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September 2018

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# Facing the factors

## Editorial

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CIBSE Journal is written and produced by CPL (Cambridge Publishers Ltd) Tel: +44 (0)1223 378000. [www.cpl.co.uk](http://www.cpl.co.uk)  
 1 Cambridge Technopark, Newmarket Road, Cambridge CB5 8PB.

**Editorial copy deadline:** First day of the month preceding the publication month

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The National Grid is decarbonising rapidly. According to the government's Digest of United Kingdom Energy Statistics (DUKES), the CO<sub>2</sub> emissions factor for electricity has fallen from 0.335 kg CO<sub>2</sub>e per kWh in 2015 to 0.265 in 2016 and 0.225 in 2017. The real-time figure can be checked at [carbonintensity.org.uk](http://carbonintensity.org.uk); as we went to press on a sunny August day it was 0.249.

The reduction of CO<sub>2</sub> in the UK's electrical energy supply reflects the increasing wind and solar power feeding into the National Grid. But this cleaner energy is not yet apparent in the figures designers use when predicting carbon emissions in new buildings.

For example, designers use SAP 2012 when assessing energy use and CO<sub>2</sub> emissions in UK homes, and this still gives a carbon factor of 0.519 CO<sub>2</sub>e per kWh. This is set to change when the next version of *Building regulation conservation of fuel and power: Approved Document L* is published, but this isn't likely to be until 2020. To give industry time to prepare for new carbon factors, BEIS and BRE have published draft SAP 10, which includes new carbon factors for electricity of 0.233 – a reduction of 55% on the SAP 12 figure.

It's a big jump and will have an impact on decisions for low-carbon buildings. The main winners will be heat pumps, which become twice as clean in terms of CO<sub>2</sub> emissions. To match gas boilers, heat pumps would only need to have a coefficient of performance of 1.1, but Elementa senior engineer Clara Bagenal George warns that they would need a COP of 4 to be cost neutral, as electricity is more expensive than gas, and this could lead to higher energy bills.

Representatives from the gas-fired CHP industry accept that CO<sub>2</sub> emission factors for electricity need to reflect reality, but they warn that an annual figure does not reflect the grid CO<sub>2</sub> emission from season to season. They are calling for a monthly average grid carbon intensity figure – something the government said it was considering a year ago in response to the SAP 2016 consultation (see page 24).

An update to the draft London Plan also considers grid electricity decarbonisation and states that carbon savings from gas engine CHP are now declining as a result of National Grid electricity decarbonising (page 7).

The policy still advocates low-emission CHP systems to support heat networks, but says it doesn't expect gas engine CHP to fit this category with technology currently available. The door has been left open, however, as the plan says guidance will be updated to ensure it reflects technology changes. Whatever solution designers choose, it's clear decarbonisation of the grid will have a disruptive effect on services design.

ALEX SMITH, EDITOR [asmith@cibsejournal.com](mailto:asmith@cibsejournal.com)

## CONTRIBUTORS



**Hywel Davies**  
 How regulations in Australia and Hong Kong are dealing with cladding and overheating respectively



**Andrew Krebs**  
 Why the building services industry needs to think in terms of digital engineering rather than BIM



**Liza Young**  
 The key changes in BSRIA's BG 6 – A design framework for building services 2018



**Tim Dwyer**  
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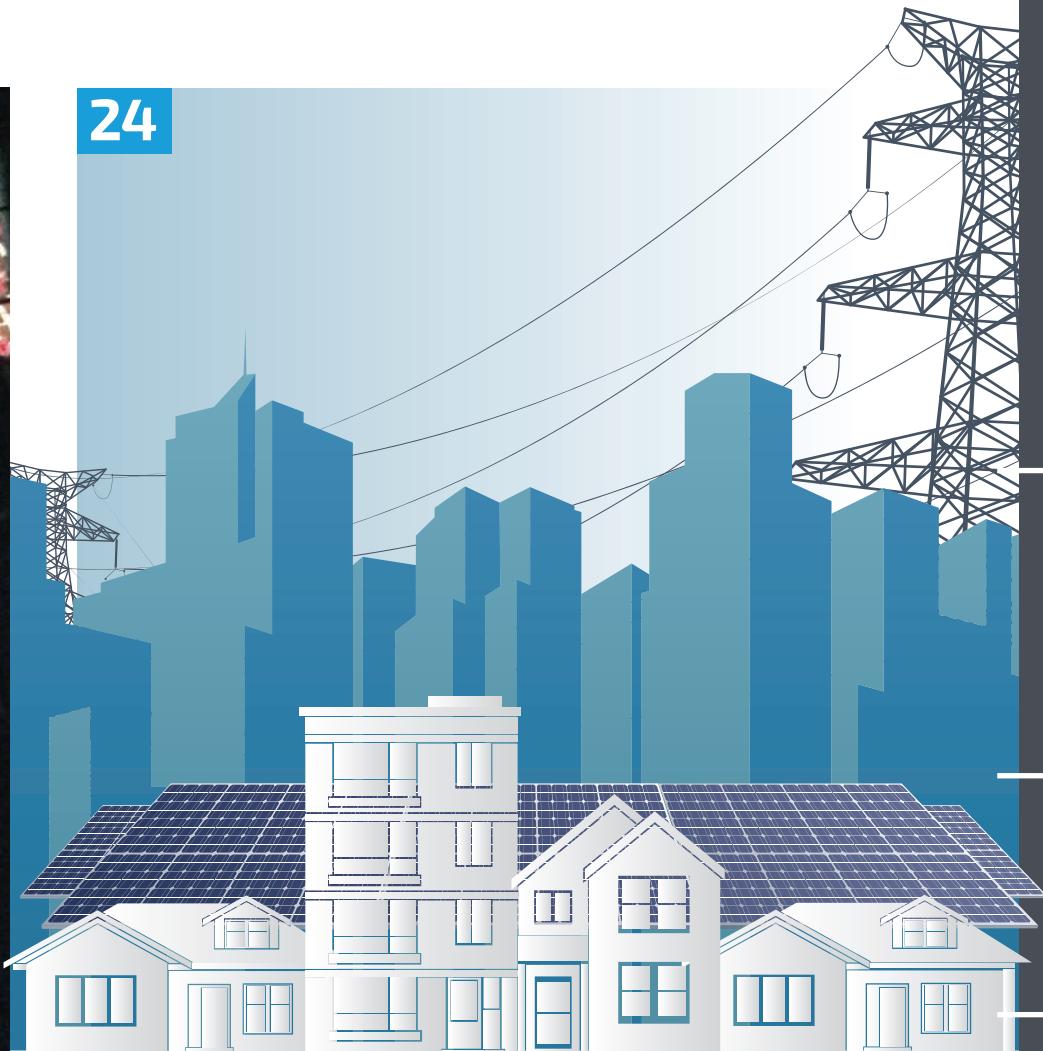
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© CIBSE Services Ltd. ISSN 1759-846X

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If you are not a CIBSE member but would like to receive *CIBSE Journal*, subscribe now! Costs are £80 (UK) and £100 (international). For subscription enquiries, and any change of address information, please contact Nicola Hurley at [nhurley@cibse.org](mailto:nhurley@cibse.org) or telephone +44 (0) 20 8772 3697. Individual copies are also available at a cost of £7 per copy, plus postage.

The 2017 US annual subscription price is £100. Airfreight and mailing in the US by Air Business, C/O Worldnet Shipping NY Inc, C/O Air Business Ltd / 155-11146th Street, Jamaica, New York, NY11434. Periodical postage pending at Jamaica NY 11431. US Postmaster: Send address changes to *CIBSE Journal*, C/O Air Business Ltd / 155-11146th Street, Jamaica, New York, NY11434.

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ABC audited circulation:  
18,331 January to December 2016  
Printed by: Warners Midlands PLC

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# SAP boost for electric heating as grid decarbonises

## Electricity CO<sub>2</sub> emissions factor in draft SAP 10 falls by 55%

The new Standard Assessment Procedure (SAP) for measuring the energy rating of new homes will strengthen the case for specifying electric heating and heat pumps when it comes into effect after the next revision of the Building Regulations.

BRE has released its updated SAP 10 methodology for public comment. It includes a new electricity carbon factor of 0.233 kgCO<sub>2</sub>/kWh, which represents a reduction of 55% compared with the current SAP 2012 figure of 0.519. The carbon factor for electricity is now only slightly higher than mains gas.

The current methodology assumes electricity produces 2.4 times the emissions of mains gas, but the increased mix of renewable-generated power and a reduction in coal burning to produce electricity, has had a dramatic impact since SAP was last updated.

This will prompt a rethink of the

approach to heat networks and could weaken the case for using gas-fired combined heat and power (CHP). Battery storage is also recognised for the first time.

'This shift to a more relevant carbon factor is a big leap in the right direction,' says Elementa senior engineer Clara Bagenal George.

For the grid to cope with an increase in electric heating, Bagenal George said the government needed to manage peaks in energy consumption. 'Further guidance and metrics will need to be introduced to manage this,' she says.

Mike Hefford, general manager at Remeha CHP, said average annual carbon factors fail to take into account increased use of energy created using fossil fuel in the winter. 'We would urge the government to adopt a more accurate monthly average intensity figure for grid electricity,' he said.

SAP 10 will not be introduced until Approved Document L of the Building Regulations is published in 2019/20.

## London Plan tackles unregulated CO<sub>2</sub>

Calculating unregulated carbon and whole life carbon emissions have been included in an update to the draft London Plan published last month.

The latest version includes suggested changes following a review of the consultation process, and four major recommendations from the London Energy Transformation Initiative, according to Elementa senior engineer Clara Bagenal George.

The draft plan now states that major development proposals should calculate and minimise unregulated energy carbon emissions from any part of the development, including plant or equipment, that are not covered by Building Regulations.

Whole life-cycle carbon emissions should be measured through a nationally recognised scheme, according to the plan, which also calls for demonstrable actions to reduce life-cycle carbon.

The update now recognises that current CO<sub>2</sub> emission factors are out of date and says appropriate factors will be set out in the forthcoming Mayor's Energy Planning Guidance.

## Heatwaves the norm by 2040, say MPs

The temperatures experienced by the UK during this summer's heatwave will be 'the norm' by 2040 as a result of climate change, according to a group of MPs.

This could result in up to 7,000 heat-related deaths every year, according to the Environmental Audit Committee. The Met Office has also said that UK summer temperatures could regularly reach 38.5°C by the 2040s.

Tougher rules are needed to ensure homes and transport networks can deal with extreme heat, the EAC said, calling on local councils to plant trees and increase green spaces to provide cool air.

During the 2003 heatwave, excess deaths in nursing homes in parts of the UK rose by 42% because high temperatures increase the risk of death from cardiac, kidney and respiratory diseases.

'Heatwaves threaten health, wellbeing and productivity,' said EAC chair Mary Creagh. 'The government must stop playing pass the parcel with local councils and the NHS, and develop a strategy to protect our ageing population from this increasing risk.'

She said homes built in the 1960s and 1970s were particularly at risk, as well as flats with limited windows. There are currently no regulations in place to prevent overheating in buildings, the committee added.

CIBSE gave evidence to the committee and produced TM59, which enables designers to assess overheating risk in homes and which has been adopted by some local authorities, including Camden and Islington.

CIBSE's acting head of sustainability development, Julie Godefroy, said: 'Overheating is even more of a problem in affordable housing as this is where you will be in noisy locations where windows can't be opened, and apartments are likely to be occupied for longer in the day.'

Read CIBSE's blog on the EAC report at [bit.ly/CISep18eac](http://bit.ly/CISep18eac)

## Manufacturing bounces back

The construction products manufacturing sector has put the bad weather of earlier this year behind it, reporting a surge in activity during the second quarter, according to the Construction Products Association.

Responding to its latest state of trade survey, 40% of firms reported a rise in sales during April to June, following two previous quarters of falling figures. However, 29% of 'light side' manufacturers said business had fallen during the quarter. This figure reflects the fallout from the poor first quarter because products, such as insulation, boilers, glass and lighting, tend to be used at the end of the building process.

Some 43% of heavy side firms and 27% of those on the light side expect sales to increase over the next 12 months.

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# Offsite report calls for radical overhaul

**Offsite manufacture could improve productivity by as much as 70%, according to Lords' Science and Technology Committee**

The construction sector needs a 'radical overhaul' and will struggle to meet the UK's need for housing and infrastructure, unless it makes greater use of offsite and modular methods, according to a House of Lords report.

The Lords' Science and Technology Committee said the government and industry must 'urgently find solutions' to growing productivity problems and labour shortages. It argued offsite manufacture could improve productivity by as much as 70% while delivering better and more energy-efficient buildings.

The report, *Offsite manufacture for construction: Building for change*, said the use of offsite manufacture had been patchy because the industry continues to use 'outdated and unsustainable' business models. It also attacked the fragmented culture of the sector and the lack of trust, which has led to poor levels of collaboration to make offsite manufacturing work.

It welcomed the presumption in favour of offsite working in the Construction Sector Deal, but said a series of key performance indicators were needed to measure the success of this approach. It also criticised public sector procurers who put low cost ahead of 'lifetime value'.

'There are clear and tangible benefits from offsite manufacture for construction that make a compelling case for its widespread use,' said committee chair Lord Patel. 'The construction sector's business models are no longer appropriate and are not supporting the UK's urgent need for new homes and infrastructure.'



## Smoke control to be certified

The Smoke Control Association (SCA) has launched a certification scheme for contractors.

The IFC SDI 19 scheme was developed to deliver competency in fire strategy verification, system design and the installation of smoke control systems, as well as service and maintenance work.

SCA chair David Mowatt said the scheme had been developed in response to the independent review of building regulations and fire safety, which called for cultural changes in the procurement, design, construction and maintenance of buildings.

'Certified contractors will have clearly demonstrated that their trained staff consistently adhere to industry best practice and fully appreciate the importance of correct installation, inspection and maintenance,' he said. 'Contractors should be responsible for the systems they install and end users should always look to use a capable, experienced contractor.'

## AECOM GETS UN APPOINTMENT

Aecom has secured a contract to work on the renovation of the United Nations' office in Geneva. It is collaborating with architects SOM and Burckhardt and Partner to supply technical design and construction monitoring services.

Aecom is to deliver the MEP design for the renovation of the vast building, much of which dates back to the 1930s. Sprawling over 1km, the Palais des Nations complex offers more than 100,000m<sup>2</sup> of office and meeting space.

The design will be delivered in a 3D format and the team is producing a BIM model for the existing building to help improve its overall efficiency. The project will also seek to upgrade power, cooling, security and IT to meet Swiss and global standards in health and safety, comfort, operability and energy consumption, but in keeping with the building's heritage status.



# Government accused of ignoring F-Gas Brexit fears

### **The EA does not have the manpower to take required direct and tough action**

The government has been accused of ignoring the air conditioning and refrigeration industry's concerns about how the F-Gas regulations will be enforced after the UK leaves the EU.

A group of MPs, along with a number of industry bodies, say the Environment Agency (EA) does not have the resources to police the F-Gas process effectively, and that breaches of the refrigerant handling regulations are rising.

The parliamentary Environmental Audit Committee (EAC) highlighted the lack of prosecutions and urged the government to publish plans for enforcing the rules after Brexit.

However, the Department for Environment, Food and Rural Affairs (Defra) said prosecutions were 'not necessarily a good indicator of the effectiveness of compliance work'. It added that enforcement notices, advice, awareness campaigns and guidance were playing an important role in reducing the amount of global warming emissions from the industry.

EAC chair Mary Creagh said the government had not shown enough urgency and asked Defra and the EA to publish plans for monitoring non-

compliance. She made particular reference to social media and online retailers for increasing the trade in illegal refrigerant gas.

'There are serious breaches going on, which require direct and tough action that the EA cannot take because it does not have the manpower,' said Graeme Fox, head of the country's main F-Gas register Refcom.

'Real sanctions with meaningful financial penalties are needed,' said Fox, who added that Refcom and its members were trying to help by acting as the EA's eyes and ears, 'but the lack of follow-up action is seriously discouraging'.

Federation of Environmental Trade Associations chief executive Russell Beattie called for mandatory qualifications to underpin standards across the sector.



### Getting the measure of historic buildings

Historic England has teamed up with Cardiff University to produce energy benchmarks for historic buildings. Caroline Cattini, FCIBSE, senior engineer and energy manager at Historic England, said the organisation started benchmarking its estate in 2006. But this benchmarking focused on the construction and original use of buildings, which 'wasn't useful because, while the construction is the same, the activities and the building services in them are very different,' she said. Historic England recognised that energy demand varied significantly depending on the activity type. 'Even with museums, energy use was very different depending on the collection,' said Cattini.

Professor Ian Knight, from Cardiff University, has found the age and fabric of buildings may have little impact on energy use, compared with the occupants and activities held inside.

To create the benchmarks, Historic England has been carrying out detailed surveys of its buildings to assess whether the energy consumed falls within acceptable ranges. Its next steps will be establishing links between weather and energy use, and it plans to install its own weather stations and internal temperature monitoring to understand how localised weather has an impact on energy use.

Historic England plans to look beyond its estate at other historic buildings with similar activities.

Read more on pages 28 and 93.



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# CIBSE unveils shortlists for young engineers' awards

## Graduate winner will enjoy trip to ASHRAE Winter Conference in Atlanta

Eight graduates and six employers have made the shortlists in this year's CIBSE Young Engineers' Awards, sponsored by Andrews Water Heaters, Kingspan Industrial Insulation, Swegon Air Management and CIBSE Patrons.

The awards celebrate the industry's young engineering talent, whose academic and professional achievements set them apart from their peers. Finalists for the CIBSE ASHRAE Graduate of the Year award are: Waqar Ahmed, Hurley Palmer Flatt and University of Surrey; Rachel Bell, Atkins and Manchester University; Reanna Evans, NG Bailey and Leeds Beckett University; Carl Fisher, Royal School of Military Engineering; Josh Hunt, Aecom and University of the West of England; Hannah Muller-Jones, Buro Happold and University of Nottingham; Gemma Taylor, Atkins and University of the West of England; and Ryan Wesley, Tata Steel

Europe and Loughborough University.

Services Design Solution (SDS) and S I Sealy & Associates are shortlisted in the small category of the CIBSE Employer of the Year award. Black & White Engineering and Elementa will compete in the medium category, and Aecom and Hoare Lea in the large category.

Winners will be announced at the Institution of Mechanical Engineers (IMechE) in London on 11 October.

The Graduate Award finalists will each give a five-minute presentation on how the industry manages and monitors professional competence and upholds technical standards.

The winner will receive an all-expenses paid trip to the ASHRAE Winter Conference in Atlanta, Georgia, USA; second and third-placed graduates will receive £600 and £300 respectively from the Rumford Club, and every other finalist will get £100 from the Manly Charitable Trust.

Visit [www.cibse.org/yea](http://www.cibse.org/yea) for details.



## Roles clear in new design framework

Team member roles will be more clearly defined on projects using BSRIA's design framework guide for building services – BG 6 – which has been updated.

The new version contains design activity proformas and drawing/model definitions to support contract documentation and to encourage more effective collaboration between members of the building services supply chain.

BG 6 offers a platform where the activities and responsibilities of project team members can be identified and allocated. It includes a series of task lists, model descriptions and sample drawings to let the user decide which team member is responsible for which activities and to what level of detail.

As well as being restructured to give more information on its purpose and how to use it, the guide has been colour coded to match the RIBA Plan of Works to aid navigation, said John Sands, principal consultant at BSRIA. The second major change has been the consolidation of Stage 3 and Stage 4 proformas, which allows project team member roles to be more clearly defined. 'While preparing the agreement, you must think about who is best placed to do these activities so you can match people's and companies' skills to the tasks, which should make coordination much easier,' said Sands.

■ See page 35 for more details on the changed in BG 6.

## IN BRIEF

### Boiler scrappage scheme launched

London mayor Sadiq Khan has launched the UK's first scrappage scheme for commercial boilers to help SMEs cut energy bills and improve air quality.

He unveiled £10m of funding for his Cleaner Heat Cashback scheme, which will offer SMEs 30% towards the cost of installing a new high-efficiency, low-NO<sub>x</sub> gas or LPG boiler. This figure can rise to 35% in 'Air Quality Focus Areas'.

If a new boiler is used as part of a hybrid system, the contribution also increases to 35% – or 40% in the air quality areas.

The Energy Saving Trust is running the scheme, which runs until 31 March 2020, and applies to existing coal or biomass boilers of any age, and gas or LPG boilers that are at least 10 years old, with a minimum total output of 70kW.

### Minister dismisses smart meter fears

Energy and clean growth minister Claire Perry has rejected a call from Citizens Advice to slow down the rollout of smart meters. She said extending the timetable to 2023 would only delay the benefits enjoyed by millions of households.

The government intends every home in the UK to have a smart meter by 2020, but Citizens Advice said suppliers needed more time to fix problems, including loss of functionality when users switch suppliers, which has been reported in early models. Perry said problems reported by Citizens Advice affected only 0.03% of the 11 million meters already installed.

### Call for three-phase power in new homes

All new homes should be equipped with a three-phase electricity supply to support greater use of heat pumps, solar energy and charging points for electric cars, according to a Renewable Energy Association (REA) report.

The approach is used in other European countries and allows loads from different appliances to be shared across phases.

Once electric vehicles become more widely used, the REA fears single-phase systems will become overloaded and the pressure on connections will grow as more renewable sources are plugged in. Spreading the total load over three phases would increase household energy capacity.

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## Large firms admit breaking payment laws

### Government urged to put in place project bank accounts on public sector projects

Many major (tier one) contractors – some of the country's largest companies – have published figures exposing their payment practices as illegal, according to the Specialist Engineering Contractors' (SEC) Group.

SEC Group welcomed trade body Build UK's decision to publicise the payment performance of its leading members, but said it was alarmed that none of the published figures showed payment times of less than 30 days. It said these companies were, therefore, unable to comply with the law – under the Public Contracts Regulations 2015 – which requires payments to be made within 30 days on public sector works.

The companies were also found to be failing to comply with the Construction Supply Chain Payment Charter, published by the Construction Leadership Council and supported by the government, to discharge payments within 30 days.

'We are urging the government to put in place project bank accounts on all public sector projects to enable SMEs in these companies' supply chains to be paid within 12-15 days,' said SEC Group chief executive Rudi Klein, who is also concerned about the insolvency risk posed by some of the largest companies. He claimed that trade credit insurers are now reluctant to offer some of them cover.



Large companies are failing to discharge payments within 30 days

## Pay rises of 5% for sector

Operatives across the building services contracting sector will receive salary increases of more than 5% by 2020, following the latest round of national wage negotiations between employers and the trade union, Unite.

The Building Engineering Services Association (BESA) – representing the industry's employers – settled on an hourly rate increase of 2.5% from this October, followed by a further 2.75% rise from October 2019.

Both parties described the process as 'positive and constructive', confirming the second phase of the four-year national operative wage settlement. Phase one, covering October 2016 to September 2018, also included a forward commitment of improved index benefits and an additional day of paid holiday entitlement, effective from February 2020.

Unite and BESA also committed to keeping the dialogue going to address issues, including the skills shortage and the need to increase the number of apprentices being recruited into the industry. 'There is growing demand for our specialist skills as the UK embarks on an ambitious infrastructure programme, so it is helpful to conclude these negotiations positively,' said BESA president Tim Hopkinson.

# Construction sector enjoys bumper summer

## Further delays in delivery times for materials during July

Construction activity rose to its highest level since May 2017 during the summer, according to latest figures from the IHS Markit/CIPS UK Construction Purchasing Managers' Index.

Purchasing managers said there had been a bounce-back from the delays caused by bad weather in the spring, and that even commercial construction activity showed signs of life during July. The housebuilding market grew at its fastest rate since December 2015, which also drove the largest rise in employment numbers since the same month.

But the report detected a note of caution among construction companies about the year ahead, with Brexit-related uncertainty dampening optimism. July also saw further delays in delivery times for materials, and costs continue to rise.

'While the recent rebound in construction

work has been flattered by its recovery from a low base earlier in 2018, there are also signs that underlying demand conditions have picked up this summer,' said Tim Moore, associate director at IHS Markit. 'New business expanded at the strongest rate since May 2017, while workforce numbers increased to the greatest extent for just over two and a half years.'



# Heat pump sales rocket

Sales of hydronic heat pumps surged ahead last year, according to BSRIA. Its latest report showed global year-on-year growth of 32%, making the market worth €5.7bn, with more than 4.5 million units sold. Asia remains the largest world region in terms of heat pumps sales, accounting for 84% of the total volume.

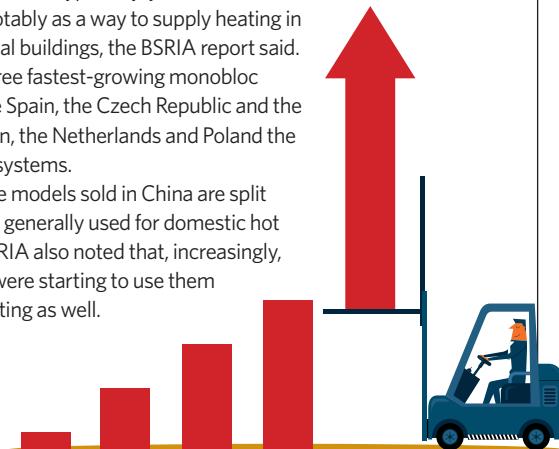
Chinese heat pump suppliers are optimistic about the future performance of the market, and say it will continue to expand from its current level of three million units. Sales across Europe also accelerated by 12% in volume terms last year, compared with a 6% increase in 2016.

'Since the implementation of the coal-to-gas and coal-to-electricity policies in China, we've seen a sharp move towards more environment-friendly heat generators, such as gas boilers and heat pumps,' said senior market intelligence analyst Aline Breslauer.

The air-to-water market rose significantly, particularly monobloc and split system types, where sales volumes grew by 19% and 14% respectively. Under the EU climate policy for carbon emissions reduction, both unit types enjoyed sustained expansion, notably as a way to supply heating in new residential buildings, the BSRIA report said.

The top three fastest-growing monobloc markets were Spain, the Czech Republic and the UK, with Spain, the Netherlands and Poland the best for split systems.

Most of the models sold in China are split types and are generally used for domestic hot water, but BSRIA also noted that, increasingly, the Chinese were starting to use them for space heating as well.



## Carillion liquidation to cost £50m

Trade union Unite has attacked the fees charged by accountancy firm PwC for managing the Carillion liquidation process.

A letter to parliament revealed PwC staff were charging an average of £356 an hour for their services following Carillion's failure, and had billed for £20.4m in fees during the first eight weeks of the insolvency. The overall cost is expected to reach at least £50m. Some specialist partners of the accountancy firm were said to be charging £1,156 an hour.

Only around 800 of the 1,200 apprentices employed by Carillion when it collapsed have found new positions.

**Building services contractor**  
NG Bailey has written off £2.2m following contract losses from the collapse of Carillion. It was due to deliver MEP work worth £80m for the Midlands Metropolitan Hospital project, which was halted in January when Carillion went under. But it also reported a 6% rise in annual pre-tax profits of close to £20m.

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## IN BRIEF

### Final call for technical papers

Research papers, technical reviews, case studies and opinion presentations are being sought for the 2019 CIBSE Technical Symposium, at the University of Sheffield on 25–26 April.

Its theme is 'Transforming built environments – Driving change with engineering'. The event offers a unique opportunity to share key insights from research, developments, and applications that will influence the regulation, creation and maintenance of the built environment in future.

All papers and presentations selected for the symposium will be peer reviewed.

Submissions should be in the form of a 250-word abstract, and need to be received by 17 September 2018. For details, visit [www.cibse.org/symposium](http://www.cibse.org/symposium)

### Engineers get chance to shine at Building Performance Awards

CIBSE has launched a new category – Building Performance Engineer of the Year – for the 2019 Building Performance Awards.

It will be the only category to recognise an individual's contribution to the industry. The accolade will reward the outstanding work done by a building services engineer and their contribution to the performance of the built environment.

Entries for this award will be by nomination only, with colleagues, employers, and corporate partner organisations able to put forward a candidate for consideration. The award will be presented to the nominee who best demonstrates an exceptional contribution to the profession.

Nominees must be practising engineers – CEng, IEng or EngTech – and a member of CIBSE working in the building services sector.

The deadline for entries for all 13 award categories is 14 September.

Make sure you don't miss the opportunity to have your project or team recognised at the awards night on 12 February 2019. Visit [www.cibse.org/bpa](http://www.cibse.org/bpa) for a full list of all categories, entry criteria and entry forms.

# Ventilation and occupant satisfaction win medals

### Prizes recognise the highest-rated papers of 2017 in BSERT

Two technical papers have been recognised for their research into single-sided natural ventilation and long-term study of occupant satisfaction.

Roderic Bunn and Ljiljana Marjanovic-Halburd won the Carter Bronze Medal for *Comfort signatures: How long-term studies of occupant satisfaction in office buildings reveal ongoing performance*. This looked at occupant surveys, which are often used as a benchmark for checking whether a building has met its desired outcomes during a soft landing

**Roderic Bunn and Junli Zhou**



handover, and the little-known, longer-term occupant perception.

The research covered two case studies of long-term occupant surveys over periods of between three and 21 years. This time-series approach enabled an exploration of the relationship between occupants' perceptions of comfort and productivity, and the buildings' physical and functional characteristics. The longitudinal analysis has generated insights into trends in building performance that do not emerge from single surveys, and provided evidence of the key factors for ensuring long-term occupant satisfaction.

The Napier Shaw Bronze Medal was won by Dr Junli Zhou, Cheng Ye, Yan Hu, Dr Hassan Hemida, Prof Guoqiang Zhang and Dr Wei Yang for their paper *Development of a model for single-sided, wind-driven natural ventilation in buildings*. This looked to develop a model for predicting total flowrate of single-sided natural ventilation in buildings caused by wind pressure. It found the total flowrate is mainly caused by pulsating flow when the area of the opening is small, but by mean flow in the case of large openings.

The Bronze Medals are awarded annually by CIBSE to celebrate high-quality research in building services. They are given to the highest-rated papers of the year published in *Building Services Engineering Research and Technology (BSERT)*. The prizes will be presented at the CIBSE President's dinner in October.

CIBSE members can access the *BSERT* and *Lighting Research and Technology* journals at [www.cibse.org/knowledge](http://www.cibse.org/knowledge)

■ Read the summary of the Napier Shaw Bronze Medal-winning paper on page 71.

## October deadline for entries to SFE's Façades 2018 competition

Entries to the Society of Façade Engineering's (SFE's) Façade 2018 competition are now open. Its fifth international competition recognises, rewards and promotes excellence in this increasingly important element of building design, engineering and application.

The SFE is seeking entries from across the world, from individuals, companies and project teams. Façade contracts completed between 1 January 2016 and 31 December 2017 – and not previously entered for the awards – are eligible. Prizes will be awarded by a panel of expert judges.

Entries should demonstrate excellence in technical design and research that has made a significant contribution to the discipline of façade engineering. The contribution may be demonstrated in the form of technical advances, innovations, or advanced engineering systems.

Three awards will be presented, for new-build, refurbishment and innovation. All entries should be received by 15 October, and the shortlist will be announced on 19 November. Winners will be revealed at the Glass Supper in December.

■ For more information and to enter visit <http://sfecompetition.org>



**Antoni Sapina Grau  
and Lucy Pemble**



## CIBSE Journal tops the poll again

*CIBSE Journal* has again topped the poll for best membership benefit in the annual CIBSE membership survey. It received 1,087 responses – more than in any other year – with 86% of respondents rating the *Journal* as excellent, very good or good.

The CIBSE Knowledge Portal was the second top-rated membership benefit, with 85% saying it was excellent, very good or good, while Professional Registration followed closely behind at 83%.

An impressive 86% of respondents rated the value they got from their CIBSE membership as excellent, very good or good. More than three-quarters (76%) said they strongly agreed or agreed with the statement: being a CIBSE member has benefited my career – with the same percentage agreeing that CIBSE membership is considered important within the industry.

Overall, the results were an encouraging sign that CIBSE is on the right track, with 95% of respondents saying they would recommend CIBSE to a colleague.

When asked about the most important message CIBSE should get across when recruiting new members, one respondent said: 'Being a member means you have the technical ability to undertake and understand building services design that can be delivered with integrity that has long been associated with CIBSE; it is your passport to a successful career.' We couldn't put it better ourselves.

CIBSE is committed to bringing members up-to-date, relevant information. If you no longer receive information from us, this may be because of your preferences in 'My CIBSE'. You can review these and amend the email communications you receive in the membership area.

# Double delight as pair fly off with travel bursary

## The winners will research demand management and climate resilience

For the first time, the Ken Dale Travel Bursary has been awarded to two people.

Lucy Pemble, studying for an MSc in sustainable engineering management for international development at Swansea University, and Antoni Sapina Grau, mechanical engineer at WSP, were both named as winners. They will each receive a bursary to travel while undertaking industry-relevant research.

Pemble won the award for her research topic 'Demand management: Integration of low carbon and renewable technologies', and intends to travel to Zambia, South Africa, America and Wales. She will investigate electrical demand management practices in different geographical and development contexts, as well as the opportunities and challenges presented by photovoltaics, and electrical vehicles and building integration.

Pemble's MSc course took her to Zambia for two and a half weeks over the summer, and she used some of this time on her research. She said: 'I'm delighted to be given this opportunity to be funded to travel the world and research a topic at the forefront of our industry. I look forward to

encountering different people and practices, and representing CIBSE internationally.'

Grau, who was the CIBSE Graduate of the Year 2017, will research 'Resilience and adaptive capacity for upcoming climate challenges'. He will travel to China, Hong Kong, Australia and America to identify and visit buildings that have been designed with consideration for the impact of weather, and that have been adapted based on current and future climate changes, and illustrate how to improve energy adaptation and resilience of buildings.

Grau said: 'Winning the bursary is a unique opportunity to discover, learn and develop things that are not written in textbooks.'

On their return, both winners will present their 5,000-10,000-word report to the CIBSE board.

The annual Ken Dale Travel Bursary offers between £1,500 and £4,000 to CIBSE members in the developmental stage of their career to spend three to four weeks abroad, researching aspects connected to their field of work.

The application process involves a written application, followed by a presentation to a CIBSE panel. Applicants have to propose a research topic, a planned itinerary, and a financial breakdown of their potential trip.

## New members, fellows and associates

### FELLOWS

**Goldsmith, Brian**  
Hockley, United Kingdom

**Scott, Duncan**  
Essex, United Kingdom

**McDermott, Peter**  
Brighton, United Kingdom

**McGowan, Peter Graham**  
Belfast, United Kingdom

**Burton, Michael Saunders**  
Harpenden, United Kingdom

**Beattie, Richard Kenneth**  
Loanhead, United Kingdom

### Wilde, Paul Alan

Brighouse, United Kingdom

### Martin, Paul

Dublin, Ireland

### MEMBER

#### Bathie-Neale, Ashton

Leighton Buzzard, United Kingdom

#### Adesina, Oluwaseyi

Lagos, Nigeria

#### Cobb, Richard

Leicester, United Kingdom

#### Bennett, Christopher

Aylesbury, United Kingdom

### Wilkinson, Jamie

Perth, Australia

### Gaylor, Joe

Peterborough, United Kingdom

### Clarke, Michael

London, United Kingdom

### Clark, Gary

Glasgow, United Kingdom

### Kelly, Lee

Newcastle upon Tyne, United Kingdom

### Gold, Gary

Glasgow, United Kingdom

### McGreevy, Paul

Downpatrick, United Kingdom

### Fox, Geoffrey Roy

Bath, United Kingdom

### Phillipson, Peter Kevin

London, United Kingdom

### Wilson, Leslie Alexander

Varsity Lakes, Australia

### Hemsley, Lee

Newcastle upon Tyne, United Kingdom

### Pratt, Carl Michael

Runcorn, United Kingdom



» Whittington, Matthew David
Dewsbury, United Kingdom
Culver, Nicholas
Luton, United Kingdom
Easter, Andrew
Pentraeth, United Kingdom
Hill, Marc Geoffrey
Bristol, United Kingdom
DeLuca, Richard
London, United Kingdom
Saddler, Kathala
Bexley, United Kingdom
Kam, Kwai Chuen
Kowloon Bay, Hong Kong
To, Ching Nok
Sha Tin, Hong Kong
Babanatsas, Athanasios
London, United Kingdom
Ricci Curbastro, Ilaria
London, United Kingdom
Kounadi, Maria-Lida
London, United Kingdom
Falcone, Nicola
London, United Kingdom
Tellakis, Apostolos
London, United Kingdom
Smaragdis, Georgios
London, United Kingdom
Vasinton, Simona
London, United Kingdom
Jones, Christopher David
Bath, United Kingdom
Ko, Wing Ming
Kowloon, Hong Kong
Choi, Kwong Ping
Tai Po, NT, Hong Kong
Lo, Hoi Chiu
Fanling, Hong Kong
Rochelle, Alexander James
Leeds, United Kingdom
Minnie, Andre Willem
Bath, United Kingdom
Aproskie, Stephen Roy
London, United Kingdom
Orme, Samuel Arkwright
Huddersfield, United Kingdom
Dickson, Craig
Livingston, United Kingdom
Herrera, Wiston
London, United Kingdom
Rooney, Neil John
Gateshead, United Kingdom
McAllister, Paul
Irvine, United Kingdom
Sargeant, Calvin
Leeds, United Kingdom
Chamberlain, Adam
St. Leonards, Australia
Jackson, Andrew
Dudley, United Kingdom
Monasterski, Pawel Adam
Epsom, United Kingdom
Maxwell, Andrew
Canterbury, United Kingdom
Lewis, Lauren
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Buggy, Garry
Shotts, United Kingdom
Zdueniak, Patryk
London, United Kingdom
Nikolaou, Rallou
London, United Kingdom
Brandle, Noel
Northampton, United Kingdom
Mulvihill, Peter Thomas
Tullow, Ireland
Mohammad, Faisal
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Gaulier, Maxime
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Fernando, Ajith
Barnet, United Kingdom
Makanju, Hakeem Oladapo Babajide
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Vangeloglou, Elpida
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Mohammadian, Khashayar
Letchworth Garden City, United Kingdom
Szantai, Ladislav
London, United Kingdom
Cooper, Elizabeth
San Francisco, United States
Yeung, Man Kit
Tuen Mun, Hong Kong
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Sawyer, Craig
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Li, Nga Yin
Wanchai, Hong Kong
Shing, Kwan Ho
Central, Hong Kong
Ruane, Vincent Anthony
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Cheung, Howard
Tseung Kwan O, Hong Kong
Chan, Ka Fung
Tseung Kwan O, Hong Kong
Xia, Liang
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Cha Kwo Ling, Hong Kong
Lam, Ka Fung
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# Setting new standards

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## A reader responds to our article on heat networks

### More than meets the eye

As an active commissioning manager, I agree that acceptance testing should be used to see if heat networks are working before handover ('Freedom through chains', *Journal*, August 2018). But key elements are overlooked during design, procurement and installation, so I don't agree that 'most issues affecting network performance could have been resolved at the commissioning stage, often through relatively minor interventions'.

For a given flow temperature, a low design return temperature will reduce peak flowrates, leading to smaller pipes and lower costs. Maintaining low return temperatures under part-load conditions is important to keep heat losses and pumping energy low.

Designing for lower operating temperatures will result in higher efficiencies with some heat sources. If the design return temperatures are not maintained in operation, the heat-network capacity will be reduced. Achieving low return temperatures starts with correct selection and balancing of radiators and other heat emitters – often the responsibility of the building owner and designer, not the heat network owner/operator.

The building connection, including the primary heat

source – for example, the heat exchanger – are mostly designed and installed without: a differential pressure-control valve to limit maximum flow and limit pressure across the control valve; temperature-controlled bypass; and a two-port control valve to ensure variable control in the DH network and to vary secondary temperature.

Using variable flow control systems will result in lower flowrates and lower return temperatures at part-load. Variable speed pumps are used and should be controlled to maintain a minimum pressure difference at the extremities of the network. This important control principle will reduce heat losses and pumping energy.

Without designing and installing a temperature-controlled bypass with DPCV and two-port control valves on the primary plate heat exchanger (PHE) at the building connection, you cannot control the return temperature on the primary source of the PHE through the variable speed pumps. So your secondary return temperature will exceed the required return temperature, and the energy centre will think the building has no requirement for heating and switch off.

A commissioning manager can have little influence when developers, clients, designers and contractors carry out value engineering that may compromise the performance of heat networks. So it is the responsibility of commissioning management to offer guidance.

*Kevin Cremin*



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# Cleaning up their act

This month, CIBSE's Julie Godefroy outlines key consultations on carbon and air quality policies

## RECENT SUBMISSIONS Clean Air Strategy, Defra

Defra recently consulted on its draft Clean Air Strategy, after the High Court ruled it must do more to tackle air pollution. The strategy clearly tries to address growing public concerns, repeatedly stating Secretary of State Michael Gove's ambition for the UK to show world leadership.

It is more comprehensive than previous plans, which had a narrow focus on NO<sub>x</sub> emissions from vehicles, and includes measures CIBSE had recommended,<sup>1</sup> such as a better use of smoke control areas and a commitment to tackle carbon emissions and air quality jointly. We can expect future changes to biomass policies, for example, including emissions limits and revised Renewable Heat Incentive rules.

However, we have strong concerns that:

- The strategy does not commit to targets in line with World Health Organization (WHO) guidelines. This is rather weak if the government wants to be 'world-leading in protecting our health'.
- There needs to be strong monitoring and enforcement. Centrally, the government should be held to account post-Brexit, as it has been by the European Court of Justice.<sup>1</sup> There must be adequate resources for local authorities to implement and enforce policies.
- There is currently no comprehensive regulatory framework on indoor air quality, and guidelines in Building Regulations Approved Document F are poorly implemented. This should be reviewed.
- A broader approach is needed, favouring solutions that address pollution at source and offer health, wellbeing and environmental benefits, including better planning to promote cycling and walking and cut transport needs, and incorporation of green infrastructure. The government should support research and development into driving behaviour change in consumers, and how urban form, trees and vegetation influence air pollution.

## London Plan

A revised draft London Plan has been published, following a consultation earlier this year. Some of our recommendations have been incorporated: more recognition of green infrastructure in relation to the urban heat island effect, flood risk and sustainable drainage, and a clearer commitment to long-term air quality targets (see Clara Bagenal George's article on carbon policies



**"It is unclear how ambitions for outdoor spaces will stand against high-density development"**

in January's *CIBSE Journal*). However, it is unclear how ambitions for green infrastructure and outdoor spaces, which are crucial for our health and wellbeing in urban areas, will stand against plans for increasing high-density development. Disappointingly, there is little monitoring of environmental objectives, which could jeopardise their delivery in practice.

## CURRENT CONSULTATIONS Energy Performance Certificates (EPCs)

The government is asking for feedback on how EPCs could better drive carbon reduction in new and existing buildings. If you think the current regime and methodology could be improved, this is a big opportunity to respond.

## Standard assessment procedure (SAP) version 10

BRE has published a revised version of SAP, not yet for official use in Building Regulations and EPCs (see page 24 for details). The proposed changes – including making the Criterion 3 solar gains test

more robust overall, and halving the carbon factor for grid electricity to reflect actual values – are significant and something CIBSE has been advocating. While not a consultation, comments can be sent to BRE.

## Building Regulations

The government is expected to publish a consultation on Part L this winter. Ahead of this, CIBSE would like to hear about changes you would like to see, whether small methodology points or wholesale changes to the energy and carbon savings approach. We are also interested in your views on how this may be an opportunity to review Part F and better address overheating risk and indoor air quality.

■ Visit [bit.ly/CJSept18HD5](http://bit.ly/CJSept18HD5) to see consultations we engage with.

## References:

- 1 See our response on Environmental Principles and Governance, August 2018.

**JULIE GODEFROY**  
is acting head  
of sustainability  
development at CIBSE

Consultation	Deadline for input to CIBSE	Closing date
Scottish Building Regulations: Review of Energy Building Standards Division	7 September 2018	14 September 2018
Helping businesses to improve the way they use energy, BEIS	19 September 2018	26 September 2018
Energy Performance Certificates for Buildings, BEIS & MHCLG	5 October 2018	19 October 2018

# A duty of care?

The collapse of a wall in Edinburgh, the Grenfell Tower fire and the heatwave have put UK building regulations in the spotlight. Now, the Equalities and Human Rights Commission has joined the debate. Hywel Davies explains

**T**he tragic events at Grenfell Tower in June 2017 triggered a wholesale review of building regulations in England.

With building regulation a devolved matter,<sup>1</sup> this is being watched closely by the rest of the United Kingdom. As well as the Independent Review of Building Regulations and Fire Safety, led by Dame Judith Hackitt,<sup>2</sup> the government has established its own Building Safety Programme<sup>3</sup> to coordinate the response to Grenfell. This has produced a comprehensive set of briefings and advice notes, as well as a monthly data release.<sup>4</sup>

The most recent data, from mid-July 2018, reveals that 474 high-rise residential and publicly owned buildings have aluminium composite material (ACM) cladding systems, which are unlikely to comply with current building regulations. As many as 159 are social housing blocks, 14 are other public buildings, and 301 are private sector residential buildings, hotels and student residences.

Just under half of the private sector blocks have undergone testing by BRE. The challenges of replacing the cladding on these buildings have already been widely reported, and will require significant design and installation skills, as well as industry capacity to deliver so many projects.

The government, in consultation with the Independent Expert Advisory Panel – established immediately after the fire at Grenfell – has published guidance for anyone responsible for fire safety in residential buildings more than 18m high in England.<sup>5</sup>

In response to the Independent Review, the government has consulted on a ban on the use of combustible materials in external walls of buildings more than 18m high. It has now been followed by the Welsh Assembly Government, which has launched a similar consultation. For full details and CIBSE's response to the English consultation, see our consultation pages.<sup>6</sup>

CIBSE broadly supports the proposed ban – subject to exceptions for materials such as seals and gaskets – and to particularly careful consideration of the transitional arrangements for projects already under way when any ban comes into force.



**"Banning combustible materials is seen as a solution, not as part of a wider overhaul of building regulations, as envisaged by Hackitt"**

However, problems with ACM cladding are not confined to England or the UK. Australia has its own difficulties, as first identified following the Lacrosse tower fire in Melbourne in November 2014. In this case, rapid vertical fire spread beyond the room, or area, of fire origin. However, no fatalities or serious injuries occurred at Lacrosse.

The official report for the City of Melbourne<sup>7</sup> in April 2015 noted that the fire raised questions about both the cladding system – and whether it had been approved or accredited – and about compliance with the Building Code of Australia.

In March 2018, the State of Victoria issued a Ministerial Guideline<sup>8</sup> restricting the use of any 'prescribed combustible product' as part of an external wall, unless the Building Appeals Board has determined the installation complies with the Victoria Building Act and regulations. The guideline has been issued 'to reduce the risks to life and property, which can arise from the inappropriate use of products containing combustible materials'.

In August 2018, the New South Wales government issued a 'building product use ban'<sup>9</sup> under powers contained in the Building Products (Safety) Act 2017. This prohibits the use of aluminium composite panels (ACM in UK terminology) where the core contains more than 30% polyethylene by mass in any external cladding, wall, insulation, façade or rendered finish in a wide range of buildings, some with as few as two storeys.

However, the ban does not apply to products that have successfully passed a test to the relevant Australian Standard, or where the product and proposed wall assembly have passed tests for both external wall fire spread and building-to-building fire spread.

These restrictions are not as wide ranging as those being proposed in England and Wales, and both say very little about the transitional arrangements for projects already under way, but they appear to apply to new applications for permission to build. They also explicitly allow systems or products that pass certain tests, subject to the test being carried out to the latest Australian Standard and in a recognised test facility. This may have relevance to the proposals in parts of the UK.

# The young are in demand

**As demand for young talent hots up, teens will avoid university, says Robin Vollert**

This summer has seen high temperatures in the UK – albeit they are normal for our readers in Hong Kong or Australia – which have caused considerable problems with overheating in buildings. The House of Commons Environmental Audit Committee decided in February 2018 to investigate the problem of overheating, and CIBSE's head of research, Dr Anastasia Mylona, gave evidence that featured at some length in the committee report.<sup>10</sup>

This called for better regulation of overheating in the Building Regulations to better protect the health of occupants. There was considerable discussion in the committee about the role of regulations in safeguarding the health of occupants.

And, in a further twist, it has been reported that the Equalities and Human Rights Commission (EHRC) has responded to the recent consultation on banning combustible cladding in England.

It is said to argue that government has a duty to protect lives under Article 2 of the European Convention on Human Rights (ECHR) and Schedule 1 to the Human Rights Act 1998 (HRA), and to have told government that it considers systemic failings that led to the Grenfell Tower fire still exist and give rise to an ongoing violation of Article 2 ECHR/HRA by the state.

Notably, the commission refers to systemic failings; there is a real concern that banning combustible materials is seen as a 'solution', not as part of a much wider overhaul of building regulations, as envisaged by Dame Judith Hackitt.

However, the commission's intervention in the debate introduces a further dimension to the ongoing discussions. With the consultation closing in mid-August, we await the government's response with additional interest, and readers will be kept informed.

## References:

- 1 For a concise summary of the current regulatory arrangements throughout the UK, see [bit.ly/CJSept18HD0](http://bit.ly/CJSept18HD0)
- 2 Independent review of building regulations and fire safety: Hackitt review, [bit.ly/CJSept18HD](http://bit.ly/CJSept18HD)
- 3 Building safety programme, [bit.ly/CJSept18HD2](http://bit.ly/CJSept18HD2)
- 4 Building safety programme: monthly data release, [bit.ly/CJSept18HD3](http://bit.ly/CJSept18HD3)
- 5 Government building safety programme – update and consolidated advice for building owners following large-scale testing, [bit.ly/CJSept18HD4](http://bit.ly/CJSept18HD4)
- 6 Current consultations, [bit.ly/CJSept18HD5](http://bit.ly/CJSept18HD5)
- 7 Lacrosse Building fire municipal building surveyor report, [bit.ly/CJSept18HD6](http://bit.ly/CJSept18HD6)
- 8 Minister's guideline under section 188 of the Building Act 1993, *Victoria Government Gazette*, [bit.ly/CJSept18HD7](http://bit.ly/CJSept18HD7)
- 9 Building product use ban, [bit.ly/CJSept18HD8](http://bit.ly/CJSept18HD8)
- 10 Heat-related deaths set to treble by 2050 unless government acts, [bit.ly/CJSept18HD9](http://bit.ly/CJSept18HD9)

The UK's further education sector is going through a major transition. Young people have more options these days, and many no longer regard a 'traditional' degree as the best way to access the right career.

Fees charged for degrees are also having an impact; many universities are resorting to making unconditional offers to encourage applicants to commit early.

The total number of unconditional offers made to 18-year-olds from England, Northern Ireland and Wales rocketed to almost 68,000 this year (nearly a quarter of admissions) – compared with just 2,985 in 2013.

The government thinks it looks a lot like a marketing campaign, rather than an attempt to drive up quality. Higher education minister Sam Gyimah said this tactic was 'irresponsible'.

Trade unions are also concerned because they think students may 'switch off' and not get the best possible A-level results, which could count against them with employers further down the line.

Unconditional offers are a blunt instrument wielded by universities to try to cherry pick the best and the brightest in an increasingly competitive market, but they should be considering this in a wider context. Young people are aware there is more than one way to access a rewarding career these days. They are also worried about building up debt and – with tuition fees for most degrees now more than £9,000 per annum – work-based training where you earn as you learn is looking increasingly attractive.

It is fruitless for further education providers to fight against this rising tide – they should embrace it and make sure they are part of the workplace training revolution. This also has huge potential for the building services engineering sector, as more employers reach out to a new generation of potential recruits, who they can train on the job up to – and beyond – degree level.

The CIBSE ASHRAE Graduate of the Year Awards, presented on 11 October at the Institution of Mechanical Engineers in London, gives us an annual snapshot of how the process of training the next generation of engineers is evolving.

Swegon is delighted to be sponsoring the awards for the sixth year because, not only does it create a procession of impressive candidates, but it also demonstrates the many and varied routes into our industry that are now available. See [www.cibse.org/yea](http://www.cibse.org/yea)



**ROBIN VOLLETT** is managing director at Swegon Group UK&I [www.swegonair.co.uk](http://www.swegonair.co.uk)

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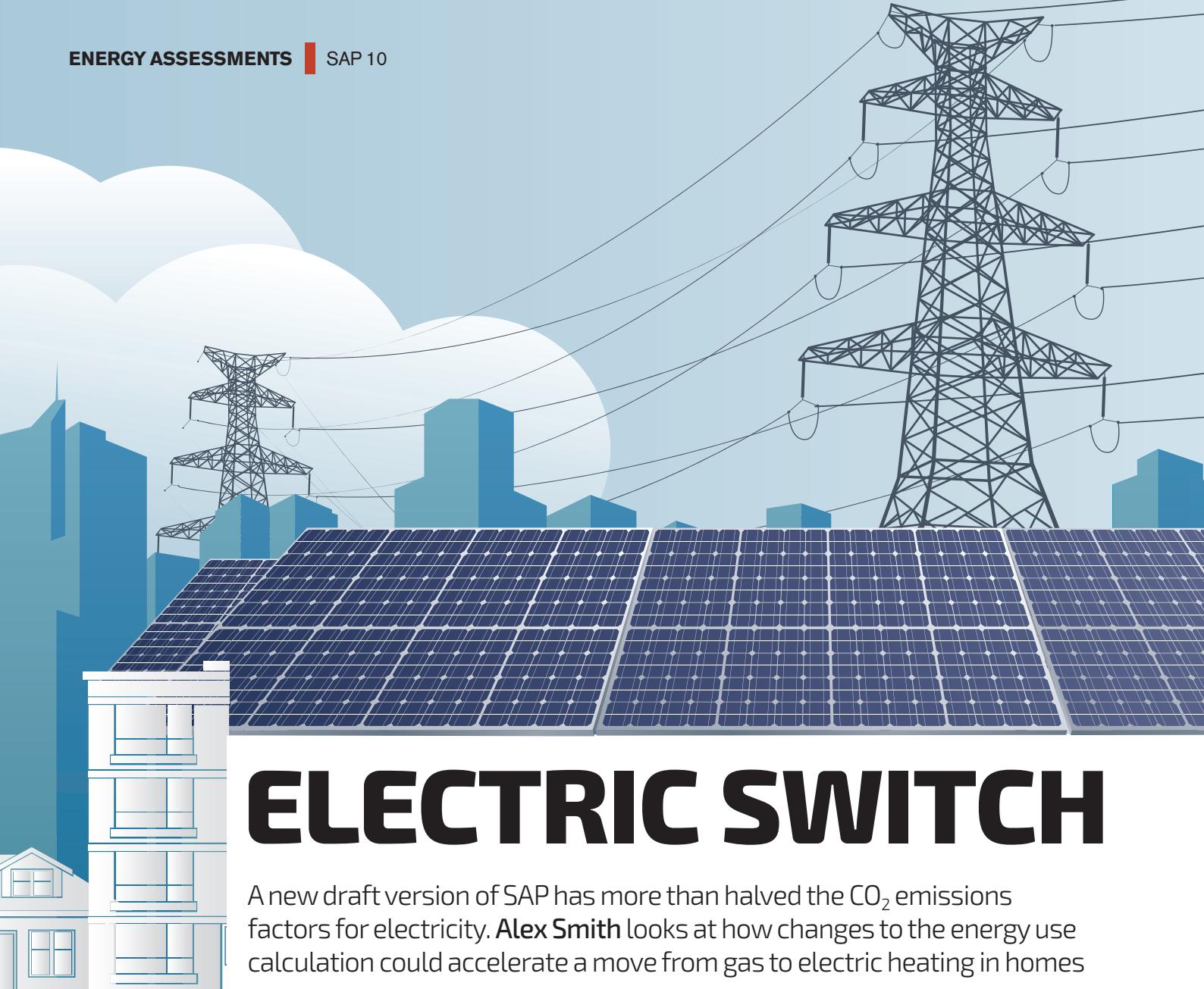
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# ELECTRIC SWITCH

A new draft version of SAP has more than halved the CO<sub>2</sub> emissions factors for electricity. **Alex Smith** looks at how changes to the energy use calculation could accelerate a move from gas to electric heating in homes

**T**he updated methodology for calculating energy use in new residential developments is set to have a significant impact on the way consultants design heating systems for the purpose of building regulations compliance.

One of the biggest changes in the draft Standard Assessment Procedure (SAP 10), published in July, is to the lower carbon emissions factors for electricity, which reflects the rapid decarbonisation of the National Grid.

Other key updates include higher distribution loss factors in heat networks, and measures taken to reduce risks of overheating (see panel 'Important changes in SAP 10').

It is not known when SAP 10 will come into effect. The new methodology will only supersede SAP 2012 when the *Building regulation conservation of fuel and power: Approved Document L*, is next updated, which will be in 2019 or 2020.

Many of the SAP changes were outlined in BEIS' Proposed Changes to Government's SAP (November 2016) and its response to the consultation a year later, but figures for CO<sub>2</sub> emissions factors in SAP 10 are far lower for electricity than in 2016.

Current SAP assumes that electricity used produces 2.4 times the carbon emissions of mains gas. The 55% reduction in the CO<sub>2</sub> emissions factor for electricity means homes heated by direct electric systems will produce virtually the same CO<sub>2</sub> emissions as gas, while heat pumps will produce even less. The SAP 10 factor is also far lower

than the carbon factor proposed in 2016 (see table 'Change in CO<sub>2</sub> emissions factors').

'SAP 10 has aligned the carbon factors with reality,' says Julie Godefroy, acting head of sustainability development at CIBSE. 'The new carbon factors and distribution losses will change the appraisal of low carbon heating options.'

Phil Jones, past chair of the CIBSE CHP-DH group, carries out feasibility projects for CHP schemes. 'CHP is still the most economic, but it is increasingly falling down on CO<sub>2</sub> emissions, particularly where lower carbon factors for electricity are already being used.' This is the case in schemes supported by the Heat Networks Delivery Unit, set up to administer government grants for heat networks, says Jones.

The lower carbon factors mean heat pumps only need a coefficient of performance (COP) of 1.1 to have carbon emissions lower than a gas boiler, says Elementa senior engineer Clara Bagenal George, MCIBSE.



However, she warns of an unintended consequence of a lower carbon factor – higher energy bills. ‘Electricity is more expensive than gas, so to be running cost neutral, the COP of a heat pump would need to be four. Hence, further guidance will need to be introduced to protect a building’s occupants from increased energy bills.’

The shift in carbon factors will change how design teams prioritise carbon reduction measures, she says, because the relative cost/carbon tonnes of different measures has changed. For instance, CO<sub>2</sub> emissions from grid electricity falling by 55% means the relative cost per carbon tonne of PVs increases substantially.

‘It is still important to install PV on buildings to help to continue reducing the carbon emissions of the UK grid,’ she says. ‘Further incentives or metrics may be needed to ensure this.’



A Mitsubishi Ecodan heat pump

Jones says the lower carbon factors are overdue, and should be used now in making SAP calculations. ‘I’m very concerned about carbon factors in the SAP proposals. I welcome the much lower electricity grid factor of 0.233, but we are close to this already. Why do we need to wait until 2020? Are we still going to be assessing heat pumps at 0.519 then?’

This view is supported by Bean Beanland, vice-chair of the Ground Source Heat Pump Association. ‘If the carbon factor in SAP and Part L is not changed soon, we will be faced with buildings still going up in 2022 that have been designed on false principles. Significant damage is being done to the heat pump sector every day that this situation is allowed to perpetuate.’

Hanaé Chauvaud de Rochefort, senior policy research manager at the Association for Decentralised Energy, says: ‘The changes to the grid electricity emission factor are appropriate. However, it is problematic for all power generation as the grid emissions are a blend of all sources of generation on the system.’

‘Gas CHP – even at very low grid emission factors – continues to displace higher emission generation, such as gas engines and turbines without heat recovery.’

Remeha CHP’s general manager, Mike Hefford, says carbon factors change depending on the season. ‘The concern is that the current approach is based on an overly simplified annual average intensity figure for grid electricity. This approach is flawed when dealing with heating as it fails to take into account the fact that the grid is cleaner in summer than winter,’ he says.

»

## WHAT IS SAP?

The purpose of SAP is to assess the energy and environmental performance of new homes to ensure developments meet energy and environmental policy initiatives, as well as building regulations.

The assessment is based on standardised assumptions for occupancy and behaviour. This enables a like-for-like comparison of dwelling performance. Related factors, such as fuel costs and emissions of carbon dioxide (CO<sub>2</sub>), can be determined from the assessment. These indicators of performance are based on estimates of annual energy consumption for the provision of space-heating, domestic hot water, lighting and ventilation.

SAP is used to assess energy use and carbon emissions for *Building Regulation Approved Document L* in domestic buildings, while SBEM is the equivalent tool for non-domestic buildings. Reduced data SAP (RdSAP) is used to produce Energy Performance Certificates.

### Change in CO<sub>2</sub> emissions factors

	Emissions kg CO <sub>2</sub> e per kWh		
	SAP 2012	Draft SAP 2016	Draft SAP 10
Mains gas	0.216	0.2077	0.210
Electricity	0.519	0.398	0.233

The SAP 10 emission factors for electricity are a three-year projection for 2018-2020. They are now closer to figures for grid electricity published by other official bodies, such as the Government GHG Conversion Factors figure of 0.283 for CRC reporting, and the BRE projected figure for 2019/21 of 0.302.



## DISTRIBUTION LOSS FACTORS

For heat networks not submitted to the Product Characteristics Database

- Heat network designed to CIBSE CP1: 1.5
- Heat network not designed to CIBSE CP1: 2.0

» Consequently, technology using electricity supplies for heating will appear significantly lower carbon than its real-world operation, says Hefford. 'We would therefore urge the government to adopt a more accurate monthly average intensity figure for grid electricity.'

The BEIS 2017 consultation response said it would assess the technical feasibility and impact of changing the carbon emission factor calculation to a monthly method. (It stressed that this did not mean the target for new buildings would vary month to month.)

It also said gas emission factors would be updated again at the time of the Building Regulations change, when regulatory impact would be assessed.

SAP 10 assumes higher heat losses from heat networks than SAP 2012, unless the performance data has been entered into a product characteristics database (PCDB), where a distribution loss factor is calculated and recorded for use in SAP.

**"The shift in carbon factors will change how design teams prioritise carbon reduction measures"**

If heat networks are not in the PCDB, the distribution loss factors (DLF) are 1.5, if they are designed to the CIBSE *Heat Networks: Code of Practice for the UK* (CP1). If the code is not followed, a DLF of two must be used. In other words, SAP 10 assumes that half of the heat generated by the system is lost in the network.

There are lower DLFs for new buildings connecting into existing heat networks. These range from 1.2 for pre-1900 dwellings to 1.5 for those installed in 2007.

Jones welcomes the fact that compliance with CP1 gives a better DLF in SAP proposals, but asks how a designer proves compliance and who has the competence to sign this off.

Jones says CP1 will be updated in the autumn to include more checklists against key outputs, so each stage can be signed off by the client and its technical advisers. He says the approach to DLF in SAP 10 should also be used in SBEM – the calculation for energy use in non-domestic buildings.

## Overheating

SAP 10 has been changed to tackle the causes of overheating in homes. It has reduced the amount of ventilation designers can assume is being gained from opening windows. 'SAP 2012 was too optimistic about how much heat gain could be removed from ventilation. Even assuming the windows are open, the removal of heat gain has been halved,' says Godefroy.

'The changes make a big difference. As you will get as much benefit from ventilation gains, designers will have to reduce heat gains in other areas, such as less glazing,' says Godefroy.

She is pleased that SAP software will also prompt designers with questions about the suitability of using opening windows, such as: is there a local source of noise likely to prevent windows from being left open for long period; and is there a security risk if windows are left open unattended?

The BRE has invited anyone with comments on the draft document to email [SAP-help@bre.co.uk](mailto:SAP-help@bre.co.uk)

Cleaner grid electricity could make PVs less attractive in SAP



## IMPORTANT CHANGES IN SAP 10

- CO<sub>2</sub> emission factors, primary energy factors and fuel prices, have been updated
- Default distribution loss factors associated with heat networks have been increased
- Assumed heating pattern has been changed to a consistent daily pattern for all days of the week
- The assessment of summer internal temperatures has been refined
- Additional design flow (heat emitter) temperature options have been provided for heat pumps and condensing boilers, which affect their efficiencies
- Default heat pump efficiencies have been updated
- The calculation of lighting energy has been updated to allow recognition of new lighting types with higher efficacy
- The options for entering heat losses from thermal bridges have been revised
- The calculation of hot water consumption has been adjusted to account for shower flow rate
- Battery storage is now accounted for in calculations for PV panels
- The impact of PV diverters is now taken into account
- The overshading factor used for the PV calculation can be taken from Microgeneration Certification Scheme data

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# MAKING HISTORY

The first Heritage Group symposium explored ways to bridge the gap between academia and practice.

**Liza Young** reports

We must investigate the past to inspire the future. This was the overarching message from the Heritage Group symposium, titled 'Historic building services in education, practice and research'.

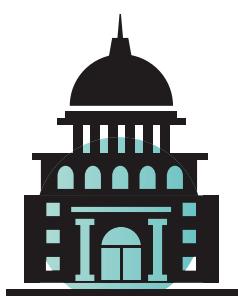
The event, organised with the Kent School of Architecture at CIBSE's Balham HQ in July, highlighted that many involved in building services pay little attention to the history of their industry. They sweep away engineering past to replace it with modern technology because they do not recognise the significance of what has gone before.

Past environmental solutions can offer important insight into the design of sustainable architecture today, as well as help engineers deal with problems of conservation, said Henrik Schoenefeldt, senior lecturer in sustainable architecture at the University of Kent, who led the event.

He said engineers need to engage in research, or establish partnerships with universities and professional bodies, to ensure the industry learns the lessons of the past.

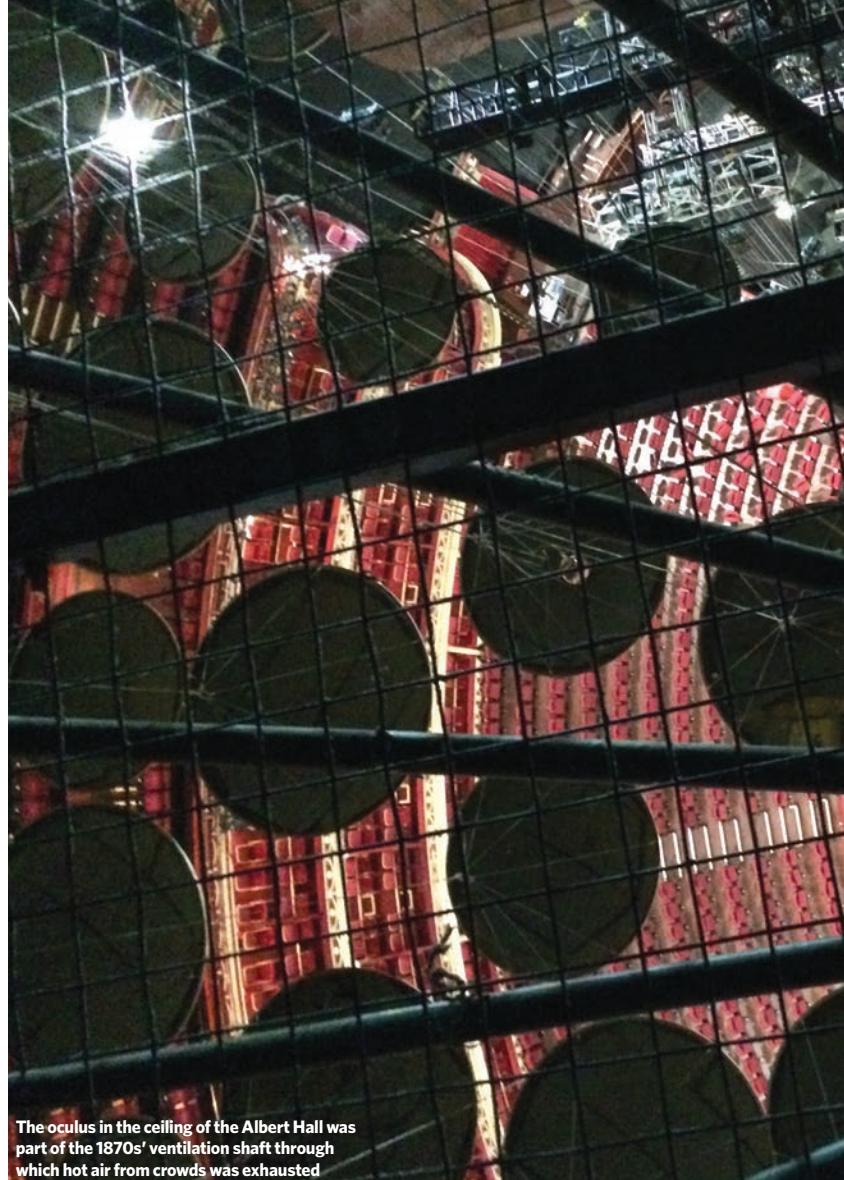
## Palace of Westminster

In the opening session, Schoenefeldt gave a presentation on the Palace of Westminster, where he is leading a large, Arts and Humanities Research Council-funded project investigating the historic ventilation system at the Houses of Parliament. 'Between heritage and sustainability – restoring the Palace of Westminster's 19th century ventilation system' feeds into the building's restoration and



**98.5%**

The proportion of UK buildings that are existing, and need to be recycled and reused using circular economy principles



The oculus in the ceiling of the Albert Hall was part of the 1870s' ventilation shaft through which hot air from crowds was exhausted

renewal programme. The project is helping to bridge the gap between academia and practice by investigating how historic knowledge can be applied to enable the re-use of historic infrastructure.

The process involves undertaking a critical reconstruction, through archival research and in-depth site investigations, to understand the original system, how much of it survived, and where it came from.

'Very often, you cannot understand how the form came into being unless you understand the process that lay behind its design development,' said Schoenefeldt. 'At the Palace of Westminster, the design process was politically charged, so a lot of the decisions cannot be explained on practical grounds but, often, only on political grounds.'

The next stage is understanding how the building performed and how it was operated – including its post-occupancy history – before drawing conclusions about how the system could be partially reused.

Schoenefeldt believes post-occupancy is critical because the way systems were used was often different from the way they were initially proposed. 'The Palace of Westminster developed over 30 years, and the process started before the building services were even considered. The architectural decisions at the beginning were not shaped by later ideas of stack ventilation.'

The palace was originally designed to be served by one system and, because of political tensions, it was divided into sections to house multiple systems, which were distinct from one other, he said. 'Those divisions cannot be understood purely on technical grounds; they're based on decisions that are part of the political dimension of design, and the way the design has evolved.'

One of the aims of the project is to produce a 3D point-cloud survey and BIM model of the historic system that can, ultimately, be used by designers working on the restoration programme.



## Closing the gap

The Palace of Westminster research project has started to build the bridge between academic interest and the practical benefit that work could offer practitioners, said Schoenefeldt.

Handing over a research publication is not enough, however. 'You need to produce a series of documents that translate into something of use to the practitioner,' he added.

For the restoration programme, Schoenefeldt produced a series of reports, and was involved in the design brief to ensure knowledge of the past could be fed into practice.

This 'knowledge' must then be translated into a form that's intelligible and meaningful to practitioners, before it can be disseminated among stakeholders. 'Then, you have to facilitate knowledge utilisation because, sometimes, the researchers will be the ones to see the opportunities and will work with practitioners to uncover them,' said Schoenefeldt.

He added that the outcome will 'close the feedback loop' by being fed back into academic research, because – in its own way – what is done in practice becomes research that feeds into academia. ▶



A natural ventilation system was used at St George's Hall, in Liverpool

## HERITAGE IN EDUCATION

Students from the Kent School of Architecture showed how the study of historic building services has been integrated into their education.

- Surabhi Pandurangi, studying the MSc in architecture and sustainable environment, explained the design interventions at the British Museum's reading room, for preservation and comfort. In the 19th century, the room was warmed by heating surfaces with hot water. From the boiler, a set of mains water pipes ran along the basement air chamber, which acted like a plenum, and fresh air passed around the surfaces of hot-water pipes, arranged in a radiating pattern in the air chamber. The dome was made of two concentric air chambers – the outer layer helped equalise the temperature during extreme weather conditions and the inner layer was used to extract stale air. She said: 'This is an example of a successful collaboration between the library, architect and engineer to produce a building that reflected the experimental enthusiasm for a variety of services.'
- MSc student Samuel Leatt spoke about building information modelling (BIM) in heritage projects. He focused on a 2012 refurbishment at the Temperate House, Kew Gardens, where blocked opening lights and vents were repaired and reopened to maximise through-ventilation to reduce internal temperatures. To promote stack ventilation, all lower-level vents were reinstated and high-level windows became automated. A BIM model had been created at Kew but – because technology had moved on so quickly – it couldn't be opened. 'With quantum leaps in technology, will you be able to open the BIM model 10 or 15 years down the line? As information is digitised, archives might be discarded, which might be detrimental if the models can't be opened in future,' Leatt said.
- MSc student Elisa Hahn discussed the adaptive reuse of buildings. She said retention of existing structures results in maximum embodied energy savings and minimum operational savings. But demolishing a building and creating a new structure will have the opposite effect. 'For an adaptive reuse project to be sustainable, there must be a balance between embodied and operational energy. Certain refurbishment projects are favourable to sustainability, where the increase in energy is minimum and the increment of time is maximum,' she said.
- PhD student Bahar Badiee presented her research on whether Persian Orsi windows were inspired by the little Ice Age – a period of cooling between the 13th and the 19th centuries – and to investigate the design and function of the windows as climatic elements of Iranian architecture. She found their large size and construction material were not inspired by climatic changes because they were unsuitable for the climate.
- PhD student Sam Johnson presented his research investigating different ways of managing fires to help conserve objects, particularly wooden furniture, in historic houses. He studied a fireplace from the 1980s, logging humidity and temperature – as well as using a thermal imaging camera to measure the thermal efficiency of fire – before modelling the data. He observed that walls were much warmer than the air because radiant heat warms objects, not air, where humidity is higher.

**"Going back in time would allow students to get back in contact with the 'first principles' of environmental design and develop a critical angle on technology that could apply to modern systems"**

## » A centre of excellence

The feedback loop is missing from our industry, Phil Jones, energy consultant and chair of the CIBSE CPD and district heating group, told the audience during the plenary discussion. 'That's why we are stuck in a cycle of getting things wrong again and again,' he said. 'We need to learn from the past and use that knowledge in buildings today.'

To get out of such a cycle, Jones said textbooks were needed that present case studies and draw out key design principles. He also proposed creating a standard module – with an hour each on the history of boilers, fans, air handling, and so on – to be taught within the curriculum of every building services course.

'Lawyers, doctors, the military – even architects – learn from case history. Building services engineers don't, and we've got to fix that through teaching and research,' he said.

Jones proposed that two or three universities should come together and – with industry funding – set up a centre of excellence for the building services discipline.

'We shape our buildings and, afterwards, they shape us – we have to recognise the heritage,' he said.

Edith Blennerhassett, director at Arup, suggested the industry could sponsor a student prize for an essay in relation to the history of building services.

'A lot of interest for the topic is from enthusiasts, so if lecturers won't squeeze it into their course, students might see it as a prize worth going after,' she said.

Going back in time would allow students to get back in contact with the 'first principles'



**We must learn from historic principles applied at the Palace of Westminster (above) and the Royal Courts of Justice (above right)**



of environmental design and develop a critical angle on technology that could apply to modern systems, said Schoenefeldt. It would also show them how to reuse existing infrastructure to limit the impact of re-servicing historic buildings.

Only 1.5% of UK buildings are new – the rest are existing buildings, said Graeme DeBrincat, senior façade engineer at Arup. 'If we use the circular economy principles of recycling and reusing them, that's a step in right direction.'

He added that the industry needed to get away from the 'take, use, dispose' mentality. 'But that takes bold decisions. Using modern digital tools, we can prove the success of traditional approaches to building design, but we have to be bold, and back it up with good communication and analyses.'

Schoenefeldt said today's working methodology is not fit for purpose and we have to explore new ways of working using the knowledge of historic principles. 'But building services engineers cannot do it on their own – they need to collaborate with all the other disciplines,' he said.

'My proposition is that the institution takes a more active lead in trying to promote the understanding of historic building services through engagement and research, through promoting new forms of practice, and through changes in education.' 

## THE SURVEY SAYS

To capture what today's engineers think about the history of building services and its role in education and practice, Schoenefeldt conducted a survey leading up to the symposium. Of 29 respondents, 23 said they felt there was not enough knowledge of historic building services among industry practitioners. The majority said their knowledge was not gained through formal education, but through practice or personal interest.

Those who didn't have knowledge of historic services said they relied on external advisers – including Historic England, facilities managers and heritage architects – for guidance on how to approach conservation.

A generational knowledge gap was also perceived; millennials were seen to be less familiar with historic buildings than those aged over 40. Schoenefeldt – a millennial himself – said: 'This suggests young engineers should be experiencing education that reconnects them to that knowledge.'

Most believed current practice doesn't promote learning about historic building services, which prevents people from creating bespoke contextual solutions. Respondents said historic services general knowledge should be included in the formal education of engineers, and those who want to know more should pursue the MSc or PhD routes. A career option of becoming a specialist was highlighted as a prospect.

Schoenefeldt said: 'Education should also be used as a vehicle to establish new working practices, including incorporating more research.'



**The Natural History Museum, London, originally used stack ventilation**

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# POWERED UP

A future of smart buildings was predicted at the ASHRAE Summer Conference, which included presentations on the application of nanofibres and the concept of 'cognitive' buildings. **Tim Dwyer** reports

In sweltering Houston, outgoing president Bjarne W Olesen opened the ASHRAE Summer Conference by reflecting on his year in office. He celebrated success in enhancing the ASHRAE offering to members while extending its global reach, and spoke of the strong partnership with the United Nations Environmental Programme (UNEP). This is developing a range of courses, training and workshops to raise awareness and understanding of effective refrigeration plant operation in developing countries.

At her inaugural ASHRAE presidential lunch, Sheila J Hayter said her future had been predestined by childhood holidays spent at ASHRAE meetings with her father, Dick Hayter, who was ASHRAE president from 1995 to 1996. Hayter is a group manager with the Integrated Applications Center at the US Department of Energy's National Renewable Energy Laboratory, and her experience is in reducing non-renewable energy consumption and increasing 'resiliency' in the

built environment. This has inspired her presidential theme for the year – 'Building our new energy future'. A downloadable document on the future of the electricity sector and the role of buildings in that future can be accessed at [bit.ly/CJSept18ASH](http://bit.ly/CJSept18ASH)

Hayter sees a near future in which distributed energy resources, such as solar and wind systems, will be integrated with improved and less-expensive battery storage and microgrids. The 100-year-old electrical supply grid will need to become smarter, she said, to enable the bi-directional flow of electricity to cope with building owners and third-party providers getting into the electricity business, as well as to provide the backbone for the burgeoning Internet of Things.

Hayter foresees a transition to smart buildings that play a dynamic role on a smart grid 'without compromising the health and wellness of the built environment'. She wants the profession to lead a smart revolution that

may enable a 'leapfrog' in technology development so 'new capacity will reflect the future, not the past', including the ability to address building-specific cyber-security issues. She announced a new ASHRAE technical committee that will focus on resilience and security.

Across four days, the conference offered up to eight parallel tracks to give more than 1,600 delegates an opportunity to sample a range of topics associated with ASHRAE activities. The full technical programme can be explored at [bit.ly/CJSept18ASH2](http://bit.ly/CJSept18ASH2) (a subscription is needed to download presentations). Here is a summary of just three presentations representing some future-looking technologies.

## Solid-state cooling

The electrocaloric effect (ECE) was introduced in the 'Recent advances in solid-state cooling technologies' seminar by Qiming Zhang, of Penn State University. ECE is the change of temperature and entropy of a dielectric material that is induced by an electric field. This effect is produced by an electrical charge applied to, and then removed from, a dielectric material similar to a sheet of plastic food wrap (see Figure 1). This is a relatively simple solid-state device with a promised efficiency 25% greater than an equivalent vapour-



**Sheila J Hayter**  
announced a new  
technical committee,  
focusing on resilience

Temperatures reached 35°C in  
Houston during the conference



compression system – and it could be scaled down to chip size.

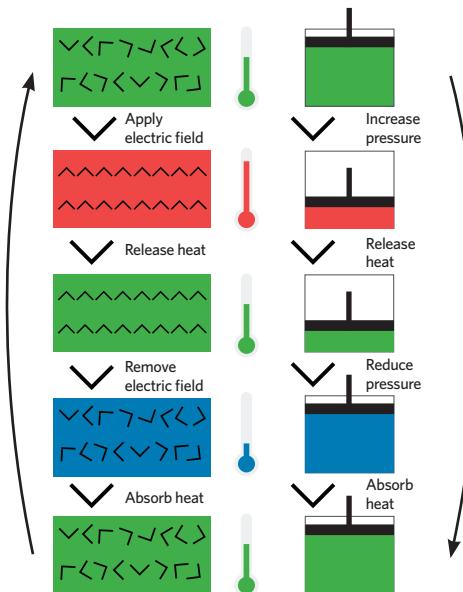
Advances in nano-materials and ceramics are resulting in increased levels of performance in laboratory-based systems, with useful temperature differences and cooling capacities at normal room temperatures. However, the materials available break down with the required high electrical operating fields – of around  $70\text{MV}\cdot\text{m}^{-1}$  – so the devices fail after a few operating cycles. Zhang estimates that the processes needed to reliably produce film will require several million dollars, but that subsequent production costs will be low. This is a technology that could disrupt cooling and enable the production of a range of new devices, including personal cooling in clothing and embedded cooling in building fabrics.

### Application of nanofibres

High voltages are essential in the electrospinning process to create nanofibres from a polymer solution. The solution, highly charged with tens of kV, is ejected from a capillary tube to deposit on a collector – such as a copper mesh, which is subsequently removed – resulting in a non-woven fibrous layer. Chun Chen,<sup>1</sup> of The Chinese University of Hong Kong, explored the application of nanofibres in filters for mechanical ventilation systems, as well as in window screens to filter natural ventilation. As the air flows between the tiny strands that make up a nanofibre-based filter, pressure loss is theoretically low.

The use of nanofibre ventilation screens for open windows in Beijing reduced the internal PM2.5 particulates significantly, while maintaining a reduced room air-change rate. Although the reduced

## "A smart revolution may enable a 'leapfrog' in technology development"



**Figure 1: Electrocaloric cooling compared to vapour-compression refrigeration**

airflow could undermine the benefit to indoor air quality afforded by the reduced particulates, this work offers a useful starting point to the development of practical filters.

### Cognitive buildings

In his presentation 'The Internet of Things: Digitising the physical world', Kevin Bailey, of IBM, spoke about the convergence of information technologies – such as virtual reality, robotics, nanotechnology and 3D printing – that 'will drive radical economic changes: value chains will fragment, industries will converge, and new ecosystems will emerge'. He cited companies that have had to change their underpinning structures, and said their longevity is increasingly dependent on their information technology.

Bailey introduced the concept of cognitive buildings that combine the experiences of automated and smart buildings to give predictive and responsive control of internal environments. He said the expectations of millennials, and the opportunity to deliver personalisation of the physical environment, are fortuitously coincidental.

Through developments such as the cognitive concierge that intelligently communicates with building users while drawing on the vast array of inputs, users' experience of the internal environment may be carefully controlled. In what is becoming an increasingly competitive labour market, Bailey showed buildings in Germany are already deploying this technology to deliver a more attractive and effective working environment. **CJ**

■ **TIM DWYER** is technical editor at CIBSE Journal

### References:

- Chen, C, *Comparison of air resistance between electrospun nanofiber filters and conventional filters*, ASHRAE Conference Houston, June 2018.

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# A CLASSIC RESTAGED

BSRIA's building services guide, *BG 6*, has undergone its most significant update. Liza Young finds out what has changed

**F**ollowing the most comprehensive review process in its history, the updated *BG 6 – A design framework for building services* has been published by BSRIA.

Appearing in various guises since 1994, the guide helps to clarify the roles and responsibilities of the stakeholders involved in the design phases of construction projects. Since then, it has been revised and updated every two to three years, to reflect the changing nature of UK construction industry practices and their implications on the allocation of design responsibilities.

During the design of a new building, myriad activities are required to produce the necessary level of detail and information, as well as the output documents. *BG 6* contains proformas where these activities can be identified and allocated to individual organisations or roles within the project team.

This helps to ensure there are no gaps between – or duplication of – responsibilities.

## The changes

Appendix A of *BG 6* contains six proformas, which include: a series of checklists for common feasible tasks at each stage of the design; model descriptions; and sample drawings. The user must select the appropriate activities and outputs, and allocate them to the required project team member. Deadlines and levels of detail can be assigned in Appendix B.

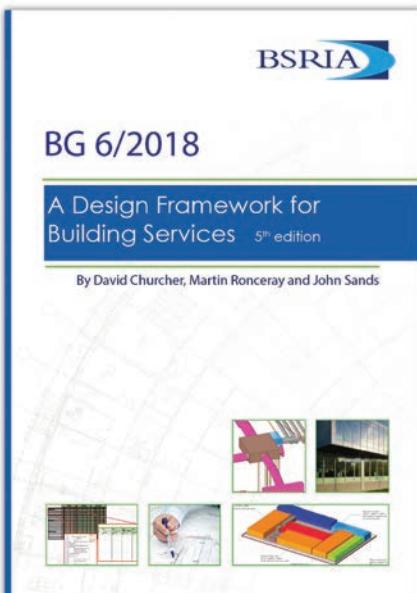
The proformas, which follow the project stages shown in the RIBA Plan of Work 2013, can be pre-emptively completed as part of a bid or, preferably, filled in during discussions when the design team has been appointed and is sitting down together.

As well as being restructured to give more information on its purpose and how to use it, the guide has been helpfully colour coded to match the RIBA guide. 'This will aid navigation and make it more welcoming to new users,' says John Sands, principal consultant at BSRIA.

The second major change has been the consolidation of Stage 3 and Stage 4 proformas. Unlike the 2007 guide, where the detailed design stages were chopped up into several sub-stages, the new *BG 6* has installed a single proforma for Stage 3 – developed design – and a single one for Stage 4 – technical design.

'Before, there were two proformas for Stage 3 and three proformas for Stage 4, which led to demarcation between the parties,' says Sands. 'Clients would appoint a consultant for Stage 4 A, and a contractor for Stage 4 B, for example, but both parties had different ideas of what that entailed – it was either less or more than was required. They were using the generic terms without realising they meant something specific.'

Now roles are more clearly defined, he says. 'Rather than saying you ➤



**"It's about producing the right amount of information at the right time for your particular project, to make sure there's enough information to prove what you have is going to work"**

***John Sands***

» do 4 A or 4 B, while preparing the agreement you must think about who is best placed to do these activities. You can match people's and companies' skills to the tasks, which should make coordination much easier.'

Andrew Krebs, information management lead at Hoare Lea – who sat on the *BG 6* steering group – adds: 'Removing the sub-stages will engage consultants and design teams at the design stage, and get contractor involvement as early as possible, defining a framework for a project in a collaborative fashion, so there's less conflict when major project milestones are reached.'

### Type of design

At Stage 4, *BG 6* allows the client to appoint different parties to complete one of three design types – feasible design, coordinated generic design and coordinated specific design. 'These represent the three types of information you can deliver during that job phase,' says Sands.

Feasible design is not necessarily coordinated, but coordinatable. 'It shows the designer has done due diligence, but not modelled everything in place. It must show the design can be coordinated without any major changes,' explains Krebs.

Coordinated generic design has space allocated for every element of the building, he adds. 'The design proves that space exists for the elements, but the objects within the model have not been specified.'

Coordinated specific design includes the selected individual components from manufacturer catalogues, identifies components, and makes any necessary changes in the model, says Krebs.

The type of design chosen depends on

the project and the procurement route, adds Sands. For example, for a design-and-build job, the consultant will produce a feasible design and the contractor can go 'straight to the goal' by producing a coordinated specific design, missing out the middle stage, 'which doesn't add anything', says Sands.

In some cases, the client may decide they want all three for the comfort of demonstrating to the supply chain that it will work, he adds.

'It will vary from project to project; in a straightforward job, such as a supermarket, they might want to miss out the middle stage – but, if it's a complex building, they may want the comfort of all stages to prove the concepts are working,' he adds.

There's also a difference between 2D and 3D-design, says Sands. 'If you're doing things in 3D, a feasible model makes sure there are no clashes. In reality, you would know there's space above the ceiling so, for example, if a fan coil is touching a light fitting, you would know there's plenty of space to re-route the services. But, in the world of 2D, it is not clear if there's space around you, so it would be more important to do all three stages and be confident about coordination.'

He adds: 'It's about producing the right amount of information at the right time for your particular project, to make sure there's enough information to prove what you have is going to work.'

### Huge effort

The proforma is a starting point, where tasks can be deleted or added by the in-house master to suit a particular project, says Sands. 'Not all activities would be allocated on a project or, if a particular requirement is not there, it can be added.'

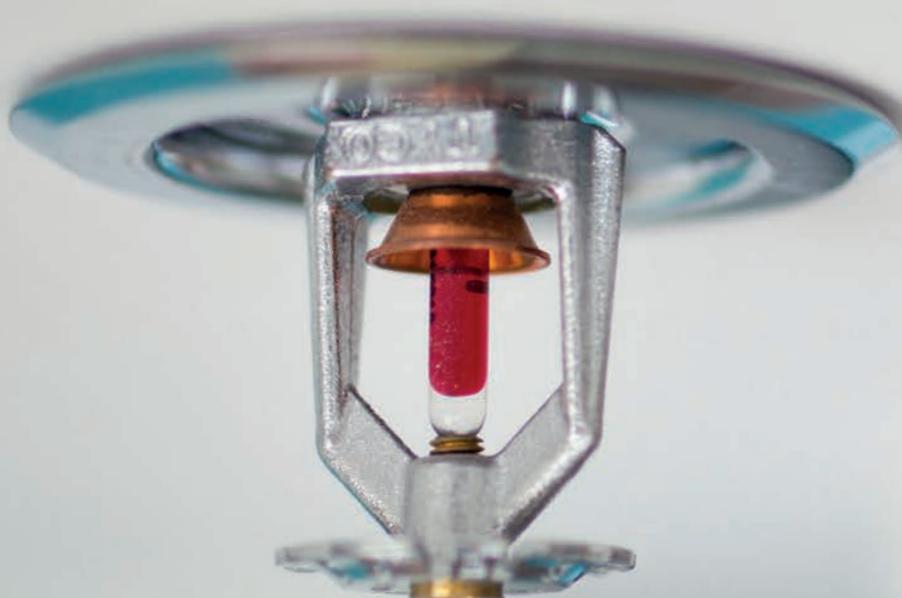
To update *BG 6*, says Sands, the 23-strong steering group – representing 15 organisations, including consultants, contractors and clients – put in a huge amount of effort, following a consultation that identified the key areas that people using *BG 6* felt needed to be improved or changed.

'Some have been involved in previous versions but, this time, there were a few new faces who didn't have preconceived knowledge of debates, so brought a fresh perspective,' says Sands. 'Without the steering group, this update would have been impossible.'

Have the changes been incorporated successfully? 'We'll have to wait and see,' says Krebs. 'But the changes that have been made match my aspirations for the document.'

**■** *BG 6* 2018 can be purchased at [www.bsria.co.uk](http://www.bsria.co.uk). A fully editable licensed version is also available.

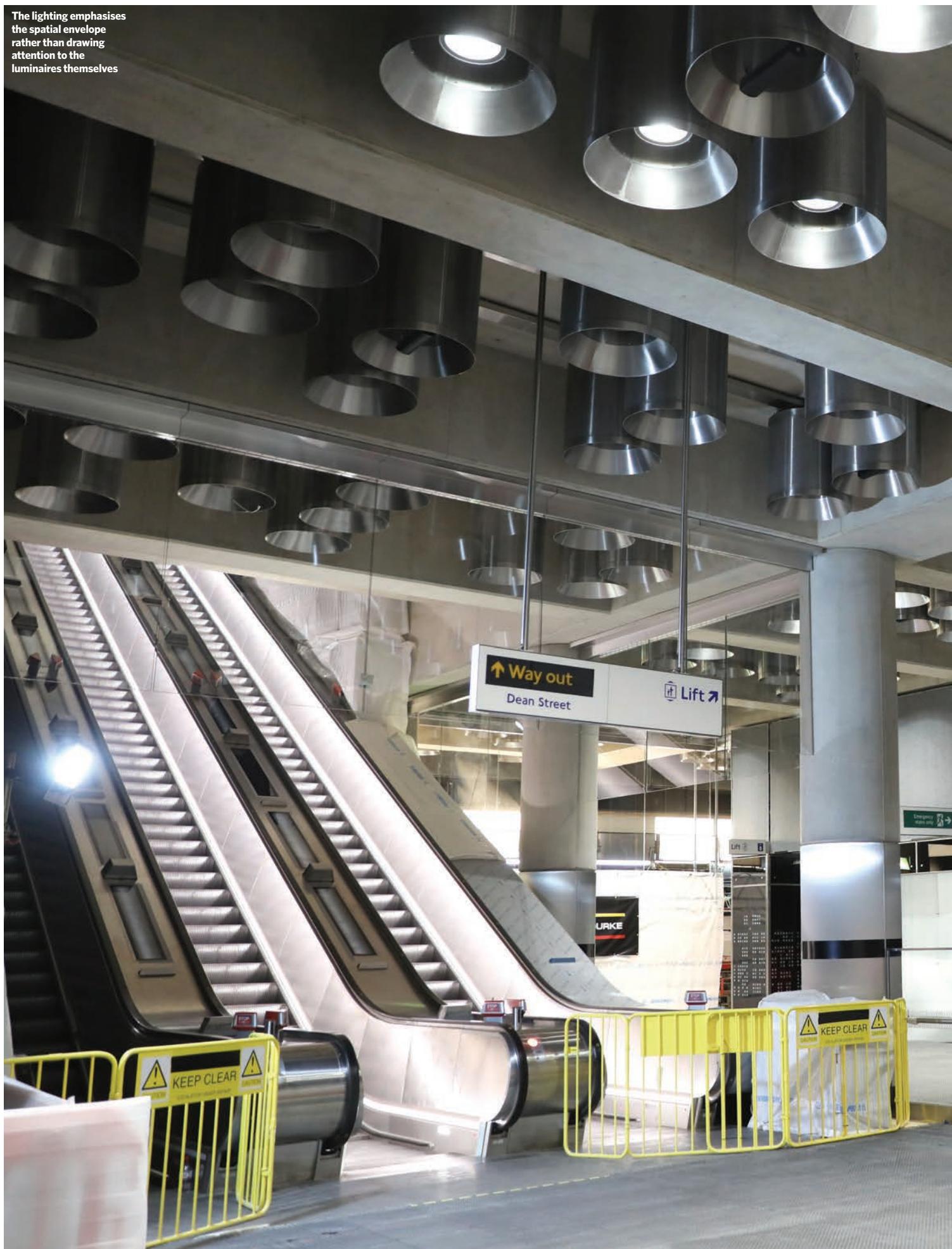
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IN THE UK AS A RESULT  
OF A FIRE IN A BUILDING  
WITH A WORKING  
SPRINKLER SYSTEM\*"



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\* [www.derbys-fire.gov.uk/campaigns/think-sprinkler/facts-and-figures/](http://www.derbys-fire.gov.uk/campaigns/think-sprinkler/facts-and-figures/)

The lighting emphasises the spatial envelope rather than drawing attention to the luminaires themselves



# ALIGHT HERE FOR CROSSRAIL

Future Designs' lighting concept for Crossrail is fire safe, eliminates glare, and uses an array of heat sinks to draw heat away from LEDs. **Andy Pearson** explains

**I**t was a brave decision by Transport for London to use LEDs to light the stations, escalator shafts and concourses of the new Crossrail Line (aka the Elizabeth Line). All the more so when you consider the decision was taken about five years ago, when LED technology was relatively new to the lighting mainstream.

'Crossrail is the first major sub-surface infrastructure project to be lit entirely by LEDs,' says Paul Kerrigan, Crossrail MEP engineer (lead electrical), the man responsible for line-wide lighting solutions and uninterrupted power supply (UPS).

'The decision to go LED on Crossrail was based on industry evidence that the benefits of reduced energy consumption and maintenance requirements would deliver a reduction in whole-life costs for the project.'

Any such savings would be significant because Crossrail is a giant infrastructure project. The new railway line traverses London, east to west. Its entire central section – from Liverpool Street in the east to Paddington in the west – is underground. This made the lighting design critical, not only for

passenger safety, but also as a means of enhancing their experience of the subterranean environment. The challenge for Crossrail was that many of the specialist LED fittings it needed to light the scheme had yet to be developed.

Having decided on LEDs, Crossrail set about developing the lighting concept for the station concourse areas, escalator tunnels and platforms. 'We wanted the lighting to emphasise the spatial envelope rather than draw attention to the luminaires themselves,' says Kerrigan. As a result, the concept uses the light-grey, matt-textured, glass-reinforced concrete lining of the station and escalator tunnels to reflect light onto the passenger areas, to 'create a sense of spaciousness within the underground environment' Kerrigan explains.

Light levels for Crossrail are defined by London Underground's task-based Lighting of Underground Assets Document. Minimum levels vary from 200 lux on the horizontal plane at the point where passengers step on and off trains and escalators, down to 100 lux on the vertical plane, to enable passengers to read display information.

The illuminance also has to be relatively consistent, with a uniformity figure of 0.75 at the stepping-off point on the escalators, down to 0.4 for general illumination of the concourse circulation areas. In addition, to improve safety and passengers' visual experience, London Underground requires all lighting to have a colour-rendering index of 80 (RA) or above.

Crossrail is using the colour temperature of the LEDs to help guide people through the subterranean stations. Cool white lamps – with a colour temperature of 5,000-7,000K – are used in transition spaces, such as escalator tunnels and cross-passages, to encourage people to



&gt;&gt;

» keep moving. By contrast, wayfinding areas and platforms, where people gather, have warm white lamps, with a colour temperature of 3,000-4,000K.

To simplify maintenance, Crossrail wants each luminaire to be unpluggable for simple replacement. In the case of the platform edge screen lighting, it also wanted the printed circuit boards containing the luminaire's LED chips to be easily removable, to allow the boards to be exchanged without having to remove the body of the light fitting.

Only light fittings made using materials that meet the requirements of London Underground's Fire Safety Performance of Materials document – developed after the King's Cross fire in 1987 – can be used. 'The fire-safety requirements tend to be more onerous than those of the British Standard,' says Kerrigan. To help manufacturers, Crossrail holds a register of materials deemed suitable for subterranean applications. It was a requirement that proved extremely onerous when it came to the selection of luminaires, because most incorporate polycarbonate diffusers, which is an excluded material.

Alongside day-to-day lighting, Crossrail wanted many of the fittings to incorporate emergency and escape-route lighting to comply with BS 5266, as well as London Underground's enhanced requirements for lighting-circuit resilience and fire survivability in a sub-surface environment.



The Icon uplighter uses linear strips of LED bulbs mounted on a standard PCB, with a light output of 60,000 lumens



'The emergency lighting has a consistent value of 15 lux across all areas in stations shafts and portals,' says Kerrigan.

Emergency escape and exit lighting must connect to the emergency lighting UPS system, to ensure illumination is continuous during a mains failure. The UPS system has been designed with a battery life of three hours in all areas – a length of time selected not because it is expected to take the public three hours to escape, but to ensure sufficient light after an incident to give emergency services time to search for casualties.

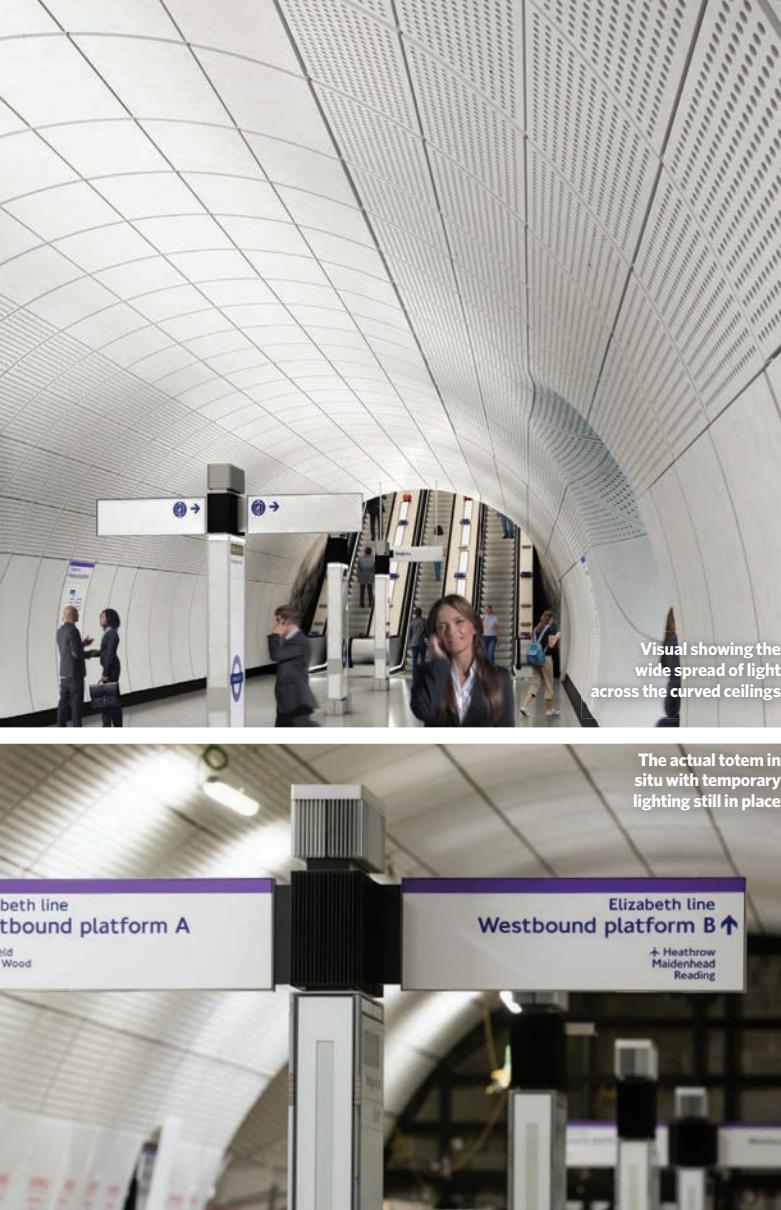
London Underground's requirement for emergency lighting is that every third fitting is connected to the UPS, but this minimum is exceeded in areas where more fittings are required to meet the 15 lux light level. To maximise resilience, emergency-lighting circuits are interleaved so that adjacent luminaires are fed from different emergency distribution boards.

The difficulty with being the first major subterranean infrastructure project to be lit by LEDs is that very few suitable LED fittings met Crossrail's specific requirements. Crossrail defined four luminaire types for specific applications, then turned to lighting manufacturers to develop them. These were the totem, the recessed escalator light, the cross-passage lighting service boom, and the platform edge screen light box. 'We'd established the concept, but we didn't know whether they would work, because we hadn't prototyped any fittings,' says Kerrigan.

### The totem

One of the lighting manufacturers that Crossrail used for the specialist LED fittings needed was Future Designs. It developed the luminaire for the totem uplighter and the six associated emergency light fixtures

**"Cables had to be LUL compliant, as did the bonding materials for the glass and even the screws. The luminaire was also subjected to bomb-blast testing"**



contained within. The totem is the primary source of light on the lower concourse. It is a 2.1m-high unit that combines signage with a high-powered LED uplighter, to bounce light off the tunnel's glass-reinforced concrete walls onto the concourse floor. It also incorporates emergency lighting, fire alarms and public help points.

'The starting point was to develop an LED uplighter with sufficient output to satisfy Crossrail's minimum level of 150 lux on the concourse floor,' says Leon Ellis, technical director at Future Designs. 'We do all our design in-house; to develop the uplighter, we used a programme that simulated the light distribution.'

The solution that was developed incorporates a chamfered edge to the LED printed circuit board (PCB). 'The curved design gave us as wide a spread of light as possible; we tweaked the chamfer to get the right amount of light directed to the ceiling.'

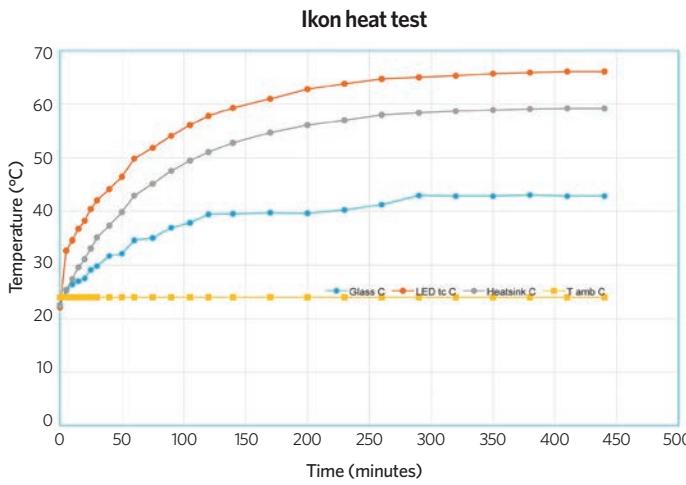
The 'Ikon' uplighter developed for mounting on top of the totem has a light output of 60,000 lumens, which is considerably more than the 5,000 lumens that a typical uplighter used in an office might be expected to produce. 'It's comparable to a 700 watt conventional fitting,' says Ellis.

This fitting uses linear strips of LED bulbs mounted on a standard PCB. 'The problem with it being an uplighter is that heat rises, so the heat coming off the LEDs had to be dissipated to prevent the ambient temperature from reaching 80°C and the LEDs from failing.'

Blowing air across the units was not an option because Crossrail did not want them to incorporate any moving parts. So a solution was developed using an array of heat sinks to draw the heat away from underneath the LEDs, limiting the ambient temperature to 35°C to maximise the life of the LEDs.

'We'd used software to model the light output, but we couldn't model the heat – we had to physically test the prototype units,' says Ellis. 'We built prototypes and powered them at full light output in controlled ambient conditions, until temperatures stabilised in the unit, to demonstrate it worked in line with the design. We then left the prototype running in these conditions for three months, taking a temperature reading six times a day.'

In addition to proving the heat-management system worked, the mock up ➤



» showed that glare from the uplighter mounted on top of the totem was more of an issue than had been predicted. 'Crossrail was always concerned about glare from the uplighters for people on the escalators, because they are so bright,' says Anouska Nemchand, head of design at Future Designs.

It's a point picked up on by Ellis: 'Crossrail thought the problem would be confined to the first totem, but you can potentially see the top of the second and third,' he says.

The solution was to fit a very fine blind of angled metal fins between two layers of glass that form the top of the units, close to the base of any escalators. 'There is a reduction in lumen output, but it negates the possibility of passengers momentarily being blinded coming down the escalators,' Ellis says.

'We also etched the glass; putting a slight frosting on it helped to soften and spread the light slightly,' Nemchand adds.

As with all products intended for use on Crossrail, the luminaires were not allowed to incorporate any combustible components and materials. 'All cables had to be LUL compliant, as did the bonding materials for the glass and even the screws we used – we had to give a breakdown of every component and what it's made from to get approval,' says Ellis. The luminaire was also subjected to bomb-blast testing.

The final version of the luminaire measures 750mm x 250mm x 250mm and weighs 80kg. It was installed on a totem and trialled at Tottenham Court Road and Farringdon stations, where it passed with flying colours. In most Crossrail stations, the totems will be spaced at 9m intervals within the 8.1m diameter tunnels, to give a consistent light level onto the floor of 150 lux and 0.5 uniformity. If a luminaire fails, it can simply be unplugged and replaced, with the failed fitting returned to the manufacturer for repair in the correct controlled environment for solid state lighting.



A prototype of the Ikon uplighter mounted on the totem at Crossrail

## The recessed escalator deck light

A recessed escalator light was also developed in conjunction with Crossrail.

The primary light source for the escalator tunnels is a large luminaire set into the escalator deck – the flat, angled plane between escalators – to provide the vertical illuminance. The uplighters' main task is to shine sufficient light on the faces of those using the escalators for facial-recognition security cameras to work. A secondary light source is a ribbon of LEDs set into the sides of the escalator to light the treads.

'You can see into the deck light fitting as you move past it on the escalator, so our brief was to develop a light to sit in the deck of the escalator that punched out an awful lot of light with zero glare,' says Kerrigan.

The design is unique in that it offers a high level of light output – 50,000 lumens – while glare is virtually eradicated. To achieve this, the LED light engine has an optical arrangement comprising three layers of diffusion to provide a homogenous uniform appearance with a 70-degree beam angle.

'As you go down the escalators, you won't realise the lamps are on because the louvre prevents you from seeing the light,' says Nemchand.

As with the totem light, the biggest challenge was to overcome was getting rid of the heat from the LEDs. 'It took us nearly two and a half years to work out a means to get rid of heat by drawing it downwards to a series of heat sinks,' says David Clements, managing director at Future Designs. 'It is the most difficult product we've ever developed, because LEDs are still so new.'

The luminaires are big. The units are 1,500mm long, 305mm wide, and weigh 85kg, and are spaced at 1,870mm centres along the length of the escalator deck. In addition to the LED PCB, the units contain the LED control gear. 'If anything fails, the whole light fitting is removed and returned to the manufacturer.'

The fitting is intended to be removed by two operatives standing on a stopped escalator. Currently, it costs London Underground approximately £1,000 per tube to replace a lamp in a fitting above an escalator.

'Most fittings are above the escalators and are only accessible from scaffolding, which has to be erected in engineering hours – so we were determined never to put lights above escalators on Crossrail,' says Kerrigan. 'This is probably the cleverest light fitting on the whole of Crossrail.' **CJ**





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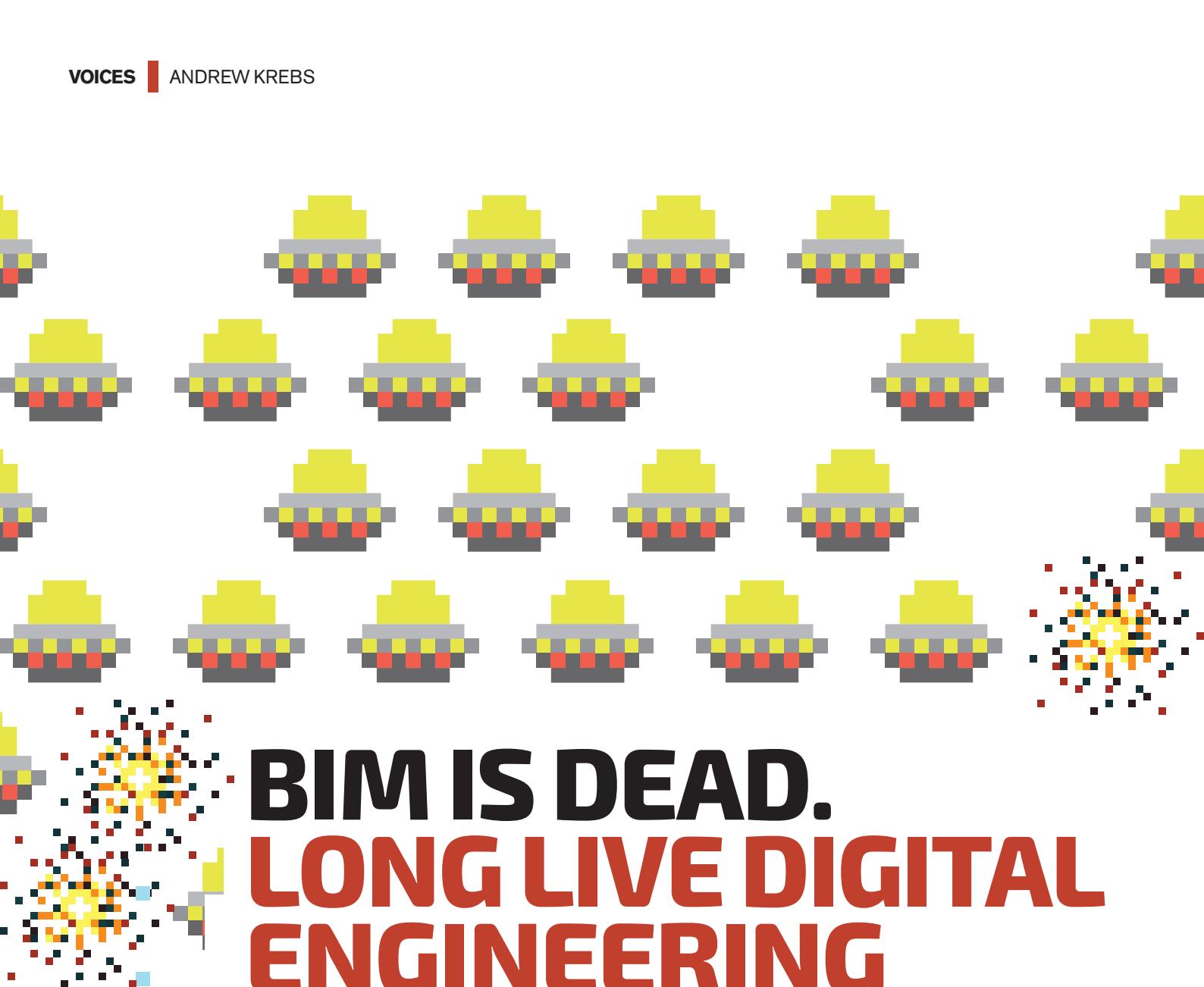
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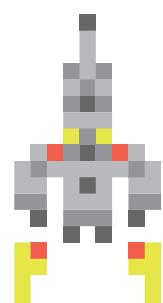
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# BIM IS DEAD. LONG LIVE DIGITAL ENGINEERING

By choosing the functions of BIM that fit the profile of our projects and that give tangible benefits, we can truly add value to our clients, says Hoare Lea's Andrew Krebs



**T**he May 2018 issue of *CIBSE Journal* included a supplement about building information modelling (BIM) that showed how the industry is dealing with the complexities and frameworks brought about by its advent. The dizzying number of standards we have to apply were covered, and manufacturers and consultants spoke about how well they are contorting their natural design processes to meet these criteria. What it didn't reconcile is why we are doing this.

The government asked us to modernise; the carrot and stick it used was to make BIM Level 2 a requirement on all public sector jobs by 2016 – and we painted a very lush veneer of being able to achieve this. What didn't come to pass were many fully compliant Level 2 BIM jobs. Why not? What has curtailed BIM adoption in private sector projects? What is the alternative? We should be told.

#### Why BIM is no longer a useful concept

Let us first examine the meaning of BIM. Does the 'M' stand for modelling or management?



**Building information modelling:** The art of storing as much building design information as possible in one database, so there can only be one version of the truth and it can be shared freely. A sound concept. Few have seriously argued with this and few fail to grasp the benefits. Today, we tend to employ 3D modelling with some embedded data.

**Building information management:** This describes the techniques used to ensure this new 3D model and database works, and can be handled correctly by everyone. It is simply communication – and the concept is not new. We did it in the 'old CAD days', but it was much simpler. Now we need to manage a much larger quantum of data, thus the requirements are more complex. Do it well and you

benefit greatly; fail to plan or give it credence and you'll watch fees evaporate before your eyes. We have to understand the power of information management and how it is the backbone required to transform how we define, design, build, commission and operate new buildings. However, we assumed BIM was really just modelling and the information management would follow along naturally. This did not happen.

When we regard both these definitions, we get: BIM = 3D modelling + information management. Thus, there are two strands to BIM: 3D modelling and information management.

We have been told that Level 2 BIM is the rigid framework we must adopt. Those are the rules. Since when has strict adherence to byzantine doctrine been the answer to a dynamic and changing marketplace?

Level 2 BIM only leads to the conclusion that BIM takes too long and costs too much. Why don't we, instead, look at the improved capabilities that BIM could give us and choose the functions that fit the profile of our projects and give tangible benefits to it?

It's fair to say the design phase of projects is no quicker, cheaper or easier as a result of BIM, but we are able to do higher-quality designs using significantly more advanced tools compared to the ones we had 10 years ago.

The real gains come as the project moves onto site and contractors use the models to carry out virtual builds, and design for off-site manufacture and assembly, which – if the design phase is

planned correctly – can start to show money and time savings, as well as welcome increases in on-site safety.

In theory, these wonderful data-rich models can give our clients great benefits, depending on the building type, the client and, of course, the design budget. Despite being vaunted as the ultimate beneficiaries of BIM, however, our clients are struggling to get on board with these benefits, as the technology and data structures required to exploit them are proving difficult to realise. The solution always appears just around the corner.

### **What is the alternative?**

We are lucky the UK government had the foresight to force us, by fair or foul means, to toe this BIM line. It has made the entire industry – which is not famed for being reactive and open to change – sit up, take notice and start to upskill in techniques that other industries have called standard practice for decades. This wasn't easy and we have not found it so, but, overall, it has

**"We need to get rid of the one-size-bloats-all approach that BIM has given us and start to look at these basic concepts for what they are: engineering using digital tools"**

worked. We are now in a position where 3D modelling is the norm, data and geometry are no longer separate, and complex calculations are becoming more routine.

It is clear, though, that we are now at the stage where we need to adopt a more intelligent and bespoke approach to delivering projects. We need to get rid of the one-size-bloats-all approach that BIM has given us and start to look at these basic concepts for what they are: engineering using digital tools. We must stop talking about BIM and, instead, start talking about digital engineering.

### **Why kill BIM?**

If we continue to apply the blunderbuss approach, we will not allow each project's own profile and needs to take centre stage.



» We shall continue to force onto projects activities that swallow time and fee, and deliver no benefits (COBie, I am looking at you). Just because a hoop exists, does not mean we must leap through it. Only jump if jumping takes us somewhere valuable.

Design teams that work together to find better, more streamlined ways of delivering what the client needs – sometimes doing more where value is apparent, but holding back in activities where no benefit will arise – lead the way in successful design. They use the tools that the digital world has brought: generative design, AI-influenced calculations, coherent, flexible information management, and so on.

Argent, which is redeveloping the King's Cross area in London, is an example of a private client that tries new techniques on projects where possible gains have been identified. Piloting laser scanning

**"Digital engineering can no longer be seen as a fancy thing going on at the fringes of a business"**



Work winners, project leaders and directors must learn about digital engineering

on the Fish and Coal buildings in 2013 allowed Argent to use it to great effect on the Coal Drops Yard in 2016, during a complex refurbishment of dilapidated existing buildings.

### Why digital engineering is better

This does not mean we should work in a haphazard and unplanned way. We must continue to adopt common data structures, to share data, collaborate and push the software and design capabilities as far as we can while retaining design integrity.

Clients that don't tell their design team they 'want BIM', but who understand the various facets of digital engineering and the value they bring to a project and specify them, will start to realise great benefits.

When building services designers have a good command of digital engineering – and when they have an understanding of what information management structures are required to deliver it – we will, as an industry, become more streamlined and more able to deliver value for our clients.

Where clients have the experience and skills to direct us to deliver certain features of digital engineering, we must adapt our 'standard offering' to suit their needs. Where clients are aware that such benefits exist, but need our counsel to help understand what will benefit them, there is a clear business imperative to help. There is also a great opportunity to build trust with clients by not selling them what they don't need and, instead, helping them realise the maximum possible value.

### Keep calm and carry on

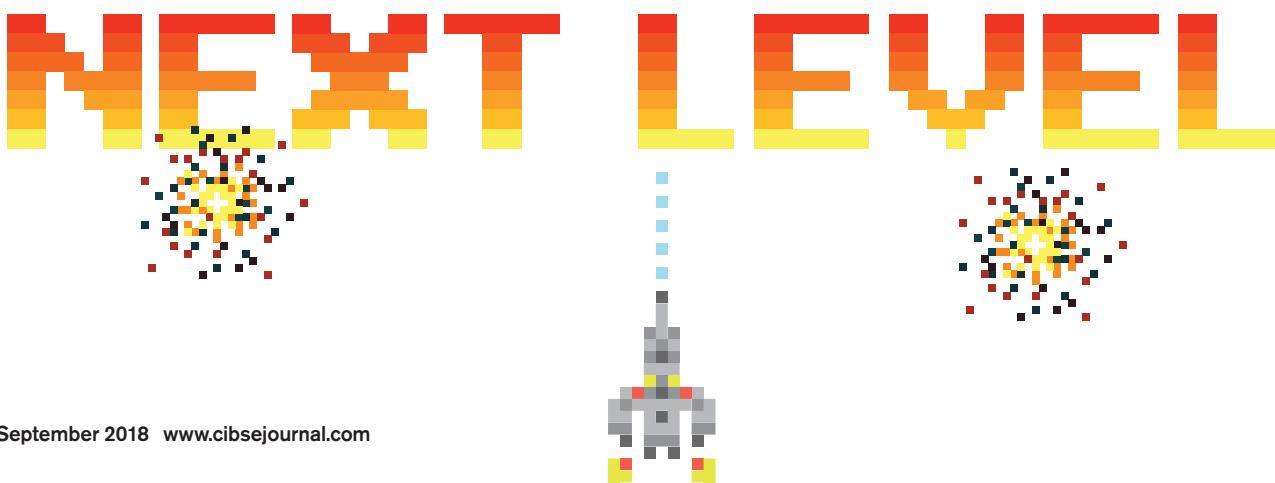
To do this, however, one fundamental change must take place in the building services industry: digital engineering can no longer be seen as the preserve of the young and tech-savvy, and as a fancy thing going on at the fringes of a business.

The work winners, project leaders and directors must show digital engineering the respect it needs, and devote time and effort to learning about this (not so) new method of delivering projects, so they can speak with authority and actively get involved in the management of digital engineering projects.

When our leaders can give advice without having to 'bring their BIM expert along', their businesses will be far better equipped to benefit their clients.

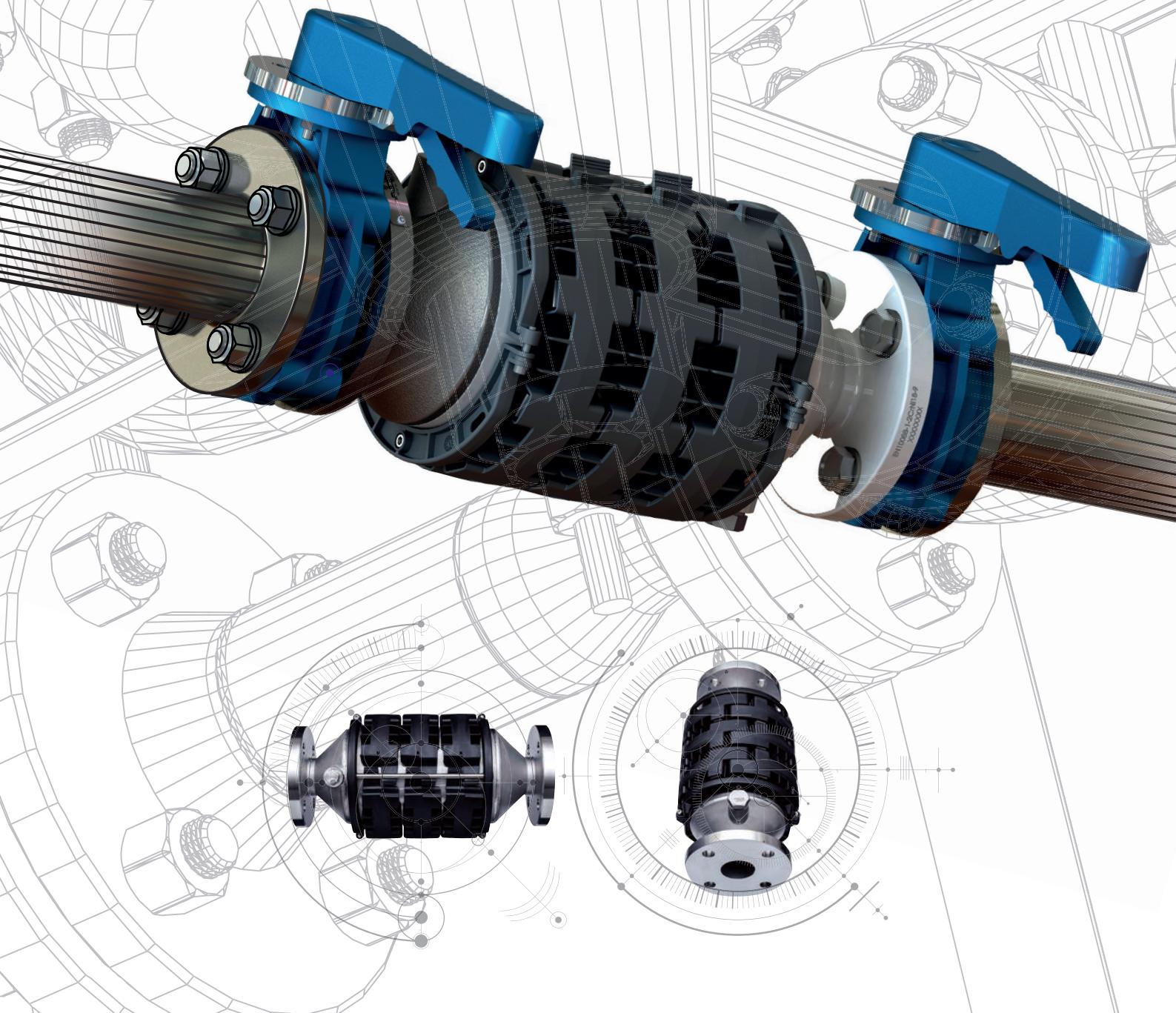
When we embed digital engineering within our businesses, and our leaders change their approach from containment to involvement, we will start to realise the goal of improving the design, build and commissioning of buildings, as well as the environmental, cost, safety and functional benefits that BIM brought to our attention – and that digital engineering is letting us perfect. **CJ**

■ **ANDREW KREBS** is information management lead at Hoare Lea



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Guidance on dilapidations from building services engineers is a specialist area, argues TFT's **Marc Hill** – so what should be considered before a lease starts, and how can tenants prepare for lease end?



# TAKE THE DESPAIR OUT OF DISREPAIR



A comfort cooling system that the tenant allowed to fall into disrepair

**T**he Royal Institution of Chartered Surveyors describes dilapidations as 'breaches of lease covenants that relate to the condition of a property during the term of the tenancy or when the lease ends'.

In the context of building services, claims for dilapidations typically include the remedy of disrepair, the reinstatement of any changes made to landlord's plant and equipment, or the removal of plant and services installed by the tenant. Although not often relevant to services installations, claims may also require redecoration of previously painted surfaces, which might include pipework and so on.

## Why M&E dilapidations advice is a specialist subject

When evaluating potential liability for building services dilapidations, an engineer must assess the tenant's lease obligations and whether there are any items of disrepair. If there are, they will also need to outline the remedy, what reinstatement works are necessary, and what routine maintenance and servicing has been undertaken.

It is essential that engineers liaise closely with their building surveying counterparts to agree an appropriate strategy – as well as to understand specific considerations such as diminution, improvements and supersession.

Building services installations require specialist advice because they have several

unique features that, arguably, require a different approach than for the building-fabric elements. Services are more dynamic, and their associated issues can often have greater disruption and cost implications.

Services installations form a significant proportion of dilapidations claims and building surveyors, generally, do not have the knowledge to assess complex M&E systems and the associated repair, reinstatement and maintenance costs. M&E systems also have a shorter service life than a building and its fabric – in some instances, the life of the services will be shorter than the lease term.

There are health and safety, statutory, and legislative implications, and plant and equipment can suffer technical obsolescence. When this occurs, replacement with a modern equivalent may be considered an improvement, which could complicate a claim under the law as it relates to landlords and tenants. Although compliance is not generally retrospective, like-for-like replacement when a plant item or system fails may also contravene regulations or codes of practice.

## Before the start of a lease

Claims are usually made at or near the end of a lease, but consideration of dilapidations before an agreement is entered into can reduce the risk of delays and disputes. There are several things both parties should consider before the start of a lease:



**"Services installations form a significant proportion of claims and building surveyors do not have the knowledge to assess M&E systems and associated repair, and maintenance costs"**

- A landlord must identify any work needed to ensure the services are in such a condition that an incoming tenant is prepared to commit to a lease on favourable terms. Existing defects or outstanding reinstatement works may have been missed during a previous dilapidations claim for an outgoing tenant. For a newly constructed property – or an existing building that has been subject to landlord refurbishment – there may be defects not addressed as part of the de-snagging process.
- A tenant should carry out due diligence to ensure they do not inherit an existing dilapidations liability. Some defects may not be picked up by visual inspection, so testing and validation works may be necessary.

- Addressing unexpected works could extend the period of time before a building/demise is suitable for occupation, leading to loss of rent for the landlord. The tenant's fit-out works may also be delayed, which could incur additional costs and result in prolonged disruption to other tenants in the property.
- If plant and equipment is old, or in poor condition, an incoming tenant may wish to cap their service charge and/or repairing liability to account for this. Should the tenant need to replace equipment during the lease period, the potential costs must be budgeted for appropriately. Careful consideration must also be given to potential technical obsolescence or compliance issues, and how such risks can be mitigated.
- It is important a tenant understands what they must do to fulfil their maintenance obligations under the terms of the lease. Historical records will be required from the landlord and should be reviewed to confirm whether appropriate maintenance has been undertaken and documentary evidence is available, or if there is a shortfall. Servicing documentation may also identify existing or legacy issues for which the tenant could inherit responsibility.
- The tenant will need the landlord to supply documentation – such as operation and maintenance manuals, record drawings and specifications, and commissioning documentation – to confirm design criteria, and whether the systems have been balanced and commissioned correctly. Having this readily available will streamline the process and reduce uncertainty over lease-cycle costs.

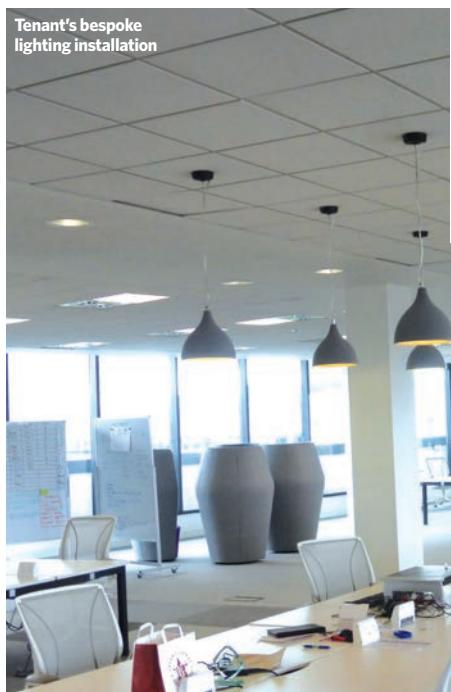


### » Preparing for lease end

Preparing properly for lease end will allow potential liability to be considered and budgeted for in good time. The tenant should ensure that the services for which they are responsible have had planned maintenance, routine servicing and statutory inspections, and that records are available to confirm this. Any outstanding defects should be addressed to ensure the services installations are in good and substantial repair. If there has been a lack of maintenance, the potential effects of this will need to be considered. Such uncertainty and further validation can draw out – and potentially inflate – a claim.

If the landlord's systems have been modified or supplemented, reinstatement obligations and potential costs must be understood. Reinstatement may need recommissioning of modified systems. Not all defects and reinstatement works can be identified by a visual inspection. Testing and validation can confirm the state of repair, any works required and the associated costs.

A liability assessment will identify lease-end culpability and enable a tenant to plan or budget for dilapidations.



### Future life at lease end

Although there are subtleties in lease covenant wording that can change this, a tenant will usually be obliged to return premises to a condition commensurate with when the lease started – assuming that it was in a good, occupiable condition. They will discharge their obligations under most repairing covenants if the plant is in repair, operational and reasonably reliable.

A tenant does not have to deliver premises with plant and equipment that has a particular remaining life expectancy. Plant age, inefficiency compared to a modern equivalent, and services not being suitable to attract a new tenant are not sufficient to trigger a repair covenant. A sound understanding of building services is vital to help a tenant defend any such claims.

### Summary

Landlords require dilapidations advice to preserve the value of their asset and ensure it does not suffer waste or deterioration. Compensation must be sought when a tenant has failed to comply with their lease obligations and losses have been incurred. Tenants need advice on the validity and size of a landlord's claim, and on statutory protection.

The M&E engineer who offers specialist technical expertise can ensure dilapidations liabilities are considered before – and throughout the course of – a lease. They can also mitigate against misguided assessments of liability, which can often result in extended and costly disputes.

Technical engineering knowledge and a sound understanding of landlord and tenant law will improve the transparency of dilapidations claims, reduce settlement timescales, and make the claim and reimbursement of costs more equitable. **CJ**

**MARC HILL** is a technical partner at TFT

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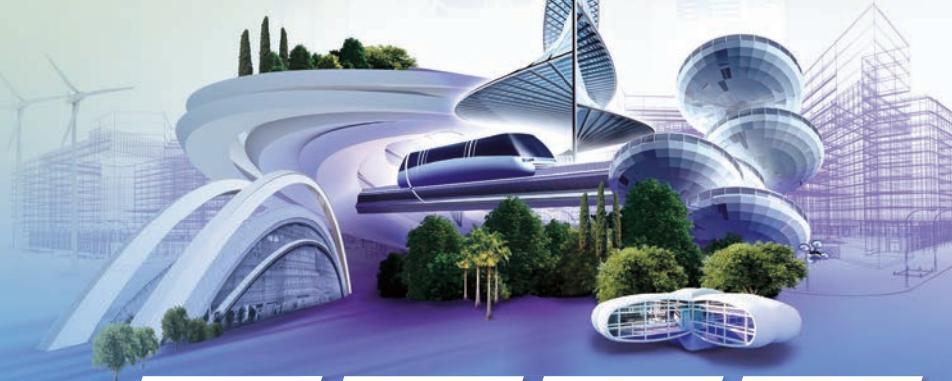
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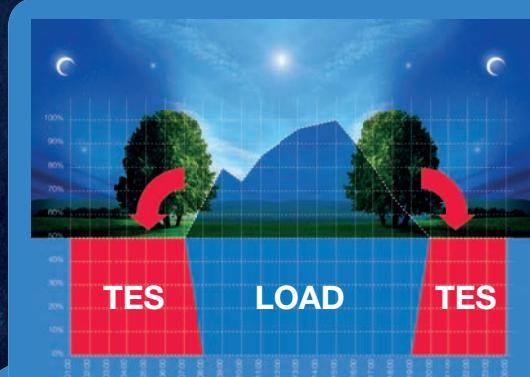
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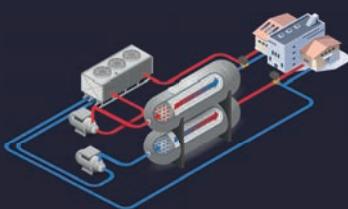
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**T**he UK government's Clean Growth Strategy has set aside £557m for renewable energy projects, in a bid to clean up the country's energy system and accelerate economic growth.

National Grid figures, meanwhile, show that low carbon power generation – such as wind, solar and hydro power – supplied more than half (52%) of the UK's electricity in the summer of 2017. Of the G20 nations, the UK is decarbonising the fastest, according to PwC analysis<sup>1</sup> – so times are clearly changing. The energy supply of the future will need to operate safely and reliably for 365 days of the year, and facilitate the decarbonisation of the energy industry.

Delivering the future energy needs of UK citizens efficiently in a low carbon economy is a complex mission. Vertiv has helped tackle it by adopting a hybrid solution after being approached by Noriker Power to deliver frequency control services to the National Grid. Using Noriker Power batteries connected to Vertiv's hybrid storage technology ensures additional energy can be immediately supplied to the grid to meet demand.

#### Managing variability

Over the past few years, the National Grid has maintained its focus on transitioning to renewable energy to meet customer demands. Some of the challenge of incorporating renewable energy is that it doesn't offer a constant supply of electricity, and variability needs to be managed.

One of the most important things worth bearing in mind when exploring this brave new world is that favouring renewable energy and managing variability are not mutually exclusive – and nor must they mean abandoning existing methods. A compromise is what's needed and, to this end, engineers should consider hybrid solutions.

Grid frequency is a key metric used by the National Grid (and other transmission systems around the globe) to monitor stability, and must be maintained within very tight tolerances.

The National Grid invites companies that can provide energy-storage solutions to join the Frequency Response Services (FRS). This includes fast frequency response dynamic (FFR-D), which helps maintain the grid's stability. Noriker Power recognised that joining the FRS required different technology, so it approached Vertiv to supply the advanced hybrid storage management and technical speed of response needed.

#### The partnership

After assessing a variety of options, valve regulated lead acid (VRLA) and lithium-ion batteries were connected to grid-support inverters. These batteries store power on standby, in readiness for additional energy to be injected into the grid in milliseconds to meet demand. They are also able to correct grid power factor and harmonics.

In addition, generators were incorporated »

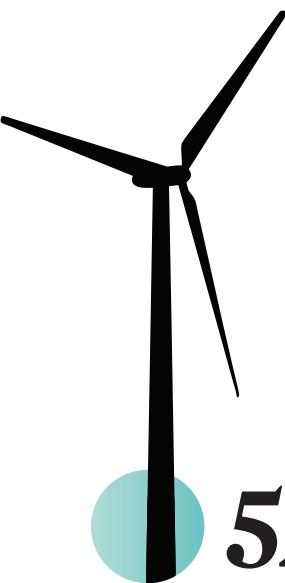
# READY TO SERVE

When Noriker Power was asked to provide the National Grid with energy-storage solutions, it approached Vertiv for a different type of technology, as **Mike O'Keeffe** explains

» into the design because the site's power supply was 'non-symmetrical', as the grid connection available had different export and input power. The generators also take the strain from the batteries after a certain period, leading to a lower-cost battery installation.

The lithium-ion and VRLA batteries are connected to a series of inverter systems. These are monitored by a remote diagnostics system that is surveyed around the clock by service experts. It offers real-time insights and information to help maximise uptime of the systems.

To manage the flow and storage of energy to these batteries, both battery types were employed and a bespoke control system required to operate the site. The control system was designed in partnership to enable the inverters to react to remote signals, thereby meeting National Grid requirements for this service. The inverter allows a consistent power supply to the National Grid at times of demanding peak-frequency response, and to store the energy generated during times of low demand. The combination of VRLA and lithium-ion



# 52%

The proportion of the UK's electricity supplied in the summer of 2017 by low carbon power generation, such as wind, solar and hydro power

# 365 days

The energy supply of the future will need to operate safely and reliably every day of every year, while facilitating the decarbonisation of the energy industry



The UK is decarbonising the fastest of all the G20 countries, according to PwC

## SCALING DESIGN AND APPLICATION

There is a range commercially available inverters, which are enabled for all types of battery-storage technology, including lithium-ion and VRLA energy sources. These systems range from 100kW to multiple MW solutions, and are able to supply large amounts of reactive power and fault currents to networks if required. There are both full turnkey packaged solutions and supply-only packages, providing flexibility to prospective solar and generator contractors.

batteries delivers 20MW of FFR-D power directly to the UK power grid at 33kV 50Hz.

### Broader considerations

Another benefit of this model is that it is truly scalable. When it comes to the application of renewable energy, building service engineers should consider using a modular system that incorporates battery and power-conversion management units, and that can be adapted to meet building specifications on a case-by-case basis.

Ultimately, it is not enough for an energy solution simply to be efficient and keep service costs low; a service level agreement that adds reliability and resilience is just as important.

By adopting hybrid solutions and clever asset management, building service engineers can have the best of both worlds: efficient, cost-effective and environmentally friendly renewable energy, with the reliability of traditional energy sources. 

### References:

1 PwC, UK leads the G20 in clean growth, 12 September 2017, [bit.ly/CJSep18PwC](http://bit.ly/CJSep18PwC)

■ **MIKE O'KEEFFE** is vice-president of service for Europe, Middle East and Africa at Vertiv

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# SPECIAL FEATURES

**This month:** Tackling overheating; edge computing; natural ventilation in the home; Indoor Air conference; hotel heat recovery

## COOL CITY LIVING

When excessive glazing caused a high-rise tower block in the centre of Manchester to overheat, contractor Proline developed a solution that plugged into a district cooling chilled water main. The firm's **Andrew Mitton** explains

**T**here's been a huge emphasis on improving the thermal performance of our buildings so we use less energy and spend less money to stay warm in the winter.

It's paid dividends for the energy efficiency and comfort of modern homes and offices, but contemporary design trends are now creating another thermal-performance challenge – overheating in blocks of flats.

This summer's heatwaves, combined with architectural trends for glazed façades, mean overheating is becoming a serious concern. If the building is constructed of concrete, solar gain during sunlight hours is stored as heat in the structure overnight, and urban locations often prevent the introduction of opening windows for natural ventilation. It all adds up to a strong likelihood of apartments overheating to unacceptable temperatures, particularly in bedrooms.

CIBSE's TM59 Design methodology for the assessment of overheating risk in homes specifies a sleeping environment of 26°C or above will result in disturbed rest, limiting the health benefits of sleep.

The obvious solution is to have openable windows to allow the movement of air within the space. Often, however, external noise can become an even bigger issue than raised temperatures for inner-city dwellings.

Another option might be to specify glass with a high solar control coefficient; however, this would impact negatively on the standard assessment procedure (SAP) – required to pass Part L – which is weighted



The flats at Salford Quays, Manchester, are highly glazed

towards free winter heating from solar gain. This takes into account the need to keep buildings warmer in winter rather than the potential for overheating which, historically, has not been an issue in the British climate.

Where solar gain is a problem and window opening is not an option, flats have to be ventilated by mechanical means, which usually involves MVHR installation. But even this may not be sufficient to manage the heat gains, forcing specifiers to introduce some form of cooling.

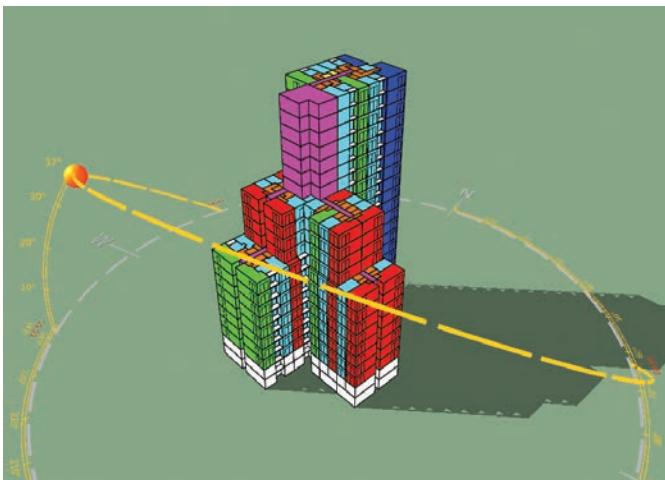
However, installation costs for split-system cooling or refrigerant gas units are high and this option presents design challenges for the architect, who must allow for the units' space requirements and visual impact. In a high-rise development, many units may be required, resulting in higher build and operational costs.

### Salford Quays solution

In August 2017, M&E contractor Proline was commissioned to take the building services engineering for a 20-storey residential tower of 191 dwellings from concept to detailed design and installation.

The project has a large percentage of glazing on the façade, creating an overheating risk when assessed in compliance with TM59. The introduction of conventional cooling would have presented several issues, including spatial challenges and the need to resubmit design changes for planning.

»



The sun path was modelled at Salford Quays

» Installation costs would be high too, making the project a lot more expensive to deliver. The running costs and noise of a standard air conditioning system were also unappealing.

When the TM59 loads and profiles were applied, it was clear the building was failing the overheating criteria by some distance. An attempt was made to control overheating by designing MVHRs into the specification with an air change rate of 8 ACH. However, as well as a lack of space to accommodate the units, construction would have been too expensive.

Design changes to the glass specification were suggested, but reductions to the G-value of the glazing had to remain within the parameters for the building, to satisfy the SAP calculations.

When the building was remodelled with the revised specification, the team was able to reduce the required number of air changes to four per hour – but this was

**"The operational cost will be 10-20p per hour per flat – less than the cost of boiling the kettle"**

still too expensive and noisy, and insufficient for comfort during the hottest periods. It was also physically impossible to fit units into the voids available for the services.

The magnitude of failure varied depending on the orientation of the apartment, but the solution was kept uniform for ease of maintenance.

After experimenting with the thermal model, the team calculated that 0.5kW of cooling introduced into the airflow of the ventilation system would enable each apartment to sit within the limits set by TM59 with a 2 ACH requirement. This is achieved by adding cooling that can be used on an 'as needed' basis to reduce the temperature in the bedroom by 6K.

To introduce the cooling into the MVHR system without compromising space, the team developed a water coil in the air supply plenum, and is chilled using cooled water supplied by a district cooling chilled water main.

The coil – which is 400mm x 200mm x 200mm – could be fitted into a small space within the flat.

The system works by intercepting the airflow of the MVHR system in the plenum shortly after the air intake enters each apartment. The incoming air passes over the face of the coil, cooled using water from the chilled district main, before entering the living accommodation to offer on-demand heat tempering, reducing the indoor temperature by up to 6K.

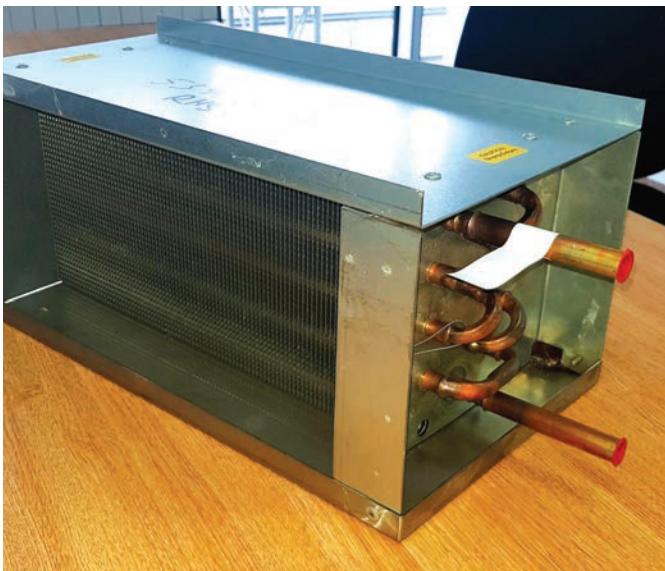
The airflow is then extracted through the kitchen and bathroom via a heat exchanger.

The district main has been designed as a three-stage chiller with a buffer vessel to store chilled water, so reducing the potential for short cycling on the system.

Chilled water flows into the cooling system at 6°C, with a return at 12°C, and residents use a switch to activate the system for their own apartment as and when it's needed.

The chilled water main is part of the building's centralised plant that falls within the remit of the developer, who is responsible for building management.

»



Cooling coil unit measures 400mm x 200mm x 200mm, and (right) the bespoke solution fits neatly within the plenum





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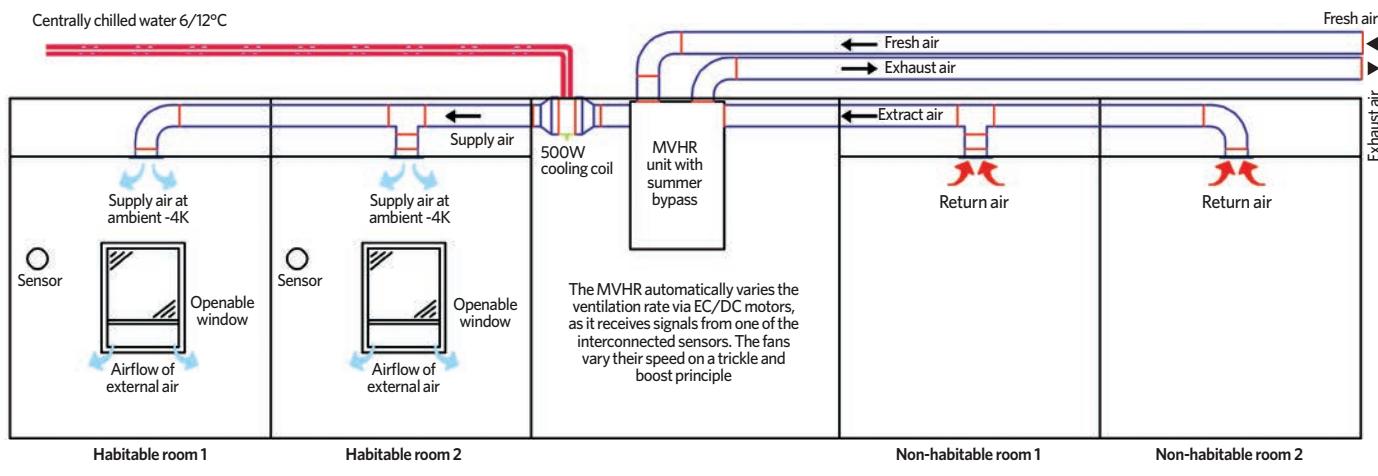
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**Schematic of the system**

## » Benefits

The on-demand heat-tempering design means this 20-storey, private-rented sector scheme will benefit from the space efficiency of centralised plant, while offering each resident control over their indoor environment, with on-demand switching and a dedicated cooling coil for every apartment. The system is practically silent and invisible in the apartments, and is simple and easy to maintain, thanks to a condensation tray accessed via a maintenance hatch.

Both the energy saving and cost benefits are considerable. The capital expenditure cost of installing the district cooling main and

individual apartment plenum cooling system has reduced build cost by a six-figure sum, compared with the original 8 ACH proposal.

Centralised chillers will also reduce the use of refrigerant gas and simplify maintenance, while the operational cost will be 10-20p per hour per flat – less than the cost of boiling a kettle. ☑

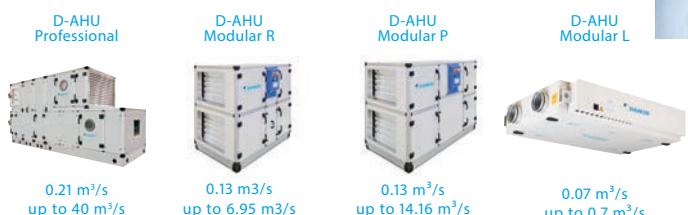
■ **ANDREW MITTON** is a chartered engineer and managing director at Proline



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# THE EDGE OF SPACE

The trend for decentralised data centres closer to end users, known as edge computing, is driving demand for smaller IT facilities near cities. FläktGroup's **Yan Evans** describes the cooling strategies being adopted

**"Regional facilities help cache data closer to the end users and the devices sending or creating it"**

Major technology trends, such as the Internet of Things (IoT) and mobile data growth, are placing new demands on existing infrastructure that, increasingly, require a massive shift in how computing resource is delivered.

It is estimated that global data centre IP traffic will grow three-fold over the next five years. This will increase the computing load on the cloud and create challenges – such as latency and bandwidth demand – that are compounded by the physical distance between connected devices and data centres. In response, operators are turning to edge data centres, which are closer to the point at which data is requested.

Currently, around 10% of enterprise-generated data is created and processed outside a traditional data centre or cloud, but Gartner predicts this figure will reach 50% by 2022.

Edge computing serves as the decentralised extension of the campus, cellular and data centre networks, or the cloud. The key benefit of regional facilities is that they help to cache data closer to the end users and the connected devices sending or creating it, which improves real-time processing and frees up bandwidth. The problem is that edge premises are often based in comparatively old, redundant, commercial spaces, so it can be difficult to manage the climate and ensure the correct conditions for optimal performance of the servers.

However, new technology solutions are available that overcome many of these issues.

Edge data centres are typically turnkey IT solutions comprising enough server racks to meet the requirements of the companies running them. The components for cooling, power supply, monitoring and security are often pre-installed and integrated – so an edge data centre can be created very quickly.

Any cooling system deployed for this environment must ensure a constant, suitable temperature throughout the data centre, 24 hours a day, alleviating the risk of downtime and allowing access to the stored data whenever it is needed.

The use of electronically commutated (EC) fans in indoor and outdoor units, together with speed-controlled refrigeration compressors, means that energy efficiency is much greater when operating at less than the design load. For this reason, it is recommended to keep any backup systems online, which not only provides 'hot' standby, but also ensures extra units earn their keep by »

- » reducing energy consumption to a minimum.

Data centres on the edge need to be flexible enough to scale up to meet demand, increasing capacity in stages as further customers sign up. As a result, they are set up to be dynamic, to meet changing requirements. Should need increase in a particular area of the country, for example, the operator will simply shift stock IT hardware to the relevant sites to process data in a suitable location. This also alleviates oversupply of equipment to quieter locations.

Because servers are often moved from site to site quickly, it is important to have a cooling solution that can be fully operational in a short space of time. Ones with large amounts of fixed site infrastructure are largely inappropriate for edge data centres. Instead, modular solutions that can be scaled up or down easily should be considered.

Cooling technology that can be installed or modified quickly, and at low cost, is also required for flexibility. Close control units that require only a single set of small-bore refrigeration pipework between the indoor and outdoor equipment – similar in size to a domestic central heating system – are a good example.

**"With operating costs a major consideration for edge facilities, new technologies can lower energy bills dramatically"**

Smaller edge data centres typically have fewer people working on site to manage operations, so systems must run as independently and reliably as possible. When it comes to cooling, this means many operators turn to direct expansion (DX) close-control units, which use refrigerant as a medium to transport heat generated in the data centre to outside. These innovative solutions offer inverter compressors and EC fans for accurate control with minimum consumption. Advanced controls also allow for smart functionality, such as running redundancy, interface integration and sensor averaging, along with the ability to record up to 28 days of events and alarm history.

Not only is this option cost-effective, but it also offers the best resilience, as every close control unit has its own pipework and condenser. What's more, installation and commissioning is simple, with minimum plant space required. Operators can save time by opting for fully packaged solutions, with



Servers in edge data centres often have to be moved from site to site quickly

factory-tested units with all refrigeration components, free cooling pumps and controls.

Products that offer simple servicing and maintenance are also attractive to edge data centre managers. Solutions with user-friendly touchscreen controls make servicing a relatively easy task that can be carried out by any competent maintenance contractor.

### Energy efficiency

A major advantage of edge data centres is that the latest cooling technology can be deployed, even if they are installed in existing premises. With operating costs a major consideration for edge facilities, new technologies can lower energy bills dramatically. For example, today, an assumed electricity cost of £0.115 per kWh means that every kW saved can be worth a £1,000 per year reduction in energy costs.

A legacy DX system with no free cooling might use 50kW to cool a load of 100kW, with a resultant annual energy bill of £50,000. Replacing this with a modern DX system using inverter compressors and EC fans, both indoor and outdoor, would cut this cost to around £25,000, paying for itself within three years. Incorporating indirect free cooling into the system cuts the energy consumption even further, to around £10,000, giving a return on investment of around two years.

Edge data centres are often characterised by a lack of space. Building engineers must consider the area a cooling system needs and explore alternative cooling methods to ensure valuable space is reserved for IT power. Enough room also needs to be ensured for maintenance without sacrificing footprint for server racks and IT equipment. Often, using the smallest quantity of highest capacity units is not the best solution.

It's also essential to remember that sufficient outdoor areas should be allocated for the external units of a cooling system. If outdoor space is limited, then compact solutions – such as a hybrid unit – are available. These combine both the condenser and free-cooling dry cooler for heat rejection.

Although slightly less efficient than having separate systems, this option is often chosen when external space is at a premium, as it takes up no more room than a system without free-cooling.

There are many issues that are unique to setting up edge data centres, but advances in cooling technology can help to overcome challenges around reliability, efficiency, scalability and space. Adopting a flexible, modular approach to cooling technology can ensure a site runs effectively by delivering the availability and performance that is essential to modern-day computing. **CI**

■ **YAN EVANS** is global director of data centre solutions at FläktGroup

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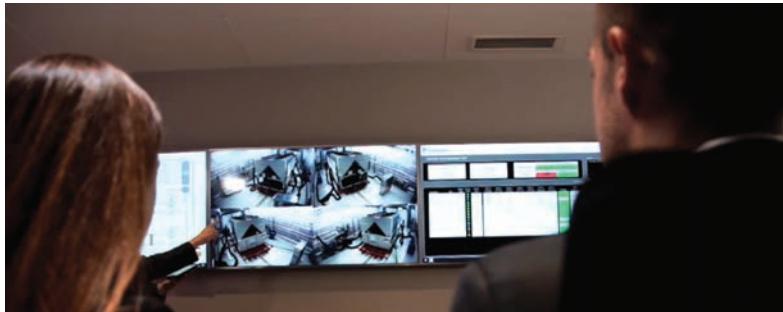
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FINALIST



# Daikin Applied opens European test centre



## Climatic conditions can be set from cool European to hot Middle Eastern regions

Daikin Applied Europe now offers a witness-testing service for clients at its new climatic test chamber for cooling-specific applications.

The facility at Cecchina, near Rome, has been independently verified and accredited to test to EN 14511:2013, ISO 9614:2009 and other major recognised European and American HVACR industry standards. The climatic chamber has been approved by the Air Conditioning, Heating and Refrigeration Institute (AHRI).

Tests on air-cooled units for the Eurovent testing campaign are also being conducted in the Daikin facility.

The climatic chamber offers a testing environment with a diverse range of testable units. This includes air- or water-

cooled chillers of up to 2,000kW cooling capacity, supporting up to 30 fans. Three test stands dedicated solely to water-cooled chillers allow the testing of units in 2MW, 4MW or 11MW cooling capacities.

Climate conditions can be set from southern European conditions to colder northern regions, with temperatures as low as -15°C. Middle Eastern conditions can also be simulated, up to +52°C.

Combined with an extended voltage and frequency range, the breadth of configuration options offers the flexibility to simulate all applications in heating and cooling modes at full and part load.

The climatic chamber allows free cooling, heat recovery and heat pump tests, multipurpose 4-pipes to 6-pipes units and engineering-grade acoustic testing. The centre also offers testing for glycol-based cooling solutions.

It is available for use from October.

## IN BRIEF

### Carrier chillers cool Elizabeth Line

Carrier is supplying 15 air-cooled liquid chillers to cool new underground stations at Tottenham Court Road, Paddington, Woolwich and Farringdon.

To meet the strict fire prevention requirements, the chillers are equipped with zero halogen, low-smoke insulation and cables, and finished with specialist paint, all formulated to emit very limited smoke and/or fumes when exposed to heat or flame.

The chillers are based on rotary scroll compressors running on refrigerant R-410A, a quiet-running fan system, and microchannel condenser coil technology.

They are built on a heavy-gauge, galvanized steel frame, and safety features include low ambient head pressure control and high short-circuit current rating.

### Panasonic cools data centre in Belfast

A combination of Panasonic gas heat pump 3-pipe outdoor units, 2-pipe VRF outdoor units and VRF cassette indoor units have been installed to heat and cool the 12,100m<sup>2</sup>, three-storey Concentrix Customer Engagement Centre in Belfast.

As well as coping with cooling and humidity control demands at its data centre, the solution also ensured comfortable conditions for the site's 1,500 employees.

The design of the building, which has low ceiling heights on each floor, meant the team – including consultants Beattie Flannigan, mechanical contractors Harvey Group and installers Aircon Sales and Service – used more indoor units operating at lower capacities. The gas-driven engine system supplies close to 1.2MW of cooling, using 20kW-25kW of electrical input.

### New appointment at Weatherite

Weatherite Air Conditioning has appointed David Garvey to the role of business development manager. Garvey will manage the company's HVAC product range, and will be responsible for identifying and leading strategic business development for the contractor side of the business.

Before joining Weatherite, Garvey worked at Nortek Global HVAC Group for almost 20 years, where he was responsible for the organisation's top 12 customers in the UK, managing both internal and external relationships at all levels.



## KFC gets timely upgrade with heat-recovery air conditioning

Transforming a Burger King fast food outlet into a KFC may sound like a straightforward task, but the recent project in Banbury, Oxfordshire, demonstrated that a restaurant refurbishment requires more than just a change of menu.

The building's standard split-type air-conditioning system was replaced with a VRF heat-recovery system from Mitsubishi Electric, which offers simultaneous heating and cooling, distributing surplus heat from cooling operations to other areas of the building when – and where – required. Waste heat from cold room equipment can be recovered and put to use elsewhere, said Kevin Gregory, contracts manager at mechanical contractor Kinlochs and Son Limited (KSL).

Gregory said: 'During the summer months, the air curtain will deliver cool air and stop insects from entering the premises – a major consideration for food outlets.'

Featuring a BC controller for 'intelligent' decision-making, the system could reduce energy consumption by up to 30%.



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Power/Industrial Plants

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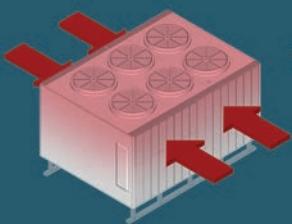
## How **EcoMesh** works

**EcoMesh**'s unique design harnesses two natural cooling effects.

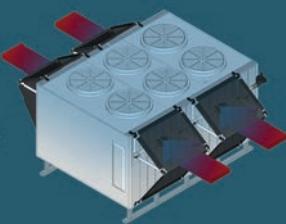
By regulating the spray of a fine water mist onto the mesh we can adjust the adiabatic cooling properties of the **EcoMesh** system. This can cool the ambient air by as much as 28°C (82°F).

Coupled with this is the shade provided by the mesh itself instantly reducing the solar radiation impact. This can have a 3–8°C (37–46°F) cooling of the incoming air.

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# WHAT'S COOKING?

To ensure indoor air quality measurements in homes are accurate and repeatable, we need standards that clearly define sensor types, calibration methods, sampling frequency, averaging periods and measurement locations, says the University of Nottingham's **Benjamin Jones**

**I**ndoor air quality is a hot topic. After years of focusing on building energy demand, evidence now shows we are harming occupants of buildings by failing to control pollutants and emissions. There are so many pollutants, however, it is difficult to know which are the most dangerous or the most prevalent, and which should be targeted first.

Current standards specify minimum ventilation rates that are set for odour control and are assumed to minimise contaminant exposures – and, so, protect occupant health. Accordingly, there is a need for performance-based, health-centred indoor air quality (IAQ) metrics supported by our best knowledge of health effects. They must be measurable, achievable and have a positive impact on the physical health of occupants.

In Nottingham, we have been measuring particulate matter with a diameter of  $\leq 2.5\mu\text{m}$

(PM2.5) for years. The Air Infiltration and Ventilation Centre (AIVC) estimates that this is the most dangerous pollutant found in homes because they are prevalent and small enough to bypass biological defences, which links them to chronic respiratory and cardiovascular diseases and cancer. So it seems pragmatic to consider this pollutant first.

We've been measuring PM2.5 concentrations for several purposes in two locations. The first is a test chamber, where we have investigated known emitters, such as electronic cigarettes, aerosol deodorants, and cooking. We use the measurements to see how their emission rates change over time, perhaps as a function of some input – for example, adding a new ingredient to a frying pan. We used them to estimate the total mass of particles emitted, and to calculate an average emission rate that can be used to set minimum ventilation rates in buildings. The second location is the kitchen of houses,





» where sensors were placed to see what happens when occupants cook, and to see if extractor fans are used and if they work.

### Getting the measure on particulates

We use optical devices that sample every second and use the light-scattering method to detect the amount of laser light scattered by particles at 90 degrees. The degree of scattering varies according to particle density, size distribution, shape and refractive index, so particles of equal diameter and different origins have divergent degrees of scattering.

Optimal performance occurs when both the airflow rate through the device and the light scattering are calibrated. Our devices are factory calibrated using Arizona test dust defined by ISO 12103-1:2016 *Road vehicles – Test contaminants for filter evaluation – Part 1: Arizona test dust*. Measurements of PM2.5 require a calibration factor – a simple multiplier that scales a measurement to give a meaningful value.

A second device, known as a gravimetric sampler, is needed to obtain a calibration factor. It uses a pump to draw air through a PM2.5 impactor, which then moves the air through a convoluted path so the inertial and aerodynamic drag forces cause larger particles to collide with, and stick to, a greased plate – and a filter at a known airflow rate for a defined period of time. Filters are weighed before and after a sampling period under controlled environmental conditions described by EN 12341:2014 *Ambient air: Standard gravimetric measurement method for the determination of the PM10 or PM2.5 mass concentration of suspended particulate matter*. This ensures humidity does not affect the filter mass, which is important when the changes can be so small that their measurement requires a five-decimal-place balance located in a case to stop local air

movement vibrating it. The mean average particle concentration is determined from the sampling time, the increase in filter mass and the airflow rate. If the gravimetric and optical samplers are co-located and measured for the same period of time, their average concentrations can be compared.

At least three measurement periods are required for a calibration factor, which is determined from the linear regression through the origin of the mean concentrations measured by each device. Identical optical devices commonly have different calibration factors. We recently worked with the Netherlands Organisation for Applied Scientific Research, cooking four different meals six times each in a tightly controlled test kitchen. We found that each meal had a significantly different calibration factor, so it is not possible to use a single factor to represent all meals without introducing uncertainty. In addition, some optical devices are calibrated using polystyrene latex spheres, which have uniform size and light-refracting properties standardised by the US National Institute of Standards and Technology. A calibration factor obtained for a device calibrated using Arizona dust cannot be used by one calibrated using polystyrene latex spheres.

### Ensuring confidence in measurement

The need to measure PM2.5 in buildings is undeniable, but measuring them is challenging because the metric does not describe a physical or chemical component of the air, but is defined by the measurement method itself. These difficulties are reflected in the measurement uncertainty of  $\pm 25\%$  for PM2.5 required by the UK's Air



**"The need to measure PM2.5 in buildings is undeniable, but measuring them is challenging because the metric does not describe a physical or chemical component of the air, but is defined by the measurement method itself"**



The year systematic monitoring of PM2.5 concentrations in ambient air began in the UK

Quality Directive for ambient concentrations. It is set at  $\pm 15\%$  for most other pollutants.

Measuring PM2.5 without diagnostic guidelines will lead to the manipulation of measurement conditions and data to meet a benchmark. For example, an hourly spot measurement could lead to an elevated reading, perhaps attributable to poor mixing or the measurer's proximity to a source. To counteract this, many measurements could be made and the lowest taken; the data could be time averaged; or measurements could be made away from known sources, such as in the corners of rooms. Without requirements for measurement devices and their calibration, an optical device with a coarse resolution could be used to give leeway, and expert judgement could be used to apply a calibration factor of  $<<1$  without penalty.

So where should we look for guidance? PM2.5 concentrations in ambient air have been systematically monitored in the UK since 1987. For a gravimetric measurement to be used to demonstrate compliance against an air quality standard or norm, the measurement procedure must follow the Reference Method in EN 12341. It controls the design of: the gravimetric sampler (pipe work, filter holder, flow control system, leak tightness); the sampling period; the storage conditions of the filters; and the weighing facilities (balances and room) and procedures. In the US, these methods are enforced by a Federal Regulation.

Gravimetric measurements of PM2.5 concentrations are the most accurate because they directly record the acquired mass of particles on a filter over a known period of time, but they do not have the granularity to be a good diagnostic tool. Real-time optical devices can be used to measure ambient air, but they must demonstrate equivalence to the reference method, defined by EN 16450.

To ensure indoor measurements are accurate, precise and repeatable, we need standards that clearly define sensor types, calibration methods, resolution, sampling frequency, desired time averaging periods and measurement locations. They must also require adherence to the reference method and the demonstration of equivalence. Only then can we think about using indoor measurements for regulatory purposes – that is if we can agree on suitable IAQ performance metrics in the first place. [CJ](#)



The University of Nottingham's study investigated known emitters, such as electronic cigarettes, aerosol deodorants and cooking

For a fully referenced version of this article, see [bit.ly/CJSep18IAQ](http://bit.ly/CJSep18IAQ)

**DR BENJAMIN JONES** is assistant professor in the department of architecture and built environment at the University of Nottingham

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# CLEARING THE AIR

The Napier Shaw Prize for the most highly rated research paper published in *Bsert* in 2017 was awarded to *Development of a model for single-sided, wind-driven natural ventilation in buildings*. One of the authors, Junli Zhou, of Wuhan University of Technology, China, summarises it here

**N**atural ventilation is a simple method to improve indoor thermal comfort, maintain acceptable indoor air quality, and reduce energy consumption. It can be categorised into ventilation driven by the pressure of the wind and stack effect, or thermal-driven ventilation. It can be further classified into single-sided ventilation or cross-ventilation, which is often favoured for its larger potential air exchange. However, single-sided ventilation is still of great importance in building design.

To calculate the ventilation rate of single-sided ventilation in buildings, some empirical correlations that can give rapid estimations have been proposed in earlier studies. However, the major difficulty with those correlations is the prediction of the fluctuating ventilation rate when they are applied in the unsteady condition. This study aims to develop a model for predicting total flowrate of single-sided natural ventilation.

Computational fluid dynamics (CFD) is a useful tool for the prediction of air movement in ventilated spaces. Usually, it is used to investigate ventilation flows and is focused on the mean flow properties and fluctuating characteristics of flow. Two important issues provide challenges in the numerical simulation of natural ventilation. The first is determining suitable methods of turbulent numerical simulation and the second is the inflow turbulence boundary. (See panel, 'Turbulent simulation methods').

In the study, the large eddy simulation (LES) simulation and the

fluctuating velocity algorithm of spectral synthesiser are assumed to supply basic results to verify the validity of the model.

## Model development and validation

Wind-driven natural ventilation through a building consists of two components – a mean component driven by the mean pressure field at the ventilation openings, and a fluctuating component driven by the fluctuating pressures and unsteady flows around the openings. The mean component is likely to be dominant when there are a number of openings around the buildings, in regions of different wind-induced pressures. The fluctuating component is likely to be dominant when there is only one major opening on the building, or where all openings are in regions of similar pressure. The mean flowrate is approximately zero in the latter case, but not in the former.

The fluctuating flow is governed by three mechanisms: broadband ventilation, >>

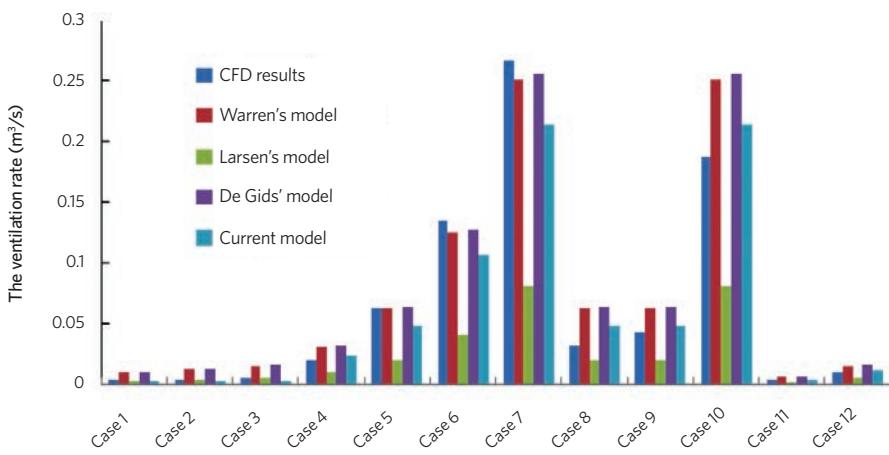


Figure 1: The ventilation rate calculated by CFD method, current model and other correlations

» pulsating flow, and eddy penetration. So the model developed in this investigation consists of four parts: (1) mean ventilation rate, (2) broadband ventilation rate, (3) pulsating flowrate, and (4) eddy penetration flowrate.

This project considered reach undertaken previously to consider single-sided ventilation, including that by Warren, De Gids and Phaff, and Larsen and Heiselberg (fully referenced in the original paper) and developed a new model to determine the flow through a ventilation opening.

In general, the mean wind velocity varies with time. The two-parameter Weibull distribution – which characterises the probability of a distribution – can be used to obtain the set of samples of the mean wind velocity. Then, the standard deviation value of the fluctuating component of mean wind velocity can be calculated, which is helpful for predicting the broadband ventilation rate. Moreover, a linear correlation was developed to calculate the mean and broadband ventilation rate, which can supply a quick estimate of the value.

The new model shows the total flowrate is predominantly caused by pulsating flow when the area of opening is small, but it is mainly caused by the mean flow in large openings. An opening ratio – the ratio of opening area to wall area – of 3% can be taken as a rough boundary to distinguish small and large openings based on the CFD study.

In the case of large openings, mean and broadband ventilation mechanisms should be counted together when the fluctuation component of mean wind velocity is large ( $\bar{V}_R/\sigma_v < \sqrt{2}$ ). On the contrary, only mean flowrate should be considered with small fluctuation of mean wind velocity ( $\bar{V}_R/\sigma_v \geq \sqrt{2}$ ) where  $\bar{V}_R$  is the mean wind velocity at reference height  $m\cdot s^{-1}$  and  $\sigma_v$  is the standard deviation of the wind speed.

The Reynolds Averaged Navier-Stoke (RANS) model, LES and other correlations have been used to validate the developed model. The results of the currently developed (new) method generally agree with those of transient simulation, as illustrated in Figure 1, above.

Simplified versions of the model were developed so that the average flow  $\bar{Q}$  and the standard deviation value of wind ventilation rate  $\sigma_Q$  can be determined by:

$$\bar{Q} = C_d \bar{U} \sqrt{C_p} (0.209h - 0.031) / z_{ref}^{1/2} \quad (h > 0.2 \text{ m}) \quad (2)$$

$$\sigma_Q = C_d \sigma_u \bar{U} \sqrt{C_p} (0.209h - 0.031) / z_{ref}^{1/2} \quad (h > 0.2 \text{ m}) \quad (3)$$

$C_d$  = discharge coefficient

$\bar{U}$  = mean wind velocity  $m\cdot s^{-1}$

$l$  = opening width, m

$C_p$  = wind pressure coefficient

$h$  = opening height, m

$z_{ref}$  = reference height, m

CFD simulation in this study shows that results at steady-state are generally less than those of transient simulation, and the steady-state results from large openings exhibit smaller relative difference than those from small openings. Therefore, steady-state simulation can be adopted to analyse single-sided ventilation with large openings if time for CFD analysis is limited, especially in the case of large openings.

It should be noted that the current model is derived with the opening located on the centre of the windward wall of the building, and it is assumed the wind direction is perpendicular to the plane of the opening. Therefore, the method to solve the mean plus broadband ventilation rate in other cases – such as other incidence angle of wind, other terrain and so on – should be explored in future studies. □

■ Dr Junli Zhou, Cheng Ye, Yan Hu, Dr Hassan Hemida, Prof Guoqiang Zhang, Dr Wei Yang, 'Development of a model for single-sided, wind-driven natural ventilation in buildings' can be read in the BSERT journal, which is free for CIBSE members at [www.cibse.org/knowledge](http://www.cibse.org/knowledge)

■ DR JUNLI ZHOU is from the School of Civil Engineering and Architecture, Wuhan University of Technology, China

**"Steady-state simulation can be adopted to analyse single-sided ventilation with large openings if time for CFD analysis is limited"**

## TURBULENT SIMULATION METHODS

Turbulent flows are commonplace in most real applications and are characterised by fluctuating velocities. CFD simulations use turbulent models to predict the development of turbulence. Three methods are usually considered:

■ The Reynolds-Averaged Navier-Stokes (RANS) equations govern the transport of the averaged flow quantities, with the whole range of the scales of turbulence being modelled. RANS-based modelling greatly reduces the required computational resource, and is widely adopted for practical engineering applications. RANS equations are often used to compute time-dependent flows, the unsteadiness of which may be externally imposed – for example, time-dependent boundary conditions or sources – or self-sustained, for example, vortex-shedding, flow instabilities.

■ Using the direct numerical simulation (DNS) approach, it is possible, in theory, to resolve directly the whole spectrum of turbulent scales. No modelling is needed in DNS. At high Reynolds numbers, the required resource becomes prohibitive.

■ In large eddy simulation (LES), large eddies are resolved directly, while small eddies are modelled. LES falls between DNS and RANS in terms of the fraction of the resolved scales.

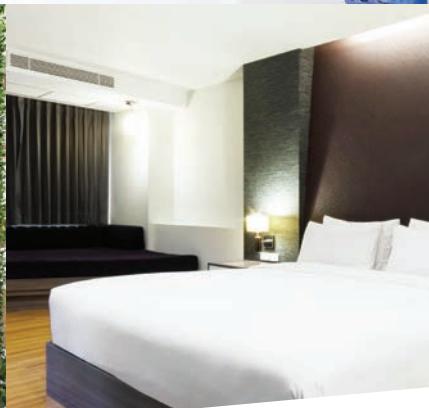
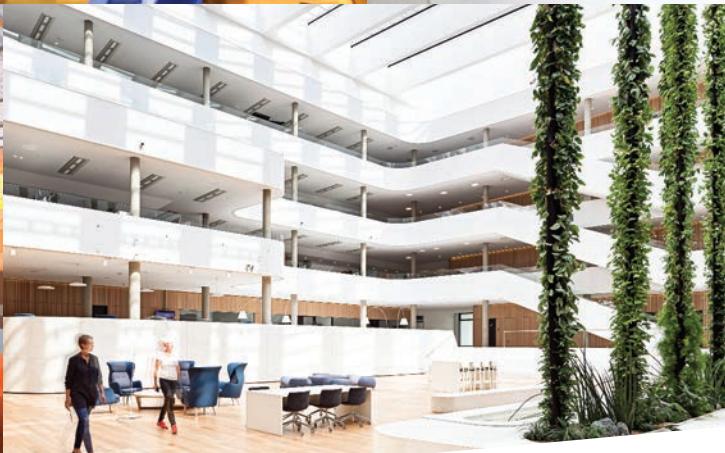


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# The fresh air now arriving at Waterloo Station ...

**Client:** Network Rail

**Project:** Network Rail Offices, Waterloo Station

Services Consultant: Hurley Palmer Flatt

Main Contractor: Spence Ltd.

Mechanical Services Contractor: Edge Design & Build Services Ltd.



The existing heating and cooling system was antiquated, out of date and inefficient. As part of the office refurbishment it was decided to strip out the existing LPHW and Chilled Water systems and upgrade the design at the same time.

The plans for the future use of the offices were for part of the building to be occupied by Network Rail and the rest to be lettable space. As a result, separate systems and components were required so that energy use could be monitored easily for the mixed use, as the existing central plant arrangement would not allow this.

The best alternative for the new systems was to go with separate EcoAirBox DX heat pump packaged air handling units, providing tempered fresh air to the rear of the DX fan coil units serving the different zones. This way, there was a definite demarcation between landlords and tenant's systems, with both parties being responsible for their own running and maintenance costs. The new packaged AHU's also had huge energy efficiency benefits. The innovative Molecular Sieve Sorption Thermal Wheels are able to provide increased heating and cooling recovery from a previous efficiency of 60% to a massive 78%. The hygroscopic wheel also incorporates moisture recovery, which enables cooling in the summer and heating in the winter. This not only takes some load off the compressors but eliminates the need for humidifiers.

Another significant benefit of using the EcoAirBox unit was that it comes complete with a fully integrated control system. One of the advantages of this is that it continually varies the speed of the thermal wheel to optimise heat transfer as efficiently as possible and to ensure that the correct humidity and temperature are maintained.

## Equipment Supplied:

**Unit 1A** Size 10 Unit Handling 0.63m<sup>3</sup>/s **Outdoor Sectional**

**Unit 1B** Size 40 Unit Handling 3.21m<sup>3</sup>/s **Outdoor Sectional**

**Unit 2** Size 50 Unit Handling 4.49m<sup>3</sup>/s **Indoor Flat Packed**

**Unit 3A** Size 20 Unit Handling 2.1m<sup>3</sup>/s **Outdoor Sectional**

**Unit 3B** Size 30 Unit Handling 3.09m<sup>3</sup>/s **Outdoor Sectional**

Regarding air filtration, EcoAirBox use as standard the F7 100% RH rigid bag, because it's 100% RH, it will not hold moisture and therefore will not freeze. This eliminates the need for a frost coil.

By providing all this in a packaged unit, contributed to cutting down on the footprint needed for the units and also the cost of separate components, installation time, split responsibility and of course, no requirement for LPHW or chilled water.

One of the benefits for the EcoAirBox unit was that the condenser fits in the extract and is not a separate standalone unit which saved external space and allowed some units to go inside.

Because of a number of physical constraints on the roads around Waterloo station, it was not possible to use a crane to hoist the units up to the roof. EcoAirBox were able to break the units down into sections small enough to fit in the lift. In one instance the unit had to be flat packed in order to reach its final location. In all instances EcoAirBox's own staff reassembled the units on site.



British manufacturing at its best

**S**ince its inception in 1978, the Indoor Air conference has been a multidisciplinary event allowing researchers and professionals to share their experience in indoor air science. This year, it attracted around 850 people, including sponsors and exhibitors – mainly companies focusing on analytical tools for indoor environments – as well as the US Environmental Protection Agency.

Held in July, at Drexel University in Philadelphia, USA, the event was led by conference president Michael Warring, assisted by Brent Stephens, of Illinois Institute of Technology, and Bill Nazaroff, of University of California, Berkeley. There were 674 conference papers on various topics around 10 themes: concentrations and exposure; sources and emissions; chemistry and transformations; air cleaning and filtration; ventilation and HVAC systems; building simulation and CFD; microbiology and dampness; health effects and epidemiology; comfort, productivity, and perception; and energy, climate change and policy.

There were up to nine parallel sessions on each of the five days, starting with 'Aerosols: life as Pig-Pen, immersed in a cloud of particles and microbes'. This session presented cutting-edge research that uses a robot baby to measure levels of pollutants inhaled by infants. It found that fungal and bacteria levels inhaled by infants during crawling can be between eight and 21 times higher than those inhaled by seated adults in the same room (Hyytiäinen et al, 2018). During the session, data on how human clothes act as sinks for pollutants was investigated. The research also demonstrated that, when walking, people might

be exposed to two and a half times more emissions than during seated activities (Licina et al, 2016).

This topic was followed by Paweł Wargoński's proposal on minimum ventilation rates for healthy buildings. The HealthVent project proposed a mix of source control, labelling and a minimum ventilation rate of 4 litres/person per second to ensure healthy homes. This rate was defined for a specific building, when pollutants exposure meets World Health Organization (WHO) air quality guidelines through source control. This base ventilation rate was intended to dilute and exhaust occupant bioeffluents.

There was much debate throughout the conference about optimal ventilation rates based on a variety of factors. However, its general theme indicated that more ventilation and air-changes per hour were equivalent to better health and human performance. This was illustrated by Shelly Miller, who presented data on 200 US homes where airtightness, weather data, questionnaires, lung-function testing and walkthroughs were conducted.

She hypothesised that when a building is retrofitted, the air change rate (ACH) decreases, so indoor air quality suffers. The research – for which the American Thoracic Society's international study of asthma and allergies in childhood (Isaac) survey was used – demonstrated that higher ACH offers better lung capacity and performance.

The next talk included some early results from House Observations of Microbial and Environmental Chemistry (HOMEChem), a collaboration between 13 US and Canadian universities and more than 60 onsite researchers, using 30 instruments. The project is based in a test house in Texas, where a team of researchers focuses on the influence of cooking, cleaning, occupation and personal care products on the indoor environment.

The team analyses the indoor atmosphere in detail, and the first glimpse of results offered some interesting data on the effect that cooking has on indoor air. They showed particulate matter (PM)2.5 and PM10 could reach values of 200–400  $\mu\text{g}\cdot\text{m}^{-3}$  during cooking of Thanksgiving turkey

# CLEAN BILL OF HEALTH

The US Indoor Air 2018 conference had a strong focus on occupant health and productivity, as UCL's Dzhordzhio Naldzhiev found out



Indoor Air was held in Philadelphia

and gravy, with a WHO guideline value of  $25\mu\text{g}\cdot\text{m}^{-3}$ . In addition, the indoor environment had up to 6,000ppm of CO<sub>2</sub> during cooking. A lot of data and research will be produced by HOMEChem, and it will be interesting to see how applicable the data would be on a larger dataset, rather than the single case study.

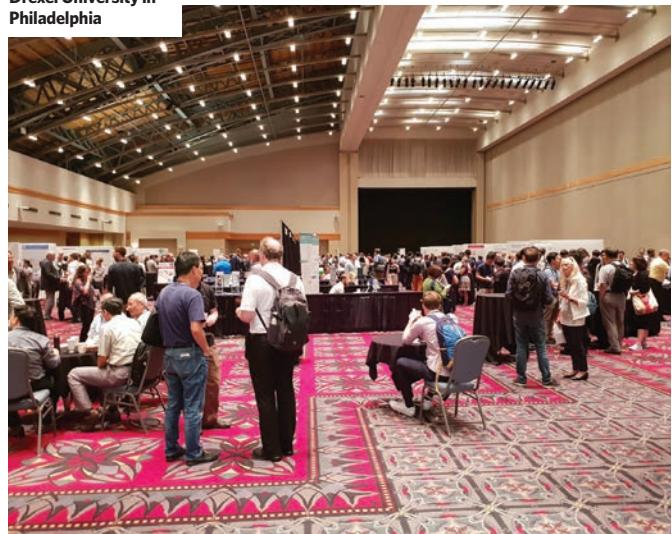
The next session focused on the theory, application and case studies for smart ventilation. Susan Doll talked about an alternative ventilation strategy using programmable exhaust fan controllers. She argued that continuous ventilation is better for particles while programmable ventilation is better for total volatile organic compounds (TVOCs), formaldehyde, or a specific type of contaminant.

A student working with Junseok Park, from the Hanyang University in Seoul, South Korea, presented data that focused on flush-out techniques – a sudden increase in the ventilation rate for a limited period – for reducing VOCs in new-build residential buildings. The case study involved testing various ventilation strategies in eight flats,

## "PM2.5 and PM10 could reach values of $200\text{-}400\mu\text{g}\cdot\text{m}^{-3}$ during cooking of the Thanksgiving turkey and gravy"



More than 800 people arrived at Drexel University in Philadelphia



using three flush-out methods: MVHR, fume hood and a new prototype. They found that, when using flush-out techniques, VOCs and formaldehyde are generally reduced. However, the implications on energy costs and the long-term sustainability of this method as an efficient indoor air-quality control environment needs further investigation.

Linking varying internal conditions, Gail Brager argued that we need fluctuation in temperature for people to feel pleasurable conditions, rather than neutral. Data shows changes in thermal pleasure have a neurophysiological basis as skin temperature changes and it might drive thermal pleasure as fluctuations in temperature occur from hot to cold, or vice versa. Tanabe and Kimura (1994), and Zhao and Li (2004), have found that thermal comfort can be achieved with lower – but variable – air speed compared to constant airflow.

Transitioning from airflow to modelling, Xudong Yang, from Tsinghua University, concluded that indoor energy simulations are much closer at predicting reality than the IAQ modelling, because the latter is more complex and underdeveloped. He argued that models must be verified by experimental data. Validation for modelling long-term results needs significant effort, time and resources.

The test period was two and a half years, and is still ongoing. There was a significant variation between seasons, and formaldehyde emissions from the materials in the room decreased yearly. Good correlation was found between temperature and emissions. However, relative humidity had very little impact on the emission rate.

A common trend among participants was the focus on people rather than buildings. Running costs for business staff are two to 20 times higher than energy bills, so researchers are interested in increasing productivity, which may mitigate possible additional energy costs.

Energy bills (for research in developed countries) are almost of secondary interest compared to the effect of building and environmental conditions on productivity and health. There is very limited research in this area and universities are slowly starting to fill this gap. However, the effects of global warming are now noticeably changing the external environment and having a detrimental effect on the building stock, such as driving overheating problems.

If the focus is productivity, the increase in energy use and respective carbon costs associated with keeping optimal internal conditions might have a significant negative impact on the already worsening changing climate. It is crucial that passive design is complemented by efficient active services, rather than overly relying on either option, the conference was told.

A take-home message from the conference was that design must focus on local conditions to deliver efficient and healthy buildings. It is essential all factors are taken into account when strategies are developed for new-builds, or when existing buildings are retrofitted, to improve our lives and limit the negative effect on our planet. **CJ**

**DZHORDZHI NALDZHIEV** is a doctoral researcher at University College London Institute for Environmental Design and Engineering, and director at Consultergy, a consultancy promoting building for performance, comfort and wellbeing



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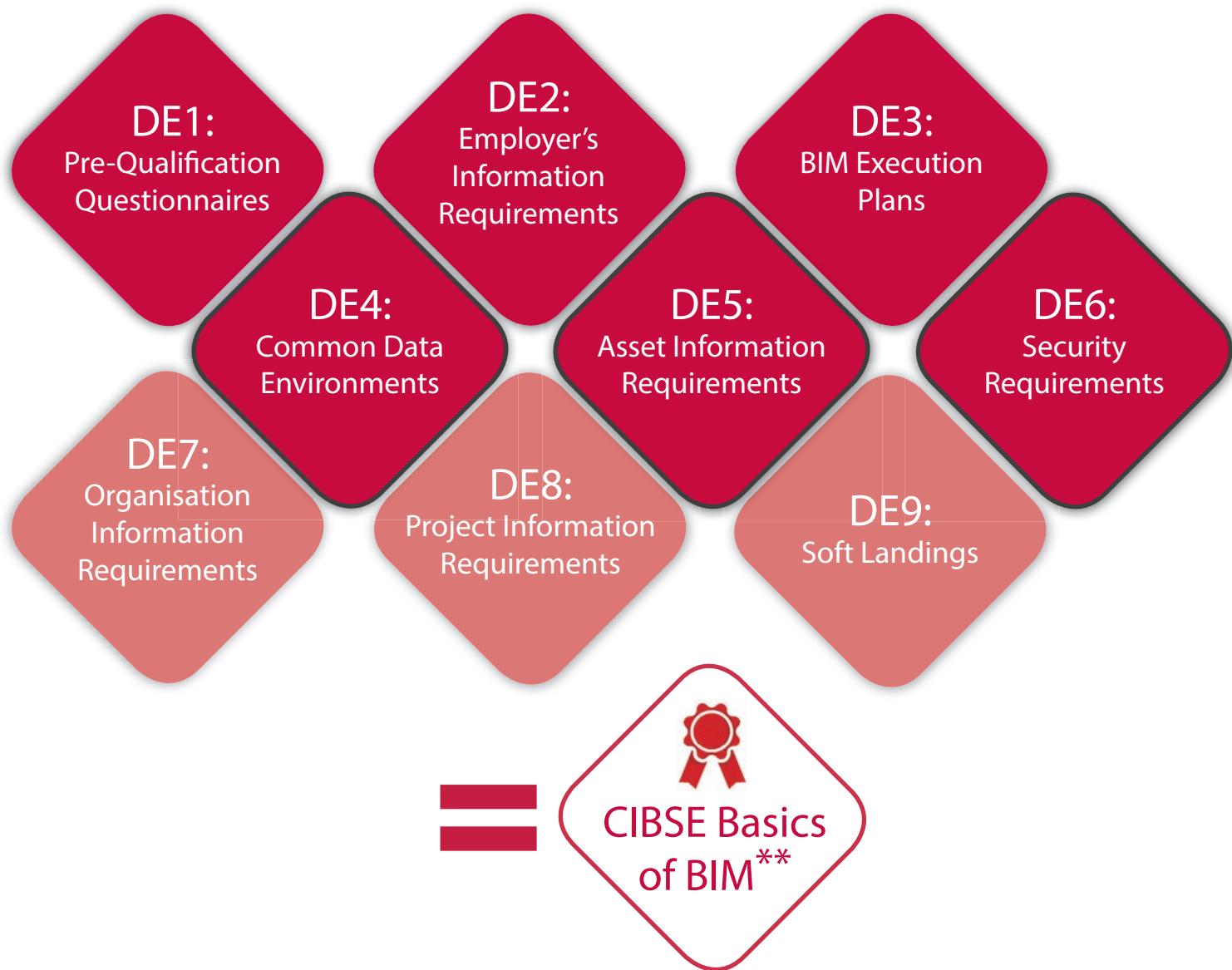
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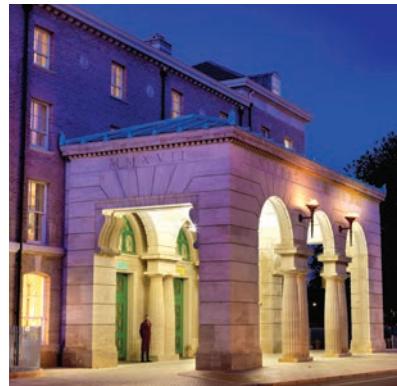


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University Arms  
Hotel entrance  
lobby, and  
exterior (inset)



Cambridge's University Arms Hotel refurbishment had to accommodate a complex heat recovery retrofit in the constrained building, covered by planning restrictions, as Nuaire's **Andrew Bott** explains

# RESTORING A PEDIGREE

**T**he University Arms Hotel in Cambridge opened in 1834 as the city's first hotel. Since then, it has undergone extensive redevelopments in 1891, 1900, 1925 and, finally, in the 1960s, when the original Regency section along Regent Street was demolished and replaced with a discordant structure typical of the period. The hotel has now reopened after an £80m transformation, which combined a complex heat recovery retrofit with a sympathetic restoration scheme.

The redevelopment is a collaboration between architect John Simpson – who oversaw the replacement of the 1960s extension – and interior designer Martin Brudnizki.

The process of designing the ventilation strategy for the hotel began in 2013 and the final design was completed by Johns Slater & Haward engineer Colin Bowen in 2016.

The overriding intention of the M&E design was to make significant improvements to the energy efficiency of the existing building fabric – a challenge

considering much of the façade and the original floor levels had been retained, bringing with them the usual problems associated with older buildings.

The importance of indoor air quality in delivering high levels of occupant comfort, including a good night's sleep, led the design team to introduce mechanical supply and extract ventilation with heat recovery to every bedroom.

Retrofitting a full heat recovery system presented a complex range of challenges. Getting ductwork to 192 bedrooms through limited ceiling voids across levels that do not line up laterally, and down risers that do not stack vertically, was complicated enough, but connecting the VRV refrigerant pipework to 192 fan coil units and the usual water system pipework – made complicated seem impossible.

## Engineering challenge

Bowen opted for a central plant solution, and turned to Nuaire for help in designing the air handling units (AHUs).

Every dimension on the roof was constrained. In plan view, the available roof space was restricted to a small plant area above the new-build section, with much of the early roofline protected by planning, including the iconic copper turrets. The height dimension was equally pressured as the new roofline is visible from Parker's Piece,

»

- » Cambridge's historic park, and planning restricted the visibility of plant equipment.

Two bespoke AHUs, serving a total of  $4.4\text{m}^3\cdot\text{s}^{-1}$  of fresh filtered air to the bedrooms, split west and east, were used. Thermal wheels were used to provide the heat recovery mechanism, and purge sectors were applied to prevent cross-contamination of exhaust air onto the supply.

The design team worked in millimetre intervals to squeeze the maximum air volume out of each AHU, the largest of which has a supply and extract rate of  $2.9\text{m}^3\cdot\text{s}^{-1}$  with a unit height of just 2,222mm.

Johns Slater & Haward designed an innovative ductwork solution to avoid 'crossovers', protecting the corridor ceiling heights, an architecturally stunning feature. Splitting the supply air into two smaller ducts running either side of a larger central extract duct allowed the extract connections to pass over the supply, eliminating the need to cross large ducts.

This unlocked many other engineering challenges, allowing the design team to think laterally. By separating ventilation ducts and other services onto alternating floors, space was created for the water pipes and refrigerant connections. A void containing air conditioning pipes and wet services on one floor, serving 'above and below', meant the next floor up had a free void for ventilation ducts, again serving the upper and lower levels. This pattern was repeated on the next two storeys creating alternate layers of vent ducts or pipes.

The challenge with any central plant solution – especially one as complicated as this – is routing and concealing the large distribution ducts serving the many risers. The decision was taken to raise the existing roof level to the highly sensitive Parker's Piece elevation to accommodate the lateral run. This move, coupled with the compact unit design, helped conceal all plant services from sight, and preserve the visual detail of the eastern façade.

### Invisible heat recovery

A former winner of the CIBSE Energy-Saving Product of the Year, the manufacturer's heat recovery units were selected to serve the other public spaces, including the library and bar areas, ensuring energy efficiency was protected throughout the building.

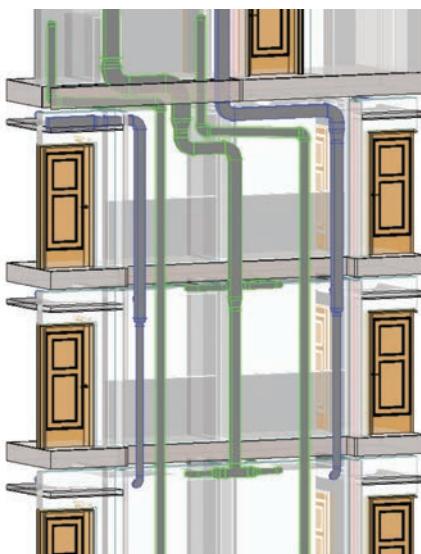
The low breakout noise units safeguarded the acoustically sensitive bedrooms located near to the lightwells, in which they were installed. Here, controls were deployed to ensure the lowest possible energy consumption by linking air volumes directly to occupancy – or indoor air quality – demands.

The extract fans, serving the main – and finishing kitchen – areas, were vertically mounted in a faux chimney stack, constructed in the lightwell, terminating in roof level vents disguised as chimney pots.

The architectural design, beautiful interiors and elegant solutions to the complex engineering challenges presented by this iconic building refurbishment make this one of the most interesting and rewarding projects to have worked on. **CJ**

■ **ANDREW BOTT** is regional sales engineer at Nuaire

**"Getting ductwork to 192 bedrooms through limited ceiling voids across levels that do not line up laterally, and down risers that did not stack vertically, was complicated"**



Vertical duct arrangement (left), and bar interior (above)



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# RINNAI HOT WATER DELIVERY – PAY AS YOU GO HEATING



Jennifer Williams looks at how continuous flow hot water delivery systems are fast overtaking the old technology of heating and storing water ready use.

Reports from the market on hot water heating system delivery in the commercial sector are showing a transition away from older technologies, which commonly use large volumes of cylinder stored and reheated hot water, are reaching a 'tipping point' with continuous flow units vastly out-perform them in terms of capital costing, economy of fuel, plant room space and lifetime efficiency.

Each family is said to use 80 litres of hot water daily and the older technologies employed by traditional means of stored hot water heating systems are increasingly unable to economically and sustainably meet these market demands. Stored types of systems feature an insulated cylinder or container that keeps large quantities of water heated by either a boiler or immersion heater, and reheated when temperatures drop below a useable temperature. Thus, when there is demand, stored water is released and used, and then the cylinder refilled and reheated to remain at optimum temperatures (above 60°C) until next use.

The market today requires and expects instant access to hot water, and in most domestic and light commercial applications there is no need for an inefficient system that can have a significant lag in recovery time to fully reheated water reserves. The major claimed benefits of storage systems lie in large commercial applications, such as a gyms or hotels, which need very large volumes of water at peak times – however, this can be easily accommodated by using a cascade system of continuous flow units.

According to an AECOM independent study (AECOM is the largest building services consultancy in the world) the life cycle costings of continuous flow systems in comparison to equivalent storage systems, on average a 'continuous flow water heating system can be up to 7% more economical.' At 89% efficiency on average, a storage system will encounter heat loss and wasted energy - reheating at times when there is no demand, for example. A continuous flow unit will maintain an efficiency level of 96%, increasing the returns on investment; or in other words, major savings on ongoing costs.

Continuous flow hot water delivery is disrupting the old ways with new ways of doing it better, faster and more economically.

The continuous flow units and systems offer heating efficiency, reliability, space saving, Legionella prevention and environmentally conscious Low NoX outputs - plus a Limescale Check system which ensures optimum performance throughout the life of the unit by constant monitoring and alerts for any buildup of lime-scale residue. Limescale can build exponentially if left and ignored, where a 1.6mm depth of limescale on a heat exchanger means a drop in efficiency of at least 12% - and a cut in the efficiency of any system means higher running costs.

'The payback investment over the 10 years-plus life of a single Rinnai unit can be measured and shown to out-perform cheaper and much less efficient water heaters in a matter of months,' adds Chris Goggin, Operations Director.



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## Continuous flow hot-water systems in commercial and institutional applications

This module considers the lifetime effectiveness of continuous flow hot-water systems

The heating and supply of wholesome domestic hot water (DHW) is fundamental to the successful operation of commercial and institutional buildings. As the thermal performance of the building envelope has improved to reduce space-heating loads, applications of heat recovery, solar thermal and heat-pump systems combined with passive and localised space-heating systems have increased. While providing excellent performance in maintaining the comfort temperature of the internal space, these are often not appropriate for the heating and supply of DHW in a safe and economical way. Continuous flow hot-water systems have evolved to meet that need, and are a mature technology that – in appropriate applications – have been shown to offer significant benefits over traditional indirect and storage DHW systems.

This CPD will draw and build on previous CPD articles in *CIBSE Journal* to consider the application of continuous flow hot-water systems, such as those in Figure 1.

As consumer demand becomes less uniform, the sizing of DHW systems that rely on storage to overcome the inability to meet peak demand is an increasingly challenging engineering task. The significant difference in using continuous flow gas water heaters (as described in the panel) is that – in their simplest form – there is no storage and the system will be designed to instantaneously meet peak hot-water loads. When drawing on mains water, continuous direct-fired hot-water heaters (such as that shown in Figure 2) are able to consistently operate in condensing mode. The low-temperature incoming mains water is well below the flue gas condensing temperature (around 57°C), so the heat exchangers in the unit can fully condense the water vapour in the products of combustion when taking water directly from the mains supply, which is typically below 10°C. The close control integrated into such systems is able to deliver a continuous flow of hot water at a set point temperature to ±1K.

### Legionella control

The UK Health and Safety Executive (HSE) advises<sup>1</sup> that the primary method used to control the risk from legionella is water temperature control. Where there are hot-water storage cylinders (calorifiers), water should be stored at 60°C or higher and distribution should be at 50°C (with local mixing at outlets to provide appropriate water temperatures). For continuous flow hot-water heating systems, there is inherently no storage and so no need to heat up a volume »

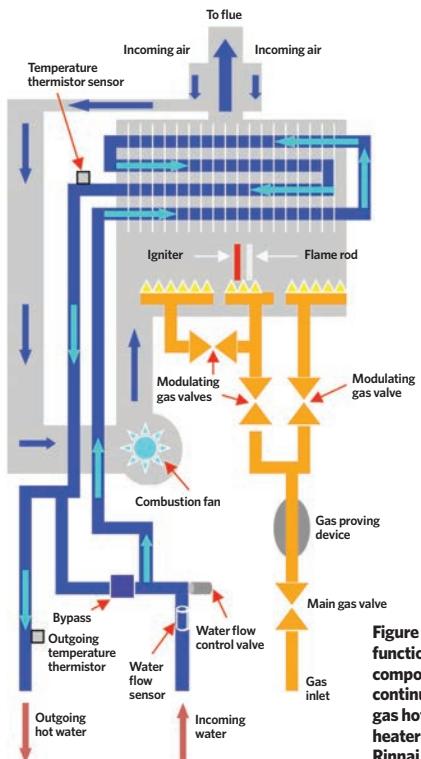


Figure 1: Example of a continuous flow cascade system, as installed in an institutional building (Source: Rinnai UK)

## THE OPERATION OF A CONTINUOUS FLOW GAS HOT-WATER HEATER

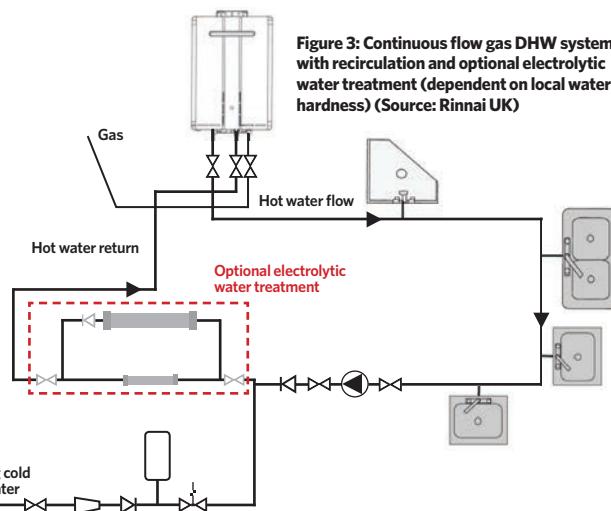
When the flowrate drawn by the hot-water system is sufficient (as sensed by the water-flow sensor) the main controller will initiate the ignition sequence. The fan then purges air through the combustion chamber and the flue (and the airflow is confirmed). A spark is established and the main and intermediate gas valves open. The resulting combustion is proved by the flame rod and the spark shuts down. The main controller constantly monitors the outlet water temperature, the temperature set point, and the volume of water passing through, and from these it can assess the heat requirement and modulate the three gas valves accordingly. The outgoing temperature sensor provides a signal at 150 times a second to ensure that the temperature can be closely controlled. If the demand on the system is too great for the heater to maintain temperature a water-flow control valve will operate to ensure the correct outgoing temperature is maintained.

There is no storage of water in the heater, and as soon as the demand for hot water changes or stops, the water heater will modulate – or halt – its output to suit. When there is no demand for hot water, the heater returns to standby, with the gas-control valve closed and the water-flow control valve reset to standby position, and freeze protection is activated as needed.



» of storage water to reduce legionella risk, as the cold-water feed to the heaters is direct from the wholesome main supply.

However, regardless of whether the hot water is provided by a continuous flow water heater, in larger systems where there is a need for recirculation pipework (as illustrated in Figure 3), there is inherently increased system water volume and opportunities for 'dead-legs'. The controls for continuous flow water systems can be programmed



to circulate water at 60°C (or above) when the building is unoccupied (for example, at weekends or at night) to supply thermal disinfection for legionella control in the distribution pipework. By the time of reoccupation, the temperature will be reduced to normal operating temperatures.

The hot-water system – particularly rarely used shower heads or terminal fittings – will still require regular checking and disinfection.

### Reduction and prevention of limescale

The UK Carbon Trust considers<sup>2</sup> that for each 1mm layer of limescale on the heat transfer surfaces there will be a 7% increase in energy input to the boiler to meet the same heat demand. Limescale will also give increased opportunity for the accumulation and growth of bacteria such as legionella. To maintain efficiency in continuous flow water heaters that draw untreated cold water direct from the mains, water treatment may be needed in areas that have hardness exceeding 150mgL<sup>-1</sup> of calcium carbonate (CaCO<sub>3</sub>). As the water that is being directly heated by the hot-water heater must maintain its wholesome nature, bulk chemical dosing is not appropriate. However, an electrolytic method can be successfully employed that uses a zinc sacrificial anode, enclosed in an inline cylindrical housing, which is incorporated in the incoming water supply (as shown in the dotted section of Figure 3). This doses the water with trace amounts of zinc (a few parts per billion) sufficient to alter the structure of any precipitating limescale from calcite to the much more soluble aragonite. The change in the shape of crystals reduces the adherence to surfaces as scale.

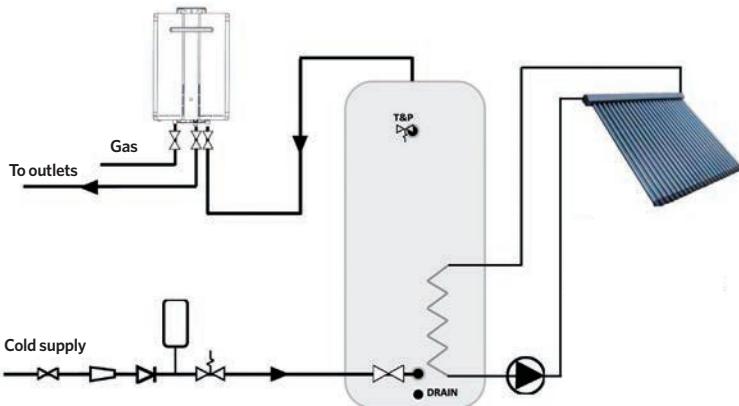
These systems are simple to install and require little space, they have practically no maintenance requirements and – having no need for salt or regeneration water – make the systems significantly cheaper to operate compared with other water-softening methods.

### Integrating continuous flow hot-water heaters with renewable heat sources

The integration of continuous flow hot-water systems with thermal stores of wholesome water can offer a closely controlled supply of hot water that can instantly increase the flow temperature of the stored water as required to meet the distribution needs. When the store is able to directly meet the required temperature, the hot-water heater will not fire.

So, for example, in Figure 4, if the stored water is at the required distribution set point because of the heat collected by the solar panels, when hot water is drawn off, the water from the store passes through the heater without it firing. If the cylinder is at a lower temperature, then the continuous flow water heater will fire to provide the required supply temperature (and will be limited to a maximum safe temperature) to meet the hot-water heating requirements, while optimising gas usage and maximising solar gains.

This thermal store can, of course, link in with other renewable heat sources.



**Figure 4:** Simplified schematic of a solar thermal collector and associated thermal store with continuous flow hot-water system (Source: Rinnai)

### Performance modelling

As detailed in the October 2016 and September 2017 CPD articles, modelling of example applications (undertaken by an independent third party) compared the lifetime benefit of operating continuous flow hot-water systems with that of more traditional options.

Different heating and hot-water supply scenarios were examined<sup>3</sup> for two student accommodation blocks, with a total of 643 occupants, to give comparative 20-year net present value (NPV) costs and equivalent carbon emissions, based on standard UK daily DHW usage data.<sup>4</sup>

#### Six systems variants were compared, including three with no storage of DHW:

- Gas boiler LTHW heating + gas continuous flow DHW
- Electric space heating + gas continuous flow DHW
- Air-source heat pump (ASHP) heating + gas continuous flow DHW.

#### Three included domestic hot water storage:

- Gas boiler LTHW heating + insulated storage calorifier (this was the base system)
- Electric space heating + electric DHW insulated storage calorifier
- ASHP heating + ASHP DHW + insulated storage calorifier

The demand for space heating was determined using a dynamic thermal model for a building that met current regulatory requirements, and applied the CIBSE Test Reference Year for London (TRY)<sup>5</sup> to the two student accommodation blocks. The base system – a modular gas boiler system, which was based on six modules each supplying 240kW, with a primary flow of 80°C and return of 50°C – can meet 37% of the hourly peak DHW load and work together with two 2,900L DHW calorifiers storing water at 65°C, with approximately 15kWh daily standing losses.

The insulated recirculating DHW distribution circuit was modelled as returning water at 55°C, and the heat loss from the pipework was seasonally adjusted for both water and ambient temperatures.

The analysis applied projected retail fuel costs and equivalent carbon emissions

factors for electricity and gas, based on UK government data.<sup>6</sup>

Figure 5 illustrates the NPV comparison on capital and operational costs, which – in this particular case – indicates that the systems need to be considered for at least five to 10 years before the life-cycle trend is clearly set.

On a smaller scale, an example was modelled<sup>7</sup> for a shower block in a holiday camp, with six showers and four basin taps, to establish the comparative performance of a continuous flow hot-water system with those of both a direct-fired storage option and a more traditional condensing gas boiler with storage cylinder.

The continuous flow system was based on four heavy-duty water heaters, each with a nominal output of 48kW – equating to around 14L per minute of hot water at 50K temperature rise (from 10°C to 60°C) and a gross thermal efficiency of 95%. The indirect-fired storage option was based on a pair of 40kW condensing natural gas boilers with a gross efficiency of 89%, heating a pair of 400L cylinders. The direct-fired storage option consisted of a pair of 230L cylinders with integral burners, each with around 37kW output and gross thermal efficiency assumed as 96%.

The model indicated that, in this scenario, the continuous flow system has the lowest 20-year NPV – 6% to 7% lower than the two storage systems.

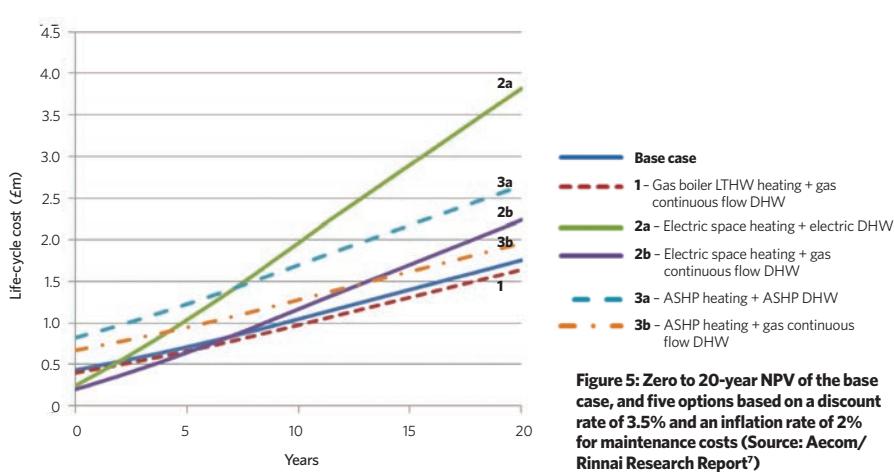
A further analysis was undertaken for the increasingly common application of a fast-food restaurant. Echoing common trends, the boiler used for the indirect-fired storage system was assumed to serve only the hot-water cylinder, as fast-food restaurants typically use heat pump systems to provide space conditioning. Using similar standard operational and efficiency assumptions as that of the previous example, the resulting NPVs again indicated that fuel consumption of the continuous flow system is around 6% to 7% lower than the two example storage systems, based on that 20-year analysis period.

### Monitoring the performance of continuous flow hot-water heaters

The operation of such systems can be readily monitored through custom gateways feeding the operational state to building management systems (BMS) networks. This can allow remote access to live operational data from the water heaters, which can be used for data capture (for example, flowrates and delivery temperatures) and to trigger appropriate planned maintenance or signal the need for servicing if any appliance suffers from a fault.

© Tim Dwyer, 2018.

■ Turn to page 86 for further reading and references. ➤



**Figure 5:** Zero to 20-year NPV of the base case, and five options based on a discount rate of 3.5% and an inflation rate of 2% for maintenance costs (Source: Aecom/Rinnai Research Report<sup>7</sup>)

# » Module 131

September 2018

**1. What is the rate of outgoing temperature measurements in the continuous flow gas hot-water heater, as described in this article?**

- A 50 per second
- B 100 per second
- C 150 per second
- D 200 per second
- E 250 per second

**2. What is the minimum temperature required to control the risk of legionella accumulation?**

- A 30°C
- B 40°C
- C 50°C
- D 60°C
- E 70°C

**3. What does the Carbon Trust suggest as the increase in energy use for a boiler that has a 1mm layer of limescale on its heat exchange surfaces?**

- A 1%
- B 3%
- C 5%
- D 7%
- E 9%

**4. In the sketch of the system integrating the solar thermal collector, which one of the following is most likely to be true?**

- A The wholesome cold water makeup passes directly through the solar thermal collector
- B The pump is being used to pressurise the hot-water distribution system
- C The available pressure in the mains cold supply moves the water through the thermal store, the continuous flow gas hot-water heater and onwards to the outlets
- D The continuous flow gas hot-water heater will only be used during the winter months
- E The hot water is unlikely to be wholesome

**5. In the specific example comparing the application of six hot-water systems, what length of time was needed before the NPV of option 1 became the cheapest option?**

- A One to two years
- B At least five years
- C Approximately six to seven years
- D At least 10 years
- E 20 years

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### Further reading:

The comparison of the systems in this article is based on the output of the independent study undertaken by Aecom on behalf of Rinnai. For more information on the full report, email [info@rinnaiuk.com](mailto:info@rinnaiuk.com)

### References:

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- 6 Data available at [www.gov.uk/government/publications/crc-conversion-factors](http://www.gov.uk/government/publications/crc-conversion-factors) – accessed 10 July 2018.
- 7 *Life-cycle study of continuous flow water heating* – report for Rinnai UK by Aecom, 2016 (available by request from Rinnai – [www.rinnaiuk.com](http://www.rinnaiuk.com)).



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# PRODUCTS & SERVICES

## UfAC services upgrade for The Bond Works, Farringdon Road ▾

AET Flexible Space has completed a major upgrade of the underfloor air conditioning system at The Bond Works, a historic building in the Clerkenwell area of London, that previously underwent a full redevelopment in 2007 by a group of private investors.

As part of the recent works, AET Flexible Space was successful in its bid to upgrade the existing downflow unit controls and replace all fan terminals on the six refurbished floors with AET Fantiles.

■ Call 01342 310 400 or email [aet@flexiblespace.com](mailto:aet@flexiblespace.com)



## NBT signals expansion as woodfibre insulation market heats up ▾

NBT, UK supplier of the Pavatex woodfibre insulation range, has responded to growing demand for natural, breathable insulation materials by expanding its team with the appointment of sales manager Phil Griffiths.

NBT has been instrumental in raising awareness of the benefits of renewable insulation materials among housebuilders, specifiers and contractors, demonstrating the thermal performance and building comfort of breathable systems for both new-build and retrofit installations.

Griffiths is part of a planned expansion at NBT and he brings 28 years of sales experience in the construction sector, including roles with British Gypsum and Saint Gobain. He also spent seven years at insulated concrete formwork (ICF) specialist Integraspec and has excellent technical understanding of modern methods of construction and specification challenges. He will work alongside the technical expertise of the company's building physicists.

■ Visit [www.natural-building.co.uk/](http://www.natural-building.co.uk/)



## Sporting spotlight is back on Glasgow ▾

The spotlight was once again on Glasgow when it hosted the European Championships this year. The competition, in which 4,500 athletes took part, was split between two cities – Glasgow, which hosted the aquatics, rowing, gymnastics, cycling, triathlon and golf, and Berlin, hosting the athletics.

The only 50m pool in Glasgow, Tollcross Park, had already held swimming and aquatic events four years ago and underwent a major refurbishment pre-Commonwealth Games. This saw the addition of a six-lane 50m second pool. Grundfos Pumps

was involved from the earliest stages and supplied all the pumps required for the upgrade.

The Sir Chris Hoy Velodrome in the east end of Glasgow staged the cycling during the championships. The pump solutions supplied by Grundfos delivered the HVAC needs to these venues, as well as ensuring all water-boosting requirements were met, regardless of demand. Additionally, Grundfos supplied the fire suppression system that kept this site safe and secure.

■ Visit [www.grundfos.co.uk](http://www.grundfos.co.uk)



## Viessmann's Christian Engelke elected MCS MCHP working group chair

Viessmann technical director Christian Engelke has been elected chair of the Microgeneration Certification Scheme (MCS) Micro CHP (MCHP) working group.

Viessmann has driven its Vitovvalor 300-P domestic fuel cell system through the MCS process over the past few years, and even became MCS-registered to undertake early product installations. The now MCS-listed product is supported by European PACE funding, covered by the government's feed-in-tariff, and 40 UK installers are trained to fit it.

■ Visit [www.viessmann.co.uk/](http://www.viessmann.co.uk/)

## Adveco Totem: ultra-low NO<sub>x</sub> CHP ▾

As concern over emissions increases, selection of the correct heating and hot-water system technology has never been more important.

With CO and NO<sub>x</sub> emissions below 12 mg/kWh, the Adveco Totem range of 10-25 kW m-CHP remains one of the greenest micro-cogeneration solutions on the UK market. Such low emission levels mean the Totem range is eligible for full Breeam credits under the revised (2018) POL02 criteria, within air quality management areas.

■ Call 01252 551 540, email [enquiries@adveco.co](mailto:enquiries@adveco.co) or visit [www.adveco.co/](http://www.adveco.co/)



## Elco introduces new range of network interface units

Elco Heating Solutions has introduced a new range of network interface units to satisfy the growing need for district/communal heating schemes. The redesigned Nexus range consists of 10 models, offering specifiers an extensive choice of products to suit the specific needs of a project.

To complement the new Nexus range, Elco has also introduced a comprehensive 56-page brochure, which offers design guidance, detailed schematics and drawings, plus full performance data for each model.

■ Visit [www.elco.co.uk](http://www.elco.co.uk)



## ▲ Professional specification service makes pump station selection simple

Aldermaston-based Pump Technology has a fully qualified civil engineer on hand to make this task easy for customers. Email your site drawings and a detailed specification for the job will be created.

The company specialises in manufacturing private Type 1 and Type 2 pumping stations. It will supply a technically accurate and commercially priced custom-designed solution, which will include either a standard or bespoke tank to meet your site requirements exactly.

■ Call 0118 9821 555 or visit [www.pumptechnology.co.uk](http://www.pumptechnology.co.uk)



## ▲ Sontay opens a new gateway

Sontay consistently offers its customers the best solutions for all applications and its new gateway products.

The SC-Gateways offer direct building management system integration for air conditioning units via the smart communication protocols, Modbus and BACnet, saving system integrators valuable time.

'The building controls industry is moving forward at a rapid pace with the focus on connectivity and interoperability,' said Sandy Damm, managing director at Sontay.

The SC-Gateways are ideal for expansion or retrofit projects, as well as for new build.

■ Email [sales@sontay.com](mailto:sales@sontay.com) or visit [www.sontay.com](http://www.sontay.com)

## ▼ Luceco LED lighting refurbishment for Blakemore Retail

Luceco has supplied more than 10,000 high-efficiency LED LuxPanels to Blakemore Retail stores throughout the UK as part of a lighting refurbishment rollout. Spar has more than 12,500 stores in 42 countries throughout the world, with more than 2,300 outlets in the UK.

Electrical and mechanical services contractor H E Barnes, from Sheffield, has installed LuxPanels delivering up to 50,000 hours of operational life with no maintenance or re-lamping requirements. This benefits the environment and is the ideal lighting solution for retail environments with high-volume operating hours.

Simple to install with remote 'plug and play' drivers, LuxPanels offer high-efficiency LED panels, which

have a frameless appearance and boast a market efficacy of 152 Llm/cW. They are available in DALI dimmable and emergency options.

Circular LuxPanels were installed in promotional areas, including branded fast food and delicatessen counters, such as Subway franchises, or where the architecture of the building or the shopfitting structure allowed for creative lighting.

■ Call 01952 238100, email [uk\\_sales@luceco.com](mailto:uk_sales@luceco.com) or visit [www.luceco.com](http://www.luceco.com)



## ErP – we are ready

Warm-air, radiant and heating products are now affected by European Regulations. Our ErP compliant range includes RTU (packaged heat pump air handlers). The RTU series is a range of packaged direct expansion (DX) air-source heat pumps and air conditioning units, showing compelling performance under EN 14511:2013 and EN 14825:2016 standards. These are equipped with EC plug fan technology and free-cooling as standard. Reznor's range of high-efficiency packaged rooftop units are available in cooling and heat pump modes.

■ Email [erp@nortek.com](mailto:erp@nortek.com) or visit [www.nortek-erp.com](http://www.nortek-erp.com)



## ▼ FläktGroup's new VAV range meets demand for controlled IAQ with ultrasound technology



With advanced airflow analysis based on ultrasound technology, FläktGroup has launched Optivent Ultra, which will offer customers simplified commissioning and installation, lowered life-cycle costs and comfort.

FläktGroup Optivent is the latest addition to its line of VAV dampers that has now been optimised with cutting-edge innovation. With the ultrasound technology, consultants, builders, property owners and construction companies can entirely avoid traditional risks and disadvantages found in VAV systems.

■ Visit [www.flaktgroup.com](http://www.flaktgroup.com)

## Wanner launches new, versatile high-flow pump

Extending its seal-free, packing-free product range, Wanner International has launched the Hydra-Cell G66, a new, powerful, positive-displacement, multiple-diaphragm pump capable of flow rates up to 249 litres per minute (65.7 US gpm) at pressures of up to 48 bar (700 psi).

The pumps are available with a choice of pump head materials, including brass, 316L stainless steel and polypropylene, making them suitable for pumping a wide range of liquids.

Simple, compact design reduces initial investment and lowers maintenance costs.

■ Visit [www.hydra-cell.eu](http://www.hydra-cell.eu)



## ▼ Red Dot recognises Ultra Quiet heat pump with design award



Mitsubishi Electric's Ultra Quiet Ecoden PUHZ-AA air-source heat pump range has been presented with the prestigious international Red Dot Award for Product Design, which recognises the highest levels of design quality.

The Ecoden units are designed to offer homes reliable, trouble-free renewable heating and hot water. The design of the new Ultra Quiet unit is highly compact, and the colour combination of white and anthracite exudes a simple yet elegant appeal, with the dark colour of the fan section underlining its unobtrusive design.

The Red Dot Award is judged by an international jury of nearly 40 experts, who said 'the design of this air-to-water outdoor unit has been thought out to the last detail. Its unobtrusive appearance easily blends into different types of buildings'.

The new design is not just about aesthetics though, every element of the unit is carefully manufactured to increase energy efficiency and decrease noise.

■ [www.red-dot.org](http://www.red-dot.org)



## ▲ Jason Fretwell heads up Hamworthy sales team

Hamworthy Heating welcomes Jason Fretwell, who spent the last 13 years at AO Smith, to oversee the sales team as sales director. He joins with almost 30 years of experience.

Fretwell started out early in his career in the HVAC sector. In 1989, he started as a pipefitter/welder apprentice, progressing to building services contractor at Woodward & Co. He is a member of the Society of Public Health Engineers where he sits on the Industrial Associates Committee.

■ Call 0120 662500, email [sales@hamworthy-heating.com](mailto:sales@hamworthy-heating.com) or visit [www.hamworthy-heating.com](http://www.hamworthy-heating.com)



## ▼ SAV adds value with AirMaster AM 150

The new AirMaster AM 150 smart ventilation unit from SAV Systems has been specially designed to offer efficient, draught-free, demand-controlled ventilation in relatively small spaces, such as offices with up to four occupants. The units are also fitted with adjustable inlet louvres to accommodate room layout.

The AirMaster AM 150 features contemporary styling, a facilitated ventilation unit and cooling module combination in a single unit, and the option to recess the unit into the ceiling void by up to 147mm.

■ Call 01483 771910, email [info@mail.sav-systems.com](mailto:info@mail.sav-systems.com) or visit [www.sav-systems.com](http://www.sav-systems.com)



## ▲ Powerful PLC control with the new mini Intuitive controller

Designed for use within demanding HVACR and BEMS applications, mini Intuitive TDB is a new powerful, compact PLC controller that can be used to control up to 560 points or devices. Using proven technology already found within the flagship Intuitive range, with an optional LCD screen, it delivers cost and space saving benefits. TDB, licence-free PLC software, comes built-in as standard, with the desktop editor tool available for free download via the RDM website.

■ Email [hello@resourcedm.com](mailto:hello@resourcedm.com) or visit [www.resourcedm.com](http://www.resourcedm.com)



## ◀ Rinnai hot water delivery – pay-as-you-go heating

Reports from the market on hot-water heating system delivery in the commercial sector are showing a transition away from older technologies, which commonly use large volumes of cylinder stored and reheated hot water. Instead customers are heading towards continuous-flow units that out-perform in terms of capital cost, economy of fuel, plantroom space and lifetime efficiency.

Each family is said to use 80 litres of hot water daily, and older technologies are increasingly unable to meet these demands economically and sustainably. These systems feature an insulated cylinder or container that keeps large quantities of water heated by either a boiler or immersion heater, and reheated when temperatures drop below a useable temperature. When there is demand, stored water is released and used, and then the cylinder refilled and reheated to remain at optimum temperatures (above 60°C) until next use. According to an independent Aecom study, on average a 'continuous-flow water heating system can be up to 7% more economical' compared with equivalent storage systems. A continuous-flow unit will maintain an efficiency level of 96%, increasing the returns on investment. 'The payback investment over the 10 years plus life of a single Rinnai unit can be measured and shown to out-perform cheaper and less efficient water heaters in a matter of months', says Chris Goggin, Rinnai operations director.

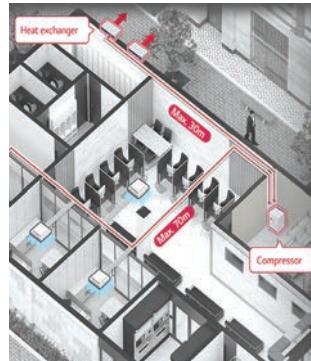
■ Visit [www.rinnaiuk.com](http://www.rinnaiuk.com)

## New LG split outdoor for indoor installation VRF system – Multi V M ▶

LG Electronics has continued its impressive 2018 with the launch of its new Multi V M – a split compressor and heat exchanger unit for indoor installation.

Multi V M is a hidden VRF system for complete indoor installation. It is available as a module-type installation with significant benefits. These include the provision of an increased freedom of design – additional structure or ceiling construction are not needed – and far easier maintenance because both the compressor and heat exchanger units are compact.

■ Email [uk.aircon@lge.com](mailto:uk.aircon@lge.com) or visit [partner.lge.com/uk](http://partner.lge.com/uk)



## ◀ Ventilation professional development

Getting a building's ventilation right is key to its performance for energy efficiency and occupant comfort. The complexity of the subject is being diffused with a new series of training sessions.

Gilberts Blackpool, provider of air movement solutions, is offering 'lunch and learn' continuous professional development presentations. Gilberts, a 'go to' organisation for ventilation technical knowledge, with the company's technical team regularly presenting to building services graduates, and sitting on numerous relevant committees for BSI, CIBSE and HEVAC.

■ Call 01253 766911 or email [info@gilbertsblackpool.com](mailto:info@gilbertsblackpool.com)

## SAV's AirMaster offers first-class ventilation to former royal station ▼

AirMaster Smart Ventilation Units from SAV Systems are providing discreet ventilation for visitors to the Old Royal Station in Ballater. The units are embedded in wall panels with only supply and extract grilles visible, to minimise the impact on the station's interiors.

The units are supplying tempered fresh air in the 'Visit Scotland' presentation area and library. The exceptionally quiet operation of the AirMaster units was a critical factor in their choice for this project.

■ Call 01483 771910, email [info@mail.sav-systems.com](mailto:info@mail.sav-systems.com) or visit [www.sav-systems.com](http://www.sav-systems.com)



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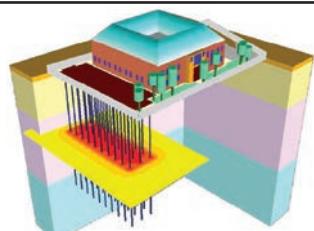
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## BIM Manager

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Seeking a BIM Manager to work for a multidisciplinary consultancy established 50 years ago. You will be responsible for developing my clients Revit Standards further overseeing other Building Services units and providing integration with the Civil and Structural teams. The role requires experience as a BIM Manager and 6+ years' in construction and Revit coordination. Excellent progression opportunities/package offered. Ref: 5095

## Senior Electrical Engineer - Electrical Associate Director

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Tired of the commute and working in Central London? We are working alongside a medium sized consultancy with impressive growth plans. They work across a diverse portfolio of projects including residential, aviation, commercial, education, healthcare, science, and retail projects. They continue to buck the trend with an enviable order book of work, several office relocations, internal promotions and team growth through 2017 and 2018. Ref: 5117

## Public Health Engineer

**SE London, £42p/h**

We have a requirement for a Public Health Engineer to work on a temporary contract in South East London. You will provide designs through to completion on high end commercial projects. The work is detailed design on above and below ground systems. This is a long-term contract with an immediate start. Ref: 5062

## Electrical Engineer

**London, £45p/h**

An exciting contract opportunity to work on a large-scale Rail project in London. The key duties of this role will consist of design, design management, surveying, and reporting. You will need a natural tendency to contribute to collaborative problem-solving, working with both clients and contractors. 12 Month contract, immediate start. Ref: 5131

## Intermediate Electrical/Mechanical Engineer

**Nottingham, £25k - £30k + bens**

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### Thank you

*"I would like to take this opportunity to thank CIBSE members for their continued support, without which the work of the Benevolent Fund could not be sustained."*  
– David Wood, Chair of the CIBSE Benevolent Fund Trust.

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## Look back and learn

Following the first Heritage Group symposium, Historic England's Caroline Cattini explains why we should be proud of our building services engineering past

**C**aroline Cattini has worked as a senior building services engineer and energy manager at Historic England for 13 years. She offers advice on the application of building services in historic buildings and writes the public body's guidance on installing renewable and low carbon technologies in historic buildings. Cattini, a chartered building services engineer and CIBSE Fellow, sits on CIBSE's membership and registration committee, and is one of its professional interviewers.

### What was your route into historic building services engineering?

After leaving school, I did a five-year engineering apprenticeship, then completed an undergraduate degree and worked at a number of consultancies as an electrical design engineer. In 2003, I joined English Heritage, now Historic England – the government's expert adviser on England's heritage – as one of its senior building services engineers in the conservation department.

### What has been the most challenging conservation project on which Historic England has worked?

We have worked on a few and, generally, the challenge is balancing the need of the occupants and minimising harm, or loss of significance, to the building. Another challenge is when the building has to remain operational while improvements to the services are made.

Currently, the conservation department is working on Shrewsbury Flaxmill Maltings. The mill was built in 1797 and was the world's first iron-framed building. The site encompasses three Grade I-listed buildings, two at Grade II that are on the Heritage 'at risk' register, and a further three Grade II-listed buildings. The malting business closed in 1987 and the site has been disused since then.

### Can you tell us about the benchmarks Historic England is creating?

We are working with Professor Ian Knight, of Cardiff University, to produce energy benchmarks for the type of buildings in our sector. We are starting with our own historic estate, and looking in great detail at the plant serving the buildings, the types of systems in them, and the activities that take place there. We are collecting our half-hourly utility data and, where we have BMS data, using that information too.

### How is Historic England's research fed into practice?

It is disseminated through our conservation research reports and the guidance we publish. For the first time earlier this year, at Somerset House, we also held a conference specifically on building services engineering within historic buildings, and how to meet the expectations of owners and occupiers. We followed this up with a one-day course in June, and hope to run more courses to share best practice, current research and guidance. This year, we will also be exhibiting at CIBSE's Build2Perform Live and taking part in the historic buildings seminar.

### What can today's engineers learn from historic buildings?

Many of our historic buildings were built with local materials, using local skills, and designed with local climatic conditions in mind. The occupiers play a vital role in understanding how their building works and how to be comfortable in it, be that by opening windows and shutters or managing the systems. Engineers from the past did more with less, and were inventive, making what they did more sustainable. Many of the systems they installed far exceeded the operational life we would give modern building services – and many are still used.

### Why should engineering students be taught 'history of building services'?

There is value in learning the technical development behind the systems and equipment we now use. It helps us to understand why we work to the standards and best practice we do. We should be proud of our building services engineering past, and know the names of the pioneering individuals who designed the systems that resemble what we still use today. People such as Dr David Boswell Reid, who designed the world's first modern air conditioning system at St George's Hall in Liverpool.

Teaching students about the history of their industry may also improve the recorded history in building services engineering. Many systems from the past were not seen to hold much value, so were simply removed. The CIBSE Heritage Group has done a lot of work in recording what it has found and is a great help to those working to understand the significance of building services engineering.

**CAROLINE CATTINI FCIBSE** is a senior engineer and energy manager at Historic England

# EVENTS

## NATIONAL EVENTS AND CONFERENCES

### 9th Symposium on Lift and Escalator Technologies 19-20 September, Northampton

With keynote speaker Dr Bryan Laubscher, of the International Space Elevator Consortium, which promotes the development, construction and operation of a space elevator infrastructure. Dr Laubscher will also give a talk on the evening of 18 September, hosted by the University of Northampton.  
<https://liftsymposium.org>

### CIBSE Young Engineers Awards 11 October, London

The Graduate of the Year and the Employer of the Year accolades, recognise and reward the innovative thinking, hard work and skills of graduate engineers, while showcasing and championing employers who are committed to developing and encouraging young talent.  
[www.cibse.org/yea](http://www.cibse.org/yea)

### CIBSE TRAINING

For details, visit [www.cibse.org/training](http://www.cibse.org/training) or call 020 8772 3640

### Mechanical services explained 11-13 September, London

### Overview of IET wiring regulations 14 September, London

### Low carbon consultant design training 17-18 September, London

### Fire risk assessment to PAS 79 18 September, London



Ant Wilson, of Aecom, will speak at the HCSW event on 5 September



David Cooper will speak at the lift and escalator technologies symposium

## SLL LightBytes series 2018-19

The Society of Light and Lighting's (SLL's) LightBytes series for 2018-19 has been announced. This year, the society has collaborated with CIBSE's Facilities Management (FM) Group to develop content for the series, which will look at topics including: how to specify a luminaire; retrofit and upgrade; emergency lighting; and the Internet of Things.

Industry experts from SLL's sponsors in partnership will present the series. These include Les Thomas, Fagerhult; Richard Caple, Thorlux; Roger Sexton, Xicato; and Graeme Shaw, Zumbotel. Guest speakers for each event will be announced shortly.

Dates for the 2018-19 series are:

- 18 October, Birmingham
- 29 November, Belfast
- 24 January, Liverpool
- 28 February, York
- 28 March, Bristol
- 25 April, Edinburgh
- 9 May, London

Visit [www.cibse.org/sll](http://www.cibse.org/sll) for details.

### Electrical distribution design 3 October, London

### Lighting design: Principles and application 4 October, London

### Emergency lighting to comply with fire safety 5 October, London

### Practical controls for HVAC systems 5 October, London

### Energy Savings Opportunity Scheme 9 October, London

### CIBSE GROUPS, SOCIETIES AND REGIONS

For more information about these events, visit: [www.cibse.org/events](http://www.cibse.org/events)

### South Wales: BS7671 18th edition 3 September, Cardiff

Summarising the amendments associated with BS 7671 18th edition, released on 1 July 2018.

### Scotland: Life-cycle assessment (LCA) – theory and practice 4 September, Edinburgh

Design professionals can now deliver life-cycle assessments using LCA software platforms available on the market.

### CIBSE Application workshop 4 September, 12 November, London

A workshop to help applicants with their Engineering Practice Report for Associate and Member applications.

### Home Counties South West: Building services engineers who help save the planet 5 September, London

Guest speaker Ant Wilson.

### YEN ANZ: Trivia night 6 September, Melbourne

With general knowledge and building services questions.

### Northern Ireland: Golf outing 6 September, Carryduff

Social golf outing.

### Southern: Black belt negotiator 11 September, Chichester

Speaker Tom Flatau will demonstrate how to win accounts, get better deals from suppliers and create value by building better relationships.

### West Midlands: Wiring regulations update 12 September, Birmingham

Steve Martin offers insight into the significant changes in the new edition of the IET Wiring Regulations BS 7671, published on 2 July, plus construction product regulations for cables.

### Combined heat and power in commercial buildings 19 September, Manchester

Society of Public Health Engineers event.

### YEN South West: Bristol's race to the sky – panel discussion about tall buildings 20 September, Bristol

The considerations needed within the built environment to ensure tall buildings can play a positive role in Bristol's future.

### West Midlands: Social – speed hill climb 22 September, Alberbury

Motor speed climb at Loton Park.

### Fire engineering the façade 25 September, London

Society of Façade Engineering event.

### North East: Weather-proof buildings 25 September, Newcastle upon Tyne

Presentation by Dr Hu Du, research fellow at Welsh School of Architecture, Cardiff University.

### South West: Virtual reality – changing construction 27 September, Bristol

Includes live demos from case studies making use of virtual, augmented and mixed reality, and explaining their differences, capabilities and applications for use.



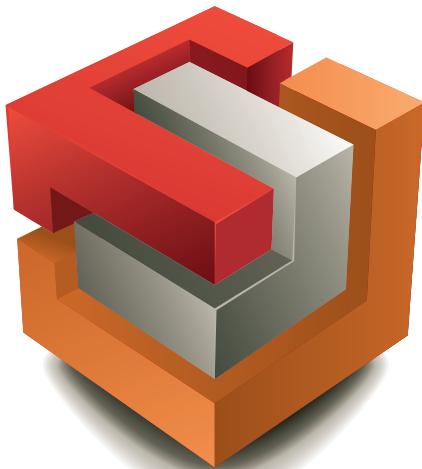


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- Building performance in schools
- Future of heat
- Energy independence
- Hydrogen as a fuel for the future
- Renovation of domestic buildings
- Daylighting considerations for integrated design
- Historic buildings
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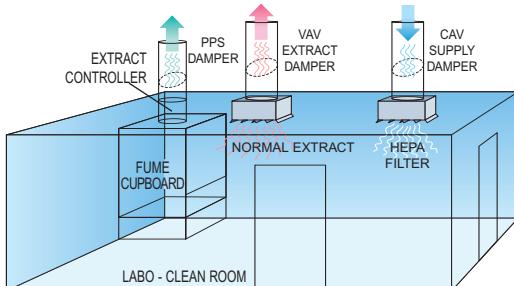


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