CIBSE JOURNAL

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MAKING IT IN AMERICA

Passivhaus takes New York as The House at Cornell Tech wins CIBSE award

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HOT WATER TANKS GAIN INTELLIGENCE

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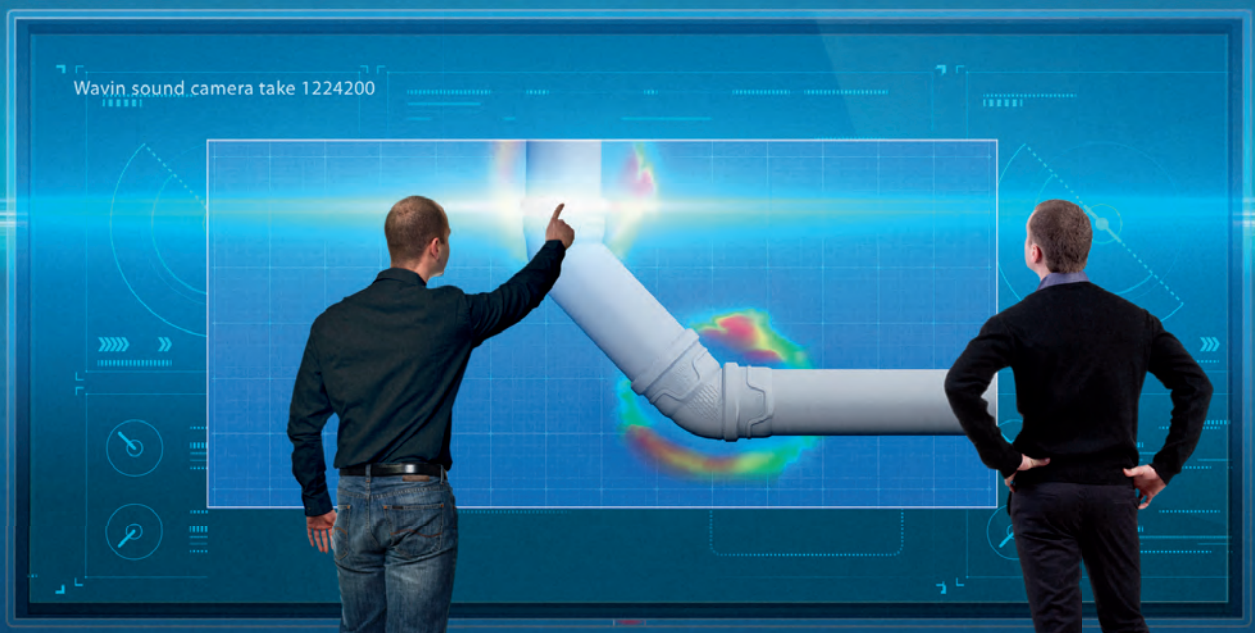

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Making a contribution

If the built environment is to hit carbon-reduction targets, every sector of the industry will need to contribute, whether that be the consulting engineer behemoth or the clean-tech startup challenging the status quo.

There are examples of both in this month's *CIBSE Journal*. Buro Happold was the undoubted star of the 2021 CIBSE Building Performance Awards, being named overall Building Performance Champion and winning three other categories. Our cover feature tells the story of its services design for The House at Cornell Tech, which – at one point – was the tallest certified Passivhaus building in the world. The scale of the tower proves that the low-energy standard has grown up, and that the principles of passive design and proving performance can be applied to any building.

Buro Happold is still engaged with The House at Cornell Tech, and its engineers are discovering that the unpredictability of human nature means that matching actual operation of the building with the predicted can take time.

For new buildings to be at their optimum, lessons learned from commissioning and operation need to be fed back to FMs and project teams, to ensure good practice is captured and maintained. Buro Happold did exactly this when it helped to create a project-review process for University College London that went on to win the Learning and Development category at the Building Performance Awards.

The project-review guidelines it produced were intended to ensure UCL's buildings: perform as intended; reduce the 'performance gap'; and document lessons learned from projects undertaken by the estates team. As UCL senior sustainability manager Ben Stubbs noted, without such a process in place, good intentions are in danger of not being realised.

Technology can also be used in certain circumstances to enhance performance. Oxford startup Mixergy has given the humble hot-water cylinder a smart makeover to help building owners maximise energy and carbon savings. Its hot water tank has been designed to be charged in increments, using whatever is the cheapest – or least carbon-intensive – energy source available. This might be from rooftop renewables, a heat pump, or the National Grid at night, when the cost of electricity can be negative.

Customers can also do their bit for the electrical stability, by allowing Mixergy to remotely take over their tank and help balance the National Grid. Seven hundred Mixergy owners are already doing so, making the airing cupboard the new technology hub of the home (page 48).

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Hywel Davies
Why it is vital to adopt ambitious minimum standards for both new buildings and retrofit, now

Julie Godefroy
Proposals for the Future Homes Standard are dissected, and suggestions made for improvement

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IN BRIEF

Sustainability focus in RIBA Plan of Work

In the first overhaul of the guidance since 2013, RIBA has addressed sustainable design in its updated Plan of Work, published at the end of February.

The updated document includes a 17-page 'sustainability project strategy', setting out specific actions and tasks at each of the eight stages. These replace the Green Overlay from 2011, and range from appointing a sustainability champion to carrying out post-occupancy evaluation.

The document outlines the desired outcome for each stage, with reference to eight factors derived from UN development goals and includes significant post-occupancy actions.

BP planning largest UK hydrogen project

BP is planning to produce up to 1GW of 'blue' hydrogen – 20% of the UK's hydrogen target – by 2030 in a project planned in Teesside, and supporting development of the region as UK's first hydrogen transport hub.

It would be the UK's largest blue hydrogen production facility and it would capture and send for storage up to two million tonnes of carbon dioxide (CO_2) annually.

The H2Teesside development is close to North Sea storage sites, pipe corridors and existing operational hydrogen storage and distribution capabilities. Industries in Teesside account for more than 5% of the UK's industrial emissions.

CLC launches zero carbon plan

The Construction Leadership Council (CLC) has urged businesses 'to play their part' in achieving net-zero carbon construction by 2050.

In the year the UK hosts COP26, the CLC says it is 'imperative that the construction sector steps up and supports the Race to Zero'. It has unveiled its CO_2nstruct Zero programme to drive down carbon. Priorities include: improving existing housing energy efficiency; scaling up industry capability to deliver low carbon heat solutions; and supporting heat pump deployment, trials of hydrogen heating, and heat networks. It also wants higher operational energy efficiency standards and more performance monitoring.

Government to spend £1bn on decarbonising buildings

Strategy to cut emissions and support rollout of new infrastructure

The government has promised to spend more than £1bn on decarbonising construction and manufacturing as part of its new Industrial Decarbonisation Strategy, which aims to cut emissions from commercial and industrial buildings by two-thirds in 15 years.

In England, £932m has been allocated to 429 projects aimed at tackling carbon emissions from public buildings such as hospitals, schools and council buildings. The Public Sector Decarbonisation Scheme will support the deployment of low carbon heating systems, including heat pumps, and energy efficiency measures such as insulation and LED lighting.

The strategy includes £171m from the Industrial Decarbonisation Challenge, given to nine engineering and design studies looking at the rollout of decarbonisation infrastructure, such as carbon capture, usage and storage (CCUS), and the potential for hydrogen.

The government will also bring in new rules on measuring the energy and carbon performance of the largest commercial and industrial buildings. It believes this could save business around £2bn a year in reduced energy costs by 2030.

'We were the first major economy to put into law our target to end our contribution to climate change, and now we are taking steps to be the first major economy to have its own low carbon industrial sector,' said Business and Energy Secretary Kwasi Kwarteng. 'While reaching our climate targets will require extensive change across our economy, we must do so in a way that protects jobs, creates new industries and attracts inward investment, without pushing emissions and business abroad.'

UK 'technically' halfway to net zero

The UK has cut its carbon emissions by 51% over the past 30 years, taking it 'technically' over halfway to meeting its net-zero target, after a record 11% drop in emissions last year at the height of the Covid-19 pandemic, according to the website Carbon Brief.

However, it warned that emissions were likely to rebound this year as the economy recovers and that 2020's sharp reduction was 'largely one-off and unique to the coronavirus pandemic', with oil demand slumping as economic output plummeted by around 10%.

The analysis shows that the phase-out of coal-fired power has been the main driving force behind deep cuts in emissions since 1990, along with cleaner and more efficient industrial practices, the rapid emergence of clean technologies, and more efficient appliances.

Energy Secretary Kwasi Kwarteng

350,000 jobs needed to deliver net zero

The Construction Industry Training Board (CITB) believes the industry will need to recruit more than 350,000 people by 2028 to keep the government's plan for achieving net-zero carbon emissions by 2050 on target.

In its report *Building skills for net zero*, the CITB calls for a 'new wave' of green building professionals, aimed at tackling emissions from existing buildings. 'The move to cleaner, greener construction presents big opportunities to make the industry more attractive to new recruits and upskill the existing workforce,' the report states. It adds that up to 27 million domestic – and two million non-domestic – buildings will have to be retrofitted.

Hywel Davies, CIBSE technical director, said the CITB report flags the need for the building engineering services sector to attract, train and retain many more people to help us to deliver a green retrofit revolution across the UK building stock.

CITB strategy and policy director Steve Radley said: 'Net zero presents a huge challenge for construction, but an even greater opportunity to create a more productive industry that's also a more attractive career option. We can get there by being clear on the key skills we'll need, making sure we have the right courses and qualifications to deliver them, and getting on with investing in them. Industry is already delivering what is needed, but it needs to happen at scale.'

Building owners facing limitless fire safety fines

Parliamentary bill also has new rules on risk assessments and competence

The Home Office has announced strict penalties to reinforce new fire safety regulations in buildings. These include 'limitless fines' for anyone found to be in breach of fire safety regulations or obstructing or impersonating a fire inspector.

Responding to its own fire safety consultation, the government said these new measures would come into force as part of the legislation in the Building Safety Bill.

The bill will create the new national Building Safety Regulator, led by the chief inspector of buildings, and overhaul the way buildings are designed, built and managed.

Fire risk assessments will have to be recorded for each building and there will be improvements to the way fire safety information is shared during the lifetime of a building. The bill will also focus on the competence of the people carrying out those assessments, and the way information is preserved and updated.

Other measures include: improving the cooperation and coordination between those responsible for fire safety, and making it easier to identify who they are; strengthening guidance issued under the Fire Safety Order so that failure to follow it may be considered in court proceedings; and improvements to the way building control and fire authorities liaise when reviewing plans for building projects.

The Fire Safety Bill is also expected to gain Royal Assent in time for the Home Office to lay regulations before ahead of the second anniversary of the first report from the Grenfell public inquiry, which set out many of these recommendations.

Grenfell safety certificate out of date

The safety certificate used for the cladding panels applied to the Grenfell Tower was described as 'vintage' by the approvals body, the British Board of Agrément (BBA), which has admitted it should have been reassessed before the fire.

The certificate was dated 2008 and was in the process of being reviewed, according to former deputy chief executive Brian Moore, who gave evidence to the public inquiry into the disaster. However, the Arconic Reynobond 55 with a polyethylene (PE) core was described as BBA certified.

An internal email sent by Moore three days after the fire, and seen by the inquiry, stated: 'We would be in a stronger position if it stated in terms "not to be used above 18m", but as the note makes clear, the certificate holder/user must comply with the building regs.'

The inquiry heard that a whistleblower raised concerns about the BBA's certification, but Moore said there was an 'information vacuum' in the days after the blaze.

'There was a mass of information swirling around. The media was full of reports, people who may or may not have been experts on the television talking about what had happened,' he told the inquiry. 'But, in the middle, clear facts from an authoritative and objective source [were] lacking.'

Moore said that was the reason it took 'some time' before he had a sense of what had actually happened and was able to reassess the status of the certification.

CBI urges government to cut taxes for low carbon heat

The CBI says the government should use tax incentives to improve the market for low carbon heating and other carbon-reduction measures in buildings.

In a new report, the business group calls for a change to VAT, business rates, and the structures and buildings allowance (SBA) requirements for energy efficiency materials and technologies. It says rates could be used to encourage businesses – particularly SMEs – to invest in onsite renewable generation and low-carbon heating systems. It also urges the Treasury to produce an overarching tax policy roadmap that has net-zero policies at its heart.

'The high burden of business rates – a tax rate of close to 50% – often means that the costs associated with improving the property outweigh the benefits, and can make the investment commercially unviable,' the CBI report explains. 'Green technologies such as solar panels are included in the business-rates calculation, which can be the tipping point of that investment not going ahead… which is out of kilter with the government's net-zero ambitions.'

The government's Heat and Buildings Strategy has been delayed, but is expected to announce a replacement for the Renewable Heat Incentive. In the meantime, the government has been criticised by the Public Accounts Committee and the BEIS Select Committee for having no coherent plan for delivering net-zero carbon emissions by 2050.

Lack of 'insight' costing firms dear

A lack of real-time insight into operations can cost construction-related businesses more than £250,000 a year, according to new research.

Procore surveyed more than 250 contractors in the UK and Ireland, and found that those with no visibility of performance were wasting 3.5 hours per week on average, and losing £265,626 a year, because of poor performance. Almost two-thirds (64%) were still using outdated manual tools, such as spreadsheets, to measure performance leading to incomplete, inaccurate, and duplicated insights. Those with better visibility of performance enjoyed fewer project defects, better tracking of safety records, better compliance with standards, and time and cost savings.

'We must look beyond manual tools and seek smarter, construction-specific solutions that not only allow on-demand and real-time access to insights, but the ability to analyse and draw conclusions from it,' said Procore director Brandon Oliveri-O'Connor. 'Only this high level of visibility will help inform better decision-making and free people up to focus on higher-value tasks, such as budgeting, forecasting, and project management.'

£7.5bn energy savings possible from retrofits

A major programme of energy efficiency and low carbon retrofits could reduce building energy costs by £7.5bn a year, create more than 150,000 jobs and cut carbon emissions by 20%, according to a group of leading banks.

Barclays, Triodos, Tide, Handelsbanken and the Ecology Building Society together form Bankers for Net-Zero, which has produced a strategy for a 'retrofit revolution' designed to deliver a 50% reduction in energy use and carbon footprints.

It has sent the plan, which also targets the elimination of fuel poverty, to ministers with a warning that piecemeal, short-term policies would not unlock the level of investment needed to stimulate the best outcomes. The group said that fully decarbonising the built environment would remove 20% of the emissions required to reach net zero.

Industry backs CLC retrofit plan

National retrofit strategy could create 100,000 new jobs and save NHS £1.4bn

A 20-year plan to improve the energy and carbon performance of homes has received widespread support from the engineering and construction sectors.

The Construction Leadership Council's (CLC) National Retrofit Strategy, aims to make the UK's housing stock greener and more energy efficient, but depends on the government investing an initial £5.3bn over the next four years to stimulate the market for building retrofits.

The CLC believes that money could generate 100,000 new jobs, while also saving the NHS £1.4bn and reducing domestic energy bills by as much as £436 per household per annum.

'Given our homes contribute 20% of the nation's carbon emissions, it is essential that we start to retrofit them to make them more energy efficient,' said Andy Mitchell, co-chair of the CLC Task Force. 'Our strategy has been fully costed and offers a roadmap [showing] how the government can create a low carbon built environment by 2040.'

With 28 million homes needing to be retrofitted, the CLC said the government should treat this as a 'national infrastructure project' capable of targeting 20% of the country's entire carbon footprint.

It added: 'At a time of economic uncertainty and growing pressure to tackle climate change, the CLC's National Retrofit Strategy offers a ready-made solution for the government to take forward and showcase to the world at COP26 [climate conference in Glasgow] in November.'

Cambridge University is retrofitting a 1930s telephone exchange to create the Entopia Building (page 43)

Bitcoin mining using more energy than whole countries

The process for producing the digital currency Bitcoin consumes more energy than several countries, according to research carried out by the University of Cambridge.

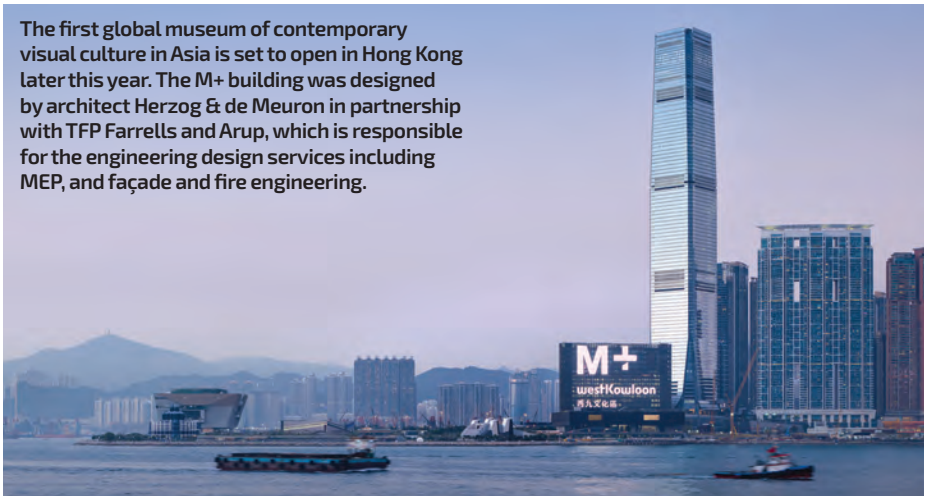
The amount of computer processing power required is equivalent to the annual carbon footprint of Argentina and uses more electricity than Ireland, the researchers found. It continues to soar as interest in the currency grows following the intervention of Wall Street in the controversial method of exchange.

The Cambridge Bitcoin Electricity Consumption Index calculated the total amount of annual energy consumed by Bitcoin mining at 115 terawatt-hours (TWh). The currency reached its record high of $61,000 in mid March and, although the value has fallen since, the energy usage continues to rise. This is because delivering one Bitcoin to a computer requires it to solve a complex series of algorithms, which is a highly energy-intensive process.

With more than 18.5 million of the total 21 million Bitcoins already 'mined', the algorithms are getting harder for those seeking to create those that remain and only specialised computer equipment can now handle the power needed.

The Cambridge researchers showed that China, which generates two-thirds of its electricity from coal, is the largest Bitcoin miner 'by far'.

LANDMARK HONG KONG MUSEUM PROJECT COMPLETES



The first global museum of contemporary visual culture in Asia is set to open in Hong Kong later this year. The M+ building was designed by architect Herzog & de Meuron in partnership with TFP Farrells and Arup, which is responsible for the engineering design services including MEP, and façade and fire engineering.

CBI study links better air quality to green recovery

Cleaner air will boost annual London economy by £500m, finds research

Improving air quality is good for the nation's profitability and productivity – not just the health of its population, according to the CBI.

Research carried out by CBI Economics on behalf of the Clean Air Fund showed that, apart from the obvious health impacts, poor air quality also reduces productivity, shortens the operating life of capital equipment and increases maintenance costs.

The business organisation said that improving air quality should be a key part of the UK's journey to net zero and that meeting World Health Organization (WHO) air quality guidelines by 2030 was 'a crucial element of the green recovery'.

Chief economist Rain Newton-Smith said: 'It is apparent from the analysis that air pollution is hitting the balance sheets of business across the country.'

The CBI reported that cities were likely to benefit most from the productivity impacts of clean air with London seeing an annual economic uplift of £500m if it raised its currently very poor air quality performance to WHO levels.

Birmingham would gain £25m a year, primarily driven by a reduction in concentration levels of PM2.5, and Bristol would realise up to £7m by preventing 16,000 working days being lost each year if it were to meet WHO guidelines. The report added that Manchester would see an annual economic benefit of £28m driven by preventing 290 premature deaths each year and gaining 60,000 working days from reduced staff absences.

The UK may move faster on F-gas

The House of Lords has confirmed the government's plans to continue looking for ways to speed up the reduction in use of fluorinated gases (F-gases), including those used in refrigeration and air conditioning, despite the UK's departure from the EU.

Responding to a written question from environmental campaigner Baroness Worthington on government plans to review the F-gas regulations ahead of COP26, Lord Goldsmith of Richmond Park, who is minister of state at DEFRA, confirmed the position already set out in the House of Commons.

'The UK has a legal requirement to review the F-gas Regulation and publish a comprehensive report by no later than 31 December 2022,' he said. 'DEFRA is now beginning internal work on the review and intends to engage with stakeholders on this work later this year.

'The review will include an assessment of opportunities for faster and further action on phasing down F-gases.'

FM mapping service launched

A mapping service to help facilities managers make buildings safe to use in the wake of the pandemic has been launched by consulting and engineering services firm Tetra Tech and the indoor mapping specialist Esri UK.

Between them, the firms will offer 3D terrestrial laser scanning, data analytics and CAD linked to interactive floorplans, indoor positioning for wayfinding, plus real-time people and asset tracking.

The firms will work on joint projects in the architecture, construction, engineering, FM, transport, defence and healthcare industries.

Indoor mapping provides users with digital twin floorplans, helping to improve operational efficiency by providing a clear picture of where things are to support performance and asset management.

Inna Lim joins Wates

Wates Construction Group has appointed Inna Lim as its new strategy and integration director for its recently formed Wates Integrated Construction Services (WICS) group. This brings the engineering and specialist businesses including SES Engineering Services, Wates Building Services and Prism offsite manufacturing together under one banner.

Lim joins from Skanska UK, where she was head of strategic markets, and will work closely with Rob Clifford, who was appointed managing director of WICS last year. She will be based at the firm's London office.

Her role will be fundamental in helping to set up an integrated offer that champions emerging technologies, innovation and modern methods of construction, a company statement said.

US bodies to publish water efficiency guide

ASHRAE and the International Association of Plumbing and Mechanical Officials (IAMPO) have agreed to jointly publish a document addressing water efficiency in buildings.

The document will combine ASHRAE 191P, *Standard for the Efficient Use of Water in Building Mechanical Systems*, and WE-Stand, IAPMO's Water Efficiency and Sanitation Standard. ASHRAE 191P provides minimum requirements for the design of building mechanical systems that limit the volume of water required to operate HVAC systems. WE-Stand focuses on achieving safe and efficient water use in both residential and non-residential buildings.

'Water efficiency and energy conservation are major considerations in the design and operation of HVAC systems in high performance buildings,' said ASHRAE President Charles Gulledge. 'Escalating costs and concerns regarding availability have brought much-needed attention to the issue of water use in the built environment.'

Engineers mark International Women's Day

CIBSE social media campaign focuses on what drives female engineers

CIBSE celebrated the incredible talent and contribution of its female members with a social media series supporting International Women's Day on 8 March. These are three of the comments by CIBSE's women engineers.

As a building services engineer passionate about the environment, I understand that humanity has no future without achieving net zero. As a woman who experienced bias, I know we won't get there without achieving social equity. Let's do this together.'
Alexsandra Sasha Krstanovic, CIBSE Building Performance Engineer of the Year 2021

'As a black female, I soon learned that I was the minority in a predominantly male industry. This only strengthened my resolve to break into the field and be another success story used to inspire future female engineers.'
Tejiri Ayerume, mechanical engineer

'I knew, since deciding to become an engineer, I would be working in a male-dominated industry. So I am inspired by the women I get to work with every day, and now share my experiences with future female engineers.'
Jennifer Cox, CIBSE Graduate of the Year 2020

"Being the minority strengthened my resolve to break into the field and be a success story to inspire future female engineers"

IN BRIEF

Make a date for 2021 Technical Symposium

The dates for the 2021 Technical Symposium have been announced as 13-14 July.

This year's event, which for the second year running will be held virtually, is titled 'Engineering the built environment for a new "normal" – delivering safe, healthy and versatile buildings'.

The symposium encourages the participation of young and experienced industry practitioners, researchers and building users, to share experiences and develop networks.

Papers are still being reviewed, with the programme due to be announced in June. But attendees can expect around 70 peer-reviewed presentations, covering case studies and research, from more than 80 sector-expert speakers.

For more information and to register for the symposium, visit **www.cibse.org/symposium**

SLL LightBytes series goes online for weekly sessions in April


Arup's lighting design for a concourse at the University of Sheffield

The new Society of Light and Lighting (SLL) LightBytes series has been announced, and will take place online for 2021. Titled 'Minimum energy, minimum resource, maximum comfort', this year's series will run over four, weekly sessions from 7 to 28 April.

Session one, focusing on minimum energy, will explore reducing energy use, understanding the space, and using surface reflectance. It will also look at employing design and lighting controls to maintain quality. Session two – minimum resource – will look at the European lighting project to develop reusable and reconfigurable parts for sustainable LED-based light systems; nano-optics; and cradle-to-cradle certification. Session three – maximum comfort – will explore what is meant by good lighting, with reference to Well standards and practical guidance on meeting those requirements.

The final session, will be a roundtable on the circular economy, chaired by SLL president Bob Bohannon, with guest speakers Emilio Hernandez, lighting designer and chair of the GreenLight Alliance, and Mark Ridler, head of lighting at BDP.

Speakers for this year's sessions, from the supporting companies, are: Steve Shackleton, lighting applications manager, Fagerhult UK; Helen Loomes, Innovation Akademie, Trilux Group; and Tim Bowes, head of lighting application, Whitecroft lighting.

● For more information and to book, visit **www.cibse.org/sll**

Volunteers encourage colleagues to get involved

CIBSE survey reveals positive attitude to volunteering, but says Institution should be more open to new ideas

Results of a survey of CIBSE volunteers, conducted at the end of 2020, showed that most volunteers would encourage colleagues to get involved.

The volunteer engagement survey aimed to gain insight into people's motivations for volunteering; how much time they spent doing it; what they got out of it; and what rewards they may like to get from it. After being sent to 800 volunteers, the survey received 234 responses, with respondents covering a fairly even spread of ages from, mainly, qualified membership grades.

The reasons people gave for volunteering were wide ranging, but the highest-scoring responses were: personal satisfaction, giving back to the industry, and professional development. Being encouraged to volunteer by employers rated low. This is an area CIBSE would like to work on to help employers see the benefits of encouraging staff to volunteer, both in terms of value to their business and upskilling of employees.

Very positively, 91% of the volunteers responding to the survey would encourage colleagues to get involved in volunteering.

In terms of recognition for their time, most respondents simply asked for private acknowledgement and thanks. CIBSE is looking at ways to more formally acknowledge volunteers for their time, hard work and dedication.

Feedback around the support volunteers had received from CIBSE was mixed; customer service scored highly, with 91% of respondents rating it good or excellent, but volunteers felt their suggestions and ideas had not been given fair consideration and response from CIBSE.

CIBSE acknowledges there is more to be done to support our network of volunteers, and it will be working through the Engagement Steering Group to address it. This will be an iterative improvement process, so the group will be asking for further and more specific feedback as needed over the next year.

Respondents' best experiences of being a CIBSE volunteer included: 'watching initiatives come to fruition within a profession I am deeply passionate about' and 'listening to a candidate that you know will be a credit to CIBSE in the future'.

CIBSE would like to thank those who responded to the survey, and all our volunteers who help CIBSE achieve all we do. If you are interested in giving some of your time and knowledge to CIBSE, email **rsweeney@cibse.org**

91% of those surveyed would encourage a colleague to volunteer

Enter Young Lighter of the Year

The Society of Light and Lighting Young Lighter of the Year 2021 competition is now inviting entries from anyone under 30 years old with an interest in light and lighting.

Entries can be on any light-related topic, and the winner will be crowned SLL Young Lighter 2021 and receive £1,000.

The Young Lighter of the Year competition provides a high-profile opportunity for younger lighting professionals in the early stages of their career.

In 2020, the judges said of Aluwaine Manyonga's winning project that his work 'reminds us how lighting can make the world a better place'.

The initial stage requires entrants to send in a short PowerPoint submission outlining their entry. Those who are shortlisted will then be asked to submit a short video expanding on their ideas.

Finalists will be selected from this second stage and invited to deliver a 15-minute presentation in front of an audience. For full details and to enter, visit **cibse.org/sll**

- Deadline for entries is 14 May.

Stephen Matthews announces retirement

It is with sadness that CIBSE will be saying goodbye to Stephen Matthews, CIBSE chief executive, at the CIBSE AGM on 6 May. He is retiring from his role after serving as CEO since 2006.

CIBSE is collating messages for Stephen, to be presented to him at the AGM. Visit **www.cibse.org/Stephen** to add your message.

Stephen has been a huge asset to CIBSE throughout his tenure and will be greatly missed. A formal notice and thank you will appear in the May edition of the *CIBSE Journal*.

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To ensure you receive the information most relevant and of interest to you, update your email preferences in the My CIBSE area of the CIBSE website.

CIBSE AGM

The CIBSE AGM will be held on 6 May 2021, as a virtual event. It will be followed by incoming president Kevin Kelly's address.

Members will receive a calling notice this month. Further details can be found at **www.cibse.org/agm**

New fellows, members and associates

FELLOWS

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Tring, United Kingdom

Lee, Sun Yu
Wanchai, Hong Kong

Jouhara, Hussam
Uxbridge, United Kingdom

Draper, Philip Andrew
Braintree, United Kingdom

Whitfield, Ian
Oxford, United Kingdom

MEMBERS

Moyes, James
Melbourne, Australia

Calcoen, Michael
Miranda, Australia

Ketchley, Keith
Sunderland, United Kingdom

Resma, Expedito Aguilloso
Milton Keynes, United Kingdom

Badiei, Ali
Hull, United Kingdom

Dickson, Adam
West Hendred, United Kingdom

Raileanu, Anamaria
Welwyn Garden City, United Kingdom

Christopher Dickson, Anibal
Warrington, United Kingdom

Walkley, Thomas Daniel
Bristol, United Kingdom

Gear, Simone
Kingston, United Kingdom

Ladipo, Oluwateniola
London, United Kingdom

Priyatharsan, Sachchithanantham
Singapore, Republic of Singapore

Hinks, Benjamin
Crawley, United Kingdom

Farrimond, Daniel
Castlefield, United Kingdom

Deng, Jie
Reading, United Kingdom

Artemenko, Jan
Reading, United Kingdom

Franklin, Keith
Bridport, United Kingdom

Kerwood, Paul
Winchester, United Kingdom

Rose, Oliver
York, United Kingdom

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Gifford, Scott
Liverpool, United Kingdom

Chandla, Anil
Birmingham, United Kingdom

Walker, Alistair
Glasgow, United Kingdom

Washburn, Adam
Gloucester, United Kingdom

Bermani, Eleonora
Woking, United Kingdom

Camino Garcia, Pablo
London, United Kingdom

Cole, Kristopher
Harrow, United Kingdom

Porretta, Nicholas
Ringland, United Kingdom

Blades, Nathan
Upminster, United Kingdom

Sanderson, Craig
Dunmow, United Kingdom

Gibson, Janine
Todmorden, United Kingdom

Bridge, David
Cradley Heath, United Kingdom

Glynn, Jessica
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Vautravers, Amedee
London, United Kingdom

Wigington, Michael James
Ingatestone, United Kingdom

Krebs, Andrew
Bristol, United Kingdom

Sherlock, Alistair
Holywood, United Kingdom

Arnold, Matthew James
Aldershot, United Kingdom

Cassandro, Florian
Maidenhead, United Kingdom

Gormley, Robert Thomas
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Clarkeson, Robert Richard
Histon, United Kingdom

Ward, Elizabeth Jayne
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Voaden, Matthew James
London, United Kingdom

Sweidan, Yasser
Wembley, United Kingdom

Crinion, Des
London, United Kingdom

Chithambaram, Vijaya Kumar
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St Columb, United Kingdom

Goodall, James
Holmfirth, United Kingdom

Salehi, Ebrahim
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Holland, Jonathan
West Pinchbeck, United Kingdom

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Cambridge, United Kingdom

Clawson, Paul
Middlewich, United Kingdom

Hilton, Alex
Canterbury, United Kingdom

Gates, Daniel
Glasgow, United Kingdom

Coldrey, Thomas
Chudleigh, United Kingdom

Holden, Mark
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Smith, Daryl
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Broome, Tom
Near Exeter, United Kingdom

Tobin, Jonathan
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Castle, Ben
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Locked in

We are all familiar with lockdown and the delay between taking action and seeing evidence of the effect of that action. Hywel Davies considers how that delay is multiplied by years when we look to reduce carbon emissions

We all know that in lockdown the delay between transmission of the virus and onset of symptoms means it takes weeks to reduce infection rates and case numbers.

There is an important and serious link between this and taking action to meet net-zero carbon emissions targets. The built environment has a long service life. What we build today will still be here in 30 years and, at current demolition rates, maybe 300 years. What we build today impacts our carbon emissions in 2050 and reaching our legal target of zero carbon emissions.

This affects not only the homes we build, but the 40 new hospitals, the schools, offices and retail premises, whether shops or warehouses. It may be argued that we focus too much on emissions from new buildings and not enough on the challenge of cutting emissions from the existing stock.

Without drastic cuts in emissions from current homes and buildings we will miss our 2050 targets. But this year's new build is next year's existing stock. And every year after. If not low carbon now, it must be retrofitted.

As with virus transmission there is a delay between decisions about cutting emissions of what we build and achieving lower emissions – a delay of years! This is why it is so vital to adopt ambitious minimum standards for both new buildings and retrofit existing buildings too. Because what we do this year, next year and beyond sets emissions levels in 2050, and locks them in.

It's also critical to get the associated review of Part F of the building regulations on ventilation right. The decisions we take this year on ventilating our homes will have consequences for years to come.

The pandemic has reminded us what Florence Nightingale knew well over 150 years ago: good ventilation helps reduce infection and promote recovery. And daylight helps, too.

While some are busy improving the ventilation of our homes and other buildings, there is a worrying upsurge of interest in devices to 'supplement' ventilation systems. Their effectiveness in reducing infection risk, their installation, the energy they use and emissions that they lock into our building stock are all unregulated. And if spaces were properly ventilated, they would be mostly superfluous.

> "It may be argued that we focus too much on emissions from new buildings and not enough on the challenge of cutting emissions from existing stock"

It is not just about buildings. The current plan to kick-start the economy includes a major programme of road building for the lorries from new retail warehouses carrying our online shopping alongside our own cars.

Even if they are electric cars on 'zero carbon electricity', they need to be manufactured, they need batteries and the 'zero carbon electricity' needs to be generated. This is in addition to the electricity for all the net-zero buildings. And all that infrastructure has a carbon content to build, operate and maintain.

It is estimated that electricity demand for all electric buildings and vehicles will need two-and-a-half to three times current generating capacity. With the associated emissions locked in for decades to come.

We face really big decisions, now. Do we just power ahead with 'decarbonised' electricity, costing unknown tens of billions of pounds and relying on unproven solutions such as carbon capture and storage, or adopt hydrogen as an alternative fuel (leaving energy supply, cost and emissions to generate the hydrogen aside for now)? Or should we look at how to reduce energy demand radically, perhaps adopting some of the lifestyle changes of the past year?

The pandemic imposed immediate changes to how we live and work. While unwelcome in many ways, the pictures of our hospitals and rising human cost of SARS-CoV-2 left us no choice. The impacts and threats from our changing climate still seem less immediate, pressing or deadly.

We now have a chance to reflect on what we build, how we build it, how much energy it needs and how we live in it. And consider the long-term carbon consequences of our choices. The lag between decisions and consequences is long. Do we understand the gulf between the potential carbon consequences that these urgent decisions will very shortly lock in?

DR HYWEL DAVIES
is technical director at CIBSE
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What's the plan?

There is insufficient ambition for new buildings in 2025, says CIBSE's **Julie Godefroy**, who also questions the plan for the existing stock

In late January, the government published a long-awaited consultation package on Building Regulations, covering: new and existing dwellings and non-domestic buildings; 2021 Approved Documents L and F; a new overheating standard for new homes; and outlines of the 2025 Future Homes Standard (FHS) and Future Buildings Standard (FBS). There are some positive changes in the proposals, compared with the 2019-20 FHS consultation:

- **Retaining the right of local authorities** to set energy and carbon standards beyond regulatory minima, allowing more carbon savings earlier, and developing the rest of the market
- **Accelerated development of the FHS**, with a draft now due in 2023. This will allow early adoption by market leaders and local authorities, and support the development of supply chains.
- **Retaining fabric energy efficiency standards** (FEES), the removal of which created serious risks of fuel poverty and poor fabric performance
- For non-domestic buildings, clear statements acknowledging the **performance gap**, with a strengthening of **commissioning** requirements, **changes to the NCM** to 'better account for energy uses and incentivise appropriate design solutions', and **energy performance modelling** (for example, CIBSE TM54) for buildings of more than 1,000m²
- For non-domestic buildings, clear statements about the **importance of heat decarbonisation**, anticipating a central role for heat pumps and no role for hydrogen in the timescale considered.

"There is little evidence that NCM drives improvements on non-domestic buildings"

However, there are many concerning measures and omissions, which could be addressed by the following key asks (with implementation date in brackets):

1. Target setting: the consultation retains the approach based on a notional building. All opportunities need to be captured towards the net-zero carbon target. The notional building prevents like-for-like comparisons and does not drive optimisation of building form and orientation. New buildings of the same type should be compared with the same target level of performance. (2025)

For non-domestic buildings, the 2021 uplift proposes to vary the heating fuel in the notional building – for example, district heating or gas if this is in the actual building. This gives artificial support factors for particular systems, rather than a like-for-like evaluation of low carbon options. (2025)

2. Metrics: the consultation proposes a dual-metric system – primary energy and carbon – alongside a fabric performance requirement. Neither metric means much to consumers, especially primary energy. They rely on conversion factors, which change over time, and this does not facilitate tracking of progress, comparing buildings, or creating a closer link with actual performance. Also, primary energy favours gas over electricity, so goes against heat decarbonisation. Energy use and carbon would better address energy efficiency, carbon reduction, and consumer engagement. (2021)

3. A commitment to actual performance, starting with disclosure: actual in-use performance beyond practical completion must be addressed – for example, as part of the regulatory regime created in response to the Hackitt Review. This should start with disclosure of energy use (broken down into fuels where applicable). (2021) The data could inform future revisions of Building Regulations and the setting of absolute, not relative, targets (see point 1). (2025)

4. Commissioning: there should be stronger incentives for commissioning and performance testing, such as a penalty in as-built Part L calculations unless satisfactory results are given to Building Control. This will benefit energy efficiency and, for ventilation, air quality. (2021)

5. Airtightness and ventilation: the draft FHS specification proposes an airtightness of $5m^3 \cdot h^{-1} \cdot m^{-2}$ at 50Pa, and natural ventilation. This is far from the 'world class' levels of energy efficiency intended for the FHS, and is a remaining important opportunity for energy savings. The FHS specification should show best-practice airtightness and MVHR (even if other systems remain allowed). This would encourage the development of supply chains so that MVHR is well designed and installed, and delivers energy savings and good indoor air quality. (2025)

6. A trajectory for existing stock: for existing domestic and non-domestic buildings, the consultation package only includes a 2021 revision, and it is a relatively modest one. Government must commit to a 2025 upgrade and set out a programme of works to introduce upgraded requirements informed by evidence, and supported by clear guidance on complex technical issues. This should incorporate lessons from recent exemplar retrofit projects,

DR JULIE GODEFROY is technical manager at CIBSE

past programmes, such as Retrofit for the Future, and additional research if required – for example, on dealing with thermal bridges and moisture. (2021)

7. A plan and a whole-building approach for the existing stock: the current requirements for existing buildings do not provide an end goal compatible with net zero, and they rely heavily on an elemental approach. This doesn't sufficiently make the links between energy, overheating, air quality and fabric, and it doesn't prevent carbon lock-ins and unintended consequences. All works covered by Building Regulations must contribute to putting buildings on track to net zero, while being healthy and comfortable. The Part F requirement that ventilation should be 'no worse' than before the works is highly inadequate, as many homes are not well ventilated. The works should be 'net zero ready', and a longer-term plan should be produced for the building, to reduce operational, embodied and financial expenditure. It is the approach promoted in PAS 2035, which regulations should build on. (2021)

8. Calculation methodologies that are fit for net zero: there is little evidence that NCM drives improvements on non-domestic buildings. Space heating is routinely underestimated, clearly an issue for heat decarbonisation and the appraisal of options. BEIS recently commissioned a study on how to turn SAP/RdSAP 11[1] into a tool for net zero. MHCLG should commission a similar exercise on the NCM. (2025)

More detailed points are available at **bit.ly/CJApr21regs**

Get involved

The consultation deadline is 13 April 2021. CIBSE is working with LETI and others on our response. Please get in touch at **JGodefroy@cibse.org** to get involved. We are very interested in contributions on the following:

- Testing of the new simplified overheating method
- Improvements to NCM – for example, changes to the method; comparisons between Part L calculations and performance modelling, Passivhaus, or actual energy use
- Fabric/thermal performance metric: views and evidence on the best approach – for example, for homes: space-heating demand, heat transfer coefficient, a combination, or both? For non-domestic: a combined space-heating and cooling demand metric, or separate ones?
- Heat pumps: comments on the proposals for heat pump applications, their efficiency and applicability depending on space heating and hot-water usage profiles, and implementation timescales
- Performance modelling against TM54: comments on the draft requirement and making it as effective as possible
- Comments on TM39 and TM23, which are referred to in the draft Approved Documents, and which CIBSE is planning to revise alongside.[2]

References:

1 Led by Etude, with CIBSE, Elementa, Levitt Bernstein, WDP, Clarion Housing Group and UCL.

2 TM23 Revision, **bit.ly/CJApr21TM23** and TM39 Consultation, **bit.ly/CJApr21TM39**

HIGH-FLIER

The House at Cornell Tech is CIBSE's 2021 Public Use Project of the Year. **Andy Pearson** spoke to **Buro Happold** to find out how an integrated approach to building services and façade design proved that highly insulated, airtight buildings can be delivered at scale

'It was the CEO of Hudson Companies who threw down the gauntlet and said "we're going to do Passivhaus on this project",' recalls Julie Janiski, a principal at Buro Happold. The project was a new, 352-unit student and faculty accommodation block for Cornell Tech, the technology campus of Cornell University, being developed in the shadow of Queensboro Bridge on Roosevelt Island, Manhattan, New York City.

Hudson Companies was one of the university's development partners, while Buro Happold was the project's MEP, structural and lighting engineer, working with Handel Architects to design what was, at the time, the world's tallest and largest residential Passivhaus building.

Another key member of the team was Steven Winter Associates; the consultant joined the design team as the project progressed, to provide specialist Passivhaus consultancy services. 'They were familiar with the technology and challenges of designing and building a highly insulated, airtight building envelope,' Janiski says.

Importantly for this pioneering project, Steven Winter Associates had an established relationship with the Passivhaus Institute in Germany. This meant it was able to have conversations about the details, and how to handle the fact that the building had a different typology from the ones more commonly certified as Passivhaus, such as the single family home.

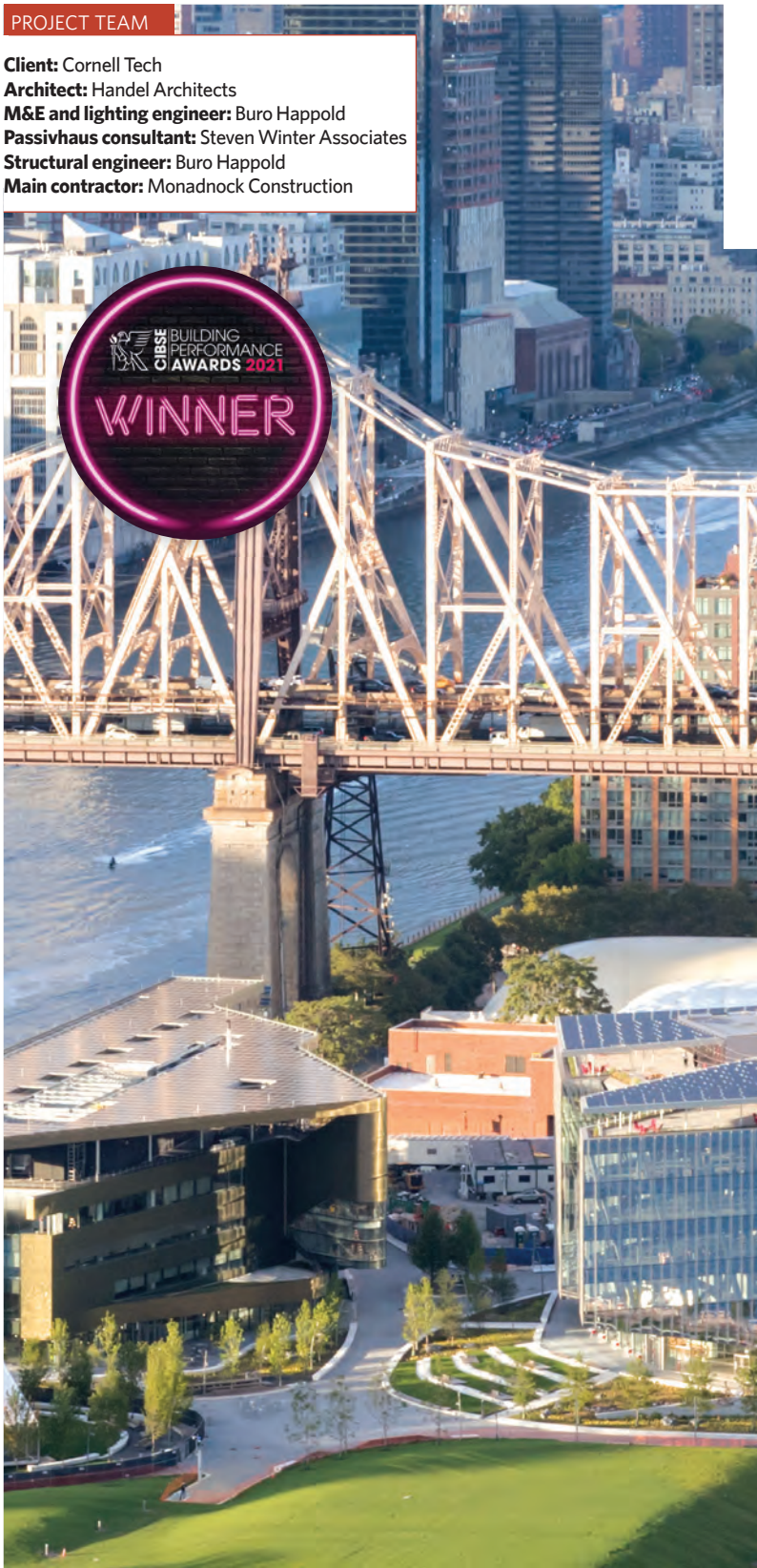
When it came to developing the pioneering Passivhaus for Cornell Tech, the design team was fortunate that the campus masterplan had conveniently placed the building on an east-west axis, so its principal elevations faced due north and south. 'The building's orientation and rectangular form are ideal for minimising east and west exposure to low-angle sun and solar heat gain,' says Janiski. Although, just to be sure, the team modelled the building in alternative orientations: 'The impact of changing orientation from facing north-south added up to 15% to its energy demand,' Janiski adds.

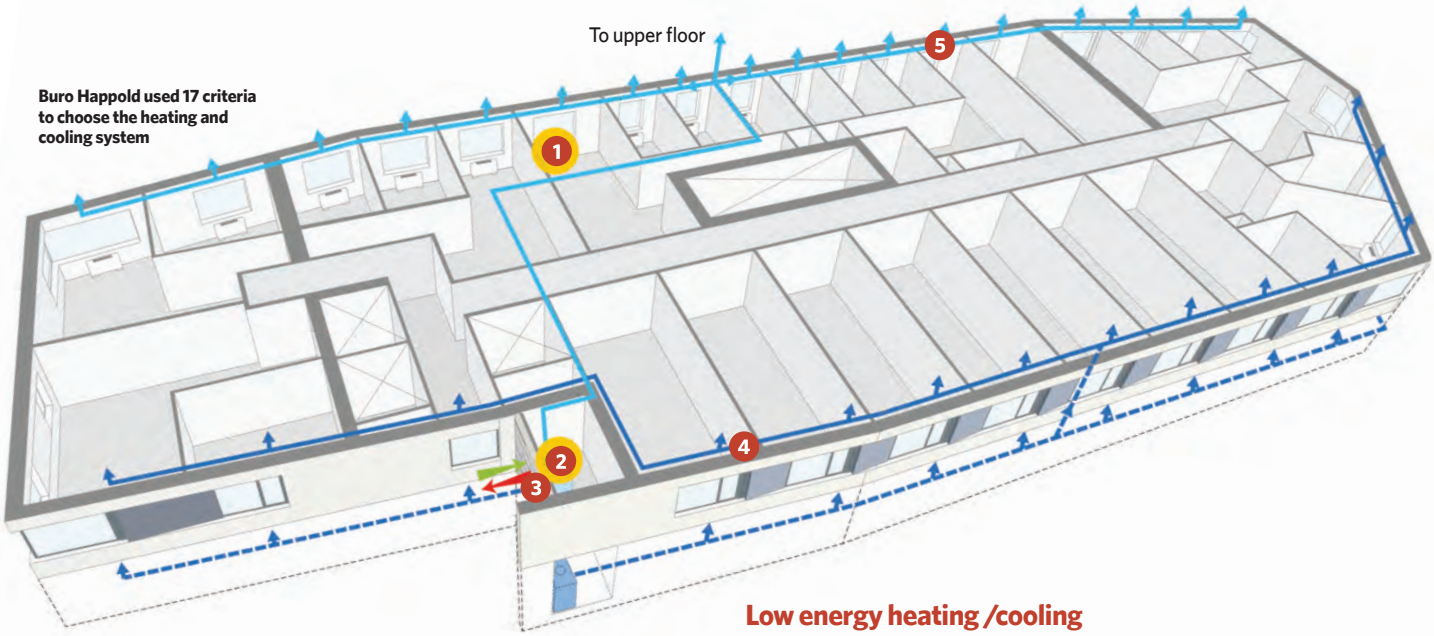
In keeping with Passivhaus principles, and in the context of a climate that spans very cold winters and very hot and humid summers, the building's envelope is formed from a highly insulated metal-panel cladding system incorporating operable, triple-glazed windows. None of the apartments has a balcony, a feature that helps dispense with tricky airtightness and thermal-bridging details, while making it easier to wrap the insulating façade tightly around the building's concrete frame.

The architect has, in fact, taken the 'wrap' concept and contrived the façade design to make it appear, visually, as if

PROJECT TEAM

Client: Cornell Tech
Architect: Handel Architects
M&E and lighting engineer: Buro Happold
Passivhaus consultant: Steven Winter Associates
Structural engineer: Buro Happold
Main contractor: Monadnock Construction





Buro Happold used 17 criteria to choose the heating and cooling system

Low energy heating /cooling

A variable refrigerant flow (VRF) system heats during New York's winters, and cools during hot summers

1 Indoor unit for heating and cooling. Individually controlled by residents
2 Outdoor unit
3 Metal grill enclosure on mechanical balcony
4 South-side refrigerant
5 North-side refrigerant

- Each pair of residential floors is served by two stacked condenser rooms: one condenser room serves two floors of north-facing apartments, and the other serves two floors of south-facing apartments.
- A metal grille enclosure, painted to echo the façade palette, hides a 'mechanical balcony' that houses the outdoor unit for each floor.
- Indoor units in each apartment give residents complete climate control, while individual billing and building dashboards influence behaviour.

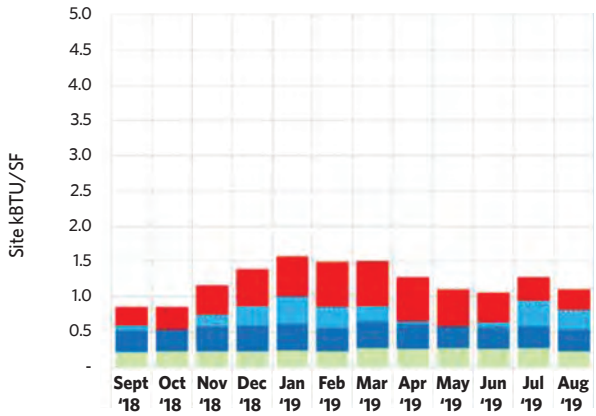
the building is swathed in an insulating blanket; this seems to start at the vertical louvre on the west elevation, wraps around the building, and then finishes as if tucked behind the same louvre. The feature is most apparent at the top of the building, where a residents' rooftop lounge is located, and at the building's base, where the wrapper has been lifted to form an angular canopy over the entrance.

It is the louvre on the façade's west elevation that is key to the building's heating and cooling solution; behind it, on every floor level, is a space created specifically to house the outdoor units for the building's variable refrigerant flow (VRF) system. The design team calls this plant space 'the mechanical balcony', because it is classed as being outside and, as such, is thermally isolated from the main building structure. Access is through an opening on each floor, into which the contractor has fitted a big, thick, white walk-in freezer door, complete with a hand lever. 'The per-floor, air cooled VRF option was viable once we'd worked up the balcony solution with the architects,' Janiski says.

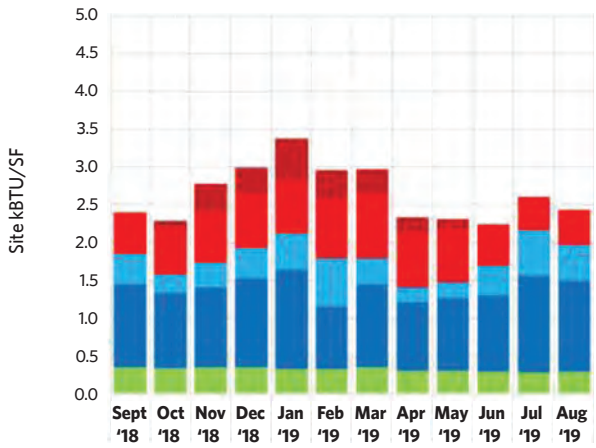
The VRF system supplies heating and cooling to the apartments. 'Given that this is apartment-style accommodation and not a student dorm, the ability of »

End users: modelled v actual operation

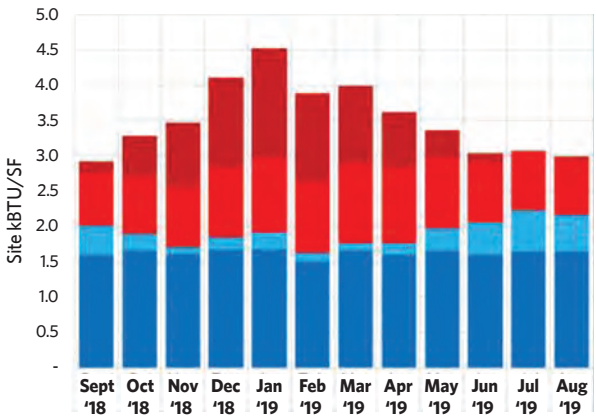
The House is using 30% less energy than predicted in the as-built ASHRAE 90.1 model and in benchmark data for New York buildings of more than 200,000ft²



The House monthly PHPP modelled consumption



The House monthly actual energy consumption 2018-19



The House monthly ASHRAE modelled consumption

Key
- DHW gas
- Central areas heating and cooling
- Apartments heating and cooling
- Common areas
- Apartment electricity

Residents of The House are mainly one-year Master's students

» occupants to control the temperature of spaces individually was very important to the developers,' explains Janiski.

Before opting for the air-cooled VRF solution, Buro Happold assessed the viability of numerous heating and cooling systems based on 17 criteria, including: energy efficiency; space requirements; noise; thermal comfort; individual controllability; the ability to bill occupants based on individual energy use; and, of course, capital cost.

The system alternatives considered included water source heat pumps and water-cooled VRF. 'The air-cooled VRF was more cost-effective from a capital cost point of view, and it offered the ability for individual fan units in every living room and bedroom,' Janiski says.

The VRF outdoor units housed on the mechanical balconies are configured in an 'every other' sequence, serving two residential floors at a time. One unit serves two floors of north-facing apartments, while the unit on the floor above serves the more tightly packed south-facing apartments on the same floors. 'To zone based on solar orientation and, therefore, similar amounts of heat gain or loss over the course of a day, and from season to season, it made more sense to have one unit serve two floors of apartments on the north and east, and another serve two floors on the south and west,' Janiski explains.

The system gives occupants a limited range of settings for the minimum and maximum temperature of their apartments, which, Janiski says, are set in line with Passivhaus criteria.

Although residents can vary the temperature of their apartment, its fresh air supply and exhaust air rates are fixed. As with all Passivhaus schemes, filtered outside air is supplied to living rooms and bedrooms, while dirty air is extracted from bathrooms and kitchens. Unusually for a Passivhaus scheme, rather than use individual apartment units, all 365 apartments are ventilated by two rooftop energy recovery ventilator (ERV) units – otherwise known as mechanical ventilation with heat recovery (MVHR) units. (See panel, 'Centralised ventilation').

The House at Cornell Tech was certified by the Passivhaus Institute in September 2017. The Passive House Planning Package (PHPP) model achieved a primary energy demand of 120kWh·m^{-2} per year for heating, domestic hot water, household electricity and auxiliary electricity. At a PHPP-modelled energy use intensity (EUI) of 120kWh·m^{-2} per year,

South elevation

the building's primary energy demand would be 73% lower than the 444kWh·m^{-2} per year median for residential buildings of more than 20,000m^2 in New York City, based on 2013 benchmark data.

However, PHPP models are for certification purposes only and are not intended to predict actual energy consumption. After its first year of operation, the building's measured primary energy demand from September 2018 to August 2019 was 235kWh·m^{-2} per year compared with the primary energy demand figure of 120kWh·m^{-2} per year used in the PHPP model to show that a building has been designed to achieve the required level of performance in the building envelope and systems. »

CENTRALISED VENTILATION

Two rooftop energy recovery ventilators (ERVs) were specified, rather than units for each apartment. Buro Happold evaluated the possibility of ventilating each apartment using individual units, but the building's configuration made these unsuitable. The need to minimise the apartment floor-to-ceiling height to get as many floors into the building as possible meant that fitting an ERV unit beneath the ceiling 'would be problematic', says Janiski.

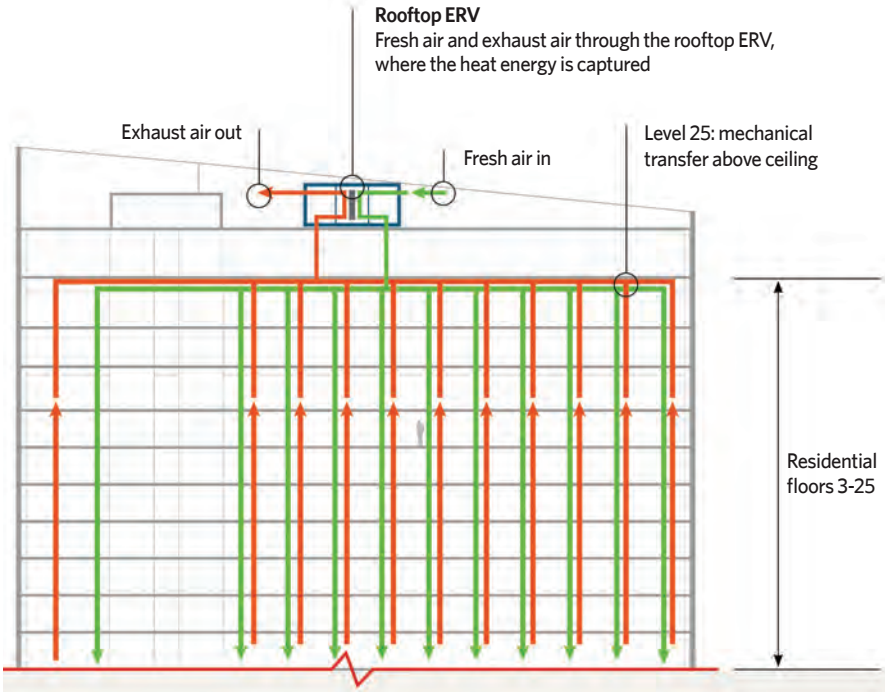
The need for access to maintain the ERV and change its filters was perceived as 'a significant challenge' and there were concerns about 'the large number of penetrations required through the façade', and the challenge of sealing each of these effectively to maintain an airtight envelope.

The deciding factor, however, was the large number of 'micro' apartments clustered on the southern elevation, which meant it was not possible to separate the locations of the units' supply and extract terminals effectively.

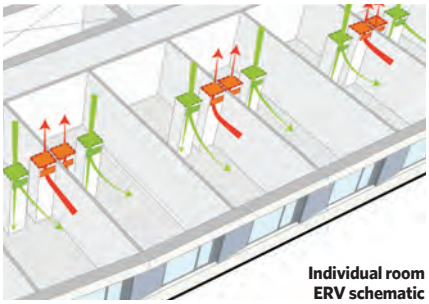
While the centralised ventilation option overcame many issues, it conflicted with New York City's building codes. In contrast to Passivhaus, where the kitchen and bathroom extracts are usually combined to make it relatively straightforward to maintain the building at a neutral pressure balance, and to simplify heat recovery from the exhaust, the city's building codes require kitchen and bathroom extracts to be separate systems. Buro Happold met officials to talk them through the scheme: 'As a compromise, we offered to maintain the kitchen and bathroom exhausts separately throughout the height of the building, only combining them at the point at which they enter the ERV, which satisfied the city,' says Janiski.

The centralised ventilation solution also made it difficult to incorporate a boost mode on the individual extracts – and, therefore, the supplies to maintain balance – in each apartment, to increase the rate of extract at those times when occupants are cooking or bathing.

To try to provide a continuous-mode and boost-mode airflow, Buro Happold investigated fitting a motorised damper at the points of extract and supply. It came down to two criteria, as Janiski explains: 'The price tag of having that many [more than 1,000] automated dampers on a project of this scale was enormous, and the reality of a damper manufacturer being able to guarantee the extract rate would go from 4 L·s^{-1} to 11 L·s^{-1} was unfeasible, because the manufacturers said the dampers "are not built for that level of precision".' As a compromise, the Passivhaus Institute agreed to accept a steady extract rate set between normal and boost mode.



Balanced ventilation and energy recovery. Building energy recovery ventilators schematic



Individual room ERV schematic

Janiski says the scheme uses two rooftop ERV units for reasons that include a zoned design approach, and that 'one unit would have been quite large'. To minimise air leakage and improve system efficiency, supply and extract ductwork systems have been sealed using Aeroseal, a polymer sealant blown through the ducts. According to Buro Happold, the polymer 'reduced air leakage by more than 90%, greatly improving energy efficiency'. Nevertheless, because the ERV units are not Passivhaus certified, their use on the system did incur an efficiency penalty on the Passive House Planning Package (PHPP) compliance spreadsheet.

Minimising air leakage through the building fabric, and through the façade in particular, was fundamental to achieving Passivhaus certification. Contractor Monadnock Construction had the façade prefabricated off site in storey-high sections, which were then hauled to the island site by barge. Once craned into place, the joints between panels were carefully taped to ensure the façade was airtight. A whole-building pressure test measured airtightness of just 0.13 air changes per hour at 50 pascals – against the Passivhaus maximum 0.60.

» In addition to the PHPP model not predicting actual use, there were some addressable reasons for the higher actual energy use compared with what was anticipated. One issue was the behaviour of the systems and residents. For example, in winter – when the outside temperature drops below freezing – residents entering their apartment chilled from being outside may be inclined to turn up the heat to full immediately, rather than waiting to acclimatise to the internal environment. 'There were likely situations where there was more heat used than there needed to be, so a cultural shift had to happen,' Janiski says.

The building's residents are primarily one-year Master's students, so the occupants typically change from one academic year to the next. To introduce Passivhaus living and explain how the building's operation differs from accommodation students are likely to have experienced, the university has created a residents' guide. This includes information about Passivhaus certification and the intended operations of the heating and cooling systems. The building also features an energy dashboard in the lobby, where all residents can see the actual energy use and how they compare. The energy used during the shoulder seasons for heating and cooling has been flagged as an opportunity for improved operational efficiency.

The modelling methodology in the PHPP also presents a number of significant differences from the local ASHRAE 90.1 modelling methodology, as well as any approaches that seek to predict actual use. For example, the PHPP methodology 'assumes that, when the temperature and humidity are nice outside, occupants will open their windows and turn heating/cooling systems off'. This action not only needs a cultural shift to rely less on active heating and cooling, it also requires that residents turn off the system when their windows are open, which is acoustically comfortable given that the building is adjacent to the Queensboro Bridge.

The multi-tenanted aspect of the project, which meant the building incorporated amenities such as a gym, yoga room, and a laundry room, were also cited as being outside the traditional family home PHPP model, which, Janiski says, 'all add up'. The common area electricity, and high plug loads serving a technology-driven resident population, are noted areas of opportunity to find additional efficiencies. The project team has been working with the owner to review detailed building operations data related to equipment, ranging from the heating and cooling VRF system to the elevators, to evaluate further optimisations.


The House at Cornell is situated next to the Queensboro Bridge

The ambition of the scheme in implementing Passivhaus at this scale was recognised by the judges at this year's CIBSE Building Performance Awards where it won the Project of the Year – Public Use category. They praised the Buro Happold team 'for its holistic integration of engineering, social aspects and lessons learned'.

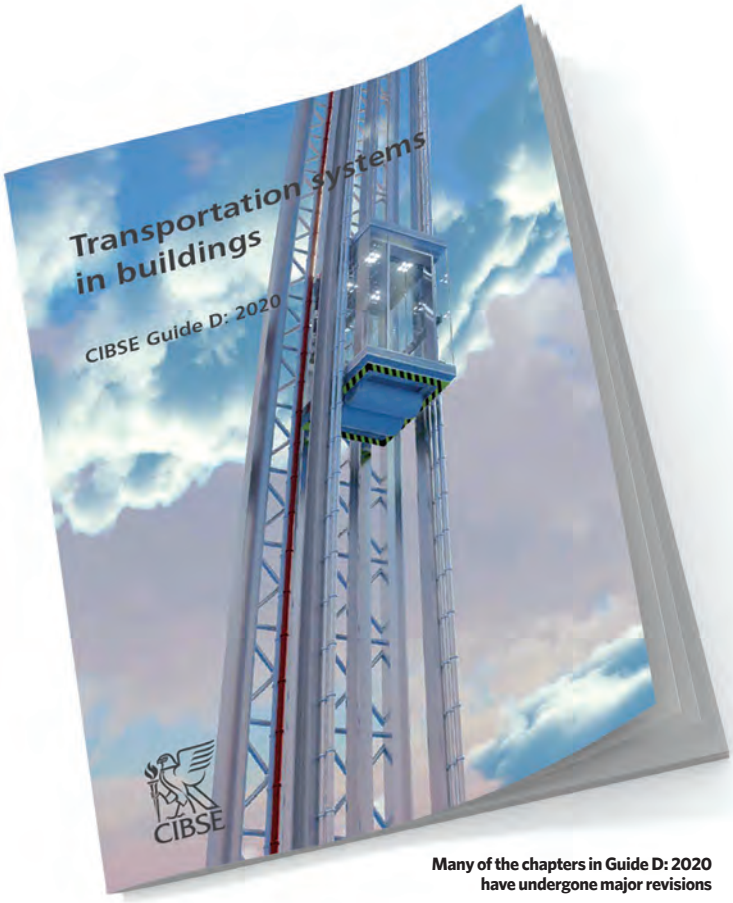
Janiski says it's an honour to have awards, but 'the most meaningful part of this experience is that our impact stretches from the scale of the individual occupants' improved health to the scale of cities through the advancement of energy codes and GHG emissions reductions'.

Lastly, she underscores the importance of the team working together, and her gratitude for having 'such clear vision and leadership' from the project developers and university. CJ

See details of all the 2021 Building Performance Award winners at **cibse.org/bpa**

CIBSE'S ESSENTIAL TRAVEL GUIDE

CIBSE Guide D: 2020 *Transportation systems in buildings* includes the latest in vertical transportation, including ropeless lifts and accessibility for older people. **Dr Gina Barney** HonFCIBSE and **Adam Scott** FCIBSE summarises its content



Many of the chapters in Guide D: 2020 have undergone major revisions

The past few years have brought a major step in lift technology, with equipment powered by linear magnet drives, freeing the lift car to move horizontally and vertically. This prototype ropeless system has no means of suspension and allows several lift cars to operate in the same well, with cars moving horizontally and vertically on a circular principle first seen in paternoster lifts (Figure 1).

The ropeless lift is one of the technologies included in the update to CIBSE Guide D: 2020 *Transportation systems in buildings*, which includes guidance on lifts, escalators, moving walkways, lifting platforms, stair lifts and hoists. Also included is information on the machine-room-less (MRL) lift, which continues to broaden its range of application, and offers more opportunity for effective, appropriate lifting capability in a space-efficient manner. As the name suggests, this lift eliminates the need for a fixed machine room. Care does, however, need to be taken to ensure that MRL equipment is fit for the intended purpose.

The main purpose of CIBSE Guide D is to provide in-depth information to practitioners involved in transportation systems who wish to enhance their knowledge through a programme of continuing professional development. The content is also pitched to act as a primer for architects and developers, as well as for facilities and building managers, who may not be directly concerned with the design and installation of lifts and escalators, but who need to understand the advice offered to them by specialists. Students embarking on a career in mechanical, electrical or building services engineering should also find the guide of value.

Contents of Guide D

The design of any lift or escalator system must start with a consideration of the traffic flows through the building for which the system is intended.

Relevant factors, – along with guidance on the location and arrangement of lifts, escalators and moving walkways within buildings – are discussed in chapter 2. This considers a range of building types and has some additional guidance principles for disabled circulation. The chapter has undergone significant revision and now provides more useful guidance in this important area, including the new principle of Body Area Index (Figure 2).

Chapters 3 and 4 are now titled, respectively, 'Lift traffic design using calculation' and 'Lift traffic design using simulation', and are closely linked. The recommended design parameters have been updated to align more closely with those proposed by the British Council for Offices, and these chapters now include an important new section covering lifts intended for use by cyclists (Figure 3).

Chapter 5 links with the 12 building types considered in chapters 2 and 3. It remains a pivotal chapter, because it gives a thorough review of various types of vertical transportation systems, and is now updated with new products and applications, including bike lifts and rigid chain technology (Figure 4).

It should be the first port of call for new entrants into the industry, because not only does it describe, in detail, the various types of lifting systems, but it also offers advice on planning and design principles. The chapter examines the standard traction drive and hydraulic drive lifts, including MRL lifts, while the appendix provides guidance on structural well sizing, and indicates common car platform areas on which passengers stand.

Chapter 6 covers firefighters' and evacuation lifts, and has been completely rewritten to cover the extensive changes in codes and standards since the last issue of the guide. This chapter now includes: additional information on building requirements; essential firefighters lift requirements; modernisation of lifts for fire-service use;

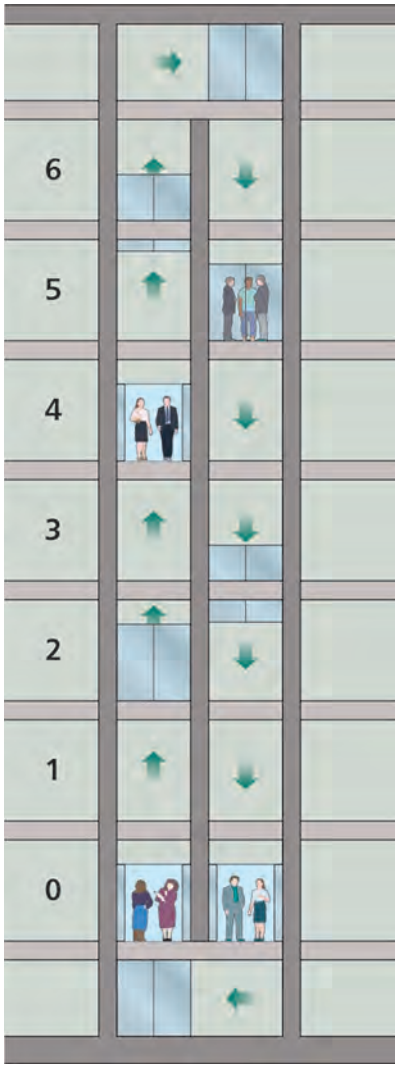


Figure 1: Ropeless lifts – two wells, many lifts

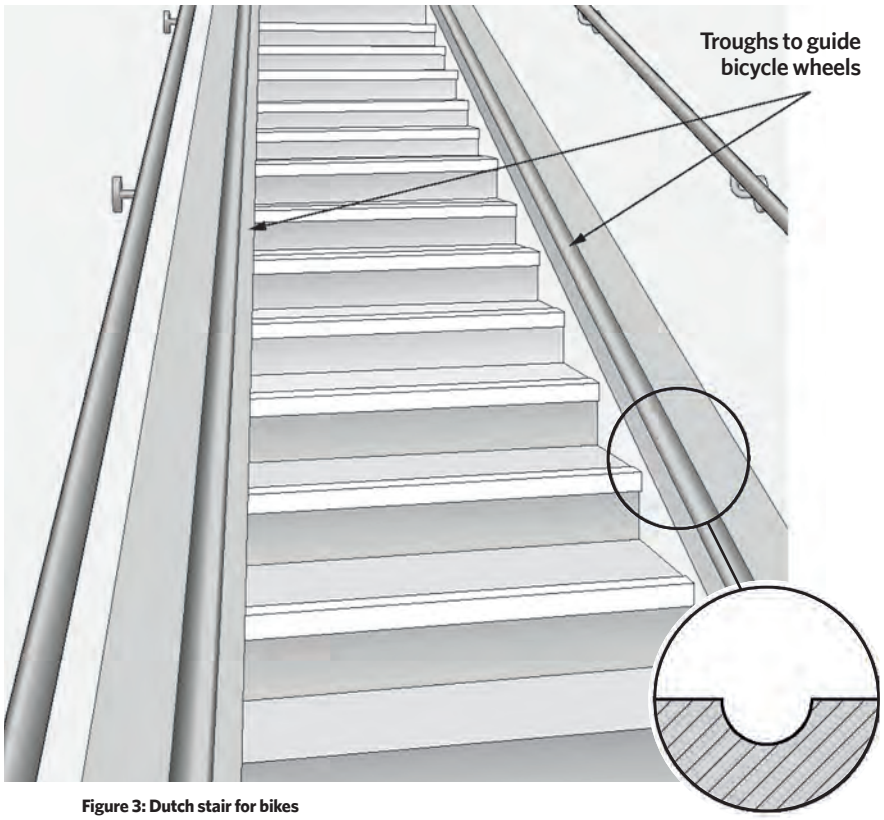


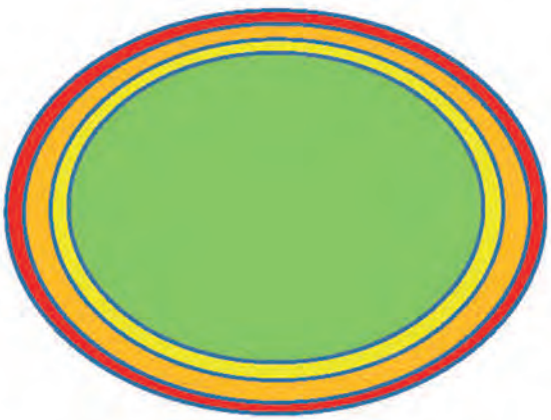
Figure 3: Dutch stair for bikes

modernisation of lifts for evacuation; use of non-evacuation lifts for the evacuation of disabled people; and emergency shuttle lifts (lifeboats).

The principal components of lifts, including the main elements of electric traction and hydraulic drives, are described in chapter 7, which has undergone a major revision. It now includes guidance on remote alarms (previously in chapter 14) and has a new section on hearing loops. The section on car and landing fixtures, and inspection controls, has been extended, and new illustrations provided (Figure 5).

Lift-drive and control techniques are considered in chapter 8, which has had a minor update. Lift traffic control is outlined in chapter 9 and includes a revised presentation of classical and destination-control technology (hall-call allocation control – when passengers input a floor number in the lobby and the system allocates them a lift number).

Figure 2: Adult occupancy ellipses



"Transportation systems in buildings should provide independent and equal access for everyone"

Chapter 10 discusses escalators and moving walkways, including safety considerations, particularly in the context of the latest BS EN115-1:2017 *Safety of elevators and moving walks*. It details the different escalator applications, which range from low-rise installations to accommodate a small change in level within a storey of a building, through to long travel installations in deep underground stations. Inclined walkways and horizontal moving walkways are also considered.

Transportation systems in buildings should provide independent and equal access for all. Chapter 11 has been updated to include appropriate reference to recently published standards, particularly BS EN81-70: 2018 *Safety rules for the construction and installation of lifts*. It offers guidance on the disability and design issues that need to be considered, along with the standards and regulations that apply. There are also illustrations of the most common types of lifting platforms in use today.

Electrical systems and environmental conditions are discussed in chapter 12, which has been updated to align with current practice. In particular, this chapter examines the provision of power supplies for the whole building and guidance on key environment conditions, which should be considered during the design process.

Lift, escalator and moving walk energy efficiency and power consumption issues are discussed in chapter 13, which addresses how energy consumption can be minimised through good design, selection, and control of the transportation equipment. The latest ISO classification system is referenced, along with guidance on the current requirements of the Breeam building classification system.

The scope of chapter 14 has been refined considerably; guidance on »

» remote alarms has been moved to chapter 7, and the principles of surveys has been moved here, from chapter 4. Much new content covers the rapid progress of technology in communications, the internet of things, cyber security, data logging, and Voice over Internet Protocol.

Proper commissioning, and thorough examination, inspection and preventive maintenance of lifts, escalators, moving walkways, lifting platforms and stairlifts is critical to maintaining the safety and capital value of these assets. These issues are dealt with in chapter 15, which has been revised extensively and structured around new headings and sections. It incorporates the requirements of SAFed Lift Guidance 1 2020.

Chapter 16 deals with upgrading the safety, performance and equipment of existing lifts. It examines the reasons for upgrading, which can range from improving the reliability of the lift, its aesthetic appearance, or obsolescence of key components. The performance upgrade can be in terms of the system's traffic handling, ride quality or energy consumption, or improving the safety of the equipment. This chapter has been updated to align with current thinking and standards, references have been updated, and the format of the tables improved.

Safety rules for the construction and installation of lifts and escalators, specifications, codes of practice, commissioning recommendations, and safe working are covered by an extensive range of British, European and international standards and codes. Chapters 17 and 18 give an overview of some of these documents, and there is a comprehensive list of legislation, standards, codes of practice and so on in Appendix A1. Appendix A3 has an extensive glossary of terms.

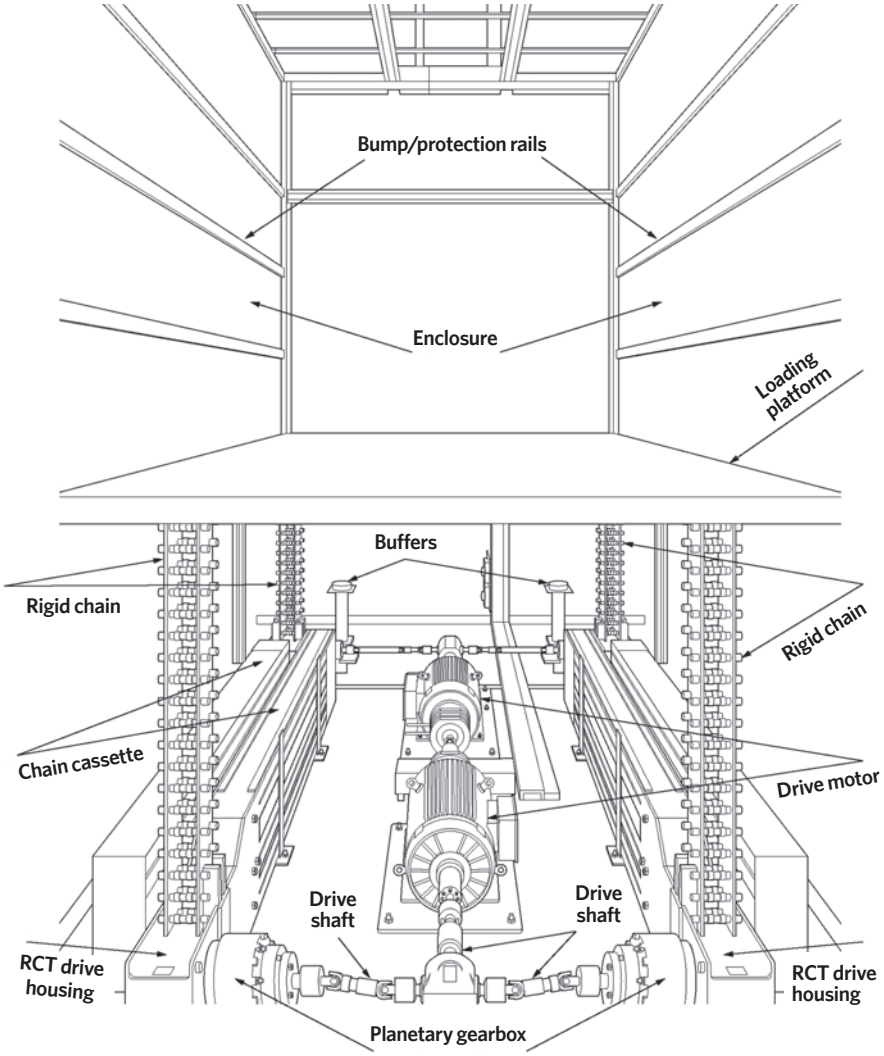


Figure 4: Rigid-chain technology lift

Other sources of information

CIBSE Guide D contains references to other sources of information, particularly British Standards, associated standards and codes of practice. These should be consulted alongside the guide and other relevant publications.

- Guide D is available at **cibse.org/knowledge**
- **ADAM SCOTT FCIBSE** is technical director (vertical transportation) at Sweco, and **DR GINA BARNEY HONFCIBSE** is a vertical transportation consultant at Gina Barney Associates
- **DR GINA BARNEY HONFCIBSE** and **DAVE COOPER FCIBSE** received the CIBSE President's Commendation this year in recognition of their work on the publication *Recommissioning of lifts and escalators post-lockdown*

Landing call push buttons

Direction indicators

LED position and direction indicators

LCD/TFT information panel

Destination control panel

Figure 5: Examples of passenger controls and lifts

GROWTH WARNING

New humidity guidance on preventing mould was one of 350 presentations at the 2021 ASHRAE Virtual Winter Conference. **Tim Dwyer** reports on what it means for design, and listens in on sessions covering nuisance lift noise, insulation in lofts, and liquid desiccant

The 2021 ASHRAE Virtual Winter Conference attracted 1,800 online delegates over three and a half days in February, when more than 350 presentations covered the increasingly wide range of topics that fall under the ASHRAE umbrella. A significant number were on areas associated with the pandemic and these are available on ASHRAE's Covid-19 resources page. Here, I have selected a small sample of the presentations to illustrate the diversity of subjects.

New humidity guidance

Lew Harriman, of Mason-Grant Consulting, has a long track record in measuring and predicting humidity in buildings. He is also co-author, with the late CIBSE president Geoff Brundrett, of the seminal *Humidity control design guide for commercial and institutional buildings*.

In his seminar, Harriman reported the change in the maximum humidity allowed in mechanically cooled buildings in the recently updated ASHRAE Standard 62.1-2019 *Ventilation for acceptable air quality*. It had previously been set at a maximum relative humidity (RH) of 65% and is now set to a maximum (absolute) dew-point temperature of 15°C (or 65°F). Harriman said this change reflects that surface temperatures near cold HVAC equipment and distribution systems raise the RH at the surface far higher than the RH as measured in the air. (Although RH governs absorption and desorption of excessive moisture in materials).

With the old limit, systems designers assumed, incorrectly, that keeping the RH of the air below 65% meant that mould could not grow in the building (Figure 1). The new ASHRAE rules include occupied and unoccupied periods (although, when unoccupied for less than 12 hours, the limit reverts back to 65% RH).

Harriman cited places, such as Dubai, as having 80%+ of July hours above the limiting dew point; also Tangiers, with 40%+, and even northern European cities such as Amsterdam, with nearly 25%+. He concluded that there are many climates where there was a need to design for independent dehumidification equipment (and not cooling) – particularly in unoccupied periods – that should be used with appropriate dew-point controls.

Benefits of liquid desiccant

Over the past two decades, significant advances have been made in the use of liquid desiccants for simultaneous dehumidification and cooling. Modelling and proof-of-concept demonstrations have shown potential savings of 30-40% compared with other technologies.

Peter Luttik, of Emerson, provided a useful overview on liquid-desiccant technologies, explaining that modern in-duct systems (see Figure 2) employ low-flow desiccant membrane technologies that have been

Figure 1: An example of an application where there was no effective moisture control (top) and, after a refit, when controlled with a maximum dew point of 15°C (bottom) [Source: Lew Harriman]

"Miller-Klein outlined the challenges of identifying the noise path by documenting all parts of the system – even riding on top of the lift car"

developed to reduce significantly the desiccant carryover (which then needs to be filtered out).

In the same seminar, Jason Warner, of Emerson Climate Technologies, Sidney, Ohio, highlighted the value of such systems to supply dry air without unnecessary over-cooling. This helps to avoid the oft, slightly bizarre, experience of occupants needing to wear additional clothes in summer to offset the low dry-bulb air temperatures resulting from traditional dehumidification techniques.

Warner explained that the chilled desiccant, being used to provide sensible, as well as latent, cooling allows the refrigeration system to operate more efficiently than when employing traditional dehumidification cooling coils, by operating at a higher evaporating temperature – typically 2K to 8K above the required dew point of the supply air.

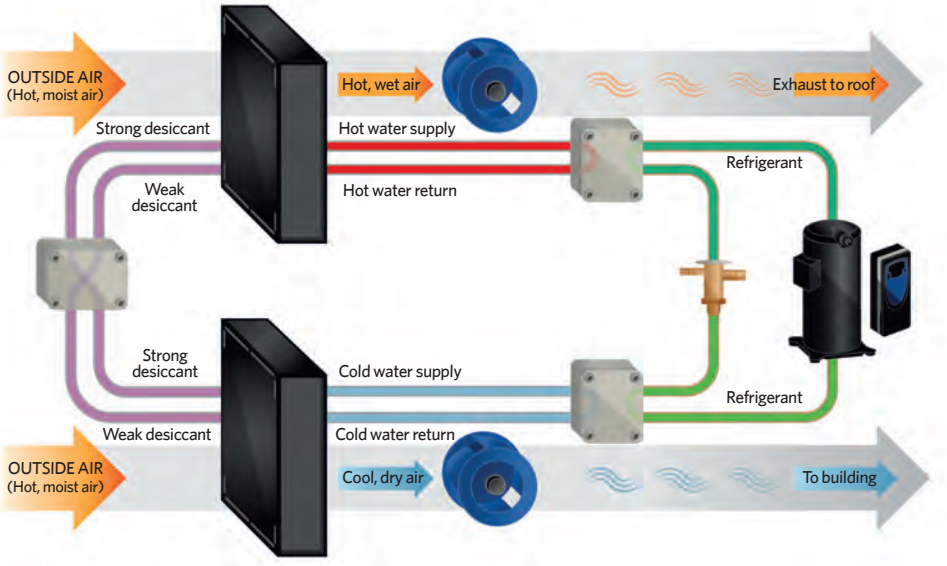


Figure 2: The basic configuration of a simple liquid-desiccant humidification control in a ventilation system [Source: Emerson]

Nuisance lift noise

Erik Miller-Klein, of Tenor Engineering Group, Seattle, gave a useful commentary on how building clients may understand key aspects of mechanical system noise design in shell and core (base build) projects, to mitigate the risk of noise and vibration that could otherwise require expensive remedial works.

In another session, Miller-Klein spoke specifically on elevator applications, noting that complaints about lift noise and vibration are common in high-rise commercial and residential towers. He provided an intriguing account of a forensic investigation in a large commercial building where one of the eight lifts (that formed a single bank) was causing noise issues in an 18th-floor sound-editing suite. As the lift passed by, a very distinct tone, at 500Hz, would be heard that was identified as being down to structural-borne vibration.

Miller-Klein outlined the challenges of identifying the noise path by documenting and undertaking measurements on every part of the system – even riding on top of the lift car, after hours, to see if something associated with the lift guide rail may be contributing to the problem. The investigating team determined that the source of the noise was the lightweight laminate floor in the machine room vibrating at 500Hz, that then transferred through the air into the building structure.

Working with the lift supplier, they examined and eliminated elements, to determine that the deflector sheave (a pulley) was the prime source of vibration. Although the sheave was rebalanced, the problem reoccurred when under load. The problem was finally resolved with a new deflector sheave (Figure 3). Miller-Klein concluded that the vibration may travel hundreds of metres through a building structure and that the construction community needs to develop resources to estimate accurately noise and vibration associated with elevator and other transient building systems. He noted that ASHRAE's sound and vibration technical committee is working to improve the available resources.

Figure 3: Lift machine room, showing deflector sheave (pulley) at bottom left [Source: Erik Miller-Klein]

Insulating timber-frame attics

Increased use of lightweight thermal insulation, particularly in timber-framed construction, benefits from low-emissivity surfaces. However, there is a paucity of independent published work that examines the installed performance. The presentation by Som Shrestha, of Oak Ridge National Laboratory, included a project for which laboratory evaluations were done on the impact of low-emissivity surfaces on the inside of the uninsulated pitched section of attic roofs ('cold lofts' in the UK.)

The attics were tested with three surface treatments: foil laminated on the underside of the pitched-roof decking board (fixed on top of the rafters); low-e foil stapled on the underside of the rafters, bridging across the void between rafters to form a continuous foil surface; and a sprayed-on, low-e coating across the whole underside of the pitched roof (including rafters). The attic floor (above the notional ceiling) had traditional insulation.

A 'large-scale climate simulator' – a lab with enough volume to hold a full-size roof with climate control and sun lamps – was used for the study. A 'summer' external condition was employed to give a (full-size) roof exterior surface temperature of 60°C, and a winter 'setting' provided an exterior surface temperature of 0°C. The performance of the surface treatments was compared with that of a simple boarded roof with no radiant coating.

For the winter condition, the tests showed a reasonable reduction in heat loss, in the order of 10%. The major benefit was revealed in summer conditions, however, when the reduction in heat gain into the room below reached almost 50% (when using the stapled low-e foil on the underside of the pitched roof). This is an example of where a simple intervention can make significant improvements at a relatively low cost. **CJ**

To view the schedule and watch on-demand sessions, visit **bit.ly/CJApr21TD**

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CIBSE JOURNAL

EDUCATION FACILITIES SPECIAL

SPACE TO LEARN

How lessons learned drive UCL's building strategy

MINIMISING COVID RISK AND IMPROVING IAQ IN SCHOOLS

TESTING IAQ IN TWO PASSIVHAUS SCHOOLS

How can schools minimise Covid risk and improve air quality?

In this month's *CIBSE Journal* podcast, members of the CIBSE Natural Ventilation Group discussed what practical measures schools could take to minimise Covid risk and improve indoor air quality

Opening windows helps dilute any virus in the classroom

Ensuring adequate ventilation in schools reopening after lockdown was one of the topics discussed in *CIBSE Journal's* latest podcast. It features the authors of CIBSE's *Covid-19 Ventilation Guidance* – Eimear Moloney, Shaun Fitzgerald, Chris Iddon and Abigail Hathway – whose work has been recognised with a CIBSE President Commendation. The extracts below discuss safe ventilation, draughts and CO_2 sensors in schools.

Eimear Moloney FCIBSE, director at Hoare Lea

The World Health Organization has stated that the risk of getting Covid is higher in crowded spaces, in poorly ventilated spaces, when people spend long periods of time together, and where people are in close proximity.

All these things are a perfect storm for a school. You have a lot of people together for a long period of time and spaces can be inadequately ventilated.

School managers should try and address these things one by one. They should try to make areas less crowded and spread people out into larger spaces, such as a sports halls instead of a classroom. They should also understand how the fresh air ventilation system works and increase rates where they can.

To reduce the time people spend together, one option would be to reduce class times and purge classrooms in between lessons. Each school setting will be different so addressing these items one by one is a useful approach.

Shaun Fitzgerald, director, Centre for Climate Repair, University of Cambridge

The reality is you're going to have many children in a classroom – that could be 30 children within 60m^2. So the proximity issue is a challenge. Lesson durations can be tackled by more – but shorter – lessons.

How do we ensure schools are adequately ventilated in the winter? If they have windows at high and low level, it's simple. On the coldest winter days, you can encourage teachers to open the top windows – by all means keep the bottom windows closed. If you open all of the top windows by small amounts, you get some degree of natural mixing within the space, which ameliorates cold draughts. If you've got controlled ventilation systems, that's great, because they can do enhanced mixing or heat recovery.

Chris Iddon, chair of the CIBSE Natural Ventilation Group

It is fascinating to see how, in the late 19th and early 20th centuries, people went around designing school classrooms with very high ceilings, with a focus on ventilation.

High ceilings create a larger volume, and the concentration of the virus in the space is important. If you've got a greater volume for the virus to mix within, it will be more dilute on average because it takes longer for the virus concentration to build up for a given ventilation rate.

So, as well as ventilation providing dilution, you've also got the space volume providing dilution of the virus, which will mean that susceptible people are inhaling less virus over a period of time.

It's interesting that before the onset of antibiotics and other medicines, designers of the built environment were more conscious of the role and importance of good ventilation with regards to infection control and air quality.

Shaun Fitzgerald

For schools, the daily average CO_2 level for a naturally ventilated space, is 1,500 parts per million (ppm). If it's mechanically ventilated, it's 1,000ppm.

The reason for the difference is, in large part, because of the vagaries and variability of natural forces with natural ventilation.

We should be trying to ensure that spaces are in accord with modern Building Regulations, because the areas of greatest concern are those that are inadequately ventilated where you are below the Building Regulations level.

Risks go up multiple times when you are at high levels of CO_2. If I go into a space and it's 3,000-5,000 parts per million, I'm going to make sure that I either don't spend very long in that space or I start opening the windows. CO_2 sensors can help identify those particular areas. **CJ**

Hear the podcast at **www.cibsejournal.com** and download the CIBSE Covid-19 guides at **bit.ly/CJApr21vent**

The PPR guidelines capture lessons learned from all UCL projects – no matter how big or small – in a formal process

CIBSE BUILDING PERFORMANCE AWARDS 2021 WINNER

Lessons learned

University College London's award-winning Post-Project Review guidelines – developed with Buro Happold – ensure lessons from projects on its estate are fed back into a process designed to improve building performance and close the performance gap. Phil Lattimore reports

Hailed by the 2021 CIBSE Building Performance Awards judges as a 'client-led, collaborative process with clear impact and tangible outcomes', Buro Happold and University College London's Post-Project Review (PPR) Guidelines were the clear winner of this year's Learning and Development Award.

The expert-industry judging panel was impressed by what it considered to be a well thought through approach to post-occupancy evaluation (POE), as well as the standardisation and clear application of a difficult process that it agreed 'is often hard to implement effectively'.

The PPR Guidelines were developed as part of a collaboration between UCL, Buro Happold, and consultants Alexi Marmot Associates. Since 2014, UCL has been engaged in a 10-year, £1.25bn 'Transforming UCL' programme that, up to the end of last year, had completed 182 projects. One of these was the award-winning 22 Gordon Street refurbishment of its Bartlett School of Architecture – led by Buro Happold and Hawkins\Brown architects – which was named CIBSE Retrofit Project of the Year in 2020. Buro Happold was already engaged in a POE of this project when the UCL Estates team commissioned it to develop PPR Guidelines that could be applied to all projects involving the college's estate.

David Stevens, director of transformation at UCL Estates, was assistant director projects mobilisation at the time, and was working with senior sustainability manager Ben Stubbs on ensuring the estates buildings were performing as efficiently and sustainably as possible. 'We had been discussing executing this for

> "UCL now has a dedicated database of lessons learned, which are captured at every project stage, from inception to completion"

some time, but it's only when we created UCL's mobilisation and transition team that we were empowered to create these guidelines – and it coincided with Buro Happold already being employed to do a POE on 22 Gordon Street. So it knitted together nicely,' says Stevens.

'Ben, I and our other stakeholders sat down with them at various stages and made it clear what we were looking for – specific things that we wanted them to include – and they constructed it and delivered that to us.'

The aims of the PPR guidelines are to ensure UCL's buildings perform as intended, reduce the 'performance gap', and document lessons learned from all projects undertaken by the estates team – no matter how small – in a formal process, so they can be applied to future projects.

The process includes a project implementation review (PIR), to evaluate how effectively the conceptualisation and delivery is carried out. For projects that are valued at more than £10m or business critical, a full POE is automatically initiated. Crucially, lessons learned are held in a central database and made available to all designers involved in UCL estates projects.

'Our dedicated mobilisation and transition team sits between our estates development and our estates operations teams,' explains Stevens. 'It facilitates that sharing of information and knowledge, creating standards and standardisation, and taking the lessons learned, following them through into operation, then feeding them back into the design process. On top of that, we have a huge number of external providers and internal project managers – both on the capital side and the maintenance side – who all use and feed into those systems for every project.'

The PPR guidelines were designed to address a number of challenges spanning project inception, delivery and handover – such as outputs from close-out meetings not being standardised or adequately shared beyond the immediate project team, and input from other stakeholders (such as FM teams and end users) not being included in the resulting learning from projects.

Stubbs adds: 'It's that age-old problem with the performance gap. In terms of sustainability, we plan and design buildings to be highly energy efficient, performing better than Building Regulations, aiming for Breeam Excellent or Outstanding awards – but, sometimes, that intent doesn't actually carry through. It's a great frustration when those good intentions aren't realised. So, it's been great to have an opportunity to address that properly; to get past the handover stage and make sure we do the fine-tuning, get everything working as it should, and make sure the lessons are learned for future projects.'

CASE STUDIES

22 Gordon Street Bartlett School of Architecture refurbishment

The first UCL project to fully complete both a PIR and POE was 22 Gordon Street, the £22m refurbishment and extension to UCL's Bartlett School of Architecture. The POE included: a review of energy performance covering all main and sub-meters; two BUS user surveys; interviews with users and FM staff; and supervision of two MSc students from the Bartlett undertaking detailed investigations of air quality and thermal comfort. In terms of operational energy, a 60% reduction in energy use per m² was demonstrated, equivalent to a 33% reduction in absolute energy use. This was despite floor area increasing from 5,260m² to 8,887m² and greater environmental control being provided in many spaces throughout the building. A key success was that the architect was novated to the design-and-build contractor during the construction stage; this safeguarded quality and enabled efficient knowledge sharing. Broader lessons included a better understanding of what worked well (for example, design, MEP strategy when fully operational) and what could be improved (soft landings around the commissioning process).

Wilkins Terrace and Lower Refectory refurbishment

Located at the heart of the UCL Bloomsbury Campus, this £27m project included the refurbishment and extension of the main refectory in the undercroft of the Grade I-listed Wilkins Building.

Sustainability was a key consideration in the planning and development of the project, and the refectory achieved a rating of Breeam 'Very Good'. The project has helped to reduce UCL's impact and operational costs, with much-improved energy performance and monitoring.

Major improvements to building fabric and the efficiency of heating and cooling systems help reduce energy consumption and improve occupant comfort. Better energy management capabilities allow UCL to monitor and manage consumption in much greater detail, highlighting energy-hungry areas and activities, as well as opportunities for ongoing efficiencies. Indoor air quality has also been optimised through careful selection of paints, varnishes, timber-based products and furniture.

Key lessons learned:

- **This project strongly informed our model for stakeholder/neighbourhood engagement. Neighbours were effectively engaged and informed, allowing them to plan their activities around disruptive work.**
- **The project adopted an 'in process lessons learned' approach, to ensure knowledge capture at the earliest possible stage. This was particularly valuable given the quantity of other construction activity going on at the time.**
- **It highlighted the benefits of engaging with critical specialist contractors directly, on a pre-construction services agreement. This provided valuable pre-construction design, method and programme advice.**
- **The whole project team is fully engaged in formal risk workshops, which give a complete picture of risks associated with the developing design – for example, relating to physical size/access constraints because of location.**

UCL's database of lessons learned is available to all framework consultants and contractors

Refining the guidelines

The development of the guidelines happened relatively quickly, says Stevens, with Buro Happold refining them in parallel with the live POE on 22 Gordon Street. The team then focused on ensuring consistency of delivery, working with external providers, consultants and internal staff to get feedback and refine the guidelines. At the time of writing, there have been eight iterations of the PPR – the most recent in August 2020 – as they have been further refined and adapted to meet new regulatory requirements and guidance.

The PPR guidelines are prescriptive in terms of minimum requirements, to help standardise the process, but they are also designed to be implemented across a variety of building typologies and applied to a full range of UCL's projects, and demand an appropriate level of detail depending on the scale and implications of the project. That way, the real issues surrounding a project can be captured, without the process overburdening those involved and becoming a 'box-ticking' exercise.

'It applies to every project, but there is a lot of nuance within that,' explains Stubbs. 'A project based around, say, mechanical life-cycle replacement is very different from a new-build construction project, or the delivery of a teaching space or a containment level-3 laboratory. So, it is scaled in a way to address that, so that it remains relevant.'

A relatively minor project – of up to £25,000, for instance – may require a Survey Monkey questionnaire, with other smaller projects needing a slightly different questionnaire sent to relevant people involved in it. Larger projects require more detailed PIR feedback and/or POE processes, Stevens explains – but that also depends on a range of other factors. 'It's based upon finance, complexity, criticality, and risk and impact,' he says. 'So, a low-cost, £25,000 project with higher risk criticality in its performance – such as in a research-lab environment – would require a much higher level of PPR. The guidelines describe how it should happen, but it requires a conversation between the project manager, the assistant director that looks after mobilisation, and the head of built environment sustainability, where we agree what level of post-project review should happen on each project.'

KEY STATS: 'TRANSFORMING UCL' PROGRAMME (2014-20)

- **£1.25bn investment in UCL's estate**
- **182 'Transforming UCL' projects completed**
- **97 major projects completed**
- **22 projects recognised with sustainability awards**
- **180 laboratories refurbished or created**
- **168,776m² space refurbished or created**
- **92 teaching spaces refurbished or created**

Lessons learned database

Through the adoption of the PPR guidelines, UCL now has a database of lessons learned – which are captured at every stage of the project, from inception (RIBA Stage 0) through to completion, post-occupancy review and in use (RIBA Stage 7) – and it is available to all framework consultants and contractors.

The UCL project mobilisation and transitions team has one staff member who maintains the lessons learned database, which can be searched by contractor, consultant, RIBA stage, building, project type, and so on. 'Every time we do a POE or a PPR, all those lessons learned and action points get uploaded onto the database – and we have a requirement in our stage gates and governance procedures that our contractors and consultants must view these at the relevant stages,' says Stevens. 'It's ensuring the lessons learned processes are built in.

'In addition, the mobilisation and transition team checks and ensures seasonal commissioning is taking place after handover, because that's one area of performance on which organisations or contractors can often fall down. That, in itself, has had a massive impact on reducing the performance gap at UCL.'

Mark Dowson, associate director in the sustainability team at Buro Happold, led for the firm on the PPR guidelines project, and says UCL's use of a dedicated team and person responsible for the 'lessons learned' database is an innovative step from which others in the sector would benefit.

'Capturing lessons learned shouldn't be a new thing. It is often part of the process evaluation stage of the POE, but those lessons learned don't always get passed on in a systematic, formalised way,' he says. 'And it's quite rare for outcomes of those sessions to be centrally related, and for someone within the organisation to be responsible for looking after that database to ensure insights are incorporated into future projects.

RESOURCES

As well as the lessons learned database, a suite of resources was created to support the PRR process. These are now being used by UCL project officers and POE consultants on completed UCL projects, and include:

- **Guidance for university project officers – introducing the PPR framework, clarifying project thresholds, timeframes, roles and responsibilities, while outlining the PIR and POE processes**
- **PIR templates – for facilitating PIR lessons learned workshops, and feedback forms for staff and members of the design/construction team**
- **POE reporting tool – a spreadsheet for reporting on energy/water/waste consumption over a 1-3 year POE. It also enables performance to be compared with similar UCL buildings, as well as facilitating direct comparisons with the design stage CIBSE TM54 operational energy predictions.**

In its first two years, the PIR process has been applied to 10 major projects. The first to complete a PIR and POE was 22 Gordon Street (see panel, 'Case Studies', on page 35).

> "The aim of the PPR guidelines was to ensure lessons learned from all projects undertaken were documented in a formal process, so learning could be applied to future projects"

'It's innovative from UCL, and the right approach that people within the organisation, and the client championing it, are looking after the lessons.'

Through these new processes, UCL is seeing a continued reduction in defects and uncompleted work at handover, seasonal commissioning being documented and diarised consistently, and a culture of holistic POEs – assessing functional, technical and process evaluation criteria in line with – and exceeding the requirements of – Breeam and the Higher Education Funding Council for England.

Getting the data from POEs is one issue, but another challenge is ensuring this is used effectively. 'When we get the feedback from this process, particularly when we've done some of the bigger POEs, we have a wealth of data and information on the actual performance of the building,' Stubbs says. 'We can pinpoint – particularly in terms of the services – exactly where things are operating inefficiently and going wrong. There are challenges; we have to ensure we have the skills to evaluate this data, and to assess whether or how issues identified can be addressed. But there is a real opportunity for improving the efficiency around building performance.'

Stubbs says the process also addresses a challenge that he experiences constantly – trying to get good, early engagement on sustainability. 'Sometimes, sustainability is left too late in the design process, and the more radical solutions that we might have wanted to look at aren't necessarily there any more. So, UCL has developed a Sustainable Building Standard, which refers directly back to this whole process. It ensures that what we learn projects, so any issues can be addressed in future.'

Major improvements have been made to the building fabric of Wilkins Terrace, on UCL's Bloomsbury campus

Sharing knowledge

For the UCL team, sharing the learning it has gained from introducing the PPR is critical. The guidelines and their outcomes have been shared across the higher education (HE), sustainability, and facilities management sectors, says Stevens, who adds: 'We have presented at Constructing Excellence events, and shared them with the BSRIA Soft Landings Conference and Soft Landings Network events, so anybody can benefit from what we do. We've also met with counterparts in other HE sectors and talked them through what we do, as well as learning from what they do.

'Our PPR guidelines are part of our wider "mobilisation transition and soft landings" procedures – they're a component of a much bigger picture in relation to how we design, transition and operate our buildings.' CJ

Measuring indoor air quality in Passivhaus primary schools

Evidence from a study on indoor air quality in two Passivhaus primary schools reinforces the importance of well thought out ventilation and control of outdoor pollution

School buildings in the UK account for 2% of national carbon emissions, and half the emissions of local authorities. To meet national climate-change mitigation targets, the energy efficiency of new and existing school buildings needs to increase. This could be achieved through the adoption of voluntary energy efficiency standards, such as Passivhaus, which has a fabric-first approach and clearly defined certification criteria.

In the meantime, there is mounting evidence on the adverse effects of poor indoor air quality (IAQ) on children's health and on their cognitive performance and ability to concentrate. Published evidence on the IAQ of UK schools is limited, however, and scarce for Passivhaus schools, in particular. To address this evidence gap, the IAQ of two UK Passivhaus primary schools was monitored.

School A was completed in 2013 and is in a suburban area. Balanced supply and extract rates are dictated by return air CO_2 levels. Fresh air is supplied to the classrooms, then 'used' air is displaced to the 'hub space' (circulation and activities space) through sound-attenuated air paths. Extraction is through the hub space and WCs. School B was completed in 2015 and is in an urban location. Supply and extract rates in the classrooms are fixed, and inlets/outlets are located in the classrooms. Heat recovery is used in winter, while a mixed-mode ventilation strategy is employed in summer, with users free to open windows.

In both schools, natural ventilation is achieved with user-operated windows and grilled ventilation panels in classrooms. Both have high-level windows in the hub (School A) or corridor (School B) of the first floor. These are operated by a BMS with override switches in School A, and user-operated in School B. School A has no high-level windows in classrooms. All first-floor classrooms in School B have user-operated high-level windows. Airtightness is less than 0.6 air changes per hour at 50Pa. The design target ventilation rates were in line with 'current at the time of completion' guidance.

Trimsaran Primary School is a Passivhaus school, but not one of those studied in this research

In each school, monitors were installed in three classrooms and at an outdoor location on the roofs of the main buildings. Real-time monitoring took place at five-minute intervals between September 2018 and July 2019 for dry bulb temperature (DBT), relative humidity (RH), carbon dioxide (CO_2) and particulate matter ($PM_{2.5}$). In addition, passive diffusive sampling of nitrogen dioxide (NO_2), and total and targeted volatile organic compounds (VOC) took place over a period of four days – including unoccupied hours – during winter and summer.

While these initial results should be interpreted with caution, given the study's small sample size, the indoor environmental variable ranges were within the range reported in previous studies of UK schools, such as the UK part of the Schools Indoor Pollution and Health: Observatory Network in Europe project (SINPHONIE-UK).

All classrooms met the overheating risk criteria based on adaptive thermal comfort thresholds during the summer monitoring period. The winter upper static threshold was slightly exceeded in four classrooms, all of which were on the first floor and had south-facing windows (low or high level) combined with minimal shading. The combination of these features can account for higher classroom temperatures in both seasons.

The differences in classroom CO_2 concentration between the two schools in winter reflected the different ventilation strategies and design targets in line with requirements at the time the schools were built (Figure 1). All averages were significantly lower than those in existing studies in UK primary school buildings (for example, SINPHONIE-UK). While further increasing ventilation rates is likely to dilute CO_2 to concentrations below the current regulatory requirements in School A, this could also lower relative humidity to unacceptable levels and increase energy use. Lower set points for

acceptable CO_2 levels, and lower air supply temperatures, could be investigated.

Similar to CO_2, total VOC (TVOC) levels were higher in winter than in summer (Figure 2). Ventilation systems in School A were found to be less effective in diluting TVOC in winter compared with School B. With regard to specific VOC, monitoring results indicate that limonene and pinene levels are consistent with average levels in public buildings and schools in the UK, and that they were introduced in the classroom through strong indoor sources. These two terpenes are associated with intermittent indoor pollution, such as cleaning, and effectiveness of dilution during and after cleaning. It should be investigated whether ventilation rates during and immediately after cleaning (morning for School B and evening in School A) could influence the contribution of cleaning procedures to indoor air pollution.

For VOC emitted from cleaning, children are probably exposed to lower concentrations than those reported in this study, because monitoring included after-class hours, when children were not in the school and cleaning took place.

The VOC 2-ethyl-hexanol was detected in winter in all three classrooms in School A (average 3.6$\mu g \cdot m^{-3}$). This is below the level of interest and was not detected in outdoor samples, summer samples, or any School B samples. Its presence can be linked to lingering effects from wall painting in School A that took place no more than nine months before winter sampling.

Indoor benzene levels in schools A and B (averages 0.80$\mu g \cdot m^{-3}$ and 0.64$\mu g \cdot m^{-3}$ in winter and below 0.32$\mu g \cdot m^{-3}$ in summer) were consistent with indoor benzene levels reported for UK primary schools. Analysis of the indoor/outdoor ratios in the existing study suggested indoor sources, such as arts and crafts materials, but also adhesives from building materials and carpets. Benzene and NO_2 (not filtered in schools) depend on the infiltration of the pollutants from outdoors. The location of the school in relation to busy roads and the prevailing wind direction must be considered at design stages. Differences in NO_2 indoor/outdoor ratios in the two schools can result from different ventilation rates and the reaction rate of the compound with indoor surface materials .

Classroom average $PM_{2.5}$ levels across both schools were 4.1$\mu g \cdot m^{-3}$ in winter and 3.3$\mu g \cdot m^{-3}$ in summer (Figure 3). The $PM_{2.5}$ indoor/outdoor ratios reported in this study (0.3-0.4 in winter and 0.4-1.0 in summer) were lower for winter than those in previous studies with predominantly naturally ventilated school

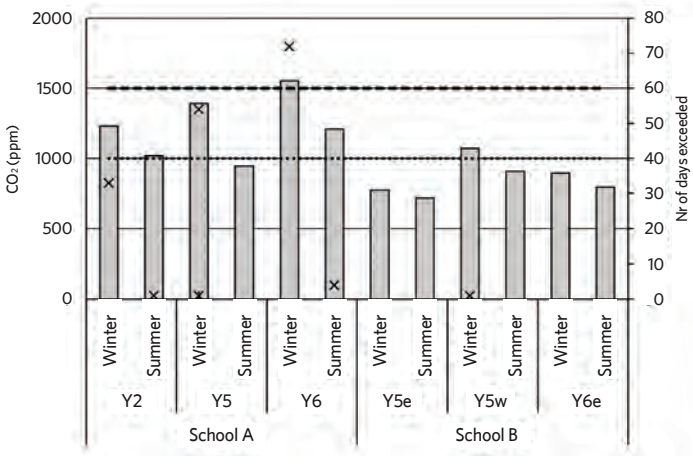

Figure 1: Maximum daily average concentration of CO_2 in classrooms during occupied periods in winter and summer, limits proposed in the 2006 and 2018 versions of BB101, and number of days of exceedance for both limits

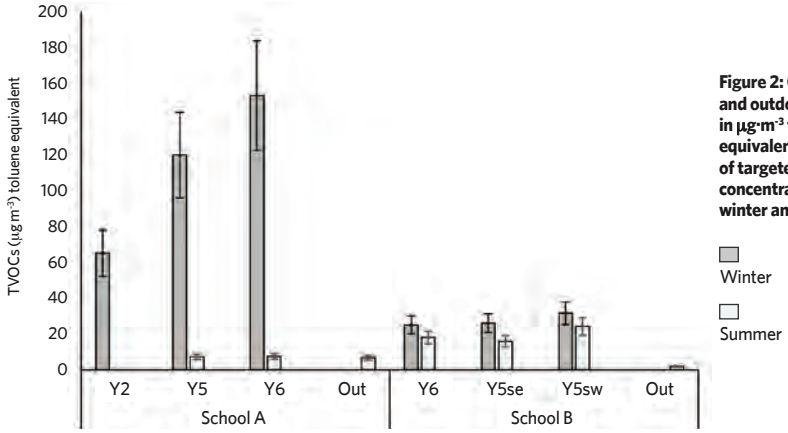

Figure 2: Classroom and outdoor TVOCs in $\mu g \cdot m^{-3}$ toluene equivalent, inclusive of targeted VOCs concentrations, in winter and in summer

buildings in Europe (for example, SINPHONIE-UK). The findings are in agreement with studies suggesting that mechanically ventilated buildings are likely to have lower $PM_{2.5}$ infiltration rates than naturally ventilated buildings.

The adaptive temperature criteria for the assessment of summertime overheating risk were met in all classrooms in the investigated schools, but higher temperatures in both seasons are associated with south-facing windows with limited shading. Solar control for summer should be designed for south-facing windows, to ensure better control of summertime overheating, at higher outdoor temperatures, when ventilation cooling is less effective.

Differences between the two schools, designed to meet different daily average supply rates corresponding to the different CO_2 compliance criteria in two versions of the *Building Bulletin BB101 Ventilation, thermal comfort and indoor air quality (2006 and 2018)*, show that higher ventilation rates can limit indoor-sourced pollutants, such as CO_2 and VOC. For building facilities managers (FMs), this means liaising with the cleaning and teaching teams, school management and controls engineers to adjust the ventilation schedule to account for dilution of pollution events.

In very airtight buildings, such as Passivhaus schools, the infiltration of outdoor-sourced pollutants, such as NO_2 and benzene, can possibly be controlled through ventilation strategies that take into account the position of the air inlet in relation to pollution sources and prevailing wind direction.

Mechanical ventilation and mixed-mode ventilation strategies with filtration combined with an airtight building envelope, can provide more effective protection from exposure to $PM_{2.5}$ in polluted environments.

Mechanical ventilation strategies in Passivhaus schools are required to balance not only indoor sources, but also the fluctuations of outdoor air pollution. Strategies for good IAQ during operation should employ increased monitoring of indoor and outdoor air-pollution levels for adaptive adjustment of the ventilation schedule. **CJ**

CHRYSSA THOUA, **DR ANNA MAVROGIANNI** and **PROFFESOR DEJAN MUMOVIC**, Institute for Environmental Design and Engineering, UCL, **LIA CHATZIDIAKOU**, Department of Chemistry, University of Cambridge, **MARK LUMLEY**, associate director, Architype

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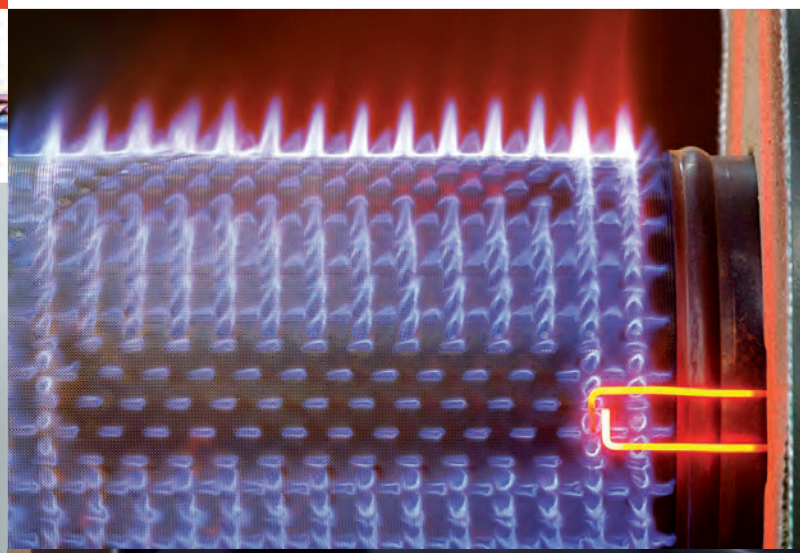

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AIRY AMBITION

The heating demands of a 1930s Cambridge University building will be reduced to a minimum during a deep energy retrofit to enable a small, all-air heating system to be installed in the EnerPHit project, as **Liza Young** reports

The old Cambridge telephone exchange building will benefit from a deep energy retrofit

PROJECT TEAM

Buildings services consultant: BDP
Breeam and Well Assessment: BDP
Architect: Architype
Project manager: 3PM
Cost manager: Gardiner & Theobold
Main contractor: ISG
Contractor's architect: Feilden+Mawson
Contractor's building services consultant: Max Fordham

Over the next 10 months, the Entopia Building – a retrofitted 1930s telephone exchange at 1 Regent Street, Cambridge – will be transformed into an ultra-low carbon headquarters for the University of Cambridge Institute for Sustainability Leadership.

The building, which is undergoing a deep energy retrofit to the Passivhaus standard EnerPHit, aims to be an exemplar in office refurbishment. As well as seeking Breeam Outstanding and Well Standard Gold certification, the project is applying circular economy principles to minimise the volume and impact of resources used in its development (see panel, 'Circular considerations' on page 44).

The deep retrofit is projected to result in an 80% saving in whole-life carbon emissions compared with a standard office refurbishment, and to deliver 75% lower heating demand compared with an average office building.

The heating strategy for the building is based on the fabric-first principles that have become synonymous with the Passivhaus standard. Its well-insulated, airtight approach is used to reduce heat demand, so a small-scale, all-air system can be used effectively.

Heating strategy

Primary heating, and cooling, is provided by the central ventilation system's air handling unit (AHU), fitted with a 65kW integrated air source reverse-cycle heat pump. This heats – or cools – incoming air, distributing it throughout the building, and exchanges heat with the exhaust air, depending on demand. The central ventilation AHU is operated and controlled by variable air volume (VAV) mechanical control dampers – linked to room temperature and CO_2 sensors – that alter the amount of air going to various zones so they can be conditioned accordingly, while the fans maintain a required pressure based on the VAV's damper positions.

Michael Williams, project engineer at BDP, which is carrying out MEP, sustainability and interior design, says this type of all-air system is only possible when used with the exacting fabric-efficiency measures required by high performance standards such as Passivhaus EnerPHit.

'Heating by air is quite inefficient, because air is not a particularly good medium for transporting energy,' Williams says. 'But by going for a fabric-first approach, and reducing the conduction and infiltration losses through fabric and airtightness measures, we've driven down the space heating and comfort cooling demands, making the all-air system viable.'

He adds: 'If you don't put in place carefully considered measures and invest in creating a thermally efficient fabric and airtight building, you will lose heat through infiltration, drafts and exfiltration. This is exacerbated on an air system, where convection is the main heat-transfer mechanism. In a leaky building, structural air leakage is a big no-no, because it gets blown out through the gaps in the walls and absorbed into the walls.'

Secondary heating and cooling are provided by electric panel radiators and variable refrigerant flow-based fan coil units to cater for certain spaces in the building, such as cellular offices, meeting rooms and designated conference spaces. This gives some additional supplementary heating or cooling when required – for example, during big conferences or events when more cooling is needed to tackle latent gains.

Williams says: 'The idea is that [these units] are used few and far between, and not in close control for the whole year. It's a long game, because we're looking to reduce consumption over an annual average – so they can give a boost when it's needed, but it's a more of a backup.'

»

The project is projected to deliver 75% lower heating demand compared with an average office

» During the initial feasibility process, a more traditional approach was considered – using a gas-fired boiler system with four-pipe fan coil units, and chillers. 'But we decided to do away with gas mains; we stripped that back and we're going to an all-electric building.

'In a way, we're future-proofing it to get onto the Grid, because, undoubtedly, we'll move to all-electric buildings. If not all-air systems, the future will be a mix, with central all-air systems and heat pumps, or other electric technology, driving the main systems.'

Domestic hot water

As a result of the relatively small domestic hot-water (DHW) demand, BDP opted to use electric showers and a mix of instantaneous and point-of-use water heaters for basins and sinks.

To minimise distribution pipework losses and mitigate overheating in corridors, direct electric heating was chosen because the DHW loads in the building are relatively low. 'We felt that a more economical and effective solution was to use point-of-use. It also factored into maintenance and legionella risk, so we can maintain local systems a lot better,' says Williams.

The rooftop PV canopy, which will provide supplementary power on site, will offset some of those demands for the building, he adds. 'It's more a considered application, rather than a bolt-on.'

Challenges

The biggest challenges with existing sites are constraints such as the geometry, orientation and form factor – fixed variables that cannot be changed. 'It's a big challenge on the Entopia building because of the "abnormals" you find on site during construction,' says Williams.

He describes the property as a 'patchwork' of previous retrofit and fit-out projects that have been added to over time, so things – such as perimeter trenches – get uncovered as work progresses. But he says the biggest challenge with a deep energy retrofit is the risk of adding measures that might have unintended consequences for other parts of the building.

For example, the Entopia Building, which is situated in a heritage site, could not be insulated externally because of planning restrictions. 'We have had to internally insulate, which creates the risk of interstitial condensation, compromising the building fabric and the building structure elsewhere,' says Williams.

To ensure the internal insulation didn't introduce a condensation risk, the team did thermal and hygroscopic (moisture) modelling of the wall build-up. 'We took the wall build-ups and ran them through a computer programme to simulate the moisture transfer through them. This gave us confidence that the architectural and engineering specifications would stack up, so we're not introducing any risk to the existing building,' Williams says.

'You've got to be really careful how you address each challenge, especially with a fabric-first approach. It's about understanding the measure, the driving force behind it, and what implications it might have for other aspects of the existing design – and whether we can design to accommodate it, or empathise with the existing context, while trying to achieve the difficult standards of Passivhaus.'

The project balances the technical demands of meeting the EnerPHit standard with the sensitivities of dealing with a building in a conservation area. When it opens in early 2022, the team hopes the building will become an exemplar for the evolution of sustainable building refurbishment approaches in the UK.

Williams says: 'When we set out to do it, we understood that it was driven by our own limitations in terms of what we can achieve. We're doing Passivhaus EnerPHit, Breeam, Well Standard; we're looking at circular economy and low-impact and bio-based materials; so it's a holistic approach to sustainability, not just operational energy. Hopefully, it will lead the way for the net-zero roadmap we're on.' CJ

CIRCULAR CONSIDERATIONS

The spirit of the project was collaboration and integrated design, says BDP's Michael Williams, who adds that all the stakeholders and invested parties, on the client and design side, signed up to a charter to ensure everyone stuck to the brief from the outset. One such 'KPI' was the application of circular economy principles during the retrofit. The project is one of the first to reuse more than 350 LED light fittings from another building refurbishment for the occupancy-driven, task-based lighting solution.

Williams explains: 'The contractor had a range of existing light fittings from another project that were destined for landfill, a lot of which we were able to use on this project – and they've honoured the warranties from the point of installation.'

The contractor has also reclaimed the steel used for the PV canopy frame, 'which is a huge win in terms of reclaimed materials', says Williams.

Leftover furniture in the building has been diverted from landfill, avoiding 21,000kg of CO_2, with 21,600kg of chairs, tables and storage cabinets donated to local communities. A third of the building's paint needs have been covered by a donation from Dulux of paint with 35% recycled paint content.

Zeroth ambient network installed in Poole loft apartments

A Zeroth Energy System, featuring an ambient network of water-to-water heat pumps, has been installed in the Harbour Lofts apartment scheme in Poole, Dorset.

The central loop of the Zeroth Energy System, designed by GDHV, runs at 25°C, rather than the 80°C of a traditional high-temperature system. GDHV claims this reduces heat loss by up to 90%.

The design features an air source heat pump and buffer tank in the plantroom, and individual air source heat pumps in the apartments. GDHV worked with Thermal & Acoustic Solutions to design the system, which uses wet emitters and underfloor heating.

'GSHPs are underestimated'

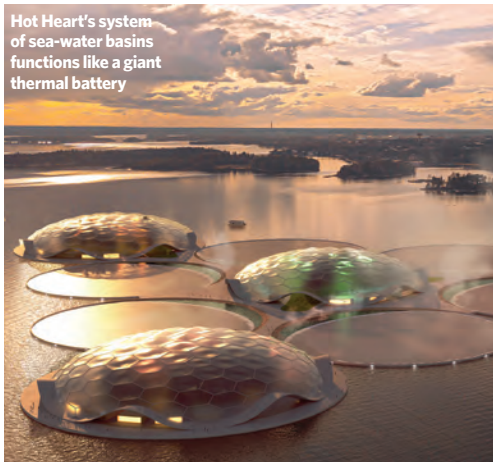
Ground source heat pumps (GSHPs) should be treated like a new type of utility, according to energy analysts Regen.

Its research claimed that the potential of GSHP technology to meet the challenge of decarbonising heat had been underestimated, and that giving it the same access to existing infrastructure as utilities such as water and gas would help reduce installation costs and make it more economically attractive.

Policymakers and industry analysts have often focused on air source heat pumps because of their lower capital costs and perceived easier installation. But new installation approaches that share ground array infrastructure could unlock the advantages of GSHPs for more consumers and the electricity system, says the report.

Regen argues that GSHPs could reduce peak electricity demand for heat by at least 10%. 'With a new system design based on shared infrastructure, and supported by a utility-style finance model, GSHPs could revolutionise how we heat our homes and businesses,' said Regen director Johnny Gowdy.

Floating thermal stores win energy challenge



Hot Heart's system of sea-water basins functions like a giant thermal battery

Hot Heart concept proposes creating giant off-shore batteries that double up as thermal baths

A carbon-neutral heating solution that uses water reservoirs as thermal batteries is one of four schemes to win the Helsinki Energy Challenge, and a share of a €1m (£855,000) prize.

The Hot Heart concept is a set of 10 cylindrical sea-water basins, each measuring 225m in diameter, located off the shores of Helsinki. When filled, they can carry up to 10 million m^3 of water. The system functions like a giant thermal battery: renewable energy is converted into heat, stored in the basins, and withdrawn through the city's heat-distribution channels during the winter. Hot Heart also aims to stabilise the national energy grid in light of fluctuating supply.

The concept doubles as a recreational venue – four of the 10 hot-water reservoirs are enclosed in transparent domes housing tropical ecosystems from the world's rainforest zones, naturally heated by the basins underneath.

The Hot Heart team, coordinated by CRA-Carlo Ratti Associati, included Schneider Electric, Ramboll, Transsolar and Danfoss Leanheat.

The international Helsinki Energy Challenge was launched to find solutions to replace the burning of coal for district heating, with the aim of decarbonising the Finnish capital by 2035.

The other three winners were Hive, Beyond fossils, and Smart Salt City.

Hive's is a heat-pump solution, harvesting up to 50% of the city's heat needs from the sea, and using solar thermal fields, thermal energy storage, and district heating grid optimisation.

The 'Beyond fossils' concept presented an energy-transition management model based on investments in clean heating solutions in low carbon energy markets.

Smart Salt City's solution is an energy system with a novel thermochemical energy-storage technology charged by surplus renewable electricity.

Hydrogen boilers to be installed in demonstration homes

Hydrogen boilers from Baxi Heating and Worcester Bosch are to be installed in two semi-detached homes this month, in a hydrogen pilot project near Gateshead. It will demonstrate the use of hydrogen-fuelled appliances for heating, hot water and cooking.

Alongside the hydrogen boilers, there will be prototypes of hydrogen-fuelled fires, cookers and hobs, installed by partners working with BEIS on the Hy4Heat project.

The properties were built in partnership with Northern Gas Networks, BEIS, and gas distribution network company Cadent, and are located at Northern Gas Network's Low Thornley site.

Both companies have already been involved in a number of trials, including 'HyStreet' at Spadeadam in Cumbria.

The semi-detached pilot homes near Gateshead

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SMART WATER

Hot water tanks have the potential to store renewable energy, balance the electricity grid, and reduce carbon emissions and utility bills. **Alex Smith** speaks to Mixergy to find out how the hot water cylinder has the potential to become the smartest technology in the home

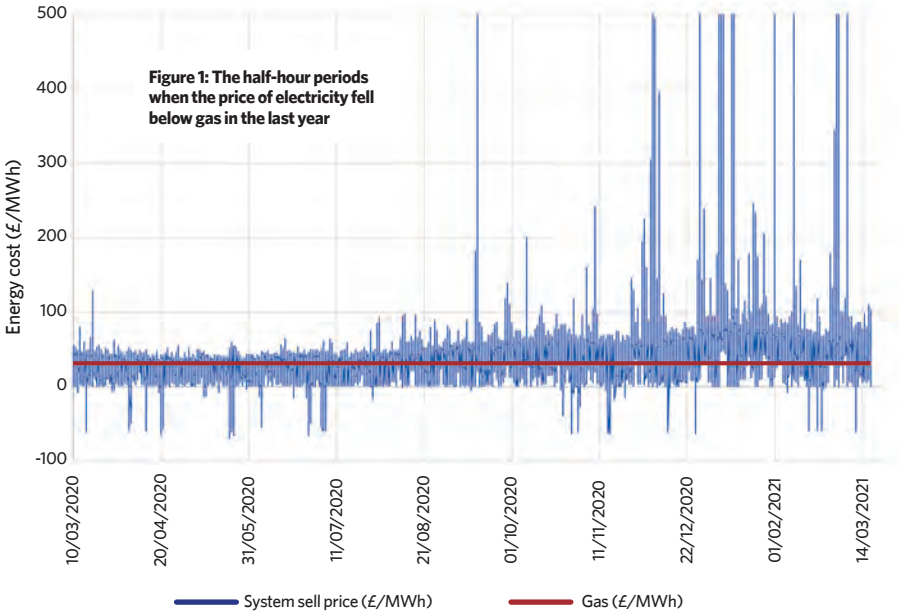

Figure 1: The half-hour periods when the price of electricity fell below gas in the last year

The past decade has seen the demise of the hot water tank in many homes, as improvements in combi boilers – which combine delivery of hot water for space heating and domestic hot water – mean occupiers can have efficient instantaneous hot water without the need for a storage tank.

Hot water cylinders are still needed in larger homes, however, where more hot water is required. More than 450,000 hot water tanks are still sold annually, and the government's target of 600,000 heat pumps installed by 2028 will boost the market, as heat pumps require cylinders with heat exchangers to deliver hot water.

The potential to store energy is another benefit of a hot water cylinder. As well as enabling energy to be stored from local renewables, they could store excess energy generated by wind and solar on the National Grid.

Innovate UK and the Department for Business, Energy and Industrial Strategy (BEIS) has been carrying out trials to see how tanks can integrate renewables in the home and connect with other tanks to offer a demand side response (DSR) to the National Grid.

One of the sector's pioneers is Mixergy, a spin-out firm from Oxford University's Energy and Power Group. Its hot water tanks featured in a BEIS DSR pilot where connected tanks were heated by the Grid when national electricity demand was low and excess energy was being generated by renewables. Storing this excess energy in a large-scale battery of hot water tanks allowed more electricity on the Grid to be generated using wind and solar.

Building on this pilot, Mixergy is now remotely operating 700 of its customers' tanks to offer a DSR service for the Grid. 'The tanks provide a stabilising service for the Grid,' says Mixergy CEO Pete Armstrong. 'The frequency response service is quite rare and hardly changes heating patterns. The typical cost of a frequency event is only 1-5 pence, and it only lasts a few minutes and usually adds to heating that is required anyway.'

Hot water tanks are the lowest-hanging fruit in terms of energy storage, he adds. 'There's a huge dormant capacity in hot water tanks. Of the 27 million homes in the UK, about 40% have a tank as part of a system boiler or direct electric. Collectively, this represents about 85GWh of energy storage, which is just over nine times the size of Dinorwig Power Station in Wales [which provides rapid-response capability in the Grid],' says Armstrong.

Armstrong says using hot water tanks as energy storage batteries is a lot cheaper than using lithium batteries, and use far less resources in their manufacture. 'Lithium-ion batteries are expensive and take a decade to pay for themselves, by which point they're dead,' he says. 'Batteries are incredibly material intensive, containing around 80kg of cobalt, lithium and copper compared with 30kg of, predominantly, stainless steel and polyurethane in a hot water tank with equivalent energy storage density.'

How it works

Mixergy's hot water tank technology differs from traditional tanks by heating from the top of the tank. It uses stratification to keep hot water at the top of the tank separated from the cold water below. An electric immersion heater and heating coil from the system boiler is installed at the top of the tank. A cold water mains feed enters the bottom of the tank and a pump takes this water, internally, to the top of

CASE STUDY

Mixergy tanks were installed in 78 East Devon District Council properties, alongside a Vaillant air source heat pump, PV panels, and a PV diverter, to allow the solar panels to charge the hot water tank. Insulation was topped up in the roof to improve the ability to retain heat, and radiators were upgraded. Using SAP, it was calculated that the retrofits lifted homes from EPC band E to B at a cost of around £15,000 per property.

the tank, where it is sprayed via a diffuser into the hot layer and heated by the heating coil or immersion heater.

The hot and cold layers are separated by a thermocline – a thin distinctive layer that changes temperature dramatically from hot to cold. It's important that the thermocline is not disturbed, to maintain the separation of the layers, says Armstrong; a novel array of temperature sensors ensure that the pump turns down if movement in the water threatens the integrity of the thermocline.

Having a separate layer of hot water means that the whole water tank does not have to be heated, and a built-in controller can ensure the tank is charged incrementally.

Heating the hot water required, rather than the whole tank, reduces energy use, cuts heat losses from the tank, and leaves spare capacity to store energy from renewables, such as photovoltaics. It also means that recharging the hot water tank is faster, as Mixergy's director of business development, David White, explains: 'As we are only heating small portions of water, we can heat up much faster than a conventional tank.'

He uses the example of a 180-litre tank running alongside an 20kW gas boiler. To heat up 36 litres of water (enough for a shower), only 20% of a Mixergy tank would need to be heated, taking around 5.5 minutes. A conventional heater would take five times as long, says White.

Machine-learning software built into the tank's controller is designed to switch to the lowest-cost energy source when heating. It accesses half-hourly electricity prices issued by the National Grid, and automatically recharges during half-hour periods when prices are low or even negative. Figure 1 shows the half-hour periods when electricity prices fell below gas last year. Figure 2 shows how one customer was credited for heating the tank when prices were negative. The tank may use another source of energy – such as gas heating, solar thermal panels or photovoltaics, which communicate with the tank via PV diverters. These are built-in, or the tank can connect to an existing diverter. The intelligent software »

> "Heating the hot water required reduces energy use, cuts heat losses, and leaves spare capacity to store energy from renewables, such as photovoltaics"

The Mixergy tank is heat pump ready but is designed to maximise the efficiency of a gas boiler

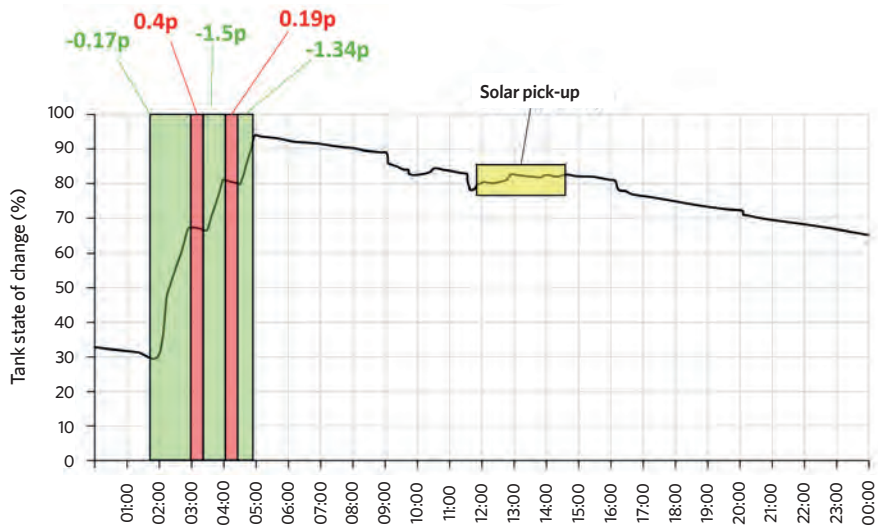

Figure 2: If electricity prices are negative, the National Grid will pay consumers to heat their hot water tanks. The green area shows negatively priced Grid electricity charging a tank from 30% to more than 90% during the night

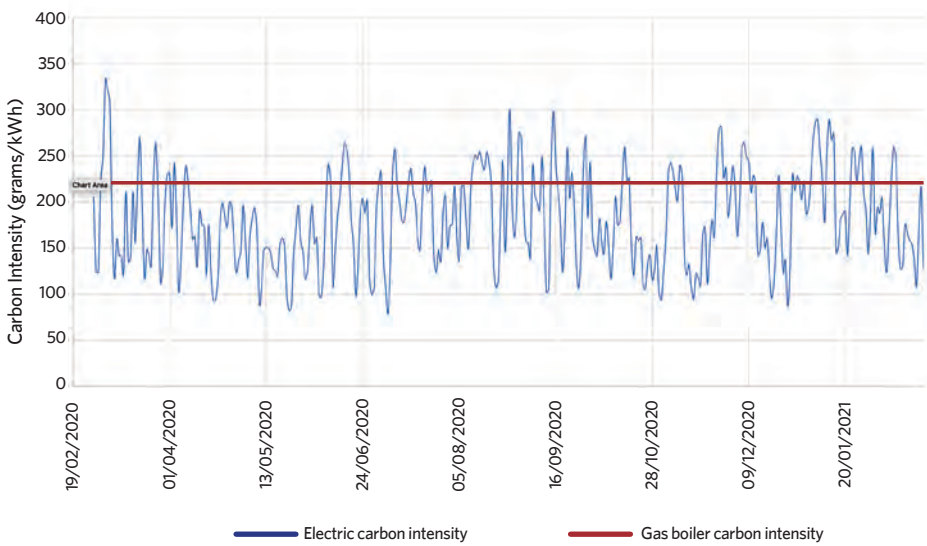

Figure 3: The smart hot water tank can automatically switch to electricity if its carbon intensity is less than that of gas

Society of Public Health Engineers

Continuous flow as a means of hygienic DHW production and carbon reduction

Temperature accurate water is now of critical importance. In the current pandemic, it is now priority. In the UK, heating accounts for a third of emissions (if we include industrial processes) with 21% of that coming from space heating (and cooling) and heating hot water. (Department for Business, Energy & Industrial Strategy, 2018). If the goals of carbon reduction are to be achieved a change is required in heating and heating for hot water.

This report explores continuous flow provision of domestic hot water; its hygienic benefits; how it can contribute towards achieving carbon reduction.

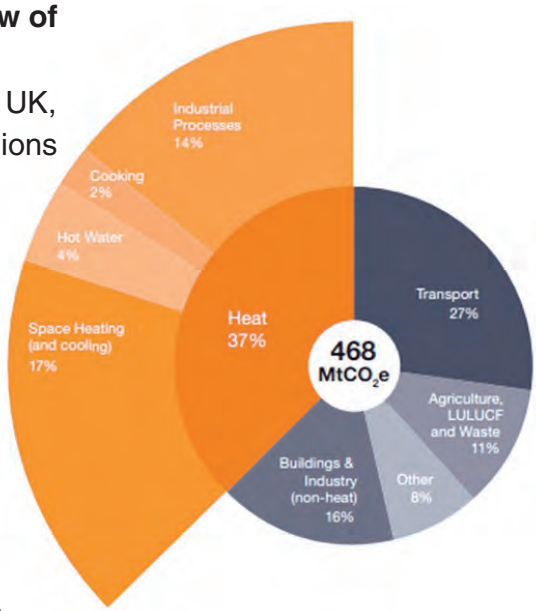

Figure 1: UK emissions in 2016 across different sectors (Department for Business, Energy & Industrial Strategy, 2018).

» calculates the cheapest source of energy. If a home has PVs, machine learning will ensure the tank is only partially charged before PVs start generating electricity during the day.

Customers have the option of becoming 'Mixergy Heros', where the tank is automatically charged using Grid electricity when the carbon intensity is low (see Figure 3). The software makes decisions based on information from the Grid's carbon intensity API. Armstrong says tests have shown that carbon emissions fall by around 16% if customers select this option. This means the tanks can take advantage of the increasing decarbonisation of the Grid as more renewables are connected.

'We spent a lot of time building algorithms for interpreting dynamic tariffs and automatically building schedules that take the burden of thought away from the consumer,' says White.

Mixergy carried out a trial comparing water heaters using MixCloud with those on Economy 7, which heats water using night-time tariffs. Assuming hot water consumption accounts for £288/year of the average householders' energy bill,[1] the firm says bills for tanks using MixCloud and Economy 7 are £80.30/year compared with £135/year for those just on Economy 7.

With tanks connected through the cloud, the firm can carry out remote diagnostics to identify anomalies. [See panel, 'Remote diagnostics'] Each tank has, effectively, a Linux computer controlling the heating. As the computing load is light, Mixergy is talking to Berkeley University about using spare computing capacity to contribute to Rosetta@Home life-science research.

The Mixergy tanks have a 25-year warranty and Armstrong is keen to ensure they are future-proof. Mixergy tanks are heat pump ready, so while they can be installed with a system boiler today, every model is fitted with ports to accommodate a plate heat exchanger to operate in future with a heat pump.

This arrangement works more efficiently than a traditional coil, says Armstrong, who claims it delivers more effective volumetric output from the same installation volume and elevates the COP of the system by anywhere between 5-10%. 'We need to create a product that's flexible for the low carbon transition, whether its with hydrogen boilers or heat pumps. A core ethos of ours is eliminating product obsolescence,' he says.

Mixergy's presence in the market is growing. It has installed around 1,000 water tanks and is aiming to install 5,000 by the end of next year. **CJ**

Reference:

1 *At home with water*, Energy Saving Trust, July 2013 **bit.ly/CJApr21EST**

REMOTE DIAGNOSTICS

With aggregated data, Mixergy can identify what good performance looks like. It knows the shape of the tank's heat-loss curve, and can determine the difference between standing heat loss and a draw event. So, if a tank has a higher-than-average heat loss, the team knows there is an issue with insulation.

Anomalies in the data can also identify leaks, limescale on the immersion heater, and whether the boiler is short-cycling. Short-cycling occurs when the boilers' internal thermostat senses that the water returning from the cylinder is becoming too hot and, as a result, it switches off to avoid over-heating.

Mixergy has created code that recognises short-cycling and lowers the set point temperature of the cylinder to allow the boiler to run continuously. 'We're using data to try to spot these issues in the field,' says Armstrong. The EST has verified that if a boiler is short cycling, a Mixergy tank can help eliminate it, leading to water heating gas savings of up to 21%.

Legionella

The prospect of a Legionella outbreak is a constant concern. Legionella is a bacterium that causes Legionnaires disease, a potentially fatal form of pneumonia. Legionella bacteria are common in natural water sources but conditions are rarely conducive to people catching the disease. This can occur in purpose-built water systems. The risk of exposure to Legionella increases in warm water, passed to humans breathing in aerosol-like droplets of water.

Guidance for the control of L pneumophila in water systems is provided in the Health and Safety Executive Approved Code of Practice (ACOPL8) and its associated regulations, HSG274 Part 2.

Certain conditions support growth of bacteria, temperatures at a range of 25°C - 45°C, as well as deposits such as lime-scale, rust, sludge and organic matter. Therefore, it is important to control the risk by introducing measures that restrict the growth of bacteria.

This is achieved through temperature control, maintaining stored water at least 60°C and ensuring distributed water is supplied with 50°C water (55°C for healthcare) within 1 minute.

According to the ACOP L8 guidelines, continuous flow direct to outlet systems are low risk for Legionella, due to it allowing for a full turn-over of water volume, AND no stored water and accurate temperature control. However, this can be further reduced by implementing more preventative measures which include:

- Good system design that has good movement/turnover and temperature control, helping to avoid encouraging legionella growth.
- Avoiding dead legs (capped ends).
- Keeping pipework as short and direct, ensuring adequate insulation.
- Maintaining cleanliness of system – hard water areas should be treated – so scale is reduced using measures such as a zinc anode or a copper and silver ionization stagnant water.
- Ensuring cold water comes from wholesome mains.

At present, two of the main forms of supplying DHW are continuous flow (instantaneous) water heaters and more conventionally, storage tank water heaters. Both have their features and benefits with the main differences outlined below.

Storage tank water heaters:

- Heavy and difficult to handle, requiring more manpower or machinery to install/remove which increases costs and consumption.
- Requires large footprint for appliance and clearances.
- Finite store of water though can cater for demand spikes.
- Standing losses that increase consumption.

Continuous flow heaters:

- Allows modulation - more energy efficient, especially condensing versions.
- Water only heated and provided upon demand, eliminating wasted energy.
- Light and requires less time, manpower and equipment to install.
- Compact in size, saving valuable space.
- Endless supply of hot water.
- Advanced models supply precise temperature accurate hot water.

Storage tank water heaters left unmaintained can be breeding grounds for bacteria. This is one reason why they are not deemed low risk, according to the Health & Safety Executive HSG274 Part 2 guidelines, an example of a low-risk system is: “where hot water is fed from instantaneous heaters or low storage volume water heaters” (supplying outlets at 50 °C)”. (Health & Safety Executive, 2014)

Table 1 below shows a comparative analysis between a storage tank water heater and a continuous flow water heater. The data suggests the storage tank option is less efficient and consumes more energy, largely due to storage and pipework losses. Once the total cost is added up a continuous flow heater is the more cost and energy efficient option as well as reducing carbon emissions.

Table 1	2 x Continuous Flow W/H	1 x Storage Tank W/H
Max Heat Input (kW)	4.4	n/a
Max heat output (kW)	116.6	127.7
Min Heat Input (kW)	4.2	n/a
Min heat output (kW)	112	102.4
Efficiency (Gross)	96%	80%
1st hour flow rate @ 50°C rise (l/hr)	1920	2013
Storage/Cylinder (L)	0	253
Continuous flow rate (l/hr)	1920	1760
Peak usage periods (hr)	1	1
Number of peak usage periods	3	3
Heating consumption (kW)	116.6	127.7
Storage recovery time (mins)	0.0	8.6
Storage recovery (kW)	0.0	18.4
Storage loss (kWh)	0	10
Secondary return system heat loss per hour (kW)	10	10
Efficiency (efficiency curve of appliance)	93%	80%
Appliance input for secondary system (kW)	10.8	12.5
Secondary system operating time (hr)	21	21
Reheat of secondary return (kWh/day)	225.8	262.5
Consumption per peak period (kWh)	116.6	127.7
Total consumption per day (kWh)	575.6	710.7
Consumption per week (kWh)	4029.2	4974.7
Annual consumption (kWh)	210,096.4	259,394.8
Annual CO2 carbon emissions (kgCO2e)	38,626.2	47,689.7

Table 1: Example of comparative consumption analysis between storage tank water heater and continuous flow water heater.

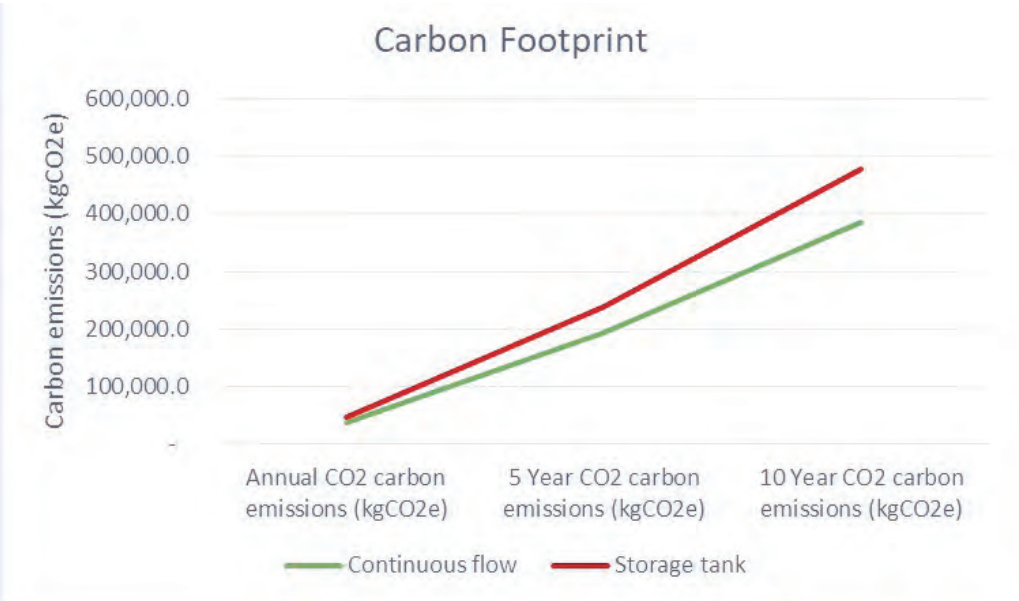

Figure 2: Graph depicting carbon footprint of both options up to 10 years.
Continuous flow direct to outlet

Another option is a design which includes continuous flow direct all outlets. Additional water heater units can be added later if demand increases. It also offers redundancy in case of module maintenance or failure. The systems are available to be applied to decentralised hot water systems that are near the draw off points, reducing distribution losses and simplifying maintenance of the hot water piping network.

Another concept is "low temperature domestic hot water." Shifting to low temperature (DHW) potentially impacts on energy reduction; as mentioned before, some specific brands of continuous flow water heaters accurately control temperature. Thermal disinfectant is a reality because of this.

The significance of temperature itself is more detailed in a 2020 article published in the CIBSE Journal "Taking the temperature – domestic hot water", which looks at potentially reducing carbon and providing modern, safe, low energy solutions by focusing more on temperature and revising guidance (CIBSE, 2020).

One method employed is a pasteurization regime. This consists of raising water temperature to over 70°C, the point at which Legionella bacteria is eradicated and then flushing the system. A safe temperature returns allowing for water to be supplied as low as 43°C reducing consumption.

The use of copper and silver ionization could potentially yield positive results, as it allows a low temperature system. This removes thermostatic mixing valves (TMVs) from the design, reducing money and energy consumption. A control routine dependant on water treatment could also allow for a low temperature system. A 2019 paper published by The American Journal of Infection, "Controlling Legionella pneumophila in water systems at reduced hot water temperatures with copper and silver ionization" studied the effectiveness of copper and silver ionization to control L pneumophila.

The Great Ormond Street hospital has removed TMVs from the system design by opting to supply water consistently at 43°C, instead relying on copper-silver water treatment protection. They concluded that not only had they saved money due to the associated costs of installed TMVs, but that the energy savings and reduction of carbon emissions amounted to "33% and 24% respectively, compared to an equivalent temperature-controlled system". In over 6 years, there have been no cases of Legionella counts being detected. (Cloutman-Green, et al., 2019).

Conclusion

The benefits of continuous flow are many. Technologically advanced continuous flow water heaters can be included as a booster to renewable heat sources like heat pumps or solar thermal. This serves to harness and optimise both renewables and fossil fuels and further reduce carbon without compromising on hot water performance and hygiene.

Modulating systems contain turn down ratios of up to 13:1. For instance, if a heater has a maximum output of 58.3kW, it can modulate to a minimum of 4.4kW. This huge difference results in significant reduction in energy consumption and emissions as its operating capacity of maximum power is rarely utilized. When combined with a temperature accurate supply of water of ±1°C, lightweight design and high efficiency, these systems can contribute towards a low carbon future.

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Left: Heatrae Sadia Supreme SS hot water dispenser

BETTER OFF

Use of timer switches on instantaneous hot water dispensers can cut energy use by 40%, says the NHS's **Istvan Sereg**, who assesses the savings that can be achieved by switching equipment off rather than leaving it in standby mode

According to the Carbon Trust, simple energy-saving measures can reduce energy bills by up to 20%.[1]

When not in use, all non-essential energy-consuming equipment should be switched off, and this can be done manually – by staff – or automatically, by building control systems and timer switches. It is recommended that equipment should not be left in standby mode for extensive periods, as it will still consume electricity.

In offices, energy is mainly used for lighting, space heating, cooling, humidification, and to provide hot-water services. Examples of small power-consuming equipment common in office environments are ICT equipment, vending machines, microwaves, instantaneous hot water dispensers, and other kitchen appliances. These account for approximately 32% of energy use in a standard office-type building.[2]

> "Electrical baseload consumption can add up and be a significant contributor to the carbon footprint"

This article focuses on the energy efficiency of a typical instantaneous hot water dispenser – a small, power-consuming piece of equipment often found in breakout areas. It discusses its energy consumption over time, considers a potential energy-saving measure, and quantifies the anticipated cost savings based on real-world data.

Energy use of instantaneous hot water dispensers

There is a wide range of countertop and wall-mounted instantaneous hot water dispensers available on the market, varying in vessel size, heating element rating, capacity, and price. They provide hot water for beverages instantaneously and on demand, meaning that the water in the vessel is kept at close-to-boiling temperature all the time.

This can waste energy, especially out of hours and on weekends, when they are not likely to be used. Some newer models come with energy-saving features as standard, while older models may require additional plug-in timer switches to minimise energy use. They may also require an additional, regular maintenance regime, such as descaling, to maximise operational efficiency.

Large organisations with multiple sites often have dozens of water boilers across their offices, predominantly in staff rooms and kitchenettes. Unless appropriately managed, their electrical baseload consumption, along with other electrical equipment and appliances, can add up, and be a significant contributor to an organisation's carbon footprint depending on the units' age, make and model.

Businesses and organisations, of any size, looking to reduce their energy bills and carbon impact should consider reducing, in the first instance, their baseload consumption. This can be done by making use of the already available energy-saving features, such as 'eco' mode or the built-in digital timer switch. Another option is to implement suitable energy-saving measures such as installing 13-amp, plug-in mechanical »

» segment- or seven-day digital timers. If financial investment is required to facilitate the project, the anticipated cost savings can be quantified using granular electricity consumption data, which can help to support the business case.

Assessing the energy-saving potential

In a real-world project, the energy consumption of a typical hot water dispenser was monitored with a pre-programmed portable energy meter, to quantify its out-of-hours energy use and to calculate the associated running costs.

Granular data was collected in half-hourly intervals over a period of five weeks. The flexible CT current sensor was installed by a qualified electrician to ensure no other power-consuming equipment would be monitored during the trial, and the collected data was later analysed in a spreadsheet.

Figure 1 shows a typical week during the trial period. The plotted electricity data gives a clear indication of when the building is occupied – generally between 7am and 6pm in this instance – and what the baseload consumption is during out of hours and on weekends, when the building is empty.

The analysis of the numerical data suggests that the daily average consumption of this particular unit is 0.6kWh from 00:00-07:00hrs, 1.95kWh from 07:00-18:00hrs and 0.46kWh from 18:00-00:00hrs on weekdays; and 2kWh from 00:00-23:59hrs on weekend days. The base-load consumption of the unit is 0.1kWh per hour (or 0.05kWh/30min).

The equipment operating outside of the period 7am to 6pm wastes electricity and money, so installing a seven-day timer switch is a reasonable energy-saving intervention. To be able to accurately quantify the potential savings, it is worth noting that, with this measure, temperature loss over night and on weekends will occur. So extra energy will be required at the beginning of each work day to heat up the water to target temperature, and the savings calculation must account for this.

To calculate the extra energy required, the following equation can be used: $Q = c \times m \times \Delta T$

where:

Q – total heat required to reach target temperature
c – specific heat capacity of water
m – volume or mass of water
dT – temperature rise

Superimposed over the original data, Figure 2 shows the modelled half-hourly electricity

> "The electricity saving can be as much as 375kWh per annum, enough to boil 4,000 litres of water to make 1,600 cups of tea"

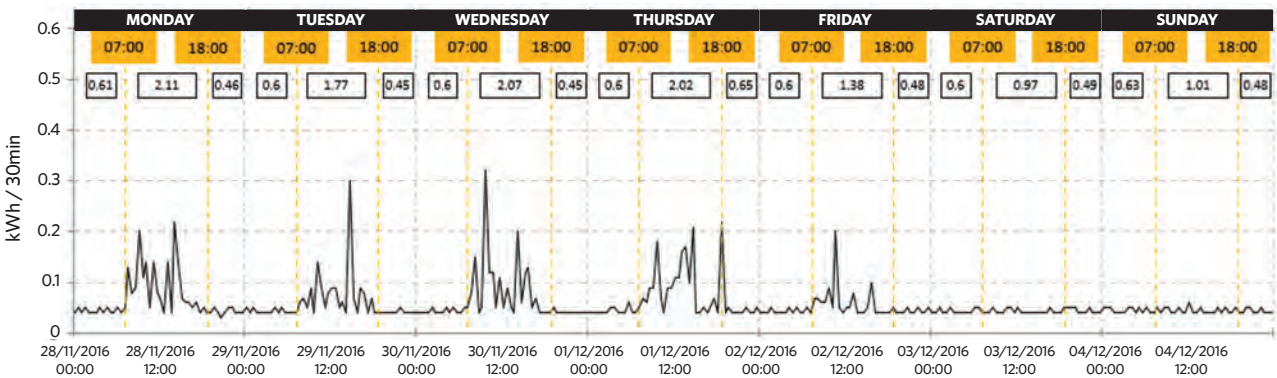

Figure 1: Time series of half-hourly energy consumption data (5 litre vessel capacity, 3kW tabletop water heater)

Legend

MONDAY	Day
07:00	Time
0.61	Consumption in period **without** timer (kWh)
———	Energy usage **without** timer

Table 1 summarises the average electricity consumption during the different periods of the weekdays and weekends

Out-of-hours consumption (average per weekday)	00:00-07:00	0.6	kWh/day
Daily average consumption (weekday)	07:00-18:00	1.95	kWh/day
Out-of-hours consumption (average per weekday)	18:00-00:00	0.46	kWh/day
Weekend average consumption (average per day)	00:00-23:59	2	kWh/day

Table 1: Summary of electricity consumption during different times of the day

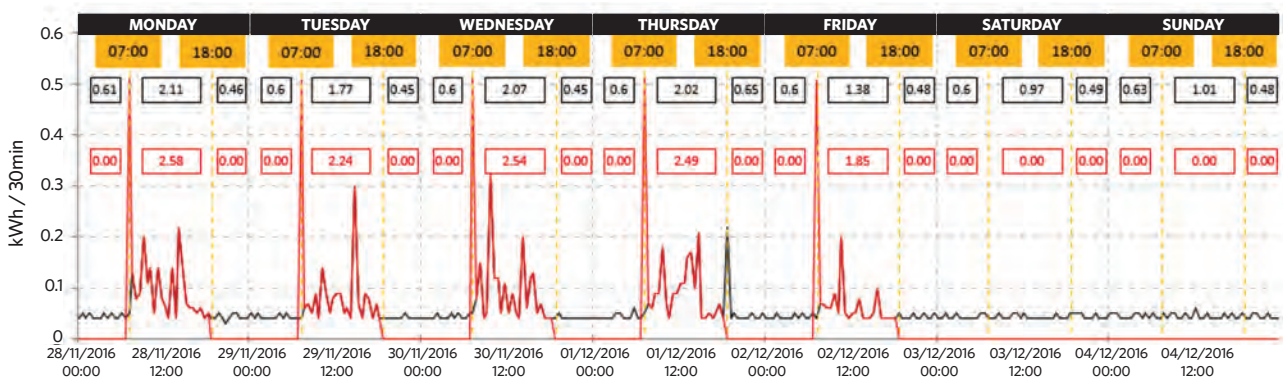

Figure 2: Time series of the modelled half-hourly energy consumption data (5 litre vessel capacity, 3kW tabletop water heater) with timer switch

Legend

MONDAY	Day
07:00	Time
0.61	Consumption in period without timer (kWh)
	Energy use with timer
0.00	Consumption in period with timer (kWh)
	Energy use with timer

Table 2 summarises the average electricity consumptions during the different periods of the weekdays and weekend days with a timer switch

Out-of-hours consumption (average per weekday)	00:00-07:00	0	kWh/day
Daily average consumption (weekday)	07:00-18:00	2.34	kWh/day
Out-of-hours consumption (average per weekday)	18:00-00:00	0	kWh/day
Weekend average consumption (average per day)	00:00-23:59	0	kWh/day

Table 2: Summary of electricity consumption during different times of the days

consumption with a timer switch installed and set to operate only between 7am and 6pm. The spikes at the beginning of each workday at 7am represent the additional heat required each morning following the overnight switch-off.

From the modelled data, it is evident that the expected energy saving outweighs the amount of extra heat required to bring the water temperature back to the setpoint. During out of hours and on weekends, the baseload consumption is expected to be zero, resulting in imminent energy, cost and carbon savings.

Conclusion

The operation of instantaneous hot-water dispensers with timer switches set to meet occupancy patterns can result in meaningful reduction of electricity use: an average of 40% less.

The trial showed that, during a 35-day period, without any energy-saving intervention, 89.51kWh electricity was used; the post-intervention modelling suggests that this could have been 53.56kWh for the same length of time. In annual terms, that is 934kWh and 559kWh respectively, so the electricity saving can be as much as 375kWh per annum, enough to boil 4,000 litres of water to make 1,600 cups of tea.

The anticipated cost saving, with a relatively low investment and short payback period, can be as much as £50 per unit, so organisations operating dozens of hot water boilers should consider fitting them with timer switches. **CJ**

ISTVAN SEREG is energy manager at Nottinghamshire Healthcare NHS Foundation Trust

References:

1 2018. *Office-based companies*. [CTV007, ebook] Carbon Trust. Available at **bit.ly/CJApr21IS** [accessed 10 March 2021].

2 2018. *Office equipment*. [CTV059v2, ebook] Carbon Trust. Available at: **bit.ly/CJApr21IS** [accessed 10 March 2021].

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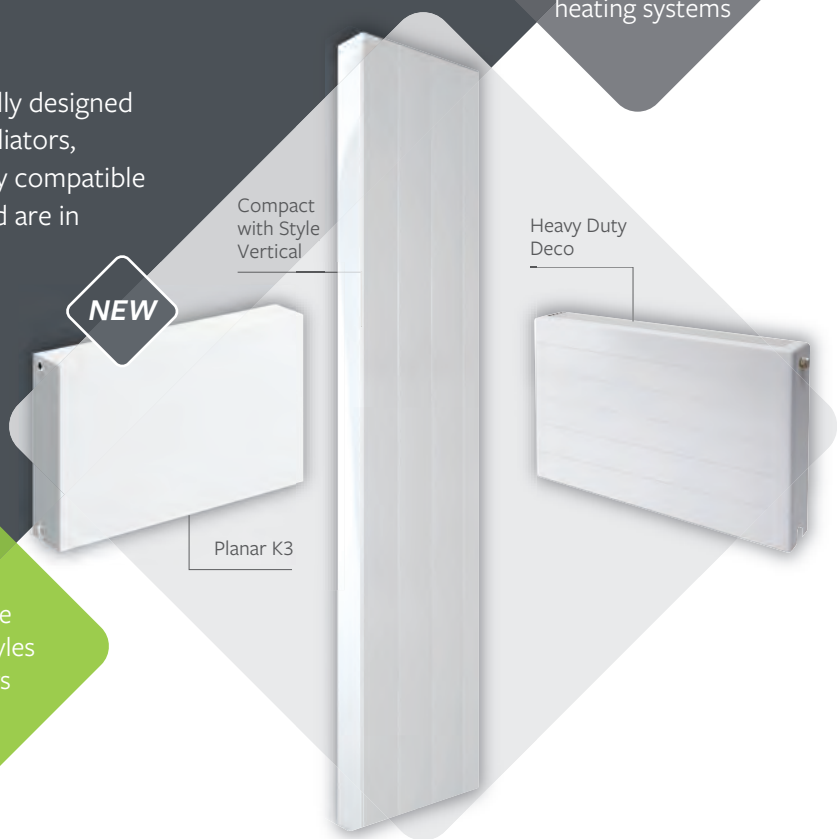

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Keeping pace with data centre growth

A growing data centre market will demand an increase in cooling, ventilation and power. Daikin Applied's Amin Dadgari explains how this might be achieved without doing further harm to the environment

The internet of things, artificial intelligence (AI), and the proliferation of smart technologies connecting the digital and real worlds, have turbocharged demand for seamless connectivity. As a result, network providers are under pressure to expand and improve their bandwidth. Cloud computing and big data mean the continued expansion of multi-tenant, hyperscale data centres is inevitable, and the data centre market is predicted to keep expanding at around 7% a year between now and 2025.

So far, the focus has been on the security of power supplies and ensuring the best connectivity, but the conversation has moved on to environmental impact and use of renewable energy and greener technologies. This presents challenges and opportunities for our industry. How about capturing waste heat for use in district heating, for example? Or could ventilation systems be adapted to help clean polluted air by removing harmful gases such as VOCs, SO_x, NO_x and ozone?

We have to look at how we reduce power consumption, too. Huge advances have been made in the fabrication of semiconductor devices, forming smaller and more powerful microprocessors, which means the capacity of data halls can be expanded without increasing the physical footprint. Each data rack is now capable of processing double or triple the amount of data it could previously. This translates into more heat generated that has to be removed by mechanical ventilation, which has significant cost and energy-saving implications.

Consumer demand – driving the downscaling and, consequently, mechanical design challenges – along with the need to improve the effectiveness of materials (for example, heat exchangers) are putting pressure on our industry to come up with new solutions.

In the short term, with most big players moving towards a standard design for data centres, we can focus on easy wins such as improving individual components' efficiency, and custom design of impellers for a specific range of static pressures. Coatings on heat exchangers are now widely used, but there is room to go further by using chemical compositions that deliver even better efficiencies while enabling air purification and the capture of harmful gases. The use of cathodic and anodic protection provided by E-Coating, for example, can ensure good protection against corrosion.

"We are still rejecting significant heat into the atmosphere that should be recovered"

Taking advantage of low ambient air for free cooling is also a no-brainer. Some data-centre operators are already using elevated temperatures to increase the return water temperature and take advantage of more hours of free cooling. Also, there is a growing appetite for building facilities in colder parts of the world, where the ambient is always lower than the supply water temperature.

However, other technology advances, such as AI, are driving demand for data processing to be closer to the source, to ensure stable and seamless connectivity. This has created a market for versatile and powerful edge-computing solutions. It looks like we are heading in the right direction, with facilities moving towards cloud computing and centralised, multi-tenant, hyperscale data centres. These innovations have a financial benefit for the operators, but we are still rejecting significant heat into the atmosphere that should be recovered and repurposed.

This requires farsighted designs, but demand for the rapid expansion of data halls, and the speed and budget for the development of microprocessors, is significantly ahead of the R&D and budget invested in the development of data hall layout and ventilation design. This results in owners reusing blueprints, with little in-depth research into different approaches or designs. It is also putting pressure on natural resources and the supply chain to provide the materials in time and in line with compressed schedules. Consultants and contractors are given too little time to design, develop and construct data centres that improve operational efficiency and the carbon footprint.

We have to press clients to recognise that these centres have huge environmental potential, and demonstrate the value in looking at the bigger picture. But greater financial incentives – partly as a result of authorities imposing tighter legislation on data centre owners and developers – would also encourage more investment in greener design and research into innovative approaches.

DR AMIN DADGARI is data centre technical manager at Daikin Applied UK

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British innovation was at its best when Excool exploded onto and revolutionised the Data Center market in 2010 breaking new ground with their unique and highly efficient indirect adiabatic cooling system.

The latest project for a large Data Center in Germany saw Excool clock up their 1,000th unit delivery and are being deployed by data centres in 14 countries and on 4 continents across the world.

Excool has now been recognised in the Sunday Times list of fastest-growing British exporters. Appearing at no 30 on the list Excool have achieved more than £32m of export sales over the past 2 years.

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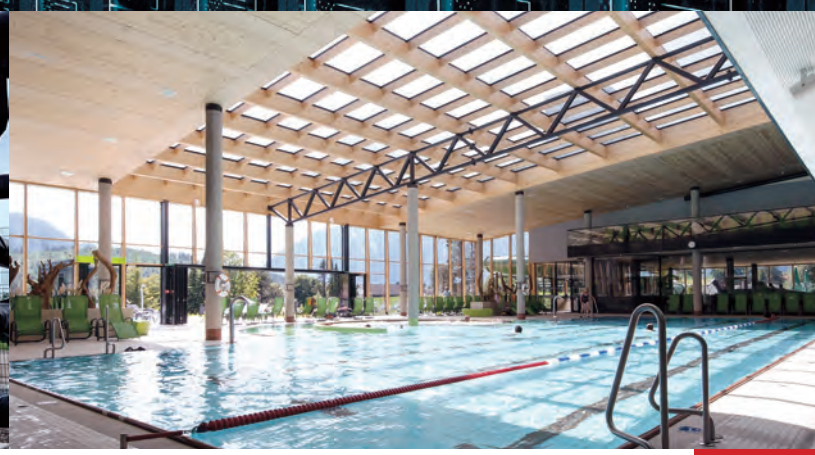

Ground Source Heating

Zeo are the largest manufacturer of ground source heat pumps in the UK today with approaching 40MW of commercial installations across the nations. In 2021 a new and exciting Domestic System will be introduced incorporating thermal and electrical storage alongside solar energy systems which together will achieve operating costs well below natural gas systems. This is in comparison with air source domestic heat pumps whose operating costs are always significantly greater than natural gas.

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Data centre demand surged during lockdown

Widespread lockdowns and homeworking have boosted demand for data centres in Europe, according to a report on data centres from JLL.

Europe's five major data centre markets of Frankfurt, London, Amsterdam, Paris and London increased 22% in 2020, reaching 201.2MW, according to the report, which expects the same rate of growth this year.

JLL said London had a record number of data centre planning applications in 2020 and is forecast to have 133MW of development.

The report said that growth was being driven by investment in the expansion of 5G technologies by communications service providers. It added that improving data centres' energy efficiency and carbon footprint was playing an increasingly crucial role in development.

Rosebery turns to Schneider Electric

Electrical engineer Rosebery is to install safety electrical equipment from Schneider Electric at a UK global enterprise data centre.

The project aims to protect the data centre from arc-flash incidents. It involves the installation of five Schneider Electric VAMP 321 arc-flash relays, 13 point-sensor I/O units, 11 current-monitoring units, and 145 point sensors.

Schneider Electric said the arc flash can cause power outages and material damage, and jeopardise the safety of staff.

The site operates at low voltage, with a total load of 8MVA, two 11kv intake supplies, and 8MVA of standby generation.

According to Schneider Electric, the VAMP 321 can send a trip signal to the circuit breaker within one millisecond.

Excool system aims to save water


A data centre in the UK

Company claims mode-switching technology saves money and water

Data centre cooling company Excool has developed a product that, it claims, saves energy and water for indirect evaporative cooling systems. Depending on the cost and availability of water and energy, a controller automatically switches between a water-saving or energy-saving mode.

If water is plentiful, then the system operates in energy-priority mode and consumes water – whether it be for direct or indirect evaporative cooling. If the priority is to save water because of high costs, or a lack of water, the unit will operate in water-priority mode.

A drop in water pressure – caused, for example, by other consumers, such as firefighters – will automatically switch the system to water-priority mode.

If low-cost renewable power generation is available, the unit can be programmed to switch automatically during these periods, to take advantage. As well as external factors, such as water flowrates, operator inputs can decide the mode of operation.

In all cases, the unit will automatically revert to free-cooling mode if the air temperature is low enough, and maintain supply air temperatures without mechanical or evaporative cooling.

When free cooling is not available, a cooling system would, traditionally, either switch to a mechanical DX or chilled water-cooling mode, or an adiabatic/evaporative mode (including mechanical DX mode for top-up), offering no flexibility.

Data centres can use a lot of water for cooling. Traditional direct and indirect evaporative cooling solutions often operate as soon as the outdoor dew-point temperature is sufficiently low to employ cooling towers or evaporative coolers. When water is cheap and plentiful, this makes sense because of savings in electricity.

Reducing water consumption at the data centre will probably shift increased water consumption to the central power generator, as more electrically powered cooling will be required. The average water consumption factor for electricity in the United States is 2 litres/kWh and, according to Murrant,[1] the UK use may be higher.

References:

1 Murrant, D, *Water use of the UK thermal electricity generation fleet by 2050*, 2017.

The new regulatory regime won't just affect buildings more than 18m high

Peter Baker

Changing the system

New chief inspector of buildings **Peter Baker** will have extensive regulatory powers to ensure building safety

Peter Baker was appointed, earlier this year, to head up the Building Safety Regulator (BSR), which was established by the Health and Safety Executive in response to recommendations in the *Building a Safer Future* report by Dame Judith Hackitt. He will lead the delivery of the new safety regime for high-rise buildings, oversee work to increase competence, and ensure effective oversight of the entire building safety environment. Baker's responsibilities, which are laid out in the draft Safety Bill, include a new role – head of the building control profession.

The BSR will be responsible for signing off building safety information compiled by duty holders at different stages – or 'gateways' – of the building's design and construction. Five categories of duty holder will be created during the construction phase (RIBA 5-7): client; principal designer; designer; principal contractor; and contractor. These are similar to health and safety roles under the 2015 CDM Regulations. Here, Baker explains what duty holders, and other companies and individuals, will need to consider in the post-Grenfell regulatory landscape.

What are the current responsibilities of the BSR?

Since January last year, when the BSR was appointed, I –alongside others – have been, full time, building the infrastructure and programme, ready for when the BSR receives its legal powers. We know enough about the principles of where the government is trying to get to, to plan the implementation of the new regime in 18 months to two years. Part of that is my appointment as the chief building inspector.

How will the new regulatory regime affect construction?

For high-rise buildings, we're shifting the balance away from relying on the building control regulator to sign off safety documents, to a system where those who create the risk will regulate it.

Part of the new regime, particularly in the construction phase, is about designing a building to prevent a fire, and – in the unlikely event of a fire – to ensure you have all the necessary steps in place to stop it from escalating. It's going to require a step change in approach, attitude, culture and behaviour. The whole idea of demonstration of safety approaches requires a different mindset. Contractors will have to be managed to ensure they are competent and doing the job properly.

The construction gateway will be about demonstrating to the BSR, who will be the building control body, that you've got the management system in place. I expect construction to cope with this, as it mirrors CDM; it should be a natural progression. For some it will be straightforward, but I imagine some businesses – particularly SMEs – will struggle with this in the same way they struggled with CDM.

How will changes affect buildings less than six storeys high?

The new high-rise buildings regime applies to buildings that are more than 18m, or six storeys, high. The view is that the risk requires an additional layer of regulation during construction and occupation. That doesn't mean a building of 17 metres shouldn't be built properly. Evidence is emerging from the Grenfell enquiry about standards of construction generally.

The BSR will have oversight of the existing building regulatory system. We will make sure local authority and approved inspectors are operating at a consistent level of competence. Ultimately, there is an expectation that all these principles of improved standards and safety in buildings will trickle down through the built environment.

The BSR will also have responsibility for the Approved Documents. You will see a much greater sense of proportionality and target/goal-setting language and tone.

How will you work with the new safety regulator for construction products?

The Office for Product Safety and the new products regulator will have much to do to improve the robustness of product safety.

Under the new regime, a lot of the demonstrations at the gateways that will need to be made to the BSR will rely on the product testing and development regime – that is, that a product will do what it says on the tin. Clearly, at the moment, confidence in the system is pretty thin for all sorts of reasons.

We will have a number of workstreams to see how the two regulators work together.

What should engineers do to ensure they're prepared for the changes?

The work on the competency frameworks is being driven by professional bodies, such as CIBSE, and the majority are pretty well linked in and aligned with all the work that is going on. My message is to make sure you are aware of what the professional bodies are doing. Keep in touch with what is emerging through competency groups and what the BSR is doing with the competency framework. If you want to influence the direction of travel, the professional bodies are the way to do it.

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A reflection on current standards for fire- and smoke-rated ductwork in the UK

This module explores standards for fire- and smoke-rated ductwork, and which should be applied for installations to be specified correctly

The importance of applying and assuring appropriate standards to building services has probably never had such a high profile. Ventilation ductwork in the UK must be specified and installed so as to protect the building's occupants in the event of a fire or smoke incident, to the satisfaction of the building control authority and the relevant fire officer. However, in these transitional times, there may be some uncertainty as to what standards are appropriate to ensure that designers evidence their competency and compliance to ensure life safety.

The standards as discussed in this article provide a reflection of the status quo in the provision of fire- and smoke-rated ductwork for UK buildings, so as to assist in understanding which should be applied for installations to be specified correctly. This is a discipline where, more than most, there is a need to call on the services of a suitably qualified professional fire engineer to oversee the design and installation.

Whatever route is taken, it is vital that, in the process, the rationale is documented. The recent consultation document *Code for Construction Product Information*[1] sets out proposals in an 11-point code for 'clear, accurate, up-to-date, accessible and unambiguous product information', and provides an indicator of the quality, depth and longevity of product information that should live on with ductwork installations.

Currently, harmonised EU standards, as required by EU regulation 305/2011 – the Construction Products Regulation (CPR) – define how to manufacture products, and allows an associated CE mark to confirm that the product has an EU Declaration of Conformity (see panel, 'Construction Products Regulation'). The exact pathway for future UK standardised marking is still being evolved. However, there will be a UK Conformity Assessed (UKCA) marking, requiring an appropriate UK Declaration of Conformity document, with the information required on the UK Declaration of Conformity being largely the same as what is required on a EU Declaration of Conformity. Products placed in the UK market can typically use CE marking in the UK until 1 January 2022.[2]

There are a number of standards that apply to fire- and smoke-rated ductwork. The standards referred to in this article are listed in the 'Key standards' panel, together with their full title. To avoid repetition, the references to the standards in the body of the article will use just the reference number.

There are three principal applications for fire ductwork in buildings:

- Fire-rated ventilation ductwork that passes through fire compartment walls or floors and will have a prescribed fire-resistance period. Where ducts pass through the structure, the fire-performance criteria »

CONSTRUCTION PRODUCTS REGULATION

The CPR lays down conditions for construction products by establishing harmonised rules on how to express their performance in relation to their essential characteristics, which is confirmed in a Declaration of Conformity, and on the use of CE marking. The CPR covers seven basic requirements for construction items:

- **Mechanical resistance and stability**
- **Safety in case of fire**
- **Hygiene, health and the environment**
- **Safety and accessibility in use**
- **Protection against noise**
- **Energy economy and heat retention**
- **Sustainable use of natural resources**

» for the penetrated wall or floor must be maintained so that fire does not spread between compartments.

- Fire-rated kitchen extraction. This is a particular hazard, as combustible deposits such as grease are likely to accumulate on ductwork system internal surfaces, and may spread fire if ignited.
- Fire-rated smoke extraction that extracts smoke from a building in the event of fire needs to be fire resistant, but also able to continue to perform the primary function while under fire conditions.

Each of these applications of ductwork systems should be tested against appropriate standards.

Prior to design and deployment, the application for each section of ductwork should be identified and the appropriate fire rating established (in terms of ductwork integrity, stability, and insulation rating – see 'Defining fire performance' panel). In practice, it is particularly important for this to be carefully considered at the earliest stages of the project so that the ductwork is designated and tested appropriately.

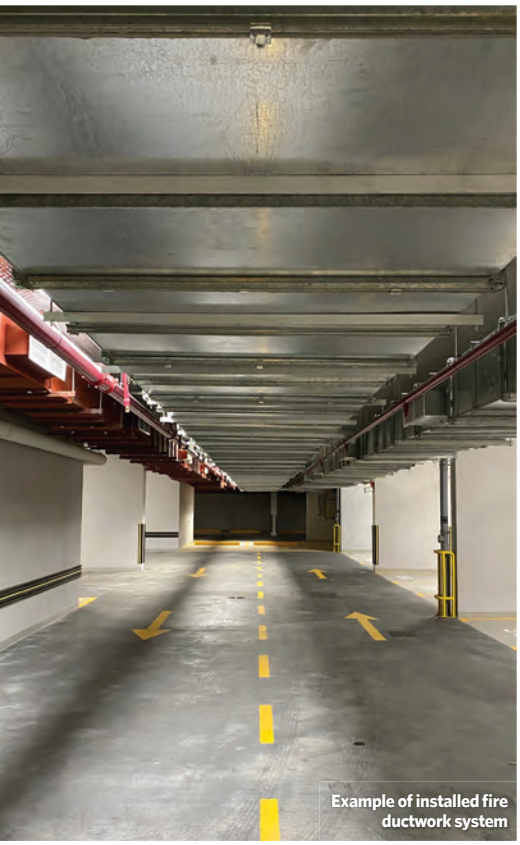
Legislative requirements for larger sizes of ductwork (in most cases to an upper size limit, as will be discussed later), for both ventilation and fire, are well documented. It is not uncommon[3] that consultants specify, by agreement, that the most appropriate standard that should be adopted is BS 476-24. However, this is not a path to obtaining a declaration of conformity.


A section of ventilation ductwork undergoing a fire test

Although ducts were previously under the auspices of BS 476-24 testing methods, this has been superseded by BS EN 12101-7 for smoke extraction. However, it is not uncommon[3] for BS 476-24 to continue to be applied and accepted for all ducts. Care needs to be taken over what is being supplied with reference to BS 476-24, as smoke-control ducts must conform to BS EN 12101-7, which specifies requirements and identifies test methods for smoke-control duct sections and their associated components. For test requirements, this standard refers to BS EN 1366-1, with the tests conforming to BS EN 1366-8 and BS EN 1366-9. The methods for the associated classification of results are taken from BS EN 13501-4. As BS EN 12101-7 provides a harmonised standard for smoke-extraction ductwork applications, the resulting tested product can be CE marked.

Fire-resisting ventilation ductwork and kitchen extract ductwork should conform to the (draft) product standard EN 15871, which specifies test methods, verification and marking procedures. However, as this is still in draft, no CE marking is yet possible, and it has yet to supersede BS476-24 for these two applications. The Association for Specialist Fire Protection (ASFP) recommends[4] that 'kitchen extract duct should be tested under BS EN 1366-1 (test for combustible linings) as this would be considered a more technically robust method than defaulting back to BS 476-24'.

There are several practical limitations on the size and design of elements that can be tested by the standard methods. Direct test results are only allowed up to 1,250mm x 1,000mm or 1,000mm diameter, so CE marking can only currently be applied up to this size. When these ducts are larger, or are of a modified design, it is necessary


Example of installed fire ductwork system

KEY STANDARDS

- **BS 476-24:1987, ISO 6944:1985** *Fire tests on building materials and structures. Method for determination of the fire resistance of ventilation ducts*
- **BS EN 1366-1:2016** *Fire resistance tests for service installations. Ventilation ducts –* (2019 revision in draft)
- **BS EN 1366-8:2004** *Fire resistance tests for service installations. Multi-compartment smoke extraction ducts* – (2019 revision in draft)
- **BS EN 1366-9:2008** *Fire resistance tests for service installations. Single-compartment smoke extraction ducts*
- **BS EN 12101-7:2011** *Smoke and heat control systems. Smoke-duct sections*
- **BS EN 13501-3:2005** *Fire classification of construction products and building elements. Classification using data from fire resistance tests on products and elements used in building service installations: fire-resisting ducts and fire dampers* – (2019 EN revision in draft)
- **BS EN 13501-4:2016** *Fire classification of construction products and building elements. Classification using data from fire-resistance tests on components of smoke-control systems*
- **BS EN 15882-1 ... 4** *Extended application of results from fire-resistance tests for service installations.... Ducts/Fire dampers/Penetration seals/Linear joint seals*
- **EN 15871 (Draft)** *Ventilation for buildings – Fire-resisting duct sections*
- **prEN 15882-xx (In preparation)** *Extended applications of test results for smoke control ducts*

DEFINING FIRE PERFORMANCE

Fire performance is the ability of a duct (as opposed to a particular building material) to fulfil its designed function for a period of time in the event of a fire. The three functions are: Stability (R); Integrity (E); and Insulation (I).

Stability refers to the capacity to resist collapse because of loss of structural strength caused by exposure to fire or, more specifically, the heat generated by a fire. Failure is where the duct collapses so that it no longer fulfils its intended function. 'R120' would indicate stability for 120 minutes when exposed to a fully developed fire. Stability rating is often not shown, as it is assumed to be at least equal to the integrity rating.

Integrity refers to a duct's ability to stop the flames or hot gases from a fire from physically passing from one side (the fire side) to the other. 'E60' would denote that the duct will not allow flames and hot gases to physically pass from one side to the other for 60 minutes.

Insulation is the ability to limit the surface temperature rise on the non-fire side of the duct to 140°C as an average, or 180°C as a hot-spot maximum, when fire side is exposed to a fully developed fire. It is considered a failure when either is exceeded. A rating of 'I120' denotes an insulation rating of 120 minutes when the fire side is exposed to a fully developed fire. The I rating cannot be quoted without an accompanying E rating.


Commissioning of fire-rated ductwork

to confirm their performance. The 'extended field of application' (EXAP) standards – BS EN15882-1...4 for ventilation ductwork systems and prEN 15882-xx for smoke-control ductwork systems – define parameters and the factors that need to be considered when deciding whether, or by how much, a parameter can be extended beyond that covered under the normal limits of the standards.


Inside the ductwork after a fire test

The EXAP standards currently have an upper limit that will only allow ventilation and kitchen extraction ductwork to be classified up to a maximum size of 2,500mm x 1,250mm for rectangular and 1,250mm diameter for circular ductwork.

For smoke-control ducts, the extended application standard, prEN 15882-xx, is yet to be published, and, therefore, specific details on how to assess duct sizes beyond those given in the fire-test standard (1,250mm x 1,000mm or 1,000mm diameter) are not yet available. As it is not possible to extend direct test results without the standard, there is no means of evidencing conformity, so this restricts the opportunity to employ larger duct sections that are CE marked. Smoke-control duct sections that fall within the scope of BS EN 12101-7 – that is, up to 1,250mm x 1,000mm or 1,000mm diameter – are the only systems that can be supplied in compliance with the CPR. When the (EXAP) prEN15882-xx standard is published, it will mean that ductwork up to 2,500mm x 1,250mm or 1,250mm diameter for smoke control may be tested and classified as meeting European standards, and so be marked as conforming.

Duct sizes beyond 2,500mm x 1,250mm or 1,250mm diameter fall outside the scope of the harmonised standards, so the UK industry organisations the ASFP, Building Engineering Services Association (BESA) and Association of Ductwork Contractors and Allied Services (ADCAS) recommend[4] that designers are encouraged to redesign systems to compliant size restrictions. Redesigning to compliant sizes is likely to reduce uncertainty and allows the use of products complying to the appropriate standard.

Smoke control ducts up to the maximum size 1,250mm x 1,000mm or 1,000mm diameter can be supplied to the product standard BS EN 12101-7. There are some options if larger sizes are required:

- The designer evaluates the feasibility of splitting ducts into two or more ducts (each with a maximum dimension of 1,250mm x 1,000mm or 1,000mm diameter) so that they fall within the limiting sizes. This may not be possible in all applications because of space restrictions.
- If a redesign is not possible, the specification could reflect that the larger sizes are not to carry a CE marking, and that larger ductwork above this size may be supplied as tested or assessed against BS 476-24 (until the extended application document EN 15882-xx is published). The client, building control, and fire engineer must have previously approved this route.
- If the specification is to remain, specifying to a non-conforming standard, consideration for a derogation or concession is to be sought from the appropriate authority (probably the fire officer and building control). Laboratory fire tests on the non-standard sizes may be required by the fire engineer. Such tests reportedly can take several months, and the output would not provide a mark of conformity, but would provide some evidence of fire performance.
- Obtain an engineering judgement from a notified body where the ductwork is based on construction type and support sizes that are coherent with the EN standards. Experience[2] indicates that it could be a derogation from the CE marking and EN test regime to adopt the use of a BS 476-24 tested ductwork section.
  However, this cannot be classified as conforming to harmonised standards, and, therefore, no CE marking can be applied. The client, building control and fire engineer must have previously approved this route.

Ducting is not an isolated product, so – when assessing the expected performance of ductwork system for its fire and smoke performance – it is important to consider it as part of the larger system that provides a safe and healthy built environment.

- With thanks to David Fitzpatrick, of SFS, who provided core information and the reflections on current practices that were used in this article.

- Turn to page 68 for further reading and references.

Module 177

April 2021

1. Which of these is not specifically included in the basic requirements for the CPR?

- ☐ A Capital cost of product
- ☐ B Hygiene, health and the environment
- ☐ C Mechanical resistance and stability
- ☐ D Safety in case of fire
- ☐ E Sustainable use of natural resources

2. Which of the following standards would be most appropriate for the conformity tests of smoke-extraction ducts serving a single compartment?

- ☐ A BS 476-24:1987
- ☐ B BS EN 12101-7:2011
- ☐ C BS EN 1366-8:2004
- ☐ D BS EN 1366-9:2008
- ☐ E EN 15871

3. What does the acronym EXAP relate to?

- ☐ A Example of advanced protection
- ☐ B Expanded form of approach
- ☐ C Explanation of advanced performance
- ☐ D Extended field of application
- ☐ E Extreme appendment

4. Which one of these is the only one that represents the current (as at 1 March 2021) position in the UK regarding ventilation ductwork?

- ☐ A Appropriate applications of BS 476-24 supersede the CPR requirements when supplying ductwork for UK use only
- ☐ B Multiple ducts of appropriate sizes provide an alternative for CE marking of otherwise oversized fire-rated ventilation ductwork
- ☐ C Smoke control ductwork may be CE marked up to 2,500mm x 1,250mm or 1,250mm diameter when applying EXAP
- ☐ D The maximum size of smoke-control duct that can receive a CE mark is 1,250mm x 1,000mm or 1,000mm diameter
- ☐ E Ventilation ductwork that passes through fire-compartment walls can only receive a UKCA mark

5. What is the main recommendation, which is noted from UK industry organisations, for where ducts are proposed larger than the maximum normally allowed by the standards?

- ☐ A Apply the standards as set out in BS 476-24
- ☐ B Employ a method of natural ventilation without ducts
- ☐ C Set the specification to reflect that the larger sizes will not carry a CE marking
- ☐ D Specify to a nonconforming standard but obtain an automatic derogation or concession from the appropriate authority
- ☐ E That designers are encouraged to redesign systems to comply

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Further reading:

CIBSE Guide E. This provides good background to fire protection relating to buildings, although it has little on ductwork standards.

ASFP Technical Guidance Document – TGD 20. This freely downloadable document provides an excellent summary of the current acceptable test standards for fire-resisting ventilation and smoke-control ductwork.

References:

1 Construction Product Information – Industry Consultation: Better Data, Safer Building, January 2021 **bit.ly/CJApr21CPD1**
2 CE Marking guidance, BEIS **bit.ly/CJApr21CPD2** – accessed 2 March 2021.
3 Information as supplied by SFS.
4 *ASFP Technical Guidance Document TGD20 – Fire test standards and the Construction Products Regulation in relation to fire-resisting ventilation and smoke-control ductwork*, ASFP, August 2020.

Products of the month

Greater application with wall-mounted meter

New Micronics product extends pipe size and temperature ranges

Micronics has introduced a significant addition to its Ultraflo range of clamp-on, heat/energy and flow meters, with the new U1000-WM.

U1000 heat/energy and flow meters are now available in the original pipe-mounted or new wall-mounted (WM) display and keyboard format, with an extended pipe range.

Micronics has built on its success with the Ultraflo U1000 range to develop a WM version, which extends the pipe size to cover applications from 25mm-225mm (8") OD pipe, and the temperature range to 135°C.

The U1000MKII is a 'best value' clamp-on, ultrasonic heat meter alternative to traditional in-line energy meters, for energy management and billing applications in domestic and commercial district or shared heating or cooling systems. It offers significant benefits over traditional in-line products in terms of installation cost and dry maintenance.

The new U1000-WM version offers the alternative of clamp-on, pipe-mounted flow and temperature sensors, but with a wall or control panel, display and keyboard, plus an extended range to cover larger pipe-size applications.

While the U1000MKII-WM can still be used as a stand-alone product, in the all-important area of connectivity, the new product supports optional Mbus or Modbus RTU slave and RS485 serial communications for aM&T or BEMs systems.

It is still simple to install, with no specialist skills or tools required, and has the added flexibility of an alternative wall- or panel-mounted keyboard and display, and a wider range of application.

The U1000 MKII heat/energy and flow meters continue to offer a 'best value' clamp-on, non-invasive alternative to traditional inline meter installation, with no drain-down required and dry servicing – which means minimum downtime and maximum availability.

Call +44 (0)1628 810456,visit www.micronicsflowmeters.com or go to YouTube

Learn to go with the flow

Rinnai offers accredited CPDs for continuous flow hot water heating

Designers, specifiers, and building services consultants and engineers who work on commercial sites requiring limitless flows of temperature-accurate hot water can now brush up on their knowledge with Rinnai's free range of accredited CPDs:

- Hydrogen – a guide to the background, applications and properties of possible new blends for commercial and residential use
- Continuous flow hot water – an appreciation
- Energy efficiency on demand hot water – how it works and comparison with other systems
- Hot water heating units and systems – an appreciation
- Hot water system design – using continuous flow mode
- Continuous flow delivering low temperature – uses and legislation
- Precision-temperature control of hot water – for commercial delivery systems

- Low temperature DHW – for commercial and domestic delivery systems.

Through its CPD and training programmes, Rinnai aims to promote a clearer understanding of the different messages faced by today's engineers, installers and designers, and aid their decision-making.

The company has invested in a fully equipped training facility, supported by a state-of-the-art multimedia suite that can deliver courses to suit any organisation.

The CPDs are available via Microsoft Teams or Zoom. or – as long as all Covid-19 safety measures are strictly observed and practised – they can be delivered face to face at the site of the end user, specifier, or building services consultant and engineer.

'We will look at the growing support for continuous flow technologies and how this can benefit the industry versus traditional storage systems,' says Chris Goggin, Rinnai's operations director. 'We will analyse water heating design and specification, discussing design issues and best practice for G3 and legionella prevention.'

Rinnai is the world's leading manufacturer of continuous flow hot water systems, making and selling two million units each year.

Its range of units can be manifolded to supply limitless hot water to any site of any size, provided there is a constant supply of gas and water. This means fast, efficient, temperature-controlled water on demand at the point of delivery, and far less space needed for plantrooms.

Call 01928 531 870, email sales@rinnaiuk.com or engineer@rinnaiuk.com or visit www.rinnaiuk.com and click on 'Help me choose' or 'Ask us a question'

Luceco helps to light up NHS birthplace

Luceco has supplied wireless lighting controls to the birthplace of the NHS – Trafford General Hospital in Greater Manchester, where Aneurin Bevan launched the health service in July 1948.

Specified by SI Sealy, in association with the Estates and Facilities Energy Division of Manchester University NHS Foundation Trust, the controls were seen as a flexible approach to introducing control that could be tailored to suit individual preferences while being monitored remotely. They also give the energy team a clear picture of where lighting is being used, and settings can be adjusted remotely to improve energy efficiency.

The hospital's ward 15/16 for the elderly was lit with 150 Luceco wireless lighting-controlled luminaires, including the LuxFrame, Epsilon, LuxPanel, Contour, Platinum and Element downlighters. The change from standard fixtures to LED luminaires reduced energy consumption from 33kW/hr to 14.85kW/hr. This has been further reduced by the lighting controls to operate at 55% of output to 8.2KW, resulting in a very welcome energy saving.

Email Zoe.nh@luceco.com or visit www.luceco.com

Toshiba domestic AC system offers infinite design possibilities

Toshiba's new HAORI model transcends traditional AC concepts to become an elegant part of the furnishings. Regardless of room style, there is a HAORI design to complement it.

The AC unit has a textile cover that comes in a range of colours – or, by using the supplied pattern, HAORI owners can make their own in the fabric of their choice.

HAORI is easy to dress: simply peel and stick the chosen fabric to the curved front panel. When the room is updated, it's easy to give the unit a facelift too.

Visit www.toshiba-aircon.co.uk

Data centre opts for PLX fuel-transfer system

During construction of a data processing centre in the Spanish capital, Madrid, Tavicce was tasked with specifying the fuel pipework system for the back-up power generator; once again it turned to the PLX system from Aliaxis.

The system is designed specifically for fuel-transfer applications. Manufactured from polyethylene with an internal permeation barrier, it offers corrosion resistance and a 30-year design life. Minimal maintenance is required when compared with traditional materials, and the system provides the assurance of non-contaminated fuel whenever the pipework is called into use.

Visit www.aliaxis.co.uk/plx

Grade I listed church warms to Dunham-Bush

Dunham-Bush has supplied five Series BM fan convector units to help heat Bath Abbey.

The units have a basic galvanised sheet-metal casing with access panel, fan and motor platform, air filter, hot-water heating coil, and electrical connections box. A single-phase electric heating coil can be supplied instead of a hot-water coil, with an output of up to 6kW.

Dunham-Bush fan convectors have moderate leaving air temperatures to reduce stratification, as well as low outlet velocities and low air throws to improve comfort.

Call 02392 477700, email info@dunham-bush.co.uk or visit www.dunham-bush.co.uk

Condair launches new evaporative humidifier

The new Condair MC in-duct evaporative humidifier and cooler can supply up to 360kg/h of humidity, and around 245kW of adiabatic cooling, to an air handling unit from less than 0.15kW of electrical energy.

Its hydraulic module can incorporate up to three low-energy, long-life pumps, with electrical consumption ranging from 74W with one pump operating, to 145W with three.

The Condair MC has glass-fibre evaporative media with antimicrobial additives for hygienic operation, plus automated flush and drain cycles to ensure the system water stays fresh.

Call +44 (0)1903 850200, email uk.sales@condair.com or visit condair.co.uk

Mitsubishi Electric's fresh-air solution for homes

Mitsubishi Electric has launched a residential range of Lossnay mechanical ventilation with heat recovery systems, to provide clean and healthy air for homes.

Designed for the UK housing market, the residential Lossnay extracts stale air continuously from spaces such as bathrooms, kitchens, toilets, and utility rooms. It replaces indoor air with filtered air from outside, and minimises the amount of energy lost by recovering heat from the extracted air and transferring it to the supply of fresh air, so it is nearer the indoor temperature.

The system is designed to operate at ultra-low noise levels, and comes with optional nitrogen oxide and particulate matter filtration.

An automatic summer bypass allows the units to bring in outside air without recovering heat, to reduce the risk of overheating. The unit enters bypass mode when it detects the room is hotter than desired and the outside air is cool enough.

A built-in LCD controller offers a clear display showing normal, boost and purge modes, and up to four speed settings can be commissioned digitally to ensure constant and accurate settings.

Visit les.mitsubishielectric.co.uk/products/ventilation

Panasonic expands Aquarea range

Panasonic Heating & Cooling Solutions has expanded its Aquarea Air to Water heat pump range with the introduction of the T-CAP Mono-bloc J Generation system with R32 refrigerant.

Available in capacities from 9-16kW, and providing heating, cooling and domestic hot water, options are available for a range of property sizes and heating requirements.

As a mono-bloc system with a single unit outdoors, the system is particularly suitable for projects where indoor space is limited. R32 refrigerant is sealed in the outdoor unit, meaning no indoor refrigerant connections are required.

Visit www.aircon.panasonic.eu

PACAIR adds Applied Projects to expand its customer service

Bespoke design and air conditioning supplier, PACAIR, has expanded its range of services, with the addition of a specialist applied project team that will assist customers looking to capitalise on the opportunities behind the legislative drive towards zero carbon.

Formerly a Mitsubishi Electric value-added reseller (VAR), PACAIR has been elevated to applied project specialist (APS) from 2021. It can now assist customers with the application of ventilation, heating, commercial and domestic heat pumps, heating-only chillers, and other applied products, in addition to the full range of air conditioning systems.

Visit www.pacair.co.uk

Virtual help at hand for customers

The lockdowns have not been all bad news, as it has made many companies look for creative ways to overcome a number of issues – for example, the inability to travel. Grundfos, which is known for its innovations in pump solutions, has proved its ingenuity by introducing a number of virtual platforms with customer needs at their heart.

Examples include virtual factory tours, virtual exhibitions, and, perhaps more importantly, the creation and facilitation of virtual pump witness testing. These interactive events can be crucial for some high-specification projects where there is a need to ensure that pumps and/or solutions meet increasingly complex project demands before their arrival on site.

Grundfos saw the potential of using virtual platforms and adapted its practices accordingly. These interactions can take place on a variety of simple to complex digital platforms, but they all mean that – regardless of where a build happens, at a local plant or further afield – customers can be right at the heart of the system, without leaving their desk.

Visit www.grundfos.co.uk

Two coils better than one

Hamworthy Heating, expert in commercial heating and hot water, has improved its range of stainless steel calorifiers to include models with a twin coil and five additional storage tanks. The new models offer better hot water performance and system security for large demand premises.

The two coils in the new Halstock calorifier can be connected in series to improve the hot-water performance, as there is a larger surface area for heat transfer, giving faster heat-up times and higher continuous output flows – up to 2,106 l/h from the largest model. They can also be connected to two different heat sources – for example, allowing the use of free solar energy when available and back-up or top-up from a gas boiler. This allows greater control of the heat input and gives you the flexibility to choose how you heat your system.

The Halstock stainless steel calorifier range is popular for soft-water areas as no electrical corrosion protection systems or sacrificial anodes are required. It has a durable, corrosion-resistant Acerinox duplex stainless steel tank and coil for low maintenance and a long life backed up by a five-year cylinder warranty. You benefit from a highly efficient product that has a corrugated coil design for maximum heat transfer, and a generous layer of CFC-free polyurethane tank insulation under protective plastisol cladding to minimise standing losses.

Call Hamworthy 01202 662500, email sales@hamworthy-heating.com or visit www.hamworthy-heating.com

State-of the-art office development benefits from Elco

Six Trigon XL boilers from Elco are providing efficient and reliable heating and hot water to office tenants of 7 and 8 Wellington Place, home to the Leeds Government Hub. Three 500kW floor-standing condensing gas boilers were specified and installed in a rooftop plant room to supply 7 Wellington Place, prior to three 570kW models being fitted at number 8. The Trigon XL is available in seven models, with outputs from 150-570kW, each offering ultra-low NO_x emissions complying with class 6 (2018) requirements, an 8 bar working pressure, 30k flow/return temperature differential and a small footprint.

Visit www.elco.co.uk

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Event details are correct at the time of going to print, but as a result of the ongoing coronavirus (Covid-19) situation, they may be subject to change. For updates, please check **cibse.org/training** for training and **cibse.org/events** for CIBSE groups and regional events. CIBSE has a range of online learning courses available to support your learning. Visit **cibse.org/training-events/online-learning**

Society of Light and Lighting LightBytes series: Minimum energy, minimum resource, maximum comfort
7-28 April
The series returns online, with weekly sessions starting on 7 April. The first is on minimising energy use, without compromising on lit-environment quality.
www.cibse.org/sll

CIBSE REGIONS AND GROUP EVENTS

For up-to-date information, visit **www.cibse.org/events**

Scotland: Achieving net zero in existing buildings
1 April
Alistair Cameron, of ECD Architects, on the challenges of achieving net zero targets in existing buildings.

UAE Awards ceremony
8 April
Online awards celebrating the achievements in the building services industry in the UAE.

SLL and CIBSE Ireland: Webinar – emergency lighting
13 April
Sophie Parry, of Zumtobel Group Lighting, on emergency lighting requirements.

CIBSE Ireland AGM
22 April
AGM held via Zoom. Pre-registration is essential.

Energy Performance Group AGM
27 April
Online AGM.

SLL and West Midlands: Webinar – DIALux evo and DIALux 4
12 May
Speaker Iain Macrae will show live operation of the software.

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For details and full programme visit **www.cibse.org/training**

Introduction to heat networks code of practice (CP1)
6 April

CIBSE JOURNAL WEBINARS

CIBSE Journal hosts regular, sponsored, webinars covering a wide range of building services-related topics. All webinars are available on demand on the *Journal* website at **www.cibsejournal.com/cpd/webinars**

The next *CIBSE Journal* webinar, titled **Smart Lighting Guide** and sponsored by **Tamlite**, will take place on 20 April.

Emergency lighting to comply with fire-safety requirements
21 April

Electrical services explained
21 April

The importance of energy efficient buildings
23 April

Heat Networks (CP1) half-day
27 April

Low carbon consultant design
27 April

Designing water-efficient hot and cold supplies
28 April

Energy surveys
5 May

Low carbon consultant building operations
10-13 May

Mechanical services explained
12-14 May

Standby diesel generator
14 May

Heat networks code of practice
17-18 May

Building services explained
18-20 May

Above-ground building drainage
19 May

Mentoring skills workshop
21 May

Heat networks (CP1) half-day
25 May

Below-ground building drainage
25 May

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CIBSE has a portfolio of online learning courses, which contain interactive content with quizzes and additional resources to support your learning.
www.cibse.org/training

WEBINARS

#Growyourknowledge

CIBSE's free webinar series continues in April. Taking place every two weeks on Thursday at 11am, the webinars support the CIBSE community in maintaining their CPD remotely. All previous webinars can be viewed on demand at **www.cibse.org/growyourknowledge**

CIBSE Membership

CIBSE Membership are hosting free webinars to support members with applications for the Associate and Member grades and registration with the Engineering Council at Incorporated Engineer and Chartered Engineer levels.

The two-part webinar series includes: session 1, covering routes to membership, and session 2, focusing on how to write the Engineering Practice Report.

Upcoming webinars:
- **6 and 20 April**
- **4 and 11 May**
- **22 and 29 June**

For further details and to register: www.cibse.org/webinars

To register for the webinars, visit www.cibse.org/webinars

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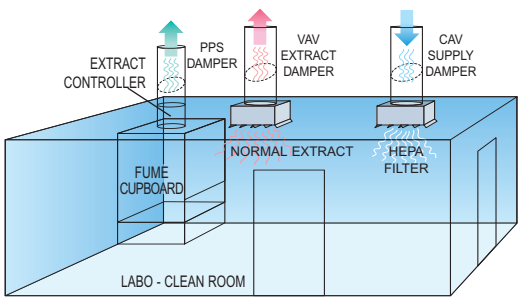

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