remarkably quick; the stadium is nearing completion despite having only started on site in 2021.

The digital engineering behind the stadium shows how technology is revolutionising building services. The profession is set to take another quantum leap with the widespread adoption of artificial intelligence. On page 37, experts from four leading consultancies explain how they are incorporating machine learning and neural networks into their working practices. They also identify the risks around its adoption and draw attention to new regulations spearheaded by the EU's AI Act that is providing a regulatory starting point for the technology.

Everton FC is not the only venerable institution embarking on a new look. We hope you like *CIBSE Journal*'s contemporary refresh, and welcome any comments on how we might continue to improve the magazine in the future, either in print or online. ●

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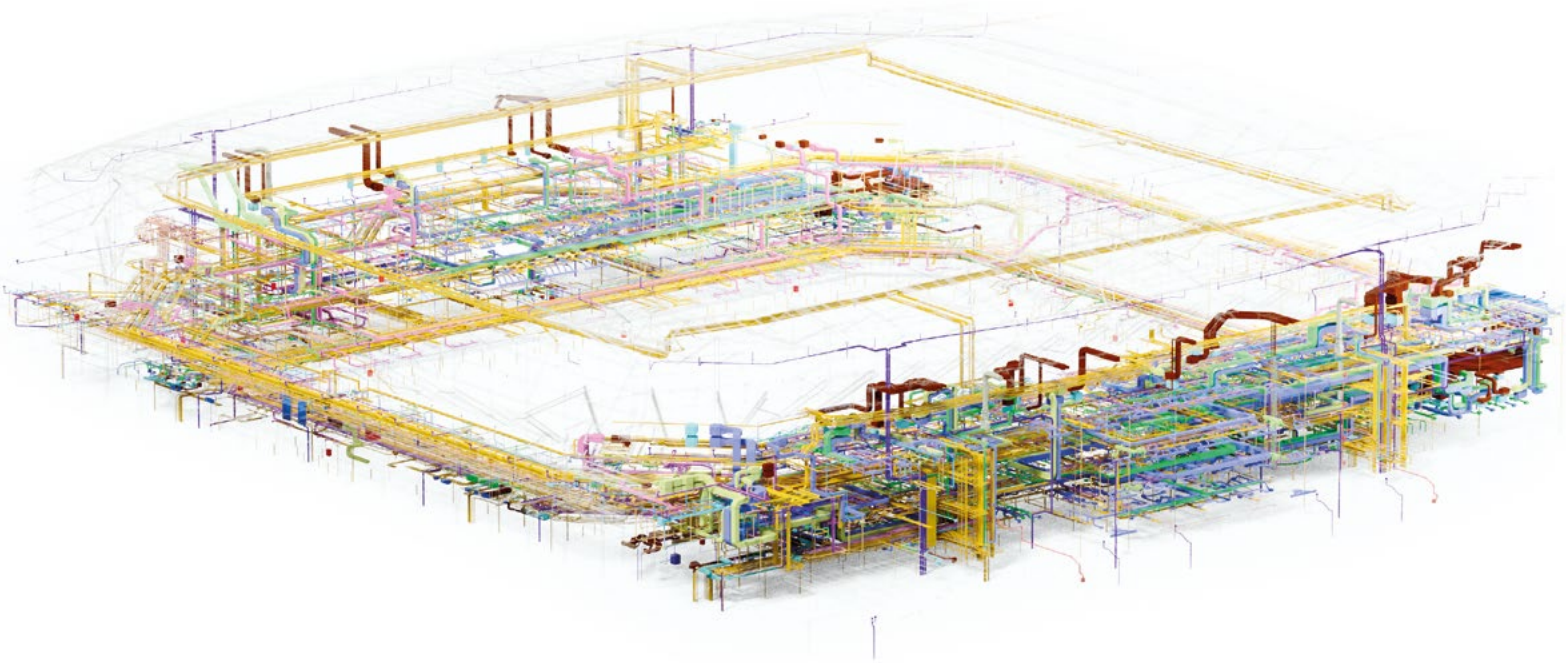

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Key events

Conference

CIBSE Building Performance Reimagined

8 October, Royal College of Surgeons, London

A look into CIBSE's transformative 'Building Performance Reimagined' project, featuring a range of experts from across the industry.
bit.ly/BuildingPerformanceReimagined

Awards

CIBSE Young Engineers Awards

10 October, BMA House, London

The awards celebrate the very best and brightest engineering talent, rewarding young graduates, undergraduates, apprentices and the employers who nurture them.
www.cibse.org/yea

Awards

The SFE Façade 2024 Design and Engineering Awards

6 November, Old Billingsgate, London

The awards recognise excellence and achievement in façade engineering, with new categories to include the Digital Innovation and Special Structures UK and International awards.
www.cibse.org/facadeawards

Exhibition

Build2Perform Live 2024

13-14 November, ExCeL, London

Join forward-thinking industry professionals, visionary speakers and leading industry exhibitors. This year's event will include a new area dedicated to facilities management, Maintain2 Perform, and the return of Light2Perform.
www.build2perform.co.uk

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More professionals now work on net zero projects

Two-thirds worked on net zero schemes in past 12 months – NBS

The proportion of construction professionals who have worked on projects with sustainable targets over the past year has risen substantially, according to a new survey.

The NBS *Sustainable Futures Report 2024*, published on 20 August, shows that 88% of the nearly 500 construction professionals it surveyed had worked on projects with sustainable outcome targets during the previous year. This was up from 70% in 2021, the last time the survey was carried out.

Nearly half (48%), said they worked on projects with sustainable outcome most, and 16% all of the time.

Almost two-thirds (64%) of respondents said they had worked on a net zero project over the past 12 months, compared with just under half in 2021. However, only 15% had worked on net zero projects most or all of the time.

Almost three-quarters (74%) of respondents said at least one of their projects included a requirement to meet a standard, such as Breeam, Leed or Passivhaus.

And some 43% of respondents stated that sustainability is usually or always achieved on their projects – an increase of 10 percentage points compared with 2021.

Professionals from larger firms were more likely to report that they had worked on net zero projects or with sustainable targets.

- The total number of heat pumps certified with the industry's quality mark has passed 250,000, according to latest figures from the MCS (Microgeneration Certification Scheme).
- A new poll shows that 68% of the public support the government's plan to set up its new public-owned Great British Energy company. However, nearly two-thirds (61%) of those polled by YouGov for the Energy and Climate Intelligence Unit do not believe the government's energy and climate policies will lead to lower bills.

Worcester Bosch revises boiler advert claims after CMA probe

The Competition and Markets Authority (CMA) has secured formal commitments from Worcester Bosch to not make 'misleading' marketing claims about the hydrogen-readiness of the company's boilers.

The consumer watchdog announced an investigation last year into whether Worcester Bosch had misled shoppers with 'confusing or inaccurate' claims in the advertising and labelling of its boiler products.

The CMA has closed the investigation after the company formally committed that its marketing material will not mislead consumers on the environmental benefits and future-proofing of its boilers.

The watchdog expressed concern that Worcester Bosch's claims could give the false impression that buying the company's boiler, described as 'hydrogen-blend ready', would enable consumers to reduce their carbon footprint and future-proof their heating system. It said consumers would be in the same position with other boilers on the market.

In addition, the CMA was concerned that Worcester Bosch did not make clear to consumers the uncertainties surrounding whether hydrogen might be used for home heating in the future.

Hayley Fletcher, interim senior director, consumer protection at the CMA, said: 'Our action – including the changes secured from Worcester Bosch – will help to ensure that consumers looking for a new heating system are provided with clear and accurate information.'

UK construction sector hits fastest growth in two years

Statistics for July show a surge in new orders and increased activity across all key areas

The UK construction sector grew at its fastest pace in more than two years during July, according to new statistics.

The latest S&P Global/CIPS UK Construction Purchasing Managers' Index (PMI), published on 6 August, rose 'sharply' from 52.2 in June to 55.3 in July.

The reading signalled a 'marked' monthly expansion in total activity in the sector, extending the recent sequence of growth to five months.

Also, the rate of expansion seen in July, was the fastest recorded since May 2022. All three categories of construction saw activity increase in July.

Work on housing projects returned to growth while commercial activity increased 'solidly', the index shows.

New business expanded for the sixth month running and at the 'strongest' pace since April 2022, it said.

Success winning new orders was the 'main factor' leading to a rise in construction activity at the start of the third quarter, according to S&P's respondents. Staffing levels increased for the third consecutive month, and at the fastest pace for a year.

The growth in input costs was the 'joint-fastest' seen in 14 months, equal with that seen in January, although still at a relatively low level.

Andrew Harker, economics director at S&P Global Market Intelligence, said: 'The election-related slowdown in growth seen in June proved to be temporary, with the pace of expansion roaring ahead in July.'

Noise from multiple ASHPs minimal, finds study

The cumulative noise impact in built-up areas of multiple air source heat pump (ASHP) installations is not 'significantly greater' than that of a single such device in a neighbour's garden, according to new research.

The noise-modelling study, carried out by consultants Apex Acoustics, was commissioned by the innovation agency Nesta to investigate the potential adverse effects of cumulative ASHPs operating in high-density residential areas.

Cumulative noise remains comparable to typical urban ambient noise levels and is expected to remain lower than the nuisance from transport, suggesting 'minimal' adverse effects on the public.

CIBSE scheme verifies embodied carbon product claims

The first two firms have received Embodied Carbon Verification (ECV) certification for products under a new CIBSE scheme.

Certification was awarded to Crane Fluid Systems for its Pressure Independent Control Valve DN15–DN50 product range, while Culligan Commercial UK, received it for its ClearScale Plus CCP product range.

The scheme demonstrates manufacturers' commitment to sustainable practices.

● **Visit bit.ly/4dR2gmv**

Concerns over Scottish energy efficiency proposals

Scotland's proposed new buildings energy efficiency standard would be obsolete before it comes into force, because it does not require onsite renewables, solar energy companies have warned.

The Scottish government has published a consultation on a new set of building regulations, including proposals for a Passivhaus equivalent policy.

Solar Energy Scotland says the regulations are out of step with an EU standard, introducing requirements for solar panels on most new buildings by 2029.

Heat pump installs 'off track'

The increase in the number of heat pump installations last year was 'significantly off track', the Climate Change Committee (CCC) has warned.

A report assessing the UK's progress on meeting climate change targets notes that the level of heat pump installations only increased by 4% compared with 2022, from 58,000 to 60,000.

However, a 62% increase in applications for the Boiler Upgrade Scheme in the first four months of 2024, compared with the same period in 2023, offers more 'promising signs'.

Call for radical action to decarbonise heat

Report says UK must make decarbonisation of power a national mission on par with vaccine rollout

A strategic decision on the decarbonisation of heat in buildings must be made 'as quickly as possible' as part of a 'radical shift' to decarbonise the UK's power system, a heavyweight new report has urged.

Compiled by an independent working group led by the Royal Academy of Engineering, the *Rapid Decarbonisation of the GB Electricity System* study says the UK must put the power system's decarbonisation on a par with the 2021 Covid-19 vaccine rollout as a national mission.

The report's working group, which includes recently appointed Science Minister Lord Vallance, says the new government's mission to accelerate the phase-out of fossil fuels from the electricity grid from 2035 to 2030 'cannot be met simply by accelerating along the path we are currently on, but will require a radical shift of approach. A plan is needed quickly, prioritising pace over perfection'.

The report says that strategic decisions on the decarbonisation of buildings' heat should be made 'as quickly as possible' to provide clarity on the UK's ambition for heat pumps and the long-term capacity required by the distribution network.

It states this will allow the distribution network to be future-proofed when planning connections for housing developments to cater for future installations of heat pumps.

The report advocates a much more 'proactive' approach to procuring grid infrastructure.

It states: 'The existing approach, which relies on competition to drive down prices, is no longer fit for purpose as the pace and scale of change increase radically and as we enter a more competitive world.'

King's Cross among projects vying for Stirling Prize

The second phase of the regeneration of Sheffield's listed Park Hill council estate is up against the masterplan for the regeneration of King's Cross and the Elizabeth Line on the shortlist for this year's RIBA Stirling Prize.

They are among six projects in the running for the annual award, which has recognised Britain's best new architecture since 1996.

The other shortlisted projects are the remodelling of the National Portrait Gallery, and Wraxall Yard, the conversion of a Dorset farm into holiday homes for disabled people. The winner will be announced on 16 October.

Read 'An engineer's guide to judging the RIBA Awards' by Mike Burton FCIBSE at bit.ly/4dsPhaQ

Public energy company to drive UK decarbonisation

King's Speech included bill to set up Great British Energy

The Labour government has made the establishment of a state-owned Great British Energy (GBE) company one of its first legislative priorities. A bill to set up GBE was included in the King's Speech, which outlined the government's legislative programme for the year ahead.

The speech, delivered on 17 July by King Charles, announced that the Great British Energy Bill will establish a publicly owned clean power company with its HQ in Scotland. Background notes confirmed that GBE will take a stake in renewable energy projects and supply chains. It is 'highly unlikely' the private sector can deliver the scale and pace of investment required to meet the government's 2030 mission to decarbonise the electricity system, according to the document.

A public energy company, combined with additional electricity market reforms, could help mitigate existing market failures and increase the speed, and reduce the cost of deploying renewable generation capacity, it added.

The speech also included a Planning and Infrastructure Bill to streamline the process of delivering 'critical' projects, such as upgrades to the National Grid and a push for more renewable energy, helping to 'unlock' delivery of the government's 2030 clean power mission.

This bill will also simplify the consent process for major infrastructure.

Chris Stark leads government's zero carbon mission

Ex-Climate Change Committee (CCC) chief executive Chris Stark has been appointed to head the new body being set up to spearhead the government's mission to decarbonise the electricity system by 2030.

In his first act following Labour's general election victory, energy security and net zero Secretary of State Ed Miliband announced on 9 July that Stark will lead the Mission Control central body. This will consist of a team of industry experts and officials to troubleshoot obstacles hindering rollout of Labour's 2030 target, such as connecting new power infrastructure to the Grid.

Stark led the CCC from 2018 until earlier this year.

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CIBSE announces key sessions for Build2Perform Live

CIBSE has confirmed the first speakers at the building service industry's leading show Build2Perform Live 2024, which is taking place at ExCeL London on 13–14 November.

The event begins with a keynote speech by Vince Arnold, CIBSE President Elect, on 'Building Performance Reimagined', setting the stage for two days of insightful discussions.

Seminars have been confirmed on best practice for heat pump design, equality, diversity and inclusivity, and noise and vibration control for net zero technologies

The newly formed CIBSE Education Guild is hosting a session on developing the expertise of the next generation of engineers; another, chaired by UCL's Mike Davies, will examine the evolving landscape of environmental, social and governance frameworks.

A healthcare session hosted by the CIBSE Healthcare Special Interest Group will explore the application of Germicidal UV (GUV) devices as a vital tool for infection control. The speakers will delve into the role of GUV air cleaners in enhancing ventilation systems (see page 47).

The event for the building services sector offers more than 70 hours of cutting-edge content and 100+ exhibitors, featuring the latest trends and technologies that are reshaping the industry.

To register for Build2Perform Live 2024 visit www.build2perform.co.uk

Cundall founding partner Rick Carr dies

Rick Carr, one of Cundall's five founding partners, has died at the age of 78.

Alongside Michael Burch, Geoffrey Cundall, David Gandy and Bernard Johnston, he founded the practice in Newcastle in 1976.

In a tribute, the company said Carr played an instrumental role in the practice's global growth, establishing its London office with Laurie Clark in 1981 and developing relationships with key clients, architects and project managers in its early days.

A popular figure in the industry, Carr helped Cundall win a wave of high-profile projects, including the West Ferry Printworks. He was also instrumental in helping to deliver the Millennium Dome project.

Remembering his close colleague and mentor, partner David Dryden, said: 'It was this ability to find a way to make everyone he met want to work with this unassuming Geordie lad, and his amazing capacity to retain names, faces and relationships, allied with a well-concealed drive to succeed that set him apart.'

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CIBSE Certification expands to include occupational health and safety management

CIBSE Certification has extended its UKAS accreditation to include occupational health and safety management system certification.

In addition to ISO 50001 Energy Management, ISO 14001 Environmental Management and ISO 9001 Quality Management, CIBSE Certification will soon offer accredited certification for ISO 45001:2018 Occupational Health and Safety.

The launch of Embodied Carbon Verification services earlier this year, plus its appointment as the administrator of Nabers UK from April, further establishes CIBSE Certification as the leading certification partner for organisations committed to better-performing buildings, whole life carbon reduction, safety, and health and wellbeing. Kieran O'Brien, director of CIBSE Certification, said: 'We are excited to broaden our certification offerings to better serve our clients and the built environment. By expanding our capabilities to include occupational health and safety certification, we are enhancing our ability to support organisations striving for excellence in performance, safety and sustainability."

CIBSE Certification supports more than 1,100 competent professionals with registration and ongoing technical support. The development of the Energy Savings Opportunity Scheme propelled its expansion into management system certification.

CIBSE Certification has now broadened its capabilities again to help manufacturers and building owners measure and manage their whole life carbon footprints more effectively. For more information visit **www.cibsecertification.co.uk**

Belfast to host CIBSE YEN Gala

CIBSE YEN Northern Ireland is proud to be hosting the 2024 Global Young Engineers Network Gala on 15 November, at the Titanic Hotel Belfast.

The event is supported by Alternative Heat, Nuaire, Bennett Freehill and Semple & McKillop.

Join us for an evening of celebration for young engineers and the chance to connect and bond with peers.The evening includes dinner, speeches and entertainment. Individual and table tickets are available to book at **www.cibse.org/what-s-on/yen-gala-2024**

Contact yen@cibse.org for more details

CIBSE YEN Gala 2023

YEN North West attracts 100-plus to summer social

CIBSE's YEN North West (NW) hosted its second summer social in Manchester in June, welcoming more than 100 students, engineers and consultants. The event was supported by Geberit, Trend Control Systems, Mitsubishi Electric, Helvar and Flowtech.

Speaking at the event, YEN NW chair Biatur Mandia emphasised the importance of volunteering to develop confidence, build a network and give something back.

YEN NW's reach is expanding, with events selling out and a good balance of early career professionals, students and senior people.

The group has a series of events lined up, including a walk in the Peak District, a factory tour, a heat network workshop, and a Viega World journey. Events are at the CIBSE YEN NW LinkedIn page.

Have your say on plans for data centres group

A proposal to establish a Special Interest Group for data centres has been submitted to the CIBSE Technology Committee.

The group would enable engineers from across the industry and specialisms to share ideas and knowledge on how to deliver energy-efficient practical design solutions for data centres, providing sustainable networks.

The digitalisation of society relies on data centres – from hyper-scale to edge facilities – and their power consumption and distribution arrangements will need to be reviewed.

Research will need to be undertaken in the context of reducing power and providing off-grid solutions for the 21st century, using a mix of onsite renewables, static and dynamic uninterruptible power supplies and demand-side management and critical controls.

● Visit bit.ly/4dqXoF6 for more details. Members can comment at groups@cibse.org by 20 September.

Heat networks grant funding extended

CIBSE Training has announced an extension to grant funding from the Department for Energy Security and Net Zero, which provides up to £500 towards select training courses on heat networks. The initiative aims to enhance knowledge and skills in this crucial area.

There is a grant of up to £500 for the following courses: Heat Networks Code of Practice full course, and Introduction to Heat Networks and Code of Practice.

Grants are eligible for those based in England. Individuals qualify for one grant only.

● For more information and to apply, visit: bit.ly/3M4psIt

Members urged to respond to three consultations

Last chance to comment on proposals for planning reform, retrofit assessments and Scottish Passivhaus

CIBSE Members are being encouraged to respond to three consultations on planning reform, retrofit assessment standards, and the principles behind the Scottish equivalent of the Passivhaus standard.

BS 40104 *Retrofit assessment for domestic dwellings – Code of practice* **bit.ly/3YDk6VH** provides recommendations and guidance for the retrofit assessment of domestic dwellings in the UK. The deadline to contribute to CIBSE's response is 8 September, and the consultation closes on 22 September.

A consultation on the proposed reforms to the National Planning Policy Framework (NPPF) and other changes to the planning system closes on 24 September. The deadline to contribute to CIBSE's response is 10 September. **bit.ly/3SGVyHE**

This consultation seeks views on the government's proposed approach to revising the NPPF to achieve sustainable growth in the planning system. It is also seeking views on a series of wider policy proposals to increase planning fees, local plan intervention criteria and appropriate thresholds for certain Nationally Significant Infrastructure Projects.

A consultation on determining the principles for a Scottish equivalent to the Passivhaus standard closes on 23 October; the deadline to contribute to CIBSE's response is 2 October.

The Stage 1 consultation is the first of two that will consider the technical, commercial and wider policy implications of improvements to Building Regulations in the context of broader action by the Scottish Government on tackling climate change **bit.ly/4cj5wpy**

For details of all current open consultations, visit the CIBSE website at bit.ly/4cqBEb5

Holley wins travel bursary to study low carbon heat

Mechanical engineer at Buro Happold Engineering William Holley has been awarded the 2024 Ken Dale Travel Bursary for his proposal 'The transition to low carbon heat – a holistic investigation into the integration of heat pump technology into the built environment'.

Holley plans to travel to Germany, Finland, China and Japan to develop comprehensive case studies to help provide a deeper understanding of how to integrate heat pumps into projects effectively.

Holley said: 'I'm really looking forward to exploring my topic. My goal is to present design guidance and cutting-edge case studies from around the world.'

The Ken Dale Travel Bursary makes awards of up to £4,000 to CIBSE Members in the developmental stage of their career who wish to spend three to four weeks outside their own country researching aspects connected to their work. Candidates are shortlisted based on their proposals, and final selections are made after presentations by shortlisted candidates during the interview stage.

For more information, visit www.cibse.org/kendale

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CIBSE publishes deep dive into retrofit

A new publication investigating how 10 housing projects are performing 10 years after their retrofit has been published by CIBSE. The *Retrofit Revisit* report was written by Marion Baeli, principal, sustainability transformation at 10 Design, and Julie Godefroy, head of net zero policy at CIBSE, and supported by Innovate UK and Historic England, as well as project partners, including Studio PDP.

Despite small fluctuations in performance over a decade, the report finds that retrofitted residences outperform non-retrofitted housing stock overall. Godefroy said: 'When done well, retrofit provides huge energy savings, as well as comfortable homes. I hope this will encourage additional studies, to gather lessons on more retrofit typologies and larger samples, and give confidence to industry and policy-makers to implement retrofit at scale.'

● Read about the research in 'A model retrofit', *CIBSE Journal*, March 2024. Download the report at bit.ly/3X3nliu

Call for 2025 nominations for officers, Board and Council members

New CIBSE officers, Board members and Council members take office from the AGM in June each year.

The CIBSE Board is the governing body of the Institution. It is made up of seven officers (President, president-elect, three vice-presidents, honorary treasurer and immediate past president) and five elected members.

The vice-presidents and honorary treasurer are appointed by the Board, but the president-elect and board member positions are subject to election if there are more candidates than vacancies.

The Council of the Institution is a much larger consultative body, which advises the Board on CIBSE policy. It includes several elected members, in addition to representatives of all Groups, Regions, Societies, and Standing Committees.

There are usually three vacancies for candidates each year, as the elected members rotate through their three-year term.

CIBSE members are invited to propose candidates for the positions of president-elect, Board members and Council members to take office at the AGM in June 2025.

All suggestions received will be considered by the CIBSE Nominations Panel, and the Board will consider the Panel's advice before deciding which candidates to recommend for the vacancies. Any candidates nominated to the Panel but not recommended by the Board may also choose to go forward for election, subject to obtaining the support of 10 corporate members, in which case a ballot will be held.

Members may put themselves forward for consideration or suggest colleagues who are willing to be considered and who meet the eligibility requirements.

Further information on the process, role descriptions and eligibility requirements can be found on the CIBSE website at www.cibse.org/nominations, deadline 14 October.

Training

New: The Electrification of Heat
13 September, Garfield House, Edgware Road, London
With the phase-out of gas boilers, heat pump technologies will play an ever more important role in heating. The aim of this new course is to help design engineers, installers and energy managers develop some of the skills and expertise required to engage with confidence in the electrification of heat through the use of heat pump technologies.

It will cover: thermodynamic principles of heat pumps; understanding the technology; application and system integration; how to size and specify heat pump systems; and how to estimate carbon savings.

As an introductory offer, use the code 'NewTraining10' to get 10% off standard and member rates. Visit **bit.ly/46DROMG**

For full details and booking:
www.cibse.org/training

Energy management system
4 September

Mechanical services explained
10 September
1 October

Building services explained
10 September
8 October

The electrification of heat
13 September

Electrical services overview
16 September

Low and zero carbon energy technology
17 September

Heat networks Code of Practice (CP1)
17 September
29 October

Low carbon consultant building operations
18 September

Designing water-efficient hot and cold supplies
18 September

Commissioning Code M: Commissioning management
19 September

Design of heating and chilled water pipe systems
19 September

Introduction to the Building Safety Act
24 September
29 October

Low carbon consultant building design
24 September

Fire safety building regulations: Part B
24 September

Energy Savings Opportunity Scheme (ESOS)
25 September

Design of ductwork systems
25 September

Energy surveys
26 September

Advanced simulation modelling for design for performance
26 September

Part O Overheating
27 September

Earthing and bonding systems
1 October

Below-ground building drainage
2 October

ISO 50001:2018 Energy management system/low carbon consultant
8 October

Electrical services explained
8 October

Introduction to heat networks code of practice
9 October

Low carbon consultant building design
15 October

Heat networks Code of Practice (CP1) short update
16 October

Fire safety building regulations: Part B
16 October

Air conditioning inspection
17 October

Overview of IET wiring regulations
17 October

Energy strategy reports
22 October

Mechanical services explained
22 October

DEC theory and ORCalc software training
23 October

Mentoring skills workshop
31 October

From left: Dr Shazia Ali, senior lecturer in energy and building services at LSBU, Peter Anderson, CIBSE Council Member and managing partner at Troup Bywaters + Anders, Edythe Qua, and Ruth Carter, CIBSE CEO

Fan Makers' CIBSE Bursary goes to 'exceptional' Qua

Apprentice Edythe Qua has been awarded a CIBSE Bursary from the Worshipful Company of Fan Makers.

Qua has just finished the first year of an engineering degree at London South Bank University (LSBU).

Peter Anderson, who leads the bursary programme for the Worshipful Company of Fan Makers, said she was awarded the bursary because she showed exceptional ambition and drive through self-motivation, built around an interest in building modelling and performance.

The Worshipful Company of Fan Makers presents a CIBSE Bursary every year to the young engineer who it believes has the potential to make a significant difference to our industry and wider society in the future.

In September

Webinar

Membership webinar: two-part series

10 and 17 September, Online

Two-part webinar series for membership applicants of Associate (ACIBSE) and Member (MCIBSE) grades, covering the application process and routes to achieve IEng and CEng registration.

bit.ly/CIBMemWeb

Conference

SoPHE Technical Conference – rainwater

19 September, London

A discussion on rainwater collection, reuse and disposal, and the challenges of design, from climate change through to final disposal.

bit.ly/SoPHETechnicalConference

Regional event

Decarbonising and reducing bills with smart technology

17 September, Newcastle upon Tyne

Nigel Banks, technical director at Octopus Energy, looks at the impact of renewable energy on zero bills and low-carbon homes.

bit.ly/octopuscpd

Health benefits of decarbonising HVAC

Medical facilities need HVAC systems that offer comfort and energy efficiency while reducing carbon emissions, says Graham Temple

Today's medical facilities place differing demands on the equipment used to heat, cool and ventilate them, yet these essential building services can deliver far more than just comfort.

Whether the building is a doctor's surgery, a research laboratory, a care home or a hospital complex, facilities managers need to keep running costs to a minimum, while making sure the building complies fully with legislation and stays productive and operational all year round.

More than 40% of the UK's carbon emissions come from buildings, so if we are to achieve ambitious carbon reduction targets, improving efficiency levels is paramount.

How we heat, cool and ventilate buildings is often the largest draw on energy use, so even small improvements can have a significant effect in reducing total consumption.

Facilities managers need complete flexibility of equipment design and installation, to enable accurate temperature control, alongside comfort, safety and reliability. HVAC Systems, therefore, need to deliver: constant, stable temperatures; energy efficient fresh air; high-temperature hot-water production; whisper-quiet operation; remote monitoring; and ease of maintenance.

Devon Partnership NHS Trust needed to replace an ageing heating and cooling system at a secure hospital facility in Langdon Hospital with a reliable and sustainable, low carbon solution. The unreliable existing units needed a suitable replacement that could not only cope with saline in the sea air, but also had a strong emphasis on energy efficiency, reliability and in-built resilience.

It also needed to be fitted and supported by a manufacturer that could deal with every aspect of the design in a secure, restricted facility, and cope with the M&E and plumbing installation involved in the onsite works.

The solution involved three e-series EAHV1500 YCL modular heat pump units for the heating and two e-series EACV1800 YCL modular chillers for the cooling, with Mitsubishi Electric providing full mechanical, electrical, and plumbing design, and an extended seven-year warranty and full-service and maintenance contract.

Find out more at bit.ly/MitsubishiHealthcare

Graham Temple is marketing manager at Mitsubishi Electric

How to beat the heat

As UK summer heatwaves bring prolonged extreme temperatures, managing home overheating has become a national priority. **Dr Zoe De Grussa** had the opportunity to shares CIBSE's advice on staying cool on national TV and radio

The threat of overheating in buildings because of the changing climate continues to feature as one of CIBSE's priority concerns. This summer, I was invited to speak to BBC News about the best ways people can keep cool in their homes.

Top of the list of my recommendations for managing overheating in homes was external shading, followed by effective window-opening strategies, good cross-ventilation, and minimising heat gains from home appliances such as ovens, washing machines and dishwashers.

During the interview, I met Marion Baeli from 10 Design who gave me a tour of her home that she is retrofitting to Passivhaus Standard. She said that 'whenever we have friends coming around in a heatwave, they think we have air conditioning [here] because the difference is so big between outside and inside [temperatures]'.

Within the retrofit, she has incorporated mechanical ventilation, external shading in her loft conversion, and has plans to install a ceiling fan in one of the main bedrooms. She also wants to incorporate more external shading in other rooms but, in the interim, is hanging dust sheets on the outside of her newly installed tilt-and-turn windows (which provide a large openable area).

Research from University College London has determined that external shading and energy-efficient retrofit measures can reduce heat-related morbidity by up to 52%[1] ,depending on weather conditions experienced.

Given that by the mid-century it is estimated there will be around 10,000 deaths related to heat exposure[2], passive measures offer a great opportunity to protect people's comfort, health and wellbeing while simultaneously reducing carbon emissions related to cooling.

The Environmental Audit Committee[3] highlighted how in 2022 and 2023 coal-fired power stations were 'fired up once more' to meet the UK's electricity demand for cooling.

"There is poor understanding of how to operate homes during heatwaves"

This has the potential to undo the good work already done in reducing carbon emissions from the built environment and why it is vital to design buildings to ensure they can adapt to the more frequent, longer, and intense heatwave events we are going to experience in the future.

In my interview with BBC Radio 4's *You and Yours*[4], I gave myth-busting advice on how to operate windows during heatwaves. I advised against opening them when temperatures were warmer outside than in, and instead opening them when it was cooler outside. This important factor is frequently overlooked and stems from a poor understanding of how to operate our homes during heatwaves.

During the interview, I spoke to two homeowners – Joshua who lives in a new build (pre-Part O) in Bedfordshire, and Hannah who has a poorly insulated Victorian end-terrace in Warwickshire.

Both had overheating issues and were unaware of the role insulation plays in keeping buildings cool in summer. I explained how improving insulation levels helps homes in winter keep the heat in and energy bills low, and helps keep heat out by protecting the thermal environment contained within them – like a vacuum flask.

However, well-insulated homes are susceptible to overheating from increased solar gains through large, glazed areas. If glazing is not well-managed with shading, it can cause a thermal imbalance inside.

The reality is that, in many existing homes, it may be difficult for occupants to keep all rooms comfortable all day so it might be necessary to move around your home using the coolest parts throughout the day.

For example, in my own home, which is east-west facing, I often work downstairs in the west side of my home in the morning, and retreat to the east in the afternoon. ●

● **Dr Zoe De Grussa is research manager at CIBSE**

Updates to CIBSE Weather Files and *TM59 Design methodology for the assessment of overheating risk in homes* will be launched at Build2Perform Live www.build2perform.co.uk

References:

[1] Comparison of built environment adaptations to heat exposure and mortality during hot weather, West Midlands region, UK (2018) **bit.ly/3Xc4bfV**
[2] Health Effects of Climate Change in the UK: state of the evidence 2023 **bit.ly/4dsFFNp**
[3] Environmental Audit Committee, *Heat resilience and sustainable cooling* Fifth Report of Session 2023–24 (2024) **https://bit.ly/3Ax0w3z**
[4] *You and Yours*, BBC Radio 4, **bit.ly/3WWQ8JO** (Starts at 33:09).

CIBSE BUILDING PERFORMANCE AWARDS 2025

ENTRIES EXTENDED

The CIBSE Building Performance Awards are back for their 18th year with over 20 categories to recognise and celebrate engineering excellence in the built environment.

These awards, reward the people, products and projects that demonstrate engineering excellence in the built environment.

Extended entry deadline: 13 September 2024

View all BPA categories

cibse.org/BPA

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Why competence is key

The Building Safety Act introduces new requirements for engineers to demonstrate competence on the buildings on which they work. CIBSE President Elect Vince Arnold FCIBSE discusses the initiatives by CIBSE and others to raise standards

Many of us will have just returned from our summer holidays by plane, and will be comforted to know that the pilot up front passed the standard training for an Airline Transport Pilot Licence. The pilot would then have gained a 'type' rating specifically for the aircraft type on which you flew, and then have to pass regular re-testing and medicals. Quite reassuring as the pilot reaches V1 on the runway and lifts off from terra firma.

For many years in our industry, standards of how to demonstrate competence using skills, knowledge and experience have been applied. Examples include the UK Standard for Professional Engineering Competence and Commitment (UK-SPEC)[1], published by the Engineering Council. This document, and the supporting guidance, is used daily by professional engineering institutions (PEIs) to assess applicants for registration as chartered engineers, incorporated engineers or engineering technicians.

The publication of the Building Safety Act[2] had a far-reaching and necessary impact on our Industry, and includes regulations and requirements around managing competence.

In her Grenfell report, Dame Judith Hackitt found it unacceptable that managers were not assessing the ongoing competence and development of their staff.

The regulations include a general requirement that everyone working and maintaining buildings must be competent to do what they do.

To support engineers tasked with demonstrating their competence in a more rigorous way, the Engineering Council, together with PEIs and volunteers, have developed a new, higher-level approach to the competence required for those working on higher-risk buildings (HRBs, as defined in regulations).

"Assessing competence by evidencing professional status alone is not sufficient"

The role of Accountable Persons and Principal Accountable Persons have been created, and they are responsible for managing safety risks.

UK-SPEC has been amended to form a further publication, *The UK-SPEC Contextualised for HRBs*[3]. This is supported by a number of discipline annexes designed to provide specific standards for the various industry roles (in a similar way to the pilot gaining their 'type rating').

CIBSE holds a licence to assess engineers against the new HRB standard by including reference to the building services discipline annex[3].

The new contextualised registration assessment for engineers presents a real opportunity for those involved in building work on new or existing HRBs. Under the *Construction (Design and Management) Regulations* clients already have a legal duty to assure themselves that those they engage on building work are competent to do so.

In my experience, I have had to remind clients that assessing competence by evidencing professional status alone is not sufficient. It is important that clients take into account the specific project for which they are engaging resources, and record how and why they made their decision.

It will be no different for those on the HRB register. It should, after all, be part of our professional duty to identify where clients might be misunderstanding the competency evidence requirements on all projects.

For non-engineers working in the built environment, similar arrangements are in place, managed by their professional bodies. In addition, the British Standard BS 8670 *Core criteria for building safety competence frameworks*[4], supported by Publicly Available Specifications[5,6,7] is available for wider industry use. ●

See CIBSE's Intoduction to the Building Safety Act course at bit.ly/BStrain

● **Vince Arnold FCIBSE is CIBSE President Elect**

References:

[1] UK-SPEC, Engineering Council UK
[2] The Building Safety Act 2022
[3] *UK-SPEC Contextualised for Higher-Risk Buildings* (and discipline annexes), Engineering Council UK
[4] BS 8670 – *Core criteria for building safety competence frameworks*
[5] PAS 8671:2022 *Built environment – Framework for competence of individual Principal Designers – Specification*
[6] PAS 8672: 2022 *Built environment – Framework for competence of individual Principal Contractors – Specification*
[7] PAS 8673:2022 *Built environment – Competence requirements for the management of safety in residential buildings – Specification*

(From left) Inkling founders Dr Claire Das Bhaumik and Susie Diamond, with recent recruit Marcus Haydon

Inkling's script for success

With a culture of knowledge-sharing and collaboration, Inkling has risen to become a key influencer in the built environment. Alex Smith speaks to co-founder **Susie Diamond** about how a three-person team can pack such a punch

Inkling was a standout winner at the 2024 CIBSE Building Performance Awards (BPA), where it won the category for Building Performance Consultancy of the Year (up to 50 employees). The company has made a remarkable impact in the building services industry, leading a wave of innovative initiatives designed to future-proof the built environment.

The judges said Inkling was an 'influential node in industry, which uses collaboration as a means to advocate positive change'.

Its prolific work for, among others, CIBSE, LETI, and the Net Zero Carbon Buildings Standard positions it at the vanguard of industry transformation.

Founded in 2011, Inkling is a building physics consultancy that champions the role and value of dynamic thermal modelling in improving building performance. The founders, Susie Diamond and Dr Claire Das Bhaumik FCIBSE, were joined this year by a third team member, Marcus Haydon MCIBSE.

The firm's mission is to broaden and deepen its skills and knowledge, and share expertise with peers and the wider industry through various voluntary endeavours. It has been active in CIBSE for more than 20 years. 'We try to be outward looking and engaged,' explains Diamond. 'It's really valuable to meet people and get a sense of what's going on. Often people become siloed within organisations'.

Diamond and Das Bhaumik have authored key technical documents and are familiar figures on the conference circuit and regularly host CIBSE events. They present papers at CIBSE's Technical Symposium, which are often the result of a collaboration with partners outside their field of knowledge (see page 52). Their willingness to look beyond their area of expertise as modellers encapsulates Fiona Cousin's Presidential call to approach engineering challenges holistically.

Diamond is on the authorship panel for *TM59 Design methodology for the assessment of overheating risk in homes* and is collaborating

"The firm's mission is to broaden and deepen its skills and knowledge"

with CIBSE, Arup and Loughborough University on an update to TM59. Her expertise on overheating extends to Approved Document O, which assesses overheating risks in new homes.

Inkling has disseminated information about the new regulation through blogs, talks, discussions with housebuilders, and publications for the Future Homes Hub among others.

Das Bhaumik is helping to drive adoption of the Nabers UK building performance standard. She is on the Nabers UK Independent Design Review Panel and has finished CIBSE's Advanced simulation training for Nabers UK course.

The designers of Eden, New Bailey – the UK's first new building to achieve a 5.5-star Nabers UK Design for Performance target rating – said Inkling was 'invaluable in steering the project through the IDR [independent design review] process' and provided 'valuable guidance on the design, modelling and operation of the building, to enable it to operate at peak efficiency'.

Diamond and Das Bhaumik are active on social media, sharing knowledge and offering support to their peers on a wide range of topics. LinkedIn is currently the preferred platform, which Diamond says offers a home to 'Twitter refugees' who have been put off by the polarisation of debate on X. 'That nice community has largely evaporated,' she says.

Inkling's blogs and coverage of events offer up-to-the-minute insights, as well as a shop window for the building services sector.

The BPA judges said Inkling's blog was 'an influential place for industry discussion' and called its founders 'incredibly prolific in spreading understanding and knowledge across the sector'.

Diamond is keen to look at new ways of communicate engineering positively. By way of an example she recently asked comedian Stuart Goldsmith to adapt his climate crisis comedy show for an industry audience.

'Engineers have the answers but they often find it hard to communicate them in an engaging way,' says Diamond.

The high profile of its female founders has helped normalise the notion of women working in building services and paved the way for more women to take on prominent roles in the sector.

Inkling was a founder member of CIBSE's Women in Building Services Engineering group (WiBSE) – Diamond was a founding vice-chair – and Inkling regularly attend WiBSE and National Association of Women in Construction events.

They are keen to promote diversity, inclusion and equality at Inkling, and part of this is having a four-day working week and flexible hours.

'As two women working in STEM [science, technology, engineering and maths], we are aware of many of the challenges,' says Diamond.

"The high profile of Inkling's female founders has helped normalise the notion of women working in building services engineering"

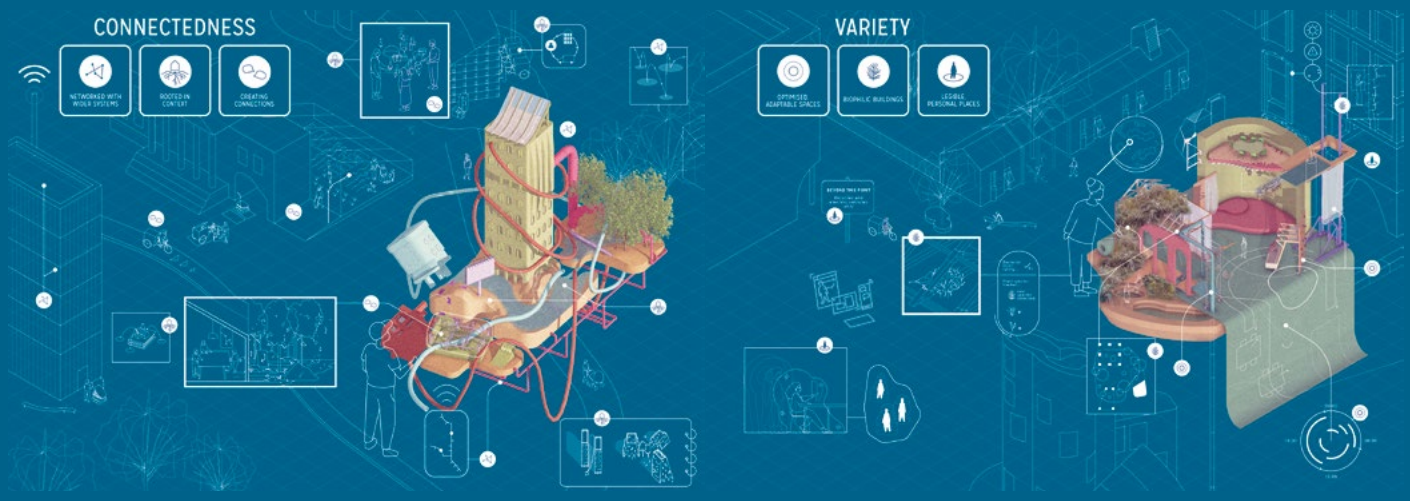
'Inkling has been a powerful vehicle in enabling us to do what we are good at and earn a living, while also giving us the flexibility we need to have a life outside of work.

'I think it's important to be visible and to show that there is more than one way to be successful,' she says. 'We are very clear that having the autonomy to work in a way that suits us individually supports better mental health and productivity. We enable and encourage those we work with to follow suit.'

The company is passionate about mentoring and has supported mentees through the Built By Us Fluid diversity and Shape mentoring programmes (**www.builtbyus.org.uk/fluid**). 'These schemes aim to address barriers to diversity and inclusion in the built environment,' says Diamond, who – together with Das Bhaumik – is keen to give back to the industry that trained her and pass on her skills.

Inkling offers a consultancy service, giving advice to less-experienced modellers within other organisations, and works with LETI to create guidance for modellers).

The firm's approach was highly praised by the judges, who said it demonstrated that innovation happens through a highly collaborative way of working. This, added the judges, allowed Inkling to 'punch well above its weight'. ●



Break from the norm

CIBSE'S conference on Reimagining Building Performance will feature thought leaders from within and outside the industry, discussing the role of engineers in delivering the resilient, zero carbon buildings of the future

In her inaugural address, CIBSE President Fiona Cousins called on members to rethink the way they deliver buildings, and revealed new research – *Building Performance Reimagined*.

On 8 October, a CIBSE conference is inviting a range of experts to consider how engineers will inspire and inform resilient, zero carbon buildings.

The event will focus on the four performance metrics identified within Cousins' report on building performance: variety, readiness, connectedness and emergence.

We asked four of the conference speakers to tell us what building performance means to them, and what areas engineers should be focusing on to ensure buildings are fit for the future.

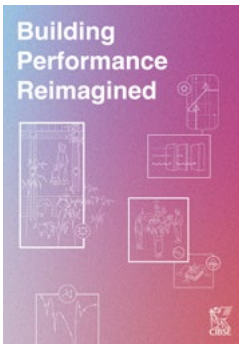
Fiona Cousins, CIBSE President

Traditionally, mechanical engineers have focused on designing systems that provide a comfortable environment in an energy-efficient way, and at a cost that owners can afford. Now, with different expectations for comfort and health in the workplace, and a shifting focus from energy efficiency to decarbonisation, we need to ask ourselves what more we can do.

There is lots to explore around how our physical environments are moderated by digital experiences, by our experiences through the pandemic, and our expectations around productivity and health.

Energy efficiency is also still important and has been joined by decarbonisation. We sometimes lose sight of how energy efficiency supports the transition to decarbonising energy and there are new factors to consider around building-grid interaction and the water-energy nexus.

In addition, we should remember that setting buildings up so they can be operated properly, renovated, repurposed and, eventually, recycled are key components of building performance. ●



CIBSE/Arup report

Fiona Cousins

Eimear Moloney FCIBSE, head of building performance at Hoare Lea

Engineers should constantly remind themselves of the ability we have to influence people's experience of the world. We need to approach each project with this mindset. It focuses us to act as true consultants, with solutions tailored to the unique needs of each end user.

The performance of existing buildings is a critical area of focus, but what does that mean for how we are set up as an industry? Do we still view ourselves as (mostly) a construction industry? Should that change? Our role should be in improving the performance of buildings – wherever and however that is needed. That place is less and less on building sites.

With building uses becoming more diverse, new technologies appearing almost daily, and targets becoming more stringent, our solutions need to be more adaptable and inventive. Building services has traditionally been seen as a science, but we need to start focusing on its ability for creativity. Engineers need to invent new ways to solve the poor performance of buildings; throw away the old rule book and focus on the art of building services. ●

Joanna Harris, UK&I hard FM ambassador at Sodexo

My background is in facilities management (FM), and my day job is about adapting the environment to suit the needs of building occupiers.

It is great that, as an industry, we have design criteria and build systems to meet these – but if that is not the right environment for the occupiers, we need to adapt.

The building performance project takes this focus on the way we use buildings a step further into the future. Three key areas of performance are health and wellbeing, connectedness and emergence, and regeneration.

Health and wellbeing has been top of the agenda in FM for many years, but came into sharp focus during the pandemic. We need to focus on embedding the lessons learned into everyday practice. I can see that standards are starting to slip; the reality is that value engineering and cutting maintenance budgets are back on the table.

Connectedness and emergence is about looking beyond the four walls for which you are responsible and sharing facilities with the local community. The creation of shared spaces is something I am seeing in new constructions, but there are many opportunities for existing facilities. With a bit of conscious effort, we can get facilities open to local communities outside normal working hours and create more value from existing building stock.

Regeneration, along with 'reuse' and 'recycle', is an area that should be discussed and actioned every time a project or repair is required. How can we deliver the same service and reduce our impact on the planet's resources? ●

Eimear Moloney

Joanna Harris

Ted Pilbeam

Ted Pilbeam, building services and sustainability director at Volker Fitzpatrick

Building services strategies touch nearly every aspect of a building's design, so a holistic approach to building performance should be taken. Designers should immerse themselves in the actual needs of the client, rather than attempt to provide a one-size-fits-all solution.

High-performing facilities are increasingly reliant on building services, so it is imperative that services engineers take the lead, rather than wait for the architectural and structural designs to evolve. Building performance has to be 'baked in' to the design philosophy from the start.

There needs to be more understanding of how buildings are performing in reality. Commissioning and ongoing performance is often divorced from the original design. The 'design and build' mentality means final detailing is often abdicated to the building services contractor at RIBA Stage 3 or 4, rather than being completed by the consultant.

Project teams should focus on commissioning and operation as much as construction and handover. Whole life-cycle assessments are helping teams focus on the golden thread, and rapid digital progress will enable us to harvest more data and finesse our designs.

We should be opening our minds to innovative technologies. As an industry we tend to be very conservative, and specify tried-and-trusted solutions rather than explore alternative ones. As engineers, we should be at the forefront of emerging technology, and be ready to devote time and energy to understanding and embracing new concepts. ●

CIBSE Building Performance Reimagined takes place on 8 October at The View, Royal College of Surgeons, London. Register at bit.ly/BuildingPerformanceReimagined

The design for manufacture and assembly (DfMA) approach meant less work and fewer workers on site

Home advantage

Everton Football Club's new stadium at Bramley-Moore Dock is nearing completion, showcasing cutting-edge digital design and modern construction methods. **Andy Pearson** reports

Nil satis nisi optimum – 'Nothing but the best is good enough'. Everton Football Club's motto is perfectly suited to the no-compromise approach to digital design and offsite manufacture used in the construction of its new stadium nearing completion at Bramley-Moore Dock, Liverpool. Modern methods of construction and digital design have played a pivotal role in the scheme from the outset, with 70% of the stadium's mechanical, electrical and plumbing (MEP) services – and much of its superstructure – delivered to site as prefabricated and modular assemblies.

It has been quite a task: 'There are 53,000 elements, of which nearly 40,000 are mechanical, electrical and plumbing services, so we've had to think modular from day one,' says Ian Siddy, associate mechanical engineer at Buro Happold, the project's engineers.

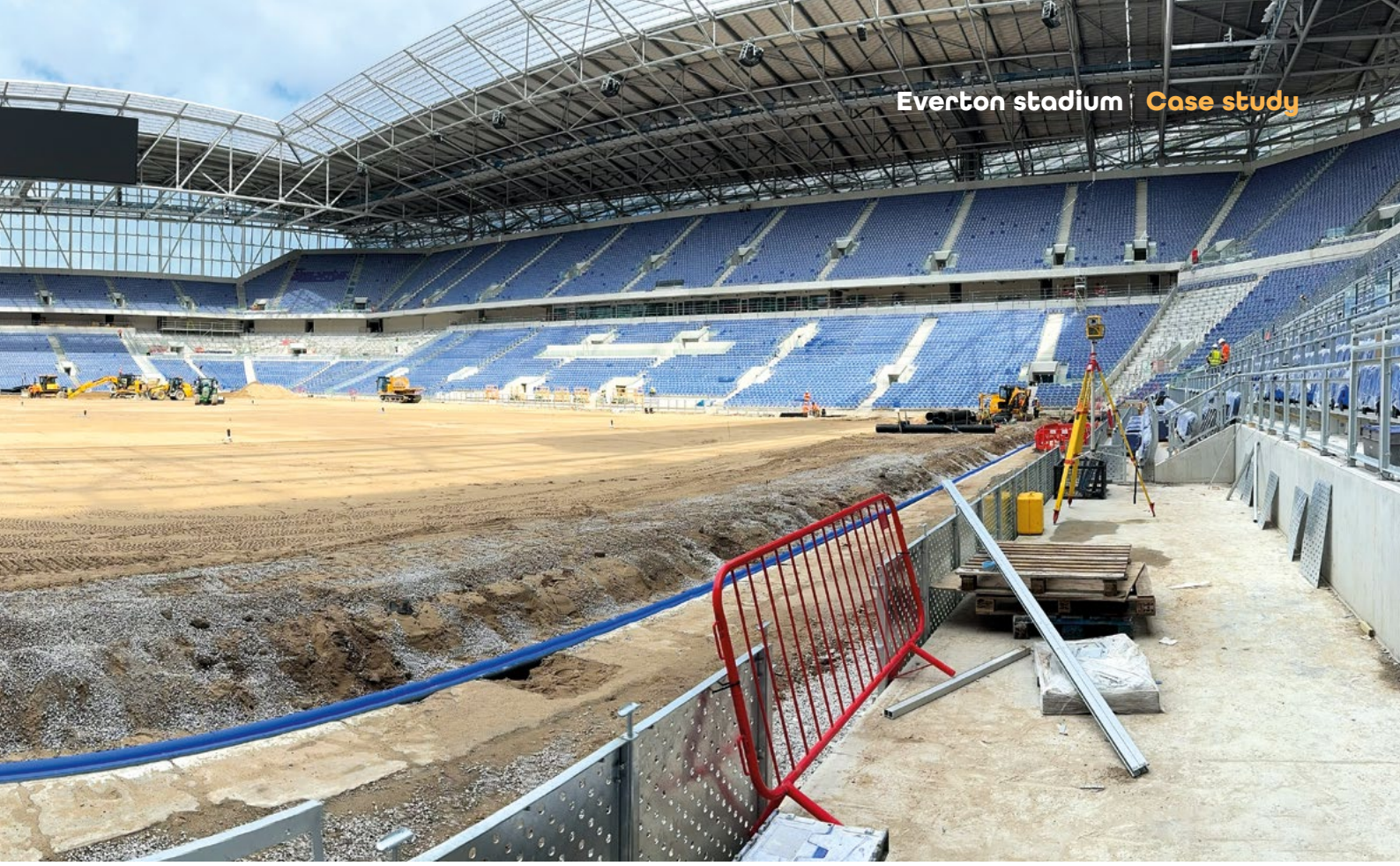
The move to a new home has been a long time coming. Everton has been at its current Goodison Park site since 1892; the club was one of 12 to participate in the first football league season in 1888. Unable to upgrade its existing stadium because of constraints imposed by its location, the club secured a new site in Liverpool's Northern Docks area in 2017. In 2019, US architect Dan Meis was appointed to develop a concept for the club's new home. Its design draws on the brick-warehouse typology of neighbouring buildings, including the Tobacco Warehouse and the Titanic Hotel, with four brick-clad stands surrounding the pitch. Unusually, these are topped by giant picture windows that bring views of Liverpool and Merseyside into the steeply raked seating bowl. The stadium is crowned with a distinctive curved barrel roof.

Working with Everton, Dan Meis and technical architect BDP Pattern, Buro Happold helped refine the stadium's design. In 2020, Laing O'Rourke (LOR) was appointed as design and build contractor under a pre-construction service agreement (PCSA). The PCSA shifted the project focus from design development to design optimisation, to enable the stadium to be split into components and modules for manufacture offsite, under LOR's design for manufacture and assembly (DfMA) process.

'DfMA is a design approach that focuses on the ease of manufacture and efficiency of assembly; by optimising the design of a product,

Project Team

Main contractor: Laing O'Rourke
Concept architect: MEIS Architects
Delivery architect: BDP Pattern
Building services engineer: Buro Happold
Facade engineering: Arup



it is possible to manufacture and assemble it more efficiently, more quickly, more safely, and at a lower cost,' explains Siddy.

LOR's DfMA philosophy is 70:60:30, which means delivering 70% of a build using offsite production, making things 60% more efficient, and saving 30% on programme. A major benefit is that a lot of work that would traditionally be done on site is taken offsite. This ensures better build quality and greater control of wastage, making the process more environmentally friendly. DfMA reduces time on site. Manufactured modules and components are simply craned into position, because every service interface will already have been positioned digitally before module manufacture can begin.

Buro Happold and BDP Pattern were contracted to LOR to ensure the design was DfMA-ready. 'By reducing the workforce on site, DfMA helps create a more efficient and safer site,' says John Edwards, project technical leader at LOR. LOR created a federated BIM model of the stadium, which allows models from all disciplines' designs to be combined in a single place in which to coordinate all objects to the construction programme. This model was linked to detailed construction programme information, to enable a dynamic digital twin to be created to help plan exactly how the stadium's construction would be executed.

The stadium's design draws on the brick-warehouse typology of neighbouring buildings in the Northern Docks area of Liverpool

"Every service interface will have been positioned digitally before module manufacture can begin"

In addition to identifying potential risks or clashes in the build programme, the 4D model allowed the LOR team to identify efficiency opportunities that might not have been realised with more conventional programming methods.

Rather than attempt to modify its MEP designs to make them suitable for modularisation and offsite assembly, Buro Happold took the bold decision to start again. Working with LOR and Crown House Technologies (CHT), LOR's

MEP contracting arm, Buro Happold set about embedding offsite principles into its MEP design from the outset

'We knew the elements that needed to be incorporated. Crown House Technologies gave us guidance, explained how it wanted the systems set out, defined the space needed for access, and explained the capabilities of its manufacturing processes,' explains Siddy.

The location of primary service routes for the mechanical, electrical, public health and containment systems was defined at the start. Regular workshops enabled Buro Happold to draw on CHT's expertise to establish these routes, taking into account practical constraints for modularisation, including weights, transportation, access requirements, and spacing of systems.

The adoption of a modular servicing solution also set constraints for the stadium architecture, including ceiling heights, and the location of access points and risers. The West Stand, for example, contains 35 large, prefabricated modules for the primary runs. These 10-tonne modules sit above the ceilings and include integrated walkways that enable the ducts, pipes and cables installed in the modules to be safely accessed and maintained. 'That was the beauty of the PCSA; the earlier we are involved with the client and their consultant team, the more value we can give to a client around the design solutions,' says LOR's Edwards.

With the primary routes established, it was important to maintain and monitor the quality of the digital models by reporting and recording clashes and coordination issues early, so they could be resolved before impacting the programme. 'When we handed over the stage-four model to Crown House, very little changed in developing it into a stage-five model that could be built,' says Andrew Waugh, associate director at Buro Happold.

The stands are topped by giant picture windows and the stadium is crowned with a distinctive curved barrel roof

Anything but bog standard

Prefabrication of the toilet units was a first for LOR. The number of toilet facilities within the stadium made these suitable for mass modularisation. CHT's facility in Oldbury manufactured 268 modular integrated plumbing system modules, in two- and three-WC variants.

Each included all pipework and plumbing within panelled enclosures to enable them to be slotted directly into a finished space. The only site operations needed after installing the modules were connecting the hot and cold-water supplies, soil stacks and electrical connections for trace heating, and attaching the WC pans.

'Imagine how many operatives we would need for a single toilet bay if each was installed as a traditional integrated plumbing system; the jointing of all that pipework, the commissioning and testing that would need to go on. Instead, all of that is done in a clean, hazard-free environment,' says LOR's Edwards.

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In keeping with Everton's aspiration for the stadium to be built with sustainability to the fore, building services systems are designed to provide flexibility of operation. The stadium will host around 20–30 matches a season, so there are more than 300 days a year without match-day revenue. On these days, the stadium will host events and conferences, to generate additional income – so the building services have been zoned to allow individual systems to run in isolation, with everything else effectively turned off. 'If a system doesn't need to run, then let's not run it,' says LOR's Edwards.

The conditioned spaces are typically hospitality areas. Each area is served by dedicated, decentralised fresh air handling units (AHUs) with integrated reversible air source heat pump, sized to provide cooling and heating based on the occupancy profile of each space.

The use of integrated heat pumps helps minimise the size of the centralised heating and cooling plant and the length of pipe runs. 'Using dedicated heat pump units is really efficient in terms of operational energy, and really good in terms of embodied carbon, because we don't need huge centralised systems,' says Buro Happold's Siddy. 'Simply by changing the AHU to one incorporating a heat pump, which is practically no bigger, there are huge benefits.'

Water usage, too, has been minimised through the use of low-flow fittings. These help minimise peak domestic hot-water loads, which occur just before kick-off. Buro Happold used its extensive stadium design experience to shed loads and improve security of supply with the addition of buffer vessels. Even so, at 3.2MW of a total 4.5MW heating load, hot-water heating is by far the largest primary heat demand. The inclusion of buffer vessels, however, helps overcome the peak and has enabled the gas boilers to be sized below peak demand. 'This leads to more efficiency in terms of equipment, cost and everything else,' Siddy says.

Water usage for pitch irrigation has been minimised through the addition of rainwater harvesting from the stadium roof.

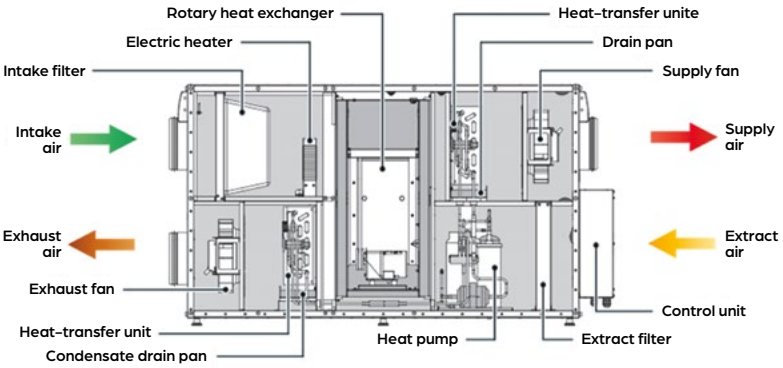
As with water consumption, power, cooling and heating load profiles also vary considerably between match and non-match days. 'Match days have short-term peak loads half an hour before kick-off and at half-time, which far exceed anything else,' explains Siddy.

To come up with realistic power demands for the stadium, Buro Happold used its experience and benchmarking data from recently completed stadiums, including Arsenal's Emirates Stadium, the Tottenham Hotspur Stadium, and the transformation of the London Olympic Stadium into West Ham's new home.

A plant skid manufactured in Laing O'Rourke's factory

Electrical resilience

The total electrical load for the new stadium's match and broadcast needs, and for catering, totalled 18MW. However, Buro Happold used its benchmarked data to anticipate how the stadium would actually be used and was able to apply a 60% diversity figure to the total electrical load, which brought it down to a more realistic 7.6MW. 'The load we requested from Scottish Power Energy Networks is about 43% of the



Integrated reversible ASHP heat pump unit

Stopping the rot

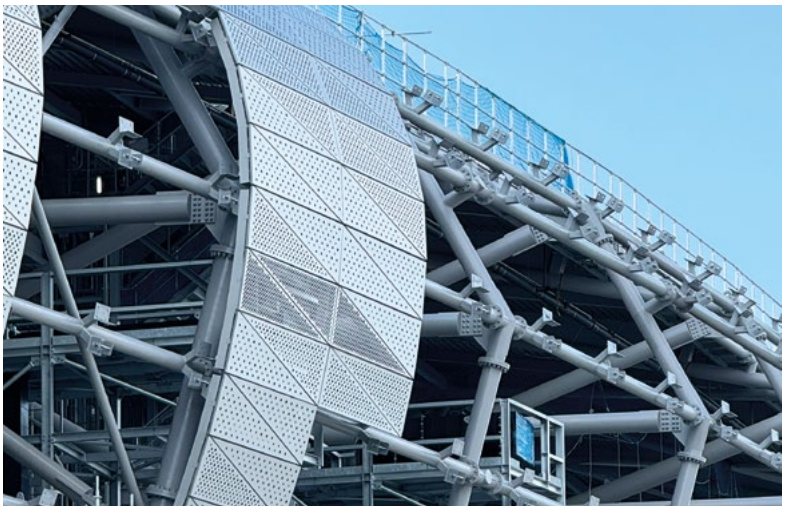
The stadium's riverside site is exposed to strong, maritime winds. Buro Happold and CHT visited plant installations close to the site to see how materials and systems were fairing in this harsh environment, to ensure plant and equipment would not need to be replaced more regularly than normally expected.

'We categorised all the different spaces: if they are completely external and subject to the external environment, they are given a C4 classification under BS EN ISO 13944, and the systems within there would be specified suitably,' says Buro Happold's Waugh. 'Then, as you come away from the salty environment and into internal spaces, we reduced the classification and specification to suit.'

connected load; even then, we have spare capacity built into that,' says Waugh.

Load diversity was also applied to the main electrical infrastructure, to ensure that it too was not oversized. This enabled smaller cables to be installed, to reduce costs and save on embodied carbon. In addition to diversity, electrical resilience is critical for the safety of the stadium's 52,888 spectators. If a mains power failure should occur, all life-safety systems will continue to operate, as will the giant screens and all field-of-play lights, to enable the match to be completed with spectators remaining in their seats. 'Match continuation for a Premier League club is huge; the show must go on,' says Waugh.

The site electrical supply benefits from two primary 33kV district network operator connections from independent electrical grids, either of which is capable of supporting the full electrical load. In addition, there are 4 x 1MVA battery systems capable of delivering about 5.6MWh of battery storage. 'If there was a mains failure, that would give us about three hours of continued operation, with some non-essential stadium services restricted, so that a game could easily be completed,' says Waugh.



The stadium's riverside location exposes it to strong winds, so materials and systems have to be able to withstand the harsh conditions

Life-safety systems – including public address, voice alarm and emergency lighting – have local, independent uninterruptible power supply systems for enhanced levels of resilience.

Construction of the stadium began in summer 2021 and fit-out is nearing completion. Everton aim to start playing there in 2025 – then we will see whether their new home inspires the Toffees to live up to their *Nil satis nisi optimum* motto. ●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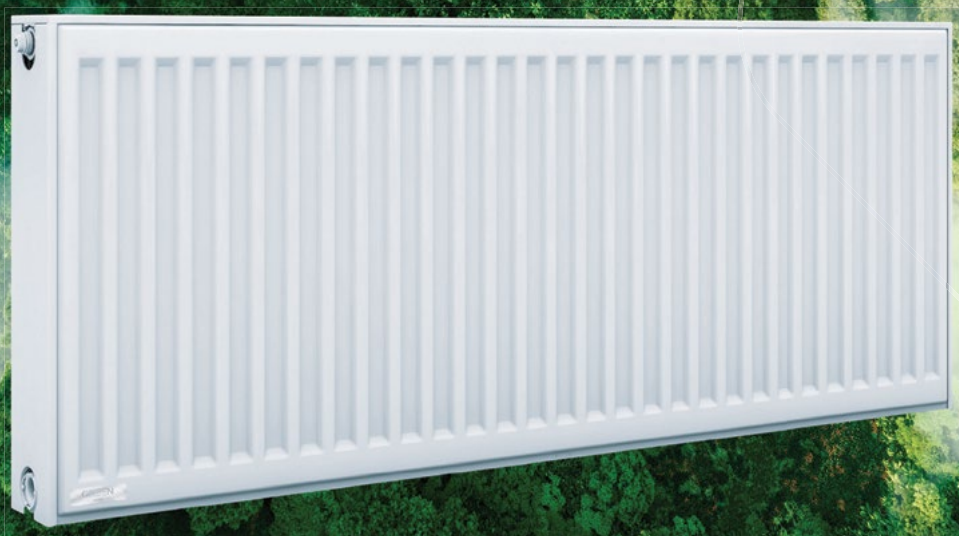

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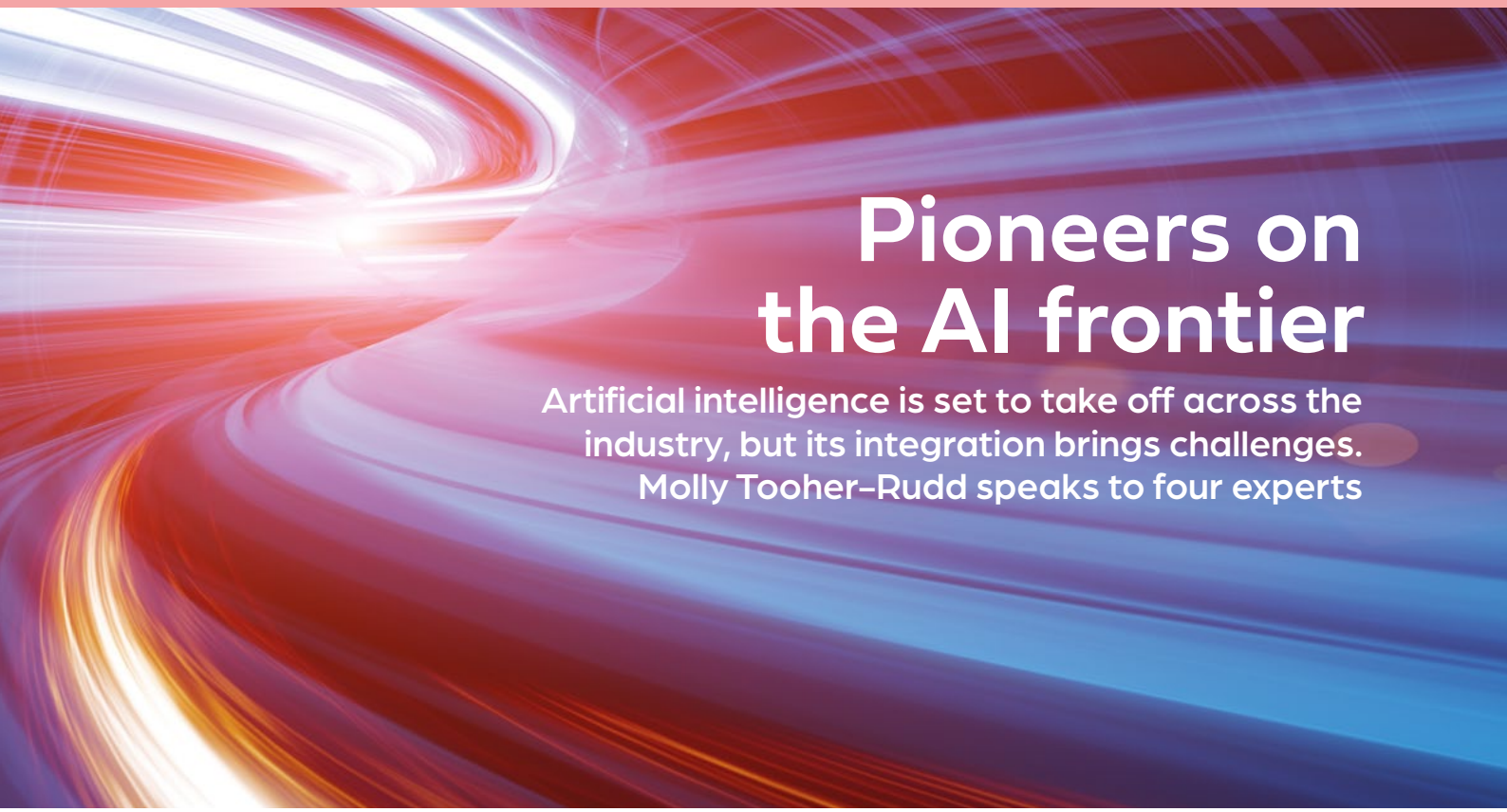
How AI is reshaping future design

Top experts at four leading consultancies dissect AI's emerging opportunities and underlying risks



Pioneers on the AI frontier

Artificial intelligence is set to take off across the industry, but its integration brings challenges. Molly Tooher-Rudd speaks to four experts

The use of artificial intelligence (AI) has been catapulted into the mainstream, and its application in the building services industry is on the rise.

There is a vision of the future where AI is seamlessly integrated into every aspect of a building's function, and consultants are already exploring how it can be used to enhance the design, management and operation of building systems.

However, the rise of AI brings its own set of challenges and complexities, particularly around data security, system integration, regulatory compliance, and reliability and accuracy. In response, regulatory frameworks are being developed to ensure integration is safe and ethical.

While some countries, such as the US and UK, are taking a sector-specific approach to regulation, the EU introduced the Artificial Intelligence Act in June 2023, which addresses critical issues such as data protection, data usage and transparency.

Cementing AI into building services

AI is already applied in many areas relating to building services such as: energy management and optimisation; predictive maintenance; building automation; occupant comfort; design and planning; security and surveillance; and emergency response and safety.

> **"While AI provides many great opportunities, there is the potential for unknown risk."**

Arup global automation leader, director and Fellow Michael Beaven, says Arup has been using AI and machine learning (ML) for many years, including developing a tool telling engineers how significant cracks are in tunnel walls.

Beaven says the use of AI has now become endemic, because the interface with the technology is now easier for everyone to understand. 'Previously, the barrier to entry was high, but now people can use ChatGPT to write code,' he says. Arup is leveraging ML to expedite problem solving, says Beaven. In a major commercial project in London, he says replacing traditional energy analysis models with regression-based AI slashed computation time. 'What would have taken 18 months on a laptop, or four weeks in the cloud, takes just seven seconds,' he says.

Foster + Partners began exploring ML in 2018 to understand how the integration of neural networks can help predictive models generate solutions easily. Martha Tsigkari, senior partner, and head of applied research and development, says it was able to predict deformation of passive materials under thermal conditions.

By analysing laminate layering, Foster + Partners reverse-engineered a process to train models to predict deformation patterns. This generative design approach, using distributed computing to run thousands of calculations, allows scalable applications such as designing a façade that deforms to create shading when its heated.

May Winfield, global director of commercial, legal and digital risk at Buro Happold, says AI allows the analysis of huge amounts of data generated by smart buildings. 'We can feed data into an AI model and ask it questions. Some of the options could be ridiculous, but it will spark new ideas.'

A key benefit of AI, she says, is automating boring and repetitive tasks, allowing designers to add value elsewhere: 'It allows our engineers to do the amazing creative work they do best.'

Several companies have launched

their own in-house large language models (AI-based programs such as ChatGPT). Tsigkari says such a program called 'Ask Foster and Partners', allows engineers to access the company's large archive using simple text questions.

'One of the challenges of AI is that lots of good, organised data is required to train a system to predict things well,' says Gavin Bonner, head of data and digital at Cundall. 'AI is more specific than automation. It needs a data source that it reads and learns from, and then applies new context or new content based on that material,' he explains.

Bonner says Cundall has built a cloud Lakehouse environment, which combines the benefits of large repositories of raw data with organised sets of structured data. The aim is to set the company up for effective ML across several disciplines.

While the computational power of AI promises to revolutionise the way buildings are designed, it comes at an environmental cost. The power needed to sustain AI is vast and growing; the International Energy Agency has estimated that electricity consumption associated with data centres, AI and cryptocurrency will grow from 2% of global energy use in 2022 to 4% by 2026.

Winfield says data centres need to become more efficient to handle the surge in demand that AI brings.

Cost is another barrier to adoption, says Bonner, pointing out that the deployment of AI systems requires substantial expenditure in data collection, storage, and analysis.

Winfield is concerned by the trajectory of AI if it is left unchecked. 'With anything new and shiny, people tend to run at it head-first. But while AI provides many opportunities, there is the potential for unknown risk,' she says.

Winfield believes large language models such as ChatGPT have scraped huge amounts of data from the internet, so there is the potential inadvertently to plagiarise designs or ideas. 'There is a huge issue around copyright that companies must navigate,' she says.

Confidentiality is another issue. Many building services firms work on unique, confidential projects. Feeding sensitive data into public AI systems could lead to breaches of confidentiality, with proprietary designs or models inadvertently exposed to competitors.

There are also safety elements to consider, says Bonner. 'If you're using an AI system to optimise an MEP design that's related to safety, fire, structural design, it opens you up for a lot of scrutiny and you must be very transparent in the way that you are developing AI applications,' he says.

'If you ask the AI chatbot a question about your building, are you going to trust the answer? What if something goes wrong and there's a massive leak in the building; whose fault is that? It's an issue people are currently wrestling with.'

Beaven stresses that engineers are responsible for the AI output. 'No matter where it comes from, it must always be checked,' he says.

Bonner says the EU AI act will help minimise risks. 'There's a lot you must comply with to ensure systems meet the requirements of the law,' he says.

The Act requires that AI systems deemed high risk, such as critical infrastructure, meet multiple requirements and undergo a conformity assessment. Bonner says Cundall is ensuring AI processes comply with the act, which could be adopted elsewhere.

The rise of AI necessitates a new skill set, which firms must address. However, Bonner says the accessibility of AI through 'low-code and no-code platforms' like ChatGPT will enable a broader range of professionals to use AI.

The future

The industry experts don't expect AI to replace building services engineers; the human element remains indispensable. Winfield says that AI's strength lies in its ability to repeat patterns, but it cannot understand concepts or capture the nuances of human creativity.

'Our AI strategy board analyses where the technology can benefit our business. At the moment ,we're looking at quick wins that can allow our engineers to do what they do best – which is the thinking and creating amazing work,' she says.

Tsigkari says AI tools should become facilitators rather than replacements of creative processes. 'As with all disruptive technologies, AI can help us rethink everything that we have been taking for granted and effectively innovate in a new way.'

Beaven says engineers have to learn to drive the machine. 'We need to be clear on what measures we give AI and who says it's of real benefit for people. We need to interpret that ourselves. It can't be the machine,' he says. ●

Artificial intelligence glossary

Artificial intelligence: the simulation of human intelligence in machines that are programmed to think, learn, and make decisions
Machine learning (ML): a subset of AI that involves algorithms learning from, and making predictions or decisions based on data
Neural networks: a series of algorithms that mimic the operations of a human brain to recognise patterns and solve problems
Deep learning: a subset of ML involving neural networks with many layers, enabling the analysis of complex patterns in data
Generative design: an iterative design process that uses algorithms to generate a wide range of design solutions based on set parameters.

Visualising whole life carbon

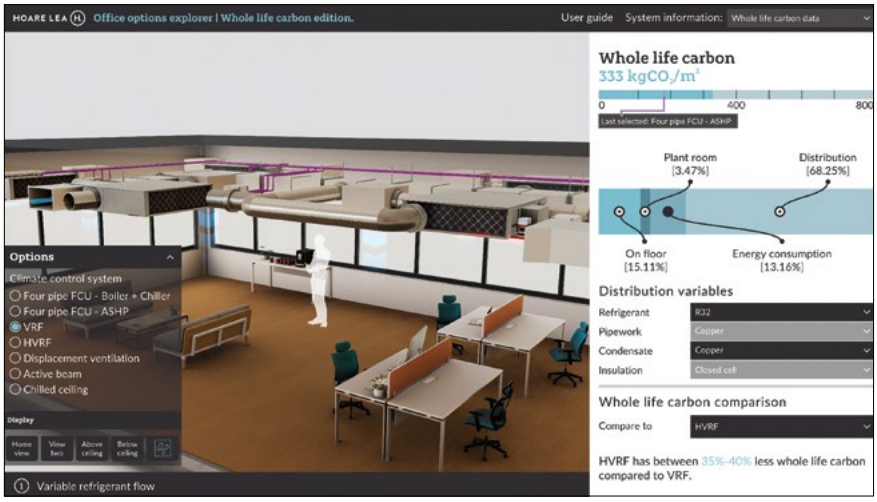
Hoare Lea's early-stage selection tool calculates whole life carbon for HVAC systems, while providing 3D visualisations for each specification. **Esam Elsarrag** demonstrates the software by assessing the performance of seven different systems

Heating, ventilation and air conditioning (HVAC) systems are crucial for indoor comfort, but are also significant contributors to a building's carbon footprint. The growing emphasis on sustainability in building design has highlighted the need for comprehensive whole life carbon (WLC) analysis in HVAC systems.

The drive towards net zero carbon buildings necessitates innovative tools that can assess and visualise the WLC impact of various HVAC systems. This article presents a 3D visualisation tool based on a framework for early-stage selection of HVAC systems, focusing on minimising embodied and operational carbon emissions. The tool aims to support decision-making in the early stages of building design, aligning with net zero carbon goals.

The concept of whole life carbon includes all greenhouse gas (GHG) emissions throughout the entire life-cycle of a building, covering operational and embodied carbon emissions. Embodied carbon emissions pertain to GHG emissions resulting from the manufacture, transportation, maintenance, and disposal of buildings, while operational carbon emissions indicate GHG emissions associated with the day-to-day operation of a building. CIBSE TM65 documents embodied carbon emissions for MEP systems and has a standardised methodology for assessing embodied carbon for products that are lacking Environmental Product Declarations.

The relationship between embodied carbon and operational carbon will evolve significantly as demand-side electrification progresses. This change is expected because of anticipated improvements in power generation efficiency, driven by a greater reliance on renewable sources, which should reduce the carbon emissions associated with electricity generation. Additionally, European Union regulations and standards intend to phase out the use of refrigerants with high global warming potential (GWP).



Visualisation of VRF option for an office

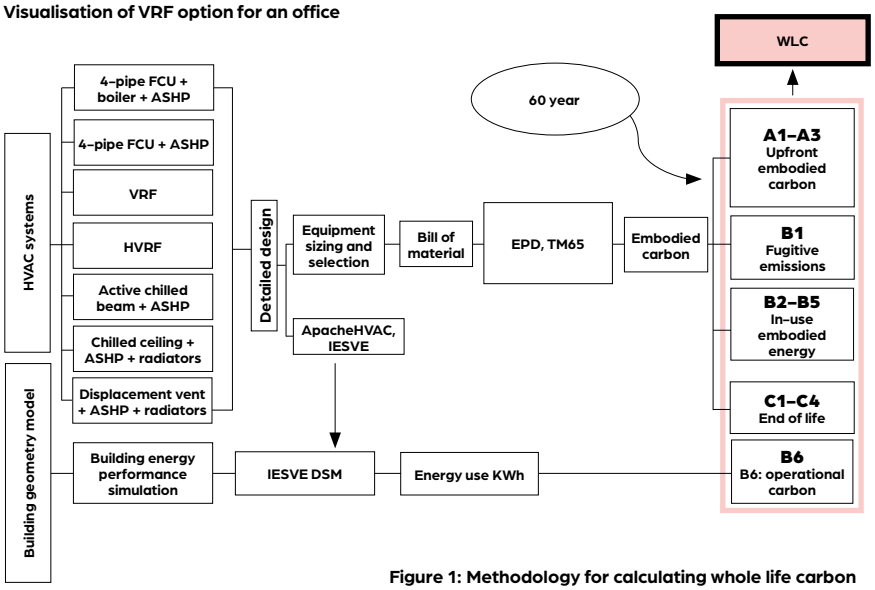


Figure 1: Methodology for calculating whole life carbon

In the early design stages, HVAC engineers face the challenge of limited data, particularly regarding the carbon footprint of HVAC equipment and materials. Making informed decisions at this stage can influence a building's long-term environmental impact significantly.

The rapid pace of technological advancements further complicates the selection process, making it essential to integrate innovative benchmarking solutions and interdisciplinary collaboration. Figure 1 shows the framework used to incorporate data for the visualisation tool.

Comparative analysis of HVAC systems via visualisation

The digital visualisation tool incorporates several essential features to address the challenges of whole life carbon analysis in HVAC systems. First,

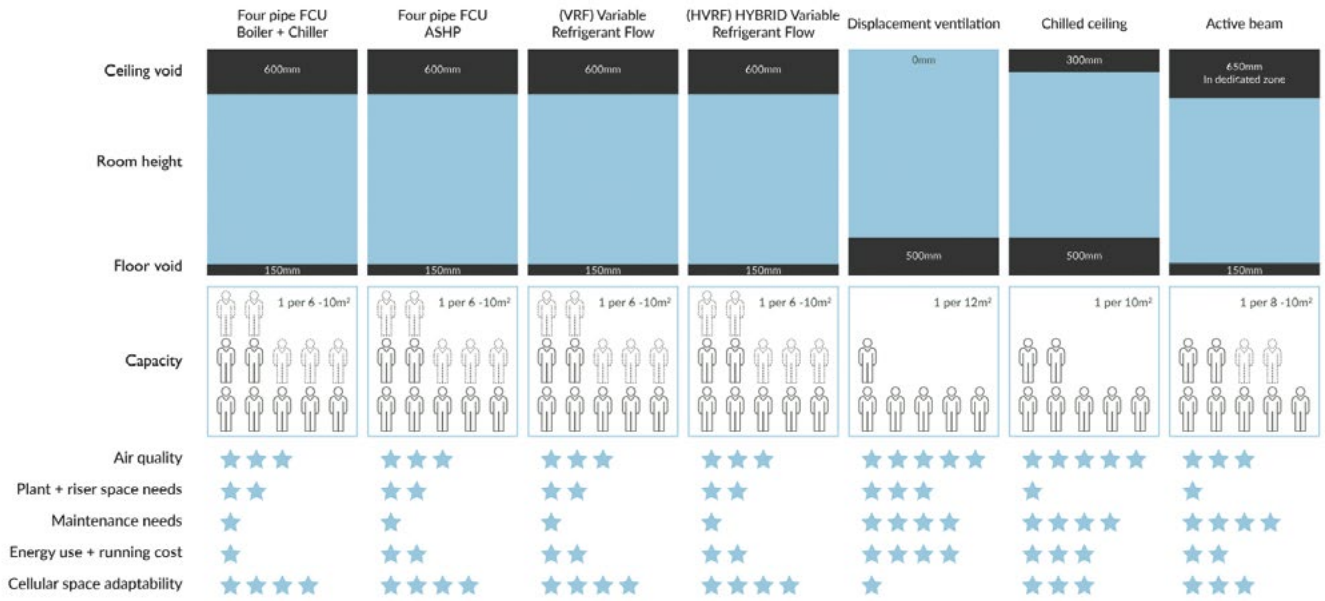


Figure 2: Sample showing whole life carbon calculated for seven systems

it integrates normalised data on embodied and operational carbon emissions, offering a comprehensive view of each HVAC system's whole life carbon impact. This data is sourced from standardised databases and industry benchmarks, to ensure its accuracy and reliability.

Second, the tool includes interactive HVAC systems' performance, energy consumption and WLC comparison, and visualisation of the system in 3D, using different material selections.

These schematics allow users to engage with visual representations of system components and their associated carbon impacts, aiding in understanding the consequences of various design choices.

Third, the tool's comparative analysis capability enables users to evaluate multiple HVAC systems across various criteria, taking into account different material selections for major components that may provide variations in embodied carbon for the selected system. This feature is particularly valuable for making informed decisions aimed at achieving net zero carbon goals.

Finally, the tool is designed with a user-friendly interface. It guides users through complex datasets and offers clear visualisations, making the information accessible to both technical and non-technical users.

The visualisation tool in Figure 2 show seven climate-control systems offering different material options and configurations. See panel 'Summary of system options' for an outline of each.

Each system's design flexibility allows for tailored solutions that can be adapted to specific building needs and material preferences. The digital tool provides a breakdown of comparisons between these systems.

It is worth noting that, while the visualisation tool provides comparisons on operational energy and whole life carbon breakdown, it also offers hints and guidance on associated parameters, such as air quality and thermal comfort potential.

Results

According to the tool, the gas boiler baseline scenario has the highest energy consumption, at approximately 60kWh·m^{-2}.

When comparing electrical-based systems using vapour compression, the air source heat pump-fan coil unit (ASHP-FCU) exhibits the highest energy consumption, at 44kWh·m^{-2}, while the ASHP radiator system coupled with displacement ventilation has the lowest, at around 18kWh·m^{-2}. This represents a reduction of about 60% in energy consumption compared with the ASHP-FCU system.

The active chilled beam system and passive ceiling systems also demonstrate significant advantages over variable refrigerant flow (VRF) and hybrid VRF (HVRF) systems.

In the context of embodied carbon, systems that incorporate ASHPs, such as the ASHP radiator system with displacement ventilation, demonstrate the lowest operational and embodied carbon emissions.

These findings underscore the importance of selecting HVAC systems that balance efficiency with low carbon emissions, especially in the context of refrigerant GWP and associated leakage percentages.

Although most VRF systems use R410a, it is intended in this sample to compare the potential of VRF with low-GWP refrigerants, such as R32. However, a few smaller VRF systems

"Users can evaluate multiple systems across various criteria, taking into account different material selections"

are introduced with R32, which has a lower GWP of 675kgCO_2e/kg but comes with limited capacities.

When using R32 refrigerant, additional precautions must be considered during the planning and installation of VRF systems because of its classification as 'mildly flammable'.

Figure 3 depicts the embodied carbon associated with all system components and materials, inclusive of operational energy emissions and refrigerant leakage emissions throughout their lifespan.

The baseline gas-boiler scenario has the highest WLC, at 353kgCO_2·m^{-2}; however, the VRF system is nearly comparable, at 335kgCO_2·m^{-2}. This is noteworthy given the use of a lower-GWP refrigerant.

If R410a is used in line with major market installations and commercially available systems, the VRF WLC will surpass the baseline scenario. The ASHP radiator system coupled with displacement ventilation exhibits the lowest WLC, at 112kgCO_{2e}·m^{-2}, representing a reduction of approximately 45% in WLC compared with the ASHP-FCU, at 204kgCO_2·m^{-2}.

The active chilled beam system and passive ceiling systems demonstrate comparable WLC values at 175kgCO_2·m^{-2}, showcasing a 15% reduction compared with ASHP-FCU and HVRF systems, and a 47% reduction compared with the VRF system.

Selecting the appropriate HVAC system within the context of WLC requires a comprehensive approach that considers embodied and operational carbon.

The rise of artificial intelligence has led to the development of advanced HVAC digital visualisation tools that are now crucial for HVAC engineers and building designers. These tools enable more sustainable decisions on climate-control systems during the early stages of building design.

By incorporating low-GWP refrigerants, efficient design strategies and advanced materials, the carbon footprint of buildings can be reduced significantly. As the industry moves towards stricter carbon-reduction targets, such holistic approaches will be essential for achieving net zero goals. ●

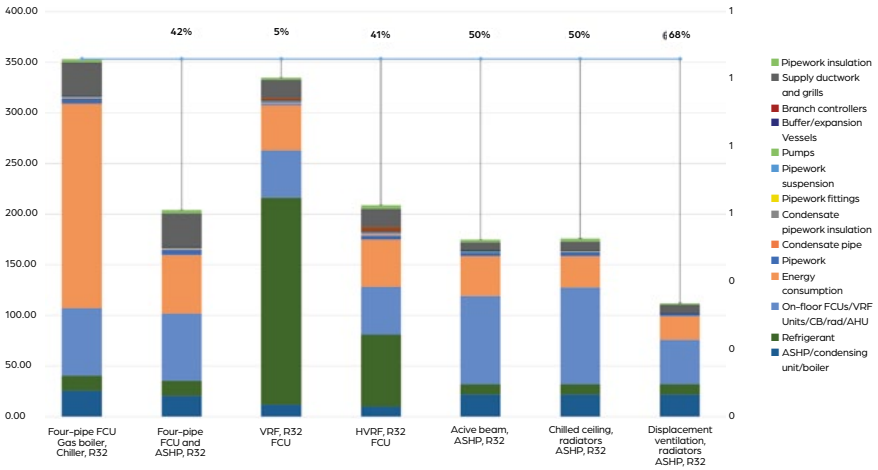


Figure 3: Whole life carbon breakdown per HVAC system, kgCO_{2e}·m^{-2}

● **Dr Esam Elsarrag MCIBSE is a consultant at Hoare Lea**

Summary of system options

- **4-pipe FCU systems: Available with boiler and chiller, or ASHP, these systems use low-temperature hot water (LTHW) and chilled water pipes, along with fan coil units and fresh air handling systems, to manage ventilation and maintain comfort**
- **Variable refrigerant flow (VRF) systems: These employ refrigerant pipes and branch controllers for precise temperature regulation. Some VRF setups also integrate a hybrid of water and refrigerant components, known as hybrid VRF systems (HVRF).**
- **Active chilled beam system with ASHP: This system uses chilled beams and fresh air handling units to provide comfort throughout the building. All zones receive either cold water or hot water via 4-pipe units, allowing some zones to receive cold water for space cooling while others simultaneously receive hot water for space heating. The units contain an integral air supply that passes through nozzles, inducing air from the space, up through the recessed ceiling units.**
- **Chilled ceiling and radiator system with ASHP: This system provides heating and cooling for the entire building. LTHW and chilled water (CHW) pipework are distributed from the plantroom to each floor and then further conveyed at a high level on each floor plate. The LTHW pipes connect to low-temperature heating radiators, while the CHW pipes are linked to passive-chilled ceilings. The system relies on natural convection within the conditioned space.**
- **Displacement ventilation and ASHPs: These systems provide heating for the entire building. LTHW pipework is distributed from the plantroom to each floor and then further distributed within each floor. The LTHW pipes are connected to low-temperature heating radiators, and the system relies on displacement ventilation.**

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Building a sustainable future while ensuring business continuity

One of the hidden challenges for businesses aiming for sustainability is the very buildings in which they operate. Currently, buildings consume about 30% of the world's energy and account for nearly 40% of its annual CO_2 emissions. This makes the built environment a significant area to target for climate action.

However, many businesses neglect to include buildings in their sustainability goals, often fearing the disruption and potential loss of productivity that a retrofitting transformation might bring.

Retrofits or new builds?

Considering that 80% of today's buildings will still be in use in 2050, simply constructing new eco-friendly buildings isn't the solution. Many older buildings are not up to par with current environmental standards – 85% of rented non-domestic properties will not meet legal minimum energy performance levels by 2030.

Research indicates that retrofitting office buildings can cut carbon emissions by up to 70%, so this is where businesses should focus to really impact their net zero journey.

Additionally, retrofitting can improve employee comfort, health and wellbeing, improve energy efficiency and reduce bills, and meet growing demand for better green credentials.

Retrofitting will soon be legally required, with the Minimum Energy Efficiency Standard mandating better energy performance ratings. The current minimum Energy Performance Certificate rating for non-domestic properties is E, but this must improve to C by 2027 and B by 2030.

Is the fear of retrofitting unfounded?

Retrofitting doesn't need to be a disruptive rip-and-replace project. A digital-first approach can ensure business continuity while advancing sustainability goals.

Deploying digital technologies can be less disruptive and more effective from a life-cycle carbon perspective. Additionally, failing to decarbonise buildings swiftly could result in stranded assets that lose value and become unattractive to investors, making the risk of not retrofitting greater than the perceived disruption.

Developing a digital-first retrofit strategy

Digital tools are available to transform the carbon footprint of existing buildings and minimise the impact of new builds. By following three key steps – strategise, digitise and decarbonise – business leaders can ensure their buildings are future-proofed and compliant with incoming regulations.

1. Strategise: Develop a clear, achievable roadmap to reduce emissions. Define the level of implementation needed and the potential impact on emissions reduction, and account for any operational disruption. This helps assess the timescale for return on investment and gain board buy-in.
2. Digitise: Measure and monitor energy consumption and carbon emissions. Leaders need to track energy use to identify waste and gather trusted data through digitisation.
3. Decarbonise: Use smart energy management solutions, such as automation, internet of things devices, renewable energy sources, and upgraded building systems. These technologies enable businesses to reduce energy waste and costs effectively without compromising building operations.

By targeting areas with the biggest climate impact – reducing reliance on fossil fuels and minimising energy demand – leaders can create a digitally driven strategy that delivers maximum rewards with minimal disruption.

● Download Schneider Electric's net zero buildings guide to find out more about digital-driven transformation: https://bit.ly/4fu48Dz

Life Is On | Schneider Electric

A golden age for smarter living

As the UK's population ages and climate warming intensifies, smart technology will be essential to ensure resilient and comfortable homes, says ABB Smart Buildings' **Kevin Lenton**

The demographic makeup of the UK is rapidly changing. The United Nations forecasts that by 2043, those aged 65 years and above will account for 24% of the population.

However, another study by English Housing Survey (2020–21) found that 1.1 million older adults live in homes that do not meet the government's Decent Homes Standard, which includes efficient heating guidelines.

Indoor environments that are too cold or too hot for sustained periods present potentially serious health risks and financial implications for residents, and further strain on the NHS.

These figures highlight the urgency of providing more homes that meet the needs of an ageing population.

Smart technology has an important role to play in making housing resilient. Systems can automatically optimise comfort and energy use, and alert carers if residents need help.

The appetite for smarter homes is growing. Samsung's Smart Home Buyers Index 2024 found that 88% of respondents aged over 65 wanted a smarter home – larger than any other age category.

With ABB as one of its technology partners, Cartwright Pickard and The Helen Hamlyn Centre for Design's study, *Age-inclusive design principles: Shaping a sense of belonging in later life*, aims to develop principles for age-inclusive buildings.

It looks at the microclimate from the outside in: from orientation and design, to the technologies that can enhance the living experience.

The study outlines the importance of the local climate, such as the wind and solar conditions that can affect energy consumption, and air quality.

In city centres, it says attention should be given to mitigating the urban heat island; the Met Office says anthropogenic climate change could produce UK summers up to 6.8°C hotter in the coming decades.

In the UK, recent heatwaves such as the 40°C+ temperatures of 2022 exposed homes' lack of resilience. CIBSE now defines residential overheating as when the internal temperature threshold of 26°C is surpassed for more than 3% of the time.

Exceeding this limit can negatively affect residents' health and comfort.

Smart technologies can help manage the internal climate in a warming climate by combining automation with greater independence and control.

Technologies currently in play include PIR Sensors that can detect when a room is unoccupied and automatically switch off heating. They can also enhance safety by alerting the care team if a room that should be occupied appears empty, or is occupied and potentially overheating.

Energy Efficiency Control systems prevent the simultaneous operation of heating and cooling systems and adjust accordingly when they detect windows are open, ensuring systems are not working against each other.

Wall-mounted controllers allow older residents to operate smart home systems from convenient locations. Ease of use is provided by a connected system of sensors, smart switches, sockets, and actuators for motorised curtains, blinds, and window openers.

Compatible with Apple, Amazon, and Google assistants, voice control also simplifies the operation of home systems to programme heating times. ABB's i-bus KNX system allows easy addition of voice control through a software update.

This smart technology is already being embedded in age-inclusive designs for new developments including at Brobyholm in Sweden, which will eventually see 2,500 smart homes fitted with smart energy systems that will optimise comfort and energy use (see panel below). ●

● **Kevin Lenton is product marketing director for ABB Smart Buildings UK**

Smart-living Swedes

The Brobyholm estate by S. Property Group is a pioneering age-adaptive living development in Stockholm, with 500 homes to be completed by 2025 and a total of 2,500 planned.

Residents have access to an integrated smart home solution combining ABB-free@home and Samsung SmartThings, managed via an app or device. Each home features an energy management system that optimises energy use across appliances, lighting, cooling, heating, and blinds.

The system prioritises renewable energy for heating and cooling, reducing emissions and energy bills and optimising thermal comfort. Surplus solar energy heats water tanks, while low solar energy triggers energy-saving modes. The system adapts to residents' habits, using geo-fencing data to pre-heat or pre-cool homes.

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Optimising performance with smarter ventilation

Partnerships between FMs, digital consultants and ventilation suppliers have the potential to achieve smarter systems that increase energy efficiency, while ensuring a safe and healthy indoor environment, says Breathing Buildings' **Louise McHugh**

As part of the drive towards net zero carbon, suppliers are accelerating the development of new smart products that reduce energy consumption.

Ventilation installations, for example, are now intelligently connected and controlled by sensors throughout buildings. Compatible with the building management system (BMS), the system is continually being optimised through algorithms, to ensure a healthy environment while minimising energy waste.

According to Jupiter Research, the number of smart buildings globally is expected to increase from 45 million in 2022 to 115 million in 2026. This is welcome news for facilities managers (FMs), who acknowledge the benefits of smart buildings, including improved safety and time savings.

Recognising the merits of collaboration, building services manufacturers are partnering with internet of things (IoT), FM, and health and safety (H&S) experts, and tendering for projects as one entity. The partnership between Breathing Buildings, IoT Horizon and facilities management company Thomson FM, for example, is pitching for smart modular-accommodation projects.

IoT Horizon is a smart buildings company, working with clients on everything from technology selection and installation to monitoring and data-driven decision-making, with a focus on sustainability, cost reduction and improving indoor environments.

Pooling expertise allows for greater efficiencies, with IoT experts integrating all services into one digital software platform, and multi-sensors feeding back to a dashboard. This simplifies data viewing for FMs and building owners, enabling informed business decisions. Manufacturers can provide solutions tailored to building demands, avoiding over-specification, while FM and health and safety experts ensure compliance with regulations and achieve maximum efficiencies.

"Clients generate numerous datasets, but this information is often underused"

'This collaborative approach is a real benefit as an FM,' says Mark Whittaker, general manager at Thomson FM and chair of the Institute of Workplace and Facilities Management. 'Having one digital platform, rather than multiple separate portals that are disconnected from the BMS system, streamlines the process and enhances efficiency.'

The partnership, led by IoT Horizon, is tendering for new-builds as well as energy-efficiency retrofits; analysing buildings' existing data can yield significant benefits. For instance, considering access-control data alongside temperature and CO_2 data can optimise heating and ventilation, ensuring energy is not wasted when occupancy is low.

Clients generate numerous datasets – such as BMS data and existing meter readings – but this information is often underused. 'Many smart building companies fail to adopt a holistic approach that could benefit their projects,' says Niamh Allen, managing director at IoT Horizon. 'Our approach involves collaborating with industry professionals to maximise the effective use of this data.'

A recent project for a theatre company aimed to improve energy efficiency without compromising indoor air quality (IAQ). On a single digital platform, IAQ data was linked to the ventilation system to ensure safe CO_2 levels were achieved without over-ventilation, and temperature sensors triggered higher ventilation rates during performances.

As buildings become more airtight and thermally efficient, IAQ becomes increasingly important. Efficient buildings must also provide a healthy workplace environment. Remote monitoring of indoor conditions allows tasks to be performed without an onsite engineer, which helps address the shortage of skilled FM engineers.

Smart buildings and sophisticated remote-monitoring technology can also help streamline health and safety demands. The Building Safety Act has increased the value of data and the need to evidence compliance. 'The ability to evidence tasks is critical,' says Whittaker. 'A common platform to access data easily and demonstrate compliance is essential.' ●

● **Louise McHugh is a product manager at Breathing Buildings**

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Can we protect staff, patients and visitors while reducing waiting times, saving money and targeting net zero in the NHS estate? NHS Scotland Assure's **Mike Ralph** investigates innovative air cleaning solutions to combat healthcare-acquired infection

Over 2016 and 2017, NHS hospitals in England faced an estimated 834,000 healthcare-acquired infections (HCAIs). These accounted for 28,500 patient deaths, 7.1 million occupied hospital bed days and 79,700 days of absenteeism among frontline healthcare professionals. They also cost the NHS £2.7bn.

Later, during the Covid-19 pandemic from June 2020 to March 2021, around 131,000 patients acquired Covid while in hospital, accounting for 1.5% of all admissions.

Hygiene is crucial in all healthcare settings, as ill patients are the most vulnerable to disease or infection. It is estimated that approximately 25% of HCAIs are the result of airborne respiratory diseases, so maintaining the correct ventilation rates is essential. This will ensure that the air is clean and healthy, and that the air occupants exhale – which could be a potential source of infection risk – is removed or inactivated quickly.

However, increasing air-change rates indoors can be costly and disruptive if upgrades to existing systems are needed. Around 50% of NHS facilities are non-compliant with the minimum ventilation standards. Traditional methods of improving ventilation also have an impact on the availability of clinical spaces during renovations, potentially increasing waiting times. Further, higher ventilation rates increases energy use contradicting the government's decarbonisation agenda.

Alternatives exist, however, that align with net zero aspirations and comply with the various guidelines, standards and regulations relating to healthcare building ventilation and infection control and prevention.

During the pandemic, portable air cleaning devices were used for short-term and temporary situations, but the longer-term strategy for the NHS estate is to install hardwired, high-level 'upper room' germicidal ultraviolet (GUV) air cleaning that uses a certain wavelength of light to disinfect the air closest to the source of airborne contamination risk (above the human-exhaled air plume).

Similar GUV technology could be applied to improve overall building ventilation using chemical-free photo-disinfection in HVAC systems. This is achieved by placing an array of GUV lamps within system ductwork, decontaminating air at source. (See panel 'The science behind GUV')

HEPA filters are another alternative. Originally designed to stop radioactive material escaping from labs, they are effective at stopping microbes. They are energy-intensive, however, because filter pores to push air through are so

Special Features

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Heat recovery systems

The science behind germicidal ultraviolet

When pathogens are exposed to GUV light of the correct intensity and exposure time, their DNA/RNA is reconfigured and damaged, rendering it harmless. This leads to safer buildings for patients, staff and visitors. Potentially allowing safely decontaminated air to be recirculated in more areas of the NHS estate will help the service hit net zero targets, allow greater use of workspace, and, theoretically, reduce waiting times.

The inactivation solution depends on the medium (air, water, surface), environment, hazard source, presence of people or animals, temperature, humidity, bio-load, exposure time, and the target microbe(s) that one seeks to eradicate. GUV lamps operate between 200nm and 280nm wavelengths of the electromagnetic spectrum by passing an electrical discharge through a low-pressure gas (including mercury vapour) enclosed in a soft glass or quartz tube.

The optimum wavelength for lamps to operate at is 254nm, when they are germicidal and most efficient at destroying microbiological matter. GUV emitters of 222nm, known as FAR UV, are currently being assessed for future potential and are less harmful to human skin and eyes.

small, and the pressure drop reduces the airflow significantly.

In summary the main options are:

Portable air cleaning units

Portable UVC or HEPA devices should only be considered as a temporary solution. When used, they must be positioned to avoid interference. They operate as recirculating air systems that pass air from the room through a decontamination chamber, which has a GUV light or a HEPA filter, and then discharges cleaned air back into the room. To be effective, they need clear space in front of their intake and their discharge grilles. Most portable units exceed NHS standards on noise.

GUV upper-room devices

GUV upper-room devices have been used for several decades to combat respiratory diseases. They were deployed successfully during the 2003 and recent Covid pandemics in Hong Kong hospitals. These devices were positioned between patient beds, and 2.7 metres off the floor, to intercept and disinfect exhaled air from the patients below.

Upper-room devices are a low-cost, intervention for areas with poor ventilation. They provide an equivalent decontamination rate and make up for shortfalls in conventional ventilation requirements, often exceeding 10 air changes per hour.

GUV in primary ventilation

Correctly engineered GUV lamps installed into HVAC ductwork, whether retrofitted into existing systems or incorporated into new hospitals, would enhance safety from respiratory-driven HCAIs. This intervention would make the NHS estate pandemic-resilient and reduce the burden of respiratory illnesses on hospitals.

Adding GUV light to building ventilation systems is a long-term investment with minimal maintenance. Some products can be linked to the BMS to optimise energy and ventilation rates. GUV is now suggested as a technology suitable for use in recirculation systems in the England Building Regulations and should be retrofitted in the NHS estate to ensure compliance with healthier building standards.

Few studies have been conducted on the impact of GUV on internal air quality. The next step is to run large trials to confirm the benefits in terms of electrical cost savings, reduced staff sickness, and reduced nosocomial infections. According to one report, potential savings could amount to £23bn per year[1]. ●

Mike Ralph is principal engineer at NHS Scotland Assure and a committee member on the CIBSE Healthcare Special Interest Group
bit.ly/CIBHealth

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[1] Infection Resilient Environments Social Cost Benefit Analysis RAE June 2022, **bit.ly/3WPmZjX**

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Ventilation vigilance

With Awaab's Law set to be extended to private rentals, PCA's **James Berry** highlights the importance of effective ventilation strategies to combat mould growth

Condensation and mould growth are often the first visible indicators of inadequate ventilation in buildings, and it can have deadly consequences for occupants. In 2020, two-year-old Awaab Ishak died after prolonged exposure to black mould in his family's one-bedroom flat in Rochdale. In response, the government introduced Awaab's Law in July 2023, as part of the Social Housing (Regulation) Act, which forces social landlords to promptly investigate and eradicate mould. The new government is now proposing to extend the law to private landlords in the Renters' Rights Bill.

Relative humidity (RH) is one of the key parameters in mould growth, and may be an indicator of ventilation and environmental conditions within the building. This article looks at the mechanics of humidity, mould growth, and what we can do about it.

The air's capacity to hold water vapour is related to temperature. The warmer the air, the greater its capacity to hold moisture. The amount of moisture in the air is expressed as RH, a percentage of the maximum amount of water vapour the air can hold at a given temperature. Air is saturated when it cannot contain any more water vapour at the existing temperature; under these conditions it is said to have reached a RH of 100%. If the temperature of the air falls until saturation point – that is, it cannot hold any more water – this is known as the dew point. At this temperature, water vapour will be forced to condense out as liquid water.

As the RH of the air is governed by temperature, care should be taken when considering RH in isolation, as variations may be a result of varying temperature and not an increase in moisture. For this reason, it should be considered an indicator to the capacity of the air to hold water vapour, but not the actual volume of water within the air.

The Building Regulation *Approved Document F Volume1: Dwellings* highlights the risk of mould growth over time when RH is high, and sets limits of 65–85% RH over prolonged periods, ranging from a day to one month. These figures are considerably less than the 100% RH (dew point) that is required for surface condensation to occur. The presence of liquid water is not required for mould growth. With a suitable substrate and adequately high RH, mould spores will germinate.

In the past, condensation and mould growth have been dismissed as problems created by occupancy. However, the problem is often

Running battle

Twelve homes on a housing development in Yorkshire were fitted with MVHR systems, the performance of which attracted numerous complaints from the owners. Upon inspection, it was found that the vast majority of units had not been serviced in the six years that the properties had been built. This would not only void any product warranties, but also impede the performance of the system.

Regular servicing reduces running costs and ensures the system runs quietly and efficiently. If the occupant perceives that the unit is too noisy or expensive to run, the system will be switched off and not used.

Another issue with these homes was that the MVHR units (with vast quantities of inappropriate, performance-hindering flexible ducting) were greatly undersized for the size of the dwelling. They were capable of achieving the flowrates required in Approved Document F, but had to overwork to do so, with unacceptable noise levels. This led to occupants turning them off.

Six-year-old MVHR unit filter that had not been serviced. Clogged filters lead to higher operating costs and inhibit a system's ability to filter out particles such as dust and pollen

multifaceted and consideration of the entire building envelope, occupation density and style, as well as an understanding of building services, are needed to establish the root cause.

Addressing concerns at the pre-construction phase is comparatively easy, although the gap between designed and real-world performance can differ significantly. Addressing them when working within the confines of an existing structure presents a different set of challenges, where sometimes little is known about the structures, fabric thermal performance, and air infiltration rates.

Understanding how to balance moisture production, insulation, energy input (heat) and ventilation, combined with a good technical understanding of the science of air moisture and condensation, is key to eliminating condensation and mould. If there is no obvious excessive source of moisture, then adjustments will need to be made to heating and ventilation.

Ventilation strategies, moisture production and heat input are typically dependent on occupants' input, and residents are often given little guidance on how to operate, balance and maintain these systems – sometimes leading to them being turned off by occupants (see panel, 'Noisy neighbours'). Turning off mechanical ventilation with heat recovery (MVHR) units will result in low air-exchange rates and poor indoor air quality, particularly in more airtight and thermally efficient properties.

There is also widespread misunderstanding about the function of trickle vents, which are frequently shut over concerns about draughts and heat loss. A government report on ventilation[2] showed that just 29% of trickle vents were open when a study was conducted into the ventilation performance across 80 new dwellings.

Trickle vents are an essential component of continuous mechanical extract ventilation systems, and increasingly so for natural ventilation systems with intermittent extractor fans. In the latter, the fan is a form of purge ventilation, removing high levels of moisture or pollutants, while background ventilators (trickle vents) provide 'whole dwelling ventilation'.

The Future Homes Standard aims to make buildings more airtight, which leaves less margin for error when it comes to the provision of adequate ventilation. As ventilation strategies can often be disjointed, we need to encourage more collaborative working from the outset to prevent a rise in damp and mould problems. ●

James Berry is deputy chief executive at the Property Care Association

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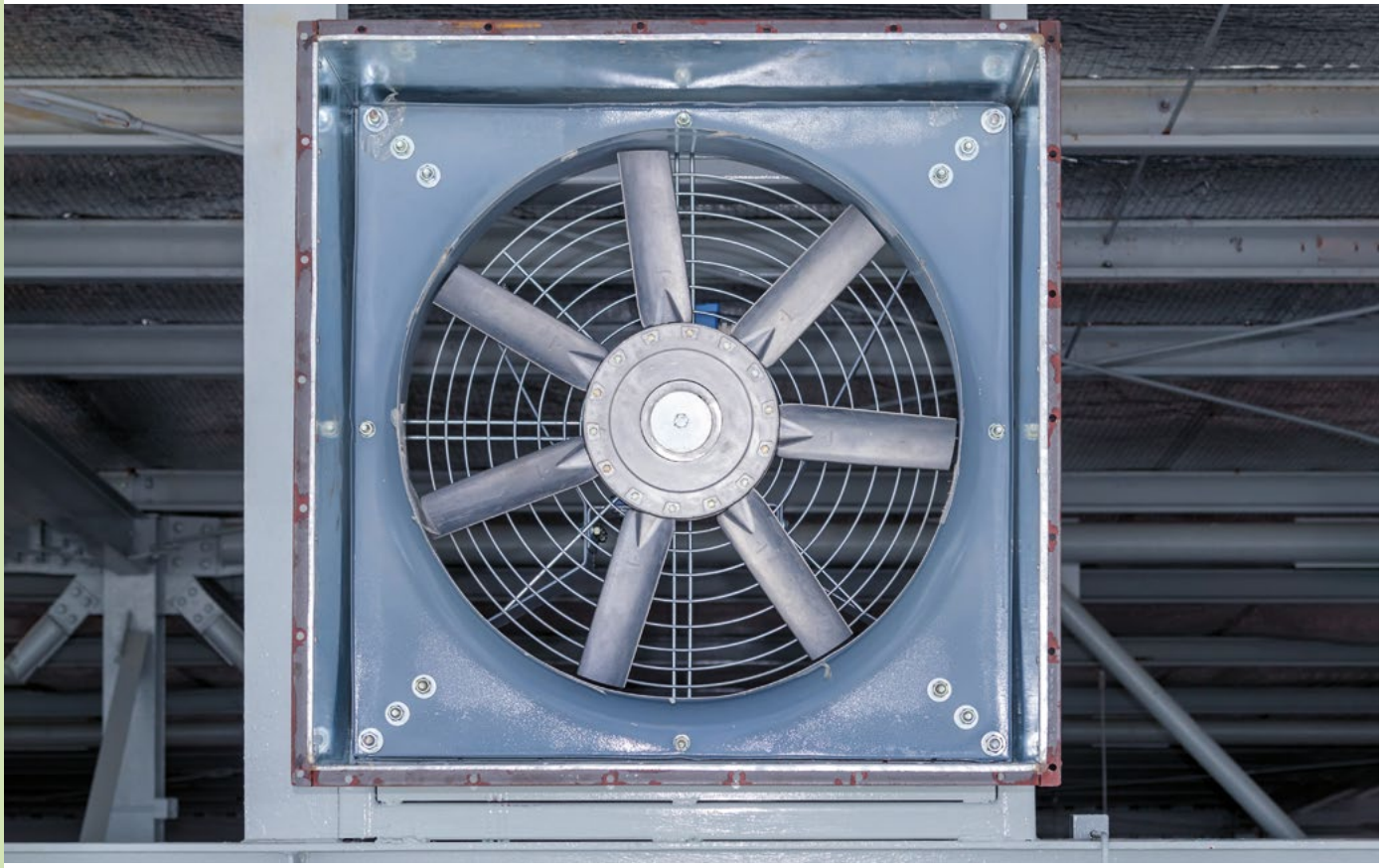
[1] Appendix B, *Approved Document F Volume 1: Dwelling* 2021 HM Government **bit.ly/3WD3evF**
[2] *Ventilation and indoor air quality in new homes*, Ministry of Housing, Communities and Local Government, 2019, **bit.ly/3M3UlGt**



Staying in the loop

Feedback loops identify what is going routinely wrong in buildings and give valuable insight into how future building performance can be improved. **Susie Diamond** and **William Box** explain the concept, and discuss how it could be applied to ventilation

One of the issues behind the persistent performance gap in buildings is broken feedback processes during design, construction and operation. For high performance to be assured, and not accidental, we recommend three classes of feedback loop: short, medium and long.

Short loops focus on giving immediate feedback when building performance is deviating from good. Medium loops link in-use performance data to energy performance models, to check whether performance is deviating over the year, and Long loops identify and communicate what works robustly in practice over time, and what doesn't. (See panel, 'Levelling up'.)

In this article, we look at how feedback loops could be put in place to optimise ventilation. As buildings become more energy efficient, managing ventilation becomes ever more important. Unfortunately, many ventilation systems fail to work effectively in real life, impacting on energy and carbon targets, and contributing to the 'performance gap'.

These failures also affect the comfort, and sometimes health, of building users. We have been looking at real-life building performance for more than 20 years, and issues with ventilation systems are a recurring theme. One example was a highly ventilated laboratory building where the heat recovery system is central to the building's energy performance. Predictive energy modelling and the use of live metering data revealed that the ventilation was using much more energy than expected in one part of the building. It transpired that:

1. The importance of the heat recovery system had not been quantified or communicated during the design and build stages
2. The heat recovery system would periodically fail, but was not alarmed in the building management system (BMS), so fixing it was a lower priority and could take weeks
3. A key part of the heat recovery system had been fitted in the wrong duct, so the system could not work as designed, and this was not picked up during commissioning.

We see the same root causes in many cases – here are questions we think worth asking around feedback loops:

a) Do you have a reasonably accurate model of how the 'as built' building is anticipated to perform? If not, how will you know if or when the building is

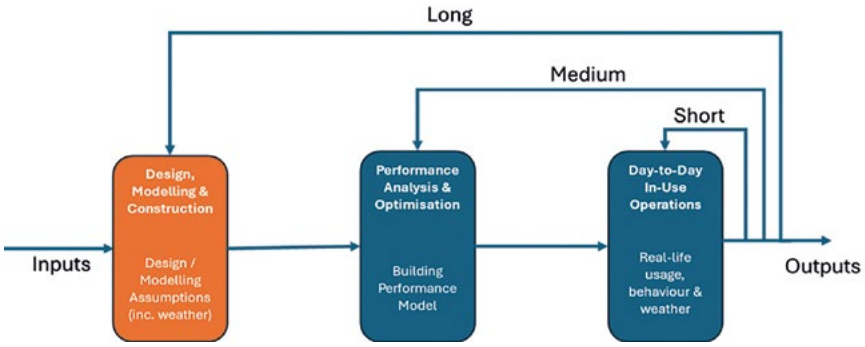
working as intended? If you do have a model, does it assume that all systems work all of the time? Is this reasonable? Can you model the impacts on energy, cost and comfort of scenarios where key systems are not working as planned? Can you break down the expected energy use from your modelling to a level where it can be used for operational monitoring and issue detection?

b) Within your building, can you identify the main systems where failure will undermine performance? Can you quantify this in kWh, tCO_2 and £s per week/month/year? An operations team knowing that a particular system is 'important' is good, but the team knowing that a failure may cost £5k per month of extra energy charges is better. Alongside O&M manuals, can you produce a one-pager that sets out the five top systems that are key to keeping the building on track, energy-wise?

c) Does the installation, commissioning and operations process ensure that these five systems work properly and can be detected and fixed when they fail – all systems do at some point.

Above all, we need to consider human beings as an integral part of building performance. People won't remember a 300-page O&M document, but they may take on board which specific systems they need to keep their eyes on most. ●

● **Susie Diamond is founder at Inkling (read an interview on page 22) and William Box is managing director at Carnego Systems**



Levelling up

At the 2024 CIBSE Technical Symposium, William Box and Susie Diamond challenged the community to do more to close the performance gap by embedding three levels of feedback loop into routine practice. The levels are:

Short loops provide immediate feedback when building performance is deviating from good practice. This might include BMS alarms, or routine checks that FM teams can perform to ensure the building is working as intended. These should be prioritised by designers, based on highest performance risks.

Medium loops take into account different operating modes for the seasons and years. On more complex buildings, this would use a 'digital twin' dynamic thermal model, which could be updated and reflect recent weather and operational patterns. This could be used to explore any deviations between model predictions and performance. Deviations can be due to unrealistic modelling assumptions or areas where the building is not optimised.

Long loops are beyond the single building, and are about communicating what works robustly in practice over time, and what doesn't. They can be used to influence the design of future buildings or retrofits. Is a design option that saves 10% on operational energy, but that only has a 25% chance of working consistently, better than one that saves 5% but will work 90% of the time?

If the industry had learned from all the (energy) mistakes we have made in buildings in the past, Box and Diamond say operating buildings to achieve near net zero energy would be considered business as usual.

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Lighting solutions for educational environments

This module explores the impact and value of suitable lighting in learning-based applications

This CPD article examines the important role of lighting in educational environments, emphasising how modern systems can enhance student wellbeing, improve the overall learning experience for both traditional and therapeutic learning spaces, and reduce the operational costs of buildings.

UK primary and secondary school students annually spend around 180 days in classrooms, and their internal environment can significantly impact their academic performance. A 2021 transverse study, employing the massive SINPHONIE[1] dataset, highlighted that daylight has the highest impact on overall student progress among all design parameters in schools,[2] indicating that larger window areas are advantageous, and that appropriate shading is important. The complete lighting solution will influence various factors, including student concentration, behaviour, and overall performance, and the complementary contribution of controlled natural and artificial lighting has been shown to be beneficial.[3] A study[4] involving 84 pupils in the mid-south region of the USA indicated that a 'focus' illumination level of 1,000lx, with a cool temperature of 6,500K, could improve activities that required oral reading fluency (ORF) compared with a 'normal' lighting level of 500lx and 3,500K, which would be used for other activities. (See the boxout, 'The temperature of light', for a brief explanation of colour temperature.) This aligns with findings[5] from a series of field and experimental studies showing that appropriate lighting significantly enhances students' concentration and academic performance.

There are several standards and guides to aid the design and implementation of lighting in educational environments. These include: the 2011 CIBSE LG5[6] *Lighting for Education* (currently under review), which provides comprehensive guidelines specifically for educational facilities; the UK DfE School Output Specification Technical Annex 2E – Daylight and Electric Lighting[7], which provides the minimum requirements for daylighting and electric lighting in schools (and similar premises); and BS EN12464-1:2021[8] *Lighting of Work Places – Part 1: Indoor Work Places*, which specifies lighting requirements for indoor workspaces, including educational facilities. From the USA, the Illuminating Engineering Society's *Recommended Practice for Lighting for Educational Facilities*[9] provides specific guidelines for lighting educational spaces, emphasising the impact of lighting on learning and student wellbeing.

Poor lighting can lead to eye strain, fatigue, and diminished concentration,[10] while well-lit classrooms with the right balance of natural and artificial light can help students remain attentive and behave positively.[11] Managing glare can have a significant impact in educational settings, preventing discomfort and improving visual performance. The benefits of reducing visual discomfort and improving performance have been studied extensively, showing significant positive impacts on students' ability to concentrate and perform academically. For example, Winterbottom and Wilkins[10] found that poor lighting conditions – including glare from windows and fluorescent luminaires – can cause discomfort and impair visual performance, affecting students' ability to concentrate and learn effectively.

Human-centric lighting solutions can be designed to mimic the profile of natural light – which is thought to regulate circadian rhythms – reducing early-morning tiredness and boosting alertness throughout the day. The use of lighting with adjustable colour temperatures can simulate natural light patterns, helping students maintain better sleep cycles and overall health.[11]

Current, commercially available LED technology can achieve luminous efficacies of 140–190lm·W^{-1} compared with circa 100lm·W^{-1} of common lamps employed from the beginning of this century. This contributes to a significant reduction in the number of required

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fittings and operational costs. Depending on the choice of luminaire, a colour rendering index (CRI) of greater than 80 is readily available from LED fittings, meeting the typical requirements for educational applications.[7] Typically, these modules maintain 70%–90% of their initial lumen output after 50,000 hours of operation – an operational life that goes far beyond that of previous technologies, such as fluorescent lamps, which have a maximum life of 15–20,000 hours. This longevity reduces the frequency of repair and replacement, minimising maintenance costs and disruption in the educational environment.

Diffuser optics for such applications should be designed to minimise glare and control ceiling illumination. This is particularly beneficial in classrooms and lecture rooms, where prolonged exposure to improperly controlled light sources can cause eye strain and reduced concentration. These effects have been measured in the field by employing a combination of subjective reports of discomfort, objective assessments of visual performance, and physiological indicators, such as blink rate and pupil size.

As well as providing effective solutions for new-build installations, LED lighting systems can be designed as a replacement for legacy systems to deliver significant energy savings and improve visual comfort, so boosting alertness and wellbeing among students. The controllability of suitably equipped LED luminaires, linked together with systems such as digital addressable lighting interface (DALI), can enable more granular control and monitoring. This can be used to provide flexible lighting schemes that are readily adjusted – manually or automatically – employing features such as daylight dimming, scene setting and scheduling. Employing such control can optimise the lighting provision based on real-time demand, the availability of natural light and the required occupant experience. Such systems also allow for adaptable lighting environments suited to a range of educational activities. For example, in lecture theatres, scene control – such as dimming controls – can allow lighting to be adjusted for presentations, note-taking or video viewing, providing an optimal setting for each activity.[7]

Lighting automation can be integrated with other building management systems to optimise energy use and enable enhanced monitoring and maintenance of lighting systems. LED lights with adjustable brightness and colour temperatures have been shown to reduce anxiety, improve task-switching focus[12] and create a more inclusive learning environment. Research indicates that lighting conditions can significantly impact cognitive and emotional states. For instance, appropriate lighting has been found to enhance students' focus, positively affect students' concentration[13] and reduce anxiety[14] by creating a more comfortable and adaptable learning environment. Creating calm areas with low or dim lighting can reduce stress and anxiety.

Lighting can play an important role in creating therapeutic and inclusive classrooms that support the wellbeing of all students, including those with neurodiverse needs. Glare from excessively bright sources of light – natural and artificial – and flickering lights can cause discomfort and disrupt concentration, particularly for individuals with photosensitivity and specific neurodiverse conditions. Additionally, glare can adversely impact students' ability to read display boards and screens, or to focus on the teacher. Studies[15] have identified the benefit afforded by therapeutic classrooms with stable, adjustable lighting environments that can improve the learning experience for students with neurodiverse needs by minimising sensory overload. LED solutions – which do not flicker or hum – can provide such adjustable lighting environments, offering flexibility in brightness and colour temperature.

Whether new-build or refurbishment, suitable LED luminaires are available that can cater to a wide range of educational applications. For example, Figure 1 illustrates an application that required a high-level installation to meet the varying lighting

The temperature of light

Correlated colour temperature (CCT), measured in degrees Kelvin (K), is used to describe the colour tone of a light source by comparing it with the colour of light emitted by a blackbody radiator (such as is approximated by an incandescent lamp).

2,000K to 3,000K: A warm, yellowish light, similar to the light from traditional incandescent bulbs or a sunset. This creates an inviting atmosphere, and is often used in residential settings, restaurants and hospitality environments.

3,100K to 4,500K: A neutral white light, like natural daylight. Often used in offices, kitchens and workspaces to provide a balance of warmth and coolness.

4,600K to 6,500K and above: A cool, bluish light, like daylight at noon. Creating a bright, alert environment, and commonly applied in commercial, industrial and outdoor applications.

Figure 1: High-output luminaires (with wire guards) were used in the gym of Hastings College. These luminaires have a high output with a wide-angle optic. This LED module delivers CRI>80, CCT of 4,000K and up to 168lm·W^{-1}

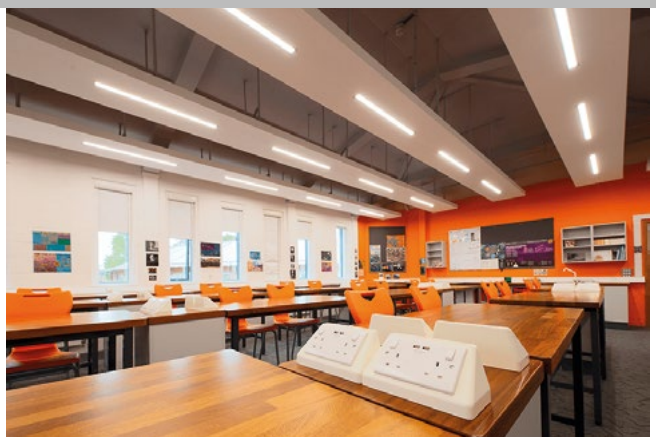

Figure 2: A refurbishment project at the science block of Radley College replaced outdated lighting systems with task lighting installed directly over desks and workspaces, employing luminaires with opalescent diffusers. This LED module delivers CRI>80, CCT of 4,000K and up to 121lm·W^{-1}

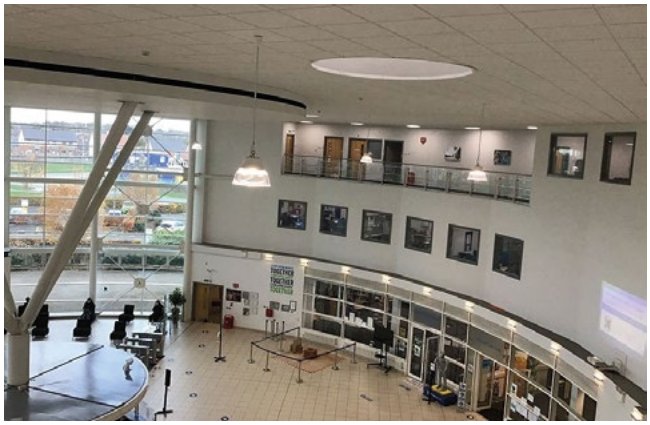

Figure 3: High-output LED modules with a wide-beam optic significantly reduced the number of luminaires required in the refurbishment at Darlington College. This die-cast aluminium body LED module with prismatic polycarbonate diffuser delivers CCT of 4000K and up to 130lm·W^{-1}

Figure 4: Installation of low-glare luminaires in IT rooms and science labs for Thornleigh Salesian College limited screen glare, delivered uniformity and optimal spacing to prevent shadowing, and provided adequate lighting for detailed tasks. The light delivered from the opal polycarbonate diffuser, CRI>80, CCT of 4,000K up to 120lm·W^{-1}

demands required for a multi-use gymnasium. The LED luminaires shown in Figure 2 replaced a legacy system to provide task lighting above benches in a school laboratory, improving the quality of lighting and achieving a high uniformity of illuminance across the working plane, with diffuse light levels that minimised shadows. Figure 3 indicates how an LED lighting system can be styled to accentuate the contemporary design of an existing entrance area, while maintaining the benefits of LED systems. Figure 4 is an application of a low-profile LED fitting, integrated into a modular false ceiling, where the optic is designed to deliver diffuse light to minimise shadows.

All these illustrated LED applications provide high luminous efficacy, and reduce operational costs through lower energy consumption and longer lifespan. The solutions also support institutional goals for sustainability by reducing carbon footprints.

It is beneficial to engage the operator and end user in the development and operation of lighting systems. Staff and students can significantly impact the operational success of an installation, so it is important that they have a decent understanding of the role and control of both natural and artificial lighting, and how to use adjustable lighting systems effectively.

By focusing on energy efficiency, human-centric design and therapeutic benefits, institutions can enhance student wellbeing, improve academic performance and achieve sustainability goals. A holistic approach to design can help ensure that lighting systems contribute towards the best possible environments for learning and development. ●

● **Thanks to Nicola Lloyd, of Tamlite, for her enthusiastic research assistance**

Module 236

September 2024

1. According to the article, what is the primary role of lighting in educational environments?

- ☐ A Reducing electricity bills
- ☐ B Enhancing student wellbeing
- ☐ C Minimising the use of natural light
- ☐ D Promoting architectural aesthetics
- ☐ E Increasing the number of classrooms

2. According to the study referred to in the article, which design parameter has the highest impact on student progress in schools?

- ☐ A Artificial lighting
- ☐ B Classroom layout
- ☐ C Daylight
- ☐ D Wall colours
- ☐ E Furniture design

3. What lighting level and colour temperature were found to improve oral reading fluency in a study involving 84 pupils?

- ☐ A 300lx, 2,700K
- ☐ B 500lx, 3,500K
- ☐ C 750lx, 5,000K
- ☐ D 1,000lx, 6,500K
- ☐ E 1,200lx, 4,000K

4. What type of lighting environment is most likely to be beneficial for creating therapeutic and inclusive classrooms?

- ☐ A Bright, fixed lighting
- ☐ B Flickering, fluorescent lighting
- ☐ C Stable, adjustable LED lighting
- ☐ D Natural light without shading
- ☐ E Dim, incandescent lighting

5. Which lighting solution was used in the gym of Hastings College?

- ☐ A Task lighting with opalescent diffusers
- ☐ B Low-glare luminaires with opal polycarbonate diffusers
- ☐ C High-output LED modules with prismatic polycarbonate diffusers
- ☐ D High-output luminaires with wide-angle optics
- ☐ E High-output LED modules with a narrow-beam optic

Name (please print) .....

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New members, fellows and associates

FELLOWS

Hassan, Sherif
Greenford, United Kingdom

Jones, Ewan Edward Newman
Leeds, United Kingdom

Kinghorn, David Martin
Dollar, United Kingdom

Koo, Tony Chun Wing
Kwun Tong, Hong Kong

Liang, Hong
Salisbury, United Kingdom

O'Sullivan, Gerard
London, United Kingdom

Royapoor, Mohammad
London, United Kingdom

MEMBER

Adomakoh, Frederick
London, United Kingdom

Ambalo, Taliya
London, United Kingdom

Anderson, Jason
London, United Kingdom

Aref, Mohammed
Dubai, United Arab Emirates

Ashcroft, Keiran
Lincoln, United Kingdom

Ashfaq, Asad
Manchester, United Kingdom

Asmar Ul Hassan, Syed
Peterborough, United Kingdom

Atteya, Ahmed
Slough, United Kingdom

Baz Sanchez, Gerardo
Pinner, United Kingdom

Brady, Kevin
Lurgan, United Kingdom

Brown, Chris
Winchester, United Kingdom

Brown, Ewan
Edinburgh, United Kingdom

Brydon, Gordon Jack
Edinburgh, United Kingdom

Cagla, Caner
Birmingham, United Kingdom

Chan, Kin Chung
Kowloon, Hong Kong

Chanrachakul, Jennarong
London, United Kingdom

Clarke, Isobel
Bristol, United Kingdom

Collcutt, Natalie
Sunbury-On-Thames, United Kingdom

Cooper, Rustin
Kingsbridge, United Kingdom

Croft, Bradley
Blackpool, United Kingdom

Crofts, Toby
London, United Kingdom

Dawson, Rob
Durham, United Kingdom

De Abreu, Wayne
Milton Keynes, United Kingdom

Dearson, Hazel
London, United Kingdom

Fairley, Gregor
Edinburgh, United Kingdom

Fehmi, Arin
London, United Kingdom

Galatolo, Elia
London, United Kingdom

Gavrilovs-Stepanovs, Dmitrijs
Hamilton, New Zealand

Gray, Callum
Feltham, United Kingdom

Greenacre, Michael
Princetown, United Kingdom

Gregory, Joseph
London, United Kingdom

Guan, Shutang
Kowloon, Hong Kong

Gurung, Shibendra
Birmingham, United Kingdom

Hamid, Asma
Maidenhead, United Kingdom

Harcombe, Geraint Rhys
Penarth, United Kingdom

Heitmann, Zak
Tamworth, United Kingdom

Hendriks, Reuben
Singapore, Republic of Singapore

Hennessy, Lorna Jane
Fortitude Valley, Australia

Hong, Chun Hei
Hornchurch, United Kingdom

Houlis, Nikolaos
St Albans, United Kingdom

Howard, Alexander
Leicester, United Kingdom

Imedouane, Abdoullah
London, United Kingdom

Jagger, Michelle
Melbourne, Australia

Jenkins, Amy
Wallington, United Kingdom

Johnson, Keith Brian
Glasgow, United Kingdom

Kataria, Gaurav
London, United Kingdom

Lam, Chung Ching
Tseung Kwan O, Hong Kong

Lau, Hoi Shuk Virginia
Sai Kung, Hong Kong

Lau, Yu Mung
Tseung Kwan O, Hong Kong

Law, Pak Yu
Kwun Tong, Hong Kong

Lloyd, Michael
Wigan, United Kingdom

Low, Jun Heng
Audenshaw, United Kingdom

Lwin, Zaw
Manchester, United Kingdom

MacDonald, Robert
Brighton, United Kingdom

Marsh, Anthony
Sheffield, United Kingdom

Marsh, Candice
Gibraltar, Gibraltar

Mason, Silke
London, United Kingdom

Mohamed, Mohamed Munir
London, United Kingdom

Mowat, Caroline
Edinburgh, United Kingdom

Mulloy, Chris
Woking, United Kingdom

O'Toole, Kyle
Cannock, United Kingdom

Page Giles, Emily
Newark, United Kingdom

Parker, Stephen
Haarlem, Netherlands

Pau, Kai Yin Thomas
Tuen Mun, Hong Kong

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Pires Lins da Silva, Isabel Carolina
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Pocklington, Ian
Bishop's Stortford, United Kingdom

Pollock, Martin George
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Price, Jack
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Rogers, Matthew
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Penarth, United Kingdom

Stark, Mathew Thomas
London, United Kingdom

Tam, Jacky Kit Hin
Kennedy Town, Hong Kong

Tang, Ka Chun
Tseung Kwan O, Hong Kong

Tapparo, Alessandra
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Vassilatos, Eleftherios
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Vause, Erin
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Wiatr, Kamila
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Wong, Ka Hang
Fanling, Hong Kong

Wong, Wang Tat
Tsuen Wan, Hong Kong

Wong, Yat Wai
Yau Tong, Hong Kong

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Penarth, United Kingdom

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Dunstan, Simon
Truro, United Kingdom

Jenkins, Elliot
Northfleet, United Kingdom

Johnston, Tom
Warwick, United Kingdom

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Buritica Marin, Daniel
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Coutts, Alex
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Dougray, Mark
Port Noarlunga, Australia

Eyre, Jake
Ipswich, Australia

Gray, Aston
Northfleet, United Kingdom

Grummitt, Joshua
Cambridge, United Kingdom

Hayward, Andrew
Sutton, United Kingdom

Keskin, Cem
Uskudar, Turkey

Keyes, Niall
Carlisle, United Kingdom

Jones, Hannah
Warwick, United Kingdom

Products of the month

IWTM introduces new water monitor

New digital Protector range and DFU meters are part of the connected water strategy.

IWTM has added to its connected water strategy with two new products for the real-time monitoring of water quality in closed loop heat and chilled water networks. The IWTM digital Protector units monitor pressure and temperature, and include sensors for pH, conductivity and, if required, dissolved oxygen, the three critical elements for VDI 2035 compliance.

Anode current is also measured so alerts can be issued if the anodes require replacing or are fouled. Total flow and flow-rate monitoring is also standard and can create an alarm in the BMS if flow is restricted, often an indicator that the particulate filter requires cleaning.

The DFU meter, which sits on the outlet of IWTM's ProFill demineralisation unit, monitors incoming water quality, recording live readings for conductivity, total flow and flow rate. This can indicate when the resin needs replacing and alerts for system water loss.

Both units meet recommendations laid out in CIBSE's CP1 code of practice for real-time monitoring of water quality and early warning of system water loss. Real-time monitoring allows immediate action to be taken to events that can impact operation, water quality and system efficiency, a benefit not provided with current periodic onsite testing.

The digital units are currently available on

IWTM Protector P10 to P70 units and give a local display of information to plantroom engineers. They connect to BMS through both MODBUS and BACNet protocols with visibility available through any web-connected device or restricted to LAN according to site-specific security protocols.

Both allow access to current and historical data. All digital units are skid mounted with pre-wired manifolds, ensuring correct and simple installation.

● **For more information on these products for new build and retrofit applications visit www.iwtm-uk.com or call the office on 020 8255 2903.**

Combat overheating in homes with latest Vent-Axia MVHR system

As houses become more airtight to reduce carbon emissions, overheating is an increasing concern. Vent-Axia has launched the Lo-Carbon Sentinel Econiq Cool-Flow, an innovative mechanical ventilation with heat recovery (MVHR) system designed to combat the problem.

The Cool-Flow system combines advanced heat recovery with intelligent cooling, automatically adjusting to internal and external temperatures to maintain optimal comfort all year.

In cooler months, it provides up to 93% heat recovery, reducing heating costs, while in warmer months, its intelligent summer bypass and cooling module prevents overheating.

The system, designed to meet the latest Residential Part O and CIBSE TM59 standards, also allows homeowners to control ventilation via a smartphone app. Additionally, it is one of the quietest systems on the market, with advanced noise-reduction technology, including acoustic enclosures and anti-vibration mounts.

● **For more information visit www.vent-axia.com.**

Passivent supplies ventilation to Olympic and Paralympic facility

Passivent has provided 11 Airscoop roof-mounted terminals for Sport England's new £3.6 million archery facility at Lilleshall National Sports Centre, Shropshire. The natural ventilation system, ideal for large spaces, ensures fresh air circulation by directing air through four chambers while extracting stale air. Controlled by Passivent's iC8000 intelligent controller, the system adjusts based on temperature and CO_2 levels. This eco-friendly solution supports UK Sport's sustainability goals and reduces maintenance costs, and will serve Olympic and Paralympic archers.

● **To find out more, visit www.passivent.com, call 01732 850 770**

Hamworthy expands low-carbon range with new CO_2 heat pumps

Hamworthy Heating has launched the Tyneham CO_2 and CO_2Q monobloc heat pumps, featuring natural refrigerant R744 (CO_2) with ultra-low global warming potential. The pumps achieve high temperatures up to 70°C and offer a coefficient of performance (CoP) of up to 3.4. Available in six models, they provide outputs from 65kW to 130kW, with options for low noise operation.

● **For more details, visit www.hamworthy-heating.com**

E-Tech M is latest addition to ACV's low-carbon electric heating solutions

ACV UK has introduced the versatile E-Tech M electric heater to complement its low-carbon electric heating line-up. The new mobile heater accelerates screed drying while serving as a backup heating solution. With a plug-in adaptable to six power sources ranging from three to 36kW and automatic power detection, it suits various commercial and industrial projects.

● **For more info visit www.acv.com/gb.**

Training opportunity in wastewater and sewage pumping systems

Jung Pumpen GmbH, in collaboration with its Authorised UK Division, Pump Technology Ltd, is hosting a specialised training session on wastewater and sewage pumping systems. The course will be held at Jung Pumpen's facilities in Steinhagen, Germany, from 11 to 13 December 2024.

● **To book, contact David Johnson at davidj@pumptechnology.co.uk or visit www.jung-pumps.co.uk.**

Expert Training Academy in Luton opens its doors

Hamworthy Heating has announced the opening of a new Expert Academy training facility in Luton, aimed at supporting heating engineers across the south and Midlands.

The 16,000 ft² facility offers four training areas and a large conference space. Courses include topics like commercial gas boiler training and air source heat pumps.

● **For more details and to register, visit www.hamworthy-heating.com.**

Directory

Your guide to building services suppliers

Q&A

Building services engineers are crucial in addressing climate change through innovative design and sustainable practices. **Ashley Bateson** discusses how engineers can drive the transition to net zero

As the climate crisis intensifies, building services engineers are at the forefront of developing sustainable and resilient infrastructure solutions. Initiatives include CIBSE's evolving Climate Action Plan, the Net Zero Carbon Building Standard, and the Building Services Engineers Declaration on the Climate and Biodiversity Emergency, which held a London conference this year. Its chair, Ashley Bateson FCIBSE, a director at Hoare Lea, discusses the event.

Q How can the building services industry tackle climate change?

A There is an enormous opportunity, and responsibility, for the industry to influence the climate emergency in terms of mitigation. For example, reducing greenhouse gas emissions, and adapting buildings for future climate scenarios. We can design and operate MEP systems to be more efficient and replace fossil fuel equipment with electric systems. Engineers can also recommend onsite renewables and advise on efficient building envelope performance, and on strategies to optimise façade insulation, or adopting solar shading.

How can we integrate biodiversity into new and existing sites?

Nature was a key topic at this year's conference. We spoke about the role of green roofs and nature-based solutions in improving the microclimate of the built environment. Evidence shows people feel more relaxed and healthier in biodiverse environments.

Engineers must collaborate with landscape architects and advocate the inclusion of nature whenever possible, as this can cool external spaces as well as solar PV panels, which improves their efficiency. The new national Biodiversity Net Gain requirements give an opportunity to include nature in projects.

How are building services engineers taking the lead in the Net Zero Carbon Building Standard (NZCBS)?

We have more responsibility and influence than any other profession in assessing and verifying the NZCBS. The standard is a collaborative industry initiative, but the metrics for achieving it should be familiar to building services engineers following best practice.

Buildings will be required to meet energy use intensity and embodied carbon targets. It is important we take the lead on this, establishing early-stage assessments, and guiding project teams to meet targets.

How do we target net zero and create climate resilient buildings?

If we design energy efficient buildings without designing for climate change, we risk creating further problems as the climate gets hotter and wetter. Homes and schools can suffer from overheating because designs haven't considered solar gains or provided enough ventilation. New and refurbished buildings need to be future-proofed using weather modelling conditions, with a priority for passive design.

> **"Buildings need to be future-proofed using weather modelling conditions"**

Passive strategies can include optimising the building form and configuration of windows, applying solar shading and providing sufficient purge ventilation. Demand for cooling can increase if we don't anticipate global warming. It will require close collaboration with architects to ensure we give early advice on how design will influence comfort and energy use.

What can be done to ensure designs minimise embodied carbon?

The new NZCBS will require designers to assess embodied carbon in their projects, raising awareness of the impact of what engineers specify. It will be a voluntary standard, but we know many leading developers and investors will want to adopt this. There are some basic principles in reducing embodied carbon: use less, use longer and use again. Simple designs can minimise the amount of material required.

Engineers should be asking makers for Environmental Product Declarations (EPDs) to ascertain the embodied carbon arising from the equipment they supply. Designers also need to think about a life-cycle perspective to minimise the embodied carbon that can come from replacing and repairing equipment. Specifying resilient materials and designing with adaptation in mind, should be prioritised to target low whole-life carbon. ●

Further reading
Climate Action Plan bit.ly/NZpolicy, Building Services Engineers Declare www.buildingservicesengineersdeclare.com

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The FGG Flowgrid has been designed to measure air volume in ventilation ducts. The Flowgrid consists of a standard duct section with a length of 200 and 300 mm and is available with a 20-30 or 40mm duct connection flange to suit standard duct work

The CMR sensing probes are fitted across the internal duct frame area in predefined spacing. Each probe has a number of pressure inlet points to measure the impact and static pressure at the same time and provide an average velocity measurement.

The result is a velocity pressure which ultimately provides a total air volume measurement. Both static and impact pressure have an independent pressure averaging tank which provides a smooth pressure signal of the whole measured area.

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The Flowgrids are manufactured in standard height increments of 100mm going up to a maximum height of 1200mm. Custom sizes can be made 3000 x 3000mm

The Flowgrids are installed in many projects such as

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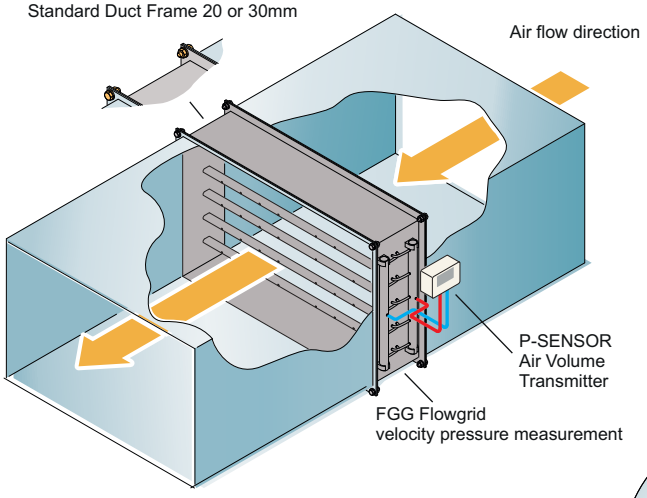
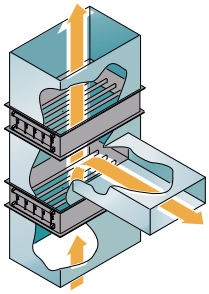
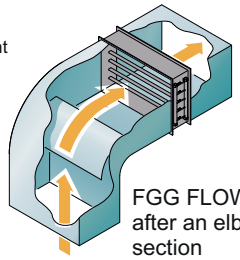
FGG FLOWGRID and P-SENSOR providing accurate average air volume measurement in ducts.



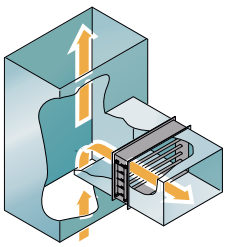
P-SENSOR
With LCD display
and keyboard



FGG FLOWGRID
before and after a
T- duct section



FGG FLOWGRID
after an elbow duct
section



FGG FLOWGRID
in a T- duct section

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