

CIBSE JOURNAL



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June 2017

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Making gains



With Labour gaining ground on the Conservatives, the General Election may not be the foregone conclusion it first appeared. However, with a lead in the polls as we go to press, the ruling Tory party, headed by Theresa May, still appears most likely to gain victory.

In its election manifesto, the Conservative Party pledges a new energy efficiency scheme, ongoing commitments to install smart meters, and a promise to upgrade homes to EPC band C by 2030. But it fails to mention measures to improve air quality, and its commitment to make clean power widely available sits alongside a promise to support the oil

and gas industries, and back fracking.

True to its roots, Labour pledges to build 100,000 council homes a year and spend £250bn on infrastructure over the next 10 years. The Liberal Democrats want to generate 60% of electricity from renewables by 2030 and have announced plans on air pollution. The party may be languishing in the polls but if it holds the balance of power in a hung parliament, some of its policies could trickle down onto the statute book, as they did in the previous coalition government.

International Women in Engineering Day is on 23 June. It's not just in government that women are well represented. The amount of female contributors in *CIBSE Journal* this month is evidence that the building industry is becoming more and more diverse (page 28). Our article on the collaborative design for a prestigious new building for the London School of Economics features three female engineers. They describe their route into engineering and the benefits of working on a design team containing such a high proportion of women. Encouragingly, all three of their employers – ChapmanBDSP, Max Fordham and structural engineer AKTII – have more than 20% of their workforce represented by women.

BDP's Clare Reinhold is another high-flying female engineer. She is leading services design at AstraZeneca's huge new headquarters in Cambridge and leads on BIM in BDP's London office.

Our BIM/digital engineering special, which starts on page 43, looks at how Birmingham City University is using BIM from design to operation, with the support of Hoare Lea. It shows the potential for the technology, and explains why it is crucial that every sector of the industry has the opportunity to benefit from BIM, not just the firms large enough to make the initial upfront investment.

ALEX SMITH, EDITOR asmith@cibsejournal.com

CONTRIBUTORS



Hywel Davies
CIBSE's technical director explains why the value of EPCs will increase with the arrival of MEES



Clare Reinhold
High-flying BDP engineer explains why more women should become building services engineers



Liza Young
Our deputy editor speaks to the new CIBSE President and explores what agile working means for design



Tim Dwyer
The Journal's technical editor looks at the application of alternative refrigerants



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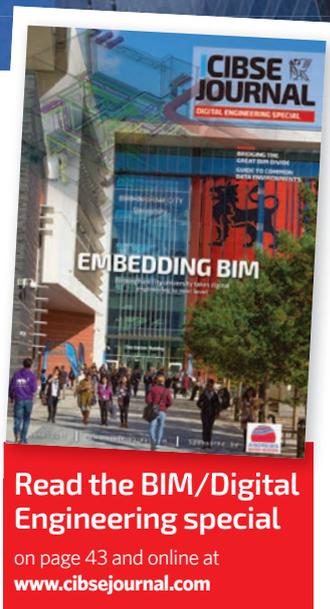
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SHANGHAI'S SUSTAINABLE BUILDING TOPS OUT



Mott MacDonald is supplying project management and engineering review services on the £88.5m Shanghai Foxconn Plaza, in China, which is in the final phase of construction.

Designed as the headquarters of the Hon Hai Technology Group, the 50,000m² plaza will set a standard for environmentally sustainable buildings in the region.

To prevent excessive heat build-up, a double curtainwall façade system will naturally ventilate the plaza and disperse the building heat. Targeting Leed platinum and national two-star green building certificates, the plaza also features rainwater harvesting, LED lighting, solar panels and geothermal heat exchange.

IN BRIEF

Skanska wins City of London contract

Skanska has been awarded a contract by the City of London Corporation to carry out mechanical and electrical maintenance, and to look after the fabric of its buildings.

The five-year contract begins in July, with the option to renew for a further two years. Included in the corporation's portfolio of buildings are Mansion House, Tower Bridge, the Old Bailey, the Guildhall and the Barbican, plus Smithfield and Spitalfields markets.

The contract also covers schools, police stations and libraries, as well as commercial offices, retail and leisure buildings.

Carillion hits carbon target five years early

Carillion claims to have hit its sustainability targets five years ahead of schedule by cutting carbon emissions by 34% since 2011.

Electricity consumption in its offices is down by 70% – against a 20% target – and gas use has also fallen by 16% in six years.

Chief executive Richard Howson said a sustainable approach to operations was 'business critical, and the only way we can achieve profitable, long-term growth'.

He said the company was close to an international 'zero waste to landfill' target – having cut total waste by 3.3% in 2016 – but the overall target is being held up by the Middle East, which has poor recycling infrastructure.

The construction giant reports that it has also cut water consumption by 37% since 2011.

Autodesk University invites CIBSE members

The Autodesk University two-day training event will be staged in London for the first time this year, on 21 and 22 June. CIBSE members are entitled to a 32% discount, which cuts the cost of a ticket from £800 to £540.

Members should register using the following CIBSE special offer link at: <http://autode.sk/AULondonCIBSE2017>

Tories back energy efficiency, but ignore issues of air quality

Manifesto fails to set timetable for the delayed Clean Growth Plan

The Conservative Party has promised to 'lead international action against climate change' if it wins this month's General Election.

Among manifesto pledges is an energy efficiency scheme designed to help large businesses cut energy consumption and lower costs. The ongoing commitment to installing a smart meter in every business and household by the end of 2020 remains, as does a promise to upgrade all homes to an EPC band C by 2030.

However, the manifesto makes no mention of measures to tackle air pollution and does not set a timetable for the much-delayed Clean Growth Plan, or the 25-year Plan for the Environment.

The Conservative's Industrial Strategy includes the pledge to make 'reliable, cheap and clean power' widely available, with funding for further research into battery storage and electric vehicles. However, these sit alongside pledges of support for North Sea oil and gas, and an extension of gas fracking.

Specific measures to increase investment in vocational training are included and the skills agenda plays an important part in the manifestos of the Labour and Liberal Democrat parties. Labour pledges to double the number of completed apprenticeships at NVQ level 3 by 2022 and set up a 'national transformation fund'

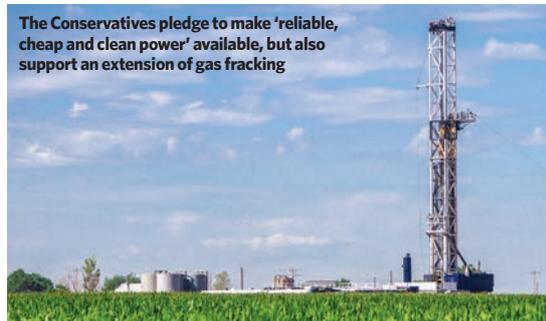
that will invest £250bn in infrastructure over 10 years. It also sets out plans to build 100,000 new council homes a year.

The Lib Dems promise a £100bn package of additional infrastructure investment and a 'Housing and Infrastructure Development Bank, to mobilise low carbon investment'.

Alongside plans to generate 60% of electricity from renewables by 2030, the party announced plans to tackle air pollution.

Plaid Cymru has promised a £7.5bn investment in Welsh Infrastructure, and will support tidal lagoons. It has also pledged to reduce energy bills by establishing a Welsh energy company. The Green Party says it will replace fossil fuels with renewable energy, while UKIP says it will review all EU environmental legislation. SNP had not published its manifesto 2017 at time of going to press.

The Conservatives pledge to make 'reliable, cheap and clean power' available, but also support an extension of gas fracking



Feta chair warns against 'bonfire of red tape'

The new government should avoid making changes to existing legislation after Brexit without first consulting industry, according to the Federation of Environmental Trade Associations (Feta).

Speaking at the organisation's annual lunch, chair Graham Wright urged the new government to adopt a measured approach to legislative changes, including the need to attract skilled labour from overseas. He also pointed out that many products used by the UK industry were manufactured in the EU, so that requiring different standards would add to manufacturing costs.

He insisted that leaving the EU should not be a trigger for dropping existing initiatives that encourage the use of renewable technologies, and advised politicians to avoid 'stoking the fires of populist opinion' with a 'bonfire of red tape'.

Tackling flammable refrigerants

The Federation of Environmental Trade Associations (Feta) has set up an A2L refrigerants working group, and has released guidance note *An introduction to A2L refrigerants and their use in refrigeration, air conditioning and heat pump applications*.

This is in response to the growing use of alternative gases to replace HFC refrigerants, being phased out as part of the F-Gas Regulations because of their global warming potential.

The guidance offers an overview of new refrigerants, as well as practical advice on their safe use. Visit www.feta.co.uk

IAQ could become part of planning laws in London

Cost of filters is tiny compared to impact of poor IAQ on people's health

Improved indoor air quality (IAQ) is the quickest and cheapest way to protect people from air pollution, according to leading campaigner Simon Birkett.

The founder of the long-running Clean Air in London campaign told an event organised by the CIBSE FM and ASHRAE Groups that



addressing IAQ was the 'single thing that we can do quickest' in the face of alarming levels of outdoor pollution.

He said he was lobbying for minimum levels of IAQ to be included in the London Plan so that buildings over a certain size would have to meet air quality standards. This could be a game-changer as could the proposal for a new Clean Air Act that, he believes, should be updated.

He said: 'A myopic focus on energy efficiency and CO₂ has led to the problems we have now.'

He pointed out that Building Regulations already contain requirements for NO₂ levels, and the proliferation of individual, portable air monitors meant people were starting to challenge their employers over air quality in workplaces.

He said: 'The cost of filtration is about 10% of the cost of actually getting air into the building and the cost of filters is tiny compared to salaries and the impact of poor air quality.'

Global AC market bouncing back

Growth in sales of air conditioning equipment will recover this year across international markets, according to the latest Bsria market intelligence study.

The world market for AC shrank by 1% last year, following a 5% slump in 2015. The major markets of Brazil and Saudi Arabia performed poorly, but Europe bucked the international trend by recording growth of 13% in 2016, after a sluggish performance in the last few years, the report said.

Most of the large European air conditioning markets did well, apart from the UK where the Brexit vote created uncertainty and market volatility. Lack of demand for office space and delays to projects nearing completion because of concern about tenant demand, hit completion dates and 'consequently the purchase and installation of air conditioning' in the UK, according to Bsria.

The economic recovery in most European countries, combined with a heatwave in southern Europe, was behind the improved figures for the rest of the continent.

The study valued the global AC market at US\$92.6bn, with packaged products accounting for almost 85% of the total.

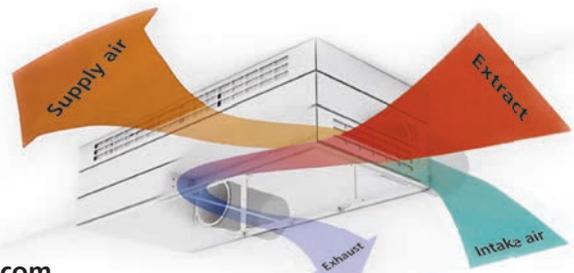
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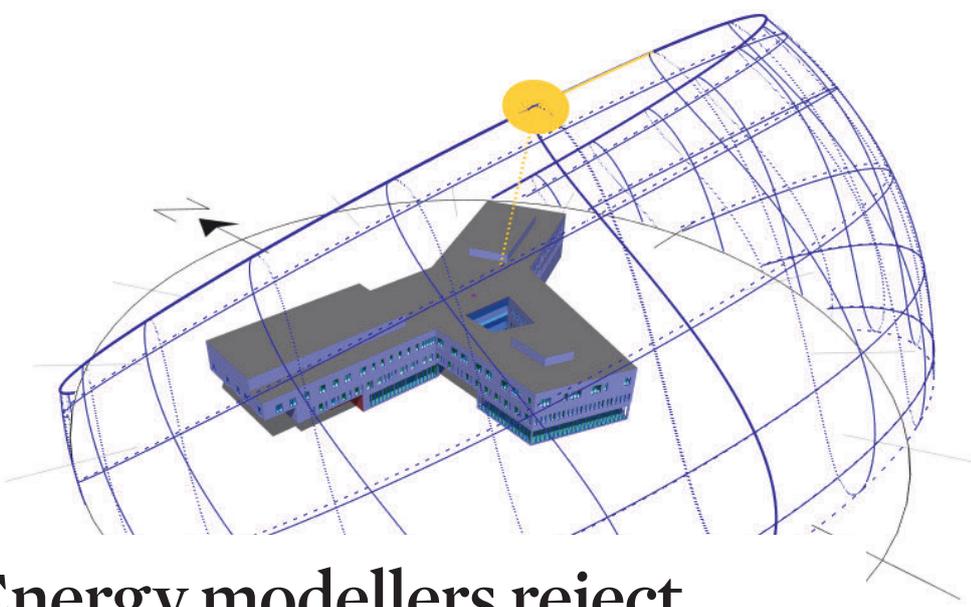


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IN BRIEF

Student bags Hilson Moran internship

The winner of the Hilson Moran student design competition – launched in celebration of its 40th anniversary – has been revealed.

Engineering students were asked how they think the design and construction of the built environment will change in the next 40 years.

Rosario Argomániz Montilla, from Glasgow Caledonian University, impressed the judges with her breadth of research. She listed components that would create a more adaptable future in, including connecting sustainability and social media, and building smart spaces that respond to virtual profiles of inhabitants. She won £1,000 and a six-month paid internship with Hilson Moran.

Dynamic thermal model image showing annual sun paths

Heritage Group links with students

CIBSE Heritage Group has launched a student engagement initiative.

The programme aims to establish a more active forum for the study of historic environmental principles by hosting workshops..

The pilot programme for 2017-18, themed 'Historical perspectives on comfort, health and wellbeing', will comprise five workshops – held from October 2017 to July 2018 – and a symposium in January.

Dr Henrik Schoenefeldt, Heritage Group academic liaison officer, said: 'The initiative would allow us to strengthen the educational mission of the group, supporting students in undertaking research, publishing and contributing towards public discourse.'

Remeha launches compact boiler

Remeha has launched the GAS 220 Ace floor-standing condensing boiler as a replacement for the Gas 210 Eco Pro.

The design is based on a monobloc heat exchanger cast from a single piece of aluminium, which Remeha says almost halves the size of the model.

The range is designed for central heating and indirect hot water production at working pressures up to five bar. The boiler is available in 160, 200, 250 and 300kW models with outputs from 343.7kW to 310kW.

Energy modellers reject blame for performance gap

Research accuses modellers of overestimating building efficiency

Energy modellers have hit back at an article in *The Telegraph*, which accused them of misleading building owners about energy bills and drew parallels with last year's diesel emissions scandal.

The article was based on research carried out by the University of Bath, which blamed lack of professional modelling qualifications for planners 'massively overestimating' the efficiency of new buildings and led to thousands of new homes, schools and offices using double the energy they should.

The Bath research team interviewed 108 building modelling professionals and reported that they could not agree on which energy efficiency measures were important and which were not, or how much difference to the energy bill changes to them would make.

Bath's professor of low carbon design David Coley told *The Telegraph* that the practice of building modelling was not 'fit for purpose'.

'It's a serious scandal [that] affects all

new buildings, as well as the refurbishment of older ones,' he added. However, energy modellers say it is unfair to lay all the blame for the building 'performance gap' at their door.

Susie Diamond, founding partner at building physics firm Inklings, said: 'We take great issue with the blanket criticism meted out to the modelling community, but agree that the industry needs to address the performance gap by having an open and honest discussion about the ways we work together.'

A spokesperson for simulation software provider IES said addressing the problem required action by all those involved in a building's life-cycle, from design to operation.

It added that the article was repeating a popular misconception that an energy performance certificate (EPC) was a true reflection of how a building would perform.

'EPCs assess a building under normalised conditions, missing out unregulated building energy loads that are not required to be included in the calculation,' the firm said.

See Hywel Davies on page 18 and Susie Diamond on page 20.

Mayor urged to shut down waste-powered district heating scheme

The Mayor of London, Sadiq Khan, has been urged to block a district heating scheme powered by a waste incinerator.

A local councillor in Sutton said the project would lead to inflated heating bills for vulnerable residents and contribute to worsening air quality.

Independent councillor Nick Matthey has written to the mayor urging him to use his powers to stop the development by the Sutton District Energy Network (SDEN), which is to provide heating to a new housing development in the area.

'If it is within your power to stop SDEN, it will save many people from fuel poverty,' wrote Matthey.

Khan recently attended a meeting in the borough and Matthey pointed out the incinerator would soon be operating a few miles from the London Extra Low Emission Zone and would burn 300,000 tonnes of waste annually. He added that Sutton Council had also granted permission for another 150,000-ton-a-year waste burning gasification plant 1km away. Matthey said several schools were in 'the shadow of these polluting operations'.

Survey shows engineering services is 'powering ahead'

Rising or steady turnover in majority of the sector, despite rising costs

Almost 80% of building engineering services contractors say their turnover increased or remained the same during the first quarter of this year, according to the sector-wide survey, sponsored by Scolmore.

Run by the Building Engineering Services Association (BESA), the Electrical Contractors' Association (ECA) and Scottish electrical trade body Select, the survey received 370 responses from companies across the engineering services sector.

Firms were even more bullish about the current quarter, with 88% predicting their turnover would either rise or remain steady.

However, most businesses in the sector said they were having to deal with rising costs, and half of the firms that responded said the vote to leave the European Union had had a negative impact on materials prices. In addition, half of

companies said their labour costs had risen – up from four in 10 firms in the previous quarter.

ECA chief executive Steve Bratt said he was 'cautiously optimistic' about the coming period of 'further change' caused by the General Election, which is due to take place on 8 June.

'These figures show that the engineering services sector continues to power ahead, against a backdrop of enormous political volatility,' he added.

'New business opportunities continue to be created across our sector, notably – but certainly not exclusively – linked to energy supply and storage.'

Bratt's BESA counterpart, Paul McLaughlin, said the results were heartening and that the sector remained 'on track'.

'For almost nine out of 10 respondents to be so upbeat about their immediate business prospects in the current, uncertain, economic climate is testament to this industry's resilience,' he said.



UK's FM market valued at £120bn

Facilities management (FM) is responsible for as much as 8% of the UK's gross domestic product (GDP), and the sector employs up to 10% of the country's workforce, according to a report by the British Institute of Facilities Management (BIFM).

Published on World FM Day, the report valued the annual global market at \$1.1tn. It said the UK market was regarded as the 'most mature and competitive in Europe', with most estimates putting its value in 2017 as high as £120bn. This is expected to rise to an estimated £139bn by 2021. This increase in value is attributed to the number of 'total FM deals' where providers are integrated into their clients' operating teams.

'In recent years, we have seen FM extend its remit and take a more proactive role across a broader spectrum of activities,' said BIFM acting chief executive Linda Hausmanis.

Because the sector employed such a large proportion of the total UK workforce, she added, it had 'an important role to play on issues such as social value, the National Living Wage and the Industrial Strategy currently in development'.

Movers and makers



Andrew Swain-Smith has taken up his role as chair of the building services engineering professions

and environmental design group at BDP. The 100-strong group comprises building services engineers, electrical engineers, lighting designers, acousticians, sustainability consultants, building physicists and digital (BIM) engineers, and is based in BDP's London, Manchester and Dublin studios.

Swain-Smith, who took up his role on 1 March, is an environmental engineer, who joined BDP in 1994 and was appointed a director in 2000. He has led the education sector for BDP's environmental design group for many years, collaborating with BDP's architects and other architectural practices to design award-winning education facilities throughout the UK.

Working alongside Swain-Smith are James Hepburn and Rob Ferry, who have been appointed principals in the London and Manchester studios respectively.



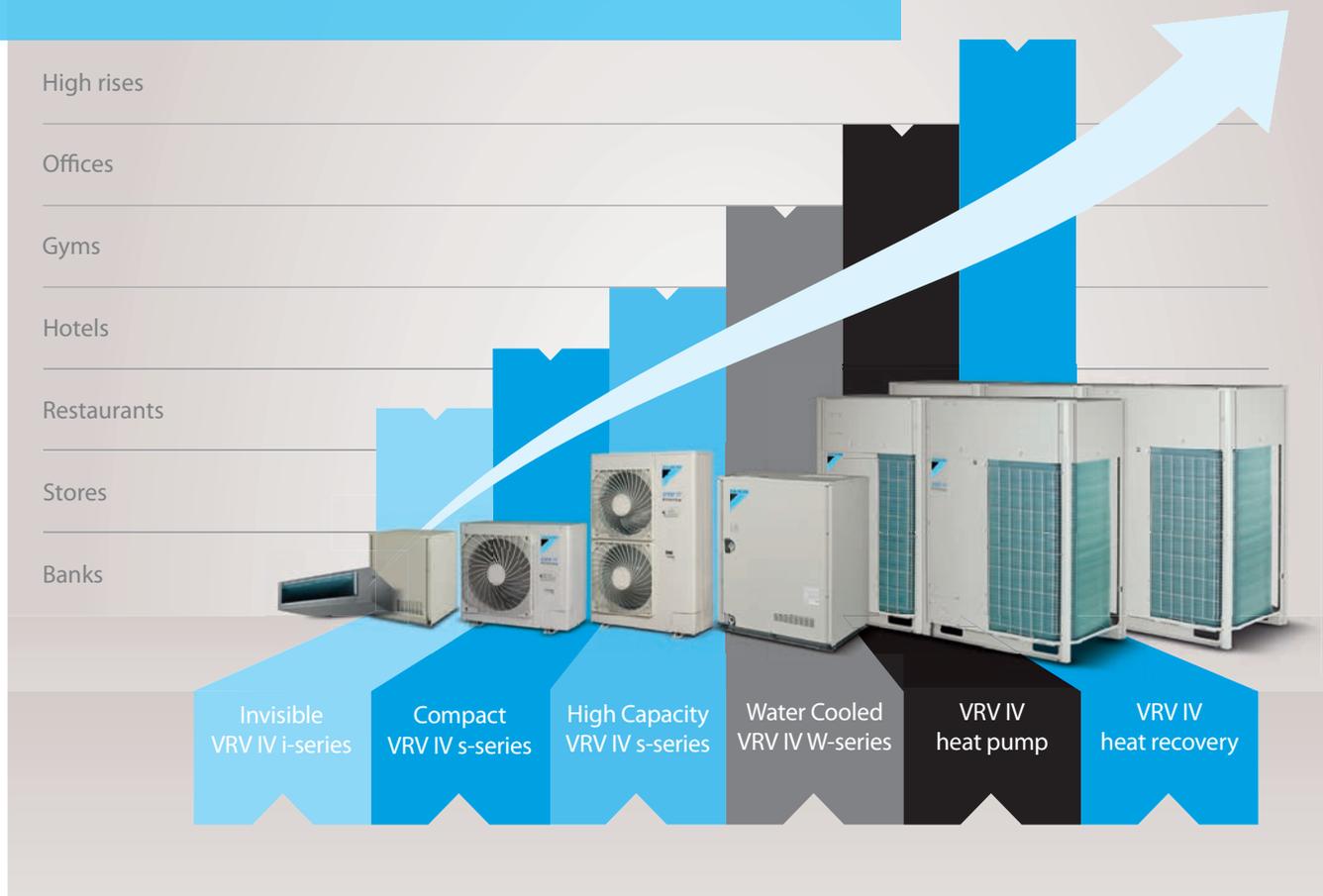
Baxi Heating has appointed **Paul Wilson** as national sales manager for Remeha's combined heat and power (CHP) division. Previously technical sales manager (CHP), Wilson (top) has five years' experience in the CHP sector



and joined Baxi Heating in 2015. He started in the heating industry as a pipe fitter and later became an estimator and project manager on Transport for London projects.

Meanwhile, **Gary Stoddart** changes his role from technical sales director (CHP) at Remeha to technical services manager at Baxi Heating. Stoddart will lead on technical services for Andrews Water Heaters, initially managing the technical aspects of the company's solar thermal offering, before expanding his remit to cover the entire product portfolio.

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Get ready to celebrate women in engineering

International Women in Engineering Day is taking place on 23 June, and CIBSE will be supporting the day, as well as celebrating the contribution of its female members.

The event was set up by the Women's Engineering Society (WES) to support, inspire and raise the profile of women in engineering, and is now a global awareness campaign. It offers an opportunity to draw attention to the varied careers in engineering available to girls and young people.

The sub-theme for 2017 is #MenAsAllies, and the list of the Top 50 Women in Engineering aged under 35 will be published on the day by *The Telegraph*.

The Women's Engineering Society resource pack is available to download at www.inwed.org.uk. See our feature on page 28.

Advanced call for papers, case studies, reviews and posters

The CIBSE ASHRAE Technical Symposium 2018 will be held at London South Bank University on 12-13 April 2018.

Current global uncertainties about climate, resources, the environment and security mean there is an increasing need for those with a responsibility to deliver healthy and productive environments to stretch beyond 'business as usual'.

So the 2018 symposium theme is 'Stretching the envelope: techniques, applications and technologies for healthy and productive environments'. It aims to give the industry a technical insight into the methods – currently available, or just over the horizon – that will drive the development of sustainable future environments. This will include presentations and discussions on established and proven – as well as developmental and cutting-edge – techniques.

CIBSE is seeking papers, reviews and case studies on research and development relating to any human-controlled environment, including all types of buildings, occupied spaces and vehicles, terrestrial or otherwise.

Abstracts are now being accepted. Visit cibse.org/symposium for more details.

New Abu Dhabi Chapter aims to offer diverse programme



CIBSE Abu Dhabi committee (from left): May Shunnar, Mohamed Abubaker, Ninos Kamber, Idris Sudi, Daniel Williams, Richard Ebrahim and Chris Ackers

Committee aims to hold accredited technical seminars and support members with career development

CIBSE has established a new Chapter in Abu Dhabi. It was officially launched in December 2016, with the intention of reaching out to more members in the capital of the United Arab Emirates (UAE).

The creation of the Chapter follows the launch of the UAE Region in April 2016. An Abu Dhabi committee was subsequently formed with members including: chair Idris Sudi, James Cubitt & Partners; vice-chair Daniel Williams, Hoare Lea Consulting Engineers; membership secretary Richard Ebrahim, Cleveland Clinic Abu

Dhabi; YEN champion May Shunnar, Acoulite; events officer Mohamed Abubaker, Schneider Electric; technical officer Ninos Kamber, Hilson Moran; and Society of Light and Lighting technical lead Chris Ackers, Fagerhult.

The committee will seek to liaise with local authorities and institutions in Abu Dhabi to host technical events, at which people in the industry and region can meet and network, thereby building collaboration and cooperation.

It also intends to hold accredited technical seminars in Abu Dhabi, as well as supporting existing members with their career development. The committee will endeavour to assist new members through the relevant CIBSE membership grades.

The CIBSE Abu Dhabi Chapter staged its first event on 11 April – a technical seminar on chilled beams, sponsored by Trox.

More than 30 people from Dubai and Abu Dhabi attended the event, which included a presentation from CIBSE Abu Dhabi chair Idris Sudi, who introduced the Chapter and its objectives for 2017.

It is hoped more events will be organised throughout this year, covering topics such as HVAC, lighting, sustainability and MEP services for healthcare settings.

The Chapter is committed to offering broad seminars to support the diverse technical needs in the United Arab Emirates.

Finding tomorrow's engineers gives region food for thought

CIBSE West Midlands hosted its first breakfast meeting to discuss strategies for attracting the next generation of engineers into the building services industry.

Organised by CIBSE West Midlands committee member Martin Trentham, the roundtable discussion – held in Birmingham in April – focused on how to increase the number of young engineers on school, apprenticeship and graduate programmes.

The panel included industry leaders, as well as representatives from the Young Engineers Network, Women into Science and Engineering, STEM and the Royal Institution of Chartered Surveyors, all of whom enjoyed a breakfast and enthusiastic discussion about the various ways to garner interest in engineering.

A key talking point was the fact that the term 'engineer' needed to be rebranded. Teachers,

parents, and students need to understand that it is a profession for talented and creative individuals, with excellent career progression and salary potential.

The debate brought to light how much is being done by individual companies in isolation, and the lack of 'joined-up thinking'. It was agreed that CIBSE West Midlands needs to spearhead an initiative – with industry support – to attract the engineers of tomorrow. As a result, a sub-committee has been formed to create events and programmes for companies, teachers, parents and students. It is hoped this will increase the visibility of engineering among students, improve their understanding of what it is, and put them in contact with firms looking for apprentices and graduates.

CIBSE West Midlands is looking to organise more breakfasts in the coming year.



Student award can boost your CV

There's still time to submit your entry for the President's Prize: The CIBSE Undergraduate Award 2017.

Sponsored by Hays Building Services, the award is open to final-year building services engineering (or related) BSc, BEng and MEng student members of CIBSE, in the UK or overseas.

This is a great opportunity for student members to showcase their skills and add a competitive edge to their CVs. The winner will receive £500, with two runners-up each receiving £100.

To enter, submit a 2,000-word synopsis of your final-year project, with the completed application form, by 21 July. Judges will be looking for clear, easy-to-read submissions, showing a strong understanding of engineering science and design, originality, evidence of engineering techniques and high-quality drawings.

To apply, visit bit.ly/CJJun17news3 and download an application form.

Peter Wong (centre) with Kevin Kelly, Lynne Jack, Stephen Lisk and Paddy Conaghan

Wong takes over as new CIBSE officers welcomed

Wong pledges to promote the positive message of the institution

Peter Y Wong FCIBSE took up office as the new CIBSE President at the institution's AGM on 9 May, taking over from John Field FCIBSE.

In his presidential address, Wong pledged to inspire the industry to embody the spirit and values of being a CIBSE member. He said he wanted to promote the positive message of the institution's values and the professionalism it treasures, as well as aspire to exchange best practice among like-minded professionals worldwide.

CIBSE also welcomed Stephen Lisk FCIBSE

as President-elect, and the senior CIBSE officers, including:

- Immediate past President: John Field FCIBSE
- Vice-president: Paddy Conaghan FCIBSE
- Vice-president: Lynne Jack FCIBSE
- Vice-president: Kevin Kelly FCIBSE
- Honorary treasurer: Stuart MacPherson FCIBSE

Details and biographies of the officers can be found at www.cibse.org/board and the AGM minutes will be published in July's *CIBSE Journal*. To read Wong's full presidential address visit bit.ly/CJJun17news1 and for an interview with him, turn to page 22.

Chance to meet the President

The CIBSE Australia and New Zealand (ANZ) Region will celebrate 30 years of shaping the building services industry with a cocktail function at the Melbourne Aquarium on 15 June.

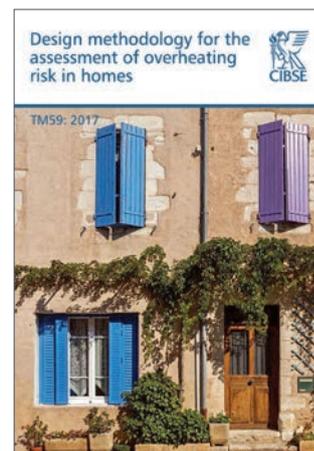
Newly inaugurated CIBSE President Peter Y Wong will attend from Hong Kong for one of his first presidential engagements. Wong was previously chair of CIBSE HK Region and is founding chair of the Building Services Division of the Hong Kong Institution of Engineers.

The 30th anniversary will also be marked by the release of a commemorative book showcasing historic events from CIBSE's past, while the ANZ Young Engineers Awards – with prizes recognising the Student and Young Engineer of the Year – will be presented on the night.

Buildings are becoming increasingly sophisticated, with more sustainable solutions required to meet tougher industry regulations.

So CIBSE's Charter to 'promote the art, science and practice of building services engineering for all, and the advancement of education and research in building services engineering' makes it an integral part of the building industry within Australia and New Zealand.

More than 100 guests, including senior industry professionals from institutions, and commercial and education leaders, will attend the event. For details, and to register, visit bit.ly/CJJun17news2



TM59: Overheating publication launch

CIBSE – together with UCL Institute for Environmental Design and Engineering (IEDE) – is holding a launch event for the new *TM59: Methodology for the assessment of overheating risk in homes* on 28 June, from 6–9pm.

The launch – at UCL, Christopher Ingold Building, London – will include a presentation of the methodology and case studies, followed by a drinks reception.

If you would like to attend, email technical@cibse.org

New members, fellows and associates

FELLOWS

Chan, Raymond Ka Lung
Cheung Sha Wan, Hong Kong

Chatwin, Paul Michael
Newcastle upon Tyne, UK

Davies, Neil Stuart
Beaconsfield, UK

Ho, Kwok Fu
Ap Lei Chau, Hong Kong

Hopfe, Christina Johanna
Loughborough, UK

Jacob, Sathesh
Largs, UK

Lai, Wing Fat Joseph
Hong Kong, Hong Kong

Lam, Chi Keung
Hong Kong, Hong Kong

Law, Moon Tong
Sha Tin, Hong Kong

Li, Siu Kong Kenneth
New Territories, Hong Kong

Lo, Yiu Cheong Joseph
Kowloon Bay, Hong Kong

Mak, Ka Chun
Quarry Bay, Hong Kong

Ng, Tat Kwan
New Territories, Hong Kong

Northey, Christopher John
Forrest Hill, UK

O'Hara, Dominic Fitzgerald
Redditch, UK

O'Sullivan, Steve
Kings Langley, UK

Storror, Ian Gerard
Falkirk, UK

Thomas, Justin Michael
Pontypridd, UK

To, Wang Kam Albert
Tung Chung, Hong Kong

MEMBER

Adam, Steven John
West Perth, Australia

Behan, Christopher
Dublin, Ireland

Cebula, Malgorzata Hanna
Sharjah, UAE

Chan, Kin Wai
Tai Kok Tsui, Hong Kong

Chung, Ka Yin
Tsing Yi, Hong Kong

Chan, Tak Fai
Quarry Bay, Hong Kong

Chan, Wai Yi
Shatin, Hong Kong

Choi, Kai Hong
Hong Kong, Hong Kong

Everell, Christopher
Solihull, UK

Fattah, Amr
Abu Dhabi, UAE

Flynn, Damien
Dublin, Ireland

Fung, Wing Hei
Tai Po, Hong Kong

Gay Tarazona, Luis
Dublin, Ireland

Ho, Yin Ling
Kwai Fong, Hong Kong

Hoy, Andrew

Ringsend, Ireland

Hung, Tsz Kin
New Territories, Hong Kong

Jayasuriya, Don Nimantha
Kushan
Colombo, Sri Lanka

Kan, Chung Ming
North Point, Hong Kong

Kei, Man Ting
Yau Tong, Hong Kong

Lam, Wing Lun Alan
Tseung Kwan, Hong Kong

Lam, Vincent
North Point, Hong Kong

Law, Tsz Chun
Quarry Bay, Hong Kong

Lei, Kin Seng
Macau

Llorens Aguilera, Carlos
London, UK

Lyons, Thomas
Ballyhaunis, Ireland

Makris, Christos
Edinburgh, UK

Pionetti, Carlotta
Sarmato, Italy

Sacdalán, Mark Reigniel
Dubai, UAE

Sheikh Alsouk, Mohamed
Qatar

Soluade, Akinbowale Oludare
Johannesburg, South Africa

Stuart, Michael James
Dalkeith, UK

Tam, Ming Hei

Fanling, Hong Kong

Topriska, Evangelia Vasiliki
Dubai, UAE

Tsipisi, Sofianna
London, UK

Vacca, Fulvio
London, UK

Valikarimwala, Aliakbar Anis
Dubai, UAE

Walsh, Michael John
Batley, UK

White, Eoin
Rush, Ireland

Wilkinson, Matthew Jon
Korora, Australia

Wong, Chung Hong Hugo
Mongkok, Hong Kong

Wong, Hiu Chi Gigi
Kowloon, Hong Kong

Yau, Ka Wai
Tsing Yim, Hong Kong

Yeung, Ko Pang
New Territories, Hong Kong

Yip, Wai Ling
New Territories, Hong Kong

Eccles, UK

Bloom, Paul
Borehamwood, UK

Butler, Jordan David
Newbridge, UK

Cashmore, Ryan Liam
Harrogate, UK

Catchpole, Mark
Dartford, UK

Charles, Bill
Northampton, UK

Crocombe, Steven
Sutton, UK

Drain, Christopher Thomas
Sevenoaks, UK

Ellis, Neil
Crawley, UK

Franklin, Daniel
Newbridge, UK

Knights, Raymond Christian
Leeds, UK

Palmer, Deshue
Ilford, UK

Perkins, Jesse
London, UK

Stevens, Daniel
Exeter, UK

Stobbs, Jake
Leeds, UK

Tobitt, Ben
North Holmwood, UK

Wade, John
Newcastle upon Tyne, UK

ASSOCIATE

Hargreaves, Brian
Wokingham, UK

Valcarce, Pablo Casuso
Billericay, UK

LICENTIATE

Alam, Khorshed
London, UK

Blake, Christopher

FEEDBACK

A reader responds to last month's article about refrigerants, and argues for a change of focus when it comes to legal action

Between a rock and a hard place

The article 'Cold case' (*CIBSE Journal*, May 2017) is an excellent summary of where we are now – between a rock and a hard place – with some worthwhile comments on the way creeping changes in environmental legislation have led to user confusion and manufacturer reluctance to research, and probably not maximised the potential beneficial effects.

Much of the irritation arises from the fact that the ozone depletion (ODP) and global warming potential (GWP) of all the refrigerants – or of their components when mixtures – were known and published in EC/EU and other 'official' documents not long after the Montreal Protocol hit the news.

Further, we can't ignore the lack of willingness by lawmakers to embrace and use the simple stop-gap tool of the total equivalent warming impact (TEWI) in legislation on the release of refrigerants into the environment and related CO₂ emissions.

TEWIs incorporate the legal concept that the way you use something is more important than the some-

thing itself. Legislation on guns, knives and even motor vehicles spring to mind.

A positive suggestion is that TEWIs be upgraded in the hierarchy of approvals, with the concentration of effort focusing on releases of refrigerants – not on their use in itself – with minimum permissible chiller efficiencies in support.

The world being what it is, there could be regulatory requirements, such as chiller servicing organisations having to record not only what they sell to – or purchase for – a user, but also what is extracted from the user's machines. Severe penalties could be imposed for fraud and for chiller owner participation in the fraud.

But for us as designers of systems that must use some form of refrigerant, there is also a growing need for joined-up and compatible environmental and health and safety legislation.

We need statutory bans on legal actions brought simply on the grounds that the safest refrigerant was not used, whether being phased out or not. The allowable actions should focus only on grounds of negligence or incompetent use of what is now available. The statutory ban on 'actions' should also extend to claims for consequential costs to third parties brought on the same basis.

The above would give a backup to the standard CDM-type exercises and greatly accelerate the uptake of the use of refrigerants such as ammonia (NH₃) and the hydrocarbon-based fluids.

John Moss, Arup



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KNOWLEDGE EXCHANGE

The RAE's Centres of Excellence in Sustainable Building met recently to discuss the state of building design education. **David Jenkins, Alex Maclaren and Mehreen Gul** report

Four years ago, the Royal Academy of Engineering (RAE) recognised four UK universities as Centres of Excellence in Sustainable Building Design, in a bid to encourage engineering students to have a more interdisciplinary understanding of the field. Sheffield, Loughborough, University College London (UCL) and Heriot-Watt, in Edinburgh, were identified as having the expertise to deliver undergraduate students who would be well prepared for current and future industry challenges. The universities recently came together to review progress, share teaching experiences and discuss the next stage of the initiative. The event, at Heriot-Watt, covered collaborative practice, enhancing engagement, course accreditation and industry links.

Collaborative practice

Buick Davison, from Sheffield, talked about how the university's architectural engineering programme makes use of architecture and electrical, structural, and mechanical engineering departments to offer an education that is balanced and structured across different themes.

Interdisciplinary projects were used

by all the institutions to show students how to collaborate with those from other programmes. Ben Croxford described the approach of UCL, where 700 second-year students – across several engineering programmes – were given an outline brief, with minimal staff involvement, to give them an insight into the skills required.

Alex Maclaren and Mehreen Gul, from Heriot-Watt, shared examples of integrating distance-learning students into this type of activity for their architectural engineering programme – the challenge being the different modes of learning, as much as the variety of disciplines involved.

The gathering also heard about TeamBuild – an independent education charity, sponsored by CIBSE – through which 80 students from built-environment disciplines were given well-defined project briefs and asked to deliver quick-fire solutions from industry-generated scenarios.

Enhancing engagement

The use of industrial mentorships was described by Jon Carr, of Sheffield, where industry contacts were used to supervise small groups of students. David Jenkins, of Heriot-Watt, focused on teaching and assessment

formats, specifically using video-based coursework exercises that stimulate students to think about their work with a specific audience in mind. Such innovations were said to be challenging, but with clear benefits.

UCL's Sam Stamp described how students were using real-time sensors to see first-hand environmental changes in buildings, observing in practice what they might otherwise only be taught in theory. Christina Hopfe gave an overview of practice-orientated learning and teaching at Loughborough, and the value that students place on interaction with real data and industry experience.

For programmes that teach very practical subjects, formal links with industry are of great importance, as is accreditation. Fionn Stevenson presented a series of questions on the future structure of education, referencing initiatives in 'work-while-you-learn' and integrated placement schemes. The group discussed the changing context of educational delivery with the recent Perkins, Farmer, and RAEng education reports, and the impact of the Teaching Excellence Framework, plus student financial pressures.

Dorte Rich Jørgensen, of Atkins, presented an industry view, and questioned potential links with research, reflecting on her time as a visiting professor at Heriot-Watt.

Moving forward

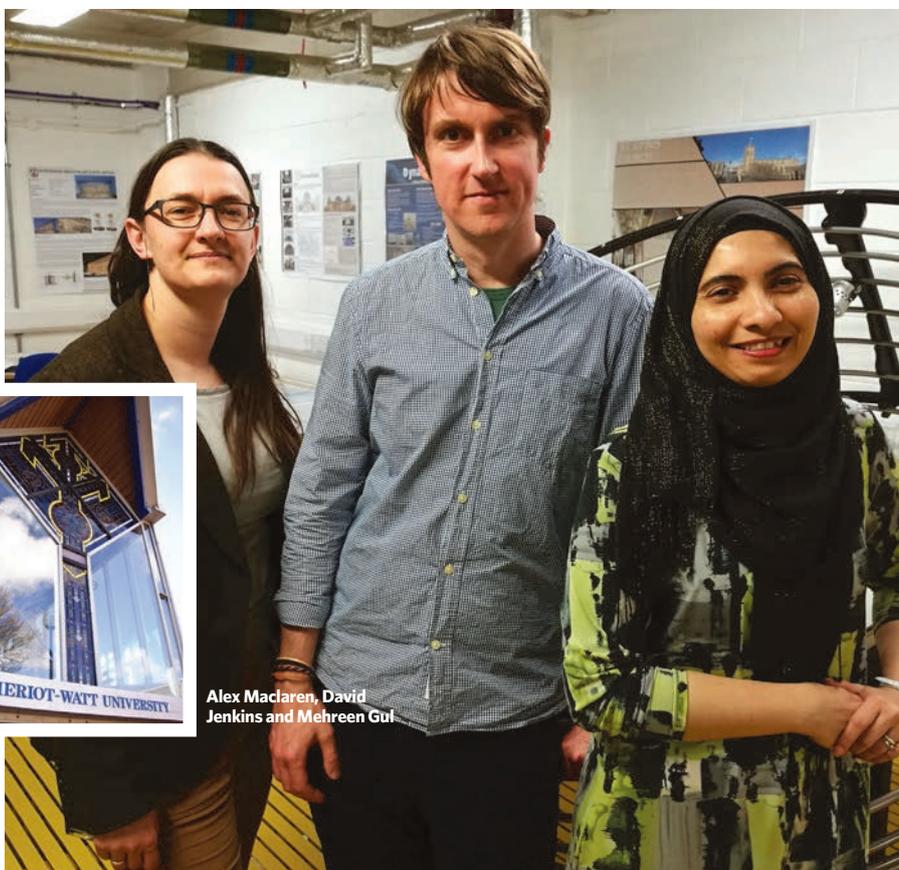
A common concern expressed by industry partners is not about quality, but a lack of quantity – how can we get more secondary school students involved in our programmes and upscale the supply-chain of talent? This question will form the basis of a larger event by the centres in autumn 2017.

There is a continued need for industry and academia to interact over programme development, and the support of organisations such as CIBSE is invaluable.

Challenges presented by rapid change – in technologies, building standards and climate – must be met with innovative solutions to grow and develop our talent pool. The four centres look forward to continuing this work. **C**

DAVID JENKINS, ALEX MACLAREN and **MEHREEN GUL** are professors at Heriot-Watt University's Centre of Excellence in Sustainable Building Design

This event was supported by CIBSE Patrons. Presentations are available on request from the authors.



Alex Maclaren, David Jenkins and Mehreen Gul

The value of EPC ratings

With Minimum Energy Efficiency Standards imminent, EPCs will take on added value. Hywel Davies looks at how to avoid inaccurate ratings

Readers should know that, from 1 April 2018, it will be unlawful to lease – or renew a lease on – a building, or a part of a building, with an F- or G-rated Energy Performance Certificate (EPC). From 1 April 2023, existing leases on such buildings will no longer be lawful. As a result, many landlords and some tenants are actively assessing the energy ratings of their buildings ahead of the deadline.

Many EPCs are being dusted down, their accuracy reviewed and questions asked about what needs doing to ‘sub-standard’ properties to get them an E rating. For some F-rated buildings, the question is, ‘Is it really an F?’ In other cases, owners are seeking advice on how to improve the building, and what impact relevant energy efficiency measures might have on the rating.

Some readers may also be aware that a recent paper in *Building Services Engineering Research and Technology* (*BSERT*) looked at the advice given by a range of energy modellers on energy-saving measures – and generated some controversial press coverage (see ‘Model answer’ on page 20). It asked 108 building modellers to comment on the importance of obtaining and using accurate values for 21 common modelling input variables – from U values to occupancy schedules.

The research team created an energy-simulation model of a house, then changed each of 21 variables to assess the impact on the model, and to create a ranking of the most significant effects of changes to that variable. This revealed the U value, ventilation rate and internal temperature set point as the most significant variables for the building being modelled.

Participants were initially asked to name the three most significant variables for determining energy demand, and to name three that they did not think were significant. Having done that, they were given a list of variables and asked to rank them in order of the effect on energy performance. This revealed a significant level of variation between the modellers: 68 identified U values as the most significant variable, with 64 choosing air-tightness and 48 internal heat gains. Only 39 opted for ventilation rate, and three identified the internal set point.

When asked to order 21 possible variables in order of impact, U values were ranked after glazing ratio, while the set point and ventilation rate were 8th and 12th on the list. The study claims that there is a lack of ‘modelling literacy’ among energy modellers.



“There are ways to ensure advice on EPCs is given by the most competent advisers”

While the *BSERT* study does reference a number of other papers, it does not refer to the Royal Academy of Engineering report on building engineering physics, and its importance in delivering a low carbon building stock in the UK¹. Nor does it cite the academy’s follow-up study, which made the case for the creation of Centres of Excellence, to teach the various aspects of low-energy design across built-environment disciplines².

The coalition government declined to support the centres, but four of them were established with the active support of CIBSE in 2013, and they have been delivering interdisciplinary training ever since (See ‘Knowledge exchange’ on page 17). It is too early for their graduates to have reached the employment market yet, so the *BSERT* study serves to underline the importance of the centres, and demonstrates that the original call by the academy and CIBSE was well-founded.

But what of the building owners and occupiers who want accurate EPCs now?

The *BSERT* paper is a warning to all that there is a range of expertise in energy modelling. However, there are ways to ensure that advice on EPCs – and how to improve them – is given by the most competent advisers.

CIBSE Certification operates a scheme for Level 5 Energy Assessors, who are approved to use simulation software – rather than the Simplified Building Energy Model – to produce EPCs. To be approved, they not only have to pass the CIBSE tests for Low Carbon Energy Assessors, but also be trained – and successfully examined in – the simulation package they use for modelling. We do not know whether any of the 108 modellers are accredited energy assessors – they were not asked.

So, by using a CIBSE Level 5 assessor, it is possible to ensure you are using an energy professional who does understand the impact of thermal insulation, ventilation rate and internal set points – and who can offer reliable advice to landlords on how to achieve an E rating on their building. They can even help a tenant to understand why a claimed E rating might not be that good.

CIBSE energy modellers are literate and ready to assist clients who want to understand the energy performance of their buildings.

References:

- 1 *Engineering a low carbon built environment: The discipline of Building Engineering Physics*, January 2010, RAE bit.ly/2q703zQ
- 2 *The case for Centres of Excellence in sustainable building design*, May 2012, RAE bit.ly/1GAItYm



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Model answer

Recent press criticism of modelling has been unfair, say Susie Diamond and Dr Claire Das Bhaumik, but they suggest there is room for improvement

A recent article in *The Telegraph*, 'Energy scandal: misleading efficiency claims leading to huge bills for homeowners',¹ caused quite a stir in the building physics community by stating that modellers are making misleading efficiency assertions.

The article was based on a University of Bath paper published in CIBSE's academic journal *BSERT*². The study intended to test the judgement of energy modellers when it comes to the relative significance of modelling input parameters. A sample of modellers, each sent a questionnaire giving a description of a real house, were asked to rank a range of specified changes-to-input parameters by the influence each were likely to have on the building's annual heating demand. This task was to be carried out without modelling software.

It is unusual for modellers to be asked questions in this way. The benefit of modelling software is that it allows us to test efficiently, in a virtual environment, how multiple building variables interact dynamically. Such interactions are not necessarily straightforward because of the complex interplay of all the parameters. For example, the influence of wall insulation on energy consumption will vary, depending on the level of internal gains and the effectiveness of ventilation.

This task requires a lot of information, and for modellers – or any construction professionals – to predict the often subtle relative changes in outcomes without using these tools is a tough ask. This view is supported by the accuracy of responses being generally poor, and not improving when participants had higher levels of qualifications/experience.

Having good instincts for the outcome of models is a valuable skill – it enables the development of more efficient models, and helps errors to be picked up and corrected in the process. But we are not convinced this test represents a fair way to assess this skill. *The Telegraph* article makes the leap that poor results in this test suggests responsibility for the performance gap in new homes – even likening it to the VW emissions scandal. This seems an unfair conclusion to reach, based on the nature of the study carried out.

Dynamic thermal modelling for energy use prediction is rarely performed commercially on new homes that require SAP modelling for Building Regulations Part L compliance. The article seems to point the finger at



"We take great issue with the blanket criticism meted out to modellers by this study"

modellers for a performance gap related to the discrepancy between compliance calculations (for Part L) and in-use energy consumption. As most practitioners are aware, the two are not well correlated, because compliance calculations are not intended to predict in-use energy. For example, they omit unregulated building loads and assume normalised building use. For this reason, the industry has adopted CIBSE TM54 for in-use energy prediction; this guides modellers in producing reliable energy prediction models, identifying the sensitivity of the results to changes in the input parameters.

The study suggests that modellers should have better instincts – and, with that, we'd largely agree. The modelling community does need to take responsibility for its models, working closely with the design team to validate input assumptions, questioning values that appear unrealistic, and being confident that they can justify their findings. We do our profession a disservice and invite criticism if we are not able to account for our work clearly. Modelling reports must give a thorough account of the input assumptions used, and clearly explain the methodology followed and what the results imply. It is unprofessional not to give this information, and means that discrepancies in the assumptions cannot be picked up. Isolated results do not make sense without the details on which they were based.

We take great issue with the blanket criticism meted out to the modelling community by this study, but agree that

the industry needs to address the performance gap by having an open and honest discussion about the ways we work together. To point the finger at any one discipline is to disregard the influence of all the other players in this team sport of building design and construction. In particular, designers – including modellers – need to complete the circle of building design by understanding how our buildings perform in the real world, and use this feedback to create better designs, more appropriate models, and improved ways of working together.

References:

- 1 Energy scandal: Misleading efficiency claims leading to huge bills for homeowners, 2 May 2017, *The Telegraph* bit.ly/2q4dqw3
- 2 The building performance gap: Are modellers literate? Salah Imam, David A Coley and Ian Walker, January 2017, *BSERT*, bit.ly/2qFvcaK

SUSIE DIAMOND is founding partner at Inklings.
DR CLAIRE DAS BHAUMIK FCIBSE is a partner at Inklings and a Level 3, 4 and 5 EPC assessor, and CIBSE Low Carbon Consultant – Building Design and Simulation

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HEADING FOR NEW HEIGHTS

New CIBSE President Peter Y Wong shares his vision for smart cities with **Liza Young** and explains how he overcame a fear of heights to reach the pinnacle of his profession

Peter Y Wong FCIBSE is the first CIBSE President to hail from Hong Kong, home to one of CIBSE's biggest branches. Wong's election acknowledges the contribution of the region to the practice and development of building services engineering.

Wong wants to share his experience of encouraging engineers in Hong Kong to eliminate barriers with the rest of the world. He urges CIBSE members to take the opportunity to share their knowledge across borders for the benefit of all engineers.

The new President used his address – given last month at the Royal Academy of Engineering in London – to call on CIBSE to reach out to engineers outside the UK, and deepen its pool of expertise on topics relevant to a worldwide audience.

'The language of engineering has no boundaries. CIBSE takes pride in sharing and learning from others, and can help those with less-developed engineering sectors to springboard to a future of low-carbon buildings,' he says.

The training and development of engineers is close to Wong's heart. He spent

15 years on the electrical and mechanical services training board at the Vocational Training Council in Hong Kong and helped classify the qualification framework for M&E graduate courses.

He believes sharing information and knowledge will be crucial for the future of the building industry.

'If we want to build smart cities, we need to be more inclusive. First and foremost, the requirement for a smart city is sharing information,' says Wong.

Although open data is key to building resilient communities, he believes governments – including Hong Kong's – could do more to share the data it gathers.

'The [Hong Kong] government has the power to collect data, but not the engineers to analyse it. Instead of just studying

"First and foremost, the requirement for a smart city is sharing information"



John Field presents Peter Wong with the presidential medal

population growth, we should be using data for forecasting,' he says.

'For example, your refrigerators or heat pumps can send their operational data to the factory in case of failure. We can use data to inform our designs, and we can do it tomorrow if we change the way we think.'

Wong says legislation around data protection is paramount because – if it falls into the wrong hands – 'it will be Orwellian'.

Another barrier, he claims, is industry's failure to go beyond the minimum. 'We have technical skill, but we must go above and beyond, and put our heart into it. We have to care about the planet and how people live.'

Wong believes many engineers in Hong Kong – and beyond – are simply completing a 'checkbox exercise'. Construction, he says,

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Peter Wong, John Field and guests at the presidential address



Peter Wong is a former chair of the CIBSE Hong Kong branch

is about the engineer going to site, talking to the contractors, and trying to find solutions, but he believes the systems of compliance mean many engineers have no incentive to go beyond the norm and be innovative.

‘The government will look for compliance, and that leads to a natural consequence – minimum standards. We need a cultural revolution. Engineering is more than basic

CAREER PICKS

- Electrical engineering degree, Illinois Institute of Technology, Chicago
- 1976-present: Yook Tong Electrical - director
- HK Institution of Engineers (building services division) - founding chair
- Engineers Accreditation Board - chair
- President-elect CIBSE

compliance,’ adds Wong, who believes tenders should be based on performance rather than lowest price.

Construction has transformed Hong Kong beyond recognition since Wong started work there. ‘It has become a beautiful urban jungle of towers, but not all changes have been good. The urban environment is less healthy – the air is still and humid,’ he says. If building services engineers were allowed to emulate award-winning sustainable projects more often, he says, the health of the city would be much improved.

In 2005-06, Wong was tasked with setting up the qualification framework to classify levels of skill – from high-school graduates to post-doctorate professionals – in electrical and mechanical engineering. He is determined to ensure engineers live

up to their potential and overcome their inhibitions. After all, Wong had to conquer a particular fear of his own in order to progress in the industry – acrophobia, or a fear of heights.

When he was young, he couldn’t go near a window in a tall building – or even go up in a lift – without experiencing butterflies in his stomach. In response, Wong took up the ultimate vertigo-inducing pastime – flying – and, with persistence, overcame his phobia while gaining a pilot’s licence.

During his Presidential year, Wong aims to promote the achievements and excellence of CIBSE members wherever they are – the health of the planet is resting on it, he says.

‘The world is depending on what we do to ensure we have healthy and productive places to live and work for generations.’ **C**



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HIVE OF ACTIVITY

Agile workplaces that allow staff to choose where they work are making inroads in offices. **Liza Young** finds out how such spaces will work alongside wellbeing principles

Imagine a workplace with a combination of quiet space, meeting rooms and ad-hoc community areas. Now imagine going to work and choosing a place to sit that suits the activity you need to do that day.

The philosophy behind this nomadic employment style, known as agile – or activity-based – working, is that, when people are able to choose where to sit, they structure their days more productively. Unlike ‘hoteling’ – where workers can reserve workstations in advance – or ‘hot desking’, where they can sit at any available desk, agile working is not necessarily a space-saving solution.

‘If you employ agile working, you can avoid having empty desks, but it does not mean you have less space – you just use it more efficiently,’ says Elinor Huggett, sustainability adviser at the UK Green Building Council (UK-GBC). ‘Agile working isn’t for every organisation, but – where it does work – we believe it has a positive impact.’ A gleaming example of this is Sky Central’s new HQ, in London, where building services have been designed to agile working principles by engineer Arup.

In its recent report, *Wellbeing lab: offices – a compendium of experience*, the UK-GBC highlighted office layout and better control as factors that influence human health and environmental sustainability.

Over the past eight months, the UK-GBC canvassed its members – including Max Fordham and BuroHappold Engineering – on the ‘quick wins’ they have made as a result of the Wellbeing Lab programme. They suggested: zoning space, to allow for quiet areas and collaborative areas; creating new types of workspaces, to reduce time spent at individual desks; and including recommendations in fit-out guides to help tenants maximise the effectiveness of their space.

Effective use of space – and giving people the autonomy to work how, and where, they want, can be beneficial for employees. But flexible spaces mean variable occupancies, so building services engineers have to ensure lighting, ventilation, cooling and heating are responsive, with excellent occupant control.

Agile pros

Arup associate Vasilis Maroulas says agile environments will work alongside wellbeing principles that are already gaining momentum in the industry.

‘Agile spaces ensure flexibility and cost-effectiveness because more people can be accommodated at fewer desks,’ he says. ‘This requires spaces that are easily adaptable, with responsive systems, which can create healthier environments through better control, suitable lighting levels, and better indoor environmental conditions.’

In addition to wellbeing and social benefits, Maroulas says the key advantage of agile working is the ability to adapt to individual needs and activity-based requirements.

‘Having a nice place to work increases productivity and adds spatial efficiencies, so

PROJECT TEAM

Building concept:

AL_A

Executive architect:

PLP

Engineer: Arup

Contractor: Mace

Workplace design:

Hassell

spaces could be reprogrammed for other uses or translated into economic savings.'

Henry Pelly, sustainability consultant at Max Fordham, says a balance must be struck between agile working spaces and giving people their own territory. 'If anyone can sit anywhere, their choice is reduced because – if the place they like to sit is gone – they are left with fewer options.'

He says a desk manages things you cannot hold in your head. 'Reducing space – and, therefore, reducing cost – is a narrow way of looking at the financial implications of agile working. By removing desks, you remove personal territory, reducing staff motivation.'

Pelly adds that turnover and motivation are intrinsically linked, and taking away things that employees need might cost more in the long run. People do different tasks during the day, so employers should offer spaces for them to do that more efficiently, but they also need a base as an 'extension of their memory'. He says the relationship between the work people do and the space available for them to do it can motivate staff to work.

Pelly, an environmental psychologist, has helped develop an approach that allows space to stimulate work (see Figure 1). The tree roots are the fundamental attributes of intrinsically motivating work; if these aren't cultivated, improving the physical environment won't make work better, he says.

The trunk is the need for basic physical comfort, and the branches are the key factors in functional comfort – the elements that need to be addressed for a workplace to be physically optimised. 'If all these factors are robust, you have the ingredients for psychological comfort that allow people to flourish at work,' says Pelly.

Max Fordham, which has been refurbishing

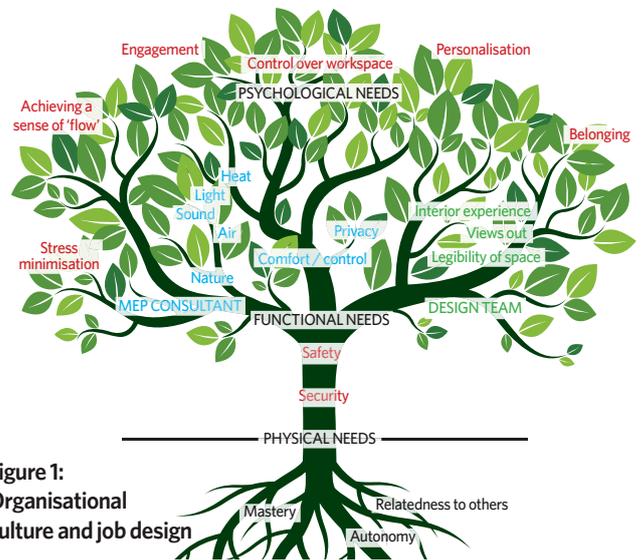


Figure 1: Organizational culture and job design

18
2,500
2,500
3,500

Inside Sky Central – 18 'neighbourhoods', 2,500 desks and 2,500 alternative settings, for 3,500 occupants

its London office over the past three years – including consultation – has incorporated a range of spaces to support the variety of work its staff do. This includes areas for collaboration, six solitary working desks, and a library on the third floor for doing cognitively difficult work.

The firm has reduced the amount of individual space, but it still gives most people their own desk, as well as a variety of additional areas to support other kinds of work. It is also switching desktop computers for laptops, so people can move around the office easily.

Trevor Keeling, senior engineer at BuroHappold Engineering, says different spaces – such as a whispery library or a lively breakout area – send contrasting signals to users, and prompt people to think in alternative ways. 'A quiet space prompts focused work, while a conference environment is better for collaborative work, because it encourages different behaviours,' he says.

All of these spaces have different requirements for environmental conditions, adds Maroulas. 'An active brainstorming session will need good daylighting and infrastructure provision, but could have forgiving comfort conditions. If you're on your own in a space, having the right indoor environment is critical. Lighting could be reduced in the ambient open-plan space, while meeting the lux requirements in the workplace, enhancing wellbeing and saving energy,' he says.

A challenge

Designing a single system with the adaptability that flexible working >>

AGILE LIGHTING

Sky Central is the main building on the media company's west London campus. With 30-40% glazing around its perimeter – which allows daylight to penetrate 7-8m into the perimeter of the floorplate – the building is predominantly top-lit.

An array of roof skylights bring light into the top floor, while several atria in key locations draw light into the ground and first floors. This ensures daylight is available throughout the building, enhanced by its tall, floor-to-ceiling heights, ranging from 4.5m at the ground and first floors to 5.5m on the top floor.

Employees have the choice to work in a space with more daylight – directly under the skylight – or in an area with more ambient, artificial light. The average ambient light levels across the floorplate are 300 lux, and occupants at workstations can boost levels to 400-500 lux using personal desk lamps. When there is sufficient daylighting, the artificial lighting switches off automatically.

Maroulas says: 'Having better control of their surrounding working environment aids occupant wellbeing, and feeds into the agile and wellbeing design principles.'



» environments require is a challenge. ‘Different activities require different lighting levels, temperatures and infrastructure support,’ says Maroulas, who adds that overloading systems and occupants with controls is not a panacea.

Another consideration is creating environments that can be adapted to accommodate future developments in technology. ‘The rate of change in our digital era is phenomenal – the meeting room of today is nowhere near the meeting room of tomorrow,’ says Maroulas. ‘The question is, how do we provide the infrastructure today, so that – in future – the same space would be able to accommodate advances in digital technology?’

This rate of advancement is the biggest challenge for creating flexible spaces, says Maroulas. Another issue is noise and distraction control.

Keeling says agile workspaces renegotiate the trade-off between interaction and privacy, improving both by offering a variety of spaces that can be used for either private work or collaborative endeavours.

This method of working makes it easy for employees to leave their desk to make phone calls and to have small meetings. Combined with specially designed furniture – such as booths with acoustic buffering – this results in less noise and disturbance for those who are working on their own. Agile spaces also offer somewhere else for people to go to work when required. ‘This not only allows people to avoid sources of distraction, but also sends a clear signal that they do not wish to be disturbed,’ says Keeling.

When comparing three office types – agile, open-plan and cellular – Keeling found that agile working combined the best parts of cellular (privacy) and open-plan offices (collaboration), giving the user the means to choose what’s best for them at any given time.’

When working at a static desk, staff can be easily distracted. ‘But if you have chosen to work on your own in a particular location, you are signalling that you don’t want to be disturbed. It is as much about sending that “do not disturb” message as having an environment that’s better for doing that work,’ says Keeling.

For BuroHappold, employing agile-working principles is a test bed. ‘We are monitoring things such as noise and air quality using sensors in different locations. People are responding about their preferences



– the average desk occupancy, over one week, at Sky Central, which has an average density of 8-9m² per person. CO₂ sensors control the amount of fresh air coming into the space



“Services designed around agile working are creating better indoor environmental conditions for staff”

– whether it’s too noisy or too stuffy – and this could be used to identify areas that are naturally more or less noisy, so tailoring agile design to how the building already works.’

The Sky’s the limit

In practice, agile spaces take a lot of planning; the concept for the new Sky Central building, at Osterley, London, was mooted 10 years ago.

Broadcaster Sky wanted to create a unique, activity-based workplace that would be responsive, inspiring, intuitive and amenity-rich for 3,500 people, catering to Sky’s fast-paced way of working.

Architects Amanda Levete and PLP and building engineer Arup responded to the brief by creating a three-storey, deep-plan ‘horizontal tower’ that would maximise opportunities for colleagues to meet and interact, but avoid the constraints of traditional high-rises. In fact, if Sky Central was a standard city-centre tower block, it would be 40 storeys tall.

Maroulas says getting design decisions about air and light correct at the beginning of the project was paramount. Arup’s approach was to bring in light from the top, and air from the floor of the 170x70m building.

The building – which is divided into 18 ventilation zones to serve multiple ‘neighbourhoods’ – was originally designed





for 2,700, but had the flexibility to cater for more than 3,500 occupants. Comprising a wide variety of space types – from desks, booths with partitions to offer attenuation from the ambient indoor noise, and secluded spaces where people can retreat from chatter – the building supports the full range of activities that Sky staff engage in every day.

To ensure adequate – and responsive – ventilation, an underfloor displacement ventilation system was installed. Air is fed out of floor diffusers at relatively high supply air temperatures – 19-21°C – and low velocity to avoid discomfort and cold draughts, displacing the existing warm, contaminated air and entraining heat from surrounding heat sources. The floor diffusers, operating in displacement mode, are connected to a pressurised floor plenum, which is fed by six risers, strategically located in the floorplate.

To ensure the system is responsive to the constantly changing space, the building services managers can lift up any 600x600mm floor tile with an inbuilt grille and move it to another location. No ductwork is connected to the diffusers, so their layout can be altered easily to suit any modifications in furniture, meeting rooms or desk positioning.

Maroulas says this approach was tested five years ago on The Hub – a 7,000m² building on the Sky Central site. ‘We had to run extensive CFD modelling and testing to ensure something like that could work effectively. When we were sure it could, we scaled up from a small prototype to a 46,000m² building.’

Sensors throughout Sky Central ensure uniform temperature in the large floorplate. ‘We are very reliant on having a delta T of 3K and low velocities to ensure we do not have large variability in temperatures,’ says Maroulas. Within the first nine months of operation, Sky Central reached its peak occupancy of 3,500 people and, so far, no complaints of cold or hot spaces have been lodged, he adds.

With an 80% average desk occupancy over one week – and an average density of 8-9m² per person – CO₂ sensors help to control the amount of fresh air coming into the space. In free-cooling mode, during the mild season, fresh air is brought through the air handling units directly from outside, reducing the refrigeration required to cool the air.

The tall, floor-to-ceiling heights mean a reservoir of ‘used’, warmer air at higher-than-occupant level rises – via the process of stratification – through the atria to the top floor, and is removed via extract points integrated into six infrastructure cores. Typically, the stale air is extracted naturally from March to June, and from September

to November, almost halving the energy consumption of the ventilation system during those periods.

Although productivity is yet to be measured at Sky Central, Maroulas believes the responsive services designed around agile working are creating better indoor environmental conditions for occupants.

Even placing staircases in prominent locations – and hiding lifts away from entrances – fosters a more agile and collaborative environment, while promoting a healthier lifestyle, he says.

‘As engineers, we are in the perfect position to instigate wellbeing choices through our designs.’ **CJ**

WOMEN MAKING A LAND

Exemplar projects with key roles for females help improve engineering's gender bias. Ahead of International Women in Engineering Day, **Andrew Brister** talks to three women who are helping deliver a new 'statement' building for the London School of Economics

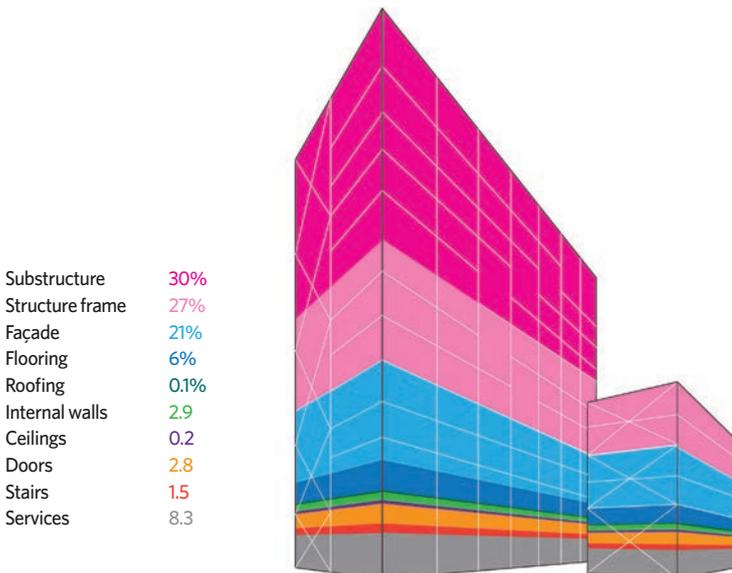
Only 9% of UK engineers are women. This alarming shortfall is something that International Women in Engineering Day (Inwed), on 23 June, aims to tackle, by drawing attention to the amazing careers in engineering available to women, and by celebrating the achievements of outstanding female engineers.

Building services consultancy ChapmanBDSP is one of the sponsors of this year's Inwed, organised by the Women's Engineering Society (WES). The firm recognises it has some way to go to achieve a 50:50 male/female split in its workforce and graduate intake. However, it has a plan of action, including going into schools as a science, technology, engineering and mathematics (STEM) ambassador, offering more work placements to female students, and being involved with WES.

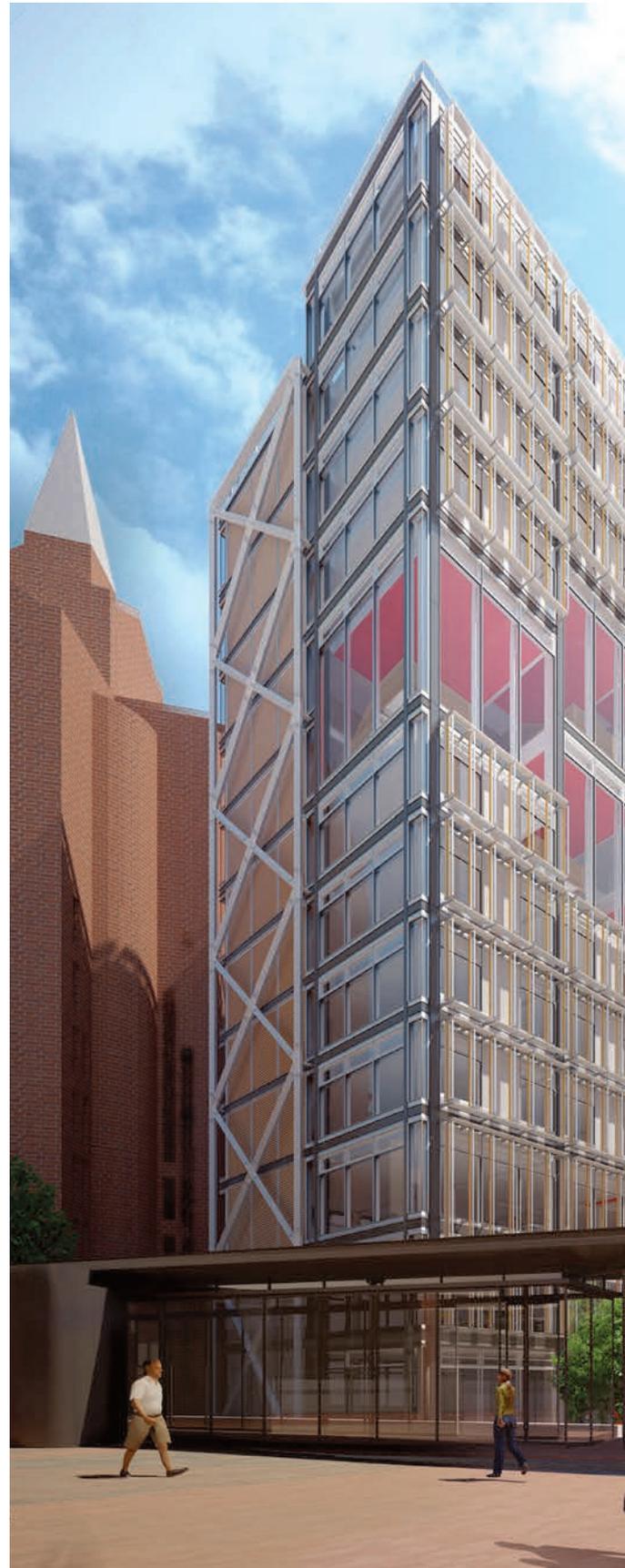
'As part of Inwed, we will be inviting former work experience people and interns to our offices to meet our engineers and look at some demonstrations and presentations taken from our current projects,' says Kathryn Cox, HR director at ChapmanBDSP. 'Staff will also be able to bring a female school/college-level relative to work on that day, to participate.'

One project that will be profiled is the £120m Centre Buildings Redevelopment (CBR) for the London School of Economics and Political Science (LSE), which ChapmanBDSP has worked on with architect Rogers Stirk Harbour + Partners. This involves the demolition of four existing buildings on LSE's Aldwych campus, to be replaced with a state-of-the-art, flexible and highly sustainable academic and teaching building. (See panel on page 30.)

What's interesting about this building is that there has been an unusually high proportion of women on the design team. To find out how this has affected collaboration, problem-solving and the often adversarial attitudes found on construction projects, we talked to three members of the team. **C**



Embodied carbon as per building elements (%)



MARK CONTRIBUTION

“The strong female representation was refreshing. The client reps were female and the tone of the working environment comes from the client; it was very collaborative”

LUCY VEREENOOGHE,
DIRECTOR AT CHAPMANBDSP



Lucy Vereenooghe heads up the ChapmanBDSP team responsible for MEP, environmental and lighting design at LSE CBR. A director at the firm, she switched to services consultancy after studying civil engineering at the University of Leeds.

‘Like many, I sort of fell into it,’ says Vereenooghe. ‘I was good at maths and physics at school, and

my maths tutor suggested I consider engineering. Yes, it was male-dominated – more so than now – but I didn’t see that as an obstacle.’

‘I’m lucky that I got that push from my teacher, because I hadn’t thought about engineering at all and had no perception of it,’ says Lucy. ‘Once I looked into it, and saw how vocational it was, it appealed to me. I did consider mechanical engineering, but I’ve always been interested in architecture and the built environment, so that led me to civil engineering.’

Vereenooghe has always worked in building services and didn’t find the switch from civil engineering an obstacle. ‘I think as long as you are numerate, keen and willing to learn, that’s the main thing – there’s a lot more to it than just your exams and studies.’

As part of its diversity policy, ChapmanBDSP aims to increase the number of women in the firm through events, such as Inwed, and the wider support of WES. The firm’s workforce is 21% female, with 13% of fee earners being women. ‘A lot can be achieved through better role models for young women – and that includes getting more women on the board. Work also needs to be more flexible in terms of hours and part-time working, and the stigma around taking paternity leave needs to be removed, so men can share in the childcare.’

Vereenooghe describes the fact that so many women were involved in the design of CBR as nothing less than ‘extraordinary’ – and it had positive benefits. ‘There was a good team dynamic and women are quick to forge good relationships, which I think pushed people to try even harder. It was less adversarial, with discussions between the team smooth and open, and less formal. It’s certainly one of the most enjoyable projects I’ve worked on.’

“There was a good team dynamic and women are quick to forge good relationships”

TAMSIN TWEDDELL, SENIOR PARTNER, MAX FORDHAM



Max Fordham is client adviser on soft landings and sustainability at CBR, led by senior partner Tamsin Tweddell. 'The strong female representation was refreshing. The client reps were female and the tone of the working environment comes from them; it was collaborative right from the start,' she says. 'There was the space to throw in ideas, without them being dismissed, ridiculed or quashed; there was an ability to disagree with someone respectfully. There were strong-minded individuals, but discussions were less adversarial than usual, and very positive.'

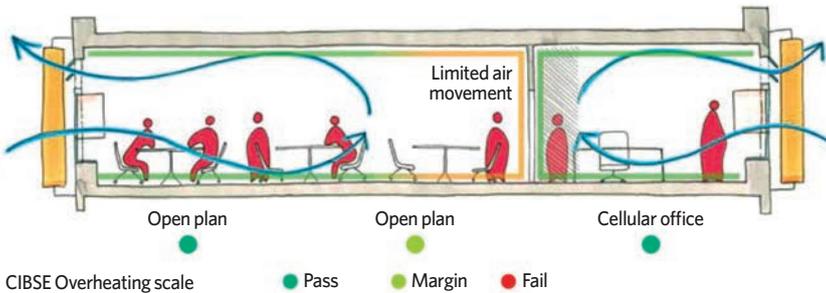
Relationships were forged in an interesting teambuilding exercise – creating a model of the proposed CBR out of

gingerbread. 'This got the project and relationships off to a great start,' says Tweddell.

Tweddell is currently the only female senior partner at Max Fordham and, last year, was elected as a one-year director. 'Two such posts exist each year, in addition to our longer-serving directors, which is an excellent way to give people exposure to this role and to understand how the business is run in more detail.'

Of the firm's 177 engineers, 24% are female – the proportion having increased steadily from 17% in 2012 – and the figure rises to 34% at graduate-engineer level. Engineering did not feature as a career option for Tweddell, either at school or after gaining a physics degree at the University of Cambridge. However, a spell at Sunseed – a practical centre for low-impact living and environmental education in southern Spain – ignited a passion for the possibilities in sustainability and low-energy building design. 'It showed me the positive impact that engineering can have, and that sustainability went beyond animals, plants and conservation.'

Tweddell was crowned Woman of the Year at the 2016 Building Awards and believes getting female role models into schools to talk about engineering is the way forward.



Section showing spatial arrangement (open plan or cellular) and effect of natural ventilation

FEDERICA ARIU, ASSOCIATE DIRECTOR, AKTII



A passion for drawing led Federica Ariu to structural engineering, and has taken her from a small practice in Milan to renowned London-based firm AKTII. 'I've always wished to move to this city, because of the high-profile projects here and the opportunity to work with leading architects.'

Ariu describes the LSE project as 'quite unusual. I could really appreciate some differences. On this project women were able to easily find common ground and a way of problem solving. I think we all felt comfortable in a short time. It was a good experience.'

AKTII is active within Women in Science and Engineering (WiSE) and is seeking to increase the number of female

engineers in the firm. Its initiatives include women engineers going into schools to explain the work being done on landmark projects such as the CBR. 'Firms do need to address issues such as flexible working, and increase opportunities for male partners to help with the family.' There are 52 female staff in AKTII – around 22% of the workforce.

'My message to young women considering a career in engineering is this: if you really like something, then go for it. Don't be put off by it being male-dominated.'

"On this project women were easily able to find common ground and a way of problem solving"

LSE'S CENTRE POINT

The LSE's CBR will replace four Aldwych campus properties: East Building, Clare Market, the Anchorage and the eastern part of St Clement's. These were no longer fit for purpose and the decision was made to demolish the buildings to make way for a new, efficient development, with more space.

The new building will increase the gross internal floor area of the centre buildings from 12,000m² to nearly 15,508m², allowing for growth in the school. In addition, there will be a new landscaped public square at the north end of Houghton Street.

One of the main objectives of the LSE's estates strategy is for the quality of the buildings to be commensurate with its international academic reputation.

The CBR will be a statement, landmark building and boast strong environmental credentials. It aspires to be a highly carbon-efficient building, achieving Bream Excellent in design to create a better environment for its occupants. The services strategy aims to minimise demand for energy, while opting for an efficient, low-carbon supply that includes biofuel combined heat and power (CHP) and solar photovoltaic (PV).

The new building will accommodate teaching and learning spaces of various sizes on the lower-ground, ground, first and second floors, a teaching and learning commons on the ground floor, and academic departments on floors three to 12.

'A simple and robust design combines the best elements of passive design with innovative and inventive MEP plant and controls, making it easy for users to adapt their individual environment on academic floors,' explains Lucy Vereenoghe, director at ChapmanBDSP.

The result is a predominantly naturally ventilated building. 'The success of the natural ventilation strategies to ensure comfort will rely on factors such as understanding of the controls, occupant interaction with controls, acceptance of noise levels from outside, fresh-air quality, achieving acceptable levels of air movement, and avoiding excessive air movement,' adds Vereenoghe.

Interiors have exposed thermal mass in the ceiling to stabilise diurnal temperature variations through night-time flushing of heat absorbed during the day. It is proposed that the top windows be triple glazed and supply daylight into deeper areas. They are openable and motorised, allowing for exhaust of hot air from spaces, and are controlled by the building management system (BMS) to enable overheating control and night-time ventilation for heat purge from the thermal mass.

Demolition of existing buildings started in June 2015 and was completed in December 2016. The new building is expected to be finished by summer 2019. Handover will be followed by a two-year soft landings period, led by Max Fordham.

PROJECT DETAILS

Client: London School of Economics

Architect: Rogers Stirk Harbour + Partners

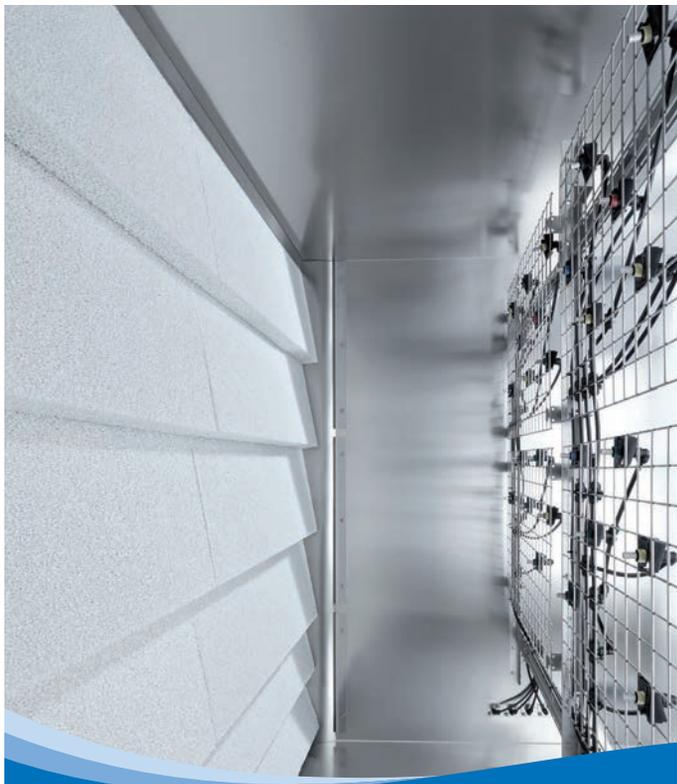
MEP, environmental and lighting consultant: ChapmanBDSP

Soft landings and sustainability: Max Fordham

Structural engineer: AKTII

Project manager: Deloitte

Main contractor: Mace



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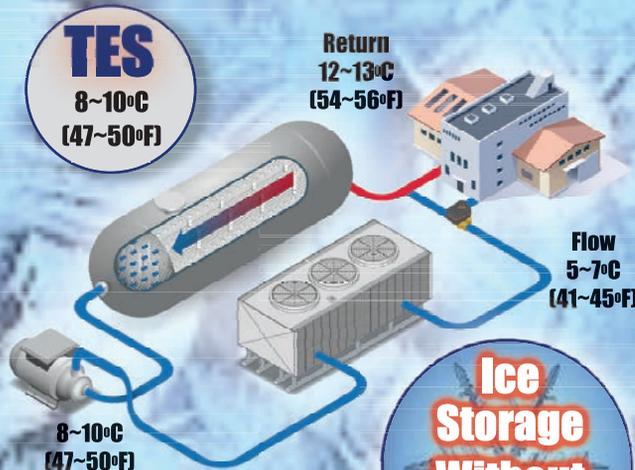
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BEIJING'S BURNING ISSUE

Tough limits on boiler NO_x emissions have been introduced to tackle Beijing's smog. Dr Gregory Zdaniuk, Joël Moreau and Lu Liu look at one retrofit's use of water vapour

China's rapid industrial growth has led to unprecedented levels of air pollution, which is having an impact on the health of its one billion inhabitants. Known contributors to this are traffic, coal-burning industries, and the combustion of solid fuels to heat homes.

The Beijing Municipality is at the forefront of the fight against air pollution, and is making a huge effort to tackle it, including banning new coal installations, restricting traffic and – of particular interest to engineers – introducing strict nitrogen oxide (NO_x) emissions standards for gas boilers. (See panel, 'War on smog').

Since 1 April, installations have had to comply with tough NO_x legal limits for new and existing



gas boilers that are even higher than European Union standards. The municipality has also introduced incentives to reduce gas-fired boiler NO_x; as a result, 1,500 boilers were modified in 2016 (see panel, 'Beijing's tough NO_x limits for boilers').

This article will look at how NO_x in boilers can be reduced by injecting water or steam into the flame zone, and describe the first project in China to adopt this method, using a system developed in Europe over the past 15 years. First, however, we will consider a range of ways to reduce NO_x – which can be classified as post-combustion methods and combustion-control techniques.

Post-combustion methods – for example, selective catalytic reduction or selective non-catalytic reduction – address NO_x emissions after formation, while combustion-control techniques prevent the formation of NO_x during the combustion process. Post-combustion methods tend to be more expensive and are generally not used on boilers with inputs of less than 10MW.

The issue of NO_x emissions in gas combustion is mainly down to so-called thermal NO_x, which is the reaction of nitrogen and oxygen molecules present in the combustion air. Thermal NO_x formation varies exponentially with flame temperature, so the primary method of NO_x control consists of reducing the flame temperature. This can be achieved in several ways:

- Improving flame distribution to reduce hot spots (improving fuel/air distribution and mixing)

Figure 2: WVP principle schematic applied to a condensing boiler

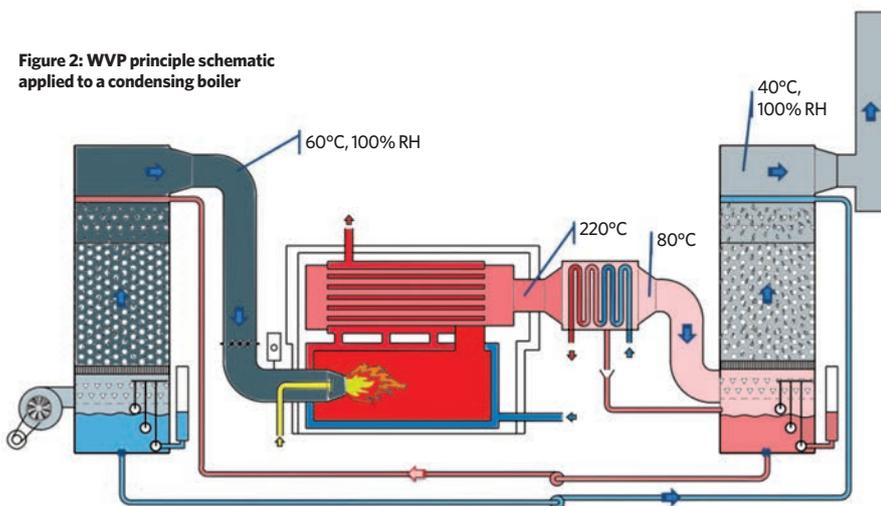




Figure 1: Same burner operating in wet combustion mode (top) and dry combustion mode (bottom)

- Altering the air/fuel ratio and excess O₂
- Adding flue gas recirculation (FGR)
- Using staged fuel or air injection
- Using staged combustion (both fuel and air)
- Injecting water or steam into the flame zone

For the combustion system supplier, the design challenge is to lower the flame temperature, while maintaining flame stability and boiler efficiency. Safety is also critical, especially when dealing with FGR, because of the risk of explosion from potential carbon monoxide (CO) present in recirculated exhaust gases.

Water vapour pump combustion system

Injection of water or steam causes the stoichiometry (the quantitative relationship among substances) – and therefore the adiabatic flame temperature – of the air-fuel mixture to be changed. Adding steam or water also dilutes the calories generated by combustion. Both phenomena cause the combustion temperature to be lowered – the flame colour becomes noticeably orange, as shown on Figure 1. If the flame temperature is sufficiently reduced, thermal NO_x will not be formed in great concentrations.

The water vapour pump (WVP) system is a wet combustion process developed and patented in 1979 by Dr Rémi Guillet, of Paris-based company CIEC, which has been part of the Engie Group since 2004. It consists of pre-heating and saturating the ambient combustion air with sensible and latent heat (humidity) recovered from the flue gases. To implement this, two spray towers are placed in the air stream: one in the fresh air intake and the other between the condenser and the chimney stack, as per Figure 2. All components are made of stainless steel and the burner is purpose-made to handle saturated combustion air. It should be noted that the WVP custom burner's geometry is nothing like that of a typical low-NO_x burner.

Because the dew point of the flue gases entering the condenser is increased (from -58°C in the case of regular gas combustion to -68°C in the case of wet combustion), a lot more latent heat is recovered in the condenser section of the boiler compared a regular condensing boiler operating at the same low temperature hot water (LTHW) flow and return temperature. Furthermore, the additional heat recovery occurring in the exhaust spray tower cools the flue gases to much

WAR ON SMOG

The Beijing Municipality has introduced a range of research measures to tackle air pollution:

- A ban on all new coal installations
- A gradual, mandatory decommissioning of existing coal installations
- Restrictions on new car registration and daily traffic
- Promotion of electric mobility
- Promotion of CNG-fuelled taxis and LNG-fuelled heavy transport
- Promotion of car-sharing and bike schemes
- Strict limits for NO_x in new and existing gas boilers

lower temperatures compared with a regular boiler. As a result, the WVP system is much more efficient than a regular condensing boiler.

Figure 3 compares the efficiency of the WVP combustion system and a regular condensing boiler as a function of LTHW return temperature. It shows that the onset of condensation is shifted to a higher LTHW return temperature, making the WVP system a perfect candidate for retrofit applications where it is not easy to reduce the building's LTHW return temperature.

The WVP system is characterised by very low flame temperatures, so is capable of reaching very low NO_x; 30mg/Nm³ is easily achieved as long as the combustion air is pre-heated to 60°C and fine-tuned to an optimal temperature. In contrast, 'dry' low NO_x and ultra-low NO_x burners can only achieve comparable levels of NO_x emissions by using a high proportion of FGR and, potentially, oversized combustion chambers.

Furthermore, reducing the flame temperature beyond a certain point in a dry combustion system results in CO formation – another controlled pollutant – but this is not a problem for the WVP. >>

NCV efficiency (%)

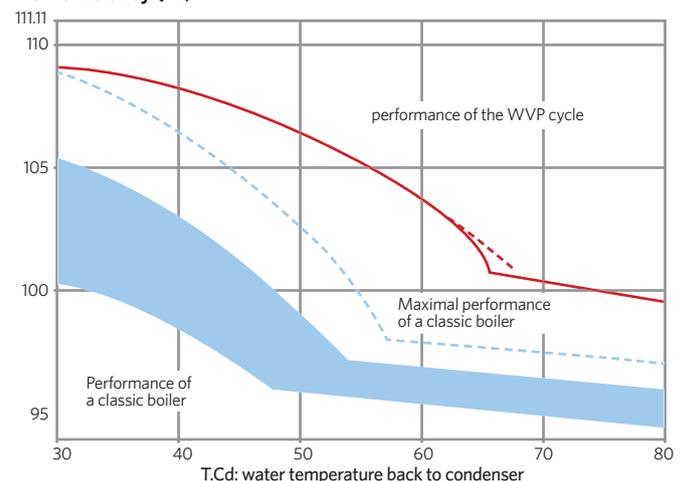


Figure 3: NCV efficiency of the WVP and regular condensing boiler as a function of the LTHW return temperature



Exhaust heat recovery spray tower

» The extensive removal of moisture in the exhaust tower also means the WVP will not generate a plume at the outlet of the chimney stack.

First project in China

Over the past 15 years, CIEC has deployed the WVP system in several European countries – mainly France, but also in Germany and Italy. NO_x limits are less strict in Europe, so the system is installed as an energy-saving measure.

In 2016, Beijing United Gas Engineering and Technology (Buegt) was awarded a contract by a college in Beijing to renew its boiler house. This consisted of decommissioning the coal-fired boiler house

and installing a new gas-fired system within the same building envelope. The scheduled completion date was before 1 April 2017, so Buegt could have installed boilers with a NO_x rating of 80mg/Nm³. However, the parties decided to explore solutions that were cleaner and achieved a better life-cycle cost; it was decided to implement the WVP system in China for the first time.

Designed by Buegt, the system comprises two 5.6MW gas-fired condensing boilers supplying LTHW to a campus serving 160,000m² of indoor spaces (the system has been sized to serve 200,000m², including planned extensions). The LTHW distribution network is designed for a flow and return temperature of 70°C/50°C; however, all terminal units are controlled by manual three-port valves, making the return temperature variable. The duty and standby arrangement of the boilers meant only one was fitted with the WVP combustion system; the second was fitted with a standard low-NO_x burner.

Commissioning works concluded in March 2017, with the NO_x emissions tested at 23mg/Nm³ (corrected to 3.5% O₂ content), well below the 30mg/Nm³ limit. Overall boiler efficiency was 107% – at an LTHW return temperature of 45°C – and CO emissions were measured at 0mg/Nm³.

Conclusions

The WVP is combustion technology capable of achieving ultra-low NO_x emissions (<30 mg/Nm³) at considerably higher efficiencies and lower life-cycle cost than conventional condensing boilers. It can be retrofitted to an existing boiler without any significant loss of capacity, whereas typical low-NO_x burner retrofits may require a derating of capacity. Faced with a severe smog problem, Beijing is at the forefront of the fight against air pollution and its actions should be observed by policy-makers from around the world. **CJ**

■ **DR GREGORY ZDANIUK**, senior engineering manager, Engie China; **JOËL MOREAU**, deputy managing director at CIEC; **LULIU**, deputy chief engineer at Buegt

BEIJING'S TOUGH NO_x LIMITS FOR BOILERS

Under the Standard on Air Pollutant Release for Boilers (DB11/139-2015), new installations and coal-to-gas conversions must now comply with a NO_x limit of 30mg/Nm³, while existing installations have a limit of 80mg/Nm³ (at a reference O₂ concentration of 3.5% for industrial boilers, including heating applications, and 3% for power plant boilers). The equivalent EU Medium Combustion Plant Directive NO_x limit for new installations is 100mg/Nm³ at 3% O₂ (70mg/Nm³ in particular cases).

As well as strict legal limits, the Beijing Municipal government introduced a gas-fired boiler NO_x reduction incentive programme, through which projects are rewarded according to how much NO_x they save. This ensures money goes to projects with the highest impact. As a result, 1,500 gas-fired boilers were modified in 2016. This year, Beijing plans to implement low NO_x modifications on more than 7GW of gas-boiler capacity.

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LIGHTING THE WAY

Revised emergency lighting standards now include sections on emergency safety and standby lighting. Atkins' David Mooney highlights what this means for designers

The way designers approach emergency lighting changed fundamentally last year, with the revision of *BS 5266 Emergency lighting – Part 1: Code of practice for the emergency lighting of premises*.

The standard has more on emergency safety lighting and standby lighting, and responsibilities are better defined – but the area is now more complex, so there is potential for misunderstandings between the parties responsible for the briefing, design, installation, testing/commissioning and ongoing operation of emergency lighting.

Emergency lighting is required for incidents involving a power failure – where the absence of electric light would compromise people's means of escape – and ensures the safety of building occupants, including in external areas, up to the place of safety as defined by BS EN 1838.

It is governed by a number of documents. The ultimate legal statutes are: the Regulatory Reform (Fire Safety) Order; the Health and Safety at Work Act; Building Regulations; and the EU Workplace Directive. Specific compliance guidance is given by Approved Documents B1 and B2, and design and product standards BSs and BS ENs as identified below:

The Society of Light and Lighting's (SLL's) *LG12 Emergency Lighting* and ICEL documents give guidance on best practice and product certification, with CIBSE Commissioning Code F offering additional guidance.

The Regulatory Reform Order, Approved Documents and BS 5266 cross-reference each other, and should be seen as the main methods of demonstrating compliance.

Since 2005, and the introduction of the Fire Regulation Reform Order, the legal imperative for installing emergency lighting systems is the same as for fire-alarm systems.

Key changes

The main changes in BS 5266 are the introduction of two new levels of emergency lighting – emergency safety lighting and

standby lighting. These have been mentioned in BS EN 1838 *Lighting applications – Emergency lighting* and BS 5266, but the 2016 version of BS 5266 expands on this.

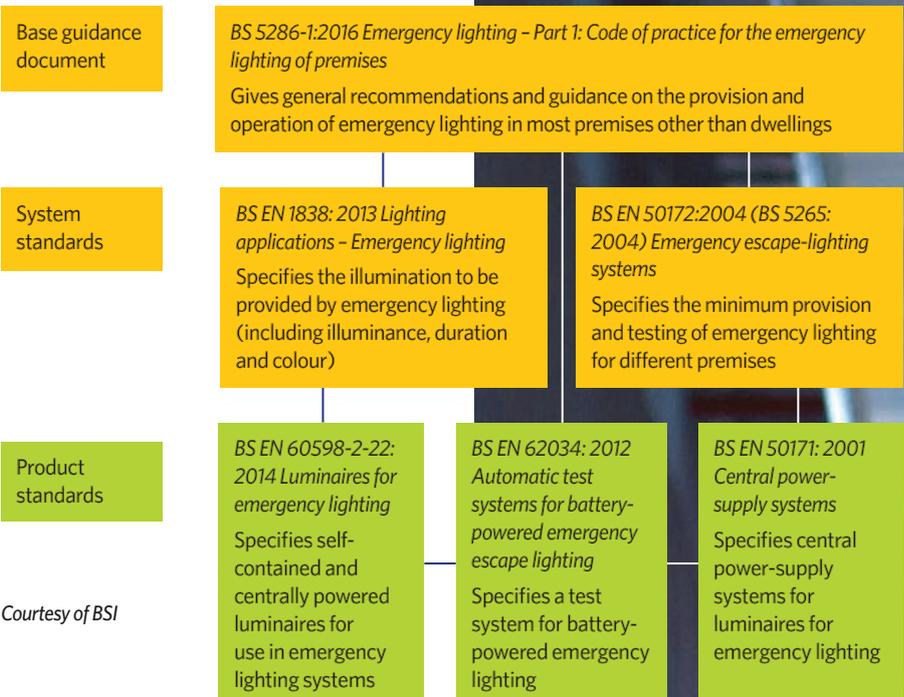
For **emergency escape lighting**, there is no change in BS 5266, but it is worth noting that the system has to cover all escape routes to the place of safety (BS EN 1838), which may be in the immediate vicinity or away from the building. This must be adequately lit by the emergency lighting system or an independent power supply, such as public street lighting.

Emergency safety lighting applies to buildings for which a staged evacuation plan is implemented during power failure. Emergency safety lighting is adequate to allow occupants to stay in an area of the building during a power failure, but is not enough for functional tasks to be continued. The Health and Safety Executive's document HSG 38 *Lighting at Work* gives the minimum requirements for this type of lighting.

Standby lighting is needed in buildings



Summary of standards covering emergency lighting



Courtesy of BSI

where functional tasks must continue during power failure. This needs to be 100% of the normal lighting.

Who is responsible?

The building owner is required to prepare a risk assessment detailing the emergency-lighting risks they have identified as applying to the occupation of a building.

In the case of a multi-occupancy building, the tenants are responsible for doing a risk assessment for their tenanted area, and the landlord is responsible for the common areas. The risk assessments can only be written by the responsible person because they include the management procedures that apply to their occupancy. This includes: identifying high-risk areas; high-risk or safety-related tasks; and areas where occupants may be required to remain in the case of a power failure. Points of emphasis and high-risk areas are likely to change during the life of a building. (For more, see the expanded version of this article at cibsejournal.com).

“Small changes can trigger a larger level of responsibility”

Facilities management (FM) teams are aware of the weekly fire-alarm tests and should be aware of the need for a daily visual inspection of the emergency lighting before occupation of the building.

BS5266 refers in more detail to competency standards for the designer, installer and the maintainer. The responsible person must ensure they engage competent people for all stages of procurement and operation of the emergency lighting system, from the time they first occupy the building until they leave.

For designers, this would include lighting-design and electrical competency. Central power-supply systems require electrical circuitry design, so a qualified electrical engineer needs to be engaged. An installation using self-contained luminaires could be photometrically calculated and laid out by lighting designers with basic knowledge of electrical engineering, and they would brief the electrical engineer for CPS systems.

The definition of competency is not established within BS 5266 Part 1. SLL recognises competency as a full member of the society (MSLL) who has sufficient emergency-lighting knowledge through relevant experience. AMSLL and MCIBSE members are not recognised. The British Approval of Fire Equipment (BAFE) also has a competency qualification course that can be

accessed through the mid-career college.

The legal basis of emergency lighting procurement is essentially the same as that for fire regulations, in that the building owner/organisation is the ‘responsible person’ as defined by the regulations. As such, they must ensure the correct provision and operation of the emergency lighting system(s). Best-practice methodology responsibility includes:

- Competent design
- Competent installation
- Annual – and at significant change – emergency lighting risk assessments
- The provision of ‘as fitted’ documentation and its continual update to represent the actual installation (annual review/update)
- Audited test records proving the continuing functionality of emergency lighting system(s), including photometric performance at the end of stated duration
- Emergency lighting log book.

New technology

The adoption of LED luminaires and the upgrading of battery technologies have opened the door to a new class of system that didn’t exist before distributed central power supplies. These systems – common in Europe – offer extensions in rated battery life from four to 10-plus years, with reduced spatial requirement and lower FM and capital costs – between those of traditional self-contained systems and central power-supply systems. LED luminaires are now often the first choice for emergency lighting, but there are pitfalls, such as the introduction of batteries and an inverter changing the ambient temperature within the luminaire. There is now no common photometry between different manufacturers with LED luminaires. (See more at cibsejournal.com).

BS 5266 now also specifies that central power-supply systems feeding emergency lighting should be in their own dedicated room. Service life for nickel cadmium batteries is mentioned as being four years. This would indicate that additional proof of the self-contained luminaire’s or battery pack’s ability to produce the required emergency lumens would be needed after four years. This proof might consist of an illumination survey at the 1hr/3hr marks of the annual duration test. Where occupiers of a building append their own non-illuminated emergency signage, this must also be illuminated by the emergency lighting system under BS 5266.

With these amendments, it is easy to see how small changes to a building can trigger a larger level of consideration and responsibility for the responsible person – usually discharged through the FM team.

■ **DAVID MOONEY** is an associate at Atkins



HERE COMES THE SUM

Design to prevent overheating in dwellings can be approached by linking adaptive thermal comfort with the basic admittance method, says **John Harrington-Lynn**

The article ‘Sounding the alarm on overheating’ in the March 2017 issue of *CIBSE Journal* triggered a potential design approach to avoid overheating.

Buildings either need to have full air conditioning and heating control to prevent overheating, or:

- Be insulated to prevent heat gains and losses
- Have appropriate glazing area, glass types and external shading
- Have adequate infiltration/ventilation provisions
- Have an appropriate level of thermal mass to deal with internal gains.

The solution is either to adopt the full air conditioning-controlled approach or attempt to cope with the problem through design.

Buildings, as well as being energy efficient – under Part L of the UK Building Regulations – must be designed to cope with summer overheating by glazing area and type, shading and thermal mass. But there is no specific definition of summer overheating.

After being approached to offer advice on the role of thermal mass – in particular, the admittance method on thermal comfort in free-running buildings – I produced a potential methodology linking this with the concept of adaptive thermal comfort.

Basis of the admittance method

The basic admittance method was developed at the Building Research Station (BRS) by Alec Loudon and his colleagues, initially to deal with the problem of summer overheating in office buildings. At the time, these were constructed with large glazed areas and air conditioning was extremely rare, while the main source of heat gains during the summer was solar gain.

The manual method calculated a peak summer temperature – made up of a daily mean 24-hour temperature and swing in temperature about the daily mean – for a typical cellular office. There was no allowance for other gains such as from lighting.

Link between the adaptive comfort and admittance method temperatures

Adaptive comfort temperature could be

considered to be made up of a daily mean value and a daily range, so to a first approximation, very similar to the peak and mean temperatures calculated in the admittance method.

It should be remembered that the comfort temperatures are a measure of what people feel, but the daily mean and peak temperatures are estimates based on the results of mathematical calculations and theoretical simulations of the physical temperatures in a building.

What is required is a method to estimate the boundary conditions for the internal temperature variations to ensure comfort within an insulated building.

This would assume the solar gains through glazing have been minimised and the internal gains are absorbed and redistributed via the thermal mass and ventilation, to cope with the increasing external temperatures.

The thermal response factor

Once it is constructed, the thermal mass of a building cannot easily be changed. The use of phase-change materials has been suggested, but I do not believe these have got beyond the experimental stage.

I suggest that by using the thermal response factor (f) it is possible to set boundary conditions via a combination of the thermal mass and



“The methodology can be applied to buildings designed to cope with the expected climate change predictions for winter and summer”

insulation levels, to assist in achieving comfort conditions throughout the future life of a building. This would be similar in concept to the clo unit.

The thermal response factor (f_r) is derived from the following equation: $f_r = (\Sigma AY + C_v) / (\Sigma AU + C_v)$

This enables the following link between the mean internal temperature and the peak daily temperature:

$$(\overline{\theta_{ai}} - \overline{\theta_{ao}}) = \frac{H \cdot f_r \cdot (\widehat{\theta_{ai}} - \overline{\theta_{ao}})}{H \cdot f_r + (24 - H)}$$

Where:

f_r = thermal response factor

$\widehat{\theta_{ai}}$ = peak daily internal temperature

$\overline{\theta_{ai}}$ = daily mean internal temperature

Table 1

Effect of thermal mass and ventilation on comfort						
Peak temp ($\widehat{\theta_{ai}}$)	20	20	20	20	20	25
Ext mean temp ($\overline{\theta_{ao}}$)	0	5	5	10	15	20
Ventilation rate	0.1	0.1	1.1	4.1	10.1	10.1
Response factor	6.5	6.5	4.96	3.4	2.2	2.2
$\widehat{\theta_{ai}} - \overline{\theta_{ao}}$	20	15	15	10	5	5
$\overline{\theta_{ai}} - \overline{\theta_{ao}}$	17.33	13.0	12.48	7.73	3.43	3.43
$\overline{\theta_{ai}}$	17.33	18.0	17.48	17.73	18.43	23.43
Daily range = $2 \cdot (\overline{\theta_{ai}} - \overline{\theta_{ao}})$	5.34	4.0	5.04	4.56	3.14	3.14

Effect on the daily mean internal temperature for daily mean external temperatures



$\overline{\theta_{ao}}$ = daily mean external temperature

ΣAY = sum of the area weighted admittances for the building

ΣAU = sum of area weighted U values for the building

C_v = ventilation conductance

Assuming the following:

- the peak comfort temperature ($\widehat{\theta_c}$) is equivalent to the peak daily internal temperature ($\widehat{\theta_{ai}}$)
- the daily range in comfort temperature is twice the difference between the daily peak temperature and the 24-hour mean temperature
- H is 12 hours.

We can use the second equation to make an estimate of the response factor for a given building design (construction and infiltration/ventilation rate), and derive the sum of the admittance values and select the appropriate constructions to meet this value.

With modern, well-insulated and sealed buildings, the denominator in the first equation will be small, whereas the numerator will be comparatively large, as it includes the surface areas of the internal spaces.

It is reasonable to treat a dwelling, or other small building, as a single unit and calculate the response factor for the complete building, rather than doing it on a room-by-room basis.

Application of response factor

A typical terrace house (approximately 6m wide x 5m high x 7m deep) – built to meet current Building Regulations with minimum ventilation – will have a heat loss rate ($\Sigma AU + 0.33NV$) of approximately 95 W·K⁻¹.

Assuming a daily mean external temperature ($\overline{\theta_{ao}}$) of 5°C, an internal peak temperature ($\widehat{\theta_{ai}}$) of 20°C for 12 hours, and $\widehat{\theta_{ai}} - \overline{\theta_{ai}}$ of 2°C and minimum ventilation – from the second equation – the response factor (f_r) is 6.5.

From the first equation, this requires an admittance ($\Sigma AY + 0.33NV$) of approximately 610 W·K⁻¹. This would require medium-density concrete blocks for the internal partitions.

Table 1 illustrates the effect on the daily mean internal temperature and temperature range for a selection of daily mean external temperatures. It shows that increasing the infiltration rate reduces the thermal response factor (f_r) and the daily temperature range.

Replacing the concrete blocks with plasterboard on studs will reduce the thermal response factor, resulting in an increase of the temperature range.

Conclusion

The above – rather simple – analysis of the use of the thermal response factor offers a useful tool to explore the effect of thermal mass on the internal temperatures of a dwelling, or other buildings, and its influence on comfort, deriving an appropriate level to cope with both winter and summer conditions.

As well as examining the current problem of summer overheating, the methodology can be applied to buildings designed to cope with the expected climate change predictions for winter and summer.

The analysis will require a decision to be made on the likely climate that the buildings will have to cope with over their lifetime, and include advice on the use of external shading and whether heating systems should be designed for intermittent operation. **C**

■ Harrington-Lynn J, Derivation of equations for intermittent used in CIBSE Building Energy Code Part 2(a), *Building Services Engineering, Research and Technology*, 19(4) 1998.

■ CIBSE's recently-published *TMS9: Design methodology for the assessment of overheating in homes* is available for free

■ **JOHN HARRINGTON-LYNN** MCIBSE is a retired consultant

TEMPERATURE'S RISIN'

In a country where temperatures reach 50°C, building and HVAC design is pushed to its limits every day. The latest ASHRAE hot-climate design conference in Qatar discussed best practice and new technologies in hot environments. **Frank Mills** reports

The second ASHRAE conference on hot-climate design was held from 26-27 February, in Doha, Qatar. Here, temperatures can reach 50°C in summer and HVAC systems must be capable of maintaining thermal comfort for health, wellbeing and productivity, while operating efficiently and reliably.

The most challenging presentations at the conference – entitled 'Energy and indoor environment for hot climates: outdoor cooling technologies, challenges and opportunities for the hot climate' – concerned the desire to improve thermal comfort outside buildings during the summer.

With a football World Cup looming in 2022, this is a pressing requirement in Qatar. The best players on the planet will visit the country along with millions of visiting fans, sports writers and support staff, who represent a major tourist-income stream. Their comfort in the summer months will be a key factor in the success of the event.

During presentations, it was clear that there was a desire to create cooler outside environments – not just for visitors or the World Cup,

but also for locals, who find the summer too hot and oppressive every year. The various proposals ranged from installing local cooling equipment to better planning, shading, use of vegetation, adiabatic cooling (evaporation) and even radiant cooling.

The conference opened with a keynote paper from ASHRAE president-elect Bjarne Olesen, who went to the heart of the main issue in hot climates – namely the design criteria for thermal comfort and air quality. He asked: can international standards for indoor environmental quality be applied in hot climates?

Experience has shown that the 'static' need for cooling, based on ISO 7730 requirements, has led to thermal shocks, discomfort and loss of productivity. But the new adaptive

"The dependence on cooling for many new buildings means any proposed alternatives must be robust, reliable and affordable"



models – such as ASHRAE 55, which recognises a flexible approach by relying, in part, on the ability of humans to adapt and interact with the environment – has been much more acceptable.

Papers by Belkhouane, Hensen and Attia took this discussion further by covering thermal-comfort models for net-zero-energy buildings in hot climates. They noted that, to some extent, the psychological aspect to the feeling of comfort means it's a 'state of mind' – and, so, subjective. Of course, engineers and their developer clients need to use more tangible data, and the new adaptive models do respond to this need and offer solutions.

The theme of low- and net-zero energy was evident throughout the conference, highlighting the new direction being taken by the Gulf states, which need to conserve their valuable fossil-fuel reserves as a long-term asset, while reducing global warming and environmental impact.

The recent announcement by the Dubai Electricity and Water Authority about constructing the largest net-zero building in the world signifies the practical intent behind these ambitions.

The keynote paper by Professor Jarek Kurnitski, Rehva vice-president, gave an overview of the road towards net zero in Europe, looking at the Energy Performance Directive and its implementation across European Union (EU) states.

He reminded us of the target to achieve net-zero-energy buildings (NZEB) for all new public buildings by 2019, and all other new premises by 2021. The UK target has been more ambitious, aiming for all new schools to be net zero by 2016, progressing towards all buildings by 2019. But, the recent postponement of Part L updates has left the UK stuck on Part L 2016.

Whatever the UK decides, it is clear that the Middle East is following the European lead and NZEB will be its target.

Professor Dejan Mumovic's address represented CIBSE, and focused on the relationship between thermal comfort, ventilation rates, IAQ and health response of students in schools and colleges, using the results from recent research in Europe. The Schools Indoor Pollution and Health: Observatory Network in Europe (Sinphonie) studies aimed to prevent and reduce respiratory disease and to raise performance.

The conference comprehensively covered the design of buildings in hot climates, starting with technology, orientation, massing and use of natural resources, such as wind and water.

The case study on Jubail Industrial City showed the environmental, economic and social benefits of roof gardens, which improve

CIBSE'S GUIDE TO BUILDING IN TROPICAL CLIMATES

The CIBSE design guide *Buildings for extreme Environments – Tropical* is now available. **David Hughes FCIBSE** traces its history

With globalisation, we must not lose sight of the demands that are made on those who deliver the engineering that supports it. CIBSE has an important part to play in giving guidance on the design of the necessary buildings and infrastructure.

Engineers first started working in the Middle East to develop oil and gas reserves. For those used to the temperate conditions of the UK, the harsh environment of the desert was quite a contrast.

In 1990 CIBSE Technical Memorandum TM4 – Design Notes for The Middle East was published to give information relating to building services design in the region. Some 20 years later, demands were greater, sustainability and energy consumption were gaining a higher profile and engineers were finding themselves working on projects all over the world.

TM4 was not fit for purpose, both in concept and in scope, but what to do? It was decided to adopt an approach based on climatic zones under the umbrella theme of 'Buildings for Extreme Environments'. These were to be in three concept documents Arid, Tropical and Cold Climates. Arid was published in March 2014, Tropical has just been published and Cold Climates should be available later this year.

The documents draw on the knowledge and experience of engineers and academics working in the relevant countries and climatic zones. They cover the design tools required, and examples of real projects and techniques that would be of use to practising engineers in these regions. View guides at www.cibse.org/knowledge

"A strategic approach, integrating past practice with modern technologies, is needed"

air quality because CO₂ is removed and oxygen is added to the air. Roof gardens reduce solar heat gains and create the 'oasis effect' – pools of cooler air.

HVAC technologies ranged from central plant and district energy to systems and equipment, with several innovative solutions. These included using phase-change materials (PCMs) to reduce plant size, optimise performance and store 'spare' heat or coolth until needed, rather than rejecting it – as tends to happen in the UK.

Hot climates sometimes offer opportunities for higher efficiencies; the presentation of the gas-driven heat pump with desiccant dehumidification (GHP/DD) showed how waste heat can be used to regenerate the desiccant wheel, as well as to augment heat capacity for heat and hot-water systems.

A number of presentations focused on the trend to replace CFC and HCFC refrigerants – R22 is still in use in Gulf countries – with low global-warming potential (GWP) and zero ozone depletion fluids. The absolute dependence on cooling for many new, modern buildings being constructed in the Middle East means any proposed alternatives must be robust, reliable and affordable.

In his paper and address, Omar Abdelaziz, of Oak Ridge National Laboratory, updated delegates on alternative refrigerants for air conditioning. He said that widespread dependence on the HCFC R22 still exists, before showing the available range of alternatives for use in hot climates. Comparisons showed efficiency, cost, reliability, performance, health and safety, and suitability for 'drop-in' replacement.

There is no simple solution, and delegates agreed that a strategic approach – integrating past practice with modern technologies – is needed for better comfort, wellbeing and sustainability. **CJ**

FRANK MILLS FCIBSE is technical director at Frank Mills Consulting



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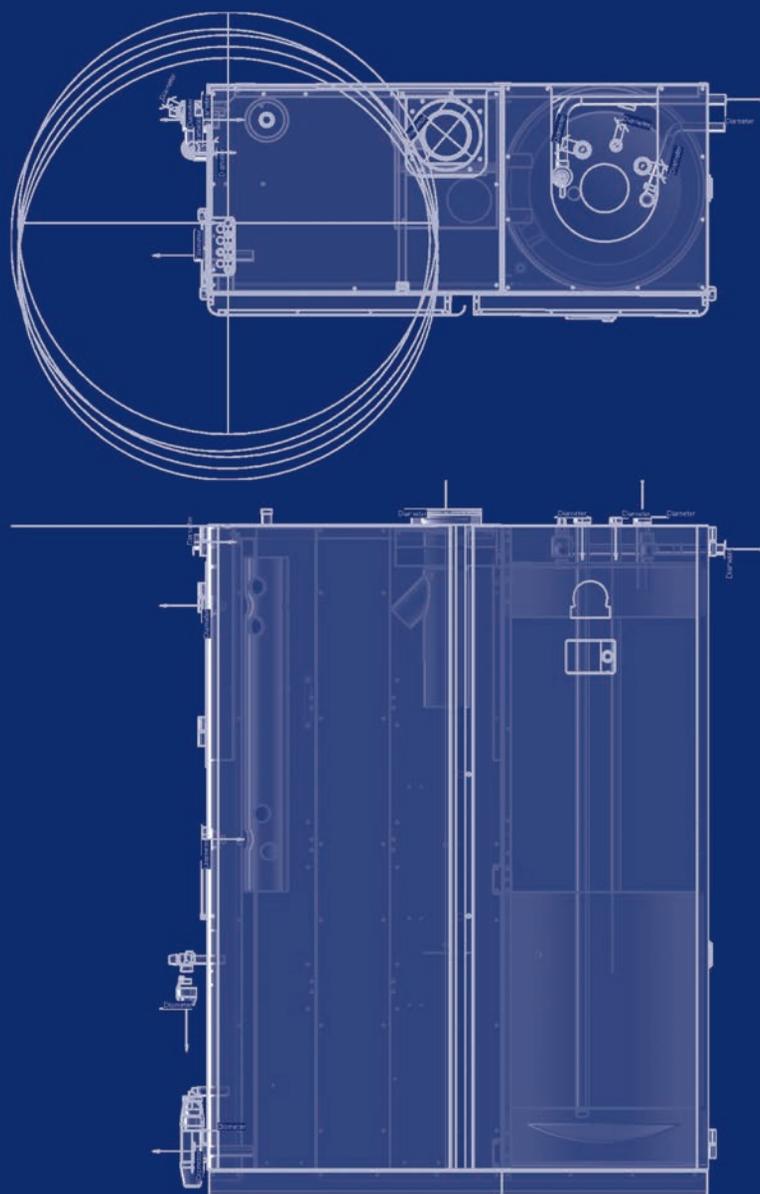
Since Building Information Modelling (BIM) at Level 2 became compulsory for all centrally procured public sector projects, there have been no industry standards for file creation. The result? A frustrating lack of uniformity between manufacturers that slows work down. The lack of interoperability means once a BIM file for a product is added to a design, it's hard to make changes – and we all know that changes are a part of every project.

Andrews Water Heaters got to work to improve the situation. Their new Autodesk Revit BIM files get straight to the heart of the problem, and put it right, by offering a varied level of detail (LOD). Sales director, Chris Meir, explains:

“In the early stages of a building’s design, products need to be moved around, which is one of the key benefits of BIM. But the more comprehensive BIM files were, the larger the file. This started to cause some major issues because they became slower to upload and manoeuvre.

Market research carried out by Andrews Water Heaters told us that specifiers want very basic drawings while the design is still being finalised. It's only during the latter stages of a project that more details need to be included in the BIM files. For example, when the building is handed over to the owner or operator, you need to add in information such as service intervals.”

This insight led Andrews Water Heaters to develop two kinds of files – ones with minimum detail for the first stages of projects (LOD 3), and more detailed files (LOD 5) for later on. It's a faster and more efficient way of working that makes it easier to get the job done.



Andrews Water Heaters Autodesk Revit BIM files are made to CIBSE PDT standards. Storage water heater files were launched in conjunction with CIBSE. The PDTs for this product group are available at: www.andrewswaterheaters.co.uk.

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Cover: Birmingham City University

Tooling up



Building information modelling (BIM) is not simply for 3D coordination – it is an engineering tool. Hoare Lea's Sadie Adams, Sabrina Gill and Alec Mabbott make this apparent on page 48. They describe how the firm created a virtual BIM environment for Birmingham City University's new and existing assets, extracting full value from the project data throughout the design, construction and operational processes.

The authors say BIM enabled efficiency in the design process; embedded information within the MEP model was taken forward by the contractors for use within the 'as built' model, before being progressed by the university into the facilities management of each building.

On page 46, CIBSE digital engineering consultant Carl Collins details why the recently-published *DE4 Common data environments* (CDE) guide is a must-read for all engineers operating in BIM Level 2. Collins says understanding what is involved in a CDE is crucial for setting up projects and standards, as well as for checking and approving required procedures.

However, it's not all plain sailing. Research student Melanie Robinson – who presented a poster at the recent CIBSE ASHRAE Technical Symposium – says the uptake of BIM in the industry is still too low, and we risk a market split between those who can and those who can't (page 52).

■ **LIZA YOUNG, DEPUTY EDITOR** lyoung@cibsejournal.com

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Ensuring a smooth transition



Awareness and adoption of BIM has no doubt risen since Level 2 implementation on centrally procured government projects became mandatory. In fact, a recent NBS survey revealed that more than six in 10 (62%) respondents use BIM, a rise of 8%

compared with the year before.

However, there is still a lot to be done in order for all parties involved in a building's lifecycle to reap the full benefits from this way of working. Not only do contractors need to continue investing in BIM training and managing cultural change within their organisations, but the onus is also on manufacturers to engage with, and support, contractors in making the transition to becoming fully BIM compliant.

Whether this means providing BIM files

with the appropriate level of detail in accordance with the stage of a project, or creating them in line with CIBSE's Product Design Templates, manufacturers – such as Andrews Water Heaters – have a key role to play in enabling a more collaborative workflow, and smoothing the process from design and build to operation and management. In doing so, not only can we help businesses win more work now and in the future, but also help position the UK as a global leader in building services on the international market.

■ **Chris Meir**, sales director, Andrews Water Heaters
■ **WEB:** www.andrewswaterheaters.co.uk
■ **TWITTER:** @AndrewsWH





Demystifying BIM

CIBSE has released the fourth guide in its Digital Engineering series. The Institution's **Carl Collins** explains why *DE4 Common data environments* is important to the building services sector

For any company operating in BIM Level 2, the common data environments (CDEs) will be the only way in which information will be exchanged. Understanding what is involved in a CDE is fundamental to setting up your project and the standards, and checking and approving the procedures that will be required. Also, there is scope for the building services actors in a project to have an input into the BIM Execution Plan – and that often revolves around the ‘standard method and procedure’ part of the piece.

‘Standard method and procedure’ is mainly the file naming, the layer naming – if you are using CAD packages that support layers – and the process by which you upload and download the information, be that drawings, 3D models or specifications, as well as reports from other team members.

CIBSE’s new guide opens up all of these topics, frames them in terms familiar to the building services engineer, gives you the right questions to ask when setting up a project – at the BIM inception meeting – and shows you how to deal with the CDE throughout the project.

What is a CDE?

Physically, a CDE can be one of several things – and how the CDE is created depends on the project. The important thing is that the rules are followed. These are laid out in BS 1192:2007 and PAS 1192-2, but can be added to.

The technology behind a CDE can be a cloud-based electronic document

management system (EDMS) or a simple folder-based system; it depends on the size of the project and how the team is set up.

There are many ways of setting up a CDE, so that BIM inception meeting is important. But it should also be possible to add in extra requirements as they become apparent, such as when contractors are brought in.

The CDE needs to alter the visibility of uploaded files to the various team members. For example, a shared file will be seen by the immediate team associated with that part of the design or construction process, so they can sort out coordination issues. This is known as a ‘state’ of the file.

As important as the state of the file is its ‘suitability’, which denotes what the file can be used for. For example, the suitability code can show that a file is for planning or construction only. These codes need to be thought through at the BIM inception meeting, but may be added to later.

CDE v EDMS

There is often confusion about these two abbreviations, so let's simplify things a bit. An EDMS allows files to be uploaded and shared, and the CDE is the rule set that governs this. We can have a CDE without an EDMS, and vice versa, but put the two together and we have a powerful engine for storing and exchanging data, and a robust rule set to prevent 'data dumping'.

This often happens when a team member is issuing a large amount of information – such as a tender issue. However, with no rules applied to the upload, the recipient is unaware of what each file contains, what has changed since the last issue, or what the purpose of the information is. If you use the CDE rules, meta-data will have been added to each file, and to the issue generally, to guide the recipient through what we have done and what it is for. Meta-data is additional data that gives a summary of some basic information about one or more aspects of the main data, so working with the main data is easier.

Who owns the CDE?

This is a tricky question. The environment for exchanging files is owned by all those who use it. We need to be able to have our input into the definition of what a CDE means for this project, and we retain ownership of the intellectual property that we upload. However, the project lead – who may be a client, a project manager or the project architect – will be the primary source of the rule set and, usually, the one who defines the technology for the project, be that an EDMS or another solution.

There are also rules on data retention for a period after the project is completed, so all the actors need access to the data for a long time after completion. This is not always allowed for, and can cause issues.

States

There are four main 'states' that a file can pass through in a CDE: work in progress (WIP); shared; published; and archive. Ideally, where an EDMS is used, this will be shown through the application of meta-data to the file. There are also two 'sub-states': client shared and client published. These are for specific purposes and are dealt with in the guidance. The visibility of each state is shown in Table 1, although this can vary depending on project requirements.

The quality assurance of the uploaded files is very important. We used to achieve this by signing drawings and specifications with a pen. That doesn't work in today's digital age, so we rely on the functionality of

the EDMS system to perform this task. If EDMS technology does not underpin the CDE, this can be more difficult, but not impossible.

Suitability

This shows what the file can be used for. Figure 1 illustrates how some of the state codes can be applied to the various states. Again, this is done by applying meta-data to the file. The table of suitability codes needs to be thought through in the BIM inception meeting, but may be added to later.

Versions and revisions

Gone are the days of revision A, B, C or 1, 2, 3. Revision codes, as defined in the BS and the PAS, are now more complex. The DE4 guide will lead you through the requirements, but a snapshot of how they may be applied is in Figure 2.

The formula for generating these codes is: Contract stage + major revision + minor revision, for example P01.01. The minor revision is only used for WIP state.

The CIBSE DE4 guidance will lead you through the process and, hopefully, demystify this aspect of BIM. **CJ**

■ CIBSE's Digital Engineering series is available at www.cibse.org/des Collins will also present at the last CIBSE BIM Roadshow on 12 June in London, see www.cibse.org/bimroadshows

■ Carl Collins is digital engineering consultant at CIBSE

"The project lead will be the primary source of the rule set and usually defines the technology for the project"

State	Visibility
WIP	You only
Shared	Immediate team members
Published	Wider team
Archive	Usually wider team

Table 1: CDE States

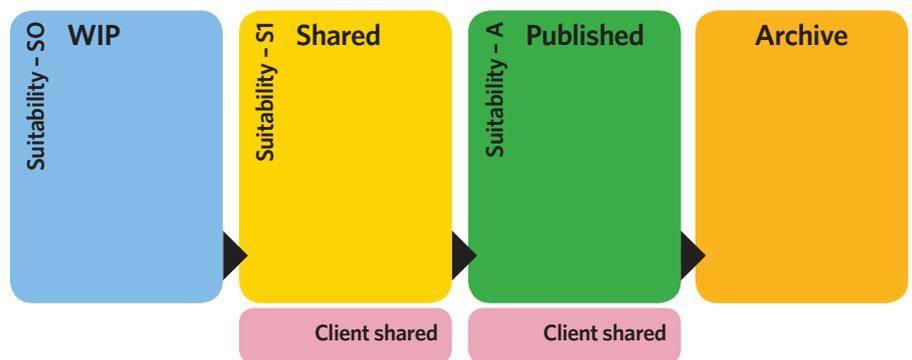


Figure 1: How some of the suitability codes can be applied to the various states

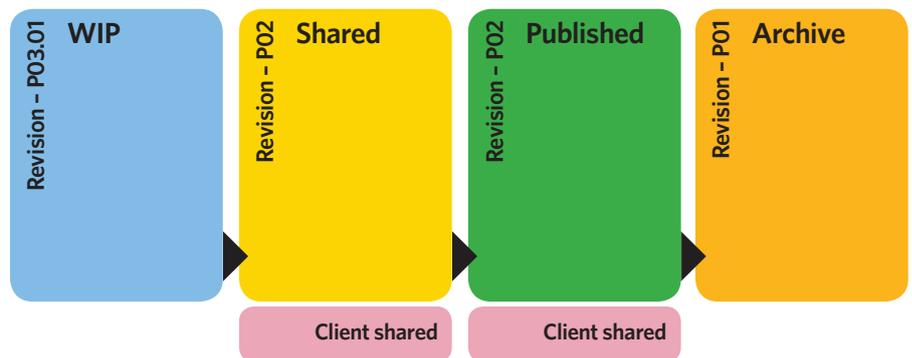


Figure 2: A snapshot of how the revisions may be applied



From first to last

BIM data has been used at Birmingham City University, from concept design to operation. Hoare Lea's **Sadie Adams, Sabrina Gill** and **Alec Mabbott** explain how they extracted full value from the project data

Since 2011, Hoare Lea has been involved in the delivery of 42,000m² of academic and office space for Birmingham City University (BCU). These projects include the completion of the Curzon Building in 2014, and the upcoming handovers of the Birmingham Conservatoire and Curzon B.

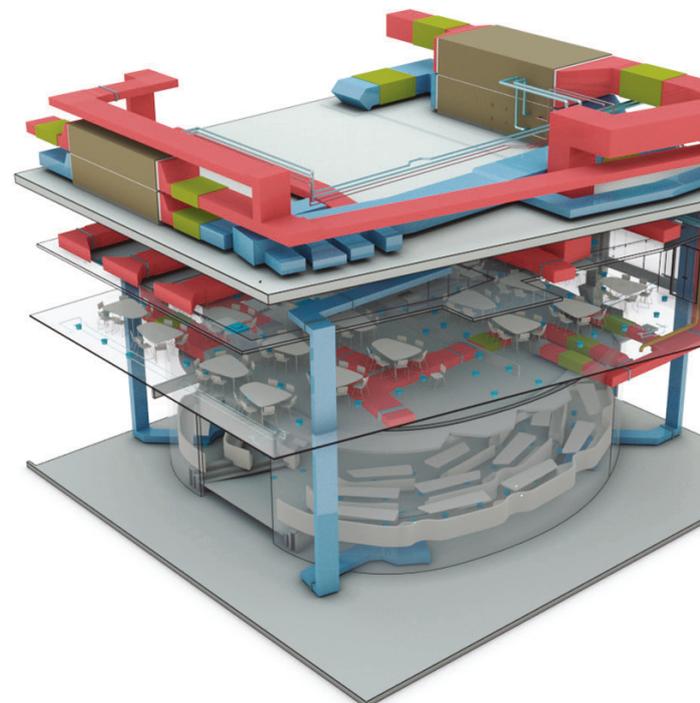
As with any project, each building has had its own specialist design and end-user requirements. However, all three projects have involved the extensive use of building information modelling (BIM) to Level 2 and beyond. The increased level of BIM has been driven by the BCU client team, which is now beginning to use the models for full facilities management procedures.

For each scheme, the principal of maintaining all project data within the model was taken through the complete building design, from concept via construction to completion and operation – a vision that was led by the university and embraced by the design team.

One key factor that has been highlighted during the design and completion of each building for BCU has been the need for planning. This may sound simple and obvious, but each project has been slightly different and – as a result – planning from the outset has been paramount in ensuring maximum benefit is gained from each model.

Engineering design work has been completed directly in each model. This has created efficiency in the design process, which is vital when working within tight timescales and programming. For all BCU projects, we embraced BIM and used the software as an 'engineering tool', rather than a '3D drafting tool'.

As soon as the architectural model was available, we used parametric data embedded within the model's 'spaces' to create zoning/strategy drawings



The 3D model helped designers to visualise the ventilation systems serving the Egg Lecture Theatre in the Curzon B building



- and pipework - was sized automatically, and total system duties were calculated, again directly within the model. The great benefit of this was that it reduced the scope for error and offered greater efficiency.

Schedules for repetitive items - such as grilles, radiators, fan coil units, distribution boards and attenuators - were created automatically, avoiding any duplication of information. As models were updated or room configurations changed, the calculations and schedules would update automatically, thereby rationalising the quality checks carried out by engineers.

“The principal of maintaining project data within the model was taken through the building design, from concept via construction to completion and operation”

This embedded information within the MEP model was taken forward by the appointed contractors for use within the ‘as built’ model - something detailed within the BCU contract’s BIM Execution Plan (BEP) and Employer’s Information Requirements (EIRs). This, in turn, was progressed by the university into the facilities management (FM) of each building, through use of the RICS ‘New Rules of Measurement’ NRM3 coding system for equipment/building items.

The NRM3 coding references were input into all Revit ‘families’ by the design team, based upon a specified asset information matrix (AIM) and a list of shared parameters - both of which were developed in conjunction with the university.

Using NRM3 coding and embedded information within the federated model, with additional onsite laser scanning, meant the BCU FM team was able to use and monitor true information on each building item - including its original design criteria, as-built information and service life - at the click of a button. This proved to be invaluable for the university as, historically, design criteria and ‘as-built’ information was often lost in countless volumes of O&M manuals.

Contractors also benefited from having live design information always available on site, allowing inevitable changes to be implemented more easily.

Throughout the design process, coordination and clash detection was addressed with cloud-based software - namely Autodesk ‘BIM 360 Glue’ and ‘Navisworks’. This was used to highlight clashes, based on an agreed ‘clash-set matrix’ set out in the project BEP, and as a communication platform between design-team members.

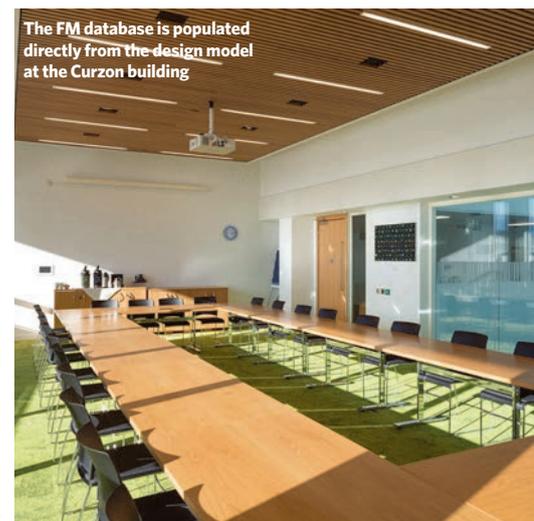
The whole team embraced the use of the software and saw the benefits, particularly on highly complex projects, such as the Birmingham Conservatoire. Clashes were managed and reduced before handing over the model to the appointed contractors, >>

quickly for each engineering system. This saved time and resources, while embedded data was also used to create initial room data sheets, and exported to prepare design criteria schedules for stage reports. These proved vital during the concept design stages, to verify and agree each project brief with the university, while also minimising timescales and improving design efficiency.

Going into the detailed design stages for all BCU projects, the BIM models were used for system calculations. For example, the ventilation calculations were created directly from each model using mechanical, electrical and plumbing (MEP) ‘spaces’ in Revit. These were created directly from the architectural ‘rooms’ in each Revit model, and managed throughout the design process to BSRIA Stage 4a¹. The spaces enabled areas, volumes and occupancy levels to be calculated automatically, allowing ventilation calculations to be completed and scheduled directly within the model. From these values, all ductwork



Engineers were able to compare their designs with the live site and report issues directly into the cloud-based model



The FM database is populated directly from the design model at the Curzon building

70%

The proportion of projects Hoare Lea is now delivering in the BIM environment. It is rapidly becoming standard procedure for the firm

» with a clash report supplied as part of the Stage 4a tender information. The software was then used throughout the construction stages by the contractor teams, for further detailed coordination.

During the construction of each of the BCU projects, the models were used for witnessing and snagging. With BIM 360 Glue and Field, issues were raised on site via iPads, and recorded within the model monitoring the construction and installation processes. All consultants and contractors had access to the platforms, and were required to raise, assign, respond and close-out issues. This mitigated the need for individual site reports, thereby streamlining the onsite communication.

The process of using BIM on site was developed through the delivery of the Curzon Building, with lessons learned on model management informing decisions about Curzon B and the Conservatoire. On BCU projects now, for example, there is a simpler interface for use on site, rather than having to negotiate the direct navigation of the model itself, which improves efficiency and performance.

As well as simplifying the recording of site issues, the BIM 360 platform manages the information, and can produce summaries, reports and timelines at the click of a button. This cloud-based method of monitoring gives BCU a clear tracker of the onsite progress and record information, while raising issues to the appropriate parties.

BCU recognises that the as-built models give the university not only a 3D coordinated replica of their buildings, but also a database of information to be used throughout the life-cycle of the building; 'Most people don't have a need to use 3D geometry, but they do need the data,' says BCU BIM process manager Richard Draper.

BCU is progressing with the integration of the BIM models for the full operation and maintenance of its buildings, including its existing building stock. As such, the use of the BIM models will be extended to all university staff and students.

The plan is to allow the use of BIM by stealth. BIM data may be currently underestimated in the FM industry, but our

approach will allow the data streams to be embedded without telling people they are using BIM,' says Draper. At present, the FM systems in place only allow the university to use a selected proportion of the information available from BIM. However, BCU is confident that it will be able to use BIM to develop and integrate the models further.

Hoare Lea is now delivering more than 70% of its projects in the BIM environment, and it is rapidly becoming standard procedure for the firm. The use of calculations, schedules, BIM schematics and duct/pipe sizing is something that Hoare Lea is constantly promoting on BIM projects across the firm, helping to ensure engineers work more efficiently and methodically. This supports the vision that BIM is not simply for 3D coordination, but is an 'engineering' tool.

The Birmingham City University projects over the past six years have identified the advantages of BIM throughout the design, construction and operational processes involved in a new build. By creating a virtual BIM environment for the university's new and existing assets, BCU has become a pioneer in its field. **CJ**

■ **SABRINA GILL** is a mechanical engineer, **ALEC MABBOTT** is a principal mechanical engineer, and **SADIE ADAMS** is a senior associate, all at Hoare Lea

References:

- 1 Stage 4A Technical design part I (RIBA Stage 3) Model and drawing definitions and examples, A design framework for building services, Bsria

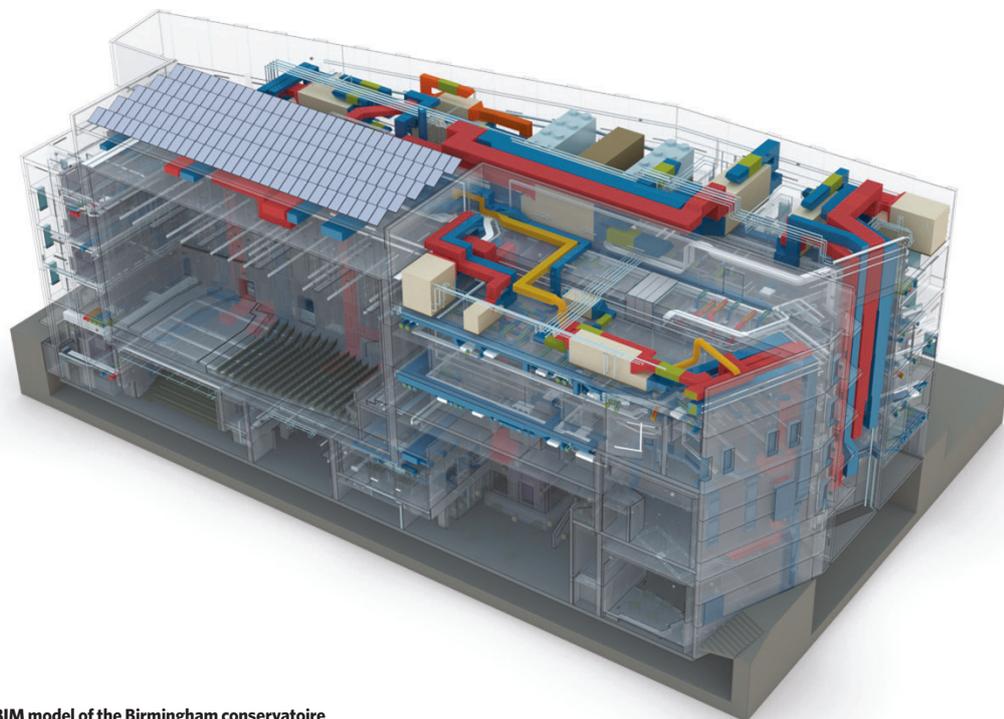
ACCESSING THE DATA

To help Birmingham City University's facilities management team, asset and space barcodes have been installed, linking the live building and services with the model.

The barcodes, located within the building, are scanned and used to navigate through the model to specific room locations and equipment, allowing maintenance issues to be recorded. Currently, the FM team is using the model to raise maintenance issues within the Curzon Building.

This has been achieved through the development of room 'totems', which share the space data through BIM 360 for integration within BCU's reactive maintenance system.

Space data forms the backbone of interactions between FM procedures and the model, creating a platform for pinpointing each issue. BCU intends to use all the asset data from each building model to plan maintenance tasks and forecast budgets.



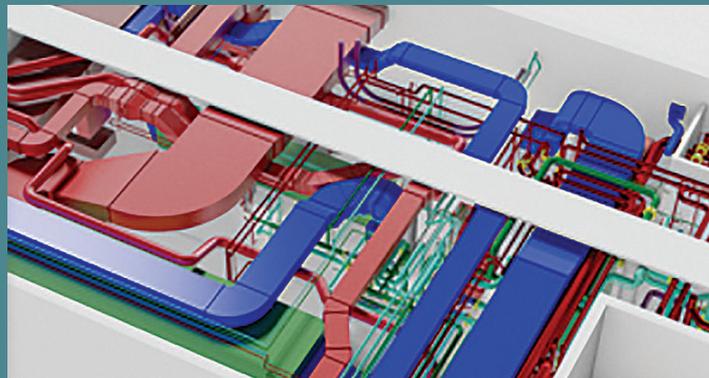
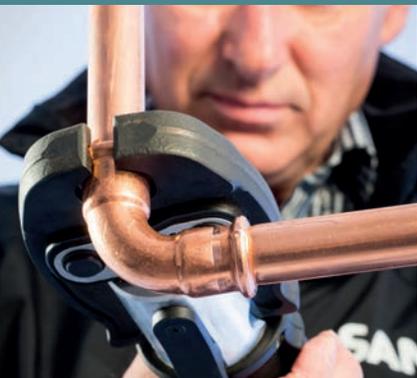
BIM model of the Birmingham conservatoire

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All in it together

Despite survey results to the contrary, **Melanie Robinson** says that the industry uptake of BIM may be lower than everyone thinks

As construction professionals, we are experiencing an exciting period for our industry. As well as witnessing radical changes in how we approach the design, construction, and management of buildings, we are also having to adapt our built environment to be resilient against the effects of climate change.

This is nothing new – the UK industry has consistently been subject to scrutiny, with projects often delivered over budget and late. It was underperforming in its capacity to deliver value.

The government's *Construction Strategy 2011* called for procurement and delivery mechanisms to change and paved the way to capitalise on the potential offered by adopting digital technologies.

Digitisation is often synonymised with building information modelling (BIM), the introduction of which has fundamentally changed how projects are managed.

However, BIM encompasses more than technology. We should think of it as an overarching process underpinned by intelligent models and facilitated by enhanced collaboration between stakeholders.

As the drive for BIM strengthens, one year past the Level 2 mandate for public sector projects, it is important to take stock of how far we have come on our journey, why we are doing it, and future implications.

So, is BIM delivering the reform we need to see within construction?

The answer lies in its ability to deliver time and cost-savings through the elimination of inefficiencies. This is attributed to the higher levels of collaboration that have replaced typically adversarial environments. 3D visualisation and clash-detection analyses have also been identified by building professionals as central benefits, and have been shown to reduce cost and effort significantly.

However, in a period of growing concern about global emissions, it remains crucial to align current efforts to digitise the industry with achieving sustainable design.

Environmental benefits of BIM can be categorised as:

- Implicit – those realised by the use of technologies, such as a reduced need to travel and the use of tablets onsite
- Explicit – those gained from specifically using tools and building data across the project life-cycle to achieve sustainable outcomes, so-called 'green BIM'.

Green BIM applications identified in academic literature include the development of decision-making tools to aid the process of sustainable design, such as the seamless integration of energy modelling and LCA tools, and aids to



"We risk a market split between those who can and those who can't"

help professionals understand the impact of design decisions earlier in the process.

Work is also being undertaken to consider the automatic generation of environmental assessment method credits, and to explore the growing role of digital technologies for facilities managers.

For the built environment to see real reductions in emissions, we need to start exploiting green BIM capabilities beyond the requirements stipulated by regulatory gateways and certification procedures.

So, we're seeing time and cost benefits and, if we can adjust our industry culture to design with sustainability to the fore, we can see environmental improvements too.

If BIM is not adopted, we could lose these benefits and be unable to reap the rewards that will ensure the reform we need to fix the credibility of our industry.

Six years after the publication of the Strategy, and over the first year of the mandate [to use BIM Level 2 on all publicly-funded construction projects], we should be seeing BIM use filtering down the supply chain. The prevailing issue,

however, is that we are unable to monitor the progress of the government's so-called 'push-pull' strategy and its spread into the private sector.

The most comprehensive studies published so far are the annual NBS National BIM Surveys. The latest survey of more than 1,000 respondents reported that about two-thirds have adopted BIM, with the rest set to follow suit within three years – overall an encouraging result.

However, surveys could potentially mask a damaging lack of understanding of BIM maturation, and uptake may be lower than we think.

The industry has to make some difficult decisions soon and they need to be based on hard facts. BIM needs to be fully adopted across industry, otherwise we risk a market split between those who can and those who can't.

While the 'adopt or die' approach is seen by many as weeding out the less-capable organisations, it is likely to be to the detriment of SMEs, given that the most cited barrier to effective implementation lies in the significant capital costs associated with BIM.

The question is: do we continue hurtling along the current path towards 'Digital Built Britain', or are we putting the cart before the horse?

We are in 'exciting' times but we could argue that the term 'turbulent' has also never been so applicable.

■ A Technical Symposium poster on this subject is available at www.cibse.org/symposium

MELANIE ROBINSON
is a postgraduate research student at the School of Engineering and Built Environment at Edinburgh Napier University

Challenges in creating customised BIM tools

Going from zero to one hundred in a blink of an eye is an unrealistically assumption and yet today's working environment differentiates itself by sustaining this speedy concept. The tendency to forget that BIM started way back in the mid-sixties led today's HVAC industries to a speed learning process in order to be able to provide accurate and appropriate design tools for their systems. LG Electronics Air Solution Business Unit has introduced its first BIM simulation tool for direct expansion systems at Mostra Convegno Expocomfort 2016, the biggest European fair dedicated to air conditioning. The application, called LATS REVIT is a plug-in for REVIT and it enables accurate design of LG Direct Expansion Systems in BIM environment. This application has been specifically developed to cater for consulting engineering companies in the field of HVAC that want to increase the effectiveness and accuracy of direct expansion systems in their projects.

During a year of working with the tool while introducing LATS REVIT to a broad spectrum of designers all over Europe, we had gathered a wide pallet of expectations and requests as to what this simulation tool has to provide to its users. So from

starting point level zero we grew in updated versions and in 2017 LG Electronics Air Solution Business Unit is ready to provide an enhanced level of development to comply with designers expectations.

The first development, after launching LATS REVIT, consisted in creating a single installation file that could be used for both REVIT 2016 and REVIT 2017 (a project build in 2017 cannot be read in 2016), the starting point of this improvement was given by several design companies' request as already it was difficult to manage several computers with different REVIT versions, a plug-in with several setup.exe would have made it even more complicated. Providing users a single installation file for a plug-in running on various versions of REVIT proved to be a real benefit to design companies.

Although, LATS REVIT could perform simulations in real time conditions for variable refrigerant flow systems considering many of the direct expansion systems constraints such as: temperature, necessary loads, piping lengths, combination ratios, efficiency, recovery conditions, designers requested enhanced details to be provided to the equipment families and LG Electronics proceeded to further developments by updating .rfa (REVIT blocks). Continuously listening to our customer's voice during last year, we

have planned further developments to be released in 2017 that will have an impact on the user friendly concept of LATS REVIT such as saving design time by providing various types of insulation for the copper pipes used in our VRF systems and billing packages through the form of exportable excel reports.

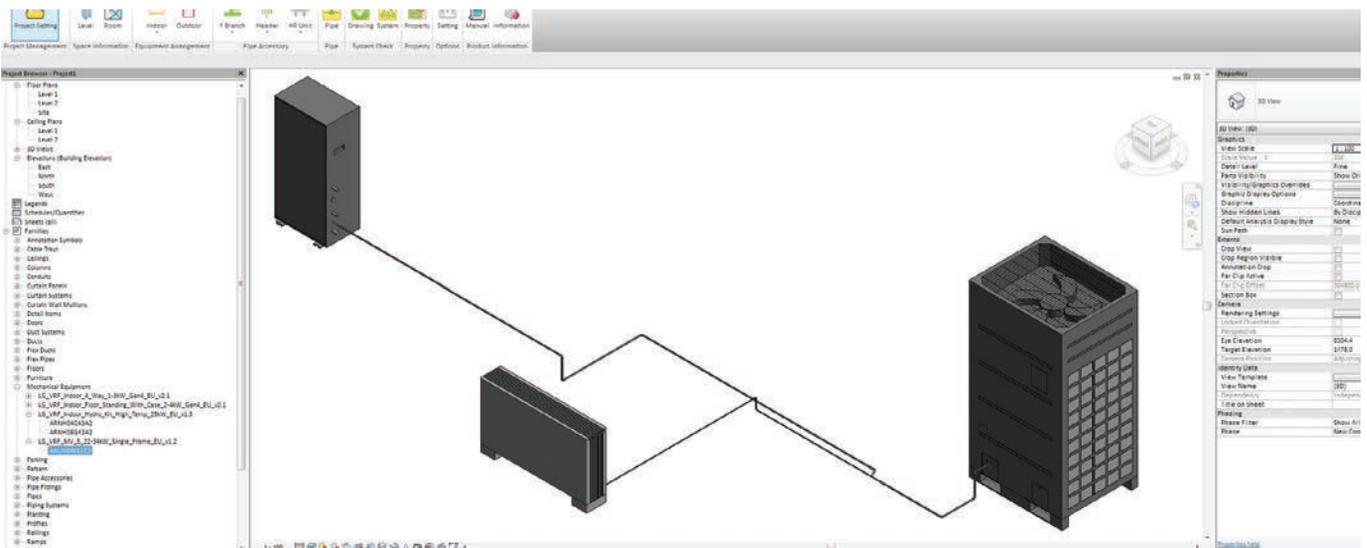
LATS REVIT is an innovative BIM tool that accompanies constructors all along the way in their pursuit of efficiently building and it shows LG's commitment to further investments in total building system solutions. LATS REVIT is distributed freely by LG Electronics in Europe to support BIM users in their initiative to design air conditioning systems.

For further information you can visit us at partner.lge.com or direct contact monica.marza@lge.com

■ **MONICA MARZA** is managing the European Engineering Centre for HVAC solutions and is a certified REVIT user.



LATS REVIT plug-in menu running for a REVIT project



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This month: Products and application round-up; chiller replacement in Chicago skyscraper; evaporative cooling



Ultraviolet boosts office cooling-coil performance

Gibbons upgrade eradicates contaminants in AHU

Ultraviolet disinfection has helped cut the requirement for chilled water in a central London office by nearly 36%, according to Gibbons Ultraviolet Solutions.

CoilCare ultraviolet germicidal irradiation air and surface disinfection system was installed in air handling units (AHUs) at a major financial institution, to eradicate contaminants and restore the original operating condition of the AHU.

The cooling coil of an AHU is a breeding ground for mould, viruses and bacteria, which form a slimy substance – known as biofilm – on coil fins. This reduces efficiency by increasing

thermal resistance, while the biofilm contaminates the airstream, which may jeopardise the health of building occupants. CoilCare uses ultraviolet-C (UVC) photoniser lamps to disinfect the cooling coil by disrupting the biofilm's DNA and eradicating it.

Gibbons claimed that, as result of the improved thermal performance, annual chilled water volume is reduced by 36%, to 18,507 tonnes. It said that, after installation and running costs, the net annual energy savings were £1,633. The payback on the investment was two years and nine months. U-values measuring the coil performance had also improved from 8,587 to 12,169 $W \cdot m^{-2} \cdot K^{-1}$, an increase of 42%, claimed Gibbons.

Humidifier claims control and low-energy technology

Condair has launched an in-duct adiabatic humidifier, which it claims offers the humidity control associated with steam humidifiers, but with the low-energy performance and evaporative cooling benefit of a cold-water system.

The Condair DL combines spray and evaporative technologies to maximise moisture absorption and give humidity control at $\pm 2\%$ relative humidity. A water-treatment system supplies pure water to a grid of nozzles inside the duct. These spray towards a ceramic droplet separator, which prevents aerosols from travelling down the duct, and offers secondary evaporation through its porous surface. Modulated control is achieved by increasing the water pressure of the nozzles.

Condair claimed that by pre-heating the airstream with gas-fired heating before the DL, the same volume of moisture can be absorbed by the air as steam humidification, but at a third of the energy cost. Use of waste heat would offer greater energy savings.

Daikin Applied offers built-in monitoring

Daikin Applied UK has made remote monitoring systems available on its modular air handling units (AHUs) and chiller ranges.

The real-time operation of equipment can be accessed via a browser using Daikin on Site. All the firm's chillers have the software embedded in their unit controller.

In addition to real-time data, historical trends can be recorded by the software. Using meters, it can monitor energy use, as well as the performance of the compressor, fans, refrigeration circuits and the thermal load. The software can be personalised to allow customers to view key information.

Daikin Applied Service national service manager Barry Coe said the software 'will enable us to give our customers even faster reaction times, as well as real-time advice on improving system efficiency and preventing issues before they occur'.

Daikin Applied said the software helps warn facilities managers of unexpected increases in energy consumption. Alarms from the unit are emailed to a helpdesk, and remote access to the systems is claimed to allow engineers to react more quickly to potential problems.

The data transfer is via event-based, outbound communication and connections that are encrypted over https. Data privacy conforms to EU *General Data Protection Regulation Chapter 5: Transfers of personal data to third countries or international organisations* claimed Daikin Applied.



CIAT AHUs on show

CIAT has been showing off its new range of air handling units (AHUs) in the UK, as part of a roadshow that has taken in more than 70 cities around the world.

The ClimaCIAT Airtech comes in nine sizes, with airflow rates of up to 30,000m³ per hour, with further capacity available in the future. Applications include offices and industrial facilities. Double-wall construction and 50mm of insulation is available for noise attenuation.

The Airclean is aimed at controlled environments, such as clean rooms, medical facilities, pharmaceutical industries and microelectronics. It is designed for ultra-clean environments and CIAT says it meets requirements for decontamination, airtightness and filtration. The Airaccess model is aimed at multi-use commercial buildings.



The CIAT electronic control unit is available on all models and can be connected to all building management systems. It can be used to optimise the energy efficiency of each unit by regulating temperature and humidity, and managing its fans, filter-fouling levels and water coils.

There is a range of heat-recovery ventilation units, including rotary heat exchangers with efficiency levels of 75-85% and plate heat exchangers with efficiency levels of 60-85%.

Airedale updates chiller range

Cooling specialist Airedale has launched upgrades for its Ultima Compact Chiller and Condensing Unit ranges (30-150kW) optimised for use with R410A refrigerant.

The company claimed the units have an energy efficiency ratio of up to 3.6 and a European Seasonal Energy Efficiency Ratio (ESEER) of up to 4.7 (Ultimate Compact Chiller range).

Airedale said both ranges use DSH scroll-compressor technology, which is focused on part-load energy efficiency. It claimed intermediate discharge valves (IDV) avoid over compression and extra effort by motors, and that they reduce power consumption and increase energy efficiency and SEER from three to 10%.

The range comes in five case sizes and Airedale said it is suited to sectors such as data centres, retail, manufacturing and leisure.

Cooltherm cuts costs for Cardiff

Refrigeration and air conditioning contractor Cooltherm claims to have 'massively' reduced the cost of process cooling in a chiller replacement project it carried out for Cardiff University.

It designed a new pump skid, featuring two Lowra Run and Standby pumps, to suit the required maximum flow rate and pressure loss through the existing hydraulic circuit. To increase performance, each pump is inverter-driven and controlled depending on the instantaneous cooling demand. Cooltherm - which claimed the existing pump was undersized - said this ensures the right flow rate through the chiller and the minimum power consumption.

The chiller feeds 13 indoor and coil units in laboratories, as well as an AHU cooling coil. The Mitsubishi E-Series Chiller chosen uses scroll-compressor technology, which Cooltherm claimed uses 5% of a conventional chiller starting current. It says that having an 8Amp start-up current - rather than a 180Amp current, as in some other chillers - will save the university £4,000 a year.



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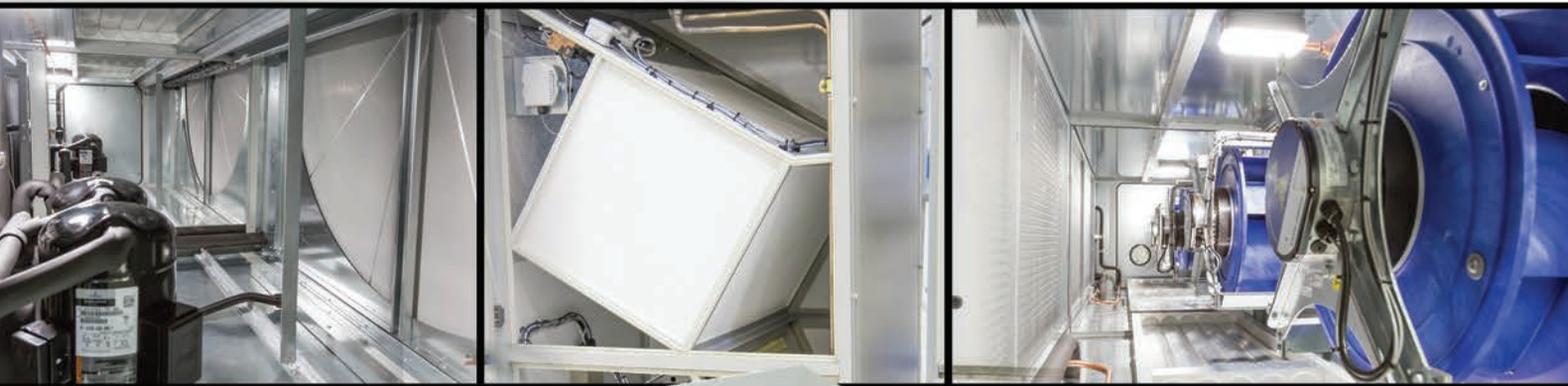
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Mansfield Pollard dives into pool upgrade



Air management company Mansfield Pollard has upgraded the air handling units (AHUs) at a Nuffield Health swimming pool in Crawley.

It replaced existing Calorex units with a single AHU at the Fitness and Wellbeing Crawley Central Club in West Sussex. Mansfield Pollard said the new AHU is easier to maintain and has increased energy efficiency. The company designed the AHU, ductwork, attenuators and controls, and carried out the M&E before commissioning the trend-control system.

To keep the pool open to the public during the two-week upgrade, the existing supply and return air ducts were connected to temporary fans, while a small LPHW coil was connected to the heating services.

The small rooftop plantroom had limited access, so the AHU had to be flatpacked and built within the room.

Trane expands XStream range

Trane has introduced the XStream eXcellent water-cooled chiller, for R-1234ze refrigerant. Chiller capacities range from 290kW to 2,600kW, and it is designed for environments such as data centres, offices, hospitals and industrial premises.

The chiller range sits under the Ingersoll Rand brand and the company claims ESEER values of 9.3 and EER values of 6.2.

The chillers feature Trane's CHIL evaporator design, oil-free magnetic bearings and high-speed centrifugal compressors, and Trane's Adaptive Control.



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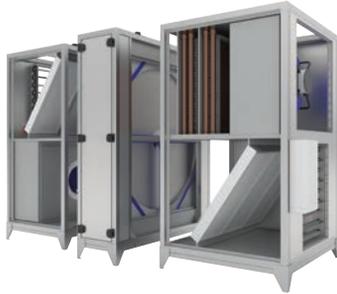


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A CHICAGO THRILLER

Replacing a district cooling system with chillers required a helicopter to lift new plant into a tiny room 200 metres above Chicago. Cyclone Energy Group's Benjamin Skelton describes the challenge

High-rise residential living is a way of life in Chicago. One of the most spectacular is 340 on the Park (OTP), which has 343 apartments over 64 storeys. The 10-year-old building is recognised for its sustainable design, and gained the first Leed Silver Certification for a high-rise residential building in the Midwestern United States.

Unfortunately, the building was not as cost efficient in operation as the residents would have hoped. The tower featured a district cooling system that – at a cost of \$500,000 (£388,000) per year – was three times more expensive than the cost of operating an equivalent independent chilled water plant.

In 2015, engineering studies were commissioned to see whether it would be worth designing an alternative system featuring a self-cooling plant.

Time was a major factor. The original developer had negotiated a contract for district chilled water supply, which expired on 28 September, 2016. If the residents were to opt for an alternative system, they only had a year to get it designed and installed.

The developers of 340 OTP had not given the residents a bad system. District chilled water is very reliable. Chilled water is produced off-site – in multiple, connected facilities – by equipment with tremendous redundancy. With a district system, chilled water can be supplied all winter, with no worries about their own equipment freezing in cold conditions. Another benefit is that there is less equipment to maintain in the building. The most significant active component, the pump, can easily be repaired or replaced if it fails. However, the buildings single largest cost was cooling so feasibility studies went ahead.

Cyclone Energy Group performed an analysis that found a new independent chilled water plant would yield annual savings of \$327,000 (£254,000) per year over the district chilled water system. The estimated construction cost of the chilled water plant, made by two contractors in 2014 and 2015, yielded figures of between \$2.5m (£1.9m) and \$3.5m (£2.7m). With a range that wide, the building's Condominium Association (CA) was not confident of moving forward.

Cyclone recommended that the CA take a different approach to the project, and procured the installation through a design-build contract. It created a performance-based request for proposals (RFP), which gave potential bidders more freedom to come up with a suitable design. This meant mechanical contractors would be the prime contractor, with responsibility for final design and construction.

The RFP outlined two feasible options – a water-cooled and an air-cooled chilled water system. They were not fully designed, but set boundaries for installation, minimum energy efficiency, and

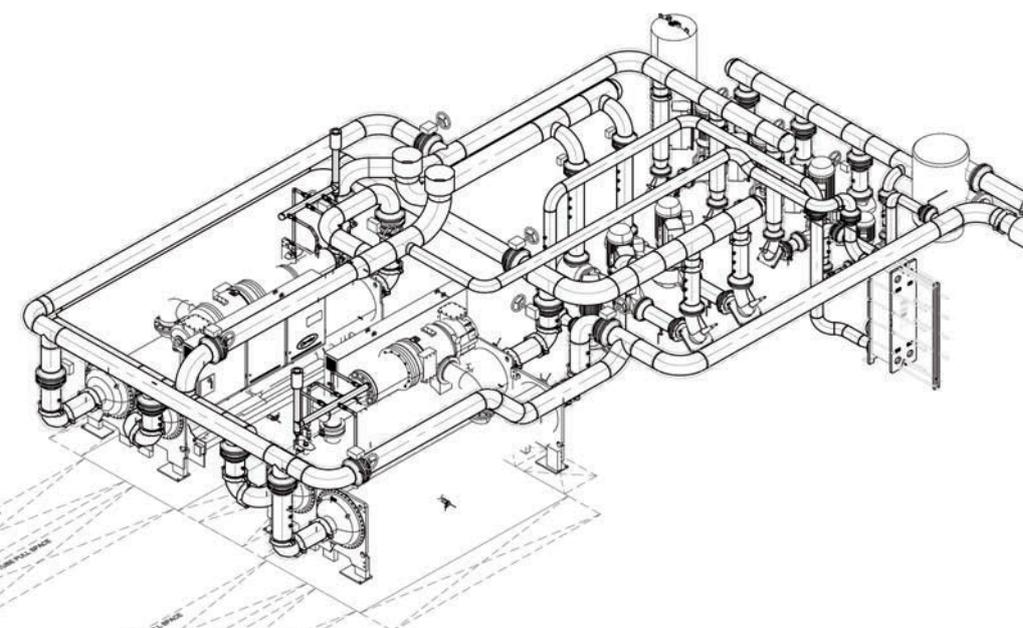


performance, and quality requirements. The design-build approach brought creativity to the bidding process. Contractors were allowed to use any equipment that met the performance requirements. The water-cooled design was competitive, with bids ranging from \$2.5m (£1.9m) to \$2.6m (£2m). Only one bidder had a viable air-cooled chilled water design and it was priced at \$3m (£2.3m). The building residents opted for a water-cooled system.

The design-build project was awarded to Hill Group at a guaranteed maximum price of \$2.6m (£2m) in November 2015, 10 months before the chilled-water contract was to be terminated. Hill Group's design was finalised in March 2016, but major equipment – chillers, cooling towers, pumps – were bought in January to keep the project on schedule. The scheme was made more complicated because installation had to happen during the peak cooling season, summer. Furthermore, the apartments were occupied all year round.

Approaching the challenge

The original building design anticipated the possibility of a future independent chilled water plant. As-built drawings indicated future



HVAC SYSTEMS

- Original district chilled water system
- 2-pipe fan coil units with electric heat and electric baseboard in residences
 - 4,900kW (1,400 ton) installed district chilled water peak capacity
 - Building split into two chilled water zones - pressure break on floor 27
 - 2x variable-speed make-up air units on floor 26, with chilled water and electric heat
 - 2x variable-speed make-up air units on floor 63, with chilled water and gas burners
 - First-floor lobby variable speed air handling unit with electric heat
 - 25th-floor amenities variable speed air handling unit with electric heat
 - 25th-floor pool dehumidification unit

New independent chilled water system

- 3,692kW water-cooled chilled plant
- Variable primary series-counter flow configuration with variable speed condenser pumping
 - 2 x variable frequency drive-screw chillers (1,846kW each)
 - 3x VFD chilled water pumps
 - 2 x Cooling towers with VFD fans
 - 2x VFD condenser water pumps
 - Free-cooling heat exchanger (528kW each)
 - VFD chilled water pump
 - VFD condenser water pump

chillers in a mechanical room on the 63rd floor and cooling towers on the roof.

Unfortunately, the rectangles drawn on as-built drawings weren't fully vetted. For example, a mechanical room was considered on the 63rd floor, but was built as a residential-storage locker room. The structural requirements for a storage room are different from that of a mechanical equipment room, and the floor slab built was rated at 610kg·m⁻² – while the new cooling plant would require 732kg·m⁻². Acoustics issues also had to be addressed. Multi-million-pound residences were located only 203mm below where equipment would be installed.

An acoustical engineer recommended that a floating concrete slab be installed to avoid noise and vibration. Other measures included air springs for the chillers, flexible coupling on chiller piping, and spring-supported suspended pumps and piping.

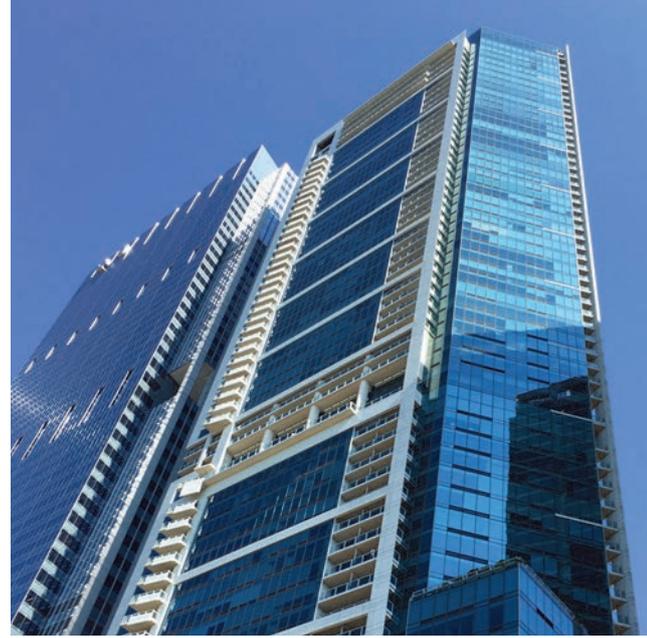
Building a chiller plant on the 64th floor >>

» of a residential building required a lot of coordination and expectation management. Noise-producing work could only be done between 8am and 4pm and there was only one freight elevator to the 63rd floor. The project team worked within these limits to build a floating slab and piping, ready for the chillers and cooling towers. Installing these would be even more spectacular; the only way to get them to the plantroom was by helicopter. More than 40 people would be needed to ensure it was done safely.

The margins were tight. The helicopter's maximum lift weight was 8,600kg and each chiller was on this limit. Such heavy weight meant the helicopter had less fuel, which limited flight time to 30 minutes. Both chillers had to be dropped through a hole in the roof that had less than 30cm of clearance. After successfully setting the chillers, the helicopter refuelled and returned for the cooling towers. These were only half of the weight of the chillers, and flexed and twisted under the hurricane-force winds coming down from the helicopter rotors.

The first tower was lifted into place, but the second proved more difficult. There was only 2.1m of clearance to work with, and the cooling tower was swinging out of control. The roof crew was able to secure the unit after the helicopter had hovered for twice as long as scheduled. Ultimately, the lift was a success, despite minor damage to roof equipment.

The chillers were put into operation in July 2016 and commissioned in August. They ran in parallel with the district system until reliability was proven. With a month to go before the contract for district chilled water expired, the district system was valved off and the new cooling plant put into full operation. There was no interruption of chilled



water on changeover, and the residents had no idea the source had been changed. In addition, acoustical measurements were taken before and after and no noticeable difference was found.

The investment 340 OTP made is paying off, with huge operating cost savings expected in 2017, when the chiller plant goes into its first full cooling season of operation. **CJ**

BENJAMIN SKELTON MCIBSE, MASHRAE is the founder and president of Cyclone Energy Group

A version of this paper was presented at the Technical Symposium. Read all the papers at cibse.org/symposium

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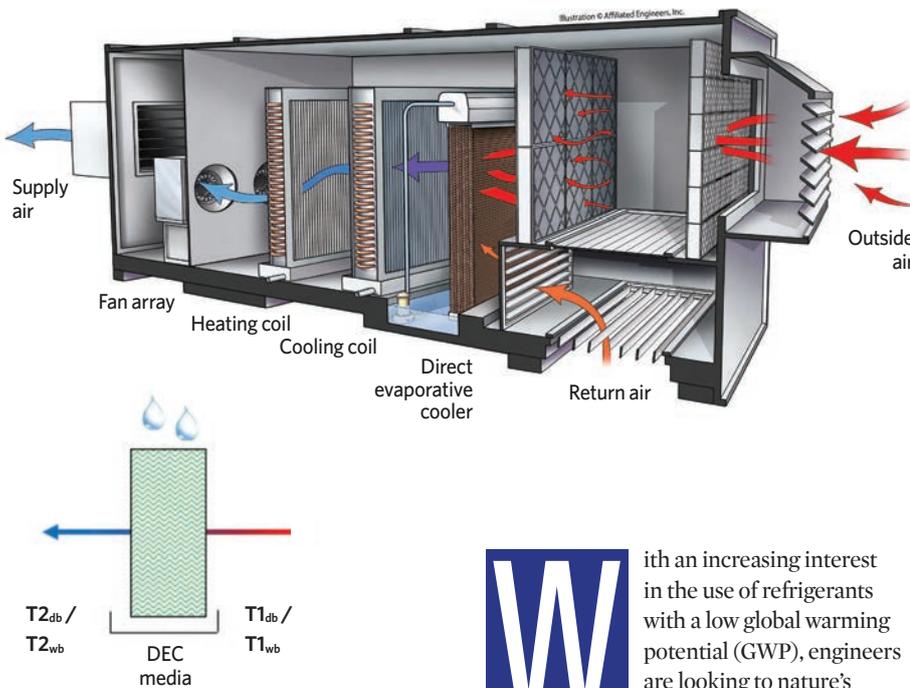
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MAKING THE CASE FOR EVAPORATIVE COOLING

Evaporative cooling can save energy when used in the right climate. AEI's **James Falconer** looks at the technology in Hong Kong, Las Vegas and London, and explains why the cooling method is making a comeback

Figure 1: Air handling unit with direct evaporative cooling



$$E = \frac{\{T_{1db} - T_{2db}\}}{\{T_{1db} - T_{1wb}\}}$$

where; E = Saturation efficiency
 T_{2db} = Dry bulb leaving (°C)
 T_{1db} = Dry bulb entering (°C)
 T_{1wb} = Wet bulb entering (°C)
 T_{2wb} = T_{1wb}

With an increasing interest in the use of refrigerants with a low global warming potential (GWP), engineers are looking to nature's refrigerant – R-718, better known by its chemical formula, H₂O.

Evaporative cooling is not a new concept; its use in buildings can be traced back thousands of years. However, renewed interest is spurring innovation in evaporative-cooling technologies. This article will discuss some of these and their applications, with a focus on direct and indirect evaporative cooling.

The effectiveness of evaporative cooling is largely dependent on the climate in which it is being considered. Hot, arid climates are the obvious choice for its use, whereas humid climates will limit its effectiveness. In favourably mild climates, evaporative-cooling technologies have the potential to replace vapour-compression cooling systems. However, for most suitable climates it will need to be supplemented with some form of mechanical cooling.

Direct evaporative cooling (DEC) – the

process of adding moisture directly to an airstream and allowing the latent heat of evaporation to cool the air – is typically achieved using a wetted medium installed in an air handling unit. This method is generally preferred to spraying water into the airstream.

The process follows the constant wet-bulb line towards saturation, while the dry-bulb temperature decreases. The effectiveness of evaporative media, often referred to as the saturation efficiency, determines how close to saturation the air becomes. Saturation efficiency, defined by the equation on the left, is a function of the media depth and the air velocity through the media.

Indirect evaporative cooling (IEC) relies on a secondary airstream, in which the evaporative cooling process takes place and sensibly cools the primary airstream via a heat exchanger. The secondary airstream can be exhaust/return air from the building, or 'scavenger' air from outside.

The advantage of indirect over direct evaporative cooling is that no moisture is added to the primary airstream. The disadvantage is that it is less efficient at cooling because of the added heat-exchange process between the primary and secondary airstreams. Indirect evaporative cooling is more suited to building types where humidity control is required – for example, a laboratory.

Both systems (direct or indirect) or a combination of the two (indirect/direct) offer significant potential in the right climate to save cooling energy. Energy savings are achieved either by eliminating the need for mechanical cooling, or by extending the range of economiser hours – to reduce chiller operating hours – and reducing the mechanical cooling load.

Parasitic energy losses need to be accounted for when designing and optimising evaporative cooling systems. These losses take the form of additional fan power associated with pressure loss across the evaporative media. For an indirect evaporative cooling system, this includes additional fan power required at the supply and exhaust/scavenger fans.

The case for evaporative cooling has been evaluated for direct, indirect and indirect/direct technologies in three distinctly

$$E = \frac{\{T1_{db} - T2_{db}\}}{\{T1_{db} - T3_{wb}\}}$$

where; E = Saturation efficiency

T2_{db} = Primary air dry bulb leaving (°C)

T1_{db} = Primary air dry bulb entering (°C)

T1_{wb} = Primary air wet bulb entering (°C)

T3_{wb} = Secondary air wet bulb entering (°C)

different climates – London, Las Vegas and Hong Kong. The analysis assumes an office building with a typical occupancy profile and a central variable air volume (VAV) system to condition the building. Additional fan power (parasitic losses) are accounted for in the analysis.

Ambient design conditions

Reviewing the weather data for each location is insightful in predicting how effectively evaporative cooling will perform in each climate. A psychrometric chart identifying ambient design conditions during operational hours throughout an average year (TMY-2 data) is an ideal visualisation tool. Design conditions falling within Zone 2 on the chart are ideal for evaporative cooling, with conditions in Zone 3 also suitable for supplemental cooling. Zone 4 represents conditions that sit above the dew point corresponding to the supply air temperature and render evaporative cooling ineffective.

The psychrometric weather data chart for Las Vegas (Figure 3) shows a significant number of hours suited to evaporative cooling (Zones 2 and 3). There are only a handful of hours when evaporative cooling would be ineffective (Zone 4).

Weather data for London in Figure 4 demonstrate some clear opportunities for evaporative cooling (Zones 2 and 3) with only a small proportion of hours in Zone 4.

As Figure 5 shows, Hong Kong is synonymous with a hot and humid climate. Significant hours of weather data reside in Zone 4, where evaporative cooling is ineffective. We can infer that evaporative cooling is likely to have very little effect in this climate.

The results for the energy study are summarised in the chart (Figure 6) and align with expectations. In Hong Kong, direct, indirect and indirect/direct evaporative cooling systems offer very little reduction in cooling energy. The additional fan power energy (parasitic losses) generally make evaporative cooling more energy intensive than the baseline condition.

In London, direct evaporative cooling gives a 28% saving over the baseline, while indirect/direct evaporative cooling enables further savings in cooling energy. However, the additional fan power is

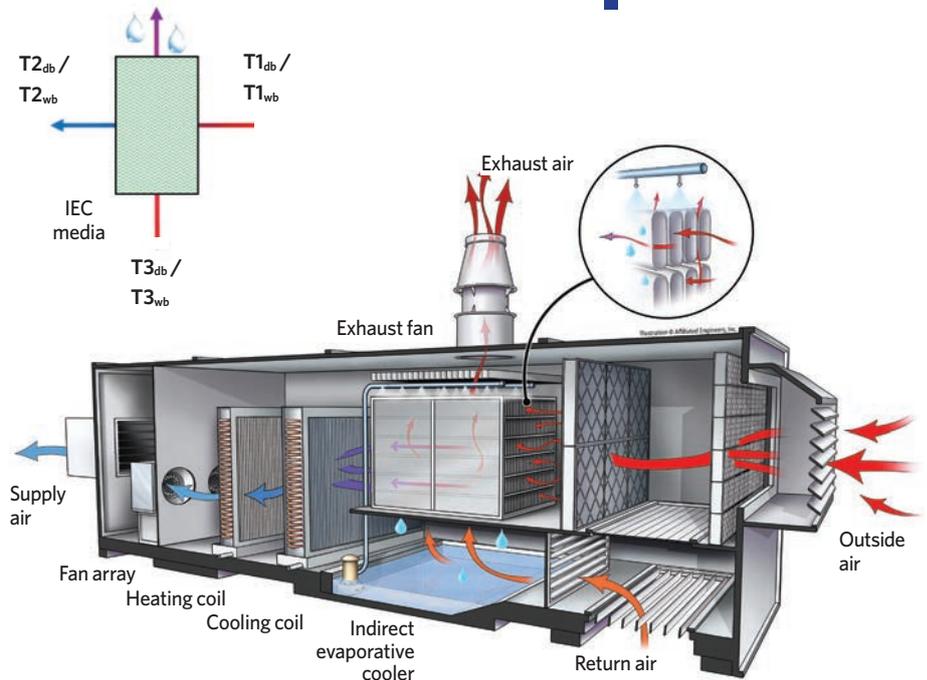
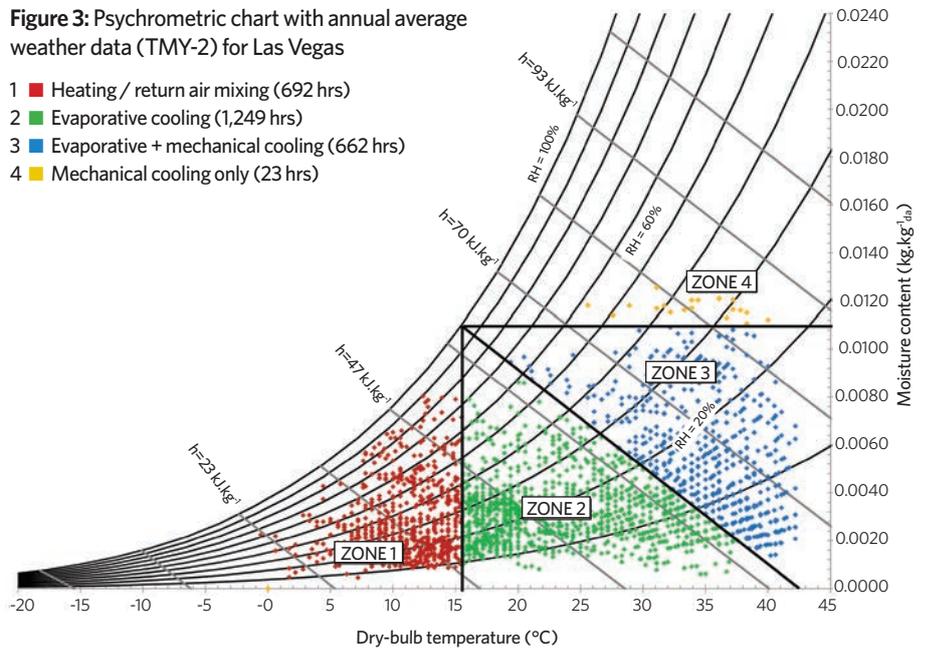


Figure 2: Air handling unit with indirect evaporative cooling

Figure 3: Psychrometric chart with annual average weather data (TMY-2) for Las Vegas

- 1 ■ Heating / return air mixing (692 hrs)
- 2 ■ Evaporative cooling (1,249 hrs)
- 3 ■ Evaporative + mechanical cooling (662 hrs)
- 4 ■ Mechanical cooling only (23 hrs)



detrimental to the overall performance.

Finally, Las Vegas – a desert-like climate – demonstrates substantial savings in cooling energy, with an indirect/direct evaporative solution offering as much as a 79% saving over the baseline.

There are some standard assumptions embedded in the analysis above, including the depth of wetted media (200mm) and configuration of the components within the air handling units. Both are variables that can be configured to optimise the system performance. For example, increasing the depth of the wetted media will increase the saturation efficiency and, therefore, the evaporative cooling effect. However, with increased media depth comes increased

“In Vegas, an indirect/
direct evaporative
solution offers as
much as a 79% cooling
energy saving”



» pressure drop, resulting in higher fan energy.

The depth of the wetted media should be studied on a case-by-case basis to optimise for overall energy performance.

Another consideration is the location of the supply fan(s) relative to the evaporative media. A blow-through fan configuration gives sensible fan heat upstream of the evaporative media, increasing the wet-bulb depression ahead of the evaporative cooling process. This improves the performance when compared to a draw-through fan configuration, where sensible fan heat is added downstream of the evaporative media.

Additionally, the use of a bypass damper should be considered for the evaporative media. Not only does this reduce fan energy when the evaporative cooling section is inactive, but it also provides some controllability of the air temperature downstream of the evaporative media, which can be subject to over-cooling.

“Evaporation losses... are such that every kWh of energy consumed in Nevada uses 27 litres of water at the source”

The water-energy nexus

On a final note, it behoves engineers to consider the water consumption for any evaporative cooling solutions. The suggestion that evaporative cooling could save water as well as energy might sound contradictory, until you look beyond the building level and consider the water-energy nexus.

In the case of Las Vegas, the state of Nevada gets most of its electricity generation from hydro-electric power – think Hoover Dam. The evaporation losses from hydro-power and, to a lesser degree, fossil-fuel power plants, are such that every kWh of energy consumed in Nevada uses 27 litres of water at the source.

So, in the case in Las Vegas, the direct evaporative cooling solution consumes an estimated 1.2 million litres/year in site water, but saves approximately 1.45 million litres/year of source water tied to a reduction in electricity consumption.

The above is an extreme case – and in many other examples of evaporative cooling there will probably be an increase in water consumption – but it draws attention to the importance of looking beyond the site metrics in any study. **CJ**

JAMES FALCONER is project manager at AEI

Figure 4: Psychrometric chart with annual average weather data (TMY-2) for London

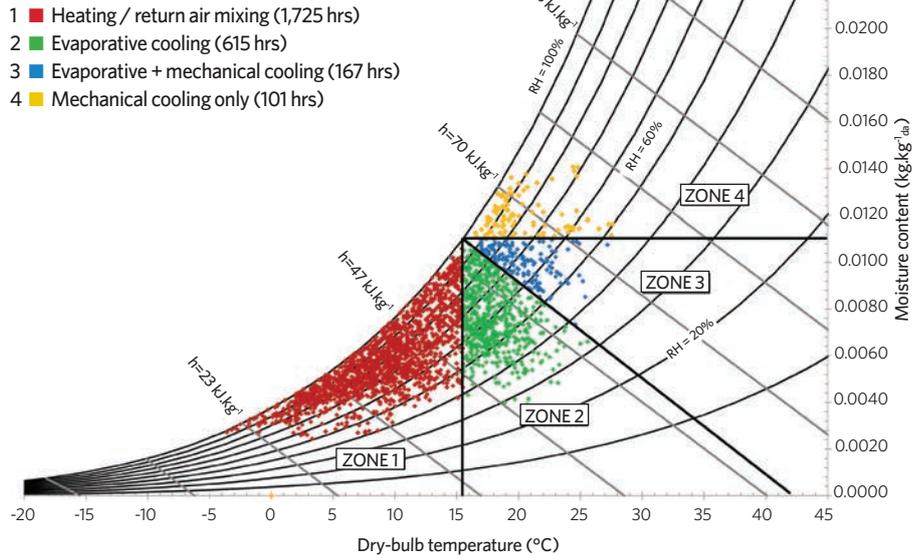


Figure 5: Psychrometric chart with annual average weather data (TMY-2) for Hong Kong

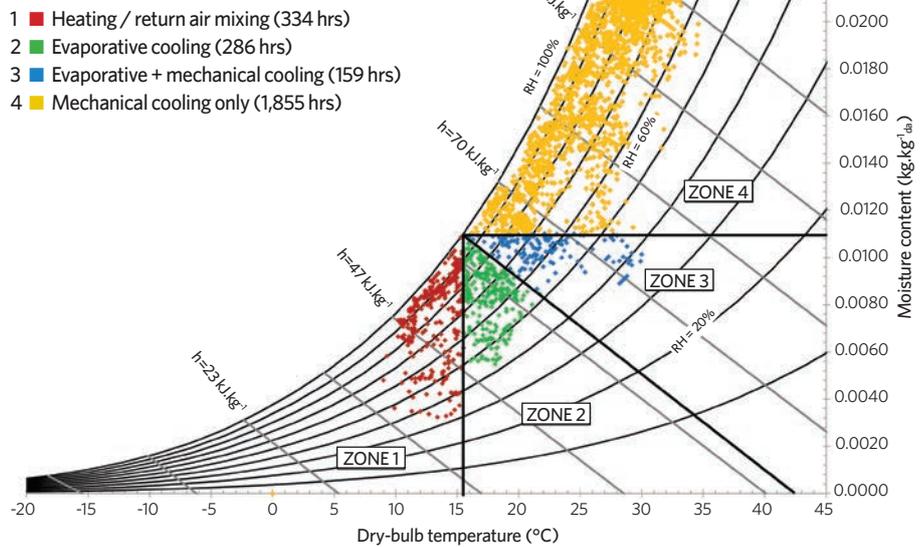
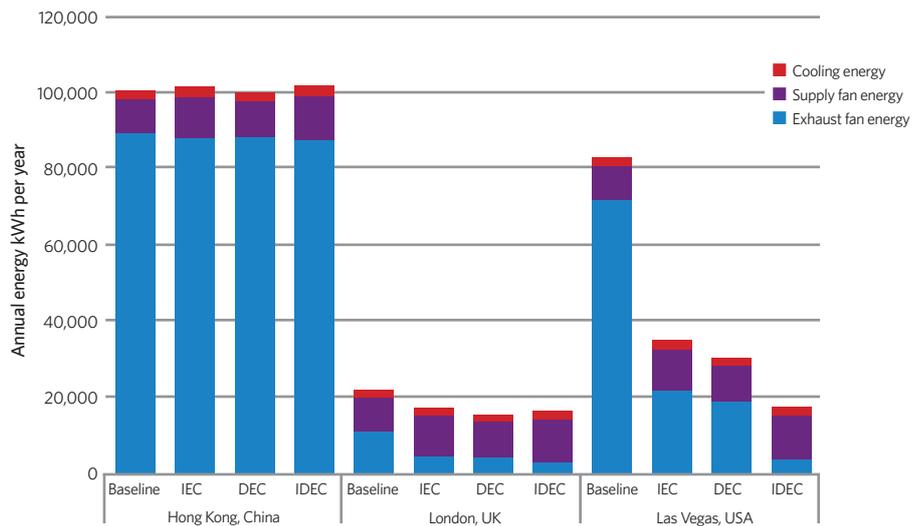


Figure 6: Evaporative cooling energy-saving potential by system type and location





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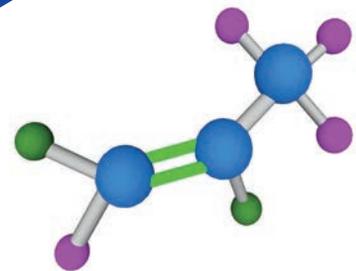
HFOs: THE GREEN EVOLUTION

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The application of alternative refrigerants to meet F-gas requirements

This module considers alternative solutions to using hydrofluorocarbons (HFCs) in order to comply with the EU F-gas Regulation – focusing particularly on the use of HFO refrigerants

Following the introduction of EC Regulation 517/2014, which came into force on 1 January 2015, there is a timetable that will lead to a reduction in hydrofluorocarbons (HFCs) available on the market to 21% of 2015 levels by 2030. This requires some advanced planning to avoid both installing systems based on technology that potentially could become redundant during their normal life-cycle, and delivering solutions that reduce overall environmental impact. This article will consider alternative solutions, focusing particularly on HFO refrigerants.

The refrigeration machines of the early 19th century used the natural – and ‘green’ – refrigerants of water and air. The early Perkins vapour compression machines of the 1830s used volatile (diethyl) ether, setting the path towards the development of purpose-made chemicals that provided the best compromise for successful applications in refrigeration. There are many attributes (some illustrated in Table 1) that contribute to an effective refrigerant – some of which are tied to particular applications and refrigerants. Many of the early refrigerants, including ammonia, methyl chloride and sulphur dioxide, were flammable, toxic or both.

Working at US company General Motors in the 1920s, Midgley and Kettering developed a non-toxic, non-flammable, stable and efficient chlorofluorocarbon (CFC) – containing carbon, fluorine and chlorine atoms – initially by creating the refrigerant now categorised as R12. This was considered a miracle compound up until the 1970s, when it was established that the use of CFCs was the main cause of ozone-layer depletion. It was also later identified as a contributor to global warming. In 1987, CFCs were banned by the Montreal Protocol, so accelerating the development and application of more ‘ozone-friendly’ refrigerants. R134a, for example, was developed as a replacement for R12 and – as it shares very similar properties – has become commonly used in medium- to large-scale water chillers, >>

Key attributes
Non-toxic
Non-flammable and non-explosive
Critical point well beyond operating range
Appropriately low-temperature boiling point at moderate pressure
Appropriately high critical temperature
High latent heat of vaporisation
Low specific volume of vapour
Specific heat of liquid should be as small as possible
Specific heat of vapour should be as large as possible
High thermal conductivity
Non-reactive with materials in the refrigeration system
Stable
Good miscibility with oil
Environmentally benign
Easily detectable
Low cost and easily available
Low viscosity so that pressure drop is small

Table 1: Some key attributes for a refrigerant applied in a vapour compression system

HFC refrigerant	CO ₂ equivalent kg	Notes on use
R23	14,800	Ultra-low temperature refrigerant (-40°C to -80°C). Because of its specialist properties, this refrigerant is currently exempt from some of the F-gas Regulation, as no alternative is readily available at this time.
R404a	3,922	Common low-temperature refrigerant, used by many in refrigeration.
R422d	3,143	Popular refrigerant used during the retro-fitting of larger R22 plant.
R410a	2,088	Common higher-pressure refrigerant used in air conditioning split systems and small-capacity water chillers.
R407c	1,774	Early alternative to R22 in new plant, this refrigerant has a large glide temperature (see boxout).
R134a	1,430	Common lower-pressure refrigerant used in commercial and industrial water chillers.

Table 2: Equivalent CO₂ value for most commonly used HFCs³

Year	% of 2015 baseline
2015	100
2016/17	93
2018/19/20	63
2021/22/23	45
2024/25/26	31
2027/28/29	24
2030	21

Table 3: Percentage of the HFC baseline that will be available to the EU market each year

» as well as in the automobile industry.

However, despite the lower ‘ozone depleting potential’ (ODP) of the hydrochlorofluorocarbons (HCFCs) – containing hydrogen, chlorine, fluorine, and carbon atoms – such as R22 and R123, and HFCs such as R134A and R410A, they have subsequently been identified as significant contributors to ‘global warming’.

HCFCs have been practically banned since January 2015¹, and HFCs are rated in terms of their ‘global warming potential’ (GWP) – an equivalent mass of CO₂, as shown in Table 2. Although R134a is not considered to have a high GWP, each kilogram is equivalent to 1,430kg of CO₂, which in the short-to-medium term is not considered environmentally acceptable, and – in common with other HFCs – it is covered

by the EU’s F-gas Regulation.² This includes a staged reduction in the use of HFCs in the years to 2030. Table 3 indicates the percentage of the HFC baseline that will be available to the EU market each year, moving towards the 2030 target, with specific targeted reductions as shown in Table 4.

The F-gas Regulation phasedown programme is constructed so that – over the next 12 years – end users and manufacturers will be drawn to using refrigerants with a lower GWP, because the production quotas will increase their availability and so make them relatively economical.

CIBSE⁵ Guide M indicates that water chillers have a life expectancy of between 15 and 25 years, depending on whether they are air- or water-cooled, and on the environment within which they operate. So, for new systems currently being installed, there is a good chance that they will be in service throughout the whole HFC phasedown period. As such, it is timely to evaluate alternative refrigerant systems.

Alternative refrigerants

There has been a resurgence in the development of modern technologies to make safer use of ‘natural’ refrigerants as an effective alternative to HFCs. These include ammonia R717, CO₂ R744 and hydrocarbons – isobutane R600a (often used in domestic fridges and freezers) and propane R290 (used in commercial heat pump and refrigeration applications). These are all successful, but each has operational challenges, such as high pressure and concerns about flammability, explosions and toxicity.

So the quest for a safe, efficient, and – crucially – environmentally friendly refrigerant has continued, leading to the application of hydrofluoroolefins (HFOs), containing hydrogen, fluorine and carbon.

Unlike traditional HFCs and CFCs, which are saturated, HFOs are olefins – so called because they form oily liquids on reaction with chlorine gas – that are unsaturated because of the carbon-to-carbon double bond in their structure. HFOs are relatively stable compounds, but are more reactive than HFCs because of the reactivity of the carbon-carbon bond. This reduces their GWP, with an atmospheric life of 18 days compared with the 13 years of HFC R134a. However, the zero ozone-depleting HFO still mimics much of the basic performance and properties of R134a.

HFO refrigerant as a ‘green’ replacement for HFCs

The principal HFO that has been applied for non-vehicle refrigeration is R1234ze(E), while R1234yf, typically, has been applied in vehicle mobile air conditioning (MAC). R1234ze(E) has operating conditions and costs in line with R134a – as indicated in the pressure-enthalpy diagrams for R134a and R1234ze(E) in Figure 1, and the key attributes in Table 5 – but with ultra-low GWP. Its performance is such that it can replace R134a in new equipment, where its lower volumetric capacity can be addressed in the design of the equipment.

A number of concerns have arisen about the safety of HFO refrigerants, including issues such as flammability, potential of hydrogen fluoride formation

Date	Description	Commonly affected refrigerants
From 2015	HFCs with GWP greater than 150 have been banned from domestic fridges and freezers.	
From 2020	HFCs with GWP greater than 2,500 will be banned from all refrigeration systems. Exceptions will be systems operating below -50°C.	R404a
From 2022	All F-gases with a GWP of more than 150 will be banned from any hermetically sealed system.	R134a R410a R407c
	F-gases with a GWP greater than 150 will also be banned from central pack systems rated at 40kw or more.	R410a
2025	F-gases with a GWP greater than 750 will be banned in single split systems containing less than 3kg.	R134a R410a R407c

Table 4: Phasedown programme for HFC refrigerants⁴

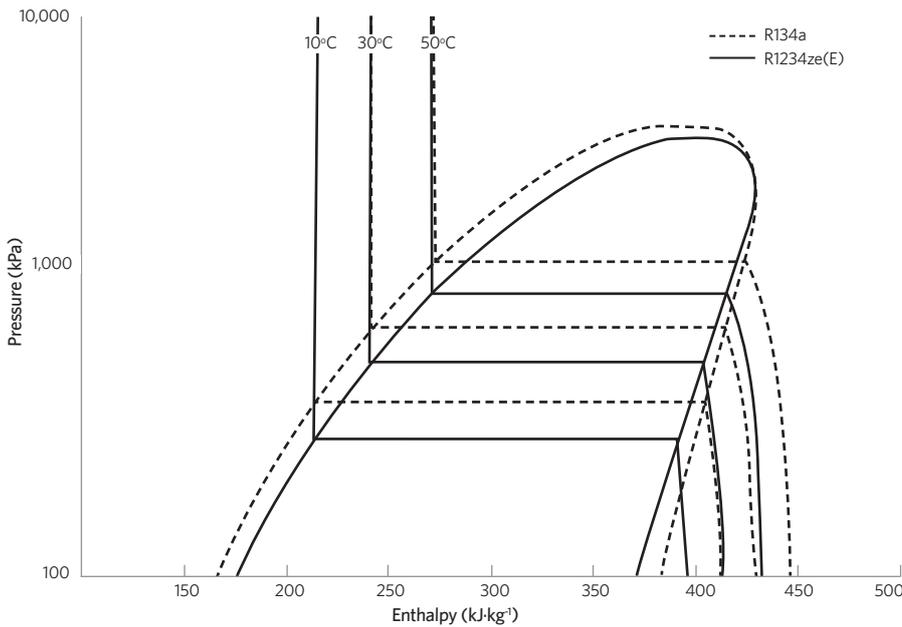


Figure 1: Pressure-enthalpy diagrams for R134a and R1234ze(E)

and formation of trifluoroacetic acid (TFA).

- HFOs have been identified as being flammable under specific non-operational conditions. However, in terms of operational safety, ASHRAE has classified⁷ R1234ze(E) in refrigerant safety group A2L (lower flammability and lower toxicity), and it is classified as non-flammable for handling and storage below 30°C. The basis of flammability is evaluated by ‘chance of flame occurring’ and ‘effect of flame occurring’ at 60°C. R1234ze(E) needs 250,000 times more energy than propane to ignite and, should a flame occur, it would be low heat (20% of that of propane), with a low burning velocity.
- In the presence of high temperatures (as might occur in a fire), all halogenated hydrocarbons – that is, hydrocarbons that include a halogen such as chlorine or fluorine – readily decompose to form hydrogen fluoride. This gas is highly soluble in water, forming acid that can present an extreme safety hazard. Ito⁸ analysed the production of hydrogen fluoride from an HFO and common HFCs across a range of high temperatures, and the overall results in these early studies indicate that there is little practical difference between the refrigerants.
- TFA is a potentially toxic by-product of the atmospheric degradation of fluorocarbons. It is removed from the atmosphere by wet deposition and is known to accumulate in certain ecosystems. It is estimated that 7-20% of R134a emissions degrade to TFA. Unlike R1234yf (that is principally employed in MAC), which reacts much

faster and decomposes completely into TFA, less than 10% of HFO-1234ze(E) is likely to decompose into TFA.⁹

R1234ze(E) performance in chillers

The volumetric refrigerating capacity of R1234ze(E) is below that of R134a and it has a higher boiling point. So R1234ze(E) cannot be considered as a drop-in replacement of R134a, but, instead, should be considered in new equipment designs.¹⁰

Field tests of optimised chillers designed specifically to operate on R1234ze(E) have confirmed that the coefficient of performance (COP) is higher than the HFC refrigerant system it is designed to replace. Operational tests have found that R1234ze(E) consumes significantly less energy than R290 (propane) – its closest ultra-low GWP rival – but without the same flammability risk and consequent additional safety considerations. Table 6 shows the comparative performance of three identical capacity and footprint air-cooled chillers. The R1234ze(E) chillers in this comparison have been under development by the manufacturers since the ready availability of the refrigerant in 2012.

Similarly favourable results were reported by Kabeel et al¹² in 2016, when they undertook an experimental study into employing R1234ze(E) for a walk-in cold room.

It is considered that the differential in the costs of the R1234ze(E) compared with that of R134a will disappear over the next 24 months, as production volumes of the HFO refrigerant increase and the F-gas quotas start to affect R134a prices.

HFOs can also be used as a component to produce a lower GWP refrigerant mixture containing HFCs. Several of these are already supported by some compressor manufacturers, but reliability issues have been raised because of high compressor discharge temperatures compared with their HFC predecessors.

This is an exciting time for the application of novel refrigeration solutions for building services engineering. To meet the legislative and environmental demands, there are several developing technologies – both traditional and new. Meanwhile, the application of recently evolved refrigerants, such as R1234ze(E), can meet the demands of both low ODP and low GWP, while maintaining good COPs, and so reducing consequent CO₂ emissions.

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■ Thanks to Robert Young of Cooltherm for his contributions to this article.

■ Turn to page 72 for references.

	R1234ze(E)	R134a
Molecular weight, kg·mol ⁻¹	114	102
Boiling point at 101.3 kPa, °C	-18.95	-26.06
Critical temperature, °C	109.4	101.1
Critical pressure, bar	45	63
Latent heat of vaporisation at 30°C, kJ·kg ⁻¹	162.9	173.1
Critical density, kg·m ⁻³	489	515.3
GWP	7	1,430

Table 5: Comparison of key attributes between R134a and R1234ze(E)⁶

Refrigerant	Compressor	COP	2017 cost comparison
R134a	Screw	2.77	100%
	Turbocor	3.42	100%
R290	Screw	2.91	138%
R1234ze(E)	Screw	3.10	114%
	Turbocor	3.70	114%

Table 6: Example comparative performances of commercially available air-cooled chillers for 300kW capacity, ambient air 35°C, chilled water 6°C flow, 12°C return¹¹





» Module 112

June 2017

1. What refrigerant did Perkins' vapour compression machines of the 1830s use?

- A Air
- B Ammonia
- C Diethyl ether
- D Methyl chloride
- E Water

2. Which refrigerant did Midgley and Kettering initially develop?

- A Chlorofluorocarbon
- B Hydrocarbon
- C Hydrochlorofluorocarbon
- D Hydrofluorocarbon
- E Isobutene

3. What percentage of HFCs, relative to 2015 levels, will be available in 2030 if the F-gas Regulation succeeds?

- A 17
- B 19
- C 21
- D 24
- E 31

4. What is the approximate relative GWP of HFOs?

- A 0 to 10
- B 11 to 100
- C 101 to 1,000
- D 1,001 to 10,000
- E 10,001 to 100,000

5. In the example of comparative performance of commercially available air-cooled chillers, what was the reported COP for the HFO-charged Turbocor chiller?

- A 1.34
- B 2.77
- C 2.91
- D 3.70
- E 12.34

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The challenge is to design a simple small adaptor, made from cheap and widely-available materials, that can fit into one ceramic filter and allow the filter to be attached to any home-made filtration set-up - even a hole in a bucket!

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Demonstrate your idea with a two to five minute video or a single A1 poster. Please refer to the SoPHE website.

Entrants

Teams of up to 3 people aged 18-35.

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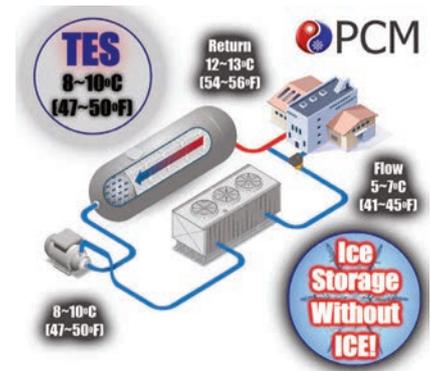


Advanced Air has announced the next generation of pressure independent control systems. The firm has entered into a special agreement with Belimo and Advanced Air's control specialist to design and develop a simple EPIV/Delta control package.

The EPIV/Delta means the fan coil unit can be pre-commissioned in the factory with the set points for both water and airflow established and pre-set, so there is no need for any onsite commissioning.

The unit is fully addressable from a hand-held device where the unit can be easily checked to ascertain that the pre-set values are being achieved even without the BMS working. The LED screen on the hand-held device shows the engineer exactly what is happening with the fan coil unit. If changes to the fan coil performance are required because of design changes, the set points can be adjusted easily using the hand-held device. All this information is communicated to the BMS when it is fully operational.

■ Visit www.advancedair.co.uk



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✓ Dunham-Bush creates a comfortable environment within school's new library

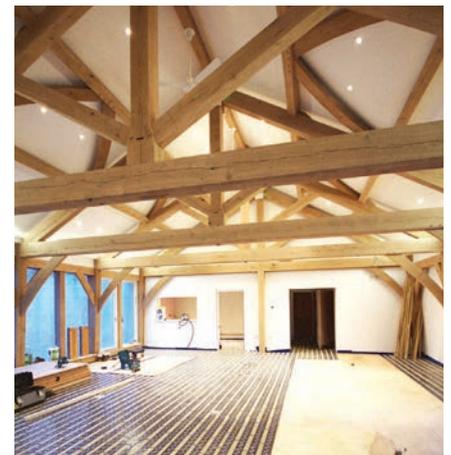
Dunham-Bush Pedestal Finvector perimeter heating, with fan-assisted Aerocourse trench heating, has been installed in the new Smythe Library at Tonbridge School, Kent, as part of a £6.1m refurbishment project, undertaken by Buxton Contractors. Trench heating was chosen as the most suitable solution for heating in the library – which accommodates more than 21,000 books – stairwell and office areas, where space was at a premium. AFA-1 type trench heating units were installed and finished with solid oak grilles.

■ Email info@dunham-bush.co.uk

✓ AET Flexible Space solves London refurbishment problem

Underfloor air conditioning has helped overcome restricted slab-to-slab dimensions at the recently refurbished 17 Devonshire Square, in London. AET Flexible Space worked with consultant Cundall on the HVAC specification in this severely height-restricted building. The final specification is a CAM-V direct expansion (DX) system, with underfloor supply air and return air at high level. The high-level return air option creates greater flexibility for positioning fanfites.

■ Call Lucy Bonsall on +44 (0) 1342 310 400 or email lucy@flexiblespace.com



✓ Omnie renewable heating selected for new church hall

After years of fundraising and planning consultations, members of Sparkwell Church, near Plymouth, are finally seeing the construction of a new hall. It comes complete with a TorFloor underfloor heating system, linked to an advanced eco-friendly heat pump, supplied by Exeter-based Omnie.

Specialist subcontractor Rod Smith Plumbing & Heating is undertaking the installation of a LWD70A/SX air source heat pump, as well as the high-efficiency TorFloor pipe and carrier panels, laid over insulating Celotex PIR boards.

■ Call 01392 363 605, email projects@omnie.co.uk or visit www.omnie.co.uk



✓ Gas-powered heat pump for home

South West Heat Pumps (SWHP) has installed a Robur K18 gas-powered heat pump boiler to supply heating and hot water to a three-bedroom home in Gunnislake, Devon. The property owner and SWHP decided the Robur K18 was the most cost-effective solution.

Powered by natural gas, while benefiting from renewable energy based on air, the Robur K18 offers exceptionally low running costs, at least 38% below those of a modern condensing boiler.

■ Call 020 8641 2346, email info@roburheatpumps.co.uk or visit www.roburheatpumps.co.uk

✓ **Safeguard's Drybase range tackles damp that other treatments can't reach**

The Drybase range, from Safeguard Europe – UK specialists in damp-proofing and waterproofing technology – is designed for use when it is not possible to protect building materials and interior surfaces from the sources of dampness, such as rain penetration or rising damp. A collection of damp-proof coverings, coatings and membranes, in three main products, the Drybase range offers practical solutions to a wide variety of dampness issues within small residential properties right up to larger industrial facilities.

■ Call 01403 210 204



✓ **Luceco lights the way for the pioneers of the future**

Luceco has supplied a complete lighting solution to Scarborough University Technical College, in Yorkshire. LED circular and 600x600mm square LuxPanels were recently installed throughout the building, serving various classroom applications. LuxPanel requires no maintenance over its lifetime and has more than 50,000 hours of operational life, as does the IP65 climate LED luminaire, used in workshops, plantrooms, and storage areas. Linear academy luminaires were installed in circulation and open-learning areas, as well as dining rooms.

■ Call +44 (0) 1952 238 100, email uk_sales@luceco.com or visit www.luceco.com



Island living in the heart of the city ✓

Evinox Energy is working with EcoWorld Ballymore and Clarion Housing Group on the London City Island development, which was recently awarded Best New Place to Live at the London Planning Awards 2017. This Leamouth Peninsula neighbourhood, by Canary Wharf, is home to 1,700 apartments. Phase one was completed by Ballymore and phase two will be delivered by EcoWorld Ballymore.

Evinox Energy is supplying the apartments with heat interface units and ENE3 room controllers, connected to the district heating network – designed for energy efficiency and reduced environmental impact – as well as metering and billing services for the 104 social-housing apartments.

These all feature the Evinox PaySmart pre-payment system. Residents can buy their energy online, at a local Payzone outlet, by monthly direct debit or standing order, through Evinox's web app on a smartphone or tablet, or by telephone.

■ Email info@evinoxenergy.co.uk or visit www.evinoxenergy.co.uk



◀ **Making office space part of the commercial landscape**

An architect's practice with a track record of devising office buildings as multi-use developments, incorporating public spaces, has won the BD Office Architect of the Year Award 2017. The accolade is sponsored by Geze UK and was announced during the Ecobuild Conference. Fletcher Priest beat five other practices to clinch the coveted title, after evidencing the strongest body of work in the office category. The company prides itself on developing long-lasting relationships with clients based on supplying workplaces that support their businesses.

■ Call 01543 443 000, email info.uk@geze.com or visit www.geze.co.uk

✓ **Waterloo's new barrel slot diffuser gives design flexibility in large spaces**

Waterloo Air Products has launched a larger barrel slot diffuser to give architects and building engineers greater flexibility in designing air-movement systems. The new CSB 25 barrel slot diffuser reinforces Waterloo's comprehensive range of air terminal devices, by offering a stylish, multidirectional answer to optimising airflow in large spaces.

The CSB 25 has 100mm-long barrels, which can be positioned to deliver air precisely to the left, right or vertically.

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Tridonic's SLE LED modules have an upgraded chip and expanded colour palette. The Art, Food and Fashion colours – each optimised to a specific application – have been joined by the Tinge light colour, making warm tones appear more vibrant. All versions benefit from greater efficiency in high-output mode and are available with a 17mm light-emission surface.

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Field control device provider Sontay has introduced the SC-ST-x smart temperature controller, to offer local control of an HVAC system. Communicating via the BACnet MS/TP protocol, the controller is easy to use and brings greater efficiency to the operation of commercial buildings and smart homes.

The smart temperature device offers close control of heating, cooling and ventilation demand within modern building control systems, and can operate as a proportional integral (P+I) controller, switching HVAC devices.

■ Email sales@sontay.com



Kingspan industrial insulation enters the space age

In space, even the smallest amount of debris can be the difference between success and catastrophic failure. So when it came to insulating building services at the new Science and Technology Facilities Council RAL Space Development and Test facility, in Didcot, it didn't take a rocket scientist to see that the fibre-free cores of Kingspan Kooltherm FM duct insulation and Kooltherm FM pipe insulation - with their strong energy performance and low thermal conductivities - were the best possible choice.

■ Call +44 (0) 1544 388 601, email info@kingspaninsulation.co.uk or visit www.kingspaninsulation.co.uk

Paint plant slashes lead times

The latest modernisation of Swegon Air Management's manufacturing facility, in Bridgnorth, Shropshire, was developed - at a cost of £150,000 - to support its Air Diffusion range of internal ventilation grilles and diffusers. And it is already speeding up manufacturing lead times.

Until the start of this year, Air Diffusion - which was launched in 1972 - had been sending products to an external paint plant for finishing, but the recent decision to bring painting in-house has dramatically speeded up the process and cut lead times for customers.

The improvement is even more dramatic with bespoke products, as internal painting means the lead times fall significantly and any defects can be remedied within minutes.

Swegon Air Management's new plant consists of two bays that allow the process to switch rapidly between colours, or to deal with double capacity if there is particularly high demand.

Environmental protection was key and the factory uses only powder paints, avoiding solvents.

■ Visit www.swegonair.co.uk



Big news for the Grundfos Academy



Since 2007, Grundfos has been running a successful online Academy, which has steadily gained in popularity. Until now, the content has mainly been relevant to plumbers, installers and merchants who work in the domestic-pump arena.

Over the years, we have added elements and moved to a new platform. Now, we are gearing up to launch this flexible learning platform to a new audience with a focus on larger applications. This means consultants/specifiers - as well as relevant distribution partners who work on larger projects and applications - will be able to access a range of online modules, covering: commercial

heating, Magna1, Magna3, water boosting, air conditioning, and life-cycle costing.

Each topic is broken down into bite-sized modules and a small gift is on offer for the successful completion of four modules (with a short test at the end of each one).

■ Call 01525 850 000, email grundfosuk@grundfos.com or visit www.grundfos.co.uk

Mikrofill helps future-proof historic Bedfordshire hotel

The Old Palace Lodge Hotel, in Dunstable, Bedfordshire, is renowned for its high standards of service and quality food.

Because of numerous issues with the old heating and hot water plant, the decision was taken in 2016 to introduce new Mikrofill condensing boilers and HWS loading cylinders to suit both the current demand and a future 18-bedroom extension.

Two Ethos 110kW stainless steel condensing boilers now provide low pressure hot water (LPHW) to variable temperature (VT) circuits, and primary load to two extreme hot water loading cylinders. The boilers have a collective modulation of 20:1 (220>11kW), integral shunt pumps and a seasonal efficiency of more than 95%. The loading cylinders, serving the kitchen and accommodation areas, can produce more than 2,000 l/hr at 60°C on a continuous basis while maximising the condensing boilers operating efficiency. The project was designed by building services consultant VSRW and installed by Dunstable-based HeatTreat Plumbing and Heating.

■ Call 03452 606 020 or visit www.mikrofill.com



Nuair offers better IAQ >

Ventilation designer Nuair has introduced a range of in-line carbon filters called IAQBOX – a step forward in both air filtration and resistance levels for carbon filter technology.

Designed to complement Nuair's MVHR range, IAQBOX removes 99.5% of nitrogen dioxide from the intake air, as verified by the BRE – a level of filtration unmatched across the ventilation industry. IAQ-BOX also offers optional PM10 and PM2.5 pre-filters that remove up to 80% of harmful particulate matter.

■ Call Alex Gallop on 02920858241 or email on alex.gallop@nuair.co.uk



> Panasonic dials up energy savings at student loans company call centre

When Capita, the business process management and outsourcing giant, decided to establish its new call centre in the Lingfield Point business park, sustainability was a key refurbishment consideration. This included the heating and cooling system, for which M&E consultants Quinnross specified an energy-efficient Panasonic system with advanced control technology.

The Panasonic ECO G 3 Way system, which takes advantage of the abundant gas supply on the site, is energy efficient and easy to install.

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■ Call 01252 551 540, email enquiries@adveco.co or visit www.adveco.co



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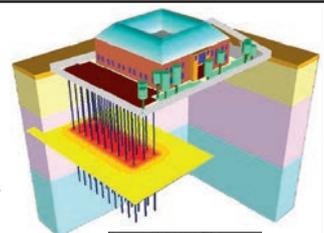


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For more information please contact
Charlie Ridd on 01728 726120

Associate Mechanical Design Engineer - London

£60k to £65k plus benefits

An award winning property consultancy operating throughout the UK is looking to add to their team of 5 in London. The successful candidate will work on a range of projects within Central London, delivering innovative solutions. They are seeking engineers capable of running your own projects and developing business.

For more information, please contact
Martin Bell on 01728 726120

Building Services Team Manager - Leicester

£55k plus benefits

This well-established firm puts a lot of time into developing their employees allowing them to excel and push their own professional capabilities. They are renowned for employee satisfaction and are offering a handsome salary of £55k with this role alongside a great benefits package.

For more information please contact
Charlie Ridd on 01728 726120

Senior Electrical Engineer - Nottingham

£45k plus benefits

A great opportunity has arisen as a Senior Electrical Engineer within Nottingham. This is a well-established company offering a fast moving dynamic work environment specialising in the Building Service Sector. Very modern company, allowing you to grow and develop on your own professional strengths and designs. A great opportunity for career progression.

For more information please contact
Charlie Ridd on 01728 726120

Senior Mechanical Design Engineer - London (Covent Garden)

£50k to £55k plus benefits

Forward thinking multi-disciplinary firm would like to meet with Senior Mechanical candidates who are well versed in low carbon technologies and have strong design skills in building services. Ideal candidates need a minimum of 10 years post graduate experience working on projects from concept to completion.

For more information, please contact
Martin Bell on 01728 726120

Associate Electrical Design Engineer - Bristol

Up to £60k plus benefits

Award winning consultancy seeks an Associate Electrical Design Engineer with excellent client development skills. Cracking opportunity for a technically astute engineer who enjoys developing client relationships. You will be given autonomy to push the business forward as well as overseeing the design team.

For more information, please contact
Jessica Davey on 01728 726120

Intermediate Mechanical Design Engineer - Leeds

£30k to £35k plus excellent benefits

A Northern consultancy powerhouse with offices in the UK and overseas is currently looking to recruit an Intermediate Mechanical Design Engineer for their recently established central Leeds office. With projects in every sector, ranging from luxury hotels through to large commercial office developments, your technical skills are sure to be challenged.

For more information, please contact Ben
Thompson on 0113 4570079

Senior Mechanical Design Engineer - Ipswich

Up to £55k plus benefits

A highly regarded Building Services consultancy with national coverage is seeking an experienced Mechanical Design Engineer. With a strong client list that includes household names within a range of industries, this client offers an excellent variety of work. This is a brilliant opportunity for an ambitious engineer to push their career forward.

For more information, please contact
Jessica Davey on 01728 726120

Electrical Design Engineer - Bradford

£28k to £35k plus excellent benefits

A well-known contractor is looking to recruit an Electrical Design Engineer at either intermediate or early senior level. Established for over a century they have strong client relationships within the retail, industrial and commercial sectors and are highly regarded by their clients.

For more information, please contact Ben
Thompson on 0113 4570079

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Mechanical & Electrical Design Engineers

Cardiff, £30 - £45k + bens

A leading engineering consultancy that boast an impressive portfolio of high profile projects and champion innovation within building services are growing their team due to continuous new work orders. This consultancy have a reputation for developing talent and with an ownership model that rewards the best engineers they are a very attractive company to work for. The wide range of sectors both UK and Overseas that are covered by the Cardiff office ensures you will be continually exposed to a range of exciting and diverse projects whilst evolving your skills to establish yourself as a leading engineer. Ref: 4354

CAD/Revit Technician

London, to £38k + bens

Currently seeking an MEP Cad/Revit technician to work on projects ranging from £20 - £200 million across commercial, hotel, and residential sectors within a leading multidisciplinary consultancy. My client has been established in the industry for 30 years and enjoyed substantial growth attracting some very high profile clients. An excellent package and career path are available to the right person. Ref: 4254

Associate Director – M+E Lead

Croydon, £75 – £80k + bens

A leading medium sized consultancy that specialise in commercial, residential, mixed use and retail projects are looking for a motivated engineer with experience of working on large commercial projects in the UK. This consultancy currently employ around 30 staff and are planning on expanding to 50 staff. This consultancy that was established almost 30 years ago are known to pay above market salaries, are looking to invest in you and have an established, dedicated and highly skilled team for you to lead. Ref: 4257

Senior Electrical Engineer

London, £38 - £40p/h

Our client is an award winning consultancy that is at the forefront of high performance buildings with a focus on sustainable design. An opportunity has arisen for a Senior Electrical Engineer to join the well-established team. You will have the opportunity to work on some of the most iconic buildings in London that are pushing the boundaries of design within the built environment. Ref: 4163

Senior Public Health Engineer

City of London, £50 - £55k + bens

An international multi-disciplined consultancy who specialise in healthcare, labs, commercial, retail and specialist buildings are looking for a senior public health engineer who can lead projects, manage engineers, and progress to associate director level within the company. This consultancy will reward you with a generous salary, healthcare cover, flexible working, and pension. You will be working alongside the company director to implement long term business strategies. We are looking for an engineer with a proven track record of specialist public health design project delivery in the UK, has lead projects from inception to completion, can design above and below ground solutions, and build relationships with clients. Ref: 4083

Resident Engineer

London, £40p/h

A Resident Engineer (Electrical bias) is required for an immediate start on a healthcare project in London. The role is very specific as you must have demonstrable Mission Critical exposure with a strong understanding of HV and LV Design. This role is unique as most of the design has been completed, you will be required to coordinate the design and move to installation. Ref: 4316

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Under construction: AstraZeneca's headquarters in Cambridge



Team player

As International Women in Engineering Day approaches, BDP's Clare Reinhold explains why she's passionate about building services

Since joining BDP in 2003, associate building services engineer Clare Reinhold has been involved in: team bidding; designing and delivering schools, city academies and further education colleges; and leading the environmental engineers working as part of BDP's multidisciplinary design teams on a portfolio of London education projects. In recent years, she has specialised in schemes combining new-build and retained/refurbishment elements on constrained inner-city sites.

Reinhold's experience in developing appropriate low-carbon technologies and preparing energy statements as part of planning applications resulted in three of her school projects achieving Breeam Excellent accreditation. She also regularly hosts Women in Building Services Engineering (WiBSE) events at BDP's London studio. Reinhold is currently leading the building services design team at AstraZeneca's new headquarters in Cambridge.

Q What's the best thing about your job?

A I really enjoy being part of creative and passionate teams that design buildings or places that will be used and enjoyed by people for many years. Most projects involve complex logistical issues, plus technical problems that need resolving, so it is challenging and very varied work. In recent years, I have had the opportunity to work on many refurbishments of listed historical buildings and it is rewarding to see the finished final transformations.

Q What are the key skills necessary for your role?

A The ability to understand technical systems, attention to detail and spatial planning skills are the core ones I use every day. Coordination, logistics and planning of work are also key to ensuring the right people complete all the required tasks within the design process, on time. To achieve all this, effective communication skills and the ability to build good working relationships with designers and clients are indispensable.

Q How do you ensure successful integrated designs?

A Communication with all the design team members is key. Traditionally, the coordination process is done by written communication and misunderstandings between disciplines can occur. To combat this, I find it invaluable to confirm understanding through drawing and sketching – a common language among designers, architects and engineers. I enjoy working collaboratively with other design team members to ensure the building services installations are as 'invisible'

as possible. This requires us to understand the aesthetic vision of the architect before assigning time to work through schemes in detail, ensuring all designers and specialist requirements are accommodated.

Q Should BIM be embraced or feared?

A It should be embraced. It is a powerful tool that can enable designers to communicate, integrate and analyse their designs more efficiently in a shared environment. A period of upskilling is needed, but the software is constantly evolving, which allows new ideas and innovation to be analysed/proven much quicker than using traditional methods.

Q What advice would you give young women considering a career in building services?

A Experience in the workplace is really beneficial, so apply to organisations with structured training to experience the many different roles and find what suits you. There are lots of women in the industry, but we are not the majority. Use this to your advantage; the different approach you may take to challenges will bring positive results. Go to site as much as possible – see it for yourself.

Q What more could be done to encourage women into the industry?

A The issue is visibility and awareness. Building services engineering is a career still very much under the radar for sixth-formers and graduates. Young women need to be given more opportunity to explore the varied and creative roles within the construction industry – its not all hard hats and muddy boots! More contact between working professionals and students would help to highlight the rewarding and important challenges the engineering professions can give to young people.

Q How does WiBSE help women in building services engineering?

A I have found it immensely helpful; the events are a great opportunity to meet other female engineers from all levels in the industry. The coaching and workshop sessions I have attended resulted in very open and supportive discussions, and enabled me to share knowledge and gain insights to aid my own development.

■ **CLARE REINHOLD** is a chartered mechanical engineer and an environmental engineering associate at BDP's environmental design group

EVENTS

INTERNATIONAL AND NATIONAL EVENTS/ CONFERENCES

BIM Roadshows

12 June, London

Presenters will use a project case study to demonstrate the real-world application of digital technologies and workflows.

www.cibse.org/BIMroadshows

CPD TRAINING

For details, visit www.cibse.org/training or call 020 8772 3640

Building services one-day overview

2 June, London

Variable flow water system design

2 June, London

Understanding psychrometric charts

13 June, London

Practical LV fault analysis

16 June, London

Electrical services explained

20-22 June, London

Energy surveys

22 June, London

Energy efficient building regulations: Part L

22 June, Manchester

Implementing energy management systems ISO5001

23 June, London

Mechanical services explained

27-29 June, London

Introduction to heat and power (CHP)

28 June, London

Building services explained

28-30 June, London

Introduction to heat networks

29 June, London

Energy efficiency building regulations: Part L

4 July, London

Low-carbon buildings for local authorities

4 July, London

Lighting and energy efficiency

5 July, London

Practical controls for HVAC systems

5 July, London

Power systems harmonics

6 July, London

Emergency lighting

7 July, London

Air conditioning and cooling systems

7 July, London

ENERGY ASSESSOR TRAINING

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Heat networks explained

6-7 June, Sheffield

LCC building operation and DEC

7-9 June, Leeds

LCC building design and EPC

13-14 June, Birmingham

Air conditioning inspector training

20 June, London

LCC building design and EPC

11-12 July, London

CIBSE GROUPS, SOCIETIES AND REGIONS

For more information about these events visit: www.cibse.org/events

SLL past and future at the Sam Wanamaker Playhouse

6 June, London

Society of Light and Lighting-curated event at Sam Wanamaker Playhouse.

Lifts Group: Evening technical meeting

6 June, Manchester

With presentations 'Lifts have stopped speaking to me - problems with AF induction loops' by John Trett, CE Electronics, and 'Our accessible world and the new Part 70', by Adam Scott, Sweco.

SoPHE: Domestic water circulation and technical demonstration

8 June, Oxford

Presentation by Owen Stephens and Matthew Camm of Kemper UK & Ireland.

CIBSE membership briefing

8 June, London

Briefing with focus on

Associate and Member grade applications, and registration with the Engineering Council.

SoPHE AGM and technical evening

13 June, London

SLL & CIBSE Scotland: LED lighting - the way forward?

13 June, Glasgow

Technical lecture by Andrew Crawford, Scottish area manager, iGuzzini.

South West: Breakfast seminar - designing and understanding local extract ventilation (LEV) part 2

14 June, Bristol

With speaker Adrian Sims, ILEVE vice-chair and Vent-Tech managing director.

Daylight Group: Smart glazing: the future of glass architecture?

14 June, London

An overview of the main types of smart glazing available, and explanation of key technical features.

SoPHE: Submersible pumps

15 June, Cambridge

With speakers Richard Sutton and Michael Rayment, technical sales consultants at Jung Pumpen.

ANZ: 30-year celebration

15 June, Melbourne

Evening event, with guest CIBSE President Peter Wong, also hosting the ANZ Young Engineers Awards.

ANZ Region: AGM

16 June, Melbourne

ILEVE: Technical day with focus on DSEAR

21 June, Buxton

An Institute of Local Exhaust Ventilation Engineers event, covering recent developments in exhaust ventilation and, in particular, changes in the law. It will be delivered by HSE laboratory experts.

YEN: Eco-design requirements for non-residential ventilation units

21 June, London

With speaker Iskender Gencer, TROX UK.

East Anglia: Technical tour, Sizewell B

22 June, Leiston

Technical tour of Sizewell B nuclear power station, on the Suffolk coast.

HIGHLIGHTS



Adam Scott at the Lifts Group technical meeting on 6 June, Manchester



ILEVE vice-chair Adrian Sims at SW seminar on 14 June, Bristol

Facilities Show

20 - 22 June, ExCeL London

Returning to ExCeL for its fourth year, the Facilities Show 2017 will again deliver the latest solutions and newest products and services, along with expert knowledge.

The show continues to grow year on year, attracting facilities management (FM) professionals - including suppliers, advisers and specialists - from all sectors.

More than 300 exhibitors will be showing the latest innovations to help end users, and the Facilities Show will also include a seminar stream. This will feature inspirational speakers Dame Kelly Holmes (pictured right), Professor Brian Cox OBE and Simon Weston CBE.

Visit the CIBSE Stand - S655 - at the show and catch up on all the latest membership and FM news, events and services that CIBSE has to offer.

CIBSE FM Group member, and partner at Troup Bywaters + Anders, James Campbell, and CIBSE FM Group vice-chair David Stevens, will present a session entitled 'The importance of FM on building performance and closing the gap' on Tuesday 20 June, 2.45-3.15pm.

To register, visit www.facilitiesshow.com





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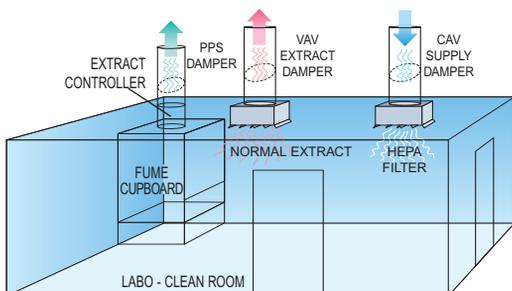


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