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Have we left it too late?

The availability of cheap and plentiful North Sea gas has provided the UK with some level of energy security over the past five decades. It has also meant there was little motivation to explore fossil fuel alternatives during the energy crisis of the 1970s, when wars in the Middle East interrupted energy supplies.

While other countries, such as Denmark, were considering the potential of heat networks and waste heat, Britain was cooking and heating on gas.

Now, because of Covid, worldwide shortages and the war in Ukraine, we are facing ever larger shocks to global energy supply. As the UK still relies on gas for a large proportion of its heat, companies and individuals are about to be hit with punitive fuel bills that threaten to cripple business and put millions into fuel poverty.

Frustratingly, we could have avoided this situation if we had taken greater measures to decarbonise our buildings. With low energy prices and few mandatory requirements to improve building stock, relatively little has been done to improve Britain s notoriously draughty buildings. Zero VAT on heat pumps and other energy saving materials are welcome gifts from the Chancellor in his Spring Statement as are the £5,000 grants for heat pumps in the Boiler Upgrade Scheme but there won t be enough time or money to protect residents from the expected trebling of energy bills due in the autumn.

Even with heat pumps and solar panels becoming more affordable, there is a big question over whether the installer base has the capacity to decarbonise the energy grid. A lot will depend on whether utility companies, such as British Gas and Octopus Energy, can swap boilers for heat pumps at the necessary scale. Octopus Energy boss Greg Jackson is optimistic, at least, saying that up to 34% of homes can be converted at minimum extra cost.

In the non domestic sector, all electric buildings are becoming more common as organisations seek to lower energy bills and reduce carbon emissions in response to green investment trends.

CIBSE s 2022 Building Performance Champion, St John s College, Oxford s Library and Study Centre, is a shining example of what can be achieved with passive first engineering and the pragmatic adoption of low carbon technology (page 20).

It was ahead of its time 10 years ago, when engineer Max Fordham proposed a design featuring heat pumps, but now it is paying dividends, with near carbon neutral performance and maximum comfort for students. It s a blueprint for how buildings must be designed in these challenging and uncertain times.

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CONTRIBUTORS

Hywel Davies
Assessing the impact of the amendments to the Building Safety Bill that were made last month

Ruth Kelly Waskett
How the SLL President is aiming to raise awareness of the benefits of healthy lighting

Julie Godefroy
Why an agreed set of net zero definitions is vital for the design of high-performing buildings

Tim Dwyer
This month's CPDs look at evolving standards and ventilation methods in homes, plus educational lighting

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IN BRIEF

No upgrades needed for 15% of domestic heat pump retrofits

Octopus Energy CEO Greg Jackson has said that 15% of UK homes could have a heat pump installed with no other upgrade costs.

The energy utility company is preparing to install thousands of heat pumps for customers this year in response to the government s Boiler Upgrade Scheme, due to start on 1 April.

The fund will provide grants of £5,000 for new air source heat pumps and biomass boilers, and £6,000 for ground source heat pumps, and will run until 2025.

Octopus Energy has invested £10m in a heat pump R&D centre.

RICS updates fire safety guidance on external walls

The Royal Institution of Chartered Surveyors (RICS) has updated the EWS1 form to reflect a more proportionate approach to fire safety checks. Published on 16 March, the new version of EWS1 reflects the BSI PAS 9980:2022 guidance note, which offers a new methodology for carrying out external wall fire risk appraisals of multi storey or multi occupied residential buildings. The PAS replaces the government s Consolidated Advice Note, which was withdrawn in January after concerns that it was being interpreted too cautiously. The RICS has also updated its valuation guidance on properties in multi storey, multi occupancy residential buildings with cladding.

Online tribute to Max Fordham created

Max Fordham Associates has created a section on its website in memory of its founder, who died in January at the age of 88. The Remembering Max pages include his most notable projects and innovations, details of his early life, and the memories and reflections that those who worked with him have shared. The website is at **www.maxfordham.com/remembering max**

Consultants withdraw from business operations in Russia

Aecom among firms pulling out, as others offer financial support for Ukrainians

International design consultants, including Aecom and Foster + Partners, have announced their withdrawal from Russia following the country's invasion of Ukraine.

Last month, Aecom announced that it was 'immediately exiting its business operations in Russia'. Its chief executive, Troy Rudd, said: 'We support the people of Ukraine who are facing tremendous suffering as a result of Russia's unlawful invasion.

'Russia's actions are inconsistent with Aecom's values and have compromised the business environment for Aecom, our clients and our joint activities in Russia.'

The global engineering giant said that leaving the Russian market would cost it around $10m.

Architect Norman Foster declared in a handwritten note on Instagram that Foster + Partners was leaving Russia. It read: 'We deplore the Russian invasion of Ukraine and as a result we have stopped work on all our projects in Russia.' The architect had two schemes in the country.

Other architects to suspend projects in Russia included David Chipperfield Architects, Zaha Hadid Architects and Swiss studio Herzog & de Meuron.

Sweco, which has no current work in Russia, has donated £400,000 to Médecins Sans Frontières to help people in Ukraine.

Ramboll UK said it would donate one million Danish kroner (£112,000) to a Ukrainian refugee organisation.

RIBA has opened up its jobs platform to match Ukrainian refugees with employment opportunities as part of its response to Russia's invasion of the country.

The move means that RIBA chartered practices can advertise job or apprenticeship roles for displaced architects and architectural students for free on the platform.

People in Vienna protest against the Ukraine war

Insulate 19 million homes to improve energy security, says Labour

Labour wants 19 million homes to be insulated within a decade as part of its new five-point plan for energy security, which was published on 8 March.

As global gas prices soared in the wake of Russia's invasion of Ukraine, the official opposition said that all homes would have to be upgraded to the Energy Performance Certificate Band C rating by 2030.

Bringing all homes up to this standard would cut national gas imports by up to 15%, save households in improved homes an average of £400 a year on their energy bills, and support around 100,000 jobs in every region, claimed Labour.

Other key points in the plan include a call to double the UK's onshore wind capacity to 30GW by 2030, increase offshore wind capacity to at least 75GW by 2035, triple solar power output by 2030, and back tidal power.

Labour also called on the government to raise its ambition for the UK's hydrogen economy, and make a final investment decision on the planned Sizewell C nuclear plant.

Shadow secretary of state for climate change and net zero Ed Miliband launched the plan on a visit to the University of Salford with Greater Manchester mayor Andy Burnham. He said: 'Energy security is national security. Homegrown, clean power is the cheaper, more secure route to energy security and sovereignty. We can make ourselves safer and more secure, and keep bills lower with a green sprint, including a plan to insulate millions of homes.'

The UK government is seeking to secure more domestic energy supplies

UK set to increase oil and gas production in response to war

UK has to use 'own hydrocarbons', says Prime Minister Boris Johnson

The first North Sea oil and gas licensing round since 2020 is due to take place this year, as the government seeks to secure more domestic energy supplies in the wake of Russia's invasion of Ukraine.

Andy Samuel, chief executive of the Oil and Gas Authority (OGA), said in an interview with the *Financial Times* that the regulator is preparing licences that include existing discoveries, which would be 'pretty much ready to go'.

Prime Minister Boris Johnson said he hoped fossil-fuel companies would be able to increase indigenous production as he prepares to publish an updated energy security strategy.

At a Downing Street press conference last month, Johnson said: 'We are looking at the possibility of using more of our own hydrocarbons. That doesn't mean we are abandoning our commitment to reducing CO_2 ... We have got to reflect the reality that there is a crunch on at the moment.'

The OGA, which changed its name to the North Sea Transition Authority last month, has not held a licensing round since 2020, when the government undertook a review of whether its policies were compatible with climate objectives.

Secretary of State for Business, Energy and Industrial Strategy Kwasi Kwarteng said that increasing North Sea oil, or starting the process of fracking, would have no impact on energy prices. In a Twitter thread, he said that the UK needed to 'move away from gas'.

Energy giant Shell said it was reconsidering plans, announced after COP26, to pull out of the Cambo oil field. It released an amended plan for the development of the Jackdaw North Sea gas field last month, which British regulators initially rejected last year on environmental grounds.

The Prime Minister has also asked leaders in the nuclear industry how the UK could rapidly secure new nuclear capacity.

EU aims to speed up heat pump rollout

The European Commission has pledged to accelerate the rollout of heat pumps as part of its wider plans to cut dependence on Russian gas.

The REpowerEU plan, which was unveiled by the European Commission in response to the Russian invasion of Ukraine, proposes that deployment of heat pumps should be front-loaded. This would enable the installation of 10 million units over the next five years, saving a total of 12bn m^3 of natural gas.

The plan says accelerating the deployment of heat pumps will require 'rapid upscaling' of the entire supply chain, and must be accompanied by measures to boost building renovation and modernisation of district heating systems. It also sets targets to double the EU's photovoltaic and wind-generation capacities by 2025, then triple them by 2030, saving 170bn m^3 of yearly gas consumption by the end of the current decade.

The plans to electrify heat and energy are part of a three-pronged strategy to 'at least' replace the annual 155bn m^3 of natural gas imported from Russia by 2030.

Responding to the EU's plan, nonprofit sustainability organisation RMI said the short-term target of 10 million new heat pumps is a 'modest and highly achievable' target based on the current deployment rates, which reached 1.8 million across the EU in 2020. However, it says the EU will need to pick up the pace 'considerably' to meet its longer-term goals.

IN BRIEF

Delay to boiler replacement scheme threatens installers

The delayed opening of the new Boiler Upgrade Scheme (BUS) will threaten the livelihoods of installers, a leading heating supplier has warned.

A two month delay between the Renewable Heat Initiative closing on 31 March and vouchers for the BUS opening on 23 May has the potential to be hugely damaging, said Vaillant.

While installations commissioned from 1 April may be eligible for the BUS, SMEs will have to wait weeks for reinmbursement for an issued voucher, it said.

Additionally, there is no guarantee that the voucher will be retrospectively granted, said Vaillant, which it suggested could create an extremely difficult relationship between homeowner and installer.

Atkins to plan decarbonisation of DWP estate

Atkins has been appointed by the Department for Work and Pensions (DWP) to carry out a nationwide study into how to decarbonise its entire property portfolio. The first stage of the assessment will be a detailed analysis of 50 buildings, mainly Jobcentre Plus sites, focusing on an analysis of existing heating systems and insulation. The second phase will then provide guidance on decarbonising the department s portfolio of 850 buildings by reducing emissions levels from heating systems.

Ground source heat pump for Brompton s global HQ

Brompton has unveiled plans to relocate its global headquarters and factory to a new building in Kent, constructed on stilts.

The bicycle manufacturer s new factory will be located within a 100 acre floodplain site near Ashford town centre, 60 acres of which are due to be rewilded to become a nature reserve. Itwill be accessible to the public via a cycle path and a network of trails.

The design, by architect Guy Hollaway, features solar and ground source energy and seeks to minimise power consumption via use of natural light and airflow.

Ukraine war adds to supply chain issues

The UK faces continuing supply challenges for boilers and other HVAC products amid uncertainty about the impact of the war in Ukraine, says the Construction Leadership Council (CLC).

In a statement issued jointly by the CLC s Product Availability Working Group and the Builders Merchants Federation, it noted supply chain issues and delayed lead times for products including boilers, cable trays and trunking. It also highlighted problems with the supply of electrical products, particularly those using semi conductors and microchips.

However, the CLC statement identified price inflation, driven by factors such as a shortage of raw materials and rising costs, as a greater concern to projects than product availability currently.

It said: Price increases of 5% to 10% have been announced by many manufacturers so far this year, and energy intensive products have increased by as much as 20%.

Chancellor offers zero VAT boost for energy retrofits


Rishi Sunak

Heat pumps, solar panels and insulation among energy-saving materials affected

Chancellor Rishi Sunak has reduced VAT to zero for heat pumps, solar panels, insulation and other domestic energy-saving materials.

In his spring statement, the Chancellor said the zero rate would last for five years. The tax savings for installing PVs on a typical home would be worth around £1,000, he added, saving £300 in annual energy bills.

The Chancellor also announced that green technology, including solar panels and heat pumps, would be exempt from business rates from this month. This is expected to be worth around £170m over the next five years.

While welcoming support for domestic renewables, the Association for Renewable Energy and Clean Technology said more technologies could have been included as energy-saving materials, such as batteries.

Mike Thornton, chief executive of Energy Saving Trust, warned that more action was still needed: 'Tackling the cost-of-living and energy crises must go hand in hand with meeting net zero ambitions and reducing costs in the long-term. '

'Instead of cutting fuel duty, the UK government could be investing more in its existing energy efficiency programmes.'

Plans for building safety manager role scrapped

Building Safety Bill changes aim to limit leaseholders' costs

The government has scrapped a proposed duty for all high-rise residential blocks to have a building safety manager following concerns that the move would be potentially too costly for leaseholders.

As part of its Building Safety Bill, the government had proposed the appointment of dedicated building safety managers by landlords managing residential towers – a key recommendation in Dame Judith Hackitt's review of construction industry failings following the Grenfell Tower disaster.

However; in one of a series of amendments to the legislation, the government has removed the proposed duty.

Instead, it has proposed that the regime should enable block managers or landlords to set the 'most appropriate arrangements' for their buildings and residents, relieving leaseholders from 'unnecessary' costs.

A further amendment to the bill removes the requirement for a separate building safety charge, which would have been used to cover the costs of appointing a building safety manager.

The Department for Levelling Up, Housing and Communities has also bought forward amendments to enshrine in legislation a series of previously announced steps to force developers and construction products manufacturers to pay their share of building remediation costs

These companies will all, potentially, be subject to new remediation contribution orders, which will also apply to developers using shell companies that are difficult to trace.

The department has announced that leaseholders with properties valued at less than £175,000, rising to £325,000 in Greater London, will be protected entirely from all remediation costs, including those related to non-cladding defects.

Crucial advice on Class O fire rating just got missed , inquiry told

A recommendation to review fire standards following a 'catastrophic' 2001 test on the cladding material later used on Grenfell Tower was 'missed', according to the official formerly responsible for the guidance.

Giving evidence to the ongoing Grenfell Inquiry on 21 March, Brian Martin was pressed on why he had not issued the government with clearer advice to review its Class O fire rating standard after the test on an aluminium composite material (ACM) cladding panel containing a polyethylene core.

The test on the panel, which had met the Class O standard, had to be suspended six minutes into the half hour allocated for it because of the ferocity of the blaze.

Martin, who was working part-time for the government on secondment from the BRE, denied that he had kept quiet about weaknesses in the guidance to 'keep the market sweet'. He said: 'This sounds awful, but I think it just got missed.'

Rising fuel bills make energy retrofits cost effective, says CCC

Energy efficiency upgrades are now a lot more cost effective following recent hikes in gas prices, the Committee on Climate Change (CCC) has said.

In its response to the government s Heat and Buildings Strategy, published last month, the CCC says the costs of delivering energy efficiency upgrades have not changed since 2020. However, the benefits of carrying out such works have increased significantly as a result of higher energy prices.

Bill payers would save significantly more from insulating their homes and reducing their energy consumption than they would under lower gas prices, it adds.

The CCC says decarbonising the economy in line with its sixth carbon budget, which covers the 2033 to 2037 period of the UK s transition to net zero emissions, will save 0.5% of gross domestic product (GDP) if gas prices remain at current high levels.

While previous analysis said costs of decarbonising the economy would peak at less than one per cent of GDP each year by 2035, an update shows a saving of 0.5% if steps such as improved energy efficiency and electrification of heating are introduced.

The CCC said: Delivering on these goals will help to protect UK consumers from future price spikes and increase energy security by reducing energy needs.

High fuel prices makes insulation even more beneficial

Construction output grew 1.1% in January

Monthly construction output hit its highest level since September 2019 in January, when it increased by 1.1%, according to the Office for National Statistics. The rise in monthly construction output in January 2022 came solely from an increase in repair and maintenance (4.6%), as new work fell slightly, by 0.8% on the month. The overall volume of construction output in January 2022 was £197m, equivalent to 1.4% above the pre coronavirus pandemic level in February 2020. This February s increase also marked the third consecutive month that growth has been greater than one per cent.

IN BRIEF

Build2Perform Live makes its return in November

CIBSE s flagship Build2Perform Live event is back for 2022. The two day event will take place on 29 and 30 November at London s ExCeL centre, and will feature more than 80 hours of approved CPD, 160 speakers and more than 70 exhibitors, making it an invaluable meeting place for forward thinking industry professionals.

The programme will again be carefully curated by CIBSE Divisions, Special Interest Groups and the Build2Perform Live Advisory Committee, with specialist speakers invited from across the built environment.

Registration will open soon, but you can register your interest now at **www.build2perform.co.uk/about the event**

To enquire about exhibiting at Build2Perform Live, contact Amy Emmett on **aemmett@cibse.org**

CIBSE reveals Technical Symposium programme

London South Bank University will host in-person event on 21-22 April

The full programme for the 2022 CIBSE Technical Symposium has been released. Taking place from 21-22 April, the symposium's theme is 'Delivering a safe, healthy and sustainable built environment – buildings that perform', and it will feature dozens of peer-reviewed papers.

The event at London South Bank University seeks to bring together practitioners and researchers, and hear from those who are applying and researching the latest thinking in building services engineering. A diverse range of topics is on the agenda, including designing for a zero carbon future and minimising infection risks.

After two years of hosting the symposium online, CIBSE is delighted that the 2022 event will take place in person.

2022 symposium topics

- Whole-life and embodied carbon assessment
- Assessing operational energy in practice
- Design for performance
- The future of heat
- Future opportunities for future benefits
- Modelling performance for future heat networks
- Reducing infection risk through ventilation
- Strategies for reducing viral concentrations in indoor air
- Lighting in practice – user perceptions and experiences
- Using simulation to improve performance
- Carbon visions – towards a zero carbon future
- Water and sustainability

For the full programme and to book, visit: **www.cibse.org/technical-symposium**


Annette Ash, chair at WiBSE


Farah Naz, of Aecom


Fiona Cousins, of Arup


Lucy Sherburn, of FairHeat

CIBSE Exchange talks women in engineering

Leading engineers discuss ideas and opportunities for the global industry

As part of its International Women's Day celebrations, CIBSE launched a new CIBSE Exchange global discussion, to showcase leading figures from building services engineering.

The online conversation, on 8 March, brought together engineers from a range of backgrounds to explore the future of the industry, opportunities for change and growth, and how to support others in their careers. The international panel of speakers included: Annette Ash, principal electrical engineer at the University of Oxford, and chair of CIBSE group Women in Building Services Engineering (WiBSE); Fiona Cousins, mechanical building services engineer and principal at Arup in New York; Farah Naz, building services engineer leading sustainability and specialist services for Aecom in the Middle East, Africa and Saudi Arabia, and chair of the CIBSE UAE region; and Lucy Sherburn, consulting engineer at FairHeat, and CIBSE ASHRAE Graduate of the Year 2021.

Each gave an overview of their journey into building services engineering, with Cousins saying: 'Engineering comprises creativity, problem solving, and technicalities, and has the ability to change the world.'

Naz added: 'It is important to understand that our horizons are expanding with the climate crisis and net zero transition. There are two keywords for our industry and our profession: co-creation and collaboration.'

Ash spoke of the importance of mentors and role models, and of making people feel comfortable to ask questions.

In what is being termed the decisive decade, CIBSE is committed to facilitating conversations within its membership and the industry more broadly.

- Watch the CIBSE Exchange discussion at **bit.ly/CJApr22CN1**

New quality scheme to evaluate circular economy in lighting

CIBSE and the Lighting Industry Association have launched a new scheme to support the accuracy of circular economy claims made by lighting manufacturers and specifiers.

The TM66 Circular Economy Assured scheme will give a quality mark for the design and manufacture of lighting products, and supports TM66: *Creating a circular economy in the lighting industry* and the accompanying Circular Economy Assessment Methods (Ceam). Published in 2021, TM66 offers practical guidance and tools to enable the sector to deliver a circular, sustainable approach to lighting and building services engineering more broadly.

Manufacturers are already rating their luminaires, while others are seeking help to do so, with a shared ambition to ensure credibility, objectivity, and consistency in their ratings.

Society of Light and Lighting president Ruth Kelly Waskett said: 'Sustainability is at the heart of good lighting practice, but our focus is now shifting from energy efficiency in use towards whole-life carbon and the life-cycle of materials. TM66 and Ceam have given us a framework within which to evaluate products and make the right specification decisions. TM66 Circular Economy Assured gives us the added benefit of knowing that circular economy claims are robust and comparable between products.'

- TM66 is available from the CIBSE Knowledge Portal: **www.cibse.org/knowledge**

IN BRIEF

Two *Journal* technical webinars to be held in April

CIBSE Journal is hosting two sponsored, technical webinars, on 7 and 26 April. They are free to attend, and both will be chaired by *Journal* technical editor Tim Dywer.

The first webinar, sponsored by Daikin, is titled *Building Regulations and Building Safety Bill update and the role of heat pumps*.

The second, sponsored by Kohler, is titled *Space the first frontier*, and will look at the space required for emergency generators and how to use it effectively.

You can register for the events at **www.cibsejournal.com/cpd/webinars** , where you will also find a library of previous *CIBSE Journal* webinars including recent discussions on water source heat pumps and ultra low heat networks, sponsored by Mitsubishi Electric, and the monitoring and management of UPS systems, sponsored by Kohler Power.

Online event to reveal net zero FAQs

CIBSE and the London Energy Transformation Initiative (LETI) will launch their Net Zero Definitions and FAQs at an online event on 7 April.

The FAQs build on the work of LETI and the Whole Life Carbon Network definitions, with simple explanations of the implementation of net zero in practice.

Developed jointly by CIBSE and LETI, the resource has been adopted by others in the industry, including RIBA.

For further details and to register, visit: **www.cibse.org/events**

For more on the definitions see The importance of defining net zero on page 14.

Save the date for the President s address

The CIBSE AGM will be held on 5 May 2022 as a hybrid event. It will be followed by Kevin Mitchell giving the President s Address. Members will receive a calling notice this month. Further details at **www.cibse.org/agm**

Significant revisions to Building Safety Bill

As *CIBSE Journal* was going to press, the government introduced a further package of amendments to the bill currently making its way through parliament. Hywel Davies explores what these changes mean

As you read this, the Building Safety Bill should have completed its Report stage in the House of Lords and be ready for third reading, before going back significantly changed to the House of Commons. The target will be to get the bill to Royal Assent before the end of the current parliamentary session at the end of April.

During passage through the Upper House, which, in the UK parliament, is the revising chamber, the bill has been revised significantly. Following the so called Valentine s Amendments on 14 February, further amendments have been made to reduce the demands on leaseholders and cap what they might have to pay to remedy historic defects. These are very important changes, although they have limited impact on building services engineers.

Of greater impact for many *Journal* readers is the removal from the bill of the Building Safety Manager (BSM) dutyholder role. This role was proposed by Dame Judith Hackitt in her independent review, to support the accountable person in the day to day management of a building.

There was growing concern that this provision, along with the Building Safety Charge also now removed could have created significant costs for residents in buildings more than 18 metres in height or with more than seven storeys. The fear was that this could become a means for managing agents and their client contractors to generate work and fees fears further fuelled by reports of managing agents already raising service charge demands for BSM costs before the bill is law.

Residents groups have welcomed the removal of the BSM and Building Safety Charge, so what does it mean in practice?

The changes remove the specific dutyholder role and requirement on the accountable person to have a BSM for every high rise building, but they do not remove the requirements for the accountable person to manage the safety of the building and its residents.

The various duties of the BSM, set out in Part 4 of the bill in particular, clauses 87 94, describing what the accountable person must have done still need to be undertaken. Now, however, the accountable person

> The changes do not remove the requirements for the accountable person to manage the safety of the building and its residents

DR HYWEL DAVIES
is technical director at CIBSE
www.cibse.org

The changes aim to protect leaseholders from escalating costs

has flexibility and discretion to allocate those duties as appropriate to their organisation. Larger social housing providers may have people on their staff or contractors who already undertake these tasks, and they can now continue to do so.

One other set of very significant amendments was introduced that did not attract quite the same comment, possibly because they had not been trailed on social media in advance. Two significant clauses create new statutory liability relating to construction products. Under these provisions a liability will arise when four conditions are met.

The liability will be triggered if, at any time after the new provisions come into force, a person fails to comply with a requirement in relation to a construction product, supplies or makes a misleading marketing statement in relation to a product, or supplies a product that is inherently defective.

If that construction product is then installed in, applied or attached to a relevant building in the course of building works so that when those works are completed a dwelling unit within that building is unfit for habitation because of inclusion of the defective or non compliant product or the misleading marketing this will create a liability on the person who supplied the defective product. They will have to pay damages to a person with a relevant interest in relation to the relevant building for personal injury, damage to property or economic loss as a result of the unfitness of the dwelling or dwellings. It will not be possible to restrict this liability through any terms and conditions or agreement.

This new clause creates a new right of action where a breach of regulations for a construction product leads to, or is a factor in, a dwelling becoming unfit for habitation.

So, anyone making or supplying products that make people s homes unfit will be very firmly in the firing line in future and that will be for any product that might be installed. We have been warned.

References:

1 Building Safety Bill as amended on 2 March, **bit.ly/CJApr22HD1**
2 Building Safety Bill amendments 22 March, **bit.ly/CJApr22HD2**

The importance of defining net zero

An agreed set of net zero definitions is essential if the construction and property industry is to design consistently high-performing buildings. Julie Godefroy says a new initiative will provide more clarity for members

Having a set of agreed, clear and comprehensive definitions for net zero buildings is necessary for investment, specifications, trusted and consistent reporting, certification and, ultimately, regulations.

There has been great progress on net zero definitions. The UK Green Building Council (UKGBC) framework[1] was followed by the LETI one pager on operational carbon[2] (energy use), which is supported by CIBSE. Last year, the first version of the Whole Life Carbon Network (WLCN) LETI[3] set of definitions was published, which are supported by RIBA.

Over the past few months, CIBSE and LETI have been working together and engaging with industry. CIBSE wanted to interact with members before deciding whether to adopt the WLCN LETI definitions. This was tested in a survey, and adoption was supported by 78% of members. The survey showed strong support for key principles in the FAQs (see panel below).

These FAQs are not final, and CIBSE and LETI are continuing to work together

Interestingly, the survey also showed that, while clarity is needed now, there is an understanding that the definitions and FAQs may evolve in particular, to include demand management considerations.

The survey tested opinions on how to acknowledge efforts towards net zero when a building faces constraints and limited agency. Responses were rather split, with many highlighting the risks of greenwash and confusion. Overall, there is broad consensus that only genuine constraints should be acknowledged.

The FAQs, therefore, propose to acknowledge net zero in progress in two situations: buildings not able to meet the energy use and/or fossil fuel criteria because of a forced connection to a heat network, if that network has a decarbonisation plan; and existing buildings not meeting the energy use targets, but with a retrofit plan in place.

The WLCN LETI definitions provide principles, but it is difficult to cover, in a succinct and clear way, the range of situations a building and its energy supplies may face in practice. CIBSE has been working with LETI to produce a set of FAQs on the definitions, to support clients and project teams, and bring consistency to how definitions are applied.

We produced a draft of the FAQs and asked for feedback in a survey in November, receiving around 200 responses across disciplines.

The 27 FAQs will be launched online on 7 April, and cover operational carbon from energy and water use, embodied carbon (upfront and life cycle), offsets, net zero claims, and more detailed points, such as how to calculate residual , or upstream, emissions. They will be available from the LETI website **www.leti.london** and from the CIBSE Net Zero guidance page **bit.ly/CJApr22JG5**

These FAQs are not final, and CIBSE and LETI are continuing to work together, and with others, to develop further guidance. Key areas of work are:

- The approach to energy targets in buildings connected to district heating schemes
- Energy use targets in a broad range of sectors (beyond offices, schools and homes)
- Embodied carbon targets (beyond offices, schools and homes), starting with upfront carbon
- The evolution of the definitions in the future for example, whether and how to further encourage onsite renewables and demand management

Contact Clara Bagenal George **clara@leti.london** or Julie Godefroy **jgodefroy@cibse.org** to get involved. To watch the launch, register at **bit.ly/CJApr22JG4**.

DR JULIE GODEFROY
is head of sustainability at CIBSE

KEY PRINCIPLES

1 The incorporation of energy use and embodied carbon targets in the net zero definitions, to promote efficient use of resources regardless of low carbon supplies
2 No fossil-fuel combustion
3 Renewable generation and procurement, prioritising onsite generation. For offsite procurement, the FAQs refer to the UKGBC guidance on options such as power purchase agreements (PPAs) and green tariffs
4 Offsets to be used only where necessary – in particular, to cover unavoidable embodied carbon emissions (once the targets are met) – and if robust. The FAQs refer to guidance from the UKGBC for criteria including additionality and verification, and encourages gradual reliance on 'removal' offsets (for example, trees) rather than just reducing emissions elsewhere.

References:

1 Net Zero Carbon Buildings: A Framework Definition, UKGBC, **bit.ly/CJApr22JG1**
2 Net Zero 1-Pager, LETI, **bit.ly/CJApr22JG2**
3 Whole Life Carbon Network – LETI, **bit.ly/CJApr22JG3**

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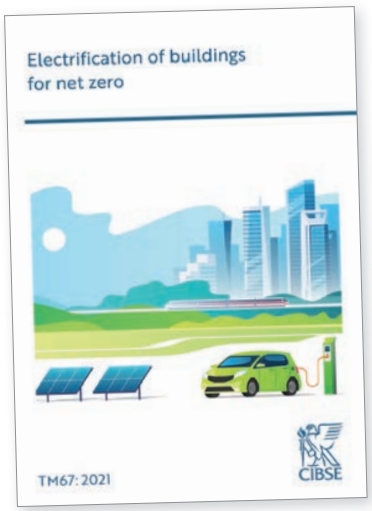
A YEAR OF INNOVATION AND SHEER HARD WORK

As CIBSE President Kevin Kelly nears the end of his 12 month term in office, he reflects on CIBSE s achievements and the positive response to the challenges of Covid 19

CIBSE President Kevin Kelly is approaching the end of his 12-month term in office



Electrification of buildings is a key area of net zero where CIBSE is taking the lead

My presidential year started with the Covid-19 pandemic still casting a nasty shadow over the world, and my presidential address was delivered at a virtual AGM in an environment of continued uncertainty.

Nearly all of us lost loved ones, friends, neighbours and colleagues to Covid-19. And yet what unbelievable resilience we have shown. This was certainly led by the medical research community, leading by example in every way.

In CIBSE some of our own work to produce leading-edge research, ventilation guidance for safer use of buildings and in quickly supporting our CIBSE community shone through for me.

CIBSE also worked very closely with the Royal Academy of Engineering to produce guidance for the UK Chief Scientific Advisor on Infection-Resilient Environments, work which caught the headlines in July 2021 and showed the key role of our profession in delivering safe and healthy environments, not just during a pandemic but in everyday life too.

Crucial guidance

This work demonstrated CIBSE's ability to provide high-quality guidance at a fast pace, delivering significant benefits to society, which is our ultimate objective as a professional body.

As CIBSE President, I have been overwhelmed by the enthusiasm, innovation, creativity and sheer hard work exhibited by all our volunteers, members and staff in adapting to the constraints imposed by the pandemic.

On the finance side, CIBSE started 2021 with a projected small deficit and we were able to turn this around to a significant surplus. This remarkable performance was in no small part because of the outstanding work of CIBSE's staff, directorate and our new CEO, Ruth Carter, who took up her role in May 2021. We must also not forget the hard work and commitment of our very many volunteers.

Voluntary work always factors very strongly in our performance. Regions, groups, Societies and committees across CIBSE have worked incredibly hard for all members, reducing their own local budgetary requirements and maintaining

CIBSE guidance on ventilation has been downloaded thousands of times

income where possible, while still holding a series of online CPD events and engaging with their communities.

In 2021, the regions organised more than 170 events, both online and in-person, with a combined total of more than 15,000 registrants. And we now have more than 200 CIBSE member volunteers on CIBSE regional committees.

We are keen to give members opportunity to serve the regions, groups and Societies and to encourage volunteers to come forward for the various committee roles, which in turn avoids people being expected to serve for too long.

Restrictions in travel have meant less networking and fewer opportunities to meet up. Inevitably, it meant that, as President, I have not been able to meet as many of you as I would have liked. Since the lifting of restrictions, I have got out a bit more to meet you and there will be more opportunities for me in my year as past president to meet even more of you.

Our training department has continued to develop our online training programme, offering more courses remotely – an essential workstream both for our budgets, and to meet our members' training needs. CIBSE Training launched five new courses in 2021 – all of which sold out – and hosted more than 1,500 learners.

#WeChampion webinars

CIBSE's webinar series also expanded, with the introduction of the #WeChampion webinars, which support the Building Performance Awards. These complemented the existing #GrowYourKnowledge fortnightly series, which in 2021 had more than 30,000 views.

Max Fordham triumphs at the CIBSE Building Performance Awards

> Since the lifting of restrictions, I have got out a bit more to meet you and there will be more opportunities for me in my year as past president to meet more

Our membership and reach have continued to grow, with more than 20,000 members from 96 countries. Over the past year, the membership department has recruited and trained 24 new membership interviewers to help support and process the membership demand.

Our reach is far wider than just our membership. Our website has had 3.5 million page views in the past year from 192 countries, and we have more than 85,000 followers across our social media channels. This global reach is essential to the work we do in sharing knowledge and improving the performance of buildings to mitigate the effects of climate change, and provide buildings that are safer, healthier and more sustainable for all.

The CIBSE staff have also seen change over the past year with a number of new appointments, most notably Ruth Carter as chief executive. Her extensive experience in managing complex organisations, together with her passion and enthusiasm, offers CIBSE a bright future as a modern, inclusive, professional engineering institution.

We also welcome new directors Simon Festing and Simon Parker. Stephen Matthews, Rowan Crowley and Stuart Brown all retired, and I extend to them all our grateful thanks for their work and best wishes for the future.

Diversity in nominations

One of the main themes of my presidential address was diversity and inclusion, and so I was delighted to see the progress made in attracting a wider range of candidate nominations for our 2022 Board and Council.

A new methodology for the nominations process was set up in 2021 to attract a wider range of candidates, improve transparency, and increase the focus on diversity and inclusion. The outcome resulted in a high number of candidate applications and ensured we could address mandatory quotas, such as representing the full breadth of our industry, and this also ensured a broader, more diverse range of representation from across our industry.

A non-mandatory quota system was introduced for the selection process, which included a maximum of 60% of nominations from one gender and having at least 20% from ethnic minority groups. Through an awareness campaign and by encouraging individuals directly, the panel achieved this, with 23 members being put forward as potential candidates for 2022.

The system will be developed further in future years, with lessons learned from minor mistakes made, to further refine and enhance the process. I would encourage all regions, Societies and groups to consider putting forward their high-performing members for Council and/or Board. This would help us identify talent and contribute further to a fully inclusive CIBSE Board and Council representing all CIBSE communities.

CIBSE technical and knowledge departments have also been incredibly busy. The demands of the pandemic created a fast-changing environment requiring digital delivery and creation of knowledge and guidance. The growing pace of technical and regulatory change in response to climate change and the building safety agenda is also driving further development of new guidance and updating of existing CIBSE guidance.

CIBSE continued to update its guidance on ventilation in buildings and on the wider considerations required to open buildings after a period of closure. The ventilation guidance is now in its fifth »

» edition and includes recommendations on the considerations applicable to the use of air cleaners. Collectively, CIBSE Covid-19 guidance has now had more than 112,000 downloads worldwide.

CIBSE also developed new digital tools in the form of an embodied carbon calculator for building services products, based on the methodology detailed in *TM65 Embodied carbon in building services: A calculation methodology*, and a circular economy tool for lighting products with the SLL, based on *TM66 Creating a circular economy in the lighting industry*.

Building safety, competence and fire-safety engineering continued to be major focuses for the technical team, with CIBSE actively communicating the scale of the changes the government is looking to drive through with the Building Safety Bill, and contributing to the development of information management standards that will support the Golden Thread and enable better working practices across the industry.

Climate change mitigation

2021 also saw the United Nations Climate Change Conference (COP26) hosted in Glasgow and with it a focus on the net zero carbon agenda. During the year CIBSE produced guidance on several aspects of decarbonisation of buildings, looking at heat pumps and electrification of buildings, as well as heat networks.

CIBSE has also continued its established record of engagement on climate change mitigation and adaptation and has continued to collaborate with a number of organisations on climate change guidance and policy. In 2021 the Institution contributed to the development of the CIC climate action plan to which CIBSE, along with nearly 40 organisations, signed up in June 2021 and which was presented at COP26. It contains significant commitments for all institutions, and CIBSE has published its own implementation proposals for the plan.

CIBSE has a huge amount of knowledge and expertise to share and the Technical Symposium is another outlet for information exchange. In 2021 the two-day event, held online, brought together more than 60 speakers, sharing high-quality technical research on aspects of building performance. It was a hugely valuable and inspiring event.

Another inspirational event, and one of my highlights of the past year, was the CIBSE Young Engineers Awards. These awards play a central role in promoting new talent and I was delighted to see the extension of the Apprentice of the Year in this, its second year, from a single award to two categories – for Technician and Degree apprentices – allowing for greater recognition for this key route into our industry.

Stephen Lisk (second from right) receives his CIBSE Gold Medal with (from left): Kevin Kelly, Ruth Carter, Olu Babalola and Stuart MacPherson

Another inspirational event, and one of my highlights, was the CIBSE Young Engineer Awards. These awards play a central role in promoting new talent

These awards continue to demonstrate the high standards our emerging engineers set themselves and provide valuable role models for others entering the industry, and it was great to see such a diverse group of talented finalists. Their hard work and dedication reassures us that the future of our industry is in safe hands.

But it's not just our new talent that we have cause to celebrate. In February I was honoured to host the President's Awards Dinner, together with past president Stuart MacPherson. There were 12 CIBSE medals awarded among a number of other awards.

Gold, Silver and Bronze medals are awarded in recognition of outstanding service to the work of the Institution by volunteers, delivering CIBSE's objectives of serving society and benefiting the public.

These members have a long history with CIBSE and have shown an incredible commitment and passion to our industry, collectively mentoring and developing countless systems and engineers through their careers. I personally thank each and every one. Groups, Societies and regions should consider nominations each year for some of these awards, and information is on our website.

The flagship awards

And finally, I couldn't round up my year without special mention of the CIBSE Building Performance Awards – our flagship event – which took place, in person for the first time in two years, in February. This event was a celebration of our industry's achievements and a real showcase of innovation and ingenuity.

These projects, teams and individuals should all be immensely proud of the bar they have set for everyone else to rise to. My thanks also to Dame Jo De Silva who provided an inspiring speech on the night.

I am extremely grateful and truly humbled for the opportunity to have represented CIBSE as President over the last year. CIBSE staff, volunteers and members have shown incredible fortitude in achieving all that we have in the ongoing impact of the pandemic, and I wish to thank each of you.

I look forward to welcoming incoming President Kevin Mitchell at our AGM on 5 May and hope that as many of you as possible can join us at the event or online as we celebrate the beginning of CIBSE's 125th anniversary year. **CJ**

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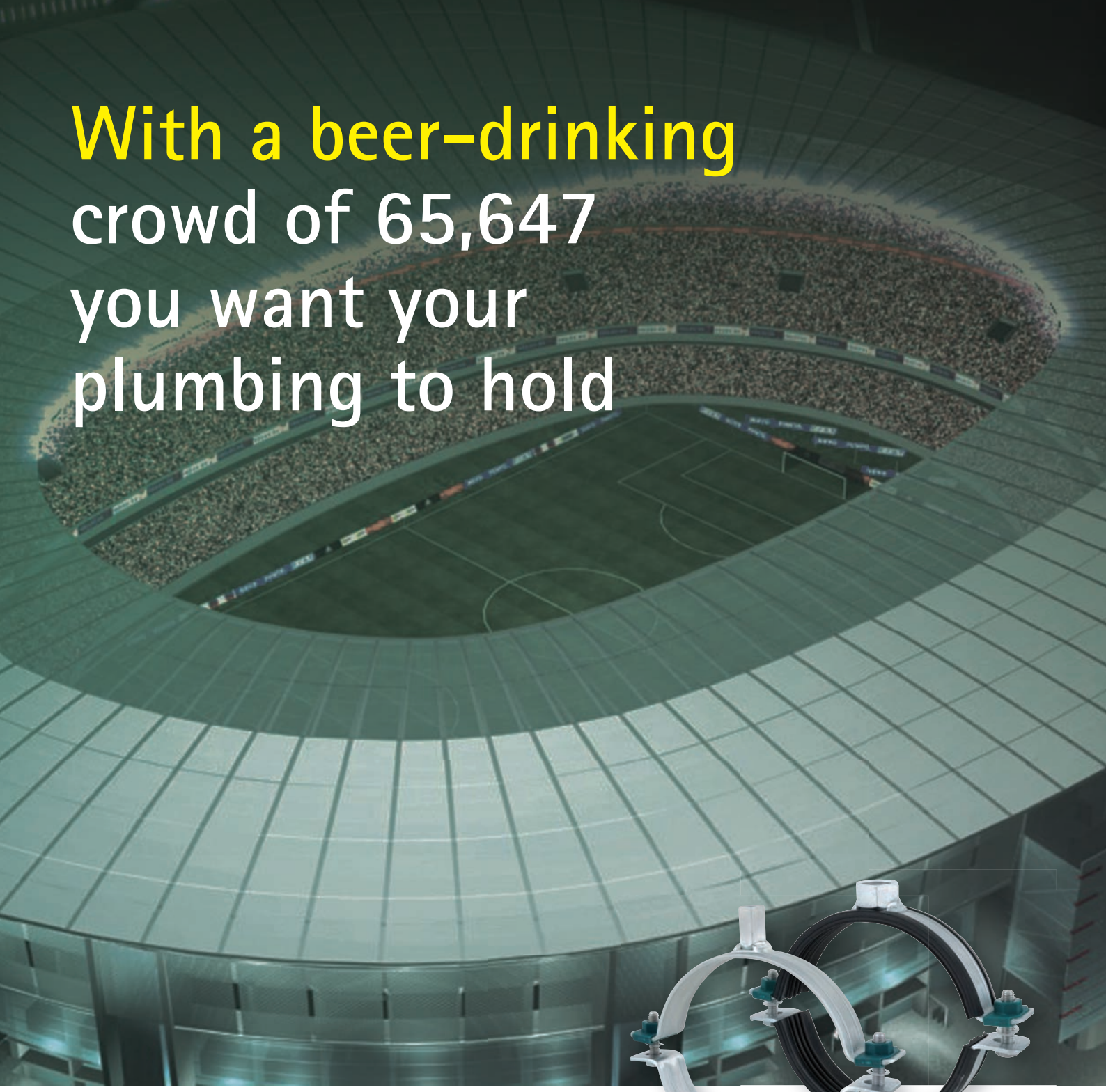

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ONE FOR THE ARCHIVES

Max Fordham s design for the library and study centre at St John s College, Oxford, is a worthy winner of the CIBSE Champion of Champions title. **Andy Pearson** looks at an all electric services design that provides comfort while targeting net zero emissions

St John s College, Oxford, was founded in 1555, but while it can look a long way back into its history, the design brief for its new library, study centre and archive building was only ever forward looking.

Ten years ago, the college asked designers to explore the options for a carbon neutral building that would impinge as lightly as possible on the environment and on the college s existing historic structures. The completed scheme, designed by engineers Max Fordham and Wright & Wright Architects, opened its doors in autumn 2019. A year later, energy measurements showed the scheme was close to achieving the college s carbon neutral aspirations, with measured carbon emissions of just 18 tonnes of CO_2 per year (11kgCO_2·m^2 per year).

The judges at this year s CIBSE Building Performance Awards recognised this achievement, with the scheme winning Project of the Year Public Use and the Champion of Champions award. Max Fordham was also named Building Performance Consultancy (51 300 employees) of the Year. The judges praised the St John s College scheme for its forward looking consideration of carbon neutral strategies before it had become common to do so .

In 2012, the concept of developing a carbon neutral building was so progressive that Max Fordham had to establish precisely what the college meant by carbon neutral before it started to develop the building services design. We helped to define carbon neutral, which in this context meant you could not offset the carbon emissions from this building outside of the St John s College campus, says Scott Rushford, principal engineer at Max Fordham.

The consultant s approach to targeting a carbon neutral solution was to develop a design based on maximising the use of passive measures, such as natural ventilation and daylighting, which it then combined with an all electric building services solution. At the outset, it was the passive measures that had to be addressed by the design team, because the building s form and window placement were constrained by its location. The library and study centre is discreetly located at the rear of the college president s garden, adjacent to a 17th century wall, to minimise its impact on historic quadrangles.

Behind its cream coloured Clipsham limestone exterior, the three storey building houses a reading room, with space for 120 students, a seminar and group study area, and a secure basement archive to house the college s precious manuscripts.

The reading rooms have views eastwards over the wall to the Great Lawn, while clerestory glazing and glazed rooflights provide views skywards, helping flood the space with natural light. There are no views to the west, over the president s garden, to preserve privacy; instead, the building s west elevation steps out in a series of overlapping planes that incorporate a sculpture by Susanna Heron.

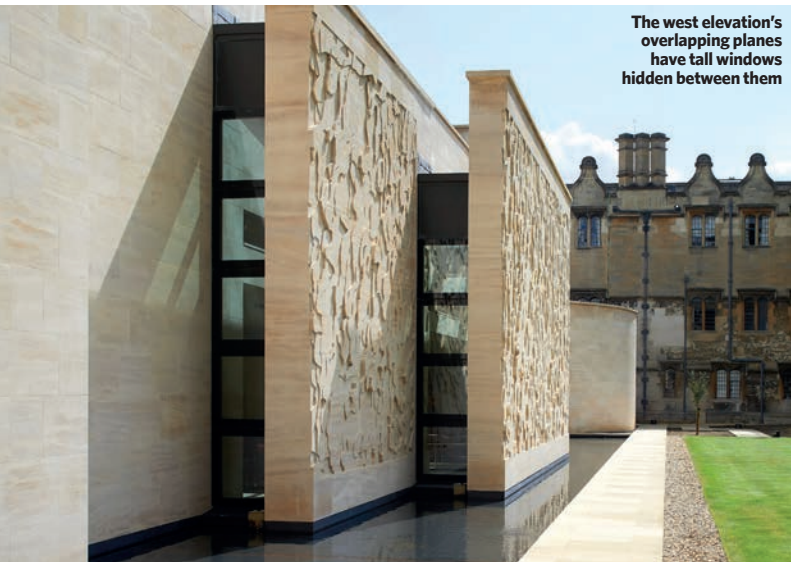
Tall windows hidden between the planes allow daylight to enter the reading room from the north and south, a feature exploited by the lighting design (see panel, Space to reflect).

As a low carbon building, you want good levels of daylight, so we worked with the architect to extend the walls outwards on the west fa ade to enable south and north facing glazing to be positioned behind the extended walls, explains Rushford.

Susanna Heron's sculpture on the west elevation overlooks the Great Lawn, beneath which are the GSHPs

PROJECT TEAM

M&E, acoustics and lighting design consultant: Max Fordham
Architect: Wright & Wright
Client: St John's College, University of Oxford
Structural engineer: Price & Myers
Quantity surveyor: Peter Gittens and Associates
Contractor: Stepnell
M&E contractor: Lowe & Oliver
BMS contractor: PA Collacott



The west elevation's overlapping planes have tall windows hidden between them

There are no views out to the west of the building, to preserve the privacy of the president's garden

Daylight modelling informed the provision of all windows, to ensure spaces benefit from natural light and that solar gains are controlled in summer to prevent overheating. The amount of glazing made sure we achieved a daylight factor of 4% to 5% in the main reading rooms, which means that lighting shouldn t be on during daytime, Rushford says. At night, a low energy lighting scheme provides low levels of background illumination triggered by movement sensors, which is enhanced by task lighting on desks.

Thermal modelling using CIBSE TM52 methodology and the CIBSE Design Summer Year established the appropriate glazing specification (g value) for each area without sacrificing thermal or visual comfort. The modelling also informed the extent of the ventilation openings.

The building s location and its linear, north south orientation meant the main reading space was effectively landlocked by the historic wall, making it harder to ventilate naturally. To overcome this, a large concrete plenum has been constructed beneath the ground floor. This runs the entire length of the building, and dampers at each end ensure it will function as an air intake whatever the wind direction.

From the plenum, outside air percolates upwards, through openings in the mezzanine floor, before exiting through the rooflights. Smaller spaces are ventilated by motorised openable windows. The only areas mechanically ventilated are the toilets and archive space, says Rushford.

The rate of ventilation to the main library spaces is controlled using a mix of windows and low level louvres, which open and close according to the internal conditions. The building management system (BMS) modulates these openings based on occupancy (CO_2 levels) and internal temperatures. Manual overrides are provided for the library staff, and smaller rooms with established occupancy have local manual controls.

The building also incorporates night time cooling. Concrete soffits have been left exposed to provide access to thermal mass to minimise overheating during periods of high solar gain. Windows and vents open at night, under control of the BMS, to allow outside air to flush the absorbed heat from the structure, recharging it ready for the following day.

In winter, heating coils fitted behind the reading room supply grilles to temper the air delivered by the plenum. Heat is provided by three ground source heat pumps (GSHPs) connected to a closed loop system of 30 »

The amount of glazing in the building means lighting should not be on during the day

In winter, space temperatures in the main library are kept between 19°C and 21°C

» boreholes, each 55m deep, sunk beneath the Great Lawn. (See panel, The Great Lawn s ground source heat pumps).

Unsurprisingly, the building s temperature and humidity are carefully monitored, with its temperature maintained between 12°C and 15°C. The space is fitted with mechanical ventilation and local dehumidifier units, but the space is largely passive in operation, without the need for intensive servicing. The only reason we d need to heat the space would be if the humidity increased at low temperatures, says Rushford.

The archive air supply does have a cooling system, as does a small IT server room. There is a fan coil fitted with a cooling coil (archive) and fan coil unit (server room) connected directly to the borehole array not via the heat pumps because the ground is roughly at the right temperature to cool the air if needed, says Rushford.

This solution has the additional benefit of slightly increasing the temperature of the borehole array and, thereby, the efficiency of the heat pumps when providing heating. In summer, when heat is not required, the warmed water is returned to the ground to help recharge ground temperature.

All domestic hot water is supplied by instantaneous electric hot water heaters.

Photovoltaic (PV) panels installed on the building s roof help meet the building s electrical demand although energy modelling at the project s outset confirmed that space on the roof for PVs was insufficient to meet the building s electrical needs.

At the early stages, we did quite a lot of hand calculations to see, very broadly, how much energy we expected it to use. Then, as we went through into more detailed design, we used CIBSE TM54 methodology to evaluate how much operational energy the building might use, which outlined a number of different scenarios, that impact what the consumption might be, says Tom McNeil, senior engineer and building performance leader at Max Fordham.

The on building PVs generate a maximum of 42kWp. The evaluation showed that, with the limited amount of PV that could be squeezed on to the roof, it was not going to achieve net zero carbon, McNeil explains. Nevertheless, since the building has started to be used by students, Max Fordham has been working to optimise its performance to minimise energy use.

The project specification drawn up by Max Fordham has helped »

THE GREAT LAWN'S GROUND SOURCE HEAT PUMPS

The college had concerns that changes to the ground temperature, caused by the borehole installation, could affect its historic lawn. In response, Max Fordham carried out an analysis to prove the array's impact on the ground temperature beneath the lawn would be negligible, now and in the future, once solar radiation absorbed by the lawn was factored into the energy balance.

As well as heat to temper the reading room's fresh air supply, the GSHPs provide all the space heating. In most areas, this is through an underfloor system enhanced by trench heaters in places with higher heat losses, which helps prevent downdraughts where the façade is glazed.

The heating is weather compensated. 'We've been tweaking it with the control specialist to make sure the water is hot enough in the winter to meet the heat demand – but, equally, we want to keep the temperature as low as possible to get the best GSHP efficiency,' says McNeil . 'Generally, the heating is maintained at around 40°C; it only needs to go above that when it gets very cold outside.'

The approach appears to be working: the first year of monitoring the heat pumps demonstrated a coefficient of performance of 3.6.

Heating is also supplied to the basement archive room, although Rushford says it has not yet been needed. The archive room contains the college's collection of rare books and manuscripts, including material from alumni of St John's such as Robert Graves and Philip Larkin.

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» in this task by incorporating elements of the BSRIA Soft Landings framework, including a commitment to aftercare and building optimisation, post handover. As a result, the college s facilities management team, the main contractor, the M&E contractor, and the BMS and controls engineer have worked together, with Max Fordham, to minimise its energy use. We worked collaboratively with the contractor s team, the facilities managers and librarians to optimise the building s performance throughout the first year, says McNeil.

Optimising the ventilation system, in particular, has been tricky because of Covid 19. This is partly because occupancy numbers have been lower than expected. The college acknowledged the impact of Covid on the process and retained the consultants for another year. Now, we should be able to get a better picture of how the ventilation system works when the library is closer to full capacity, says McNeil.

As part of the aftercare reviews, BMS data is scrutinised to understand how well the building is maintaining internal conditions. Outputs show the first floor spaces are significantly warmer than those on the ground floor because of higher solar gains and less thermal mass. That said, the temperature on the first floor has only gone above 28 C three times, so overheating does not appear to be a problem, says McNeil. In the ground floor reading room, the temperature has not risen above 24 C all summer.

In winter, space temperatures are maintained between 19 C and 21 C in the main library, which students have found acceptable. Feedback indicated that some other rooms were struggling to reach temperature set points in cold weather. In response, it was decided to increase the heating system weather compensation curve, to raise the set point of the buffer vessel, which would slightly increase the flow temperature of the circuit feeding the underfloor and trench heaters (which had been lowered to save energy). This was done gradually, because any increase in supply temperature will decrease the efficiency of the heat pumps. The rooms are now up to temperature and the increased flow temperature is in line with that of the original design.

Rooflights flood the reading rooms with natural light

SPACE TO REFLECT

The series of planes that form the building's west-facing wall feature sculptural stonework by artist Susanna Heron.

The addition of a water-filled pool beneath the façade enables light to be reflected upwards onto the carvings and into the reading room in a series of moving patterns, capturing the movement of the water.

The architect wanted to exploit this effect, so Max Fordham developed a 3D modelling technique to accurately predict the caustic reflection and refraction patterns from sunlight hitting the surface of the pool and from lighting submerged in the pool. The results were validated by testing at the artist's studio.

The controls have been centralised at the reception desk touchscreen. This allows the librarian to shut down the upper floors at quiet times to avoid heating and lighting spaces unnecessarily. We explained that, in order for the building to get near to carbon neutral, the college would have to consider some of these more intrusive measures, says McNeil.

In 2012, when Max Fordham designed this project, there were very few precedents for carbon neutral schemes; now, there are many more. So, if the Max Fordham team were to design the scheme today what would they do differently? If I was doing it now, I would go for insulated shutters on the glazed rooflights, so when it s dark and cold the shutters would close to further reduce heat losses, says Rushford. He would also investigate a mixed mode solution, which would save energy , but would also undoubtedly increase the complexity of the building and so may not be appropriate considering the additional embodied energy it would require.

The scheme s 2020 21 measured energy use intensity (EUI) of 65kWh·m^{2} per year shows that the building meets the RIBA 2020 and 2025 interim EUI targets, and comes close to the RIBA 2030 and London Energy Transformation Initiative target for schools a great achievement considering the building s servicing strategy was designed in 2013. CJ

Few precedents for carbon-neutral schemes existed when the building was designed in 2012

The latest update to the Building Regulations includes reference to a new CIBSE TM23 guide on airtightness testing. **Julie Godefroy** reviews the new TM, which includes a new approved air testing methodology, and considers the impact of the changes

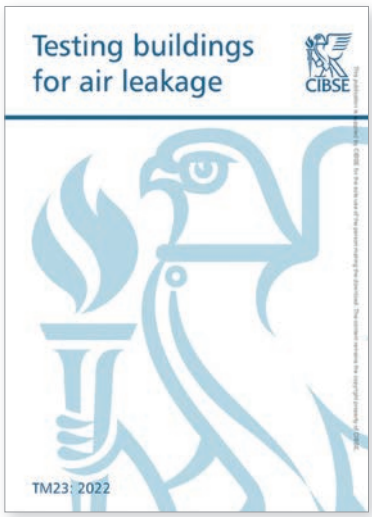
TIGHTENING UP

A substantial revision of TM23 *Testing buildings for air leakage* was published in January 2022, prompted by two important changes introduced in the update to Building Regulations in December 2021, which come into force on 15 June 2022.

The Approved Documents now refer to CIBSE TM23, rather than the Air Tightness Testing & Measurement Association (ATTMA) standards, as approved methodology for air leakage testing. A revision to TM23 was, therefore, needed to reflect the significant advances and standardisation in the fan pressurisation (blower door) method that have occurred since the original publication of TM23 in 2000.

A second testing method, the low pressure pulse (LPP, or Pulse) technique, is now approved by the Department for Levelling Up, Housing and Communities for testing new build homes, alongside the blower door technique.

These developments are part of a number of recent advances in building performance evaluation, which include the use of smart meters for estimates of heat transfer coefficients[1] and the new BS 40101 on in use building performance evaluation.



Left: The revised version of TM23, released in January

To improve the design and performance of buildings, it is essential that we carry out much more testing, says David Allinson, from the Building Energy Research Group, School of Architecture, Building and Civil Engineering at Loughborough University, who is one of the peer reviewers of the TM. Measuring air leakage is one important and cost effective approach. So, it is fantastic to see CIBSE providing updated guidance in this fast moving and exciting area of research and innovation.

Testing techniques

The fan pressurisation technique, developed in the 1980s and used throughout the world, uses a fan (or series of fans) to pressurise or depressurise a building; the air leakage rate is derived at a reference pressure, which is 50Pa in the UK.

There are a number of standards available to cover the technique and associated calibration requirements, and a reasonable track record on repeatability of results.

As the building is under (de)pressure conditions, it is possible to carry out leak finding during the test for example, using smoke pens. The reference pressure of 50Pa is higher than buildings experience in normal conditions and, as such, the technique is viewed as a stress test .

Consequently, there has long been interest in developing a test that would be more representative of the pressure conditions usually experienced in buildings. While tracer gas methods directly measure

DEFINITIONS

Infiltration is used to refer to air movement through the envelope under normal conditions.
Air leakage is used to refer to air movement through the envelope under a pressure differential. It is expressed as air leakage rate at a reference pressure, either as air change rate or air permeability.

Left: The airtightness of new-build homes can now be tested using either the blower door or low-pressure pulse technique

Figure 1: (left) Fan pressurisation equipment typically used in individual dwellings and small buildings for blower door tests, and (right) a multi-fan installation that can be used for large buildings (courtesy of BSRIA)

Figure 2: Pulse 2.0 system – compressor on the left-hand side, air receiver in the middle, controller on the right-hand side (courtesy of Build Test Solutions)

infiltration, they are specialised and time consuming, and results are heavily affected by conditions at the time. It means tests need to be repeated to give a good representation of building performance.

The LPP technique looks to address this. It works by releasing a short burst of pressurised air (a pulse) and measuring the pressure response of the building. It derives the air leakage rate using similar principles to the fan pressurisation technique, but over a very short space of time (a few seconds) and a narrower and lower pressure range, with a reference pressure of 4Pa. While still not normal conditions, this is much closer to those usually experienced in buildings.

The LPP method is patented by the University of Nottingham, which has developed the Pulse technology in partnership with manufacturer Build Test Solutions (BTS). It is recent with the main field trials carried out in 2016 18 and, overall, the results were obtained from a relatively small sample of homes, and under relatively narrow testing conditions.

By the nature of R&D, the majority of the reported studies were undertaken with earlier iterations of the system (that is, testing equipment and/or software). While Building Regulations allow the technique for all new homes, TM23 recommends caution when using it on homes targeting very airtight levels, because of more limited evidence in that range.

Because of the lack of standards covering the LPP procedure and equipment calibration, TM23 recommends that, for regulatory purposes, calibration should be done against a master device, and not by the tester or their organisation, to provide a degree of independence. This is an important area, where requirements may evolve as the technique matures to become increasingly similar to those applied to the fan pressurisation method. See panel, TM23 procedure recommendations , on page 28.

Use in SAP

As well as being a performance metric in itself, the air leakage test result is used in the UK in energy calculations, including Building Regulations Part L. For homes, this is done using the divide by 20 rule , to derive the infiltration rate from the air permeability at 50Pa.

The rule was initially based on air change rate, not air permeability, so using it with air permeability assumes a volume to envelope area ratio of 1. This could be addressed relatively simply in SAP by taking account of the building envelope and volume, rather than using a blanket ratio.

The reliability of the rule has been questioned in academic research for a number of years, however, and it is a source of uncertainty for energy use and infiltration, and, in turn, ventilation.

Following the government s approval of the LPP, a conversion formula has been developed by BRE with BTS, so that air permeability results obtained at 4Pa can be converted into estimated results at 50Pa for use in SAP. The formula is based on analysis and correlation of a large number (293,000) of blower door tests, and a more limited number of tests obtained at both pressures on the same buildings. While the conversion is »

» understood to be within the margin of error of each testing method, it introduces another level of uncertainty into SAP calculations, in addition to the divide by 20 rule. It is hoped that both these aspects will be examined for SAP11 and the Future Homes Standard.

As the industry will now be communicating air leakage values at two different reference pressures, it will be important when reporting results to be clear about the reference pressure to which they relate, and whether they were obtained directly from a test at that pressure, or by correlation from a test at the other pressure. For example, tested air permeability at 50Pa obtained by fan pressurisation test, or estimated air permeability at 50Pa obtained from a test result at 4Pa and the SAP conversion formula (the latter is not actually a test result at 50Pa).

What next, and what can you do?

An important source of uncertainty is not the techniques themselves, but what happens on the ground for instance, measurements, building preparation, departure from recommendations (whether intentional or not), and so on.

The Competent Persons Scheme (CPS) can help address this. The TM provides a framework methodology for consistency in testing procedures and how test results are reported, but it does not go to the level of detail of industry resources such as the ATTMA suite of documents. It is expected that the CPS will revise its resources to align with the new TM, and CIBSE is open to collaborating with CPS.

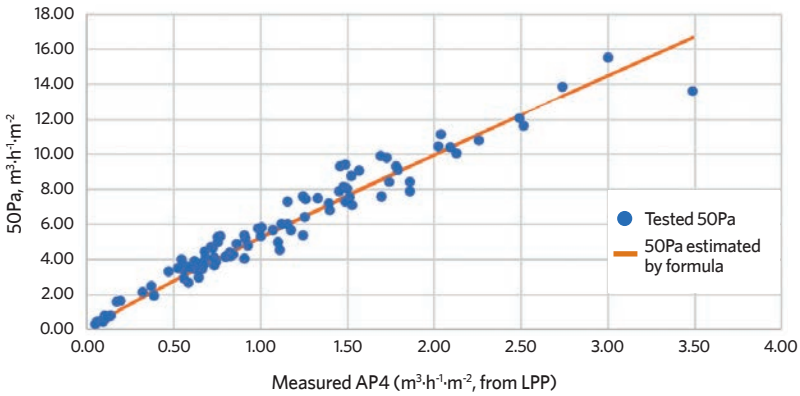


Figure 3: Tested 50Pa (by blower door test) plotted against tested 4Pa (by LPP), obtained during the BTS field trials (BTS, 2018); the orange line is the estimated 50Pa obtained by conversion from tested 4Pa using the formula to be used in SAP (figure courtesy of Build Test Solutions)

Martyn Reed, group managing director at Elmhurst Energy, says TM23 offers an opportunity for all airtightness testers to have a say in how tests should be performed. However, he believes the guide is just a starting point: In our view, the speed of publication has meant that some of the detail is lacking, and some of the previous assumptions needed to be tested, but we are delighted with the direction of travel.

This is an evolving field. TM23 includes a literature review on the current state of evidence, including for method issues such as accuracy, repeatability, and influence of outside conditions. This has informed the recommendations and points to areas where project teams may wish to go beyond minimum requirements, or where knowledge and practice may still evolve.

Testers and project teams are encouraged to contribute to the growing body of knowledge by sharing testing data with CIBSE, academia and the industry, especially in the following areas: feedback on TM procedures; test results obtained on the same building under both techniques; test results (under either technique) obtained on buildings where tracer gas methods to assess infiltration rate are also used. CJ

■ **CIBSE TM23** is free to members of the Competent Person Schemes, ATTMA and Elmhurst Energy Airtightness. Contact your scheme to obtain the download code. Watch the CIBSE TM23 launch video at **bit.ly/CJApr22JG1**

References:

1 Smart meter-enabled thermal efficiency ratings (SMETER) technologies project: technical evaluation, 27 January 2022, BEIS **bit.ly/CJApr22TM23**

TM23 PROCEDURE RECOMMENDATIONS

TM23 is based on ISO 9972:2015 and builds on best practice. As such, most recommendations will be familiar to testers. Points to note include:

- **Record wind conditions during the test; take photographic evidence of building preparation and the building's state of completeness**
- **Trickle vents can be closed, but should not be sealed**
- **With blower door tests, carrying out both pressurisation and depressurisation is not required for regulatory purposes, but is recommended whenever possible. The result is then the average of both. This provides a more complete picture of fabric behaviour, and can reduce the risk of errors because of outside wind, especially gusts. It is required when testing for Passivhaus.**

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Educational lighting CPD

A passive giant

The London School of Economics Marshall Building invites the public to the heart of the university via its spectacular Great Hall. Andy Pearson finds out how ChapmanBDSP used the concrete structure to deliver a passive first design that delivered natural ventilation in key areas

'The design adopts a fabric-first approach with passive design features to limit the demand on mechanical systems,' says Tom Williams, associate at ChapmanBDSP. He's talking about the Marshall Building, an 18,000m^2 development for the London School of Economics (LSE), for which optimisation of form and fabric have been instrumental in minimising energy use.

Designed by Grafton Architects, with ChapmanBDSP as MEP consultant, the Marshall Building's imposing Portland-stone façade faces onto Lincoln's Inn Fields. Its lower storeys are clad in ashlar blocks interspersed with large, punched window openings, and, above, two successive layers of angled fins form an orthogonal stone veil in front of the glazing. The side and rear elevations are more jumbled where they front the tight network of streets that make up the LSE estate.

ChapmanBDSP used daylight modelling and irradiation mapping to develop the façade design, to ensure access to natural light and fresh air. Its permanent solar shading is dimensioned to reduce solar gain and minimise summer overheating.

'The ideal scenario in terms of reducing operational energy is to design the building to limit the amount of mechanical services we put into a space, introducing them only where they are needed to perform a specific function that cannot be achieved through passive means,' Williams explains.

The building houses lecture theatres, informal study spaces, academic offices, public spaces, music rehearsal and arts spaces, squash courts, and a sports hall. These facilities are stacked vertically – the sports hall and squash courts in the basement, civic space on the ground floor, teaching spaces and lecture theatres on floors two and three, and research and departmental spaces on floors three to nine.

The most spectacular of the spaces is the expansive entrance hall. Here, giant concrete, tree-like structural columns support the concrete mass of the building above. One of the columns even disappears through a void in the ceiling, and a broad, curving concrete stair sweeps students up through a second void to the teaching spaces. This Grand Hall is naturally ventilated. At one point, it was intended to be an open piazza outside the building envelope, but as the design developed it became incorporated into the occupied space, Williams says.

High-level openings in the exposed façades that enclose three sides of the hall allow fresh air to enter the space. ChapmanBDSP's experience as engineers for the LSE's Centre Building, completed

in 2019 and almost entirely naturally ventilated, meant they were 'confident' in its application to the Grand Hall, says Williams. The designers were helped by the building's location in one of the quieter, less traffic-congested parts of London.

Actuators control the high-level openings based on temperature and CO_2 levels in the hall. 'It doesn't matter which direction the wind is from, only that there is a pressure difference between the façades,' says Williams. 'If the wind speed is high, the windows open less, or not at all.'

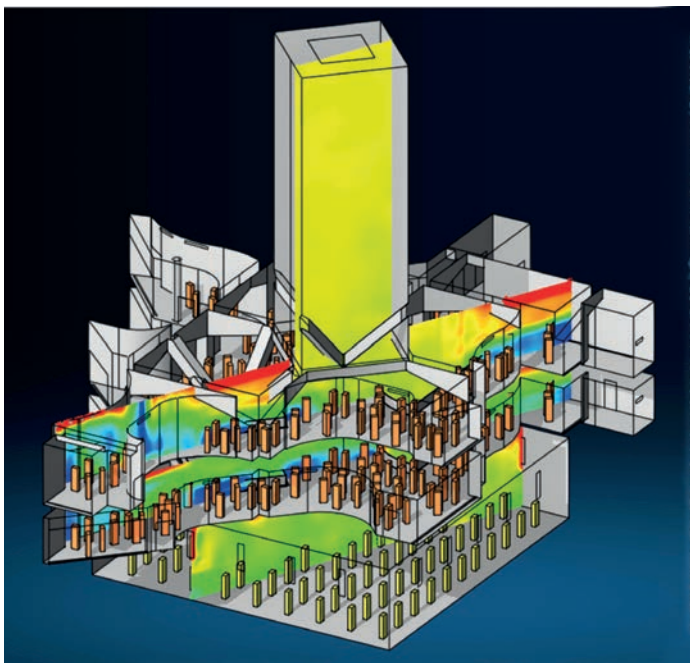
In summer, the large, low-level windows can be opened manually to further link the space to the outside.

Radiant heat from a low temperature hot water (LTHW) underfloor heating system allows the space to be used in winter. The density of the underfloor heating is increased in non-transient spaces, such as the reception and cafe, to provide additional heat, while fan-assisted LTHW trench heaters help prevent cold draughts.

From the Grand Hall, the sweeping staircase leads to the two teaching floors. Here, six Harvard-style, horseshoe-shaped lecture theatres – along with classrooms – are arranged around the floors' perimeter, providing views out; the spaces in between are occupied by informal seating. The lecture theatres, which seat up to 90 people, are served by a displacement ventilation system. 'These spaces are so densely occupied that conditioning the fresh air supply is sufficient to heat and cool the space without the need for a secondary system,' explains Williams.

Fresh air is supplied to the void beneath the stepped, raked seating, from where it can permeate upwards through vents in the stair risers. 'The architect was a driving factor behind the servicing strategy adopted for this building because Grafton's style is bare, exposed concrete, without the services on display,' Williams says. 'The fact that you cannot see the mechanical services was one of the reasons behind the choice of displacement ventilation for these spaces.'

Variable air volume (VAV) units in the underseat void regulate the air entering each theatre. The VAVs are supplied with fresh air through low-level ductwork in the floor void, supplied from one of two roof-mounted air handling units (AHUs). Air returns through open ductwork at high level, concealed behind acoustic baffles. The ducts then drop to low level to be routed back to the main riser concealed in the floor void.

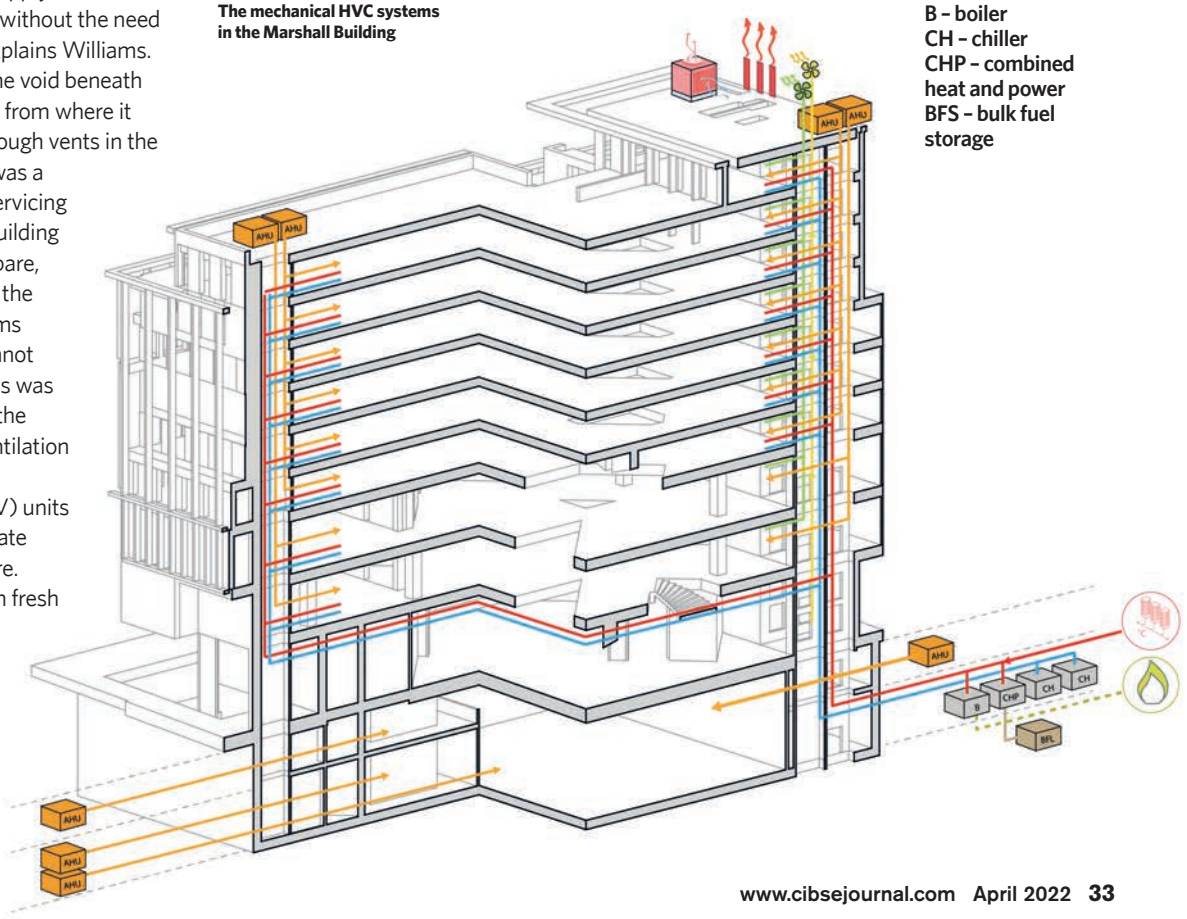


CFD analysis model with vertical section, showing temperature distribution

From a comfort perspective, displacement ventilation works best when the supply air temperature is close to ambient temperature, to prevent the feeling of cold draughts at the students' feet. The system is controlled to prioritise fresh air supply. In summer, if the VAV damper is fully open and more cooling is needed, the AHUs will decrease the supply temperature 1°C at a time, until it can meet the cooling demand.

Common spaces on the teaching floors are also conditioned using a displacement system, with the air load split evenly between the two roof-mounted AHUs. Computational fluid dynamics (CFD) modelling was used to validate the »

The mechanical HVC systems in the Marshall Building



B – boiler
CH – chiller
CHP – combined heat and power
BFS – bulk fuel storage

» heat-gain calculations for the displacement system (see panel, 'CFD modelling').

Floors three to nine are occupied by departmental and academic staff, housed mostly in cellular and group office spaces. These floors are sparsely populated in summer, so incorporate minimal cooling. AHUs located on roof levels 9 and 10 supply tempered fresh air to these floors via vertical risers and ducts hidden in the floor voids. In the group offices, the fresh air supply terminates at the rear of a four-pipe fan coil unit (FCU), also concealed in the floor void, to heat or cool the spaces. PIR sensors turn off the FCUs when spaces are unoccupied. Vitiated air is removed via an extract duct concealed in the floor void, which is linked to the AHU via the extract riser.

Concealing almost all of the services in the floor void was a challenge, made more difficult by the void also having to contain cabling and wiring serving the concrete soffit-mounted services on the floor below. Services such as power to lighting and fire alarm cabling are sleeved through the slab to connect into the rear of the exposed soffit-mounted fixings. 'In Revit, we had to coordinate the services while interfacing with the structural solution and the demands of the architecture,' recalls Williams.

A benefit of having so much exposed concrete is being able to exploit its thermal mass. 'A lot of systems run with a night-purge function to use the thermal mass to its fullest to absorb heat during the day and then flush it out at night,' Williams explains.

The roof-mounted AHUs also provide ducted tempered fresh air to the cellular offices. Ducts terminate at passive trench-heating units where, in winter, the LTHW coil provides heat to the offices. Thermal comfort in these spaces mid-season and in summer is from occupants opening the windows.

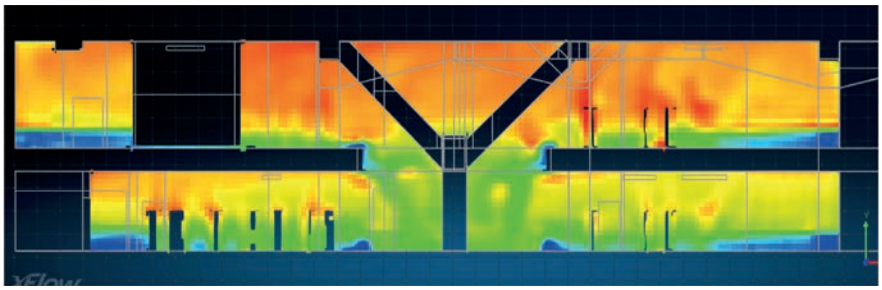
The rooms have been tested, using CIBSE TM52, to ensure they will not overheat. In response to climate change, or after a change in use, FCUs can be added to floor voids in the cellular spaces for more cooling. The main water-cooled chiller plant is in the basement, with adiabatic heat rejection on the roof. The chiller has been designed to accommodate this potential additional load, based on average occupant density across the floor being one person per 8m^2.

Heat is provided by gas boilers in the basement plantroom. When ChapmanBDSP first conceived the system, it included a bio-fuelled combined heat and power (CHP) engine. However, after a number of iterations and value engineering, the CHP option was scrapped in favour of standalone gas boilers. 'If the project were designed today, the central energy strategy would reflect an all-electric approach with the use of heat pumps to maximise the benefit of low carbon electricity," says Williams.

The basement is also home to a 20m x 35m x 7.5m-high sports hall, two squash courts, a gym, and music rehearsal facilities. A VAV system from a dedicated AHU serves the sports hall and squash courts, with a second AHU serving the remaining spaces. 'Because of the size of the sports hall, and the amount of fresh air we are putting into it, the ventilation can also be used to heat and cool the space,' Williams explains.

A unique feature is a special button on the BMS that enables the sports hall's ventilation system to be turned off. This ensures compliance with a Sports England requirement that elite-level badminton courts do not have forced air movement, as it might affect the flight of the shuttlecock. It is probably the one passive design feature that ChapmanBDSP failed to anticipate. **CJ**

CFD MODELLING



Section showing temperature distribution across floors

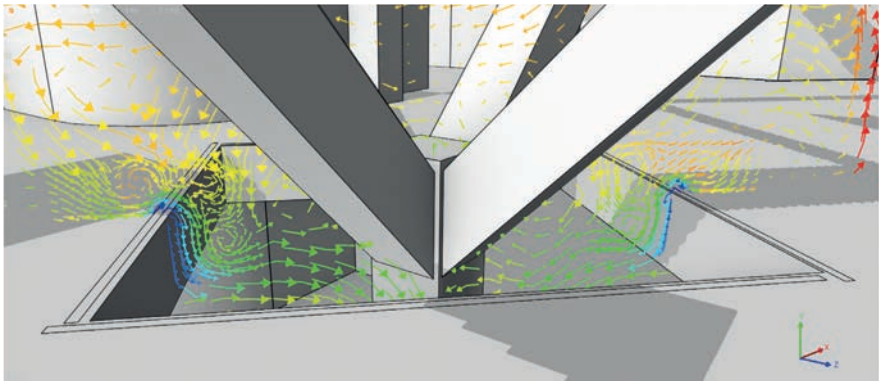


Image showing air flows at a section through a square void on Level 2

CFD modelling was used to validate ChapmanBDSP's heat-gain calculations for the displacement system. These assume that some heat gains do not fully impact the occupied space directly, such as heat gains from lighting. 'A proportion of the heat gain from the lights influences the occupied zone, but a lot of heat is almost instantly extracted from the space at high level,' explains Williams. This approach enabled ChapmanBDSP to apply weighting factors to the different heat gains within a space, to refine the amount of air provided by the displacement system.

ChapmanBDSP also used CFD modelling to assess how much air would drop through the two open voids in the teaching floors to the Grand Hall below. 'The teaching spaces are served by displacement ventilation, while the entrance hall is served by natural ventilation. We're interested in the temperature transfer between the two spaces,' says Williams. Modelling showed that, if the vents are open on the ground floor, there is a rush of air down and out of the building. If the vents are closed, the relatively cool air from the first and second floors, at approximately 19°C, sinks down through the voids, depriving the first and second floor occupants of the benefit of cooling. 'As a result of the CFD modelling, we implemented 750mm-high upstands around the openings to contain the cooled air,' Williams says.

One of the giant, tree-like columns in the Grand Hall

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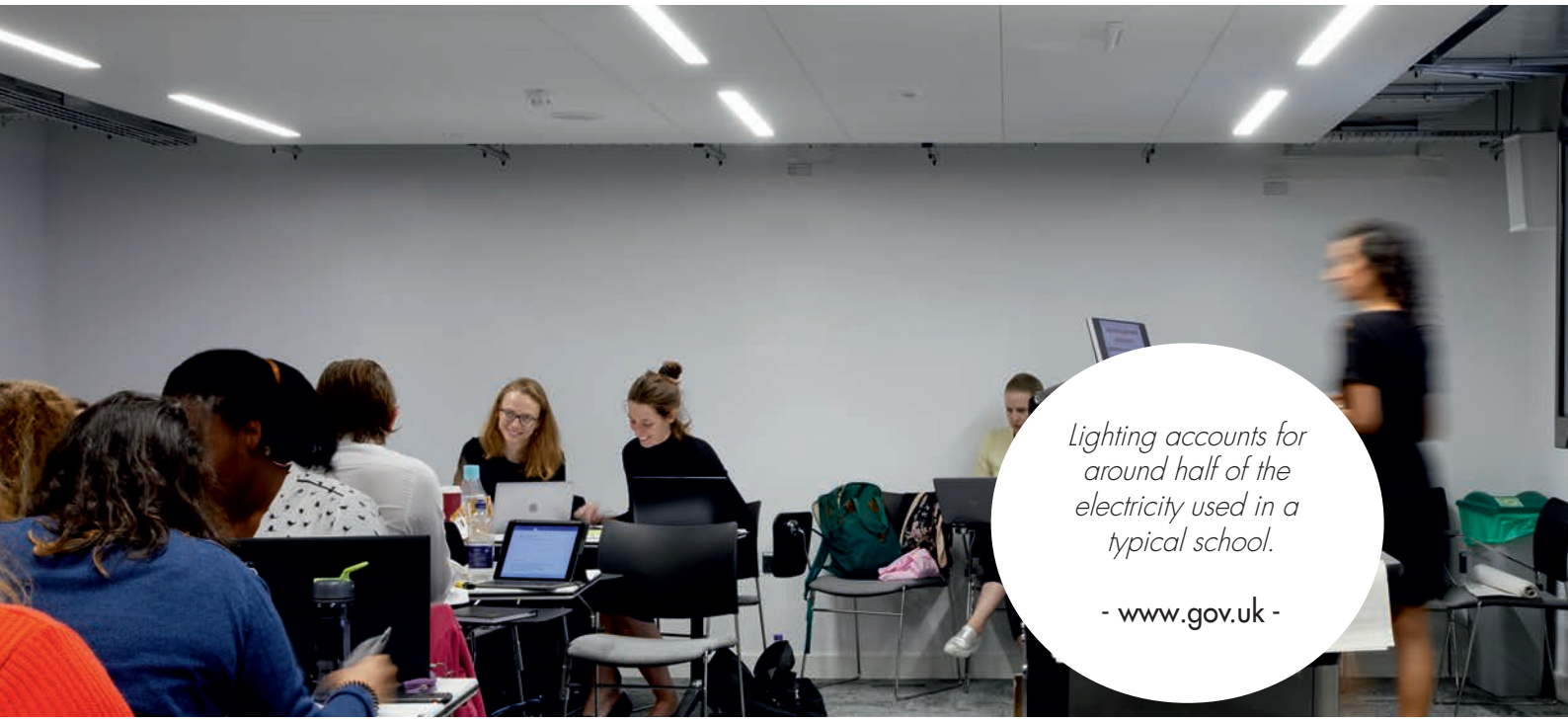

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The dash from gas

With the need to switch from fossil fuels to renewables becoming ever more pressing, one heat pump retrofit schools project in Yorkshire could be the example to follow. Phil Lattimore looks at the project funded by the government s Public Sector Decarbonisation Scheme

Even before the war in Ukraine's impact on future gas prices, steep increases in energy costs were highlighting the urgent need for many organisations in the private and public sectors to reduce energy consumption, which, of course, goes hand in hand with reducing carbon emissions. A government initiative – the Public Sector Decarbonisation Scheme (PSDS) – offers the opportunity for organisations to get grant funding for heat decarbonisation and energy efficiency measures.

A £5m PSDS-funded project at the Abbey Multi Academy Trust (Abbey MAT), in Yorkshire – to replace existing gas boilers in five schools with a heat pump-based system – is an example that other education providers may be keen to follow. Installed over the summer holidays in 2021, the new system has eliminated the trust's reliance on gas for space heating and hot water, and aims to reduce its carbon emissions by an estimated 9,000 tonnes over the 12-year lifetime of the scheme, saving an estimated £84,000 a year in energy costs.

The project involved the installation of 38 CIAT AquaCIAT TD300 air source heat pumps in the five schools, as well as LED lighting to reduce electricity consumption and solar photovoltaic (PV) arrays, designed by services specialist Robert Whetham Associates, that partly power the heat pump system. During the summer, when the school is closed, electricity produced by the PVs feeds into the Grid, providing an income for Abbey MAT.

The trust aims to optimise system performance by adjusting flowrates and set points, to ensure comfortable indoor temperatures for students and staff throughout the day and over the year, as the seasons change.

One of the initial challenges for the project was the short timescale available to put together Abbey MAT's grant application to Salix Finance, the PSDS scheme administrator. It required detailed proposals for each school to be collated within a two-week period because of delays in the process, tendering, and the logistics involved in getting contractors on site to do the work during the summer holidays. The trust worked with decarbonisation specialist Energy Management Group (EMG) to prepare the application.

Another key challenge was assessing the requirements for upgrading existing radiators to take account of the lower water temperatures delivered by the heat pumps. Detailed surveys were carried out by BREng Hull, in collaboration with EMG and Toshiba Carrier distributor Cool Designs.

'We have done a lot of work on these type of projects, in terms of assessment and modelling classrooms, and that experience enabled us to meet the very tight timescale by applying our accumulated knowledge from those school projects to these buildings,' says BREng Hull director Rob Smelt.

The school buildings ranged in age from the 1960s through to 2006, and the audit took account of the type and size of existing heat emitters, glazing, building fabric, room orientation, insulation and occupancy levels.

'We had the details of recent fabric improvements, so we could evaluate room heat losses,' says Smelt. 'This enabled us to provide a rough estimate for tender purposes, based on what was in the room.'

The air source heat pump-based system connected largely to the school buildings' existing infrastructure, such as pipework,

Bishop Young C of E Academy, one of the Abbey MAT schools. The air source heat pumps can be seen in the bottom right of the picture

radiators, fan convectors and air handling units. 'The infrastructure didn't have to change to deliver the same energy to the room, because we were still working at the same 10-degree temperature drop,' says Smelt.

On the basis of the survey, however, around 50% of existing radiators were replaced with higher-capacity units or augmented with new units to achieve the required heating output.

Concentrating on improving the fabric to maintain classroom temperature wasn't deemed the most cost-effective or efficient solution, according to BREng. It may also have created additional overheating issues, according to Smelt. 'One of our thermal models proved that if you had a classroom with two outside walls, and it was double-glazed to a U-value of around 2.2-2.6, it has a gain of 1KW, even when it's -4°C outside,' he says. 'If you tighten up thermal efficiency too much, it would result in temperatures of 28°C-29°C, even in March.'

That situation would necessitate cooling the rooms via natural ventilation, with a subsequent waste of energy, says Smelt.

Load profile

In terms of the new heat pump systems' efficiency, the coefficient of performance (COP) at 7°C/6°C ambient temperature at 65°C flow/57°C return, was calculated at 2.7, while the seasonal COP (SCOP) was 3.29, based on the manufacturer's performance figures for full load.

Rather than using the SCOP figure, however, the team created a six-month profile for the period when the heating is used, which it felt would create a better result for the schools' requirements.

Specialist Andrew Gill, of Cool Designs, produced a run cost calculation based on average temperatures in the Leeds area for the past 10 years, focusing on the heating season. For these purposes, the team considered a simplified banded model that, for example, evaluated the duration of operation at 65°C flow temperature in winter, to pre-heat the buildings at low external temperatures; a transitional period for the initial hours of occupation; followed by the remainder of the day with a 50°C flow temperature (with the heating load part offset by internal gains). A similar exercise was applied across the remainder of the six months from October to April, to generate a load profile based on that part-load data at the different outdoor temperatures.

'We felt that, by doing it this way, we arrived at a better result than using a seasonal COP,' says Smelt. 'We always assess our schemes at extreme, as well as typical, conditions to ensure we factor in real-life operational requirements – such as defrosting in winter – so the specification provides the appropriate space heating and hot water when needed.'

Rather than using the SCOP figure, the team created a six month profile for the period when the heating is used

With different buildings across the five sites, various domestic hot water solutions have been implemented to suit each situation. One way directly employs a 65°C primary loop from the air source heat pumps being connected to the existing calorifier, while other methods include using a plate heat exchanger, linking the primary heated water to the calorifier or new cylinders with direct electric heaters.

The system is being fine-tuned to maintain 50°C-55°C temperatures, with legionella risk being monitored with the current planned preventive maintenance (PPM) at the taps. The PPM is not affected by the change to air source heat pumps, as regular automatic pasteurisation is implemented. Booster heaters on the hot water system are used to pasteurise stored water at night at 70°C two or three times a week, using 9kW electric heaters in the cylinders.

Fine-tuning of the systems at the converted schools has already begun. Each school is monitoring the performance of the system in terms of classroom thermal comfort, and adjusting individual systems by a few degrees as necessary.

The trust is developing an innovative school-wide heat map, produced using temperature data from new heat-sensitive fire alarm systems, with the idea of giving a real-time overview of actual conditions in each space across a school, so that set-points and flowrates from the heat pumps can be further optimised. Each school has either installed a new control panel with a building management system interface on each site or has adapted what was already there.

Smelt stresses the importance of the collaborative effort across disciplines that has enabled Abbey MAT to make the switch to a lower-carbon heating system. 'Lots of different people that have worked together on this – and, like most projects, if you collaborate with each other you get the best outcomes.' CJ

38 CIAT AquaCIAT TD300 air source heat pumps were installed in five schools

Environments for learning

As we look towards a sustainable future, what should schools and colleges be doing to improve energy efficiency and air quality in their buildings? We ask leading suppliers for their advice

Steve Simmonds, special projects engineer for Spirotech

Where is a good place to start to improve the energy efficiency of a school or university's heating system?

Testing the condition of the system fluid. This will point to the causes of issues such as erosion, corrosion and biological contamination, each of which can affect the efficiency and performance of the unit and lead to balancing issues, pump inefficiency, kettling, or poor circulation.

Good water-quality management within a properly set-up system will combat the conditions that cause these problems, and deliver greater efficiency, reduced maintenance and, ultimately, a longer system life. As the market moves towards more sustainable, energy-saving technologies and reducing carbon footprints, the quality of the fluid within heating and cooling systems becomes ever more important – in fact, it is the single most important 'component' of the system.

So, can it make a contribution towards net zero?

The focus on better heating has been highlighted in the government's School Rebuilding Programme, which seeks to transform 500 schools into 'modern energy-efficient buildings'. This includes replacing ageing systems with upgraded 'green' models, contributing to schools operating to carbon net zero.

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> The quality of the fluid within heating and cooling systems is the single most important component of the system

Spirotech offers two levels of system water testing

Edward Ballsdon, co-founder and managing director, Rensair

How do schools ensure they have adequate air quality in classrooms?

The Department of Health and Social Care references the World Health Organization's recommended air change rate of 10 litres of fresh air per second per person – but many schools are chronically under-ventilated and cannot achieve that level. With limited budgets, a complete overhaul of ventilation is usually an impossibility.

To bridge the gap where ventilation is poor, the UK Scientific Advisory Group for Emergencies (SAGE) committee advocates portable air purifiers, and recommends HEPA filtration and UVC light to capture and inactivate pathogens.

Its advice is to seek evidence of independent tests, and it warns that technologies using chemical reactions are unproven and could have harmful side effects. Air purifiers must be heavy duty, with a powered fan system to enable air cleaning throughout an entire space. Residential air purifiers will not serve as a substitute for a hospital-grade device.

Cost consciousness and indoor air quality are not mutually exclusive. The return on investment goes far beyond safeguarding health, with portable air purifiers being a fraction of the cost of an integrated HVAC system. Air purification units consume about the same power as a fridge freezer, (a few pence per day), and large energy savings (and carbon emissions) can be made from not having to heat fresh air intake. Ongoing savings can quickly offset the initial capital cost of air purifiers.

All things considered, HEPA/UVC air purifiers represent a practical solution: high-performance (min 99.97% efficacy), cost-effective (fraction of the cost of an HVAC system), multi-tasking (viruses, bacteria, allergens), and instant to install (simply plug and play). Job done. Visit **https://rensair.com/industries/education**

> Cost consciousness and indoor air quality are not mutually exclusive. The return on investment goes far beyond safeguarding health

Air purification units use just a few pence worth of power a day

Graeme Shaw, technical director UK and IE, Thorn Lighting

Is it right for schools to focus primarily on energy efficiency?

We live in a world obsessed with reducing energy. Given soaring electricity costs and government net zero/sustainability targets, it's no wonder planners/consultants and contractors design schools to just meet standards.

How important is quality of light?

Classrooms are designed to provide uniform light. A minimum illuminance of 300lux (0.6 uniformity, UGR19 and Ra80) is widely regarded as 'suitable' for general tasks – designed to fulfil the requirements of BS EN 12464-1: 2021.

Primary students spend more than 7,000 hours at school (by the end of Year 7), most of which are in a single classroom designed before the development of dynamic lighting and digital technologies, such as smart boards and tablets.

We understand that the sector is grossly underfunded and lighting is a quick win (it accounts for the greatest proportion of energy costs in schools). But good design, specification, management and controls – such as DALI – can have a significant impact on limiting electricity consumption, keeping running costs to a minimum while providing a nurturing environment.

It can't just be about meeting numbers (whether that's net zero, energy reduction or a lighting standard) – not when there is growing evidence that classrooms with dynamic, human-centric lighting capable of adapting to individuals' needs (where the teacher is in control of colour and intensity) improves student behaviour, concentration, engagement, health and results.

At Thorn, we believe the schools of 2030 need to offer an environment where children can learn. The focus moving forwards has to be on lighting for people and quality over energy efficiency.

> Good design, specification, management and controls such as DALI can have a significant impact on limiting electricity consumption

Schools of 2030 must offer an environment where pupils want to be

To optimise classroom indoor air quality, schools need to take a holistic approach to natural ventilation and air cleaning technology, argues CIBSE s **Chris Iddon**

Optimising ventilation in the post Covid classroom

There has been much clamour in recent months about the poor state of school ventilation and the need for investment in air cleaners for classrooms[1] – but is ventilation in schools poor?

Since the start of the pandemic, there has been growing recognition of the importance of virus carried in exhaled breath in the transmission of SARS-CoV-2.[2] Virus shed in the respiratory system of an infected individual become encapsulated in droplets of respiratory fluid.

These droplets have a continuum of sizes (and, therefore, volume of fluid) ranging from <1µm to 100µm-plus. Once exhaled, they can decrease in size because of evaporation, and the smallest droplets (sub 5µm) – often termed aerosols – can remain airborne for hours, building up in poorly ventilated indoor spaces.

Over time, the concentration of viable virus in the air of a room containing an infector will reach a steady state. The poorer the ventilation, the greater the steady-state concentration of virus in the air.

Are schools poorly ventilated?

The importance of ventilation in providing suitable air quality for comfort, concentration and health has long been understood. Before the early 20th century,[3] the only way to provide outside air was by natural means – exploiting the natural forces to encourage outside air in and exhausting contaminated air out. This principle has remained popular for UK classrooms and most schools have a natural ventilation strategy, although mechanical and mixed-mode ventilation are becoming more popular – especially in newer schools.

Most natural ventilation designs require the opening of a vent, usually a window, to provide a means of incoming and exhaust air. This can create issues with cold draughts in the winter and often – because of a lack of occupant understanding of the ventilation strategy – results in vents being kept shut. The resulting lack of ventilation leads to a build up of exhaled breath, bio-effluents, off-gassing pollutants from furnishings, and pathogens, leading to a less healthy environment, which has been shown to affect pupil concentration and cognitive ability.[4] Perhaps this has led to the notion that classrooms are poorly ventilated?

Before Covid-19, much research into school indoor air quality (IAQ) concluded that, in the main, poorly ventilated classrooms are the result of a lack of occupant interaction with the ventilation design strategy rather than a sub-optimal strategy.[5]

Often, classes noted as being poorly ventilated in winter are assessed as being well ventilated in summer, despite the design strategy remaining the same.[6] Indeed, if we are to say that most school classrooms are poorly ventilated, it would suggest that the many architects, engineers, contractors and building control personnel involved in the design and build of schools for more than a century have failed to consider this important aspect of building design.

As well as providing adequate IAQ, ventilation is often used to cool classrooms. Typically, the flowrates required to provide ventilative cooling are larger than the flowrates required for IAQ. As such, there should be the capacity within the ventilation design to provide adequate IAQ during the heating season.

How can we balance ventilation provision with occupant comfort? This is not

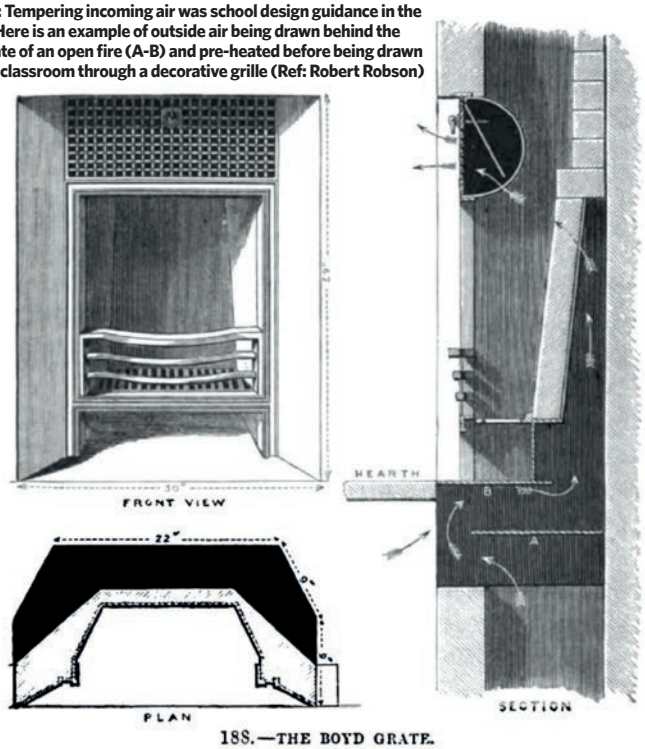
> Classes noted as poorly ventilated in winter are assessed as well ventilated in summer, despite the design strategy being the same

a new problem. See Figure 1 for a Victorian solution for tempering incoming air. Another strategy was pre-heating incoming air and using heat sources under windows, creating a plume of hot air that mixes with incoming, cooler outside air. However, this method resulted in heat escaping out of the window.

In recent decades, there has been a drive to improve the energy efficiency of classrooms, with more airtight rooms to prevent the continuous flow of outside air through cracks. In older classrooms, these adventitious draughts have provided some background ventilation, but in newer buildings, it has become even more important to get the ventilation design strategy right.

For more than a decade, guidance for new-build schools has requested that the supply of outside air be delivered in a way that does not result in draughts. In 2018, the school ventilation design guide BB 101[7] set out a non-statutory design framework for the delivery of outside air year round. This has led to several innovations for classroom ventilation that use heat generated in the classroom from occupants, lighting, computers, and so on to pre-warm incoming air – reducing the need for additional space heating while delivering comfortable ventilation.

Figure 1: Tempering incoming air was school design guidance in the 1870s. Here is an example of outside air being drawn behind the back plate of an open fire (A-B) and pre-heated before being drawn into the classroom through a decorative grille (Ref: Robert Robson)



As there are many thousands of school buildings in the UK, it is inevitable that there will be some poorly ventilated classrooms. These may have arisen because of modifications to spaces, changes of use, changes to ventilation provision – for example, the addition of window-opening restrictors – or systems in need of repair.

The provision of CO_2 monitors to schools should help them identify poorly ventilated classrooms and undertake remedial works to bring it up to standard. In those spaces where ventilation provision cannot be solved in the short term, consideration should be given to air cleaning technologies until an appropriate solution can be implemented (see CIBSE's *Air cleaning technologies*).

Future classroom design

Ventilation should not be considered in isolation. If we focus building design solutions on the health and wellbeing of occupants, we must consider all aspects of design, including energy efficiency, ventilation, lighting, and acoustics (see CIBSE *TM40 Health and wellbeing in building services*). The golden thread of design intent of the holistic design also needs to remain unbroken from concept through to construction completion.

The Department for Education's Building Bulletin design guides are useful. Where guidance is non-statutory, designers should ensure clients and building users understand the benefits of adhering to the guidance notes to produce the best indoor environments for the life of the building. Educating occupants about how to use their building to get optimal performance from these designs will remain a challenge. CJ

DR CHRIS IDDON MCIBSE is the chair of the CIBSE Natural Ventilation Group

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Learning, whether by discussion, interaction, practical application, or formal lecture, requires sufficient light of an appropriate quality. As highlighted in CIBSE SLL LG5,[1] whether a primary school classroom or a professional lecture theatre, used by the young or old, with differing visual abilities and needs, the quality of light in the learning environment will directly affect the learning experience and motivation to learn. If the occupants cannot, for example, see clearly what is being displayed, identify true colours, or read the facial expression and body language of others, then the learning experience will suffer.

Educational establishments encompass a wide variety of categories including nurseries, schools, universities, and colleges, as well as many other facilities that may be used for education in what are otherwise commercial and institutional locations. Buildings that would be considered as primarily educational in their function will include a multiplicity of areas that could include diverse use of spaces such as classrooms, lecture theatres, gyms, laboratories, workshops, offices, cafeterias, assembly halls and communication areas. In each of these areas, lighting is likely to play a different – but always important – role, serving a specific purpose depending on the tasks undertaken. In the UK, the Department for Education (DfE) publishes *Advice on standards for school premises for local authorities, proprietors, school leaders, school staff and governing bodies* that includes a brief summary of the key deliverables of a lighting design. Although this is specifically for school premises, the list is equally relevant to other centres of learning. In terms of the internal environment these are:

- Achieving adequate light levels, including the lighting of teachers' and pupils' faces for good visual communication
- Giving priority to daylight in all teaching spaces, circulation, staff offices and social areas
- Providing adequate views to the outside or into the distance to ensure visual comfort and help avoid eye strain
- Providing lighting controls that are easy to use
- Providing means to control daylight and sunlight, to avoid glare, excessive internal illuminance and summertime overheating
- Providing emergency lighting in areas accessible after dark.

The DfE document directs designers to the 2011 edition of CIBSE SLL *Lighting Guide 5: Lighting for education* (LG5) for detailed advice (LG5 is currently under review). LG5 advises that a holistic strategy will maximise benefits and reduce wasted resources with a 'whole building' design perspective, reaching beyond natural and electric lighting to include the effects on thermal loading, ventilation and acoustics. It proposes that six distinct aspects of lighting need to be considered: legal requirements; visual function; visual amenity; architectural integration; energy efficiency; and sustainability. These aspects may not have equal weight, and the creative design will require iterative processes that revisit factors as the design progresses to produce an integrative, and satisfactory, solution. The philosophy of holistic design is possibly even more important today than »

» it was when LG5 was published in 2011. The impact of the lit environment on productivity, health and wellbeing has become far more widely appreciated and understood, with commonplace, and popular, discussion of such things as circadian rhythms; light induced sleep deficiency; intrinsically photosensitive retinal ganglion cells (ipRGC); and seasonal affective disorder (SAD). Alongside the drivers of physiological and psychological factors, the volatile energy markets are raising end-user interest in lighting efficacy and control that has also increased focus on improving the integration and utilisation of daylight.

There have been many research projects in the education sector that have linked daylighting with increased achievement rates, health and attendance. One of the most recent[2] examples, by Baloch et al, provides some evidence that 20% of the variability in performance test results was the result of classroom characteristics associated with daylighting (this was based on observations of 2,670 schoolchildren, aged eight to 13 years from 155 classrooms in 53 schools across 12 European countries). Guidance for assessing the opportunities for daylighting are provided in the UK Education funding agency's publication *EFA daylight design guide – Departmental advice – version 2: January 2014*. This describes 'climate-based daylight modelling' (CBDM) that aims to provide a numerical approach to support good design, taking account of the quality and quantity of sunlight and daylight. The guide notes that 'real weather data are used to calculate lux levels and targets can be set which are relative to user needs. Also, the CBDM criteria sets a peak acceptable illuminance which reinforces the need to provide suitable glare control which modulates the light transmission rather than eliminating the light.' CBDM determines a 'useful daylight illuminance' (UDI) that was devised to ease the interpretation of climate-based simulation without sacrificing the detail of the output data. UDI indicates what proportion of the year illuminances on the working plane are within a range considered 'useful' by occupants (this methodology is briefly described in LG5). Unlike commonly employed methods, such as the daylight factor that assumes a simplification of an overcast sky for a specific time, CBDM necessarily requires a significant digital modelling capability.

Unlike many general-purpose buildings, educational facilities often cater for a majority of occupants from a particular age band – ranging from pre-school children all the way through to late learners – and so lighting levels may need to be changed, controlled, or adapted depending on who is using a specific area. For centres that deliver further and higher education, where there is likely to be a mix of learners, there may need to be an increase in light levels for older students. Approximately[3] 8% of UK higher education students are in their 50s and 60s. A recent review paper[4] by Kunduraci reports on various studies that have presented that the elderly suffer from reduced visual ability and contrast sensitivity, with loss of depth perception, and increased sensitivity to glare and diminished light-dark adaption. It is typically considered that three times the illuminance may be required for elderly learners to see fine details, such as when reading, using a keyboard, or discriminating between low contrast objects.

An example that considers younger learners is provided by Wessolowski[5] et al, who examined the effect of variable lighting on pupils' restlessness and behaviour. A variable lighting system employed seven lighting programmes that delivered different varieties of illuminance and colour temperature. In a controlled field study, including 110 pupils of various age levels and school types, and 11 teachers, the findings showed a significant decline in restlessness and aggressive behaviour and a tendency toward increased positive, social behaviour – indicating that variable lighting can play a part in optimising general conditions for school learning.

As an example of the metrics that are employed to define a suitable lit environment, Table 1 provides (in black text) general lighting requirements for a sample of educational spaces taken from BS EN 12464-1:2021,[6] which sets the standard for UK and European working spaces. Additionally, the table includes the requirements from the UK DfE School Output Specification Technical Annex 2E[7] (shown in green) that sets the technical requirements for the design and construction of schools.

Table 1 provides:
$\bar{E}_m$ (lx) is maintained illuminance, the minimum average illuminance of an installation on a reference surface related to the specified task (at the required viewing location/height).
$\bar{E}_m$ *required* is a normal minimum value for normal working conditions.
$\bar{E}_m$ *modified* provides an indicative higher level related to application factors as needed for specific tasks, surfaces or visual abilities. This may be varied through control.
U_o is uniformity of illuminance = minimum (derived) illuminance value/average illuminance value (increased values may be more appropriate for those with poorer vision).

Area as defined by BS EN 12464-1:2021	$\bar{E}_m$ (lx) SOS Technical Annex 2E for similar area	$\bar{E}_m$ (lx)		U_o	R_a	R_{UGL}	$\bar{E}_{m,z}$ (lx)	$\bar{E}_{m,\ wall}$ (lx)	$\bar{E}_{m,\ ceiling}$ (lx)
		Required	Modified				$U_o \geq 0.10$		
Classroom – general activities	300	500	1,000	0.60	80	19	150	150	100
Auditorium, lecture halls	300	500	750	0.60	80	19	150	150	50
Attending lecture in seating areas in auditoriums and lecture halls	300	200	300	0.60	80	19	75	75	50
Art rooms in art schools	300	750	1,000	0.70	90	19	150	150	100
Circulation areas	100	100	150	0.40	80	25	50	50	30

Table 1: A sample of lighting requirements for a selection of common spaces found in educational buildings (Source: BS EN 12464-1:2021 and School Output Specification (SOS) Technical Annex 2E: Daylight and Electric Lighting)

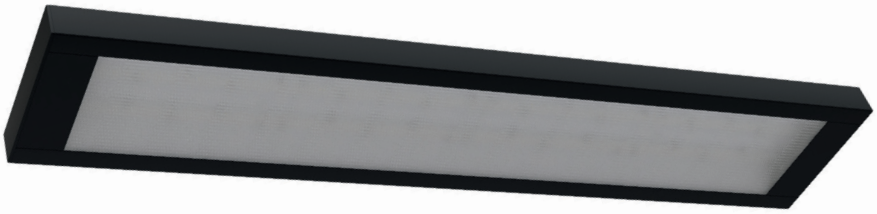

Figure 1: Example of luminaire with microprism diffuser (Source: Tamlite)

R_a is colour rendering index – measure of the ability to reproduce the colours faithfully (although this measure is not universally respected); maximum value of 100.
R_{UGL} is the limit value of CIE Unified Glare Rating (UGR); ranges from 40 (extremely high glare) to 5 (imperceptible glare) – glare being light that interferes with vision.
$\bar{E}_m z$ is maintained average cylindrical illuminance (minimum required for visual communication and recognition, particularly on people's faces) measured on a horizontal plane. BS EN 12464 sets a default height of the horizontal plane to be 1.2m above the floor for seated people and 1.6m for those standing. Technical Annex 2E includes more detailed guidance on horizontal task heights.

LG5 provides contextualised guidance for the lighting requirements for all the areas that are likely to be encountered in educational buildings, which can assist in providing granularity to basic standards data. So, for example, a particularly challenging area is the 'multi-purpose room' that may be primarily considered as an 'auditorium' for which there are two entries in Table 1 (auditoria) differentiated by the task that the space will be used for, with each one providing quite distinct design criteria. As with all interior lighting designs, the recommendation in LG5 is that the lighting designer must work with other professionals (and the client) to develop an internal environment to meet the needs of the expected use of the space. This is likely to be driven by a prioritised list of tasks and functions, which might present clear scenarios that can be accommodated by an appropriately selected, installed and controlled set of luminaires.

Although the values for $\bar{E}_m$ in BS EN 12464 might be considered as a minimum, this design parameter may be modified up or down in relation to the context of the application – this is graduated in steps[8] employing the sequence 100lx - 150lx - 200lx - 300lx - 500lx - 750lx – as a result of carrying out a risk assessment for the particular users, tasks, location and application. The UK DfE has not yet adopted the BS EN 12464 metrics and, without careful interpretation, inappropriate application of higher levels may over-light the majority of space users, potentially causing discomfort and increased energy use.

Directing light to where it is needed, rather than providing general illumination to a whole space, can reduce energy use while enhancing the lit environment. In an education setting, there will be a particular need to design the lighting and its control so that it is simple and clear for the target user, and so that the teacher/instructor/supervisor is able to maintain overall control (without resorting to repeated reference to a technical manual). The opportunity for such control has increased in recent years with the widespread development and adoption of LED lighting, which not only provides a more directional, lower energy light source but – owing to its 'solid-state' construction – has spawned a revolution in control techniques, accelerating the application of so-called 'smart' control. The high-intensity LED lamp has also increased the importance of appropriate luminaire optics in educational environments, so that the final lighting design is able to provide a comfortable, productive environment for students and staff. Through employing carefully selected diffusers, lighting systems can achieve the required illuminance levels and unified glare ratings (UGR) recommended by LG5. The impact that optical control can have on all occupants – students, staff and visitors – is significant, and when selected appropriately can reduce discomfort and distractions and improve wellbeing. For example, when establishing the performance requirements for luminaires and the associated diffusers, there will often be a dilemma between delivering the required lighting while maintaining appropriate levels of glare. As discussed in *CIBSE Journal* CPD module 176 (**www.cibsejournal.com/cpd/modules/2021-03-led/**), diffusers that incorporate microprisms – such as that illustrated in Figure 1 – are able to offer fine control of light output, directing it only to where it is needed. This ensures that the luminaire, in an appropriate lighting design, can achieve a suitable UGR in spaces such as open-plan teaching areas and multi-use applications. Students working on the other side of the room can look at that luminaire and not be adversely impacted by glare, as the light has been directed downwards.

Figure 2: Example of luminaires with built-in uplighter function (Source: Tamlite)

However, anyone directly below (or nearby) a fixture with a microprism diffuser may perceive a harsher light than somebody positioned below a more traditional opalescent (opal) diffuser.

An option is to combine an opal diffuser with a microprism. This attenuates the light before it passes through the microprism. This does impose a slight reduction in luminaire efficacy; however, it satisfies the most important element of the educational environment: the occupants.

The basis of a successful lighting design is to consult the client and, potentially, end user as early as possible, to understand how the educational space will be used, and to determine how best to provide a lit environment that meets the needs of those in the space. The technical decisions that deliver an appropriately integrated system that meets the specifications and standards – and accounts for advice from guides such as LG5 – can follow if the desired outcome has been properly defined and interpreted by employing the expertise of a lighting professional.

Turn to page 46 for further reading and references. »

Module 194

April 2022

1. Which of these areas is not noted as specifically covered in DfE s guidance document on lighting for schools?

- ☐ A Achieving adequate light levels
- ☐ B Adequate views to the outside or into the distance
- ☐ C Control daylight and sunlight
- ☐ D Equipping occupants with smart controls
- ☐ E Prioritising daylight in most spaces

2. What does CBDM particularly relate to in lighting?

- ☐ A Control protocol to ensure optimum use of daylight
- ☐ B Design assessment method suitable for simple manual calculations
- ☐ C Numerical modelling method taking account of sunlight and daylight
- ☐ D Provides statistical analysis of occupant spacing for lighting design
- ☐ E Quality assurance system that ensures installed system meets specification

3. What is the required basic maintained illuminance for circulation areas as tabulated by BS EN 12464 1:2021?

- ☐ A 100lx
- ☐ B 150lx
- ☐ C 200lx
- ☐ D 300lx
- ☐ E 500lx

4. What type of diffuser offers fine control of light output, directing it only to where it needs to be?

- ☐ A Glass
- ☐ B Microprism
- ☐ C Obscured
- ☐ D Opal
- ☐ E Upward

5. Which CIBSE SLL lighting guide is most appropriate for educational lighting?

- ☐ A LG 2
- ☐ B LG 5
- ☐ C LG 12
- ☐ D LG 13
- ☐ E LG 15

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Further reading:

CIBSE SLL Lighting Handbook (2018) provides excellent coverage of lighting design, technology and the application of light.

CIBSE SLL Lighting Guide 5: Lighting for education (2011) provides fully contextualised advice.

Sophie Parry provides an inciteful article on the interpretation of BS EN 12464-1:2021, *Work in Progress*, CIBSE SLL Light Lines Vol 14 Issue 6 - **bit.ly/CJApr22CPD1**.

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Heat focus at symposium

Sessions on the Future of Heat and heat networks will feature on first day

Heating will be a key topic at the Technical Symposium taking place in London next month. The theme of the event, which will be held in person on 21-22 April, at London South Bank University (LSBU), will be 'Delivering a safe, healthy and sustainable built environment – Buildings that perform'.

Among the programme of peer-reviewed presentations and papers, the first day features a session on the Future of Heat.

Presentations include *Electrification of heat generation for heat networks*, by Tom Burton, of FairHeat; *The generation gap! Are 5th-generation district energy schemes better or just different?*, by Graeme Maidment, from LSBU; and *Application of a novel solar-assisted double sources heat pump system for building heating*, by Yunhai Li, from the University of Hull.

Modelling performance for future heat networks is the focus of another heating-related session on the first day. Key presentations include *Carbon, costs and coefficient of performance – new metrics for RACHP*, by Catarina Marques, from LSBU; *Impact of building-level heat load testing on heat network performance*, by FairHeat's James Gallimore; and *Using heat pumps for heading towards net zero*, by Lasath Lecamwasam, from ESBS Pty.

Day two has a session on developments in building services for data centres. Other presentations include *Aurecon – Building integrated mini data centres*, by Ross McCarthy, from Technological University Dublin; *A super performance dew point cooler for data centres – From lab to real-life application*, by the University of Hull's Cheng Zeng; and *A retrospective look at a retrofit application*, by Cameron Steel, of Silver EMS.

For the full programme, and to book tickets visit **www.cibse.org/technical-symposium**

New £288m heat network fund opens

Applications for the first round of the £288m Green Heat Network Fund (GHNF) opened last month. The fund will focus on supporting the integration of heat pumps, solar and geothermal energy into new and existing heat networks.

The Triple Point Heat Networks Investment Management group has been appointed by the government to oversee the GHNF. It ran the previous Heat Network Investment Project and the group includes Gemserv, Aecom, Lux Nova Partners and Asteros Advisers.

There will be quarterly rounds of applications until the fund closes in 2025. The government said applicants to GHNF must show what actions they can take to enable growth within the supply chain.

For net zero targets to be achieved, it added, the heat network sector's supply chain capacity and capability would need to deliver an annual installation rate that is more than 10 times the current activity.

Heating will be a key topic at the Technical Symposium

Sales jump for heat pump water heaters

Sales of heat pump water heaters increased by 27% last year, according to new analysis by the Building Services Research and Information Association (BSRIA).

Following a dip in the first year of the pandemic, the UK water heater market enjoyed improved sales in 2021, including more traditional electric and gas-driven systems, according to BSRIA. This included an 11% increase in sales volumes of dedicated renewable-powered water cylinders.

BSRIA's research said that, while the water heater market is 'largely driven' by like-for-like replacement, the generous incentives available to replace old boilers with heat pumps have boosted the refurbishment market.

RADICAL DEPARTURE? RETROFITTING FOR HEAT PUMPS

With the pressure on homeowners to replace domestic gas boilers with heat pumps, it is essential that engineers ensure that existing radiators and pipework are suitable for the lower temperature heat source. **David Palmer** looks at the key considerations when upgrading a heating system

Within a few years, every heating designer and contractor in the UK will be installing heat pumps and upgrading heating systems. This will require the reskilling of engineers and contractors, not only in the design and installation of heat pump systems, but also in the upgrading of heat emitters and pipework to operate at low temperatures. This article addresses radiator and pipework upgrades for domestic heating installations, excluding hot water provision. Operation at much lower flow temperatures will result in significantly lower radiator outputs, and heat pumps which require a typical 5K maximum temperature drop will require higher flow rates which may necessitate the replacement of heating pipework.

The output from a radiator is a function of the flow temperature (Tf), return temperature (Tr) and room ambient temperature (Ta) as defined in BS 442 as follows:

$$Output\ (W) = \text{Output}_{@75\ 65\ 20} \times \left(\frac{\frac{T_f + T_r}{2} - T_a}{50} \right)^{n\text{-}coefficient}$$

The output at 75 C flow, 65 C return and 20 C ambient (75/65/20) and the n coefficient exponent are radiator dependent, and are supplied by the manufacturer in radiator output tables in accordance with BS 442. Radiators are described by the number of panels and fins, as shown in Figure 1. The industry standard panel radiator, from which all radiator outputs are calculated, is of type K1, 600mm high and 1,000mm long. At 75/65/20, the output is 1W per mm of radiator length to give a total of 1kW. The output at other temperatures can be calculated using the equation above, and is shown in Figure 2:

From the above, it is clear that operation at temperatures well below the typical 80 C/60 C or 82 C/71 C results in dramatically reduced radiator outputs, and that it is not possible to simply replace a boiler with a heat pump without taking measures to upgrade the building insulation, increase the size of the radiators, or both.

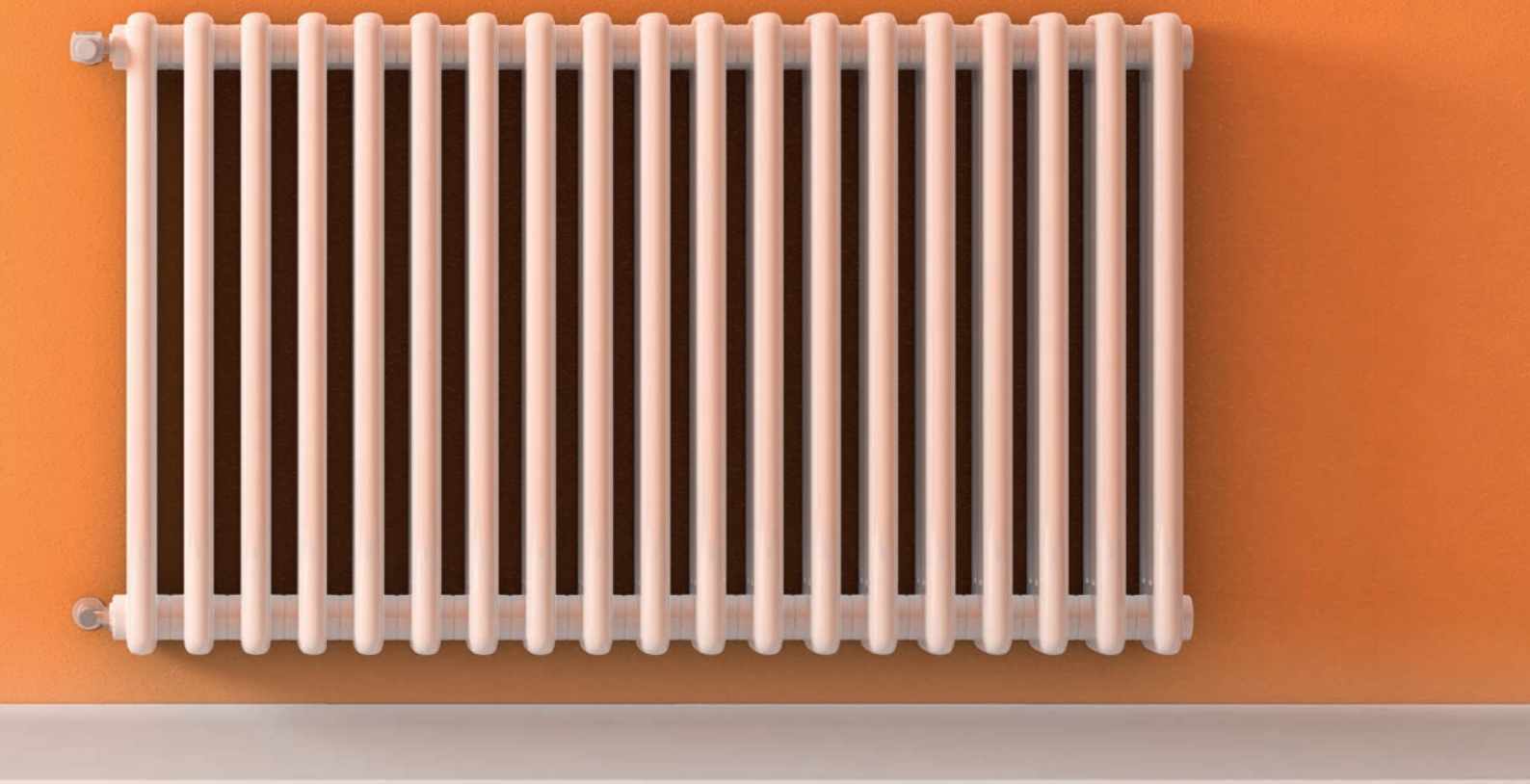
From a baseline of 5K ΔT across a radiator, increasing the radiator ΔT by 1K decreases the radiator output by between 1.0% and 1.3% for each 1K increase in ΔT above 5K. The output of this radiator at 5K ΔT at 45/40/20 is 36% of that at 80/60/20, while, at 10K ΔT, it is 31% of that at 80/60/20.

Radiator pipework

The majority of heat pumps require a very low condenser ΔT, typically 5K. If upgraded radiators are operated at a temperature difference of 5K, rather than the current 11K or 20K, the existing pipework may be too small and may have to be replaced.

Whether or not pipework needs to be upgraded along with radiators depends on the pipework material and internal pipe diameter. Take the example of a K1 radiator 600mm high x 1,000mm long, operating at 80/60/20 with an output of 1kW. If the radiator is upgraded to a K3 700mm high x 1,000mm long, at 45/40/20, it would produce almost the same output, 963W. If connected to 10mm 5 layer PEX barrier pipe (internal diameter 6.7mm) the pressure loss would be 3,822Pa·m^{1} at 1.32m·s^{1} velocity. If connected to 8mm copper minibore pipe (internal diameter 6.8mm), the pressure loss would be 3,646 Pa·m^{1} at 1.28 m·s^{1}.

The significant increases in pressure drop, and potential increase in noise, may necessitate upgrading the pipework. By comparison, for the 700mm/1,000mm K3 radiator at 10K ΔT ie, 45/35/20 the output would be only 821W, giving 846Pa·m^{1} and 0.56m·s^{1} for 10mm PEX or 799Pa·m^{1} and 0.55m·s^{1} for 8mm copper. Operating at 7K ΔT ie, 45/38/20 the output would be 906W, giving 1,881Pa·m^{1} and 0.89m·s^{1} for 10mm PEX, and 1,786Pa·m^{1} and 0.86m·s^{1} for 8mm copper. In both of these situations, it is very likely that the existing pipework could be reused.



A hybrid solution could avoid the need to upgrade pipework as radiator sizes are increased, as described above. While it is essential not to exceed the maximum permitted condenser ΔT for the heat pump, the radiators are not necessarily constrained to operate at the same ΔT. Figure 3 (on page 50) shows the configuration required to maintain a constant and controlled ΔT across the heat pump while permitting a greater ΔT across the radiators.

Two pressure independent control valves are used to set and maintain the flowrates along the bypass and into the radiator circuit. This guarantees that the heat pump manufacturer s preferred ΔT will not be exceeded, while allowing the radiators to operate at 10K ΔT. This may avoid the need to replace the interconnecting pipework.

Building heat loads and very cold weather operation

Radiators are usually sized for the load including a heat up allowance at the design external air temperature, a location dependent figure, but typically around 3 C for much of the UK.

Two issues must be considered when converting to heat pump operation. First, heat pumps should not be oversized, which means, unlike a boiler, they will not have spare capacity to operate in very cold weather below the design outside air temperature. While boiler temperatures can usually be increased to cope with very cold weather with little efficiency penalty, increasing the flow temperature from a heat pump can result in a significant reduction in performance. Furthermore, air source heat pumps may not work well below 2 C dry bulb outside air temperature because of the need to defrost evaporator coils regularly. This is a very important consideration when choosing the type of heat pump to install. »

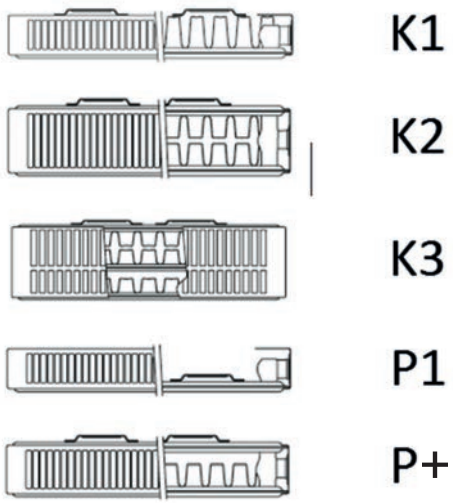


Figure 1: Configurations of panel radiator types K1, K2, K3, P1 and P+ (diagrams courtesy of Stelrad)

Outputs from a Stelrad elite K1 radiator, 600mm high x 1,000mm long at temperature differences of 5K, 10K and 20K

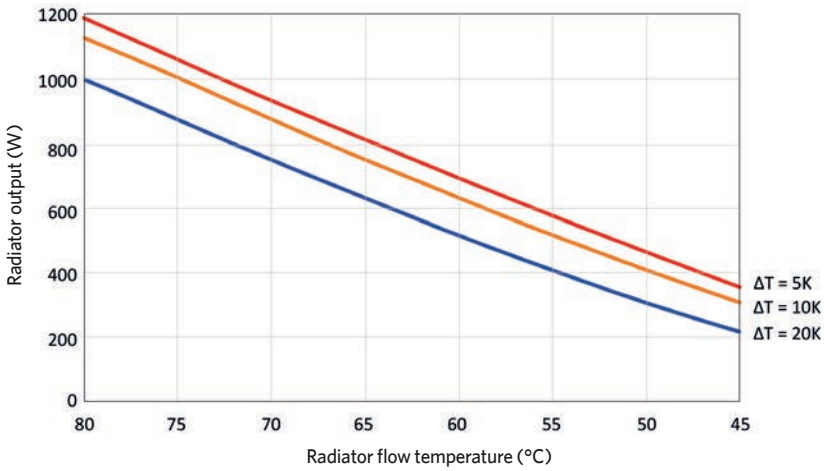


Figure 2: Radiator outputs at different flow temperatures and ΔTs for a 600mm high, 1,000mm long K1 radiator

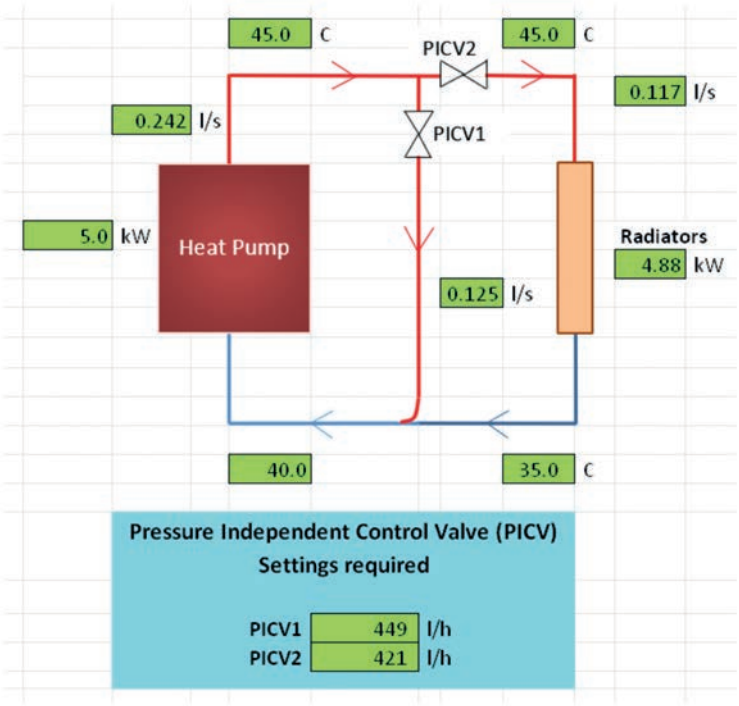


Figure 3: A bypass circuit maintaining 5K ΔT across the heat pump while allowing the radiators to operate at 10K ΔT

» The solution to cold weather operation would appear to be a hybrid system for example, retaining a boiler for use below 2 C and interlocking it so it cannot operate at the same time as the heat pump. Some gas condensing boilers have a calibrated temperature setting control, which allows the user to adjust the flow temperature to a specific value.

Typically, flow temperatures from 45 C to 82 C can be set on the dial, which allows the performance of an existing heating system at low temperatures to be evaluated before heat pump installation. This could give useful data when determining the extent of radiator upgrades required.

Comfort

The currently accepted measure of comfort is expressed by the operative temperature (T_o). CIBSE Guide B1 defines T_o as the average of the air temperature and the mean radiant temperature as in equation 2: $T_o = 0.5T_r + 0.5T_a$

> Heat pumps will not have spare capacity to operate in very cold weather below the design outside air temperature

The mean radiant temperature is calculated by multiplying the area of each surface in a room by its temperature, summing these products together, then dividing the result by the total surface area.

Clearly, the use of radiator surface temperatures of less than 45 C compared with the current 65 C or more will produce a lower overall mean radiant temperature, and achieving the same comfort level will generally require a higher air temperature and, hence, radiator outputs.

Procedure for radiator and pipework design

Following a room by room heat load calculation, radiators should initially be sized based on the flow and return temperatures for the selected heat pump. Radiators of the same length as the existing ones, but of a higher output type and/or greater height, should be chosen, with the aim of using the existing pipework.

A check of the pressure drop and velocity in each pipe will show whether radiators can be operated at the heat pump ΔT or whether the radiator ΔT needs to be greater than the heat pump ΔT, noting that it is only when the smallest pipe sizes are present that it may be necessary to replace pipework.

All of the calculations required can be done using the radiator and pipework calculator, downloadable at **bit.ly/CJApr22RPSC**

■ **DAVID PALMER**, is now retired. He was formerly a director of the Campbell Palmer Partnership

Acknowledgements

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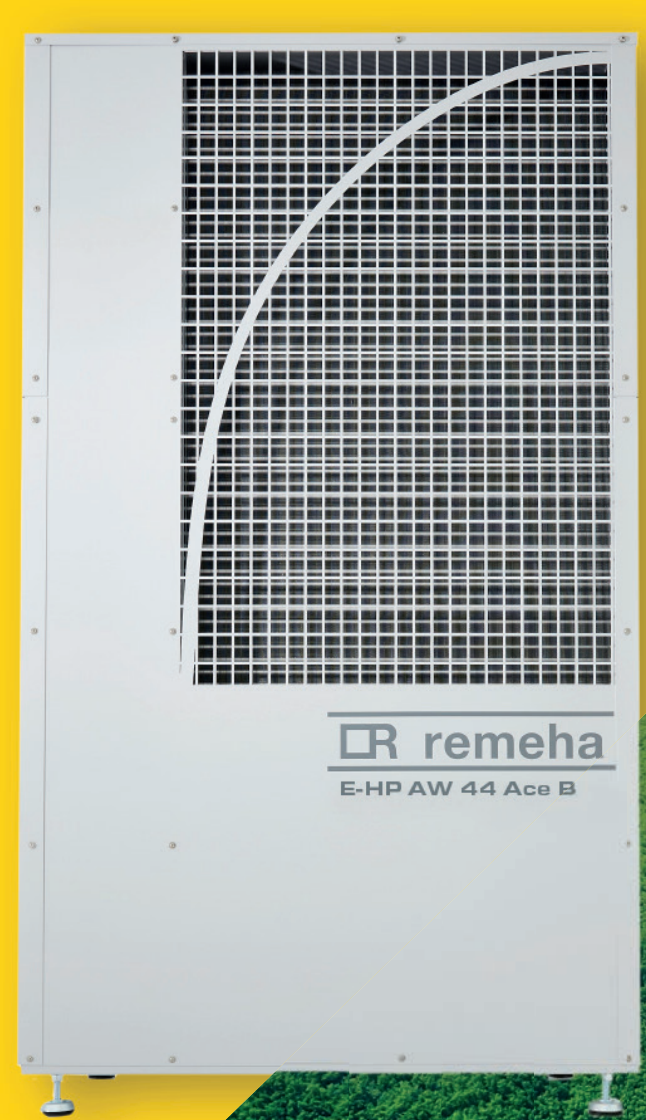

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What new energy regs mean for water heaters

Non-condensing water heater replacements will be banned under upcoming Building Regulations. Baxi's Andy Green looks at the implications of the new energy efficiency standards in Approved Document L

On 15 December 2021, the government published updates to Approved Document L of the Building Regulations, which sets the standards for the energy performance and carbon emissions of new and existing buildings. One of the changes relates to stricter thermal efficiencies for domestic hot water systems.

From 15 June this year, direct fired water heaters must achieve a minimum heat generator seasonal efficiency of 91% (gross calorific value, GCV) for natural gas and 92% GCV for liquefied petroleum gas (LPG). For indirect fired water heaters, the minimum heat generator seasonal efficiency is 91% (GCV) for natural gas and LPG. The new standards apply to existing and new non domestic building stock.

What will the stricter standards mean in practice? Effectively, it will remove the option to carry out like for like non condensing water heater replacements in the majority of non domestic buildings. Only in very exceptional circumstances, where a condensing water heater replacement is deemed not suitable by the building control body, may a minimum seasonal efficiency of 80% for gas, or 79% for LPG, be used.

The uplift is part of the government s roadmap to reaching the UK s net zero target by 2050, and represents an important step towards more energy efficient existing non domestic buildings.

Direct fired water heaters are an efficient, cost effective means of delivering large volumes of sanitary hot water, and hospitals, hotels and leisure centres with their high demand for instantaneous hot water are just some of the buildings that rely on this technology. Up until now, most manufacturers and suppliers have offered a choice of condensing and non condensing models. Condensing water heaters can capture and reuse latent heat that would otherwise be lost through the flue. As a result, they are up to 20% more efficient than non condensing models. Units like the Andrews Water Heaters ECOflo, MAXXflo EVO and SUPAflo EVO can achieve efficiencies of up of 98%.

The energy saving benefit of switching to more efficient condensing units is evident. However, many organisations still rely on the ability to carry out like for like non condensing water heater replacements when the existing equipment comes to the end of its serviceable life. As no major work is involved, the appliances can be replaced quickly, with minimal disruption to the daily operation of the building.

The energy saving benefit of switching to more efficient condensing units is evident

While the move from non condensing to condensing water heaters can be relatively straightforward, certain factors, such as flueing and condensate arrangements, will need to be assessed on a project by project basis. So, our advice is to work with building owners now to implement an asset management programme. With regular condition surveys and plant asset inspection, they will be sufficiently informed to plan ahead to future proof their hot water systems.

Switching from a reactive to a proactive approach will enable them to prepare for change, and to budget for future upgrades. Even on the few projects where exemptions may apply, forward planning is important. Early engagement with building control will be critical if heating engineers are to ensure they are satisfied with the recommendation and avoid any risk of censorship.

With challenges come opportunities. An upgrade will encourage a reassessment of the building s hot water requirements. Many firms will have experienced changes in building occupancy over the past two years. Ultimately, the revised calculations could point to a smaller water heater now being required, which would reduce initial capital expenditure and longer term running costs.

For designers, the shift to condensing technology brings the chance to relocate plant to make better use of space. In hotels, for example, the original plantroom could be converted into an extra bedroom. Budget permitting, there may even be the option to integrate low carbon air source heat pumps with condensing water heaters in a hybrid system, for a greater reduction in the carbon footprint.

But forward planning is essential and the clock is ticking. What nobody wants is for buildings to be left in an emergency situation with no hot water supply. To protect their operations, we must encourage them to start plotting a robust upgrade plan now.

■ Andrews Water Heaters is part of Baxi Commercial Solutions.

■ **ANDY GREEN**
is technical director at Baxi

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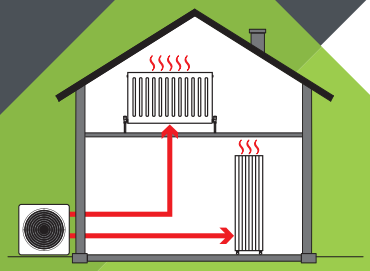

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THE POTENTIAL FOR DEW POINT COOLING

A dew point indirect evaporative cooler developed by researchers in Hull aims to reduce electricity consumption in data centres and other buildings significantly. PhD student **Cheng Zeng** looks at the performance of a system at the Maritime Data Centre

Researchers at the University of Hull have developed a super performance dew point cooler that can save 90% in electricity consumption compared with traditional mechanical vapour compression and evaporative cooling systems.

With a coefficient of performance (COP) of 52.5, the cooler can also save 50% compared with an evaporative cooling system.

From 2019 to 2021, the Centre for Sustainable Energy Technologies at the university worked with several partners to deliver a demonstration project that uses the dew point cooling technology in a live data centre in Hull.

This case study looks at a real life application of the technology, and shows how it can achieve a significant impact in reducing energy consumption and carbon emissions for data centre cooling.

The aim was to demonstrate a 100kW super performance dew point cooling system in a live data centre that could remove a significant amount of heat dissipated from the IT equipment, while maintaining an adequate space temperature in the data centre.

The dew point cooling technology, as a form of indirect evaporative cooling (IEC), cools the air using the principle of water evaporation. This results in significant energy savings and further temperature reductions compared with more conventional technologies.

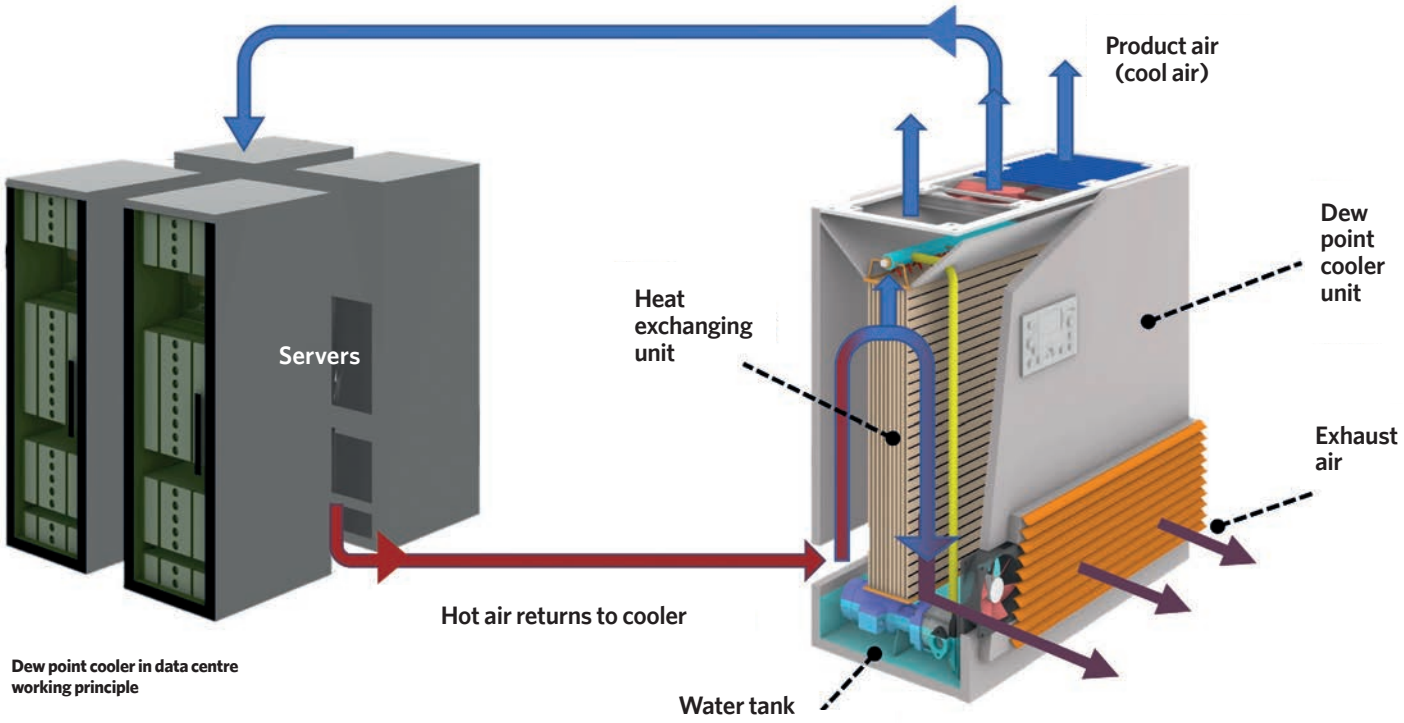
The case study is directly relevant to data centre space cooling, although the technology can also be applied to other types of buildings, such as greenhouses and railway stations.

The innovation

The core technology of the demonstration project is an innovative super performance dew point cooling technology. The dew point cooling process is based on an IEC heat and mass exchanger, as shown in Figure 1.

During operation, the intake air flows into the dry channels of the exchanger. The air moves forward along the dry channel and loses heat to the adjacent wet channels because of the temperature difference established between the channels and water evaporation on the wet channel wall. At the end of the dry channel, the air is divided into two parts. One fraction of the airflow the product air is delivered into the conditioned space for cooling, and the other fraction the working air is diverted into the adjacent wet channels for water evaporation.

Within the wet channels, the working air moves backwards, absorbing the heat transferred from the dry channels and receiving the moisture evaporated, thereby completing a heat and moisture »



Dew point cooler in data centre working principle

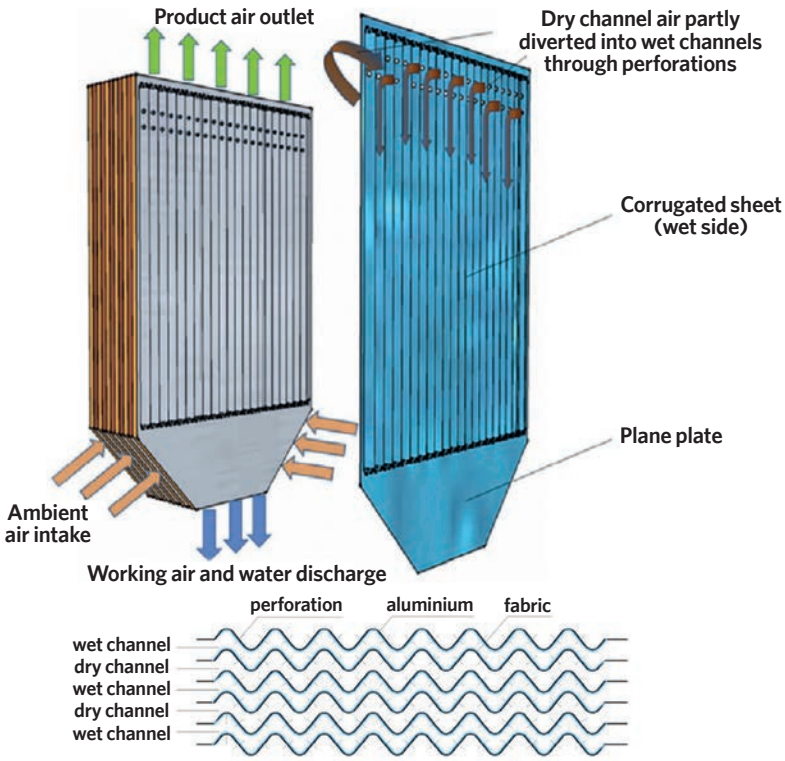


Figure 1: Novel heat and mass exchanger for the dew point cooler

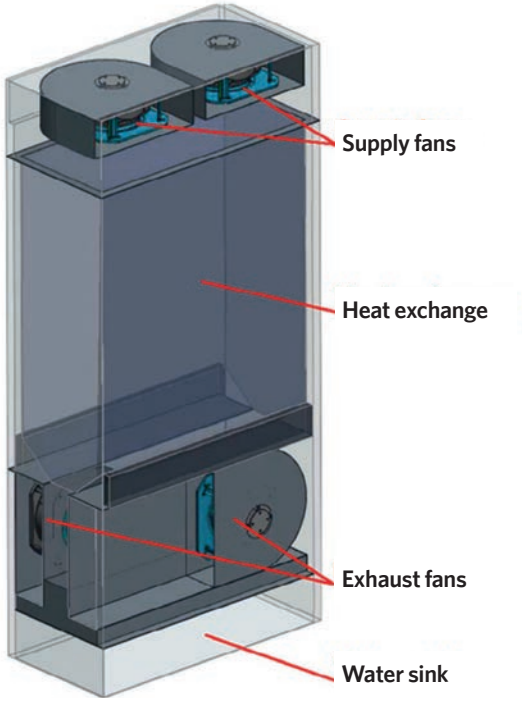


Figure 2: Dew point cooler schematic structure

» transition process from one part of the air to another.

The dew point cooler comes with a series of innovations, which include:

- Complex heat and mass exchanger: a novel complex heat exchanger was developed that comprises numerous heat and mass exchanging sheets. Compared with a conventional plate heat exchanger, the structure increases the heat transfer area by around 40%
- High water absorptive, diffusive, and anti bacteria wet agent, and strong binding between the dry and wet agents
- Intermittent water pump operation and well tuned water pressure and flowrate
- Optimised fan configuration: in this dew point cooler, the fan structure and associated motor type were investigated using a computational fluid dynamics and structure optimisation approach. This yields the optimised fan structure, most appropriate motor, and the best coupling approach between both of them.

The Maritime Data Centre

A novel dew point cooling system with 10 10kW (total 100kW) modular cooling units was designed, constructed and installed at the Maritime Data Centre in Hull.

The demonstrator cooling system was installed externally. An air ducting system to bring the cooled air from the external demonstrator cooling system into the indoor environment was designed by the project consortium. The design of the dew point cooler system involved detailed numerical simulations and the development of a modular structure design, which included a heat exchanger and components for water distribution. Before installation, the system was performance tested in an environmental chamber.

Performance optimisation and monitoring

The project partners worked together in testing the dew point cooling system under various settings. A series of settings was updated to enable the cooling system to achieve optimal performance.

After the installation, optimisation and testing, the dew point cooling units operated continuously for six weeks, from 17 September 2021 to 31 October 2021. To minimise the risk of failure, the equipment was built with a minimum number of moving parts. »

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Results

The system was highly energy efficient for cooling at the demonstration site achieving an average cooling capacity of 53.5kW, average power consumption of 1.8kW, average COP of 29.7, and maximum COP of 48.3.

The average COP of 29.7 was smaller than the target 40 because the existing air conditioning units took up part of the cooling load. This reduced the cooling capacity for the demonstration equipment but it gave the data centre manager the assurance of backup cooling when the new technology was operating.

The indoor air temperature of the data centre during the test ranged from 18 C to 25 C. By using the dew point cooling system, the average power consumption of the existing air conditioning system at the demonstration site was reduced from 35.5kW to 4.7kW.

By simulating the dew point cooling system performance throughout a year at the demonstration site, using a validated model, the average annual COP of the cooling system can reach 37.6, with a cooling capacity of 70kW and average power consumption of 1.9kW. Applying the dew point cooling system can reduce cooling energy consumption by more than 90%.

For the demonstration cooling units, part of the cooling effect is driven by water evaporation. The water usage for the units evaporative cooling is around 400L per day the daily water charge would be around £1.60.

Project learnings

The key learnings from the project were:

(1) Dew point cooler engineering design strategy and manufacture: The design of the heat exchanger, considering the ease of manufacture, is critical in future dew point cooling projects. The size of a dew point cooler affects the installation complexity and costs significantly, which should be considered in future projects.

(2) Dew point cooler data centre installation methods and the related issues: During the project, the partners investigated various installation methods of the dew point coolers at the demonstration site. The process provided experience in installing the cooling units, both internally and externally, with installation innovations to minimise interruptions to the site and reduce costs.

(3) An optimised control and data presentation for the dew point cooler: The demonstration led to optimised control settings and improved data visualisation, which can be the basis for the control box of a dew point cooler. CJ

This project is funded by the Department for Business, Energy and Industrial Strategy's Industrial Energy Efficiency Accelerator programme. Project partners include the University of Hull (technology developer), Environmental Process Systems (cooling specialist), and NPS Humber (data centre manager).

This paper will be presented at the CIBSE Technical Symposium.

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Evolving standards and ventilation methods in homes

This module considers revisions to Building Regulations in England for ventilation that set the path towards the Future Homes Standard

Following the recent consultation document on the England Future Homes Standard, the UK government introduced revised England Building Regulations in December 2021, with the interim aim that new homes planned from mid 2022 will include adequate ventilation as well as producing 31% fewer emissions. As part of the package of new regulations, there was a separation of the previous Approved Document (AD) F into a new volume 1 for dwellings and a new volume 2 for buildings other than dwellings. This CPD will focus on the provisions developed to help ensure suitable ventilation for new homes.

Inadequate ventilation in homes will produce a miscellany of effects, ranging from the immediate manifestations of condensation, through to the undesirable impacts on the occupants from a cocktail of airborne contaminants. These may be emitted from the fabric and furnishings, as well as resulting from the everyday processes and products used when living in the space. Many impacts will be challenging for building occupants to identify, but a poorly ventilated home can directly adversely affect health through poor indoor air quality (IAQ) and create delayed, possibly long term, problems such as mould. This is starkly illustrated in Figure 1, and frequently cited in cases considered by the Homes Ombudsman[1] (although significant numbers of mould cases result from, in part, deficiencies in the building construction or maintenance procedures).

There have been many studies and reports that have contributed to the knowledge and understanding of the role of building air tightness and ventilation strategies on building performance. Work undertaken by Crawley,[2] based on the airtightness of newly constructed UK dwellings (investigating a large dataset collected to meet the requirements in the Part F 2010), found that the ventilation strategy appeared to make little difference to the airtightness of homes. For dwellings featuring mechanical ventilation with heat recovery (MVHR), the results suggested that infiltration levels are too high to maximise the energy savings; and for those naturally ventilated homes, there may be air quality issues. The overall data indicated little practical difference between houses built for MVHR and those for natural ventilation with both sets hovering around the air tightness figure of $5 m^3 \cdot m^{-2} \cdot h^{-1}$ @ 50Pa. In that same work, there were some disappointing findings (drawn from an earlier dataset) that might be reasonably interpreted as indicating that many new homes were caulked up for the purposes of meeting an airtightness test rather than being inherently designed and constructed to perform effectively. Crawley concluded that coupling airtightness design and ventilation strategy can reduce a dwelling s energy demand and can support achieving the required energy performance rating .

In 2016, Zero Carbon Hub (ZCH) published[3] an informative catalogue of real world observations that, despite the sad demise of ZCH, lives on as record of deficient home ventilation installations. This includes examples of the number and performance of installed trickle ventilators not working in harmony with the installed systems (that is, natural, mechanical or MVHR); illustrations of excessively long, poorly supported, flexible ducting that inevitably leads to higher »

» system pressure drops and increased noise; inappropriate and inadequate commissioning of ventilation systems; and poorly labelled controls and inadequate handover instruction for end users. The report highlighted that a lack of detailed specification and detailing had resulted, in some cases, of improvising on site (with no consultation back to the designer) and some checking of systems being done by ear , using noise levels as the guide to performance, not flow rates. Homes in occupation and operation have been similarly found wanting in the practical operation of ventilation. A key preparatory study undertaken by Aecom[4] that contributed to the development of the Future Homes Standard covered 80 occupied homes 55 naturally ventilated and 25 with decentralised mechanical extract ventilation that had been constructed after 2010 to meet the requirements of Part F 2010, and which were studied across the winter period 2015 16. Although considering a relatively small sample of homes over a single quarter of a year, the findings were able to reveal some significant concerns; 30% of the tested homes with continuous mechanical extract were not maintaining recommended IAQ performance standards. Further analysis suggested that this resulted in part from the relative position of trickle ventilators causing short circuiting of airflow to the room extract grilles, and that the standards set by Part F were not, in themselves, inadequate. In the naturally ventilated homes, the location of trickle ventilators was again identified as being a significant contributor to poor performing ventilation and the resulting poor IAQ. Trickle ventilators that were obscured often at night behind closed curtains were considered as being the likely culprit leading to relatively high levels of carbon dioxide (CO_2) and total volatile organic compounds (TVOC), particularly in bedrooms, driven by the relatively low air change rates. Additionally, the report highlighted that noise from extract fans resulted in occupants choosing not always to switch them on when they were needed, which could potentially lead to the consequences of long term under ventilation. In locations with high external sound levels, there was a tendency for occupants to close (or obscure) trickle ventilators to reduce the ingress of noise, so reducing the home ventilation rate.

The development of the new AD F volume 1 2021[5] (AD F1) was driven, at least in part, by such deficiencies described above, with an overall aim to protect the health of occupants of the building by providing adequate ventilation . It was widely considered that the ventilation rates of the previous Part F would have likely been adequate if the installation and operation had followed through the intent. (See boxout Understanding AD F1 2021 .) The important, relatively discreet, updates in AD F1 integrate with the desire to make the requirements clearer and more useable, and to align with the demands presented in the complementary ADs. So, for example, AD F1 ensures sufficient levels of ventilation are provided despite the more stringent building airtightness requirements of AD L1.

Figure 1: Extreme example of the consequences of poor ventilaion in first-floor bedroom when room was closed up for 12 weeks during ground-floor building works in winter 2021-22. A trickle vent in the top corner had been previously plastered over (Photo source: Martin MacDonald)

The categories of ventilation are now simplified into three main types. Passive stack ventilation and natural ventilation without the use of mechanical extract are no longer specifically included. The first system type described in AD F1, natural ventilation with background ventilators and intermittent extract fans, might be considered as reasonably traditional for UK housing but is deemed as only applicable for new dwellings with a design air permeability higher than $5m^3{\cdot}m^{-2}{\cdot}h^{-1}$ @ 50Pa (or $3m^3{\cdot}m^{-2}{\cdot}h^{-1}$ @ 50Pa as built), referred to as a less airtight dwelling . (Practically, this means that it will not suit most new homes, as otherwise they are likely to struggle to comply with energy related regulations.) Background ventilators are required with significantly greater equivalent area than in the previous AD F, which together with higher whole dwelling ventilation rates, and

UNDERSTANDING AD F1 2021

As with all regulations and standards, there will be some interpretation required for the new AD F1, the need for which may not become obvious until the new ADs are applied to design, installation and operation. It is important to review the ADs directly to understand the detail (and they are freely available at www.gov.uk/government/collections/approved-documents). However, a useful general side-by-side comparison of the requirements of AD F1 2021 with the previous requirements may be seen at www.titon.com/uk/building-regs-update.

more specific requirements for room by room ventilator distribution and position should make compliance more straightforward.

The opportunity for cross ventilation should be taken, if available, and noise attenuating background ventilators are recommended where there are high external noise levels previously the problems of noise were focused on mechanical systems.

Highly airtight buildings require one of the remaining two system types. The first of these is continuous mechanical extract ventilation (MEV), which comprises a central extract system or individual room extract fans or a combination of the two, with a prescribed minimum equivalent area of background ventilators for each habitable room (except wet rooms). The required area for background ventilators has been significantly increased in this revision.

The intermittent and continuous extract rates remain the same as the previous AD F; however, there is a 50% increase in the required minimum whole dwelling ventilation rate.

The final system, MVHR, explicitly rejects the use of background ventilators (to prevent uncertain airflows).

AIR BRICKS FOR CONTROLLED VENTILATION

The humble 'air brick' – which has typically been associated with the ventilation of otherwise unventilated and unoccupied spaces such as underfloor voids, cavity walls and disused fireplaces – is increasingly being employed as a mechanism to enable intakes and discharges for designed natural ventilation, mechanical ventilation or MVHR applications. As the name suggests, the air brick typically fits into one or two courses of bricks, often keyed to ensure a robust bond with the brickwork. Air brick materials have evolved from the traditional terracotta (with its practically limited dependable equivalent 'free' area) to cast iron, plastic, and, most recently, powder-coated steel (such as those shown in Figure 2).

Although these may be used simply as background (or trickle) ventilators, the steel 'mechanical air brick' is designed as a robust, low pressure drop ventilation grille, so that it can connect soundly with matched ducting, as in the example in Figure 3, to provide an air path for natural ventilation or for any form of mechanical ventilation, including ducted MVHR, central MEV and purge systems. As with any properly installed air brick, they will restrict the ingress of external insects and animals and provide weather protection. To comply with England Building Regulations for fire safety, appropriately powder-coated (fire-rated to A2-s1, d0 – non- or limited combustibility, little or no smoke, with no flaming droplets), non-combustible (A1) steel constructions will meet requirement B4 of AD Part B[9] for external walls (and AD Part 7[10] for materials and workmanship) regardless of whether they are employed in walls above or below 18m from ground level. Steel air bricks are available as single bricks, brick-and-a-half and double bricks, with a variety of depths to accommodate a range of wall thicknesses.

Air pressure drops through the steel air bricks are commensurate with metal louvres of similar dimensions.

Figure 2: Examples of powder-coated steel 'mechanical airbrick' (Source: Titon)

Figure 3: Steel double air brick with extension to connect to ductwork system (Source: Titon)

Beyond those systems described in AD F1, alternative means of ventilation are allowable, but they need to be demonstrated to be meeting the requirements of AD F1.

Additionally, the requirement for purge ventilation, used to rapidly dilute indoor air pollutants and extract water vapour where necessary often done by opening windows, but which can also be provided mechanically remains unchanged. However, the new AD O[6] may require a higher purge ventilation rate to control overheating and so will need cross checking.

There is now a complete section devoted to commissioning and the provision of record information. Key administrative inclusions are the provision of a permanent evidence of performance, and to produce a record of the operational system intent, methods of use and maintenance. In addition to the operating and maintenance instructions a home user guide will need to be prepared and provided for new dwellings. This will contain a section on ventilation that gives non technical advice on the ventilation systems, including some basic details on how to operate and maintain the home in a healthy and energy efficient manner. A basic template[7] is provided for this guide, and is described more fully, in AD L1.[8]

There are subtle changes in performance requirements, such as the change in the reference value in allowable noise to 45dB LAeq,T in less noise sensitive rooms (for example, kitchens and bathrooms) when a continuous operation system is running at the minimum high rate or an intermittent operation system is running (previously it was 35dB LAeq,T for a mechanical ventilation system on its minimum low rate). Ventilation ductwork is now required to be constructed of rigid ducts, wherever possible, to reduce noise and energy consumption (compared with flexible ductwork). Flexible ductwork, where installed, should only be used for final connections and have a maximum length of 1.5m this is a significant change.

AD F1 2021 provides a useful tool to help deliver homes that are appropriately ventilated and, so far, has not excited the same heated debate as recent changes to other ADs. The clarified and enhanced interpretation of prescriptive requirements, as well as the more explicit description of ventilation performance, will it is hoped lead to more robust system designs that are installed appropriately and that can be operated reliably to deliver good dwelling air quality.

Turn to page 64 for references.

Module 193

April 2022

» **1. Which of these is most likely to identify a house as a less airtight dwelling ?**

- ☐ A As built air permeability higher than $3m^3 \cdot m^{-2} \cdot h^{-1}$ @ 50Pa
- ☐ B Design air permeability higher than $3m^3 \cdot m^{-2} \cdot h^{-1}$ @ 50Pa
- ☐ C Does not employ MVHR
- ☐ D Includes passive stack ventilation
- ☐ E Naturally ventilated

2. Approximately what increase is there in the minimum whole dwelling ventilation rate in AD F1 compared with the previous AD F?

- ☐ A 30%
- ☐ B 40%
- ☐ C 50%
- ☐ D 60%
- ☐ E 70%

3. Which other AD is mentioned as potentially impacting the required purge ventilation?

- ☐ A AD 7
- ☐ B AD B
- ☐ C AD F2
- ☐ D AD L
- ☐ E AD O

4. In the fire rating designation, which of these indicates non combustible ?

- ☐ A A1
- ☐ B A2
- ☐ C B4
- ☐ D d0
- ☐ E s1

5. Which publication was noted as indicating that the ventilation strategy appeared to make little difference to the airtightness of existing homes?

- ☐ A AD F1 2021
- ☐ B Home Ombudsman s Report
- ☐ C The relationship between airtightness and ventilation in new UK dwellings
- ☐ D Ventilation and indoor air quality in new homes
- ☐ E Ventilation in new homes

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6 The Building Regulations 2010, Approved Document F, Ventilation, Volume 1: Dwellings 2021 edition.
7 Template available **bit.ly/CJApr22CPD1932.**
8 The Building Regulations 2010, Approved Document O, Overheating, 2021 edition.
9 The Building Regulations 2010, Approved Document B, Fire Safety, Volume 1: Dwellings, 2019 edition with 2020 amendments.
10 The Building Regulations 2010, Approved Document 7 – Materials and workmanship, 2013 edition with 2018 amendments.

Products of the month

Rinnai s Sensei N Series range: providing limitless hot water with precise control

The UK s first continuous flow water heating unit that is also good for the environment

Rinnai's Sensei N Series features a range of models designed to ensure reliable hot water delivery for every possible site requiring limitless hot water with precise temperature control.

The Sensei N Series is the first continuous-flow water heating unit in the UK that is manufactured with stainless steel heat exchangers, which greatly extend the working life of all four models in the range.

N Series heaters offer a more compact and enhanced combustion design that allows for easy installation, superior operational performance and high serviceability.

All four models have a class A water efficiency rating and a dispersion rate of at least 775 litres per hour at 50°C.

Other features include turbo fans; built-in controllers on both internal and external models; an air inlet filter; frost protection for temperatures below 20°C; a

built-in flue damper; and a maintenance monitor for engineers.

The cascade cable assembly allows up to 24 water heaters to be connected and function as one total and complete system. Any number of N Series water heaters can be manifolded together, allowing for some of the largest capacity on the market.

All Rinnai N Series range models are low-NOx and use Rinnai's patented advanced burner technology, with a 13-1 turn-down ratio that offers extremely quiet operation. Integral controls on the units enable the water heater to achieve high efficiencies due to advanced burner control and high modulation ranges.

The advanced burner controls with the Sensei N Series models ensure that all appliances are well ahead of the NOx requirements set within ErP. The current level of permissible NOx set by ErP is 56mg/Kwh. The Sensei N Series range has been third-party tested at 28mg/Kwh, making them one of the greenest water heating appliances available.

Rinnai's continuous-flow heater systems are proven to be more energy-efficient than conventional storage systems and are becoming the experts' preferred method of hot-water provision.

Rinnai units easily cater for any size projects that need high volumes of water at any time of day.

Visit www.rinnaiuk.com

Rinnai s H3 range: hydrogen, hybrid and heat pumps with an eye to the future

New products include systems for carbon neutral heating for residential and commercial use

Hot water solutions provider Rinnai has just launched its H3 range of products, consisting of hydrogen-ready water heating systems in hybrid versions and a comprehensive selection of heat pumps specifically designed for commercial use. The company will also be launching electrical formats for existing product ranges throughout the next 12 months.

Over the coming year, Rinnai will possess a range of residential and commercial decarbonising technology capable of functioning through natural gas, hydrogen blends, hybrid formation and electrical formats. To complete Rinnai's H3 range, heat pumps will be introduced as an option for carbon neutral heating and hot-water delivery for residential and industrial properties.

Rinnai has a large global client base and an annual production rate of more than two million units. All products meet or exceed UK legislation and certifications.

Chris Goggin, operations director for Rinnai, said: 'We have a global reach, over 650 design engineers, plus testing facilities in Japan, America and Australasia.

'We have moved this quickly because we believe the market is changing. We have huge populations that want to fight the rate of climate change but there is still the need for assessment of the technical, practical and economic feasibility of this in the UK. We aim to continue working towards net zero without compromising product quality or customer satisfaction.'

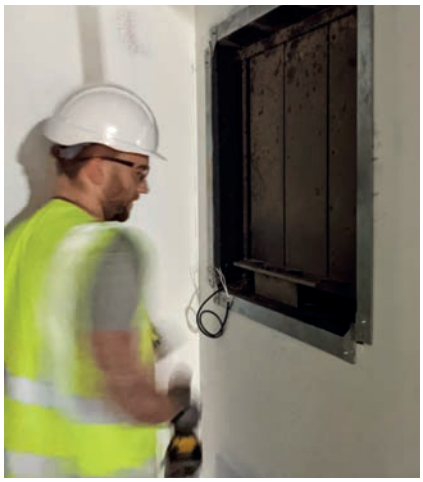
Rinnai has also commissioned a comprehensive comparative report focusing on gas and electrical appliances utilising a variety of energy vectors in both residential and commercial scenarios. The report is headed by a prominent multi-national consultancy firm within the building sector: a team of empirically motivated, non-partisan academics who will supervise the final draft of Rinnai's energy efficiency review. An appliance analysis will concentrate on the separate levels of energy efficiency of individual products.

'The consumer needs to be given the facts to make an informed decision,' says Goggin. 'We have positioned ourselves as a company that offers the highest quality products and excellent service.

'We have a responsibility to do the absolute best we can for our customers, and that includes anticipating the future.'

Visit www.rinnaiuk.com

Gilberts helps protect Elliotts Yard towers from fire



The Elliotts Yard site in Coventry, named after the historic automotive business once based there, has been transformed into a high-rise, high-specification living space equipped with the latest building services technology. This includes a high-quality smoke evacuation system designed by air movement specialist Gilberts Blackpool.

The project's M&E contractor, Excelsior Services (Residential), commissioned smoke control specialist Baiceir, which recommended the installation of a Gilberts Series 60 smoke damper into the fire shafts on each floor. Gilberts' Series 60 delivers up to two hours of fire integrity, combining a low leakage rate and high free area to deliver high smoke evacuation rates. Powered motors open the damper on the fire floor for smoke evacuation while all other dampers close to protect the rest of the building.

Baiceir director Andy Baker said: 'The great design and quality of manufacture in Gilberts Series 60m smoke dampers makes fitting them a breeze; the depth of detail in their design and testing gives us the confidence to specify them.'

Call 01253 766911 or email info@gilbertsblackpool.com

Modutherm launches heat pump ready HIU

Modutherm has launched the MTA PLUS, a high-performance heat interface unit (HIU) that has been specifically designed for use in fourth-generation low-temperature heat networks that use heat pumps or boilers. The product launch follows a partnership agreement with heat pump manufacturer alpha innotec.

The MTA PLUS is an indirect HIU featuring two high-performance SWEP LAS heat exchangers, offering domestic hot water up to 75kW and heating up to 10kW while ensuring return temperatures do not exceed 25°C.

Visit www.modutherm.co.uk

The Rockwool HVAC Systems Guide

The Rockwool HVAC Systems Guide brings together all the key information and resources needed to specify effective HVAC insulation for each and every application, including: product performance information for thermal, fire resilient and acoustic applications; installation guidance and specification clause advice; details of technical resources that you can access through Rockwool; advice for developing your professional knowledge through Rockwool's targeted CPDs; and routes to compliance for devolved building regulations across the UK.

Download your free copy at rockwool.com/uk/hvacbook

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Are you the person responsible for ensuring that healthcare premises comply with water regulations?

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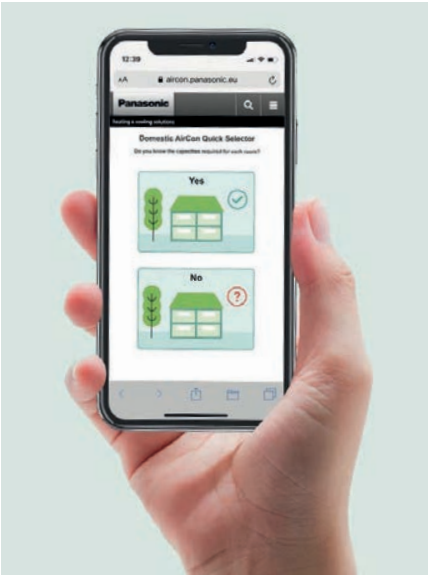


Panasonic launches domestic aircon quick selector

Panasonic Heating & Cooling Solutions has recently launched its new Domestic AirCon Quick Selector online tool, which has been created to help customers choose the right Panasonic heating or cooling unit from its Domestic Single Split and Multi Split range.

The tool shows the user the most appropriate Panasonic solutions to suit each room, then selects the ideal outdoor model to go alongside the indoor units for a full-service solution. Service is available on hand to answer any questions.

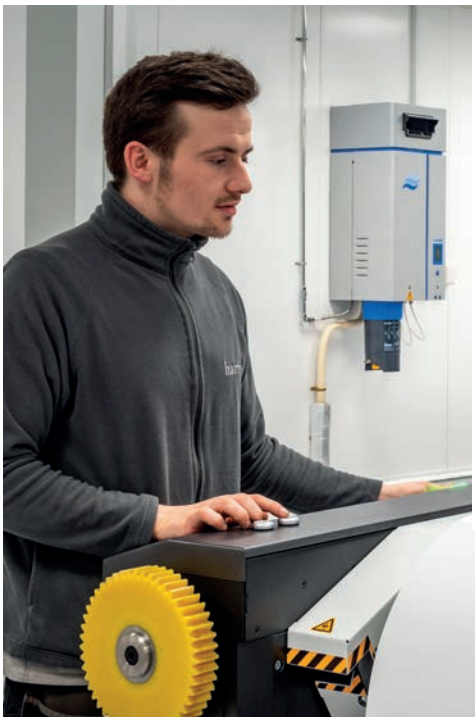
Visit www.aircon.panasonic.eu/GB_en

First Scottish nursery to adopt Passivhaus principles

Thorn Lighting, a subsidiary of the Austrian-owned Zumtobel Group, has equipped the new nursery attached to Blackridge Primary School in West Lothian, Scotland, with a bespoke collection of its energy-efficient LED luminaires. This is the first nursery in Scotland to be built using Passivhaus principles: buildings designed to use virtually no energy for heating or cooling.

A range of the Thorn luminaires was chosen, from the continuous suspended IQ Waves in the main nursery space to the Thorn Equaline system in the lobby.

Visit www.thornlighting.co.uk



Condair helps Harrier s print run smoothly

Digital printing firm Harrier Group has invested in four Condair RS restive steam humidifiers to maintain the perfect production environment in a new print room in Newton Abbot, Devon.

The Condair RS humidifiers, specified by contractor Brothwell Irvine, monitor the room's humidity level and provide steam directly to the atmosphere whenever needed. Having multiple units installed in the large print room ensures very accurate humidity control. The accurate humidity control maintains the integrity of the paper being used.

Visit www.condair.co.uk

Nittan launches visual alarm base for photoelectric smoke detector

Global fire detection manufacturer Nittan Europe has just launched the new EV-PYSVAD Visual Alarm Base, the latest addition to its range of analogue addressable fire-detection products.

The EV-PYSVAD is a Type A Indoor Beacon Base VAD, featuring 12 high-power white LEDs that all meet the EN 54-23 Category C (Ceiling) certification requirements.

It was designed for use with Nittan's EV-PYS smoke detector, which has an advanced smoke sensing chamber designed for maximum effectiveness.

Call 01483 769 555, email sales@nittan.co.uk or visit www.nittan.co.uk

Top marks for efficiency

Putteridge High School, Luton, was recently rebuilt after receiving funding from the Department for Education.

As part of the project, building services consultancy Hoare Lea chose TRILUX lighting for all areas of the site as its high level of efficiency would help to reduce the school's carbon footprint.

Using LED technology, daylight-linked controls and the LiveLink integrated smart lighting management system, TRILUX was able to bring energy consumption down to an absolute minimum, resulting in the site achieving a BREEAM 'Very Good' rating for energy efficiency.

Visit www.trilux.com

New hot water catering pump solution ›

The DrainMinor C (Combi Oven Pump) has been specifically built for Combi Oven hot wastewater cleaning cycle discharges.

This system is fitted with a Jung Pumpen submersible pump featuring a mechanical shaft seal for motor protection and a rigid external float arm with low-level float that facilitates an inlet height of just 70mm. It is capable of handling up to 10mm soft solids. For pumping equipment enquiries please call the dedicated Jung Pumpen team at Pump Technology.

Call 0118 9821 555 or visit www.pumptechnology.co.uk or www.jung pumps.co.uk

‹ Celebrating 30 years in air conditioning

This month, Panasonic Heating & Cooling's senior sales manager Rachel Wales will be celebrating her 30th anniversary with the business. Wales was originally employed in 1992 by founders of AMP (now Panasonic Heating & Cooling).

Jose Alves, UK country manager for Panasonic Heating & Cooling, said: 'Rachel is highly regarded and respected throughout the industry. Her passion and drive, coupled with her wealth of knowledge, experience and exceptional customer service is admirable. She is a real asset to the team.'

Visit www.aircon.panasonic.eu/GB_en/

Aliaxis UK launches active drainage ventilation CPD ›

Aliaxis UK has launched a new continuing professional development (CPD) course focusing on active drainage ventilation (ADV), a means of managing air pressure within a building's waste drainage system that eliminates the need for roof penetrations and secondary venting.

Fully backed by CIBSE, the CPD discusses the types of systems used to manage water and air; ways to manage trap seals and the effect of loss; and the benefits of Active Drainage Ventilation.

Visit www.aliaxis.co.uk

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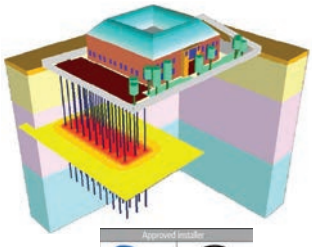
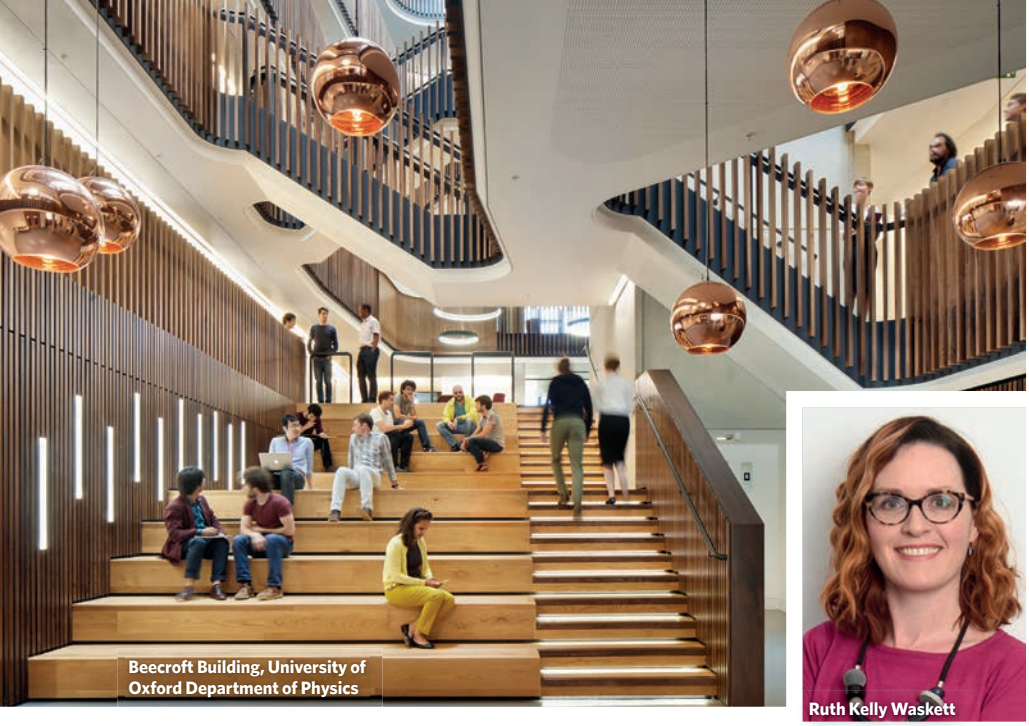


Fire Protection



Beecroft Building, University of Oxford Department of Physics

Ruth Kelly Waskett

Lighting the way

Increasing awareness of healthy lighting and attracting more women to the Society of Light and Lighting have been Ruth Kelly Waskett MCIBSE FSLL's prime objectives in her year as SLL President

Ruth Kelly Waskett has spent the past year as President of the Society of Light and Lighting (SLL) engaging with lighters all over the world in a bid to increase the diversity of the Society s membership.

Despite women representing half of those working in lighting, they only make up 25% of the SLL membership, so Waskett has been keen to promote the inclusive nature of the Society to as wide an audience as possible.

With a background in daylighting, Waskett has been drawing attention to the importance of natural daylight in healthy lighting designs. She has also been highlighting guidance from SLL that encourages the reuse of lighting equipment.

What has been the main focus of your presidency?

There have been two main focuses: One is communicating the importance of light in human health to the wider world, and the other is about the make up of SLL membership. On the first point, I want SLL to take its place as an independent and reliable source of information in what can be a sea of misinformation about how to make healthy choices with light.

The second point arises from the fact that SLL membership is overwhelmingly male, but lighting as an industry has an almost 50/50 gender split; so why is that? I want our membership to reflect the sector and be more diverse as a result.

What were you able to achieve during the pandemic?

Being online has actually turned out to be a real benefit for us because we have been able to connect with people all over the country and, indeed, the globe. We ve delivered an unparalleled programme of online content, and I m proud of the diversity of that content, too; ranging from technical to inspirational.

Last autumn I took part in my first in person event since the start of the pandemic a panel discussion about gender equality in lighting at the Darcroom pop up at London Design Week. It was a great discussion and it was also a really nice example of the kind of audiences that we are actively trying to connect with I want people to know that SLL isn t just for people who ve come to lighting through engineering, which is often the perception because of our association with CIBSE.

Why is daylighting so important at SLL?

Daylight is the ultimate light source and it is an essential part of sustainable and healthy buildings. So far, at least, it hasn t been commodified in the same way that artificial light can be.

That s why there needs to be a voice for daylight, and the impartiality of SLL makes it an ideal advocate for healthy light in all its forms. We have the ability to keep daylight high on the agenda.

How do you get the balance right between artificial and natural light?

We need to bear in mind the 24 hour life of a building or space. During daylight hours, the predominant light source should be natural.

Artificial light is there to balance the brightness in deeper areas, accentuate architectural features and provide supplementary light when daylight is not sufficient. But we seem to forget this when we approach lighting design, focusing only on what happens when it s dark outside.

It s an exciting time, because we have a perfect storm with the new version of BS EN 12464 pushing for higher illuminance levels and, at the same time, the drive to net zero carbon and the need to reduce lighting energy.

Daylight is key to this, of course!

How can the lighting industry take a more circular approach?

This is a huge conversation right now. Many of us are exploring new ways to think about what we specify, if we re specifiers, and what we produce, if we re producers of products.

There are many questions, including: what are the products made from, where do their components come from and how easy or difficult is it to update/upgrade/repair them when needed?

Last year we published *TM66: Creating a circular economy in the lighting industry*. This is a hugely important document and has given people a roadmap to begin the journey towards circularity.

Then just earlier this month (March) we launched the CEAM quality scheme jointly with the Lighting Industry Association (LIA), giving manufacturers the opportunity to have their products independently accredited using the CEAM system given in TM66. This is a great step forward in helping the industry embrace circular principles. See the launch at **bit.ly/CJApr22SLL**

EVENTS

NATIONAL EVENTS AND CONFERENCES

CIBSE Technical Symposium
21-22 April, London
The CIBSE Technical Symposium will this year be held at London South Bank University. The theme for 2022 is 'Delivering a safe, healthy and sustainable built environment – Buildings that perform', and will feature a mix of peer-reviewed presentations and posters.

Topics on this year's agenda will include: development of zero carbon building standards; embodied and operational carbon; and the challenge of refurbishing buildings.
www.cibse.org/technicalsymposium

CIBSE AGM
5 May
Followed by incoming president Kevin Mitchell's address. This will be run as a hybrid event
www.cibse.org/agm

CIBSE REGIONS AND GROUP EVENTS

Check the website for up-to-date information on regions and groups meetings, webinars and podcasts visit
www.cibse.org/events

CIBSE Online membership application workshop
14 April
These bitesize sessions are designed to help you prepare to apply for ACIBSE or MCIBSE, with guidance from CIBSE interviewers over four live sessions.

SoPHE webinar: Water pressure control in tall buildings
27 April
Presentation by Andrew Stokes-Roberts, from Resideo, discussing how best to achieve safe pressure control in tall buildings, where booster water pressures can reach very high levels.

LIVE ONLINE TRAINING COURSES

CIBSE training courses have been reformatted to work online, with a live trainer, meaning you can expect the same interaction and participation as you would in a classroom setting.
Upcoming courses:

Low carbon consultant design
5-7 April

Standby diesel generator
6 April

Building services explained
12-14 April

CIBSE JOURNAL PODCASTS

The latest *CIBSE Journal* podcast, 'The challenge and opportunities of delivering heat networks', sponsored by Grundfos Pumps, discusses the challenges and opportunities of realising the government's ambition of significantly growing heat networks in the UK.

All *CIBSE Journal* podcasts are available on the CIBSE Soundcloud – at **soundcloud.com/build2perform** – Apple Podcasts and Spotify.

Above ground building drainage
13 April

Heat Networks Code of Practice (CP1)
19 April

The importance of energy efficient buildings
19 April

Energy strategy reports
20 April

Below ground building drainage
26 April

Low carbon consultant building operations
26-29 April

Fire safety Building Regulations: Part B
27 April

Overview of IET wiring regulations
28 April

Energy efficiency related Building Regulations: Part L
28 April

Earthing and bonding
11 May

Energy efficiency related Building Regulations: Part L
11 May

ISO 50001:2018 Energy management system
17 May

Electrical services explained
17-19 May

Air conditioning inspection for buildings
18 May

Energy efficiency related Building Regulations: Part L
18 May

Low carbon consultant design
24-26 May

Mechanical services explained
24-26 May

For details and the full programme visit
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Membership webinars

CIBSE Membership hosts free two-part webinar series to support members with applications for the Associate and Member grades and registration with the Engineering Council at Incorporated Engineer and Chartered Engineer level.

To register for this and for all other membership webinars: **www.cibse.org/webinars**

Upcoming webinars:
- 10 and 17 May, and 14 June

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

CIBSE Technical Symposium 2022

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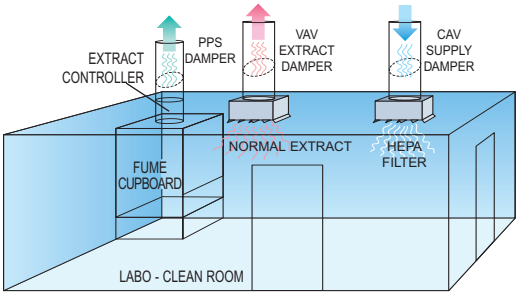
Accurate air flow measurement with the unique CMR Venturi built into the airtight shut-off damper to control room pressure or constant volume.

Metal Damper

AIR MANAGEMENT SYSTEM

A complete turn-key system to control room pressure to +/-1Pa. Fume cupboard face velocity to 0.5m/s at high speed and provide constant air changes into the labo - clean room.



PPS EXTRACT DAMPER

Poly-propelene control and shut off valve incorporating the CMR Venturi Nozzle. This is essential when dealing with corrosive extract air especially from fume cupboard systems.

PPS Damper

PRECISION COMPONENTS FOR VENTILATION AND PROCESS CONTROL

CMR CONTROLS
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