CIBSE JOURNAL

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The official magazine of the Chartered Institution of Building Services Engineers

July 2016

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REQUIRES IMPROVEMENT
Why school buildings fail on energy performance

SEMINAL WORK

Sensitive retrofit of historic Cambridge college sets standard for restoration of heritage buildings

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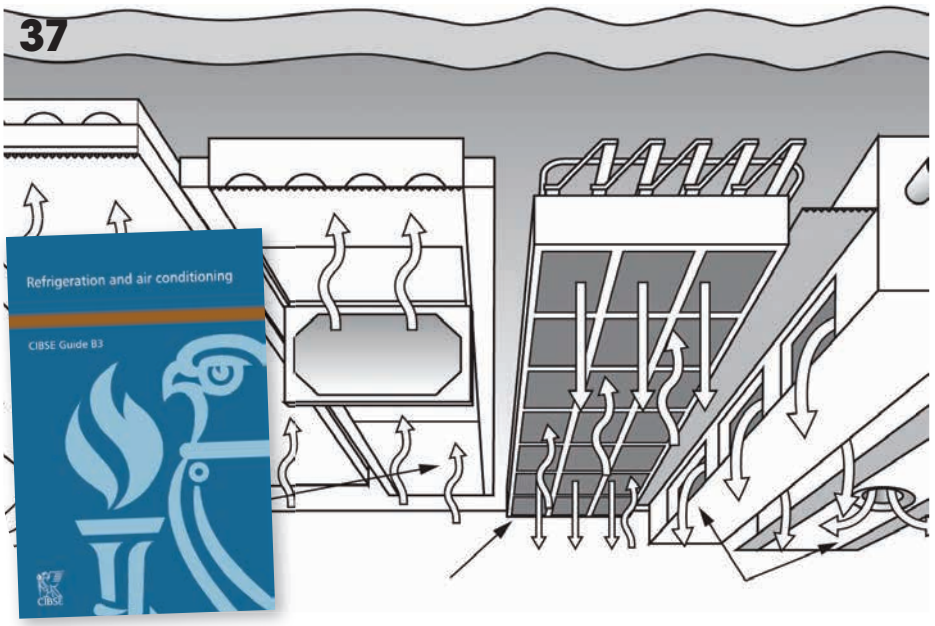
Contents

NEWS

OPINION

Why schools are failing to make the grade in their post-occupancy evaluations – page 28



Features

SPECIAL FEATURES

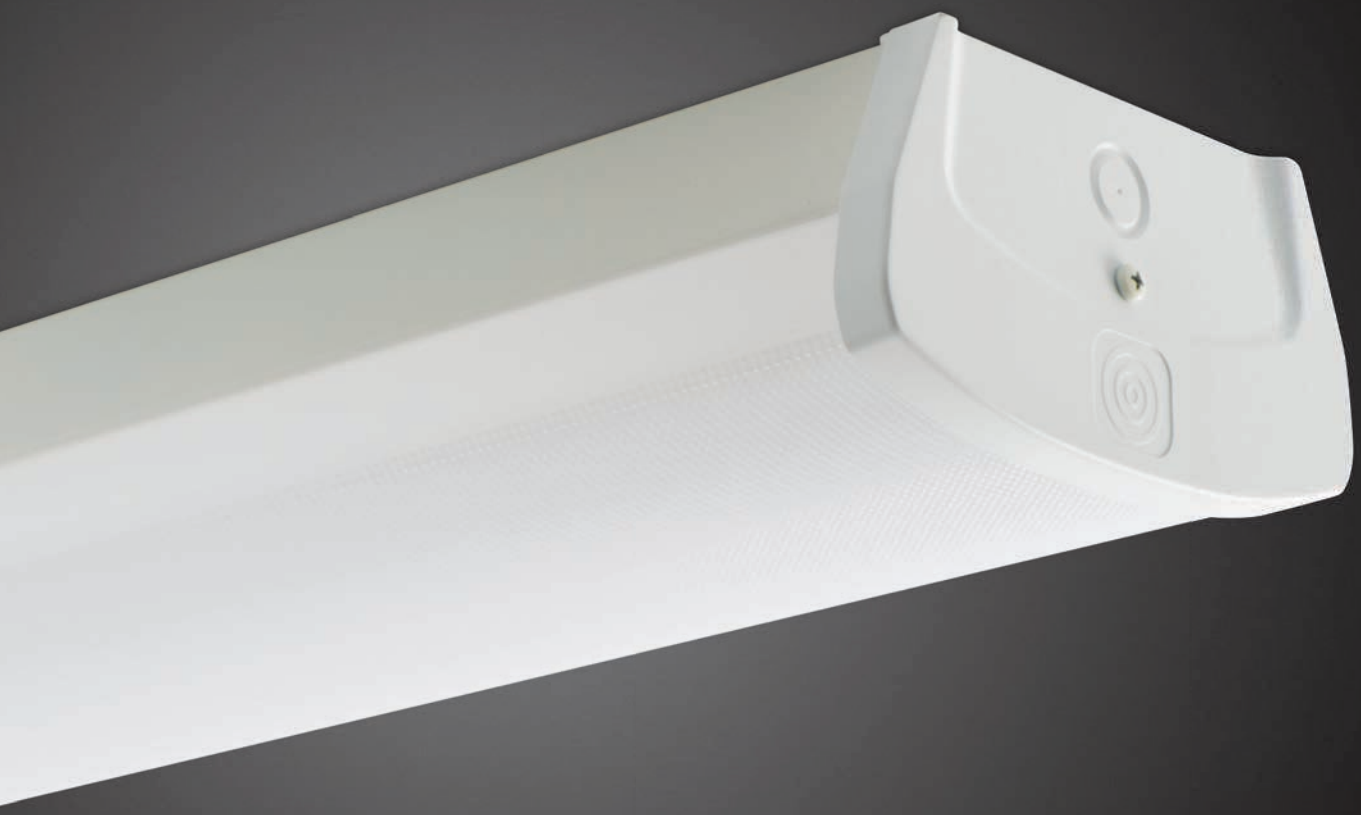
LEARNING

CLASSIFIED

PEOPLE AND JOBS

Luceco product installation guide:

1. **Fit**
2. **Forget**



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Great Dane

For anyone interested in engineering and architecture, a trip to see the Ove Arup retrospective at the Victoria and Albert Museum is a must. The exhibition looks at the Danish-born engineer's 'total design' philosophy, which advocated close collaboration between architects and engineers. In 1938, when Arup was formed, this was a unique proposition; at the time, engineers had no involvement in design at an early stage (sound familiar?). The exhibition features well-known examples of total design – with structure, architecture and building services intertwined – including the Centre Pompidou in Paris, where the structure is famously expressed by the 'inside out' service design.

Arup still strives for total design, but – according to vice-chair Tristram Carfrae – only 30-40% of his projects involve primary engineering disciplines at the design stage. The figure is worse for secondary disciplines such as fire, acoustic and lighting design, he says, with only 10% being involved from the outset.

Without total design, some of the world's best buildings would never have been built. Carfrae cites the Beijing National Aquatics Center, where all the disciplines worked together from day one. He says the suggestion for its signature EFTE roof came from the mechanical engineers, who wanted to retain heat in the pools, and they were supported by the acoustician, who said the material would deal with noise much more effectively than a glass façade. Thus the distinctive 'bubble' façade came into being – not on the whim of the architect, but through sound building services engineering.

> Without total design some of the world's best buildings would never have been built

The refurbishment of New Court hall of residence at Trinity College, Cambridge, would not have been possible without an integrated design and engineering team. Preserving the Grade I listed building's fabric was a key requirement for the college and English Heritage, and the team had to research forensically the state of the existing walls – and original architectural details – before devising the services strategy (see page 22). The project illustrates how much care has to be taken when planning to insulate existing buildings – an engineering miscalculation risks raising the spectre of mould and damp.

It is encouraging to hear that the work has been recognised beyond the wisteria-clad walls of the University of Cambridge. Peabody is employing the same team to look at the refurbishment of the brutalist towers on the Thamesmead estate in south-east London, which has its own acute issues with damp.

Alex Smith, editor
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NEWS

All the latest news from around the building industry

Berkeley launches 'sustainable' high-density housing

Berkeley Homes claims to have created a new type of housing that cuts carbon emissions, water use and noise, but in a high-density format that can help solve the housing shortage.

The company has completed its first project using the Urban House prefabricated system, which it claims cuts gas bills by 83% and water use by 30% compared with traditional terraced housing. It has a patent pending on the concept, which it says doubles the number of homes that can be built on a site thanks to the use of roof gardens and front-of-house parking. The housebuilder believes this will make it economically viable to develop plots that were previously considered too small.

Two streets of 22 homes each have been completed in the London borough of Greenwich using the modular design, which is transported to site by lorry and benefits from construction times of just 14 weeks. Another development is nearing completion in Reading.

Berkeley says energy efficiency measures could cut carbon emissions by 19% compared with traditional alternatives. 'The Urban House… will help us build the types of home that people love at the kind of densities that could solve the housing crisis,' said group chair Tony Pidgley.

Expert team to stop the rot at London's Thamesmead estate

Refurbishment scheme aims to alleviate fuel poverty

The team behind a major retrofit of Trinity College, Cambridge, is to tackle mould and damp in homes on the Thamesmead estate in south London.

Preventing condensation was a key requirement in the refurbishment of the Grade I-listed New Court halls of residence at Trinity (see feature, 'Cambridge First', on page 22). Architect 5th Studio worked with Max Fordham and building monitoring company ArchiMetrics to ensure that new insulation and services would not damage the fabric of the 200-year-old building.

Extensive monitoring and modelling was carried out to ensure moisture would not become trapped in the fabric of the building. It is the first major refurbishment of any historic college building at Cambridge. The task at Thamesmead is to work out how best to insulate the estate's brutalist towers, which served as a backdrop for Stanley Kubrick's big screen adaptation of *A Clockwork Orange* and which suffer from severe damp problems.

JON BENNETT CC BY-SA 2.0

'The scheme will help alleviate fuel poverty and aims to radically transform the character and image of the estate – but the way the fabric and systems have to work together is similar to Cambridge,' says Oliver Smith, a director of 5th Studio.

The project is set to go before planners at the end of July and work is due to start next year.

TfL's sideway glance at lift tech

Ropeless elevators are set to transform the way people use metro systems, according to experts at a panel discussion held in London last month. Architect Chris Williamson, partner at Weston Williamson + Partners, said innovations such as ThyssenKrupp's Multi could be used to reduce congestion at tube stations in London. He added: 'For most commuters, it is as important to swiftly and comfortably access the deepest platform as it is to move quickly from station A to B.'

The Multi system does away with cables by borrowing the linear motor technology from Maglev train systems to move cars horizontally as well as vertically. Lauren Sager Weinstein, head of analytics and customer experience at Transport for London (TfL), was enthusiastic about the technology. She said: 'In the same way Manhattan was transformed by the lift, this could revolutionise cities.'

Engineers in the audience saw the technology's potential use for step-free access and in congested stations with little room for vertical shafts. For more on ropeless lifts see 'Lift off', *CIBSE Journal*, January 2016, at **www.cibsejournal.com**

THE ART OF HEATING AND COOLING

Tate Modern's new extension – The Switch House – opened on 17 June.

Working alongside Swiss architects Herzog & de Meuron, environmental engineer Max Fordham's heating and cooling strategy passively controls temperature in the building by extracting or rejecting groundwater from a layer of river terrace gravels ten metres below the site.

To combat humidity, Max Fordham used a rotating wheel made of hygroscopic material – like silica gel – to transfer moisture between the supply and extract air streams.

CREDIT ALEX UPTON

Building industry holds breath after Brexit vote

- **Fears over environment, skills and investment**

A wave of uncertainty has hit the construction industry after the UK voted to leave the European Union (EU) in the referendum on 23 June.

Industry experts have expressed concern about what the vote will mean for UK's infrastructure, investment, skills and the environment.

Hywel Davies, CIBSE technical director, said: 'The vote to leave creates enormous uncertainty that will distract many in UK construction and engineering from the significant challenges that face the MEP sector worldwide: digitisation of the sector and the drive for greater resource efficiency together with the demand for the skills to deliver. '


Cameron announces his departure

MATT CARDY / STRINGER / GETTY IMAGES

Dorte Rich Jørgensen, sustainability consultant engineer at Atkins and member of built environment think-tank The Edge, was concerned about the loss of EU funding in the sector.

She said: 'Businesses need stability and investment, and there is uncertainty about how this will impact UK commerce, jobs and prosperity.'

As an EU member state, the UK has access to the European Investment Bank (EIB) and the European Investment Fund, which last year invested €7.8bn in infrastructure projects, and leant €665.8m to SMEs.

Up to 60% of funding for some infrastructure projects – such as Crossrail and HS2 – comes from the EIB, which last month also announced £280m of funding for the expansion of UCL facilities and £700m of finance for the Thames Tideway Tunnel.

There are also fears that the London economy could be impacted by the vote to leave, reducing engineering output.

Other engineers warned there may be fewer opportunities for UK firms in the EU unless they already had offices in Europe, and that the outcome would affect industry's ability to recruit engineers.

The cost of labour is set to rise significantly according to some housebuilders, whose shares fell by up to 40% following the Brexit decision.

Monika Slowikowska, founder of Golden Houses Developments, said: 'The cost of labour in construction has increased by an average of 8% in the last six months and it's set to keep rising. By leaving the EU, and based on our projects, we predict that this could increase by an extra 15 to 20%,' she said.

Brian Berry, chief executive of the Federation of Master Builders, added: 'If ministers want to meet their house building and infrastructure objectives, they have to ensure that the new system of immigration is responsive to the needs of industry.'

The Leave vote means we will have to look again at the Energy Performance of Buildings Regulations in the UK, which deal with energy labelling and nearly zero energy buildings.

Robert Cohen, director at Verco, said: 'We could have a better tailored set of regulations, but is there the ambition to have a far-reaching policy as we had when influenced by the EU directive?'

The Climate Change Act establishes a target for the UK to reduce its emissions by at least 80% from 1990 levels by 2050, but Cohen questioned whether it will survive under a new government.

The UK's energy security is also uncertain, said Michael Grubb, Professor at UCL's Institute for Sustainable Resources. He said the ability to import cheap energy from adjoining European countries will be diminished if a trade deal cannot be struck.

Grubb said: 'You require a physical connection, and the only entities we can connect to physically are mainland European continents. There is no possibility of offsetting electricity trade losses with the continent, by trading electricity elsewhere'.

Despite the uncertain times, industry professionals urged people to remain positive.

Davies said: 'We must stay focused on addressing the challenges of digitisation, resource use and skills while working through the consequences of the vote.'

Jørgensen added: 'We need to use this to our advantage and as an opportunity to raise our game.'

...Brexit facts

- The Leave camp won with 51.9% of the vote, to Remain's 48.1%
- Cameron said he would stand down by the time of the Conservative party conference in October, and a new prime minister would invoke Article 50, triggering negotiations for Britain's withdrawal from the EU, which could take two years
- The vote has had an negative impact on markets: the value of the pound fell dramatically, at one stage hitting $1.33 – a fall of more than 10% and a low not seen since 1985
- The stock exchange fell 8% in response.

In brief

APPLE FORMS ENERGY COMPANY

Technology giant Apple has entered the renewable energy supply business with the formation of Apple Energy. The subsidiary is designed to help Apple sell off the excess electricity it generates, as part of a 'trade system' to buy net-metered energy on days when onsite solar generation is low.

The company says 93% of its facilities are powered by renewable energy and has excess capacity from solar panels and farms, hydrogen fuel cells and biogas systems. Apple also has a data centre powered entirely by solar and biogas.

SMART METERS INSTALLATION WAY OFF TARGET

The government's programme for installing smart energy meters in every UK home by 2020 is a long way behind schedule, according to the Department of Energy and Climate Change (DECC). Its figures show that, by the end of last year, just 2.3 million meters had been installed out of an estimated 51 million. Across Europe, 17 of the 27 EU member states that signed up to the programme claim to be on track, but most are only aiming to install meters in 80% of homes – the UK is one of nine aiming for 100%.

The Institute of Directors has called for the rollout to be halted in the face of rising concern that it would fail to deliver value for money and that the technology could become rapidly obsolete.

BLIP IN GLOBAL AIR CONDITIONING SALES

The international market for air conditioning 'disappointed again' in 2015, and is expected to recover at a slower pace than previously projected, according to a BSRIA report. It said the market lost 5% of its value last year, compared to 7% growth in 2014, with a dip in the Asia-Pacific region, which accounts for 61% of the world market for packaged air conditioning (PAC) systems.

The four biggest markets – China, Japan, Indonesia and South Korea – contracted and contributed to the downward trend, BSRIA reported, while Vietnam, Australia and the Philippines were bucking the downward trend.

In brief

ENGINEERS JOIN LONDON PRIDE MARCH

As the *Journal* went to press, engineering and construction firms were gearing up to take part in the Pride in London parade on 25 June. Employees from Arup, Mott MacDonald, Balfour Beatty, Carillion, Laing O'Rourke, Lend Lease, Arcadis, Nathaniel Lichfield & Partners, Skanska and WSP Parsons Brinckerhoff were to march under the banner #BuildingEquality, to champion LGBT inclusion.

CONTRACTORS TO PAY DOUBLE TRAINING LEVY

Large construction firms will pay two training levies from next April, after the introduction of the government's apprenticeships funding scheme. Those with monthly wage bills of £3m-plus will have to pay the Construction Industry Training Board (CITB) levy and the new charge, at least until 2018. Both require them to pay 0.5% of their wage bill, but the CITB said it was looking at ways of giving back some of the money in 'enhanced funding for training they undertake'.

ASHDEN AWARD WINNERS

The Sustainable Buildings award went to RE:FIT London – the Mayor of London's scheme to reduce carbon emissions in Greater London – and the Shanghai Landsea Planning & Architectural Design Co.

Cosy Homes in Lancashire (CHiL) – a partnership between 14 local authorities helping to prevent fuel poverty – took the Sustainable Homes award.

Stress is 'forgotten' health and safety issue in industry

Industry still has a long way to go to tackle mental health issues in the workplace

The Samaritans is helping a group of building services bodies, including the CIBSE Patrons, to tackle growing problems of workplace stress and depression.

The Patrons – along with the Electrical Contractors' Association (ECA) and the Building Engineering Services Association (BESA) – are hosting a seminar on 21 July, in Westminster, London, to dig more deeply into an issue that is of growing concern to employers.

BESA chief executive Paul McLaughlin, who will chair the event, said 80% of engineering services firms believe workplace mental health will have a serious impact on their businesses in the next five to 10 years. This worrying statistic emerged from an occupational health survey carried out by BESA and the ECA, which also revealed that 31% of companies found on-site mental health issues 'hard to manage'.

KIEFERPIX / SHUTTERSTOCK

The Samaritans said callers to its helplines ranged from tradespeople to senior managers feeling the isolation of leadership. Many small and medium-sized businesses are also struggling to cope with stress created by tight deadlines and cashflow issues, which can lead to feelings of depression, it added.

CIBSE Patrons chair David Fitzpatrick said: 'For an industry that already has serious recruitment issues, tackling mental health has to be a priority.' McLaughlin added: 'Mental health is the forgotten health and safety issue.'

For details of the seminar, which is free for CIBSE Patrons and ECA and BESA members, email **cbrown@cibse.org**

Aecom enters world of virtual reality

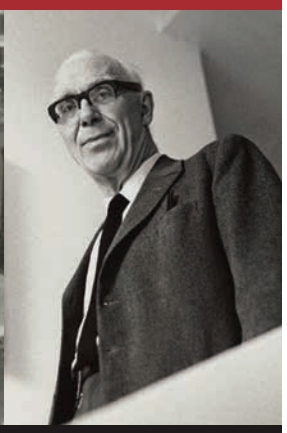
Designers and engineers at Aecom are using virtual reality headsets to help them design projects in London, Hong Kong and Denver.

The HoloLens headsets produce 3D models as holograms, allowing the Aecom team to interact with virtual projects. Engineers can view a complex structure as if it were a 3D model placed on a table, or zoom in for a 1:1 view that simulates what it would be like to move through its structural framework.

Aecom president Stephen Kadenacy said: 'Exploring complex structures in a mixed-reality environment has huge potential to accelerate the engineering design process. With this technology, we can gain greater clarity earlier in the design-review process than with 2D drawings or 3D models on screen. Team members in different locations, each wearing a headset, can also explore the same holographic projections simultaneously.'

Aecom is working with technology specialist Trimble on the scheme, which has already been trialled on the Serpentine Galleries' annual architecture programme.

ARUP SHOW AT V&A REVEALS OVE'S 'TOTAL DESIGN' PHILOSOPHY



An exhibition on the life and work of engineer Ove Arup (1895-1988) has opened at the V&A. The retrospective examines his 'total design' principles, which encouraged engineers to collaborate at an early stage on buildings such as the Finsbury Health Centre (above). *Engineering the World: Ove Arup and the Philosophy of Total Design* – supported by VW Group and Tideway – runs until 6 November.

Women in Engineering Day prompts gender debate

- **International event aims to attract women into industry**

Dervilla Mitchell

Last month's National Women in Engineering Day (NWED) has prompted calls for the industry to tackle its lack of gender balance.

The annual event, organised by the Women's Engineering Society (WES), forms part of an international awareness campaign to raise the profile of women in engineering and focus on the wide range of career opportunities available to women and girls.

To coincide with this, the *Daily Telegraph* compiled a list of the top 50 most influential women in engineering, which included Royal Academy of Engineering president Dame Ann Dowling; Naomi Climer, president of the Institution of Engineering and Technology (IET), along with a former Institute of Refrigeration President Jane Gartshore.

BBC Breakfast presenter Steph McGovern was also included, along with the only female engineer in the House of Commons, Chi Onwurah MP.

The top 50 were picked from more than 900 nominations and Dawn Bonfield MBE, WES chief executive, said this gave the industry 'amazing role models who could raise the profile of talented women engineers and make them more visible, both within the industry and to the next generation'.

But others said the UK engineering community's lack of gender balance was hampering business.

'There are still not enough women in engineering,' said Arup director Dervilla Mitchell , who was named in the *Telegraph*'s top 50. 'The lack of women in the industry is exacerbating an already acute talent shortage; almost 65% of engineering employers say a shortage of engineers in the UK is a threat to their business.' She added that companies are 15% more likely to perform better if they are gender diverse.

Women engineers honoured by Queen

Two leading female engineers became members of the Order of the British Empire, in the Queen's Birthday Honours on 10 June, for their efforts to inspire and support fellow women in their profession.

Dawn Bonfield, chief executive of the Women's Engineering Society (WES), was honoured for promoting diversity in engineering, while Susan Bird – consultant acoustic engineer and partner at Bird Acoustics – was recognised for her services to engineering and women in engineering.

Bonfield, who has worked as a materials engineer for British Aerospace and missile systems firm MBDA, joined WES five years ago as a volunteer, before becoming chief executive last year.

Bird made her mark in the industry as one of the few women working in the field of acoustics at the British Aircraft Corporation in 1970. She worked on Concorde – specialising in flyover noise – and in the noise and acoustics department at the Greater London Council.

Movers and makers

Send your job moves to **editor@cibsejournal.com**

Tamsin Tweddell has been appointed a senior partner at Max Fordham – the first woman to take up this position at the environmental engineering firm. Tweddell joined the practice in 2000, having studied natural sciences at the University of Cambridge. Much of her work has focused on the performance of completed buildings. 'Our goal is to firmly establish our understanding and delivery of buildings with exemplary performance in use,' she said.

Carl Collins has been appointed by CIBSE to lead a range of BIM and digital initiatives planned for members and the building services supply chain. He has more than 30 years' experience working in engineering environments, for companies including Arup. 'I'm very excited to be joining CIBSE and driving our whole approach to BIM,' he said.

Gary Marshall has been appointed operations director of engineering consultancy Sweco. With a background in electrical engineering, Marshall has 25 years' experience of working with electrical engineering distribution systems, data centres and bespoke tenant fit-out projects. He also lectures at CIBSE's training college. 'I was attracted to join Sweco because of its industry reputation, professionalism and depth,' he said.

Research at your fingertips

A full list of – and information about – research projects supported by CIBSE, is available in the knowledge section of the CIBSE website.

CIBSE supports research activities for the advancement of knowledge in all areas of building services engineering. Activities range from supporting academic research as partners, stakeholders and as a dissemination route of research outputs, to funding research projects, such as doctorate and post doctorate studies, Knowledge Transfer Partnerships and engineering doctorates.

For details visit **www.cibse.org/knowledge/research**

Whistleblowing support

The Engineering Council's statement on whistleblowing, issued in 2015, enables engineering institutions to support members if they need to 'raise a concern either within the workplace or externally, including a danger, risk, malpractice or wrongdoing, which affects others'.

Whistleblowing is a vital mechanism for engineers and technicians, many of whom work in environments and on projects that can seriously endanger the health and lives of members of the public in the event of wrongdoing.

Engineers and technicians must deal with the management of risk every day, but the new statement expands this definition to include the 'inadequate quantification and management of risk', as well as risk that they are not directly involved in, but become aware of during the course of their work.

Details are available at **www.engc.org.uk**

New SLL president sets out course for lasting legacy


Jeff Shaw with outgoing president Liz Peck

Inspiring the next generation to join the lighting community is my mission, says Jeff Shaw

Jeff Shaw was inaugurated as the new Society of Light and Lighting (SLL) president, during its AGM at City Hall, London in May.

Commenting that most people in the room would have entered the lighting industry by accident, he reflected on his interest in light long before he had ever considered it as a career.

'I was a budding lighting designer, but what I didn't know as a child was that I could have a career in lighting,' he said.

Reflecting on the achievements of Liz Peck's presidential year and the UNESCO International Year of Light, Shaw outlined his vision to inform and inspire the next generation about lighting and engineering.

'I want to inspire a different experience for children growing up today and in the future. I want to inspire the lighting designers and engineers of tomorrow; to let their parents know that a respectable career lies ahead for those who want to join our industry.

'I want to help to create a lasting legacy of engagement and interaction between the lighting community, the construction industry and the public,' he added.

With changes in the lighting market and technologies, Shaw highlighted the need for SLL to inform the public about the benefits of quality lighting. Citing recent mainstream press coverage on the potential negative effects of blue light from screens, he drew attention to a need for better, more accessible information on lighting and health, as well as providing useful consumer guidance.

Shaw, who has been SLL education and membership committee chair for many years, said he aims to develop and launch structured advice and tools for lighting-related STEM ambassadors, in collaboration with other lighting organisations.

Rounding off his address, Shaw thanked outgoing SLL president Liz Peck.

Shining stars at SLL awards

Together with the inauguration of Jeff Shaw as the new Society of Light and Lighting (SLL) president, various awards were presented at the SLL AGM.

Christopher Fordham and Charlie Upton were awarded certificates for completing the LET Diploma.

Prizes for technical papers published in *Lighting Research and Technology* (*LR&T*) – available free to SLL members – were also awarded:

The Leon Gaster Award was presented to Peter Csuti, J Schanda and F Szabó, for their paper *Colour fidelity for picture gallery illumination, Part 1: Determining the optimum light-emitting diode spectrum*, together with P Csuti, A Fáy, J Schanda, F Szabó, and V Tátrai for their paper *Colour fidelity for picture gallery illumination, Part 2: Test sample selection – museum tests.*


John Fitzpatrick was awarded an Honorary Fellowship

The Walsh Weston Award went to Mark Rae for his paper *The lumen seen in a new light: Making distinctions between light, lighting and neuroscience.*

Peter Philipson, London events committee chair, won the Regional Award.

This year there were four recipients of the SLL Lighting Award: Dan Lister, Simon Fisher, Rhiannon West and Liz Peck.

An Honorary Fellowship went to John Fitzpatrick, and the President's Medal was given to David Carter for his long-standing contribution to the lighting industry.

CIBSE celebrates new United Arab Emirates Region's licence to operate

More than 300 members are based in the UAE

CIBSE has gained a licence from the Dubai Association Chamber to operate as an official region in the United Arab Emirates (UAE).

A milestone for both the local committee in the UAE and for CIBSE, this is the first new region to launch in 29 years, following a great deal of work by the UAE committee and staff support.

CIBSE would like to extend its thanks to all those who contributed in the past and to the current committee. Further work can now be done to support members and prospective members in the country with technical events and conferences.

ChewPieng Ryan, Arup associate and current UAE committee chair, said: 'This is a great achievement for CIBSE in the UAE and now allows us, as a committee, to support members who live here with more technical networking events, and gain traction locally with companies as well as local institutions and government bodies.'

Members of the UAE Committee with CIBSE chief executive Stephen Matthews (back row, second from right). Front Row: industry liaison Barrie Harmsworth, UAE region chair ChewPieng Ryan, outgoing President of CIBSE Nick Mead, UAE WiBSE rep Farah Naz and CIBSE director of membership Carilyn Burman

The UAE construction industry continues to grow at a phenomenal rate with ongoing projects, investment into green open spaces and strong government support, with increasing emphasis on quality standards, efficiency and excellence.

Building designs are in the forefront of implementing sustainability and green system accreditation, and there is huge movement on research and innovation in clean energy in the Middle East.

A dinner for 200 people was held on 21 April at The Westin Hotel, Dubai to celebrate the launch of the UAE region. Saeed Al Abaar, Emirates Green Building Council chair, gave the keynote speech entitled 'The role of UAE buildings in a post COP21 world'.

Nick Mead, CIBSE immediate past President, who attended the launch, said: 'There are more than 300 members based in the UAE and we need to ensure that we are able to serve members outside the UK – the licence in the UAE will now help us to do this. There is a lot of opportunity in the UAE in terms of membership and sharing and delivering knowledge, as well as development of country-specific guides and technical memoranda.'

Call for Symposium papers and posters

CIBSE is calling for papers, posters and case studies for the 2017 Technical Symposium, taking place on 5-6 April, at Loughborough University.

The theme is 'Delivering resilient high performance buildings', inspired by the debates and discussions dominating the industry.

Strongly allied with this year's ASHRAE and CIBSE presidential themes – respectively 'Adapt today to shape tomorrow' and 'Improving performance' – the 2017 event aims to offer evidence of the adoption and protraction of resilience in the design and operation of buildings.

All papers, posters and case studies will be peer reviewed and published electronically by CIBSE.

Material should be based on recent or current research and application, as well as the actual or potential impact on the built environment. Send abstracts to **symposium@cibse.org** by 12 September. For details visit **www.cibse.org/symposium**

Latest BSERT hot topics have tropical air

The application of building services in hot and tropical climates is the theme of the latest issue of *Building Services Engineering Research & Technology (BSERT)*, the international journal for the publication of original research in building services engineering.

In Volume 37, issue 3, there is a study on the use of computational fluid dynamics to explore airflow patterns around a building in a tropical climate, and an investigation into conditions for the use of thermal imaging cameras for analysing energy transfer in buildings in hot climates.

There are two contributions on the application of weather data to building simulation. A new approach is presented for modelling cooling demands for use in generating European energy performance certificates, and there are case studies on energy use in heritage-type buildings, as well as improved comfort for occupants of commercial buildings in the tropics, using advanced control strategies.

BSERT covers all areas of interest to CIBSE members with the exception of lighting, (which is the focus of sister journal, *Lighting Research & Technology – LR&T*).

Members can freely access both journals at **www.cibse.org/knowledge**

Annual general meeting

The CIBSE Annual General Meeting was held at the Royal Society, Carlton House Terrace, London, on 5 May 2016. Nick Mead, outgoing President, chaired the meeting. Chief executive Stephen Matthews read the notice convening the meeting.

The minutes of the 38th CIBSE AGM, held on Thursday 7 May 2015, and published in the July 2015 issue of *CIBSE Journal*, were accepted as a correct record and signed by the chair.

Annual report and financial statements

Nick Mead introduced the annual report for 2015, which he believed showed the Institution's strength in both the delivery of its objectives and its financial position. Collaboration with other professional bodies and input to government, including the Parliamentary Estates issue, shows that CIBSE was at the 'top table' of institutions. The Conference and Exhibition was a success, with improved attendance on the previous year, and the first international YEN conference was held in Hong Kong. The Building Performance Awards – with additional categories – achieved its best attendance, and the Technical Symposium in Edinburgh included a wealth of diverse and informative papers.

New publications included Guides A and D, the heat networks guide and TM57. A large investment in IT would ensure improved service through electronic media to CIBSE members and wider society.

Groups and Societies ran many events such as the SLL Night of Heritage Light, which raised CIBSE's profile in national TV and press.

Regions continued to support membership development, and CIBSE's first new region in 29 years was established in UAE. Regions are key to serving society, both in the UK and overseas, and CIBSE's global shared knowledge and experience will continue to contribute to the development of the built environment.

Nick Mead acknowledged the work of CIBSE volunteers, without whom this work would not be possible, and thanked the board, Regions, Groups and Societies for their contribution. He referred to the Governance Task Force, the work of which will be implemented over the coming months with the support of a small working group. The development of the 2020 vision and strategy embracing membership, knowledge, building performance and CIBSE Services will also be developed over the coming months.

Nick Mead concluded by thanking the Institution's staff for their support, and wished John Field every success as President.

Richard Willis, audit partner at Moore Stephens, read the audit report, which confirmed that the financial statements gave a true and fair view of the Institution's affairs, and had been prepared in accordance with all relevant requirements. There were no matters to be reported as exceptions under the legislation.

Stuart Macpherson presented the financial statements for 2015, drawing attention to the overall financial position. Income has increased slightly overall; a mixed picture showed an increase in membership income and charitable service, and a decrease on trading subsidiaries and investment income.

He drew attention to the breakdown of income from CIBSE Services, encompassing the *Journal*, Certification and MCC as the main income areas. He presented a breakdown of expenditure for the year, noting that it had increased from 2014. The net movement in funds for the year showed a deficit of £258,000, although there had been an operating surplus of £141,000 before accounting for the IT investment.

Stuart MacPherson confirmed that a major IT investment had been identified more than three years ago, and that a £1m project, which was approaching completion, had been approved. It had always been acknowledged that this would require draw-down from reserves, although much of the expenditure to date had been funded from operating income.

The pension fund position was also under control, despite the variability of valuations, and there were no concerns over its funding.

Stuart MacPherson drew attention to the summarised balance sheet showing net assets of £3,146,000, a reduction from £3,404,000 the previous year.

In response to questions, it was agreed that a breakdown of the expenditure of more than £1m shown against Regions and Groups would be provided. It was subsequently clarified that this included around £320,000 in respect of Regions (grants £140,000, expenses £55,000, staff costs £31,000 and overheads £94,000), £648,000 on Societies, £85,000 on Groups and £7,000 on networks.

Board and Council for 2016/2017

Stephen Matthews reported that Electoral Reform Services had been used to conduct the ballot for the election of officers and board members, in those categories where candidates outnumbered the vacancies. He read the results of the ballot and declared the following individuals elected to serve as officers, board members and council members following the AGM 2016:

Officers:

President:	John Field
President-elect:	Peter Wong
Immediate past President:	Nick Mead
Vice-presidents:	Paddy Conaghan
	Stephen Lisk
	Tadj Oreszczyn
Hon treasurer:	Stuart MacPherson

Members of the board:

Elected member:	Lynne Jack

Members of council:

Elected member:	Tessa Guy

The Scrutineers' Report, setting out the results of the ballot for vice-presidents and elected board members, would be made available in the members' area of the CIBSE website at **www.cibse.org/members**

CIBSE was not in regular receipt of any government grants, although government funding for specific projects was occasionally received. The IT strategy investment was behind schedule because of the withdrawal of a key supplier, but it was hoped that the project would be completed within the original £1m budget, with an anticipated July go-live date for the new CRM system. The new bulk email system was developing promisingly, and this would help in managing the volume of email communications.

The improvement in the Pension Scheme funding position was welcomed, although it was noted that this remained subject to future valuations. Fluctuations in the market value of investments resulted in the loss in the current year.

A breakdown of the £300,000 spend on research was requested, and it was confirmed that this could be provided.

It was suggested that the return on commercial subsidiaries appeared modest compared to the expenditure invested; however, around £350,000 of profit had been gift-aided to CIBSE. Richard Willis explained that the gift aid figure could only be based on taxable profit, which was not always the same as accounting profit; it was also noted that CIBSE Services absorbed a substantial share of the overall costs of the Institution.

Auditors

Stuart MacPherson proposed that Moore Stephens be appointed as the Institution's auditor for 2016, and that the board be empowered to agree its remuneration. This was seconded by Donald Leeper and approved *nem con*.

Special Resolution

Stuart MacPherson proposed adoption of the Special Resolution for membership subscriptions for 2016, as set out in the Calling Notice. The proposals were based on a rounded 2.5% increase, which was felt to be reasonable in view of the current economic circumstance and the position of the industry, along with the need to continue investment to develop the work of the Institution.

It was suggested that the free subscription rate applied to full-time students might be extended to part-time students. After consideration, the board felt that the rate charged was reasonable because part-time students were generally in employment.

While it was not possible under the Regulations to raise this suggestion as an amendment to the resolution before the meeting, the board agreed to give it further consideration in the future.

It was suggested that the additional subscription payable by Fellows, in excess of the Member rate, might be a discouragement to those considering transfer to the Fellow Grade. But the board felt that the additional amount was not excessive.

This resolution was seconded by Donald Leeper and approved *nem con*.

Feedback

Response to query over overheating shows that new CIBSE guidance will offer designers more flexibility when making assessments

A suitable approach

The issue of overheating ('Weather alert', *CIBSE Journal*, June 2016) is clearly a topic raising much discussion in both the popular and technical press.

Unfortunately, there does seem to be a common misconception in the industry about the overheating criteria that thermal models are to be assessed against. The 'Weather alert' article continues this.

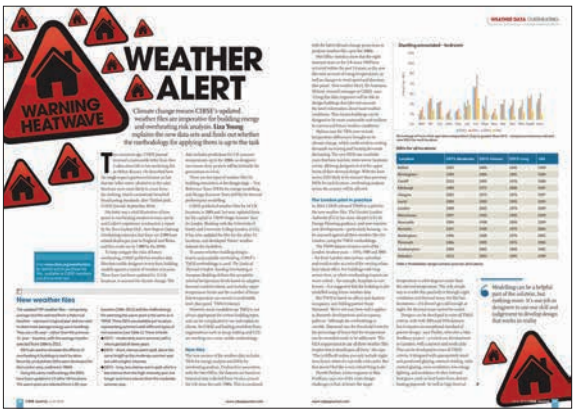
The issue arises out of the application of the 'adaptive' approach, which is put forward in both TM52 and CIBSE Guide A 2015. There seems to be a general impression that the adaptive approach can be arbitrarily chosen over the more 'traditional' fixed temperature (usually around 26°C). In fact, a building must be suitable for the adaptive approach to be used. This is clearly defined in *BS 15251 Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics*.

Annex A2 states a number of criteria that have to be satisfied, the most notable being that occupants must have the option of easy access to opening windows that have a significant effect on the thermal environment. So a space that is mechanically ventilated (without opening windows, perhaps for acoustic reasons), or that only has nominally openable windows, is not suitable for the adaptive approach and the traditional fixed temperature criteria must be used.

Unfortunately, the CIBSE guidance (which refers back to BS 15251) about the applicability of the correct criteria is unclear. The matter is probably also confused by the fact that BS15251 sees fit to define any mechanical ventilation using a fan as 'mechanical cooling', in the same way as if a chiller were installed. This means that a mechanically ventilated building cannot be 'free-running'.

I agree that we do not want to get to the stage where there is no option other than mechanical cooling – which most people would consider to include a chiller or similar – but, as an industry, it is important to make sure we are using the correct measure for defining overheating.

Nick Hart MCIBSE



From *CIBSE Journal*, June 2016

> As an industry, it is important to make sure we are using the correct measure for defining overheating

CIBSE research manager Anastasia Mylona, replies:

CIBSE is aware of this issue of defining free-running buildings for application of TM52 criteria in overheating analysis, especially in the domestic sector.

CIBSE's Homes for the Future Special Interest Group is working on a clarification of the definition, which it is hoping to publish in the new technical memorandum (TM) *Good practice in the design of homes*.

A draft summary of the group's advice is as follows:

'It is proposed that for clarification, the forthcoming CIBSE TM *Good practice in the design of homes* should advise:

1. Homes that are predominantly naturally ventilated, including homes that have MVHR with good opportunities for natural ventilation in the summer, should assess overheating using the adaptive method described in CIBSE TM52. To allow the occupants to "adapt", each habitable room needs openable windows with a free area that satisfies Building Regulation Part F "purge" ventilation criteria – that is, the window opening area should be at least 1/20th of the floor area of the room (different conditions exist for windows with restricted openings). Further advice on the assessment method is given in TM52.
2. Homes that are predominantly mechanically ventilated, including homes with MVHR that have no opportunities – or restricted opportunities – for opening windows, should assess overheating using the fixed temperature method. The rooms should not exceed an operative temperature of 26°C in the summer for more than 3% of the occupied hours.

Care homes and accommodation for vulnerable occupants, or where external background noise would be unacceptably high when windows are open, should use the fixed temperature method. Further advice is given in CIBSE Guide A, 2015.'

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Please send all material for possible publication to: editor@cibsejournal.com or write to: Alex Smith, editor, *CIBSE Journal*, CPL, 1 Cambridge Technopark, Newmarket Road, Cambridge CB5 8PB, UK. We reserve the right to edit all letters.

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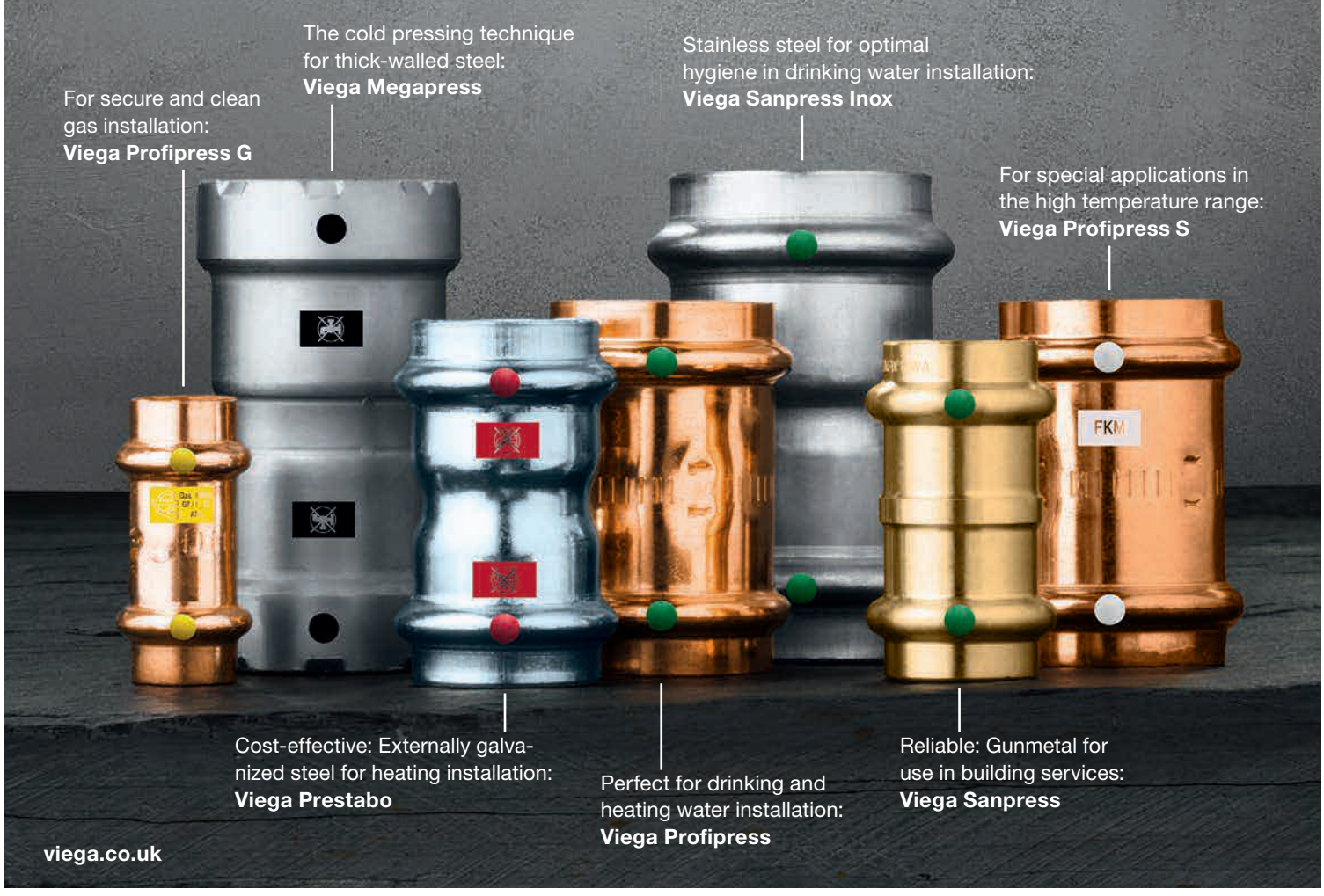

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FORUM FOR CHANGE

Productivity in the global engineering and construction sector has stagnated over the past 40 years, prompting the World Economic Forum to investigate why. **Hywel Davies** summarises its findings

The World Economic Forum (WEF) – a coalition of business, academic, charity and government leaders – has taken a hard look at the current state of engineering and construction. Its recent report takes in the views of engineering, architecture and planning firms; contractors; suppliers of building materials, chemicals and construction equipment; project owners and developers; academics; government leaders; and industry organisations – and the conclusions are a challenge to us all.

The Future of Construction project aims to support change in the engineering and construction sector, and the WEF's initial analysis, published in May, makes uncomfortable reading. It is not the first time that the industry's slow rate of innovation and technological change, adversarial relationships and lack of collaboration have been observed – but it is the first time such a group of stakeholders has provided a detailed analysis of where we are and where we need to go.

The world is changing rapidly; its urban populations are growing by 200,000 people per day, all of whom look to the engineering and construction sector to deliver affordable housing, as well as social, transport and utility infrastructure. Construction faces many areas of change that apply across the globe. In addition to the social challenge of urbanisation, infrastructure must meet the needs and aspirations of increasingly articulate and vocal populations.

Two-thirds of the predicted growth in construction over the next decade will be in the developing world. That is a challenge for CIBSE and for all our members in developed economies. We operate in a global market; the developing world is building huge projects, while developed countries have ageing infrastructure – creating a global infrastructure gap. Construction is the No 1 consumer of raw materials and produces half the solid waste in the US, while our buildings generate a third of global carbon emissions. They also face increasing challenges to resilience from natural phenomena and cyber threats. Politically, too, the world is not getting any easier.

> The world's urban populations are growing by 200,000 people per day, all of whom look to the engineering and construction sector to deliver affordable housing, as well as social, transport and utility infrastructure

Most other industries have undergone major transformations in the past 40 years; look at shipbuilding, car making, steel and coal, air and rail transport, telecommunications, broadcasting, publishing, retail and leisure. They have all changed dramatically, while the engineering and construction sector has been slow to adopt technological opportunities, and its labour productivity has stagnated as a result. The WEF report suggests that, in the US, labour productivity has even fallen over the past 40 years. Construction is the last unreformed industry sector, and its inefficiencies are increasingly hampering our economies.

The slow pace of change matters because the sector accounts for about 6% of global gross domestic product (GDP), rising to 8% in parts of the developing world, such as India. It uses half of global steel production and more than three billion tonnes of raw materials – so improved productivity and successful adoption of innovation would have a major impact. The report argues that a 1% rise in productivity worldwide could save $100bn a year.

'In the face of such challenges,' the report's authors argue, 'the industry is almost under a moral obligation to transform.' They identify persistent fragmentation and inadequate collaboration in the supply chain, difficulties recruiting talented workers, and insufficient knowledge-transfer from project to project as major causes of the poor performance of the sector. However, they claim the industry has vast potential to improve productivity through digitisation, new technology, and new construction techniques. By adopting augmented reality, drones, 3D scanning and printing, BIM, autonomous equipment and advanced building materials, the sector can boost productivity, streamline project management and processes, enhance the quality of output, and improve safety.

Some of this is not new; it has been said before and will require a committed effort by the industry to bring about. The report identifies eight topical areas in which the sector needs to change:

- Technology, materials and tools
- Processes and operations
- Strategy and business model innovation
- People, organisation and culture
- Industry collaboration
- Joint industry marketing
- Regulation and policies
- Public procurement

It sets out 30 measures, classified in three groups – for private companies; for companies in collaboration with peers or by the industry as a whole; and for government, acting either as the regulator or as a major project owner.

For each topical area, the WEF report identifies current best practice, and offers case studies of innovative approaches – but, above all, it leads with what companies can do. It emphasises the role of digital technologies, so our work on BIM is again underlined, while the report also highlights the importance of data. It focuses on learning from projects, and on the need for knowledge to be developed, maintained and exchanged, and for training across the sector.

The WEF has given us much to think about, and its report deserves to transform our summer reading lists.

● Link to the full report: **bit.ly/1TUq3Ba**

● **HYWEL DAVIES** is technical director at CIBSE **www.cibse.org**

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MOVING TO A ZERO CARBON, ELECTRICALLY POWERED FUTURE

Building regulations do not take into account the rapid decarbonisation of the electric National Grid, according to Keepmoat's **Nigel Banks**, who warns millions of pounds could be wasted on off-grid technology that makes relatively small inroads into cutting carbon emissions

In the early hours of 10 May 2016, for the first time since the 1882, no coal was burnt to generate electricity in the UK. This was not only a symbolic achievement, but it highlighted a significant shift in the way electricity is now being generated. In 2012, the average carbon intensity of the National Grid was 531g CO_2/kWh, with coal delivering on average 43% of electricity. This dropped to 391g CO_2/kWh in 2015 (25% coal) and for the first five months of 2016 has dropped to 318g CO_2/kWh (12% coal).

Ever-rising amounts of solar and wind energy, lower overall electricity consumption and the greater use of more efficient – and significantly lower carbon polluting – combined cycle gas turbine power stations, have led to this dramatic change.

April 2016 witnessed the shutting down of a number of major coal generation plants as a result of electricity generation from coal being unviable, and May 2016 saw more energy being generated from solar PV than from coal. This seemingly permanent move is not only good news for delivering the UK's carbon reduction targets, but also has very profound impacts on the relative carbon intensities of heating systems that heat our homes and buildings.

The government has committed to no coal being burnt by 2023 and DECC's projections (November 2015) are that the carbon intensity of the grid will continue to fall to below 250g CO_2e/kWh by 2020, and then continue on a downward path to 165g CO_2e/kWh in 2025, 110g CO_2e/kWh in 2030 and 65g CO_2e/kWh in 2035. Given that heating systems being designed today will mostly spend their operating lives in a time with UK grid intensities below 240g CO_2/kWh – the carbon intensity of heat delivered from a 91% efficient natural gas boiler – this has a fundamental impact on how we should design, heat and manage energy in our homes and buildings. [*Note: Emissions intensity projections are in kg CO_2e/kWh, which include other greenhouse gas emissions, whereas Building Regulations uses kg CO_2/kWh. Consistent use of kg CO_2e/kWh would amplify the impacts shown in the example below.*]

Building Regulations – and consequently most policy relating to energy in homes and buildings in the UK – still use carbon factors identified in 2012 for determining the carbon emissions of homes and buildings. For most fuels this is acceptable, as

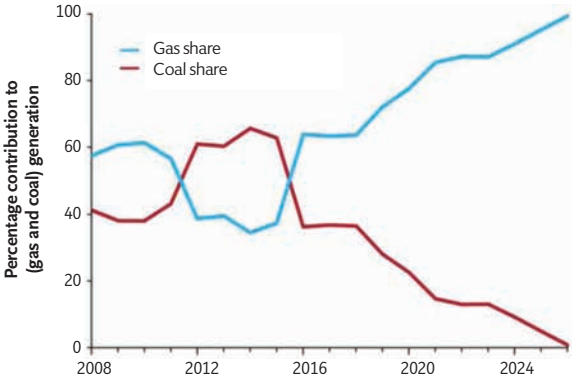

Figure 1: Relative share of (gas and coal) fossil fuel generation

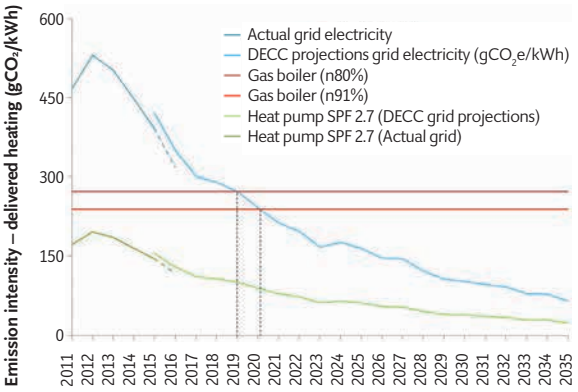

Figure 2: Grid electricity, DECC projections, gas and heat pumps

Carbon ranking	2012 emissions (tCO_2/home) with grid intensity 519g CO_2/kWh		2016 emissions (tCO_2/home) with grid intensity 288g CO_2/kWh	
Low carbon	Gas CHP district heat	1.74	ASHP heat and DHW	1.15 ↑
	ASHP heat and DHW	2.07	ASHP heat, direct DHW	1.53 ↑↑↑
	Local gas boilers	2.13	Local gas boilers	1.67 -
	Gas boiler DH	2.40	Electric storage heat	1.87 ↑↑
	ASHP heat, direct DHW	2.72	Gas boiler DH	1.94 ↓
Highest carbon	Electric storage heat	3.37	Gas CHP district heat	2.06 ↓↓↓↓↓

Carbon ranking	2025 emissions (tCO_2/home) with grid intensity 165g CO_2/kWh		2035 emissions (tCO_2/home) with grid intensity 65g CO_2/kWh	
Low carbon	ASHP heat and DHW	0.66	ASHP heat & DHW	0.26 -
	ASHP heat, direct DHW	0.87	ASHP heat, direct DHW	0.34 -
	Electric storage heat	1.07 ↑	Electric storage heat	1.07 -
	Local gas boilers	1.42 ↓	Local gas boilers	1.22 -
	Gas boiler DH	1.69	Gas boiler DH	1.49 -
Highest carbon	Gas CHP district heat	2.23	Gas CHP district heat	2.36 -

Figure 3: Emissions for 2012, with predicted emissions for 2016, 2025 and 2035

ASSUMPTIONS FOR FIGURE 3

2,000kWh/yr heating demand; 2,500kWh/yr hot water demand; 2,000kWh/yr electricity demand; 90% new gas boiler; 20% new DH distribution losses; heat pump heating SPF 2.7; heat pump hot water SPF 2.0; gas CHP 30% electric 50% thermal; 0.218kg CO_2/kWh gas; 0.32kg CO_2/kWh grid electricity. Biomass district heating discounted due to NO_x emissions and fuel delivery.

they do not change much, but not for grid electricity with a current figure of 519g CO_2/kWh in SAP2012 – based on incorrect 2012 projections for grid carbon intensity across 2013-15. If derived now for an updated SAP2016, the figure would be just 288g CO_2/kWh (2017-19 projected average).

A grid carbon intensity of 288g CO_2/kWh has very significant impacts when considering heating systems options; on a recent project this changed the ranking of lowest carbon solutions significantly:

As you can see from the example in Figure 3, gas CHP district heating moves from lowest carbon on 2012 emissions to highest carbon of the options considered with 2016 carbon emissions factors. Also local gas boilers become higher carbon than electric storage heaters from around 2020.

> May 2016 saw more energy being generated from PV than coal

This also has significant impacts for retrofit programmes. For example, many electric storage heating systems are being replaced with local gas boilers (or gas district heating), which over the next 12 years will increase emissions by 28% and not deliver the 52% emissions savings projected by SAP 2012.

This has profound impacts on upcoming programmes such as the new Energy Company Obligation, which should bring more than £3bn of funding to retrofit from 2017-22.

However, the current Ofgem consultation proposed the use of SAP2012 carbon factors, which in some circumstances could mean significantly increased emissions, when the programme is claiming to deliver significant carbon emission reductions.

With electricity providing heating, cooling, hot water, power and, in time, transport smart controls significantly improves the ability to manage demand and peak loads on the grid. The introduction of domestic time-of-use tariffs next year will also dramatically shift the economics of electric storage heating, electric hot water and battery storage in the domestic sector. This should help make electric heating solutions not just lowest carbon but potentially also lowest running cost.

The conclusion I have drawn is that – unless natural gas decarbonises very rapidly, which seems very unlikely – a National Grid with a lot less coal means we need heating without gas.

In the UK, I believe we will move to a largely zero carbon electrically powered, electrically heated and electrically transported future – the question is, how quickly? The faster we get there, the better our chances of averting catastrophic climate change...

● For more on gas-fired CHP read Arup's Technical Symposium paper at **bit.ly/28R3U6I**

● **NIGEL BANKS** is group sustainability director at Keepmoat

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CAMBRIDGE FIRST

A Grade I listed hall of residence at Trinity College, Cambridge has undergone a highly sensitive upgrade that sets the standard for the green retrofitting of UK's historic buildings. **Andy Pearson** reports

For almost 200 years, New Court in Trinity College, Cambridge, has been a place of study and contemplation. Its neo-Gothic walls have been home to the likes of the poets Tennyson and Hallam and even the current Prince of Wales. However, after two centuries as a student residence, the accommodation in the four-storey courtyard fell far short of current regulatory standards and present-day expectations of comfort and amenity.

The college wanted to refurbish the notoriously draughty Grade I listed block so that it could continue using it for another 200 years, but the block's listing meant that any changes to the structure would require listed building consent.

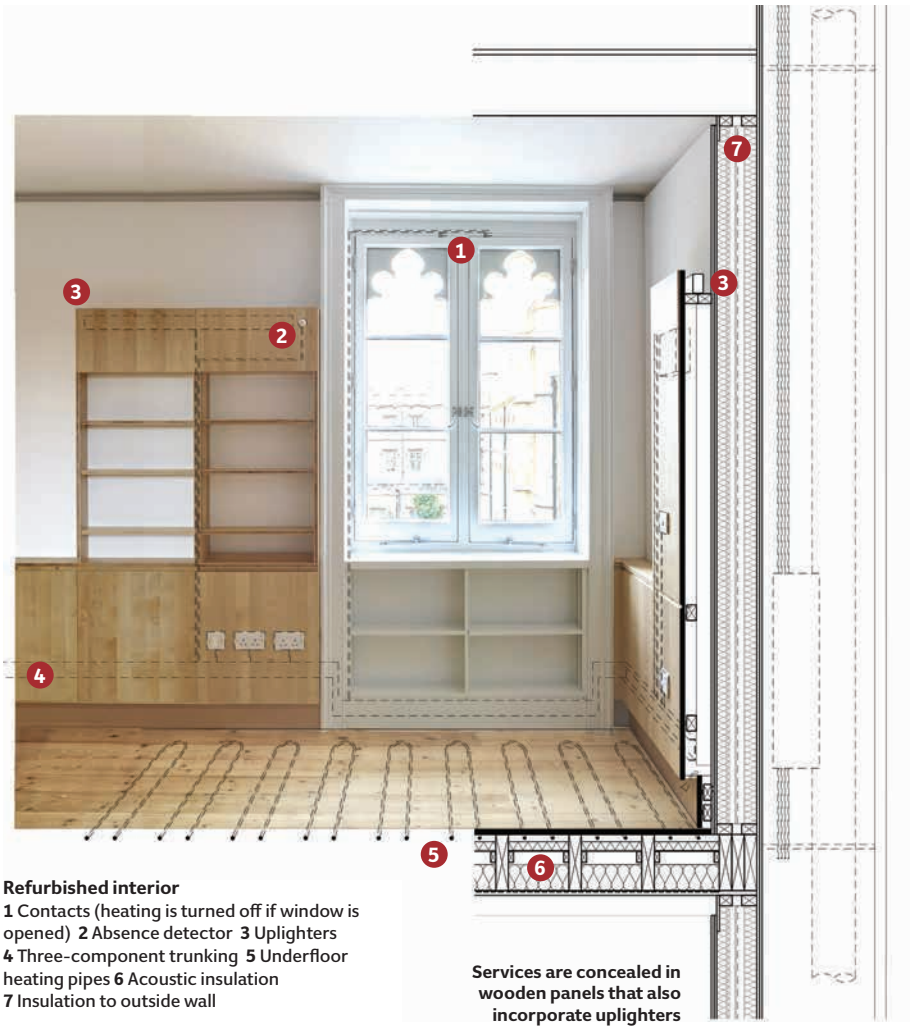
'The conservation-as-normal approach would have been to do very little in terms of improving performance and sustainability because the integrity of the historic fabric was more important than tackling the building's shortcomings,' says Oliver Smith, a director of architects 5th Studio. To its credit, Smith says, the college decided that 'it had a responsibility to work out if it was possible to do something exceptional in reconciling heritage and sustainability through the refurbishment of New Court'. It appointed 5th Studio and engineer Max Fordham and together the team got to grips with one of the most radical refurbishments of a Grade I listed building ever attempted.

'Fundamentally, the building had a heat loss problem,' says Joel Gustafsson, senior engineer at Max Fordham. Adding insulation to the listed exterior was not an option, so the team set about exploring options for insulating the inside face of the exterior walls. Aside from the issue of obtaining listed building consent for the intervention, there were serious concerns that improvement of the wall's thermal performance would also create moisture and condensation problems.

'When you insulate internally, you change the metabolism of the building; the risk can be anything from cold bridges leading to condensation and mould growth through to

PROJECT TEAM

- **MEP and building physics modelling:** Max Fordham
- **Architect:** 5th Studio
- **Contractor:** SDC
- **Structures:** CAR
- **Cost consultancy:** RUA
- **CDM coordinator:** Gleeds
- **Building performance research:** ArchiMetrics
- **Specialist sub-contractor:** Munro – M+E Service
- **Building products:** NBT
- **Windows:** Mat Bateman
- **Lime render:** AVV
- **Joinery:** Cousins



Refurbished interior
1 Contacts (heating is turned off if window is opened) **2** Absence detector **3** Uplighters **4** Three-component trunking **5** Underfloor heating pipes **6** Acoustic insulation **7** Insulation to outside wall

timber joists rotting,' Gustafsson explains.

As luck would have it, Max Fordham had just completed a Knowledge Transfer Partnership (KTP) on moisture movement in the fabric of buildings. The New Court project offered the perfect opportunity to employ the theoretical expertise gained on a real project, using the industry standard hygrothermal modelling tool WUFI to characterise how heat and moisture moved through New Court's historic walls.

Using this modelling tool, Max Fordham was able to undertake numerous WUFI appraisals with varying thicknesses of insulation and vapour barrier locations. On new build schemes, the vapour barrier is installed on the inner face of the wall to stop moisture inside the building from entering the wall, while using rainscreen cladding to stop moisture entering from outside. 'The problem we had with New Court's wall of brick, stone and render is that you get solar-driven inward vapour diffusion, which drives moisture into the building. This can lead to a build up of moisture on the cold side of the insulation,' Gustafsson says.

The extensive modelling showed the most promising solution was to do away with the vapour barrier entirely to create what Gustafsson terms a 'vapour open strategy'. This solution would reduce the heat losses,

Fulfilling a seven-year 'watching brief'

Monitoring installations were repeated during the main contract to provide a minimum seven-year 'watching brief', with E4 and E9 locations shown below as examples with slightly different time spans.

E4 (first floor) faces north into the courtyard and is well shaded by building geometry; with a rendered external finish this is perhaps a worst-case scenario.

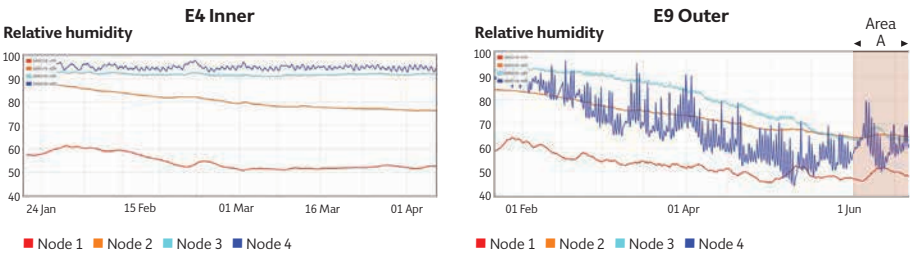
E9 (second floor) faces north onto Garret Hostel Lane and, although in close proximity to other buildings, receives significant direct solar exposure; with the external finish as exposed brick this is perhaps a best-case scenario.

In both cases, the overall trend over time of relative humidity (RH) at all through-wall nodes is downward, although for the two outer nodes (3 and 4) in E4 this is much slower.

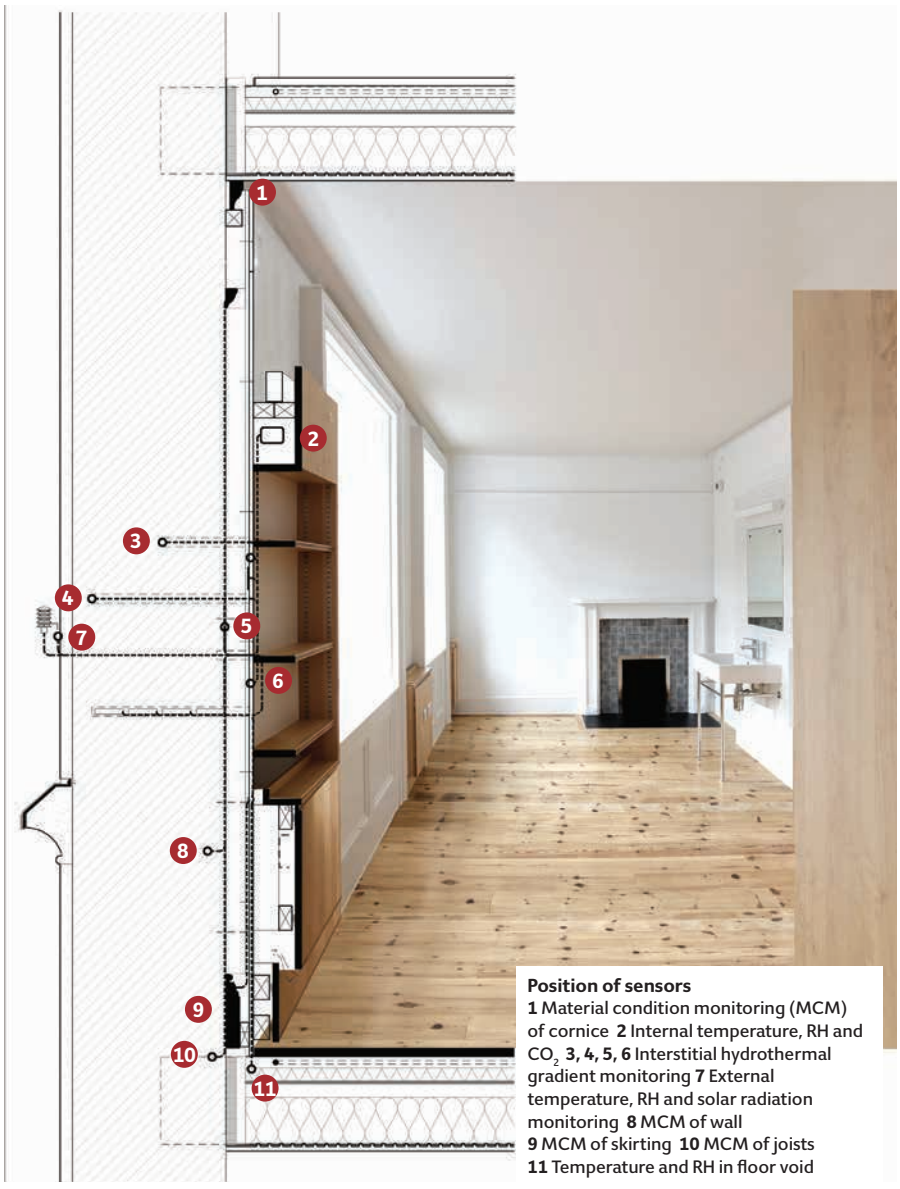
RH at the wall/insulation interface node 2 falls below the important 80% value at the end of February in both cases, indicating that drying of construction moisture is taking place.

The difference in solar exposure between E4 and E9 is clearly visible. The volatility of RH in E9 node 4 is a signature of 'vapour openness' – the rendered face of E4 clearly being more closed than the exposed brick face of E9, although solar exposure will also be playing a part. The effect of solar exposure on the drying of the outer brick wall in E9 is clear. At the end of May, there were a few grey days that were accompanied by significant rain on 31 May, causing increased RH at node 4 and, in turn, a little later at node 3 – Area A.

Solar activity thereafter affects rapid drying seen at both nodes 3 and 4 – a small residual effect may still be observed at node 2, the masonry/insulation interface sensor.

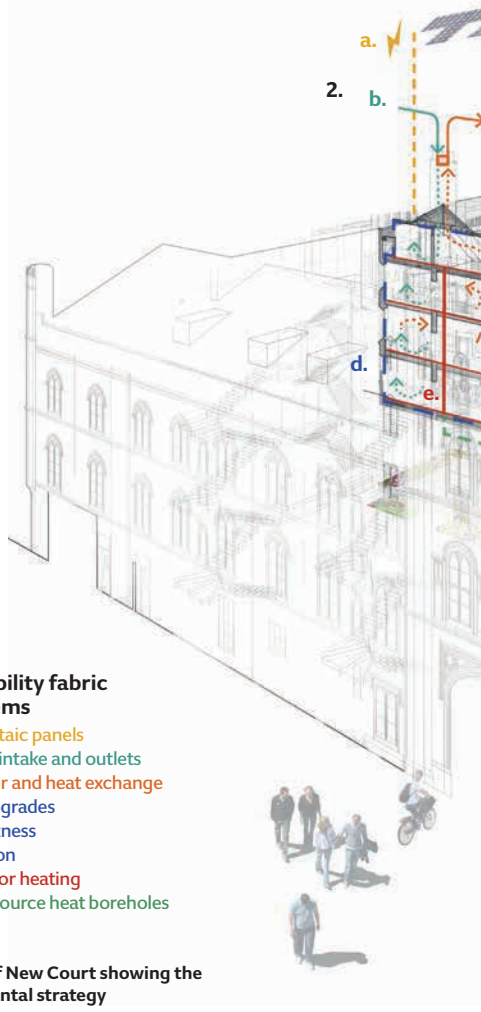


Comparing relative humidty at four nodes within external walls – two locations



Position of sensors
1 Material condition monitoring (MCM) of cornice **2** Internal temperature, RH and CO_2 **3, 4, 5, 6** Interstitial hydrothermal gradient monitoring **7** External temperature, RH and solar radiation monitoring **8** MCM of wall **9** MCM of skirting **10** MCM of joists **11** Temperature and RH in floor void

Sensors measure moisture, RH, temperature and CO_2



Sustainability fabric and systems
a. Photovoltaic panels
b. Fresh air intake and outlets
c. Extract air and heat exchange
d. Fabric upgrades
- air tightness
- insulation
e. Underfloor heating
f. Ground-source heat boreholes

Drawing of New Court showing the environmental strategy

while still allowing vapour movement through the insulation.

This approach was not without its challenges, because it relies on keeping the moisture as a vapour by limiting the quantity of insulation added to the wall. ‘You are slightly limited on what your U value can be because, if you restrict the heat too much, but not the moisture, you will have a condensation issue in the wall,’ says Gustafsson.

Precisely how much insulation could be added was dependent on various parameters including the properties of the brick, stone and render used to construct the wall. ‘These are all natural materials, so their properties tend to vary considerably,’ Gustafsson explains. Nevertheless, because the properties of the materials from which the wall was formed were fundamental to the success of the scheme, samples of each material were sent to testing laboratories at Glasgow Caledonian University.

At the same time as the materials were being tested, the college employed the building performance research practice ArchiMetrics to measure the conditions internally and externally to the block and the moisture and temperature at various points within the wall, using hygrothermal probes. A weather station was also installed. ‘This was a key piece of work because it allowed us to calibrate our model,’ says Gustafsson.

When, however, the team did compare measured data for the wall with the results from the model, calculated using the measured material properties and the actual weather data for the sample period, there was, according to Gustafsson, ‘a small but repeatable difference between the model and the measured data’.

The surface convection coefficient was considered the most likely cause of the variation because it was affected by wind turbulence. The initial modelling had used the CIBSE semi-urban value for the coefficient. However, Gustafsson says the site is actually quite exposed and close to open landscape so that once the convection coefficient had been adjusted to between

The plantroom in the Grade I listed building

Glass panelling allows the cornice to be seen where kitchenettes and ensuite WCs have been added

semi-urban and rural, the model aligned with what had been observed during the monitoring period. 'This gave us confidence in our prediction,' he says.

Using the calibrated model, 5th Studio worked with the consultant to put together a proposal to insulate the walls internally. 'We worked with Max Fordham to work out what type of insulation was best and at what thickness,' says Smith. 'For parts of its life, this was as much a research project as it was a building project.'

> To help limit moisture build-up in the student rooms, the proposed solution also includes an MVHR system

Slim vacuum double glazing is fitted to the windows

The solution eventually decided upon was based on levelling the wall's inner face with a 4mm-thick lime plaster skim, then attaching a 72mm-thick sheet of wood fibre insulation board. The inner surface of the wall is finished with a 15mm-thick layer of gypsum board attached directly to the insulation board.

Because the insulation is attached to the inner surface of the wall, Smith says, there was 'a lot of angst about what to do when it gets to the cornice'. It was decided to leave the cornice exposed in its original position. 'It makes it very explicit, what we have done,' he says.

To help limit moisture build-up in the student rooms, the proposed solution also includes an mechanical ventilation with heat recovery (MVHR) system. 'The MHVR is jointly for energy saving and to help improve air quality and occupant comfort, but is also a key component of the vapour control strategy,' explains Gustafsson.

UPGRADING WINDOWS

In addition to insulating the walls, the team also had to come up with a way to minimise heat losses through the building's combination of sash and wooden casement windows.

Max Fordham appraised the effectiveness of 15 different options, which included fitting new triple-, double- and single-glazed units as secondary glazing or into the existing frames, only refurbishing the existing – and even doing nothing.

English Heritage would not permit replacement with new triple-glazed windows, even though the existing timber frames are already replacements for the original metal windows. Instead the solution decided upon was to take out the old frames, refurbish them, fit draught-proofing and new slim vacuum double glazed units. The team even found rippled heritage glass to add an aged look to the glass.

Along with cutting heat losses, the new windows also help reduce air leakage. 'We aimed for an air permeability of 3 $m^3 \cdot m^{-2} \cdot h^{-1}$ @ 50 Pa and achieved 3.7,' says Gustafsson.

> The existing radiator-based heating system was installed in the early 1960s when Max Fordham was a student at Trinity and living in New Court

The MHVR units are hidden in the tiny roof void of each apartment block. At the college's request they are designed to be ultra quiet; in fact they meet Noise Rating 20, the same criteria used for many recording studios. From the roof space, supply air is ducted down the old chimney flues and discharged from the fireplace in each room. The air is either extracted via the ensuite WCs and communal kitchenettes or it passes under the doors before being extracted from the head of the staircase.

The college and 5th Studio applied for listed building consent. The BRE appraised the team's work on behalf of the local council and concluded that the exercise was about as robust as it could have been, but that there was still a residual risk of moisture problems.

When listed building consent was granted, Trinity College decided to commit to the scheme. To manage the residual moisture risk, a condition of being granted listed building consent was that Trinity College has to undertake to monitor and report on moisture levels within the fabric for the next seven years. This obligation will be fulfilled by ArchiMetrics.

As part of the refurbishment, the student rooms were given all new services, including new heating and lighting. The existing radiator-based heating system was installed in the early 1960s when Max Fordham was a student at Trinity and living in New Court. Now, 50-odd years on, the eponymous consultancy he founded has devised a heating scheme for the insulated rooms, replacing the radiators with a low temperature underfloor heating system hidden beneath the original, refurbished wooden floor.

The maximum flow temperature of the underfloor system is designed to be 45°C. Currently the heat is provided from an existing plantroom, but in the not-too-distant future, heat will come from a ground source heat pump. 'We've run two pipes ready to pick up the ground array when it is installed,' says Gustafsson.

To keep energy consumption to a minimum, particularly during college holiday periods, room heating is controlled by an occupancy sensor. Under normal use the rooms are to be maintained at 21°C. However, if the room is unoccupied for more than four hours, the heating temperature will set back. And if the room remains unoccupied after 24 hours the temperature will set back further still. Additionally, sensors in the window frames register when windows are opened for any length of time during the heating season, turning down the heating until these are closed.

The college required that the rooms also incorporate an electric heated towel rail, which Gustafsson has set to be off by default. 'If you want it hot you push a button and it will come on for an hour,' he says.

Aside from the towel rail, the remainder of the services are incorporated into a clever series of lining panels and attached

Supply air from the roof space is discharged via existing fireplaces

Stone façade on the western side of the Grade I listed New Court

to the inner surface of the wall. The lining panels hide new LED uplighting – they are a neat solution that eliminates the need to chase cabling into the walls. The panels do, of course, incorporate vents to ensure air circulates behind them to prevent any moisture build-up.

Electrical supply to the panels is from a new courtyard distribution system. This is routed up the building via risers tucked into the central stair well and then out through conduit concealed beneath the floorboards.


The original shutters are still in use

The mechanical services, heating flow and return, and domestic hot water flow and return follow a similar route. All the services are routed from the courtyard, under the main entrance doorway to a service pit hidden beneath removable stone flags in the entrance lobby. The space in the risers was so tight that the mechanical and electrical systems are distributed differently. The electrical systems rise up through the building from the pit, whereas the mechanical services go up to the roof void in larger risers from where they divide, and return back down the building through smaller risers. Each and every riser is different. 'Design coordination meetings were many and long,' recalls Gustafsson. However it was a worthwhile exercise because he says 'everything pretty much went in as designed'.

Oliver Smith is happy too because the building is performing as expected. 'At the beginning of this week we got the first monitoring report, and it backs up what we said we'd deliver,' he says. **CJ**

MISSING THE MARK

A RIBA review of school performance revealed an industry-wide struggle with delivering new buildings that operate effectively. **Lisa Pasquale MCIBSE** of Six Cylinder explains why adherence to design codes is causing high levels of complexity in controls and services, resulting in significant inefficiencies

As most building services engineers know, for a building to perform well it needs to be considered, designed and commissioned holistically, as a single, unified entity. For example, daylighting can't be designed without understanding its effect on overheating and the ventilation required to mitigate it – and ventilation needs to be considered alongside acoustic performance and the controls needed to manage it. The loop goes on and on.

In other words, lighting, heating, cooling and acoustics cannot be designed effectively in isolation – they are interconnected. Yet that is what most schools' design guidance asks – teams must deliver design performance criteria without any regard for how these requirements impact on other aspects of performance. There is no flexibility for interpretation and adaptation, and – crucially – the guidance allows no alternative routes to compliance by proving in-use performance.

The consequences of this lack of integrated design is clear in a report from RIBA that analysed 129 schools' post-occupancy evaluations (POEs), 30 of which had extensive technical data. This review of case study data showed that designers were forced to come up with technologically complex solutions to meet the design guidelines, and this was leading to operational difficulties.

Problems included excessive electrical energy consumption, high base loads (40-60% of energy consistently being used out of hours), lack of controllability, overheating and poor comfort, and a large

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> Many renewable systems experienced significant downtime or operational problems throughout their POEs, with some being abandoned or decommissioned

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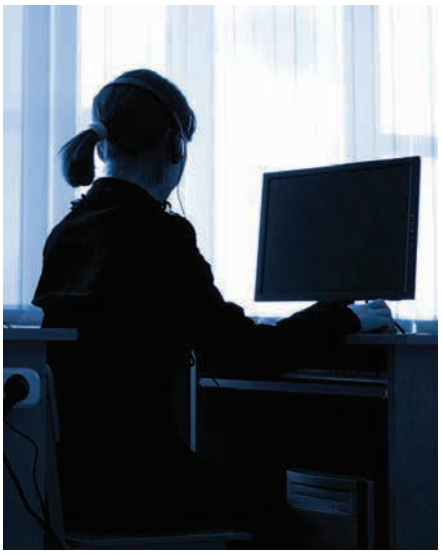

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number of technical devices being either disabled or abandoned because they were too burdensome for the school to manage.

A frequently noted clash was where schools pursued mechanical ventilation to meet acoustic and overheating targets (Building Bulletins 93 and 101). To comply with Part L with this level of servicing, engineers had to rely on complex building management systems (BMSs) to ensure the theoretical efficiency in their designs, and often added at least one low-carbon generation system to offset operational carbon emissions.

The complexity of servicing in these buildings resulted in caretakers and facilities managers (FMs) being quickly overwhelmed, so operational efficiency was likely to be compromised.

Complex controls

The complexity of BMSs was often the reason for schools' high energy use and operational costs, and modifying the systems to enable more efficient operation was not a straightforward task. Furthermore, complexity made it difficult to monitor and understand the energy use within a number of school buildings – despite the technology being supplied to enable exactly that. Only 18 of the 30 studies had good enough data to be able to understand energy use with confidence.

Nearly every case study noted significant controls faults, ranging from inaccurate sub-metering to scheduling, optimisation and setpoint errors. Many FMs and caretakers were 'locked out' from making critical adjustments and corrections, and manual override controls – even basic light switches – were non-existent.

Of seven schools monitored by one consultant as part of the Innovate UK Building Performance Evaluation (BPE) programme, not one had a fully operational BMS – and, most case studies noted that school staff lacked the technical skill to operate them.

> Guidance would benefit from focusing on the need for school buildings to 'simply work'

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Low carbon systems

Many renewable systems experienced significant downtime or operational problems throughout their POEs, with some being abandoned or decommissioned – leaving the anticipated carbon emissions reductions undelivered, despite the capital investment. These systems still enabled the schemes to garner BRUKL Simplified Building Energy Model (SBEM) points and/or Breeam points for theoretical carbon reductions, as neither assessment registers whether the low carbon system is used after it has been commissioned.

Simplicity is key

Nearly every project reviewed said building services and their controls should be kept as simple as possible, with complexity 'designed out', especially when the client is unlikely to have the staff to manage complicated systems. Four case studies had more meticulous approaches to integrated passive design that minimised and simplified the reliance on active building services and controls. These reported less variation from anticipated performance and better manageability. Even among the 'fabric first' case studies, all noted areas where technology could have been simplified or designed out to offer improved performance.

Redefining collaboration

The tensions between competing requirements gave an insight into what would work better in school buildings. There is clearly a need intelligently to choose – or reject – environmental performance targets in the development of the brief, to enable effective passive design and less reliance on mechanical and electrical (M&E) solutions.

Guidance would benefit from focusing on making school buildings 'simply work'. At the moment it is perpetuating a quagmire of complex specifications. Shifting the legislative focus from design to operational targets may remove some barriers for design teams, enabling them to use evidence-based learning to inform design decisions.

Case studies repeatedly highlighted a lack of understanding among designers of the scale of the risks associated with embedding complex services in buildings with limited technical staff. This was largely attributed to insufficient, industry-wide mechanisms for feedback on in-use performance; 'industry-wide', in this case, clearly needs to include those who write and specify the performance guidelines and targets. Technical designers will be pivotal to design teams achieving good in-use performance, and they – and

engineers – need to be engaged early in the process; this will enable them to hone the building strategy and balance the range of interrelated performance criteria that schools must deliver to produce a physically – and fiscally – healthy schools estate.

Seeing the light

Architype's St Luke's C of E Primary was one of the most successful examples of pragmatic and functional daylight design among the case studies. It employed variable levels of daylight within the classroom, with whiteboards in darker, shaded areas, and desks in brighter areas, nearer windows. Good zoning and control enabled users to minimise how much electric lighting they used, which worked very well in practice.

There were no blinds, and occupants liked the quality of light. This was achieved, however, by choosing not to pursue the Breeam credit for daylighting (HEA-01), the simulation-determined requirements of which can drive excessive glazing ratios. Architype verified and improved upon this earlier design strategy with independent POE feedback, to further reduce glare and improve functional daylight. It has stopped pursuing this credit for schools, and continues to design non-uniform daylight levels. It now uses a minimum sill height to control overheating and consequential ventilation requirements.

Lighting tended to be one of the highest uses of energy in all the studies, despite the majority of schools having advanced controls such as daylight sensing and occupancy sensor control. These were often noted as being poorly commissioned. **CJ**

● **LISA PASQUALE** is a director at Six Cylinder and a CoRE Retrofit Coordinator

Critical barriers to good design

Examples	Recommendations
Passive strategies – such as compact forms, external solar shading, controlled glazing ratios and orientation – must be designed before submitting for planning. Well-zoned lighting controls worked well in some schools. However, this relied heavily on the architectural layout and articulation of the daylighting, and well-commissioned controls. Systems that required additional space allocations – such as fuel stores for biomass boilers – often encountered pragmatic issues with placement and access, which contributed to the systems becoming impractical.	Proper technical skill needs to be employed early in the project to make the most efficient use of the site and building fabric. Early-stage thermal performance modelling can help ensure that good passive design principles are integral to the concept design. Concept designs need to include robust strategies for accommodating technologies, otherwise their financial viability is at risk, post-handover.
A number of schools employed night-purge systems that were disabled by managers because of concerns about security and/or complex controls that led to them being difficult to manage. Dual heat-generation systems demonstrated a high risk of the low carbon source being abandoned when a full-capacity gas backup system was also supplied. The low carbon system often became too burdensome, so schools reverted to using the conventional boilers.	Design for security and discuss the implications of any ventilation strategy with the senior managers early in the design process, to ensure that it is appropriate, manageable and efficient. When in doubt, aim for simplicity. Dual systems require a more complex level of control, which increases the capital costs and risk of difficulties with delivering a fully commissioned system successfully.
A large number of buildings employed mechanical ventilation in response to acoustic requirements. These were often difficult and expensive to operate, and users opened windows regardless. Guidance that defined fixed minimum daylighting factors sometimes drove design strategies that resulted in overheating, high levels of ventilation, and the use of blinds to reduce glare – negating the benefit of daylighting and forcing the use of electric lights. Where the needs of the school – as it related to the site and context – had informed design choices, the school was less likely to encounter technical issues and difficulties after completion. Buildings that employed under-used low carbon technologies still received 'points' in BRUKL/SBEM calculations and Breeam, despite the systems not delivering their full carbon reduction benefit.	Carefully select performance targets that drive low-risk design, and beware of pick-and-mix environmental targets that may conflict and drive a need for complex services. Consider the acoustic requirements of spaces realistically – in terms of the activity taking place within them – before selecting a ventilation strategy. Demand alternate routes to compliance from SBEM, such as Passive House Planning Package (PHPP), to produce more detailed performance predictions. This will give teams more useful feedback from simulation work. Demand alternative routes to awarding Breeam and BRUKL points, such as in-use performance confirmation through POE. This would allow firms to innovate using evidence, and produce rated designs that work in practice, rather than in theory.
Several case studies noted problems when part of the building was operated out of hours, resulting in significant portions of the buildings being fully serviced because zoning did not allow those areas to operate independently. Complex systems may be too difficult for FMs and caretakers to adapt to changing operational requirements, whereas simpler systems may be easier to reconfigure for future needs.	The range of supported activities in the building needs to be defined early – with a clear brief – so that the environmental strategy can be developed in response. Zoning needs to be thought out for all services, including ventilation, heating, cooling, lighting and domestic hot water circuits.

GYMS AND SPAS CENTRAL LONDON

In this cost model covering mechanical, electrical and public health services, Aecom's **Andrew Freeman** and **Garry Burdett** examine the capital costs of the fit-out of a gym and spa in central London

With the growing demand for housing and commercial property in London and with increasingly limited space, mixed-use schemes are now incorporating greater variance into the final use of the scheme by supplying an opportunity to the leisure property market.

A number of mixed-use schemes are looking to generate a destination that offers a vibrant look and feel, incorporating a number – or all – of the following: sky bar, gym, restaurant, spa, rooftop pool, high-end coffee shop and small-scale cinema.

For this model, costs are base-dated on Q1 2016 and the prices used are reflective of a project procured through a competitive, two-stage tender process. Costs are included for connecting to central plant via plate heat exchangers to provide hydraulic separation for heating and cooling requirements.

The model includes subcontractor preliminaries, testing and commissioning and builders' work for connection only. Costs for furniture, fixtures and equipment (FFE), including gym and active IT equipment, professional fees, tenant enhancements and VAT are all excluded.

Gyms

Last summer the *2015 State of the UK Fitness Industry Report* reported that the number of gym memberships in London had surpassed 1.5 million for the first time – a rise of 5.8% on the previous year, and showing that the market still has potential for growth.

Demand is pushed by a mixture of London residents and commuters who live a fast-paced lifestyle and can only find time to train before work and during lunch hours.

Increasingly, the model for gym membership is changing, not only within cities but also across regions. The shift seems to be towards rolling memberships and increased hours of operation; a number of gyms now open 24 hours a day and seven days a week.

This will require independent plant for heating and cooling, rather than a connection into the base build plant. The

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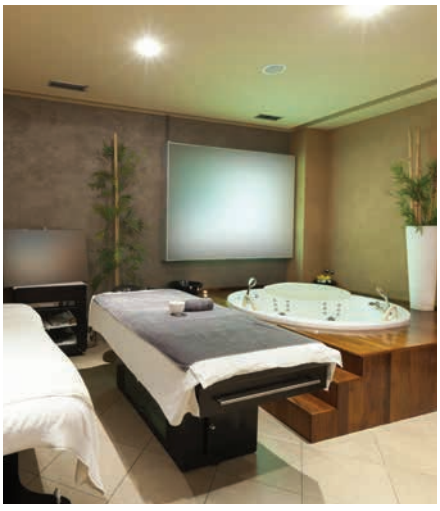

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plant will also have to be specified to cope with continuous use, which will require additional space in the basement or on the roof. This will have a knock-on effect on the services costs and the space lost to more HVAC equipment.

This cost model is based on a gym in central London on the ground floor of a mixed-use development; a total net internal area (NIA) of 1,695m²; and the assumption that it is connected to central plant within plant rooms.

It also includes: an air handling unit (AHU), which is only ventilating the gym; four-pipe fan coil units for heating and cooling; and additional underfloor heating for changing rooms.

ABOUT THE AUTHORS

The engineering services cost management group of Aecom specialises in the cost estimating, procurement and cost management of building services installations. It is producing a series of cost models for *CIBSE Journal* in 2016, on areas such as data centres and London's commercial buildings.

AECOM

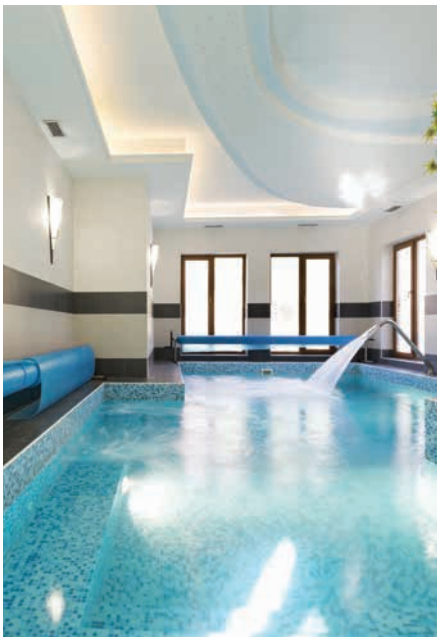
GYM fit-out costs	Based on NIA of 1,695m²		
	Total (£'000)	£/m² of NIA	% of total MEP cost
Sanitary installations Sanitary appliances including WCs , hand basins, cleaners' sinks, water fountains, urinals, showers and the provision of disabled toilets and accessible showers.	50	29.50	3.64
Disposal installations Connection to base build foul disposal system. Soil, waste and vent installation to all sanitaryware points, provision of stub stacks. Condensate drainage for fan coil units, including insulation. Rainwater disposal excluded as part of base build installations.	30	18.18	2.18
Water installations Connection to base build foul disposal system. Soil, waste and vent installation to all sanitaryware points, provision of stub stacks. Condensate drainage for fan coil units including insulation. Rainwater disposal excluded as part of base build installations.	40	23.60	2.91
Heat source Connection to base-build plate heat exchanger, energy meter, buffer vessels, associated pump sets and primary distribution pipework and insulation.	35	20.64	2.55
Space heating and air treatment Connection to base build plate heat exchanger for chilled water, energy meter, buffer vessels, associated pump sets and CHW distribution pipework to AHU and FCUs. Secondary LTHW distribution to underfloor heating and FCUs. Intake and exhaust air ductwork to basement AHU. AHU and associated supply and extract ductwork distribution. VRF installation to comms/media rooms.	400	235.99	29.12
Ventilation systems Intake and exhaust air ductwork to basement fans, toilet and shower supply and extract system. Extract to stores and cleaners' cupboards. MVHR unit to office/staff restroom.	50	29.50	3.64
Electrical installations Installation of LV distribution system, including switchgear, containment and cabling. Provision of power to mechanical plant, installation of small power and lighting, including emergency lighting and controls. Provision of floor boxes to gym equipment. Provision of enhanced lighting to lobbies, reception areas and toilet/changing areas. Earthing and bonding.	345	203.54	25.11
Gas installation N/A	0	0	0
Fire and lightning protection Connection to base build installations, zone valve, concealed fast-action sprinkler heads throughout.	57	33.63	4.15
Communication, security and control systems Fire alarm and, PA/VA installation, interfaces to base build systems. Access control, including card reader turnstiles at reception controlling entrance to the gym. The security system has security cameras, access control and intruder alarms to back of houses. Induction loops to reception. Disabled WC alarms. TV and data installations to gym equipment. Complete sound system including speakers, cabling and central music generation and smart device docks. Installation of central building management system, including central control panels and BMS to plant and equipment.	300	176.99	21.84
Lift and conveyor systems/installations N/A	0	0	0
Builders' work in connection with services BWIC for services installations, including fire-stopping.	66.7	39.35	4.86
Gym total cost	**1,373,700**	**810.44**	**100**

Spas

With an increasing desire for high-end residential-led, mixed-unit developments in the City of London to attract buyers and set them apart from the competition, resident and members-only spas are becoming more commonplace. These developments include: swimming pools, steam rooms, saunas, treatment rooms, a hair salon and associated high-end AV systems and lighting to create a luxury feel.

The model is based on a luxury spa located in central London in the basement level of a mixed-use development. It has a total NIA of 1,040m², with costs for connection to central plant within plant rooms. It includes an AHU that is only ventilating the spa area and swimming pool hall; four-pipe, fan coil units for heating and cooling; displacement ventilation for the pool hall; and additional underfloor heating to the changing rooms. Included in the plan are costs for specialist plant for the swimming pool, steam rooms and sauna. Excluded are FFE and active IT equipment.

Locating elements such as spas in a basement development will attract a cost premium caused by the difficulty associated with bringing services into these areas. A holistic approach to costing must be considered for spa areas, as basement digs to accommodate swimming pools and the associated structural and waterproofing needed can make a scheme become too expensive. **CJ**



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This cost model has been written by **ANDREW FREEMAN**, trainee surveyor and **GARRY BURDETT**, director, engineering services

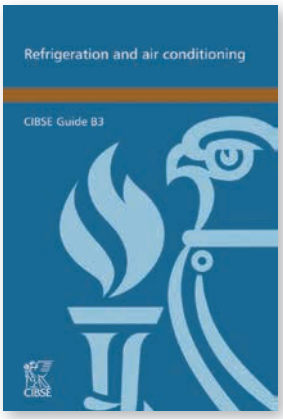
Spa fit-out costs	Based on NIA of 1,040m²		
	Total (£'000)	£/m² of NIA	% of total MEP cost
Sanitary installations Sanitary appliances, including WCs, washbasins, cleaners' sinks, water fountains, urinals, experience showers, ice fountain and the provision of disabled toilets and accessible showers.	115	110.57	4.88
Disposal installations Connection to base build foul disposal system. Soil, waste and vent installation to all sanitaryware points, provision of stub stacks. Condensate drainage for fan coil units, including insulation. Backwash drainage to pool plant. Rainwater disposal excluded as part of base build installations.	28	26.92	1.19
Water installations Installation of mains cold water services, including meter, storage tanks, pumps, electromagnetic water conditioner, and connections to sanitaryware. Hot water, including connection to base build plate heat exchanger for hot water generation, bulk storage, distribution, pump sets and connections to sanitaryware. Miscellaneous water points to drinking fountains and plant supplies. Softened water to shower, saunas and steam rooms.	75	28.85	1.27
Heat source Connection to base build plate heat exchanger, energy meter, buffer vessels, associated pump sets and primary distribution pipework and insulation.	30	28.85	1.27
Space heating and air treatment Connection to base build plate heat exchanger for chilled water, energy meter, buffer vessels, associated pumps sets and CHW distribution pipework to AHU and FCUs. Secondary LTHW distribution to underfloor heating and FCUs. Intake and exhaust air ductwork to basement AHU. AHU and associated supply and extract ductwork distribution. VRF installation to comms/media rooms. Supply and extract installation to pool hall.	600	576.92	25.45
Ventilation systems Intake and exhaust air ductwork to basement fans, toilet and shower supply and extract system. Extract to stores and cleaners' cupboards. MVHR unit to office/staff rest room. Extra over-provision for smoke extract to ventilation installation.	129	124.04	5.47
Electrical installations Installation of LV distribution system, including switchgear, containment and cabling. Provision of power to mechanical plant, installation of small power and lighting, including emergency lighting and controls. Provision of enhanced lighting to lobbies, reception areas and toilet/changing areas. Allowance for statement lighting, full lighting control, fibre optic lighting with pool and scene-setting, earthing and bonding.	356	342.31	15.10
Gas installation N/A	0	0	0
Fire and lightning protection Connection to base build installations, zone valve, and concealed fast action sprinkler heads throughout.	36	34.62	1.53
Communication, security and control systems Fire alarm and PA/VA installation, interfaces to base build systems. The security system comprising security cameras, access control and intruder alarms to back of houses. Induction loops to reception. Disabled WC alarms. TV and data installations throughout equipment. Complete sound system, including speakers, cabling and central music generation and smart device docks. Installation of central building management system, including central control panels and BMS to plant and equipment.	367	352.89	15.56
Specialist installations Pool plant, including all pumps, water treatment, filters and controls. Saunas and steam rooms	510	490.39	21.63
Lift and conveyor systems/installations N/A	0	0	0
Builders work in connection with services BWIC for services installations including fire stopping.	112	107.69	4.75
Gym fit out total cost	**2,358,000**	**2,267.31**	**100**

This month: New CIBSE Guide to air conditioning and refrigeration; fire strategy in retrofits; and a comprehensive review of smoke control standards

GUIDE B ESSENTIALS

AIR CONDITIONING AND REFRIGERATION

CIBSE's seminal guide to HVAC systems has had a major revision. Guide B covers best practice for heating, ventilating, air conditioning and refrigeration, and noise, and features a new online chapter that will be continually updated. **Guy Hundy** highlights the main changes in the air conditioning and refrigeration section



A new edition of *Guide B Heating, Ventilating, Air Conditioning and Refrigeration* has been in preparation for some time and is about to be published, replacing the previous 2005 version. Guide B has been one of CIBSE's main publications since its first appearance as a loose-leaf volume in 1940.

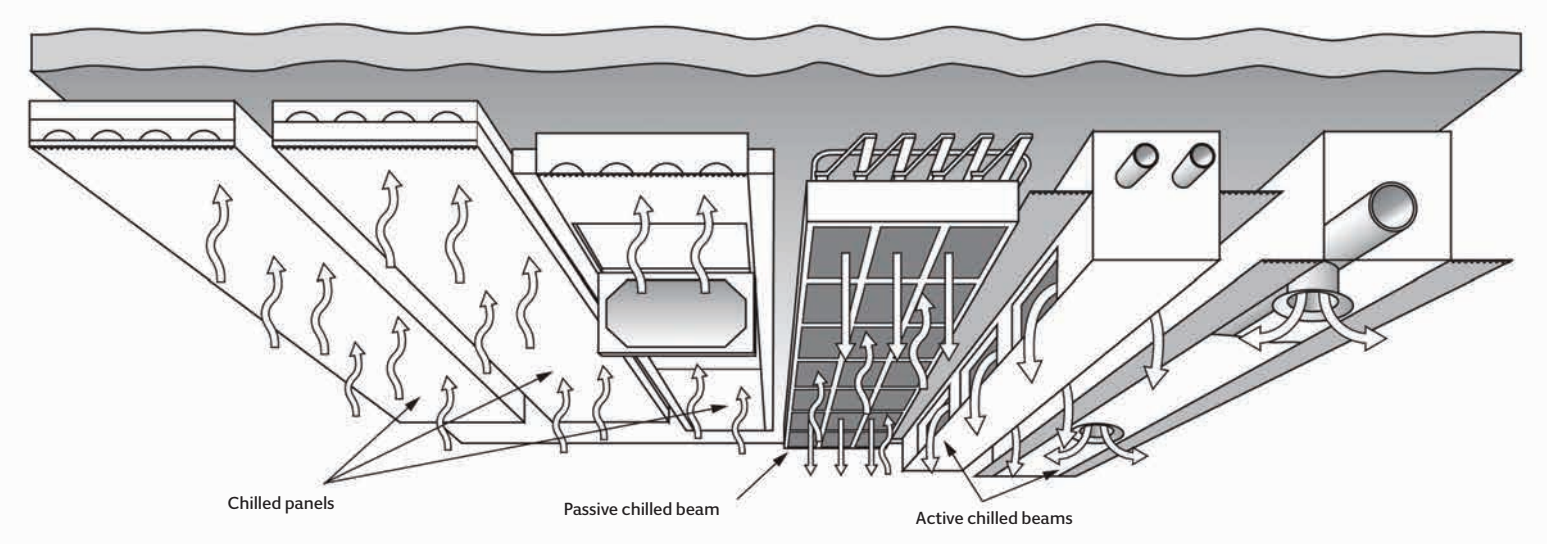
For more than 75 years, it has evolved in content and form, but always with the objective of providing an overview of guidance to good practice in the selection and design of HVAC systems.

Chapter 3 of the new guide brings together the air conditioning and refrigeration sections. Previously air conditioning was partnered with ventilation. Much of the previous air conditioning material – updated where necessary – has been moved to the first part of this chapter; there are some topics that are also relevant to Chapter 2 – Ventilation and Ductwork – and some duplication may be found.

The overall purpose of the chapter is to provide detailed guidance for those involved in the design and specification of air conditioning systems. With any project, there will be numerous alternatives at every stage, and the approach takes the reader through the options, describing them and highlighting advantages and disadvantages.

Following an overview that highlights essential environmental considerations and whole-life cost, there is a general introduction to the air conditioning section. The approach is to look first at strategic considerations.

Chilled ceiling types



New Guide B has numerous diagrams such as this one on chilled ceilings to aid understanding

This prompts the main questions to be asked and information about each topic is provided.

Getting conditioned air to where it is needed leads into room air movement phenomena, in association with various strategies, such as the use of ceiling or floor-height space to duct or distribute cooled air as required.

The physics principles do not change and this material is drawn from the previous Guide B edition.

The distinction between air conditioning and comfort cooling is also explained. Where natural ventilation can satisfy part of the requirement – termed mixed mode – detailed strategies and provisions for these systems are given.

A strategy to be adopted for cooling and dehumidifying the local air supply is the next major step for the designer. Potential candidates include a centralised scheme, comprising a water-based or hydronic system, where water is chilled in a central plant for distribution around the building or an air-based scheme, where the air to be supplied is temperature – and maybe humidity – controlled centrally and ducted to local areas

Localised systems generally use the refrigerant itself as the distribution agent and these are termed direct expansion systems. More detail on system types is provided in the refrigeration section where the pros and cons of all these cooling methods are discussed. An alternative – where local conditions permit – is a ground air cooling system that takes outside air through a ground heat exchange process to remove heat before treatment.

New material covering use of the vapour compression cycle for heating has been added, with a description of reversible systems and unitary heat pumps, both ground and air source.

Finally, the air conditioning equipment section deals with specific items associated with processing air such as: intake and discharge points; heat recovery devices; humidifiers; fans; and air flow control.

Refrigeration, in the context of this chapter, deals with the cooling and heat rejection equipment necessary to provide the cooling that air conditioning requires.

This part of the guide is a development of chapter 4 of CIBSE Guide B (CIBSE, 2001–2). It has been comprehensively revised to take account of developments in the intervening years, in particular to incorporate guidance on health and safety issues, new regulations, and updated refrigerant information.

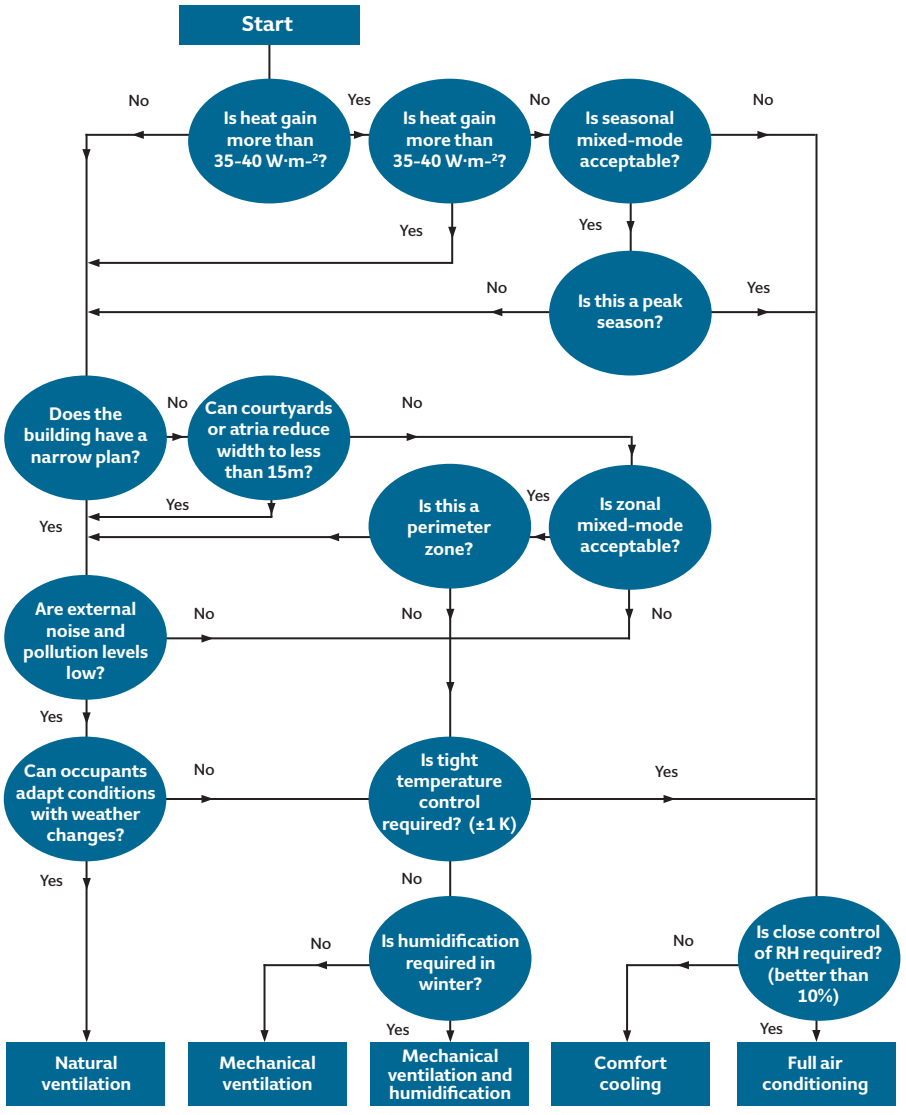
The introduction emphasises the environmental considerations that should be examined at an early stage, including energy efficiency. No longer is it sufficient to satisfy the cooling demand; it must be done in an energy efficient way, and the means of achieving this are to be found here. Encouragement is given to the application of heat pumps, 'free cooling' and integrated heating and cooling systems.

It is not practical in this review to list all the possibilities, but attention is drawn to new developments, in particular the use of carbon dioxide as a refrigerant, both directly and in the form of a secondary coolant.

Variable refrigerant flow (VRF) systems, whose flexibility has stimulated growing demand, are given more coverage. VRF popularity has also prompted the launch

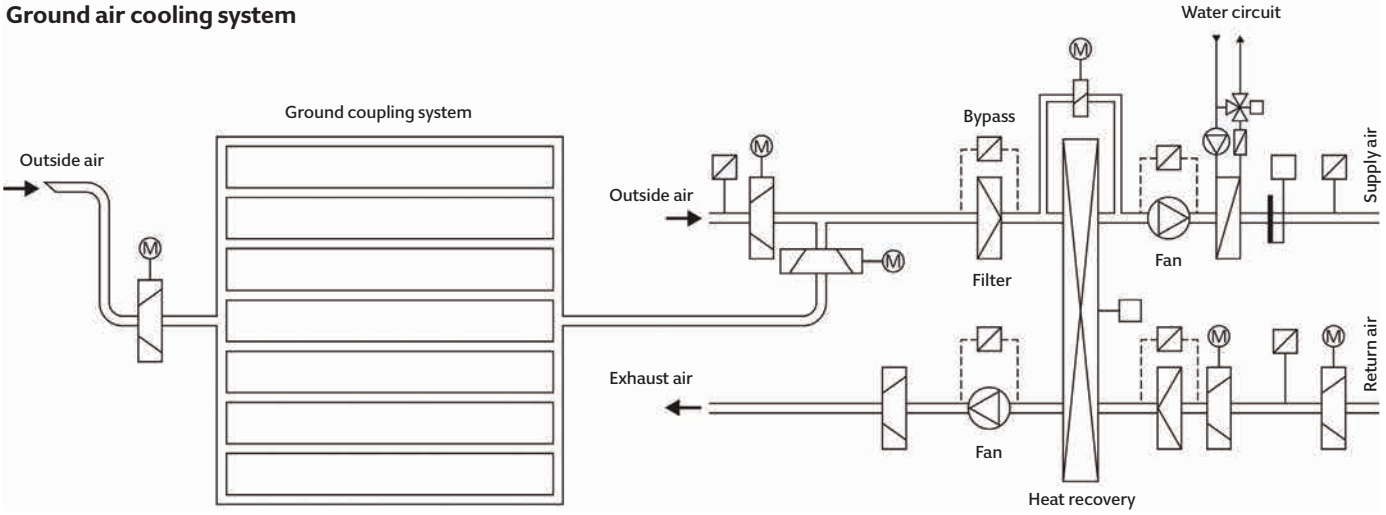
> If you think you can fill gaps or expand existing sections please get in touch

Chart to aid the choice of system type

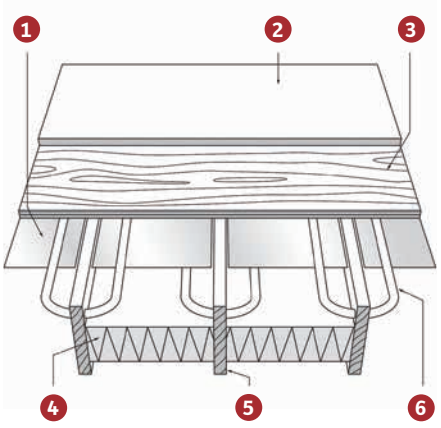


The air conditioning and refrigeration section features a decision tree to help designers select systems

Ground air cooling system



Cooling pipework in sub-floor



1 Heat emission plates increase heat transfer where necessary **2** Floor covering **3** Flooring boards **4** Insulation with reflective surface **5** Wood joist or truss **6** Tube

of a dedicated CIBSE VRF Guide. Novel methods – such as adsorption and magnetic refrigeration – are included, although readers should consult references for up-to-date information about commercial adoption.

Refrigeration components, evaporators, condensers, compressors, and so on are described in outline and the guide concludes with an overview of controls and maintenance.

This guide will give designers a good insight into possibilities that may be unfamiliar, and is backed up by an extensive list of references. A comprehensive index, and a search function in the electronic version, should speed access to the desired information. **CJ**

● Guide B is available from the CIBSE Knowledge Portal at **www.cibse.org/knowledge**

● **GUY HUNDY** is chair for the Air Conditioning and Refrigeration chapter of Guide B

What's new in Guide B

The new version of Guide B continues to give an overview of good practice in HVAC specification and design. Content has been added where there is new information and experience, wording has been clarified where necessary, and sections that are now less relevant have been judiciously pruned.

With the declining importance of printed literature, the new version has reverted to having separate chapters available in both printed and downloadable versions, with one exception – a new, online only, chapter B0 *Applications and Activities: HVAC strategies for common building types.*

Intended as a subject introduction for trainee engineers, or for the more experienced faced with an application with which they are unfamiliar, it summarises issues around the selection and design of HVAC systems and highlights typical problems and solutions for specific buildings and user activities.

Member contributions make up much of the content and we hope to draw on the wider experience of readers to boost its value, especially by adding guidance for applications for which we were lacking good, recent knowledge. As it's an online-only document, new details should be relatively easy to add – so, if you think you can fill gaps or expand existing sections, please get in touch.

Detailed information on HVAC system characteristics, design and selection, and on generic issues, such as acoustic and vibration control, is found in the later chapters, which retain the structure of the previous edition:

B1: *Heating*, including hot water systems and a new annex on hydronic systems, (also applicable to chilled water systems)

B2: *Ventilation*, including ductwork

B3: *Air conditioning and refrigeration*

B4: *Noise and vibration* control for building services systems.

The level of detail varies; where comprehensive guidance from CIBSE or other sources is available, Guide B is relatively brief and refers to these sources. This is the case, for example, for low carbon systems such as heat pumps, solar thermal water heating and combined heat and power. On-site energy generation such as wind power and photovoltaics are not covered. Information on energy efficiency and sustainability can, of course, be found in Guides F and L.

Since the last edition of Guide B in 2005, the European Energy Performance of Buildings Directive has been introduced. This requires national building energy regulations to be based on calculations integrating the impact of the building envelope and the building services systems, formalising what is already recognised as good design practice. In addition, the use of voluntary energy efficiency and sustainability indicators has increased. These changes have influenced content, but the emphasis remains on system selection and design.

Regulatory requirements are not described in detail – information varies between jurisdictions and is liable to change more rapidly than the guide can be updated. Instead, the existence of regulations is signposted and their general scope explained. Emphasis is on the UK, but much of the guidance is applicable in countries with similar climates and regulations, so its use overseas should be carefully considered.

● **ROGER HITCHIN** is chair for the CIBSE Guide B Steering Committee

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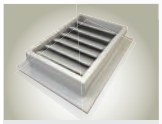
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COLT

CLEARING THE SMOKE

Smoke control is covered by a complex series of interrelated legislation and guidance. Colt's **Paul Compton** explains the current regulatory landscape ahead of any changes that Brexit might bring

In the event of a fire, the largest contributor to deaths and injuries is smoke – not the fire itself. More than 60% of deaths occur as a result of being overcome by gas or smoke and, similarly, inhalation of smoke causes around 60% of injuries.

Controlling smoke plays a large part in reducing these statistics, as well as protecting the building. People specify and install smoke control systems both to protect escape routes and to assist fire fighters. Legislation, such as BS 9999 and 9991, focus on these objectives.

Smoke control systems can also protect stock and machinery, as well as reducing the risk of roof collapse. These aspects are not legislated for, but many building owners and occupiers will nevertheless specify smoke control for these reasons.

In the UK, smoke control systems are subject to an ever-evolving, complex network of standards and legislation. The standards represent a hierarchy (see Figure 1), with the most important documents at the top.

The process of updating these documents means there are some inconsistencies between them; it takes time for an update in one document to filter through to another that covers the same theme or one related to it.

No recent changes have been made to legislation in England and Wales. The latest change was the repeal of fire protection provisions in the Local Acts in 2013. This rationalised the requirements across England and Wales, but reduced the level of fire protection in large buildings, where provisions previously existed.

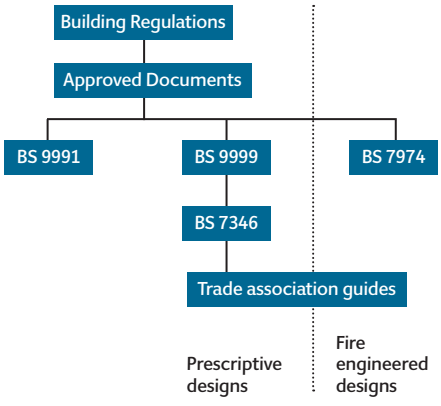


Figure 1: Standards hierarchy

On the horizon – but not before 2017 – is the next revision of Approved Document B (ADB), since the existing one is now 10 years old and showing its age.

In residential buildings, *BS 9991: 2015 Fire safety in the design, management and use of residential buildings code of practice* is a welcome update to the 2011 edition and is supported by the Smoke Control Association (SCA) document referred to below.

The contentious recommendation for pressurisation of escape stairs in all buildings with a floor higher than 30m has been replaced with a recommendation for either mechanical shaft ventilation or more sensible pressurisation. Mechanical shaft ventilation is less costly and less complicated than pressurisation, and could be the only option

The Runcorn site of the Ineos ChlorVinyls waste-to-energy plant, where Colt designed and installed labyrinth natural ventilators, adhered to ISO9001: 2008

if travel distances are to be extended. It adds guidance for mechanical shaft ventilation, either as a direct alternative to a natural shaft, or for extended dead-end travel distances. This is useful because ADB is too outdated to include mechanical shaft ventilation.

For natural – and mechanical – shaft systems, the standard builds on the guidance in ADB, including a recommendation to:

- Limit shaft leakage to 3.8 $m^3 \cdot h^{-1} \cdot m^{-2}$ at 50 Pa
- Exclude non-shaft-related services, such as pipework or cabling from the smoke shaft, which could otherwise cause system failure
- Locate the shaft remote from the stair, enabling the whole corridor to be ventilated.

The new *BS 7346-8: 2013 Components for smoke control systems. Code of practice for planning, design, installation, commissioning and maintenance* offers both technical and procedural guidance, including useful pro-forma for certificates for all stages. It is referred to in BS 9991.

The second edition of *BS 9999 DPC: Fire safety in the design, management and use of buildings code of practice* has been issued as a draft for public comment, and is likely to be published in 2017. It covers all buildings apart from residential, which are dealt with in BS 9991 (as described above). The update will bring consistency with BS 9991 and regularise good practice that had been poorly defined.

It mirrors BS 9991 in recommending mechanical shaft ventilation or pressurisation of fire-fighting cores in buildings with a floor higher than 30m, and adds guidance on mechanical shaft systems. For natural shaft systems, this standard builds on the guidance in *BRE report 79204: Smoke shafts protecting fire-fighting shafts: their performance and design*, relating to shafts for fire-fighting stairs, including recommendations for:

- Shaft ventilators
- Excluding non-fire related services from smoke shafts, as with BS 9991
- Locating shaft terminations in negative pressure areas.

Last October, the SCA published a revision to its guidance on *Smoke Control to Common Escape Routes in Apartment Buildings (Flats and Maisonettes)*, which is available free at www.feta.co.uk/smokecontrol It is a reference point for those involved with the design and approval process of such systems, bringing together all the relevant details and giving recommendations not previously covered.

This revision expands on BS 9991:2015, and offers helpful design information, including design fire sizes, tenability criteria and suggested timelines for the design process. It also gives guidance on the standard of ventilation and controls equipment to be used, along with guidance on installation, commissioning and maintenance.

The guidance is particularly helpful when extended travel distances are proposed. It contains the first piece of published guidance recommending a maximum dead-end travel distance in an extended corridor protected by a suitable mechanical shaft ventilation system of 30m – as measured from the stair, not from a protected lobby door.

It has useful diagrams showing how to measure the free area of a ventilator for several common practical applications – extending the guidance of Diagram C7 in ADB – and gives illustrative design tenability conditions for firefighters.

It also reflects changes in architectural practice. For example, there is often a limitation of the space available at the top of the staircase in many small single-stair apartment buildings. This can make it difficult to incorporate a natural ventilator – which had previously been proscribed – so a mechanical solution is often adopted to save space. This guidance sets out helpful performance criteria for designing such a system.

It provides useful guidance on the layout and ventilation of exit routes from the stairs at the final exit level, the purpose of which is to avoid smoke logging in this area.

Although going through final stages of preparation, the EU EcoDesign Energy Efficiency Regulation for fans raises some issues. But in its drive for efficiency, there is concern that dual-purpose systems – commonly used in car parks – could be adversely affected. The high temperature smoke extract fans and jet fans cannot meet the efficiency requirements that have been initially proposed. This could significantly affect installed cost and space requirements, and might make the systems less efficient.

Since 2013, the Construction Products Regulations (CPR) have required all products covered by a harmonised standard under the Regulations to be CE marked.

For smoke control products, independent testing and certification to the relevant part of EN 12101 are required, leading to manufacturer application of the CE mark. While this was already a requirement across most of Europe, it did not previously apply in the UK (see panel, left).

These standards are being gradually revised, with the aim of improving the standard of testing. A helpful change to EN 12101-3 – which now permits testing with variable speed drives (inverters) and includes jet fans – was published in 2015. **CJ**

HARMONISED STANDARDS FOR EN12101

European standard *EN 12101 Smoke and heat control systems* covers products and systems in the field of smoke control. Its first part – of a planned 13 – was published in 2003. Currently, six parts have been published as harmonised standards:

- *EN 12101-1: Specification for smoke barriers*
- *EN 12101-2: Specification for natural smoke and heat exhaust ventilators*
- *EN 12101-3: Specification for powered smoke and heat exhaust ventilators*
- *EN 12101-7: Smoke duct sections*
- *EN 12101-8: Smoke control dampers*
- *EN 12101-10: Power supplies.*
- *EN 12101-6: Specification for pressure differential system. Kits* is also harmonised but, as written, it is impossible to test to this standard so a new edition is being produced.

Part nine, covering control equipment, is the only harmonised part of EN 12101 that is not yet published. The other parts of the 12101 series cover design and installation and will not be harmonised. It is not clear whether any of these will be implemented in the UK, although the existing ones have not been.

A shortage of available land is driving refurbishments in central London. **Gerard Sheridan** of FDS Consult explains the importance of fire design when undertaking retrofits

GREAT FIRE DESIGNS OF LONDON

FDS Consult's engineered approach achieved both cost savings and design aspirations on the listed Queen Mary University

Fire safety is one of the key considerations for any consultant involved in a building refurbishment. The failure to implement an appropriate strategy can result in substantial costs and delays, and can result in building plans being rejected by local authorities.

Whether or not a new fire safety plan needs to be submitted to Building Control depends on the scale of the changes made.

A material alteration is classed as any work that results in a building being less satisfactory than it was in relation to the functional requirements of Building Regulations.

For instance, if a property's occupancy levels are changed, exit widths and escape routes will need to be revisited, requiring the submission of an application to Building Control. As will an additional floor, extension of a floor plate or removal of a stair

When considering fire strategies, there are two methods that can be employed – a code-compliant approach or an engineered strategy.

Taking a compliant approach means meeting the requirements of Part B of the Building Regulations. This has some advantages – namely faster approval by Building Control and clear requirements that must be met – but it may require extensive remodelling of a building's existing design. In addition, a code-compliant approach often fails to make best use of a space and may carry higher costs. For example, such a code-compliant solution may limit travel distances and compartment sizes, or include items such as smoke shafts that are larger than can be achieved with an engineered approach using a mechanical system.

The alternative route to compliance, is spelled out in the Building Regulations 2000 Act: '...there is no obligation to adopt any particular solution contained in an Approved Document if you prefer to meet the relevant requirement in some other way'.

Provided that the suggested strategy is as safe as that outlined by Part B, and can be proved as such, then this is perfectly acceptable, and can offer a number of advantages. One way of doing so would be to follow British Standards. For example, a plan could be based on British Standard BS 9999:2008 for commercial properties or BS 9991:2015 in residential properties.

By carrying out in-depth analysis of the property's proposed use, occupancy levels and the inclusion of fire protection systems, the creation of larger spaces or compartment sizes can be justified. This can also allow the extension of travel distances from an occupant's location to the nearest escape route or safe area, unlocking additional

Meeting requirements

In new build properties, fire design consultants would typically be involved in the design and build phase, with plans being submitted to Building Control.

Once occupied, responsibility for ensuring ongoing compliance with fire safety requirements is passed on to the Fire Service, as prescribed by the Regulatory Reform (Fire Safety) Order 2005.

If alterations in a refurbishment are significant, a new plan needs to be sent to Building Control.

FDS Consult worked closely with the architects at Alexander McQueen to refurbish its flagship London store

saleable space within the building.

In order to maximise the cost savings presented by working within an existing structure, building elements can be incorporated in the fire plan. For example, service risers can be used to form smoke shafts and windows can be included in automatic opening vent (AOV) systems, allowing the extraction of smoke to facilitate occupant evacuation and firefighting access.

In addition, when separating spaces, for example, the conversion of open-plan offices to multiple residential apartments or hotel rooms – the fire safety of a building may be improved, as the compartment walls added by the refurbishment will help to limit potential fire sizes, reducing the risk of fire-spread to nearby buildings.

Challenge of listed buildings

If the building to be refurbished is listed, the challenge of achieving the client's end goal and meeting building regulations can require a lot more planning.

Protected properties offer a number of unique challenges. As alterations to the building's exterior are often prohibited and its layout may be fixed, an intelligent approach to fire design is required.

One example of this is the creation of a comprehensive fire strategy for the conversion of a Grade II listed London hospital to more than 150 houses and apartments.

Because of the property's protected status, no substantial alterations could be made, requiring the existing structure to be used as efficiently as possible. Through the inclusion of a pressurisation system in the open stair/corridor areas, a high-pressure area could be created in the event of fire, preventing the ingress of smoke in order to create a protected area to allow means of escape.

By refurbishing existing windows as AOVs, excess pressure could be alleviated, preventing the equalisation of pressure between the corridor and apartment areas, which could otherwise lead to the spread of smoke into these residential spaces.

In order to retain the hospital's appearance, the pressurisation system equipment was housed in an existing bell tower, keeping the project's aesthetic impact to a minimum.

Another issue that can often arise is the back-dating of fire safety requirements. For instance, new residential blocks more than 30m high require the inclusion of sprinkler systems. While a historic property may not be fitted with these systems, its refurbishment could see this requirement come into play.

> Failing to consider a building's fire safety strategy can incur substantial costs and delays, and risk plans being rejected entirely

Another key consideration is the state of the existing structure. Because of the wear and tear on a property during its lifespan, it is possible that its structural elements will no longer give the level of fire protection required under Building Regulations. This issue may be intensified where the refurbishment project calls for the construction of additional floors above the property's former upper level.

In cases such as this, taking a code-compliant approach may require the entire structure's fire protection to be upgraded, resulting in significant cost implications. By taking an engineered approach it is possible to minimise these additional costs.

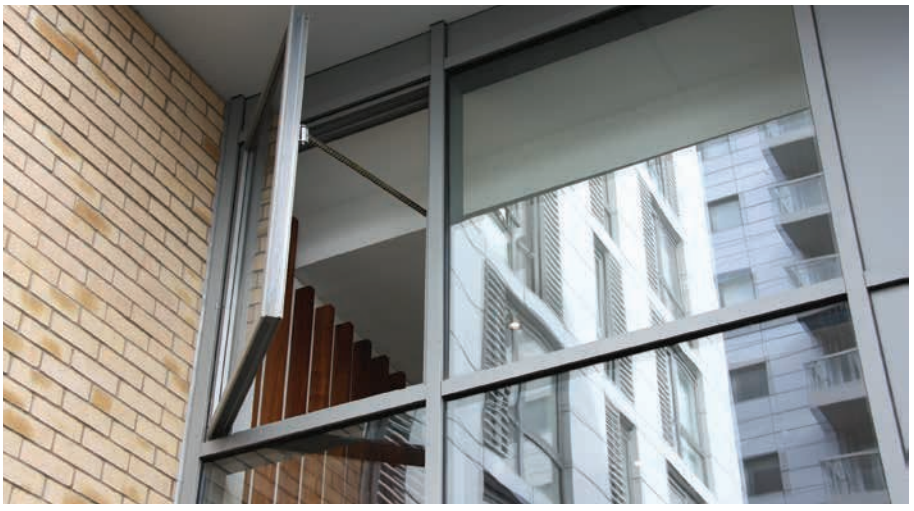
Approved Document B's recommendations for structural fire resistance do not consider available ventilation or the specific use of individual buildings within general purpose groups. However, Structural Eurocode PD 6688-1-2 provides alternative methods that can be used for establishing the required periods of fire resistance for structural elements. By taking this into account, it is possible to reduce the amount of fire protection needed.

One such strategy is the consideration of glazing within the building. When a fire reaches the 'flashover' stage (where it has spread to an entire compartment) window glazing fails, allowing cool air to enter and hot gases to escape. Where a property's façade features a high ratio of glazing, substantial ventilation will be available in the event of a fully developed fire, allowing heat to dissipate at a rate that will prevent very high temperatures close to the structure.

Though there are a number of hurdles to overcome, the advantages offered by refurbishment projects are making them increasingly attractive to developers.

When working with an existing building, much of the initial work has been completed already, removing the need for structural contractors and surveyors, so cutting labour and material costs.

By involving experienced fire engineers from the outset, further savings can be made, while also ensuring that the most appropriate fire safety solution is being put in place for the building's future use, satisfying client and authority requirements. **CJ**



Automatic opening vent systems extract smoke to facilitate occupant evacuation

GERARD SHERDIAN is chair of FDS Consult

Award winning innovative natural cooling system which has been successfully installed in various offices and universities across the UK

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Natural cooling and ventilation for improved building sustainability and healthier occupants

This module explores the use of phase-change materials in ventilation systems to reduce a building's energy consumption and carbon footprint

While there are worldwide calls to reduce energy usage in an effort to control global warming and climate change[1], building users will still wish to control their environment, with many wanting to maintain consistent temperatures throughout the year. The very recent RIBA report[2] on school building design highlighted the significant need for natural ventilation and, where appropriate, simple, responsive mechanical ventilation to maintain air quality.

This CPD module considers how natural cooling can utilise phase-change materials (PCMs) both to facilitate ventilation and to reduce the building's energy use, so lightening its carbon footprint. This application is particularly appropriate in temperate climate zones – such as the UK and northern Europe – where external (ambient) temperatures are typically moderate, with cool night-time temperatures.

The technology behind phase change systems

There are three types of energy storage:

1. Sensible heat storage
2. Latent heat storage
3. Thermochemical energy storage.

In sensible heat storage, energy (or heat) is stored/released by heating/cooling a liquid or solid storage material through heat transfer – a significant change in temperature in the storage medium is required to transfer the heat. Examples of materials typically used as a storage medium are water, air, oil, ground rocks and sand.

Latent heat storage involves the change of a substance from one phase to another at a fixed temperature (the melting temperature, as shown in Figure 1), and is stored during the phase change – for example, melting or crystallisation. The PCMs are usually packed in tubes or plastic capsules, or incorporated into plasterboard or ceiling panels.

Thermochemical energy storage is an emerging method with the potential for high-density use. Energy storage based on chemical reactions is particularly appropriate for long-term storage, such as the seasonal storage of solar heat.[3]

Natural cooling systems take advantage of the PCM's reaction to temperature. By melting and solidifying at a known temperature, it is capable of storing or releasing large amounts of energy. This article specifically focuses on latent heat storage that has the advantage

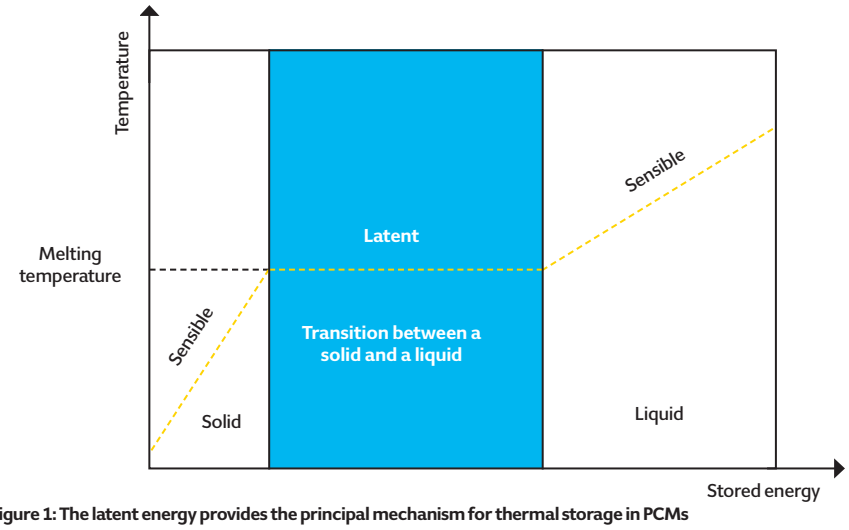


Figure 1: The latent energy provides the principal mechanism for thermal storage in PCMs

of high energy storage density, small temperature swing and a wide variety of PCMs available.

Organic and inorganic compounds are the two most common groups of PCMs, and there are manufactured PCMs – organic and inorganic – that can meet specific system needs of temperature and energy storage.

Typically, organic PCMs are non-corrosive and chemically stable, and exhibit little or no sub-cooling. Sub-cooling requires lower temperature outdoor air before the PCM solidifies, so is not beneficial. Organic PCMs are compatible with most building materials, and have a high latent heat per unit weight and low vapour pressure. Their disadvantages include low thermal conductivity, high changes in volume on phase change, and potential issues with flammability.

Generally, inorganic compounds have a comparatively high latent heat per unit volume, high thermal conductivity, are non-flammable and are low in cost compared with organic compounds. However, they can be corrosive to some metals and can suffer from decomposition and sub-cooling.

Simple applications of PCM cooling systems

When used as an application for natural cooling, the PCM works across the 24-hour period to keep the room cool, without using active air-conditioning. During the day, as warm air is passed over the PCM, it absorbs sensible heat from the air to turn from a solid to a liquid, thereby cooling the air. Overnight, cool air is passed across the PCM, returning it to its solid state.

There are many applications where PCMs can be applied for heat and cool energy storage in buildings. Natural cooling is a building design approach that attempts to control temperatures in a building with either very low or zero-energy consumption. An example of a very simple form of a passive cooling application uses static PCMs in ceiling or wall tiles to cool a building. In the summer season, cool night air is drawn into the building and used both to lower the room temperature and to store cooling energy in the PCM, for use the following day. While this is a straightforward approach, the building user has no control – it is not possible to manage which areas are cooled or when the stored cooling energy is utilised. It also requires a separate ventilation strategy, as this simple approach only controls temperature and not the 'indoor air quality' or the CO_2 level.

More advanced natural cooling systems can utilise PCMs to control how much energy is stored and released from the thermal store, and manage where and when this energy is released. So, for example, the benefit of the cooling may be held off until the afternoon, when maximum heat gains are most likely. By removing the need to use a traditional air conditioning system, the building will have no need for the refrigerants that are required for mechanical cooling systems.

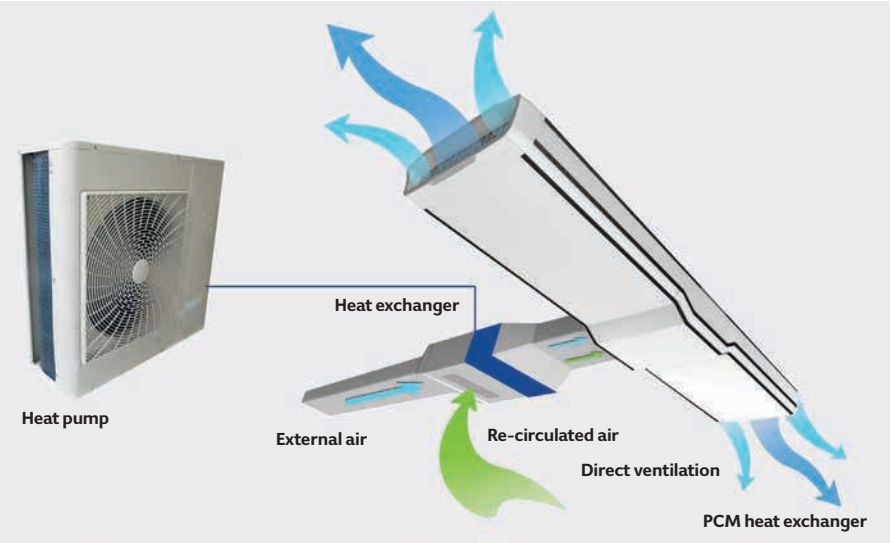


Figure 2: Hybrid PCM cooling system, augmented with an air-sourced reversible heat pump to supply additional 'top-up' cooling when internal loads have consumed all the cooling stored from the overnight cool outdoor air (Source: Monodraught)

In cases where peak loads are less predictable – such as in a teaching space with computers – natural cooling PCM systems can integrate with heat pumps to form hybrid cooling systems, allowing greater capacity while still minimising year-round energy use. Both these systems can also provide full ventilation as well as building-specific CO_2 and temperature control. By using PCMs in a natural or hybrid cooling system, building owners and users can reduce their carbon footprint – helping to meet carbon reduction commitments, as well as reducing energy costs. It also allows building owners to satisfy building regulations for ventilation and thermal comfort.

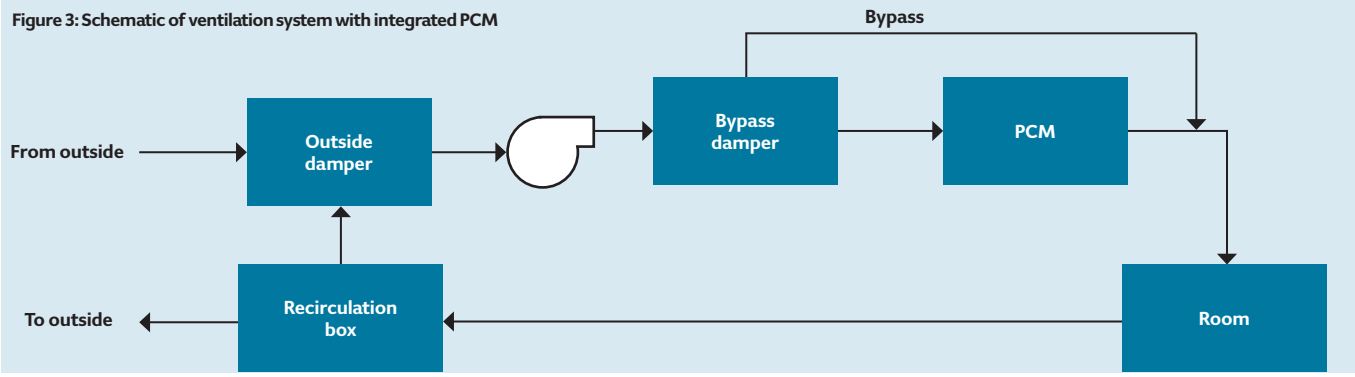
The appearance in the room for the PCM system is no different from that of a standard ventilation system

Using a natural or hybrid cooling system will reduce both the peak power and annual energy demand, and can improve the building's 'environmental rating'. There are also health benefits for users of the building as, by continuing to furnish high outdoor air supply rates, occupants are likely to feel more alert and maintain higher concentration levels.[4] During the daytime, natural cooling systems can monitor indoor and outdoor temperatures, internal CO_2 levels and humidity, and modulate the natural ventilation rate accordingly. By improving air quality, the natural cooling solution can improve productivity and attendance – potentially reducing the environmental aspects associated with 'sick building syndrome'. A recent study in the US also showed that students in schools built using 'green' credentials were more likely to be eco-conscious in their everyday lives.[5]

Hybrid PCM cooling solutions

Commercial applications of hybrid cooling systems (such as that shown in Figure 2) can use night-time cooling to charge dedicated thermal stores that contain PCM. The natural cooling system combines the cooling effect of the PCM with fresh air supplied by an integrated air handling unit to provide ventilation and cooling. This can reduce energy consumption compared with traditional air conditioning, while maintaining thermal conditions that are still appropriate for the space.

Figure 3: Schematic of ventilation system with integrated PCM



This can be designed to take into account the building's thermal properties, the local weather conditions, and internal loads such as electrical lighting, equipment and occupancy levels – applying adaptive principles that can allow the controlled energy saving alterations to set-point temperature. For example, when the weather is particularly hot, the system can be set to allow internal temperatures to rise towards the limits of acceptable comfort (typically considered as being 26°C[6] in summer for temperate climates). Such systems will always benefit from a night-time recharge of the in-built thermal store during peak summer periods but, in hybrid systems, additional top-up cooling can be applied through the use of the heat pump during the daytime. The integration of active refrigeration will ensure the most appropriate use of the stored cooling, while maintaining control of the indoor temperature.[7]

PCM natural cooling systems are recognised by BREEAM new construction-non-domestic buildings[8], contributing 28 credits across areas such as life-cycle costs, air quality, thermal comfort and low and zero carbon technologies.

Natural cooling case study, utilising PCM to reduce energy use and improve CO_2 levels

A recent article[9] reported on a year-long monitoring programme of a PCM cooling system (with no additional active refrigeration) that was applied and monitored in a university seminar room in south-west England in 2013. The seminar room was chosen because of its use as a computer laboratory, resulting in high internal heat gains. The 117m² room had one west-facing quarter-glazed external wall, internal blinds and 26 computers inside, with a total internal heat gain[9] of 60W·m^{-2}. The room's ventilation and cooling was provided with an 8kW (cooling)-rated PCM unit (as shown schematically in Figure 3), and heating was supplied by perimeter radiators. The windows were also operable. The system was concealed in the false ceiling, and for building occupants it appeared to be a conventional ventilation system, featuring two air supply terminals and one air extract terminal. Air was drawn from outside the room using a variable-speed fan. During operational hours – and depending on monitored CO_2 levels – the air was mixed with recirculated air from the room to conserve energy. The air was then directed through the PCM thermal store, known as a 'thermal battery', made up of a battery of PCM plates, where the air passes in the parallel channels between the plates.

The air was cooled if necessary (determined by air temperature sensors and control rules) or bypassed the store if cooling was not needed. Outside occupied hours, outdoor air was used to recharge the PCM thermal battery, with the recharge duration determined by air temperature sensors and control strategy.

The system maintained the room temperature within the range of the upper and lower limits of the Education Funding Agency criteria of between 20°C and 28°C. The CO_2 concentration was also monitored for the whole year, with daily average concentration always less than 1,000 ppm, and the 1,500 ppm maximum specified limit was never exceeded. The current, widely regarded standard for good indoor air quality is 1,000 ppm[10] for a mechanically ventilated space, and the performance in this installation exceeded the requirements of UK's Education Funding Authority's 'Baseline Designs for Schools'.[11]

The fan energy used by the system for the year was determined as 0.77kWh·m^{-2} – which was the energy required to provide the ventilation air as well as the integral cooling. To offer some comparison, CIBSE TM57, *Integrated School Design* (Table 15) indicates that – based on surveys of electrical energy use in UK secondary schools – those using (traditional) 'mechanical ventilation' compared with (traditional) 'natural ventilation' annually consumed an additional 6kWh·m^{-2}, far greater than the 0.77kWh·m^{-2} of this particular system. (CIBSE TM57 also presents case studies of good quality natural ventilation systems that require an annual cooling energy of 3.5kWh·m^{-2}. This, again, indicates that the PCM system may deliver a very favourable energy performance.)

While traditional air conditioning systems are likely to offer more accurate temperature (and humidity) control, PCM-based natural cooling and ventilation can be beneficial through reducing energy consumption while supplying ventilation air for a building. Case studies[7] – including the one referred to in this article – have shown that energy costs of such systems can be relatively low, while CO_2 and temperature levels are also kept within the required limits.

● With thanks to Ruth Buckingham for her core contributions to this article.

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10 CIBSE TM57, *Integrated school design*, CIBSE 2015.

11 **www.gov.uk/government/publications/baseline-designs-for-schools-guidance** – accessed 4 June 2016.

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Module 97

July 2016

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1. Which one of these is not necessarily true for the latent heat PCM, as discussed in the article?

- ☐ A It has high energy storage density
- ☐ B It is always an organic material
- ☐ C It melts and solidifies at a known temperature
- ☐ D It requires a small temperature swing
- ☐ E A wide variety of PCMs are available

2. What is the quoted 'typically' accepted maximum internal temperature for comfort in temperate climates?

- ☐ A 20°C
- ☐ B 22°C
- ☐ C 24°C
- ☐ D 26°C
- ☐ E 28°C

3. Which of these attributes of PCM installations is least likely to attract BREEAM credits?

- ☐ A Air quality
- ☐ B Life-cycle cost
- ☐ C Low and zero carbon technology
- ☐ D Potential for unobtrusive ceiling mounting
- ☐ E Thermal comfort

4. In the case study, what was the annual fan energy for the whole PCM system?

- ☐ A 0.77kWh·m^{-2}
- ☐ B 3.5kWh·m^{-2}
- ☐ C 5.7kWh·m^{-2}
- ☐ D 6kWh·m^{-2}
- ☐ E 15kWh·m^{-2}

5. In the hybrid PCM system (illustrated in Figure 2), which one of these is most likely to be true?

- ☐ A The heat pump is driven by waste heat from the ventilation system
- ☐ B The heat pump is only used as a top-up if the PCM system requires additional top-up cooling
- ☐ C The heat pump is unlikely to use a refrigerant
- ☐ D The heat pump is only used at night to charge the PCM
- ☐ E The heat pump is used to provide the lead source of cooling

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District Heating at Banbury Park in Walthamstow

Evinox Energy has just worked with Higgins Construction & Circle Housing on a development in the creative heart of Walthamstow. Banbury Park is a mixed-use scheme comprising private and shared ownership homes, with landscaped community spaces and shops. The site housed a former warehouse, industrial works and electronics factory located in Waltham Forest.

Evinox engineers completed a full design of the primary network for the district heating and hot water system for a complex of six different types of building. The apartments are connected to the district heat network and each includes an Evinox ModuSat FS storage HIU to provide heating and hot water. The integrated hot water storage within the ModuSat enables the central plant to be reduced.

Residents at Banbury Park benefit from the Evinox PaySmart pre-payment system.

● **Call 01372 722 277 or visit www.evinoxenergy.co.uk**

Competitive quotations from Aircon Installations

Aircon Installations has been carrying out major air conditioning plant replacement since 1992, offering all insurances, including £5m professional indemnity. It offers competitive quotations for the installation of water chillers, air cooled and water cooled (any make), plus air handling units, cooling towers, condensing units, pumps, power cables, steel structures and acoustic enclosures.

Aircon Installations would be pleased to submit its best price to your specification.

● **Call 0845 006 1403, email info@aicrs.co.uk or visit www.aicrs.co.uk**

Aquatech Pressmain pressurisation unit helps keeps trains running

Aquatech Pressmain supplied a high temperature pressurisation unit for Ilford Train Depot, which provides stabling for up to 12 trains from the north eastern section of the Crossrail Network. The pressurisation unit enables constant pressure control and thermal expansion of the heating system for the maintenance workshop. Fabricated in 304 stainless steel, the unit features a 150°C. nitrogen control vessel, expansion spill vessel and dual pump managed via 2020plus control system with remote web based-monitoring.

● **Call 01206 215 121, email sales@aquatechpressmain.co.uk or visit www.aquatechpressmain.co.uk**

33 Glasshouse Street refurbishment features underfloor air conditioning

AET Flexible Space is currently delivering equipment to 33 Glasshouse Street, London, after receiving the order from Emico to supply space-saving underfloor air conditioning to floors three to seven of the building.

The system specified is a CAM-C Direct Expansion system with supply and return air distributed via the floor plenum. The Fantiles are AET slimline TUS-EC fan terminals, designed to fit into the shallow floor plenums common in London refurbishments.

● **Call 01342 310 400, email lucy@flexiblespace.com or visit www.flexiblespace.com**

KoolDuct stands the test of time at fashion academy

The Fashion Retail Academy campus features a top quality specification that includes the external use of the Kingspan KoolDuct System with a waterproof, VentureClad facing. Reducing long-term running costs was an important consideration for the architects.

At the 10-year celebration, Kingspan and VentureClad staff were able to revisit the London W1 campus.

They found that, aside from a natural build-up of dirt, the ductwork was still in perfect condition with all joints and seams sealed and preventing water ingress.

● **Call 01544 387 384, email info@kingspaninsulation.co.uk or visit www.kingspaninsulation.co.uk**

Daikin Applied achieves the highest peak in chiller technology, the new VZ inverter water-cooled chiller

Daikin Applied has launched the next generation of high efficiency chillers. The new inverter screw water-cooled EWWD-VZ chiller has the highest ESEER ratings in its class – minimising running costs and CO_2 emissions.

The extremely compact VZ chiller series offers a 40% reduction in footprint as well as a low noise solution.

The launch is the latest in an innovative product range developed to support specifiers to stay ahead of EU legislation and rising energy costs.

● **Visit www.daikinapplied.co.uk and follow on Twitter @DaikinAppliedUK**

A step forward in commercial boiler design

Elco Heating Solutions has launched the Thision L Evo, a re-engineered range of highly efficient, wall mounted, gas-fired condensing boilers with outputs from 60kW to 140kW.

The highly flexible unit can be specified for an extensive range of applications.

Features include a flat metal fibre cold flame burner for extremely low NO_x emissions; a robust stainless steel heat exchanger with double wall geometry; extensive cascade arrangements; and the latest control functionality to ensure optimum performance.

● **Visit www.elco.co.uk or follow @elco_uk on Twitter**

DRU gas fires have pride of place in prestigious Belgravia development

DRU Fires – manufacturer of contemporary gas fires, wood stoves and functional gas heating appliances – was awarded a contract to produce and install purpose-designed gas fires into Ebury Square, a development of luxury apartments by Berkeley Homes in Belgravia, London.

Its PowerVent system can vent fires over large distances and, due to the size of the buildings, the flues were extended up to 64m throughout the service ducts in the complex. The operation of the fires is entirely noise-free.

● **Visit www.drufire.co.uk**

Gunfire
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UCL appoints Gunfire primary fire prevention contractor

UCL, one of the UK's largest universities, has commissioned passive fire protection specialist Gunfire, part of Gunite Group, to work across more than 50 teaching and residential buildings.

The latest contract win, which is valued at £300,000, will see Gunfire retrospectively install fire stopping technology to more than 30 residences, as well as teaching and administrative buildings. The appointment is believed to be one of the most wide-ranging fire stopping contracts in the higher education sector.

● **Visit www.gunite.co.uk/gunfire**

Oventrop Interface for Bluestone

After visiting Oventrop's Professional Development Centre in Basingstoke, Bullock Consulting worked with Oventrop to specify heat interface units for 62 new holiday lodges at Bluestone National Park.

Each heating-only interface unit, with integrated flushing bypass arrangement and safety group, provides the lodge with a hydraulic break from the site-wide heating system and a heating capacity of up to 15kW. The lodge heating water temperature is controlled by a pressure independent control valve and a mechanical temperature controller.

● **Call 01256 330 441, email info@oventrop.co.uk or visit www.oventrop.co.uk**

Ideal Commercial Boilers rolls with the times to become part of England's engineering history

As part of a £4m renovation project, Ideal Commercial Boilers has supplied an Evomax Cascade, consisting of three Evomax 150s and a multiline flue cascade, to Marble Hall, the former Rolls-Royce engine factory on Nightingale Road, Derby. The Evomax boilers were chosen by Palms Facilities specifically for their compact size and high kW output for a wall-mounted boiler.

● **Call 01482 492251, email commercial@idealboilers.com, visit idealcommercialboilers.com and follow on twitter @idealboilers**

FDS helps former British Newspaper Library make headlines again

Award-winning smoke ventilation contractor Fire Design Solutions (FDS) has been appointed to work on a new residential development on the former British Newspaper Library site in North London.

Fairview New Homes is building its Edition development of 395 apartments on the site in Colindale in the London Borough of Barnet.

FDS has been appointed to design, supply, install and commission natural and mechanical smoke ventilation systems for the development. It will also install its corridor environmental systems, which will be used to mitigate excess heat build-up in the building's common areas during day-to-day use.

Working with the project's designers, FDS carried out CFD modelling to justify the smoke ventilation system. The technique demonstrates the system's effectiveness through the creation of a virtual model.

● **Visit www.firedesignsolutions.com**

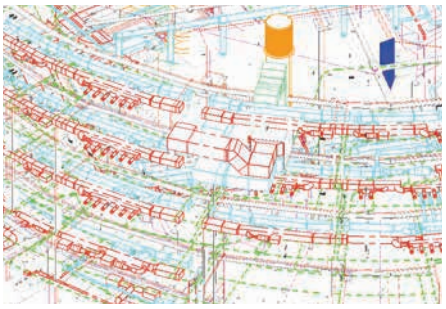
CP Electronics takes safe route

CP Electronics, designer and supplier of lighting controls solutions, is celebrating the award of an international safety standard.

The company is believed to be the first lighting controls manufacturer in the UK to become accredited to British Standard BS OHSAS 18001-2007.

The award follows a rigorous audit process spanning 12 months. The accreditation means companies working with CP Electronics can be assured it is operating to independently verified standards in all areas of health and safety.

● **Visit www.cpelectronics.uk.com**



Grundfos puts BIM in focus

Building information modelling (BIM) is a valuable tool for building services specialists to manage every step of a building's life-cycle, as it enables real-life simulation of all tasks related to design, construction, commission and operations.

BIM assets are often based on 3D drawings from the initial product development, which results in data-heavy files with a lot of detailed information – especially when you multiply this by the 100,000 building components that are often involved with a project.

Grundfos has, therefore, invested time and effort in creating purpose-built BIM assets from scratch, to ensure they are lightweight and do not contain unnecessary data.

So how is this different? To sum up, with Grundfos you get a well-structured approach to BIM that offers purpose-built Revit type catalogues; data-light concept; coarse, medium and fine renditions; exact geometry plus electrical and piping connectors; and access to operational, service and I&O data.

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

Sika launches innovative online sustainability hub for specifiers

Architects, contractors and clients are set to save time with Sika's Sustainability Hub, **sarnafil.co.uk/hub**, a new website packed with tools for those specifying projects with a sustainability requirement. Users are guided through the all-in-one portal. The hub contains information on life-cycle assessments, BRE green guide ratings and environmental product datasheets. In addition, general sustainability packs and packs for green building certification schemes such as Breeam and Leed are available. The hub has information on Sika Roofing's sustainable systems.

● **Call 01707 394 444, email sarnafilroofing@uk.sika.com, visit sarnafil.co.uk or follow @SikaSarnafilUK on Twitter**

Mikrofill supplies plantroom upgrade at Leasowes High School

The inefficient LPHW and HWS equipment at Leasowes High School has been replaced with six Ethos 130kW wall-mounted condensing boilers.

Leasowes site manager Rob Upton said: 'The upgrade of the heating system is an integral part of the continuing improvements being made here at Leasowes High School. I would like to thank both Mikrofill Systems and Dudley Metropolitan Council for all their help during the design and installation phase. Collectively this has made a huge difference to the school.'

● **Call 03452 606 020 or visit www.mikrofill.com**

New Myson LST range includes narrowest model on UK market

Myson offers a range of LST radiators that are perfect for commercial projects where safety is key, such as schools, hospitals, nursing homes and social housing projects.

The surface temperature remains under 43°C to eliminate burns, and rounded edges minimise injury. It complies with NHS Estates Health Guidance Notes 1998 and includes a 10-year guarantee on radiator and casing.

Myson can provide a like-for-like quotation against any other supplier and offers a spec break.

● **Visit www.myson.co.uk**

Everett Bunt joins Dunham-Bush's chiller division

Dunham-Bush, manufacturer of heat emitters and air conditioning equipment, has appointed Everett Bunt as regional sales manager for its chiller division.

He will be responsible for developing sales of both air and water cooled, scroll and screw chillers. With his engineering background, Bunt brings a wealth of experience to Dunham-Bush, gained at Lutz Refrigeration and HC Heat Exchangers in Johannesburg, South Africa.

Dunham-Bush models are designed to deliver the greatest amount of cooling from the lowest energy input.

● **Email info@dunham-bush.co.uk**

Rehau underfloor heating chosen for new super school in Wales

Rehau underfloor heating has been installed in the largest school ever built by Ceredigion Council in South Wales. The £30m Llandysul School features more than 11,000m^2 of Rehau pipework – 9200m^2 fitted using Rehau's Tacker sheet system and 2000m^2 fitted using its diffusion plate system over a timber suspended floor.

The underfloor heating is integrated into a full BMS intelligent control system. A built-in MODBus communication network enables easy connection into most BMS systems.

● **Call 01989 762 600, email Jo.Trotman@rehau.com or visit www.rehau.co.uk**

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Based in Stoke-on-Trent and Stockport with national coverage, PHD Design Engineers would be pleased to submit a proposal and pricing for your projects.

● **Call Nick Hyde on 01782 202 567, email nick@phdd.co.uk or visit www.phdd.co.uk**

PHDD

Wieland Electric does a 'grate' job with its modular wiring system at London's 122 Leadenhall Street – The Cheesegrater building

Wieland Electric's popular Metalynx2 modular wiring system has been installed in office space at 122 Leadenhall Street, London, a building more informally known as 'The Cheesegrater'.

The system was specified and installed by contractors PhoenixME, which chose Wieland's new generation in modular wiring to connect power and lighting MDBs. These, in turn, feed LCM's and fan coil units within the office space.

The Metalynx2 system arrives on-site pre-wired and pre-tested for quick installation.

● **Call 01483 531 213 or visit www.wieland.co.uk**

Ruskin thinks 'out of the box' with new fan coils

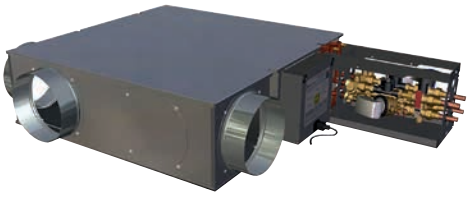
Ruskin Air Management has developed an industry-first total system approach to fan coil projects, which can reduce installation costs by 70%.

Its Hydropac EC fan coil units (FCUs) are now available as a complete 'straight out of the box' system, including fully integrated controls that are factory set to improve accuracy and minimise commissioning time on site.

Ruskin, through its group companies Actionair and Air Diffusion, ensure the whole package works together and is tuned to match demand patterns in the building before it leaves the factory. There is no need to carry out the usual water flow commissioning tasks as the FCUs arrive on site ready to 'plug and play'. Wiring costs are also reduced because the Hydropac system is line voltage powered.

An online selection programme allows specifiers to witness how the system is put together.

● **Visit www.ruskinuk.co.uk**



Sontay reaches new heights in France

Building measurement and control peripherals expert Sontay is helping to create the right climate at the new Incity Tower building in Lyon, France, after the recent installation of sensor and measurement devices.

Working with Distech Controls, Sontay supplied 240 of its GS-CO2-D carbon dioxide sensors, chosen for their reliability and accuracy.

The size of the building required a scalable and modular building management system (BMS), and a BACnet system was chosen to ensure all HVAC equipment work together seamlessly.

● **Email sales@sontay.com**

Portsmouth Civic Centre gets improved performance from Stokvis plate heat exchangers

A contract to update Portsmouth Civic Centre's plant room has included the installation of low and medium temperature plate heat exchangers from the Econoplate range manufactured by Stokvis Energy Systems.

The high performance plate heat exchangers, installed by contractor Corrigenda, are being fed from new medium temperature boilers.

Corrigenda contracts manager Matt Kind said: 'The Econoplates are providing a high-efficiency hot water service for all the toilets and the coffee shop, including numerous sinks around the building.'

● **Call 020 8783 3050 or visit www.stokvisboilers.com**

Tridonic's RLE EXC OTD 2x4/2x8 HP LED modules have 1000,000 battery life

Ideal for outdoor and industrial applications, with up to 161lm/W and 4kV overvoltage protection in temperatures ranging from -40° to +105°C, Tridonic modules have been assessed according to IEC 60068-2-52 and are resistant to hydrogen sulfide (GR-1217-CORE).

They have an estimated life expectancy of 100,000 hours and are available with external and internal logic and protected against polarity reversal.

M3 screws or M4 fixings can be used to secure the LED modules with the selected lens.

● **Call 01256 374 304, email Kirstie.Abbott@tridonic.com or visit www.tridonic.com**

Francis Pegler extends its popular Araya tap range

The 10-piece Araya collection from Francis Pegler – expanded because of its success – offers sleek contours and minimalistic styling.

Araya products not only look good, but also function well with simple and effective single lever operations that keep the user in control with the minimum of effort. All products are supported by a 10-year guarantee.

Designed for washrooms, bathrooms and kitchens, the range delivers a number of options including deck mounted sink mixer, monobloc mixer, pillar taps and much more.

● **Visit www.pegleryorkshire.co.uk**

PRODUCTS & SERVICES

Telephone: 0207 880 7633 **Email:** greg.lee@redactive.co.uk

Rinnai – reliability really rules

Rinnai, manufacturer of continuous flow gas-fired water heaters, is supplying the UK with individual units that have gained a reputation in the industry for their reliability.

The ErP A-rating applies over the complete Infinity range. Rinnai fields a complete range of gas-fired water heaters that more than achieve a coveted A-rating.

Rinnai offers more than high efficiencies. During 2015, warranty claims against Rinnai stood at just 0.05%, demonstrating the high levels of reliability its continuous flow gas-fired water heaters have reached.

● **Visit www.rinnaiuk.com**

Rehau Nea Smart System optimises efficiency in rural cottage

Rehau's Nea Smart underfloor heating controls have been installed in a cottage refurbishment project in rural Herefordshire.

The homeowners wanted an easy-to-operate control system that would maximise heating efficiency of the Rehau underfloor heating. The Nea Smart System met the brief. Simple room controls in different zones mean the homeowners have precise control over the temperature in each area, and remote operation is an option. The system even anticipates heat demand in advance.

● **Call 01989 762 600, email Jo.Trotman@rehau.com or visit www.rehau.co.uk**

New electric boiler range launched

Atlantic Boilers of Lancashire has added a comprehensive selection of electric boilers – from 1kW to 980kW and water heaters of 445 to 7,520litres/hour – to its range.

Models in the range include the HBI-S20 Electric combi boiler and the Multi- Elec Compacte floor standing boiler with a small footprint, which is economic to install and run, and has no flue requirements.

The new CER modulating electric boiler for closed heating systems comes with a long-life aluminium-silica heat exchanger.

● **For more information, email info@atlanticboilers.com or see full range at www.atlanticboilers.com/electric**

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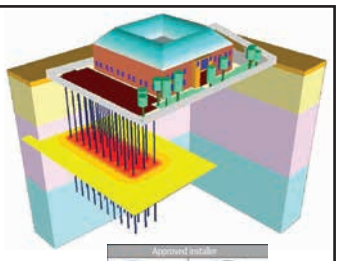

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You will plan, programme, arrange and supervise the new mechanical installation work across the entire University estate. You will ensure all work is designed, installed and commissioned in accordance with University standards. The main purpose of this role is to support the Principal Mechanical and Energy Engineer in delivering quality mechanical installation work across the University. You will work closely and develop working relationships with both internal and external designers to ensure designs comply with University requirements.

You will possess a minimum of a HNC/HND in Building Services (or equivalent) together with substantial vocational experience and possess or be working towards BTEC National Certificate or Diploma in Mechanical Engineering/Building Services Engineering (or equivalent) and/or BTEC Higher Certificate or Diploma in Mechanical Engineering or Building Services (or equivalent). You will have experience in a mechanical environment and experience of supervising groups of multi-disciplinary, technical, staff and external contractors. You will be capable of working to tight deadlines.

As an equal opportunities employer, we welcome applications from all suitably qualified persons. However, as black and minority ethnic (BME)/female candidates are currently under-represented at this level in this area, we would particularly welcome applications from BME/female applicants. All appointments will be made on merit.

Enquiries about the vacancy, shortlisting and interviews, contact Mr Bradley Murphy, Project and Mechanical Engineer bradley.murphy-2@manchester.ac.uk or 0161 275 3303.

Closing date: Midnight, 14 July 2016.

The University of Manchester values a diverse workforce and welcomes applications from all sections of the community.

www.jobs.manchester.ac.uk/displayjob.aspx?jobid=11350

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To apply online, please visit www.cityoflondon.gov.uk/jobs Alternatively, please contact 020 7332 3978 (24 hr answerphone) quoting reference number SUR313. Minicom service is available for the hearing impaired on 0207 332 3732.

Closing date: 12 noon on 12 July 2016.

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The City of London Corporation is committed to Equal Opportunities and welcomes applications from all sections of the community.

INVESTOR IN PEOPLE

DOMINE DIRIGE NOS

CITY OF LONDON

Principal/Associate Mechanical Building Services Design Engineer, Jersey

Jersey Energy is a pan Channel Island building services consultancy with offices in Jersey & Guernsey, specialising in the design of high quality, low energy and sustainable solutions within the built environment, providing a wide range of services to Clients on projects ranging in size and complexity from domestic dwellings through to commercial and industrial properties.

We are seeking a motivated and talented, Principal / Associate Mechanical Building Services Design Engineer to join our Team. You will be capable of working closely with like-minded dynamic engineers and will contribute to developing the business and your own career progression, which will be actively and positively encouraged.

Candidates will be able to demonstrate:

- Experience & Management skills working in a professional team
- Ability to lead and manage client interfaces
- An industry related degree or equivalent
- Minimum of 5 years' operating at a senior level within a consultancy practice
- Membership of a professional body such as CIBSE and the Engineering Council
- Conversant with modern IT systems and design software packages, including AutoCAD / Hevacomp / Cymap / Amtech / BIM
- Excellent project management skills in delivering and managing projects from inception through to completion
- Strong communication skills, able to relate well at all levels within an organisation

Inter-island travel will be required, as will a team working ethic and flexibility to ensure project deadlines are met.

This is a unique opportunity for an engineering professional. As well as having a rewarding career the successful postholder will enjoy the fantastic and unique quality of life that Jersey offers.

In return an excellent remuneration package is offered to the successful candidate, which will be based upon experience and qualifications.

Please write or email marked confidential enclosing your C.V. by Friday 22nd July 2016 to:-
The Head of Consultancy Services, Jersey Energy
CTV House, La Pouquelaye St Helier,
Jersey, JE2 3TP
Tel: 01534 618801
Email: admin@jersey-energy.com
Website: www.jersey-energy.com

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For further information and to apply, please call us on **+44 (0)203 176 2666** or email **cv@b-a-r.com**

Senior Mechanical Engineer
London, £45 - £55k + bens

A London based CIBSE Accredited design consultancy are looking to recruit a senior mechanical engineer. They provide design and management to some of the UK's largest companies and work on a number of London's top projects. They have and excellent development program and can offer a route to becoming a Chartered engineer. Ref: 3585

Senior Public Health Engineer
London, £60 - £65k + bens

My client are an international design consultancy who only work on very large scale projects such as the current corporate HQ build in Saudi Arabia for the largest petrochemical company in the region. This project is worth in excess of $800m and is in line with other current projects with values ranging from $20-30m to almost $1b. They are looking for someone who has extensive experience of leading projects and teams, is client facing and has delivered projects in a variety of sectors. You will be rewarded with excellent pay, performance bonus, promotion and personal development. Ref: 3610

Senior Electrical Design Engineer
London, £40 - £44 p/h

Currently seeking a Senior Electrical Engineer who is creative and practical in equal measure to come on board and work on demanding projects specifically across the rail and aviation sectors. This opportunity is a long term contract to join the 3rd largest consultancy in the world based out of the central London office. Ref: 3598

Lead Mechanical Engineer
Central London or Dartford, £40 - £60k + bonus + bens

A specialist fire systems contractor are seeking a mechanical bias building services engineer to design, develop, and coordinate drawings and specifications for air conditioning, smoke ventilation, and car park ventilation systems. You will be providing technical advice whilst interfacing between the design teams and site teams on both residential and commercial projects. This is a forward thinking company that are committed to providing an enjoyable working environment for all staff. Ref: 3614

Principal Electrical Design Engineer
London, Up to £65,000 + bens

An Electrical Engineer experienced in concept and detailed design is required by a reputable consultancy to work on major London projects. Producing layout and schematic drawings, you'll also work with Architects and Structural Engineers and benefit from a clear and structured career path. With 10 years UK experience you'll receive a market leading package. Ref: 3517

Senior Mechanical Design Engineer
London, SE1, £42 p/h

Global mechanical and electrical engineering design firm with a commitment to sustainable design. An opportunity exists to work on large complex stadium/arena projects, prior experience of projects with similar scale and complexity in particular sports facilities is vital. You will be required to carry out all technical design and co-ordination of project HVAC systems. Ref: 3575

Thinking of your future

www.b-a-r.com

Events & training

NATIONAL EVENTS AND CONFERENCES

CIBSE Young Engineers Awards 2016
13 October, London
Comprising the Graduate of the Year and Employer of the Year prizes, the awards scheme is sponsored by Andrews Water Heaters and Ruskin Air Management. It is supported by the CIBSE Patrons and organised by the CIBSE ASHRAE Group, in conjunction with the CIBSE Young Engineers' Network.
www.cibse.org/yea

CPD TRAINING

For more information, visit **www.cibse.org/mcc** or call **020 8772 3640**

Lighting and energy efficiency
5 July, London

Energy efficiency building regulations: Part L
5 July, London

Designing water efficient hot and cold supplies
8 July, London

Emergency lighting to comply with fire safety
8 July, London

Energy strategy reports
12 July, London

Mechanical services explained
12-14 July, Manchester

Wiring regulations (including July 2015 update)
14 July, London

Air conditioning and cooling systems
15 July, London

Gas safety regulations – designing for compliance
15 July, London

Building services explained for FMs
19-21 July, Manchester

Electrical services explained
26-28 July, Manchester

Mechanical services explained
7-9 September, London

ENERGY ASSESSOR TRAINING

For more information visit **www.cibse.org/events** or call **020 8772 3616**

Heat networks
6-7 July, London

LCC design and EPC
12-13 July, London

LCC building operations and DEC
18-20 July, London

ISO 50001
26-28 July, London

LCC building operations and DEC
28-30 June, Manchester

CIBSE GROUPS, REGIONS AND SOCIETIES

For more information, visit **www.cibse.org/events**

SoPHE: Technical event: New water regulations certification scheme
7 July, London
Presentation looking at plans for the development of a new certification scheme for water fittings compliance, with speaker Gareth Mapp, programmes director at NSF-WRc.

YEN South West: BBQ and Pimms
15 July, Bristol
Join YEN South West for a summer barbeque at Rack's in Clifton, sponsored by Hydrotec, for a chance to meet and network with other young BSE professionals.

West Midlands: Summer social – guest pass to Loton Park speed hillclimb
16 July, Shrewsbury
Guest pass to Loton Park speed hillclimb in Alberbury, near Shrewsbury.

SoPHE: A guide to water pressure booster sets
20 July, Manchester
A talk by Mark Penny and David O'Neill, of AquaTech Pressmain.

Yorkshire: CP1 – Heat networks
20 July, Leeds
Overview and practical guide to the new CIBSE *CP1 Heat Networks Code of Practice*, by Matthew Turner, regional director of Sustainable Development Group, Buildings + Places, Aecom.

HCNW: Energy efficiency beyond Part L and the Green Deal
28 July, London
With the Green Deal abandoned in 2015, and three years after the HCNW debate – with panel members Peter Thorn, of Green Heat, Peter Rickaby, of Rickaby Thompson Associates, Jim Green, of Envos, and Bill Wright, of Wright Energy & Environment – this event reunites the panel to ask: How do you feel business and the public can progress energy efficiency? What are the barriers and how can construction professionals assist by inspiring motivating decision-makers?

Northern Ireland: Golf day
4 August, Belfast
Taking place at Dunmurry Golf Club.

West Midlands: Summer social – guest pass to Loton Park speed hillclimb
6-7 August, Shrewsbury
Guest pass to Loton Park speed hillclimb in Alberbury, near Shrewsbury.

Scotland: Golf Championship
25 August, Glasgow
Individual and team prizes, team bonding, client business development, networking and an overall fun day. Taking place at Eastwood Golf Club. Sponsored by Kingspan Insulation.

Northern Ireland: Golf day
1 September, Belfast
The last CIBSE NI golf outing for 2016 will take place at Rockmount Golf Club.

Ireland: CIBSE annual golf outing
2 September, County Kildare
The annual CIBSE golf held at Castlewarden Golf Club.

Ireland: CPD 2: New form of contract and implications for M&E sector
14 September, Dublin
Presentation by Sean Downey, specialist contracting director at CIF.

Building Performance Conference and Exhibition

17-18 November, QEII London

The CIBSE Building Performance Conference and Exhibition returns to the QEII Conference Centre in London, once again promising to inform and inspire building services professionals with a broad range of seminars and CPD programme.

This year, a very special anniversary interview between Patrick Bellew and Max Fordham on their visions of our future built environment, will kickstart the conference.

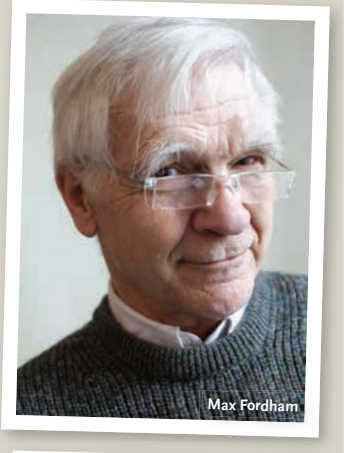
Both of these iconic figures in building services engineering lead two of the most prestigious and well-known building services companies, which are both celebrating significant anniversaries: Atelier Ten celebrated its 25th anniversary in 2015, and Max Fordham LLP turns 50 this year.

The figureheads, who are two of the industry's most influential environmental engineers, will be interviewed together sharing their visions and aspirations for the next 50 years in the building services industry.

Other speakers confirmed for the two-day conference include: Mat Colmer, Lead Technologies; Casey Cole, Guru Systems; Munish Datta, Marks & Spencer; Paul Davidson, BRE; Keith Jones, National Trust; and Marine Sanchez, Enhabit (formerly Green Tomato Energy).

This year, the free-to-attend exhibition, will be doubled in size, giving visitors more opportunity to meet and network with companies across the wider industry. The exhibition area will also host a complimentary CPD event stream.

To book your place now, taking advantage of the early bird rate, and to view the full speaker and exhibitor lists, visit **www.cibse.org/conference**


Max Fordham


Patrick Bellew

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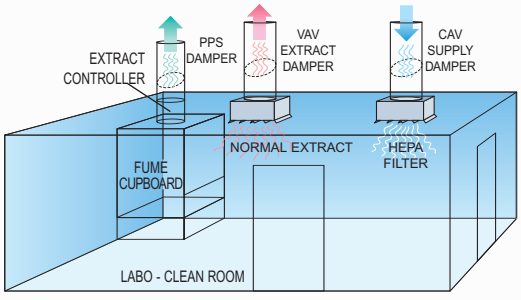

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