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Editorial
Editor: Alex Smith
Tel: 01223 378034
Email: asmith@cibsejournal.com
Tel: 01223 378048
Technical editor: Tim Dwyer
Reporter: Molly Tooher-Rudd
Designer: James Baldwin

CIBSE Journal is written and produced by CPL (Cambridge Publishers Ltd) Tel: +44 (0)1223 378000.
www.cpl.co.uk
1 Cambridge Technopark, Newmarket Road, Cambridge CB5 8PB.
Editorial copy deadline: First day of the month preceding the publication month

Advertisement sales
Display and sponsorship Jim Folley
jim.folley@redactive.co.uk
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Products & services Daniel Goodwin
daniel.goodwin@redactive.co.uk
Tel: +44 (0) 20 7880 6217
Recruitment advertising
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Tel: +44 (0) 20 7880 6215
Advertising production Jane Easterman
jane.easterman@redactive.co.uk
Tel: +44 (0) 20 7880 6248

Political frackricide

By the time you read this, the UK will have its third Prime Minister of the year. Liz Truss was finally forced to resign after the financial markets took umbrage at her £45bn of unfunded tax cuts in the mini budget, pushing the pound to its lowest level since decimalisation.

Rather than the economic growth she promised in her bid for the Tory leadership, Truss's time as PM will be remembered for fuelling inflation, hiking up the cost of borrowing and harrying the UK towards recession (construction product sales fell for the first time in more than a year last month).

This period will also be remembered for uncertainty. Truss's 45 days in office marked a shift away from the broadly green policies of her predecessor. She supported more North Sea gas and oil extraction, questioned the business case for net zero and advised the King not to attend COP27.

A vote on fracking precipitated her demise, with senior Tories refusing to vote against a Labour motion to ban shale gas extraction. They included Chris Skidmore, the man chosen by Truss to lead a review into net zero. He nailed his colours to the mast when he tweeted: As the former energy minister who signed net zero into law, for the sake of our environment and climate, I cannot personally vote tonight to support fracking and undermine the pledges I made at the 2019 General Election.

However green the new government turns out to be, there will be no reversing the march to net zero carbon, partly because industry and environmentalists are already in step low carbon equals lower energy costs and cleaner environments, and, consequently, more desirable buildings from the perspective of occupants and property agents. Industry is no longer waiting for government to act and is crafting a net zero carbon standard that will create a benchmark against which to judge all buildings.

And last month, David Partridge was appointed chair of the initiative's governance board. It's the perfect appointment as chairman of King's Cross developer Related Argent, he understands the synergies between the financial and property worlds that will help reward investors for backing greener performance.

Discussion around the Net Zero Buildings Standard will kickstart CIBSE's Build2Perform Live event on 29 30 November, at ExCeL London. Speakers will include government figures relaying the latest on the new building safety regime.

Governments may change, but laws are laws, and the Building Safety Act has sparked the biggest change to construction for a generation. Make sure you attend Build2Perform to keep up to speed with what's required.

ALEX SMITH, EDITOR asmith@cibsejournal.com

CONTRIBUTORS

Hywel Davies
Why many businesses still need to wake up to the challenges of the new Building Safety Regulator regime

Milena Stojkovic
How a new wellbeing tool may help organisations improve equity, inclusion and accessibility in the workplace

Clare Jackson
Why hydrogen could have a key role to play as part of the solution to decarbonising heating in the UK

Tim Dwyer
CPD module 205 explores the application of bivalent heat pump systems for heating and hot water

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FOR CIBSE
Journal production manager: Nicola Hurley
Tel: +44 (0)208 772 3697, **nhurley@cibse.org**
CIBSE, 222 Balham High Road, London SW12 9BS
Tel: +44 (0)208 675 5211

 ISSN 1759-846X

SUBSCRIPTION ENQUIRIES
If you are not a CIBSE member but would like to receive *CIBSE Journal*, subscribe now! Costs are £80 (UK) and £100 (international). For subscription enquiries, and any change of address information, please contact Nicola Hurley at **nhurley@cibse.org** or telephone **+44 (0)208 772 3697**. Individual copies are also available at a cost of £7 per copy, plus postage.

CIBSE Journal, ISSN 1759-846X (USPS 4070) is published monthly by CPL, 1 Cambridge Technopark, Newmarket Road, Cambridge CB5 8PB, UK.

Subscription records are maintained at CIBSE, 222 Balham High Road, London, SW12 9BS, UK.

ISSN 1759-846X (print)
ISSN 2756-1895 (online)

CREDITS
Cover image © Charles Hosea

iStock.com / Allinvisuality / Robert Breitpaul / Richard Johnson / Intpro / Deepblue4you / TebNad / Piranka

Credits / Getty images / Nigel Young / Foster + Partners / Michael Eleftheriades / Rod Edwards / Mark Siddall, LEAP / © Nick Kane Photography / © Ilya Ivanov_Tchoban Voss Architekten / © Buro Happold / Backdrop Productions / John Sturrock / Brendan Bell / Hufton and Crow / James Budgen / Peter Landers

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ABC audited circulation: 18,724 January to December 2021
Printed by: Warners Midlands PLC

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MAGDALENE COLLEGE WINS RIBA STIRLING PRIZE

The New Library, Magdalene College, Cambridge, has won the prestigious RIBA Stirling Prize.

Judges said the building, designed by Níall McLaughlin Architects, 'presents exceptional engagement with environmental design principles'.

Max Fordham provided M&E engineering and acoustics for the project.

The New Library was designed on passive principles and natural ventilation is provided by openable windows, louvres and high-level openings in the chimneys.

Dynamic modelling ensured that the large glazed areas and natural ventilation system did not lead to overheating in the summer.

Government launches review into net zero target delivery

Review will assess whether 2050 target is being delivered in 'pro-growth' way

The terms of reference have been published for the independent review, commissioned by business and energy Secretary of State Jacob Rees-Mogg, into the delivery of the government's net zero target.

Former Prime Minister Liz Truss announced last month, when unveiling the government's energy bills support package, that Bristol MP Chris Skidmore had agreed to lead the review.

The exercise, due to end by Christmas, will investigate whether the 2050 decarbonisation target is being delivered in a 'pro-business and pro-growth' way. It will assess how the costs of net zero technologies can be cut.

Businesses have been asked to give feedback on the challenges and opportunities surrounding the transition to net zero, as well as the barriers to decarbonising their operations.

Skidmore, a former energy minister, has been a prominent advocate of government action on net zero since returning to the backbenches in 2019. Last month he refused to vote down Labour's anti-fracking motion, defying the Conservative whip. In a Tweet, he said: 'I am prepared to face the consequences of my decision.'

Aims of the review

- Deliver maximum economic growth and investment across the UK
- Support UK energy security and affordability while increasing and strengthening UK energy production and supply
- Minimise costs borne by businesses and consumers, particularly in the short term

Partridge appointed net zero chair

David Partridge, chairman of Related Argent, has been appointed chair of the governance board for the UK Net Zero Carbon Buildings Standard. The standard is designed to develop a single, agreed set of performance targets to identify and verify whether buildings, both new and existing, are net zero carbon, addressing operational energy and embodied carbon emissions.

Partridge is a former chairman of the UK Green Building Council and immediate past president of the British Property Federation, and sits on the Construction Leadership Council's CO_2nstructZero advisory board.

A series of task groups, made up of stakeholders from across the construction industry, are being assembled to deliver elements of the proposed standard. They are expected to start work 'imminently' and produce their initial outputs next year.

Partridge said: 'If the real estate industry and built environment is to seriously address its impact on climate change, a universally adopted net zero carbon buildings standard is absolutely essential.'

IN BRIEF

Minister urges rethink on how to reach emissions goal

A minister has called for a government rethink on how it approaches reaching its goal of net zero emissions by 2050.

Steve Baker, appointed to the Northern Ireland office in the government reshuffle after Liz Truss became Prime Minister, was speaking during a fringe meeting organised by the influential Institute for Economic Affairs think tank at the Conservative Party conference.

He said he does not question climate change science or the government s commitment to cutting emissions to net zero in the long term. However, while renewables are great when they are available, he added, it is also a big problem that they are an intermittent source of power.

Baker said such energy projects require a lot of subsidies, pointing to the Renewables Obligation contracts from which the first generation of projects benefit, now superseded by the cheaper Contracts for Difference support regime.

Baker, who is chair of the Net Zero Scrutiny Group of Tory parliamentarians, said gas is needed for the transition to greater reliance on nuclear power.

Bim Afolami, chair of the Praseg renewable energy all party parliamentary group, told the same meeting that the UK should use as much... as we can of its abundant wind resources.

IN BRIEF

Embodied carbon targets under scrutiny

The Business, Energy and Industrial Strategy department says it will explore the potential of a future maximum embodied carbon level for new buildings, as previously outlined in 2021 s cross government Net Zero Strategy. The government also intends to consult in 2023 on measuring and reducing embodied carbon in the built environment.

Britishvolt in emergency fundraising talks

Britishvolt, the company planning to develop the UK s first gigafactory for producing car batteries, in Blyth, Northumberland, is reportedly holding emergency fundraising talks with car manufacturers and other investors. According to a report in the *Financial Times*, options being examined range from selling a minority stake to a full takeover of Britishvolt.

UK faces risk of power cuts over winter

Supplies under threat if European energy crisis worsens, says National Grid

The UK could face rolling power cuts during the upcoming winter if an escalation of the Europe-wide energy crisis means insufficient gas is available, the National Grid has warned.

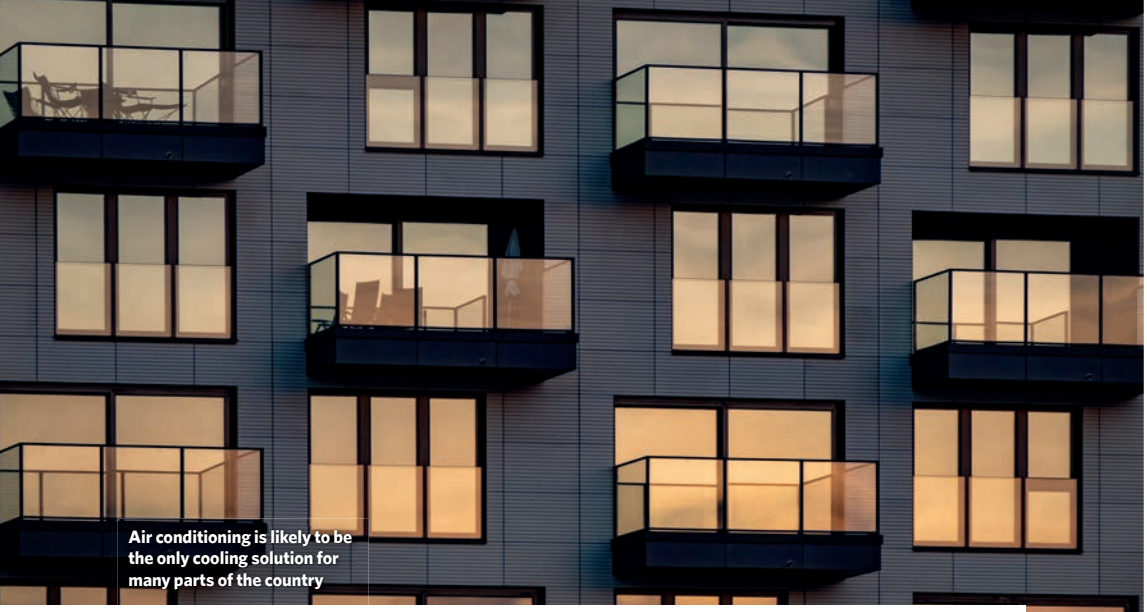
In its *Winter Outlook* report, published on 6 October, the Grid's electricity system operator (ESO) said its base case remains that power margins will be 'adequate' at 3.7GW of supply over demand.

To maintain security of supply, the ESO has signed contracts for 2GW with coal-fired power stations that would otherwise have closed. They can be fired up during the winter if supplies are tight and demand for heating and power is high.

In addition, the ESO is launching a Demand Flexibility Service, which offers customers incentives to cut their consumption at peak hours when margins are tight.

However, the ESO has also assessed the impact of a more extreme scenario in which supply constraints mean no electricity can be imported via interconnector cables from the European Union and insufficient gas supply is available because of an escalation of the energy crisis, knocking out around 10GW of electricity generation. In the event of such shortages, rolling blackouts may have to be instigated, lasting up to three hours, says the report.

Commenting on the report, Jess Ralston, senior analyst at the Energy and Climate Intelligence Unit, said: 'We didn't need to be here. Had investment in energy efficiency and onshore wind gone ahead over the past few years, we'd be much more certain about meeting demand. Every spin of a wind turbine and loft lagged means less gas we need to try to buy.'



Air conditioning is likely to be the only cooling solution for many parts of the country

Nine out of 10 UK homes will overheat at 2°C warming

Arup study finds smaller houses and flats are at greatest risk

A new report by Arup says nine in 10 existing UK homes will be at risk of overheating if worldwide temperatures rise to 2°C above pre-industrial levels, which is expected by 2050 if global warming continues on its current trajectory.

The study was carried out by Arup for the Climate Change Committee, and appraised current and future risks posed to the UK housing stock by summertime overheating.

Even if temperatures stay at current levels, the report says that 55% of UK buildings fail the criterion in CIBSE's TM59 guidance for assessing whether bedrooms are comfortable overnight during heatwaves.

The remaining 45% – which equates to 12.6m homes – require no mitigation because they pass the overheating risk criteria for both living areas and bedrooms.

Overheating risks are particularly high in the south of England, with London being the hottest spot, and are moderate in the Midlands and Wales under current weather conditions. However, if temperatures were to rise by 2°C above pre-industrial levels – the benchmark used to assess the impact of man-made warming – 92% of homes would fail the TM59 criterion.

Of these, 17%, mainly in London, would also fail the overheating criterion for living areas. No buildings outside Scotland would pass the criterion for bedroom overheating.

If temperatures rise by 4°C, all UK homes will be at risk of overheating, according to the report. In this worst-case scenario, virtually all homes in the UK will require adaptation – including in Scotland; air conditioning would be the only cooling solution in many parts of the country.

Arup says smaller houses and flats are the homes at greatest risk of overheating.

Its report says that rolling out a mass homes retrofit programme will be a 'challenge', but that designers can mitigate problems in buildings by maximising the use of natural ventilation.

Building safety regime must be firmly enforced, says Actuate

The government's new building safety regime will require firm enforcement to ensure it is not undermined by an 'unscrupulous' minority in the industry, Actuate UK has warned.

The engineering services umbrella body supports the legislation's focus on more rigorous enforcement in its response to the government's consultation on the implementation of the Building Safety Act and the new building control regime.

Actuate UK says the Hackitt Review's call for a golden thread, to ensure up-to-date and relevant building and safety records are easily accessible to all contractors, should apply to all buildings.

It endorses the move for the early appointment of subcontractors at all tiers to ensure their knowledge is presented at the design stage, but raises concerns that lack of clarity about the definition of 'designer' in the new duty-holder regime will discourage collaboration within the supply chain.

Dr Hywel Davies, chair of Actuate UK's Building Safety Group and technical director at CIBSE, said: 'The new requirements need clear guidance and firm enforcement to discourage the unscrupulous from undercutting the majority who want to reform the industry for the safety of all.'

IN BRIEF

HSE appoints Cath Noakes to review scienti c research

Professor Cath Noakes, who was one of the government s key advisers during the Covid 19 pandemic, has been appointed to chair a new scientific assurance committee for the Health and Safety Executive (HSE).

Professor Noakes, a ventilation expert at Leeds University s School of Civil Engineering, co chaired the Scientific Advisory Group for Emergencies environment and modelling sub group during the pandemic.

She also advised the NHS, the World Health Organization and several government departments.

Professor Noakes, who was made an OBE in 2020 for her services during the pandemic, will now chair a new Science Quality Assurance Group at the HSE.

The group of 12 scientists and engineers is being set up to provide the workplace regulator with independent assurance on the relevance and quality of its scientific research.

Members will be organised into four subgroups, tailored to cover the HSE s strategic objectives: health and safety, net zero, chemicals safety, and buildings safety.

Greater Manchester cuts public sector emissions

Annual emissions from more than 200 public sector buildings across Greater Manchester have fallen by the equivalent of 7,000 tonnes CO_2 equivalent per year.

Thanks to energy efficiency upgrades to buildings, funded by £78m from the government s Public Sector Decarbonisation Scheme, the city s public estate has reduced its energy use by more than 43 million kilowatt hours, saving around £2m across the city region per year.

Measures implemented include the installation of air source heat pumps, solar panels, insulation, LED lighting, and energy monitoring and control systems to accurately measure energy usage.

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CONSTRUCTION TO START ON MIDLOTHIAN WASTE HEAT PROJECT

Midlothian Council and Vattenfall Heat UK are to deliver low carbon heat to homes and businesses by tapping waste heat from sources such as redundant mines and sewers.

Their joint venture, Midlothian Energy Limited, will explore the capture of waste heat from industrial processes to supply customers via new district heating networks.

The initial phase will supply around 3,000 homes, education and retail properties in the new town of Shawfair. Waste heat from nearby Millerhill recycling centre and energy from waste incinerator will eventually supply 170,000 homes, and will be supplemented by the use of other sources, such as mine-workings and sewers.

Gas boilers installed in two-thirds of new UK homes

More than 70% of London new-builds linked to community heating schemes

New data compiled by the Office for National Statistics, after a request by the openDemocracy website, shows that mains gas is the main fuel or type of heating method in 64.6% of new homes completed in England and Wales during the 2022 financial year.

This dwarfs the proportion of English and Welsh homes that rely on community heating schemes (15.9%) or electricity (12.4%).

Outside of London, 72.6% of homes in England were connected to gas mains for heating. Within the capital, just 18.4% used gas for heating, compared with 72.2% that are connected to community heating schemes. The highest proportion of new homes heated by gas was in the North East (90.9%).

The data also shows that the proportion of homes in England and Wales reliant on gas boilers for heating had barely fallen since the previous year, when it was 65%.

In Germany, by contrast, just 16.2% of the approximately 60,200 residential buildings approved in the first six months of 2022 will be heated primarily with gas, according to Destatis, the Federal Statistical Office.

Under the Future Homes Standard, which is due to come into force in 2025, new homes will not be allowed to connect to the gas grid.

The Climate Change Committee has calculated that it is much cheaper to fit a new home with an air source heat pump and ultra-high levels of fabric efficiency than attempting to install them later.

Call for 1m hydrogen homes by 2035

A new report says the government should set a target for one million homes to be heated by hydrogen by 2035.

Launched at an event at the Conservative Party conference in October, the report – by trade body Hydrogen UK (HUK) – sets out wide-ranging recommendations to accelerate the development of the industry.

To foster demand, it not only recommends the one million homes target, but also calls on ministers to commit to funding two hydrogen villages and to mandate that all gas boilers sold from 2026 are hydrogen-ready.

To scale up production rapidly, the report recommends awarding hydrogen business model contracts to producers by early next year.

HUK CEO Clare Jackson said: 'If we truly want Britain to secure a slice of this $2.5tn global hydrogen pie, we need to get our skates on, because we are competing with other countries for investment.' Read more on page 61.

Clare Jackson

IN BRIEF

Government backs 24 heat pump projects

The government has awarded £15m of funding from its Heat Pump Ready programme to 24 projects. Among the schemes being supported by the second stream of the £60m programme are a project in Harrogate, North Yorkshire, that uses data from smart meters to optimise the running of a heat pump in a household energy system. Another scheme, in Truro, Cornwall, is looking to develop efficient and ecological refrigerants for use in heat pumps. The government programme backs innovations designed to reduce barriers to the rollout of the low carbon technology,

Bristol s WSHP energy centre crowned best in Europe

A project in Bristol that features the largest water source heat pump (WSHP) in England has won a Europe wide award. Castle Park Energy Centre received the Heat Pump City of the Year accolade at the 2022 European Heat Pump Association awards. The centre contains a 3MW water source heat pump, which takes heat from the city s floating harbour to heat thousands of households connected to Bristol s expanding district heating network. It was developed through a collaboration between Bristol City Council, Goram Homes and Vital Energi.

Construction product sales fall in Q3

Construction product sales fell for the first time in two years in the third quarter of 2022, according to the Construction Products Association s latest State of Trade Survey.

The survey also indicated a slowdown in construction activity in the publicly financed and repair and maintenance sectors since summer. That, and the UK s deteriorating economic backdrop, were informing manufacturers expectations of a contraction for the year ahead.

In the third quarter, 12% of heavy side manufacturers reported that sales of construction products had declined the first fall since the nationwide lockdowns in the second quarter of 2020. In addition, 17% of light side manufacturers reported that product sales rose, which marked the lowest balance in two years.

The survey suggested that demand was viewed as the key constraint on manufacturers activity; 53% of heavy side firms anticipated a decrease in sales over the next 12 months. On the light side, a balance of 13% of firms anticipated a decline the first negative view since the height of the Covid 19 disruption in 2020.

Scrapping of zero carbon standard 'adds £791m to bills'

More than 1m homes have been built since standard was removed in 2016

English households living in new build properties have had £791m added to their energy bills since 2016 as a result of the government's decision to scrap its Zero Carbon Homes Standard, according to new figures.

An analysis carried out by the Liberal Democrats shows that 1.2m homes have been built since the standard, which was due to come into force in 2016, was axed by the Conservative government.

Based on an estimate in a recent report by the Energy Climate Intelligence Unit, which said that those living in zero carbon homes would have saved around £200 on their annual energy bills, the Lib Dems have calculated that the total saving over the past six years would have been £791m. In 2021 alone, according to their analysis, households would have saved £234m.

Wera Hobhouse, Liberal Democrat climate change spokesperson, said the 'shameful' scrapping of the zero carbon standard had left people living in poorly insulated homes, making them 'even more vulnerable to soaring energy prices'.

'The Conservatives are more interested in cosying up to their property developer friends than slashing people's bills and tackling the climate crisis,' she said.

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Five win CIBSE Silver Medals

Tony Sung CEng FCIBSE. In 1981 Tony taught the first MSc building services degree course in the UK, at Heriot Watt University. He also developed the first MSc sustainable electrical building services engineering course. He was chair of the CIBSE Electrical Services Group, a CIBSE Board member, a membership interviewer and an accreditation panel member. Citation by Leon Markwell.

David Stevens CEng FCIBSE. David serves on the CIBSE Board, is vice chair and secretary of the FM Group and a membership interviewer. He is a leading author for CIBSE Guide M and was awarded a presidential commendation in 2021 for the Emerging from Lockdown series. Citation by Sebastian Gray.

Gary Jones CEng FCIBSE. Gary was CIBSE Southern Region chair twice. He was instrumental in establishing the YEN Southern Region group in 2014. He is actively involved in the CIBSE Education and Learning Group and is currently chair of Constructing Excellence Hampshire. Citation by Peter Prentice.

Paul Angus CEng FCIBSE FSoPHE. Paul has more than 20 years experience leading and managing complex projects, with his key discipline being in hydraulics (public health) engineering. He has been a volunteer on CIBSE committees since 2006, as CIBSE New South Wales chair and ANZ chair, and is currently ANZ treasurer. Citation by Mark Crawford.

Martin Liddament FCIBSE. Martin joined the Air Infiltration and Ventilation Centre or AIVC in 1980, becoming its head in 1986. He has contributed to a number of CIBSE s publications, including Guide A, B and Applications Manual 10. He began publishing the *International Journal of Ventilation* in 2001, editing it for 14 years. Citation by Chris Iddon.

UCL wins Happold Brilliant Award

University College London was awarded the Happold Brilliant Award in recognition of excellence in the teaching of building services engineering. The award was presented to Dejan Mumovic on behalf of the university by Priti Parikh.

Annual event celebrates engineering excellence

Three Gold Medals and five Siver Medals presented to recognise achievements

Three Gold Medals and five Silver Medals were presented at the annual President's Awards Dinner last month. The Gold Medal was presented to George Adams FCIBSE, Tim Dwyer FCIBSE and Liz Peck FSLL, who died in 2020.

The medals are presented to those who have demonstrated an exceptional commitment, dedication and service to the Institution and the wider industry.

George Adams (centre) with CIBSE President Kevin Mitchell (left) and David Hughes

Liz Peck FSLL

Tim Dwyer (centre) with Terry Giles (right), who read the citation

Silver Medals were awarded to Tony Sung FCIBSE, David Stevens FCIBSE, Gary Jones FCIBSE, Paul Angus FCIBSE FSoPHE and Martin Liddament FCIBSE (see left).

Basem Ghanemi Pilar was awarded the CIBSE Undergraduate Award (right), and University College London won the Happold Brilliant Award.

Gold medals

George Adams CEng FCIBSE George's career started in the building services division of Matthew Hall in 1973 as an apprentice, where he still works today as director of energy and engineering. He joined CIBSE in 1981, becoming a Fellow in 2012 and President in 2013. George is chair of the Cities and Climate Change Group and was fundamental in the formation of what is now the Inclusivity and Diversity Panel. He chairs the CIC Green Construction Panel. He has also been involved in the post-Grenfell Tower work around engineering competence.

Liz Peck FSLL Liz started her career on the sales desk at Concord, before joining the design team at Marlin following a merger. After a move to Philips, Liz studied for a Master's in architecture light and lighting at UCL. She set up her own design practice and became SLL President in 2015. Her presidential year coincided with the UNESCO International Year of Light, when SLL organised the Night of Heritage Light. Liz was named Lux Person of the Year 2015. In 2020, Liz made a huge contribution to *SLL Guide to protecting the night-time environment*, before she died.

Tim Dwyer CEng FCIBSE For more than 20 years, Tim has led the CIBSE ASHRAE Group to foster information exchange. He has been involved in the CIBSE ASHRAE Graduate of the Year since it launched. For the past five years, he has been managing editor of *BSER&T*, and is technical editor on the *CIBSE Journal*. Tim has chaired the CIBSE Technical Symposium for 10 years. His lecturing at LSBU and UCL has been an inspiration to several generations of engineers.

Presentations were also made to the winners of the four awards for technical papers and the Ken Dale Travel Bursary 2022, details of which were reported in the October and September *CIBSE Journal* respectively.

- **See citations and winners' responses at www.cibse.org/presidentsawards**

Basem Ghanemi Pilar (centre) with CIBSE President Kevin Mitchell and CIBSE CEO Ruth Carter

Basem Ghanemi Pilar wins President s Prize

John Moores student impressed judges with his heat pump project

Basem Ghanemi Pilar, from Liverpool John Moores University, was awarded the CIBSE Undergraduate Award 2022 at the President's Dinner.

Ghanemi Pilar, who is studying for an MEng in architectural engineering, won with his final-year project titled *Making the most out of heat pumps*. His project looked at improving the heating systems of a campus building completed in the late 1960s.

The judges selected Ghanemi Pilar's project for its topical and relevant subject matter, its depth of research, and its benefit to our collective strive towards net zero carbon. He was presented with a cheque for £500 and a certificate. The runners-up were Deepak Sadhwani and Wei-Ting Dai. A trophy was also presented to Laurence Brady on behalf of John Moores University in acknowledgment of its achievement.

The award recognises excellent understanding, application and analysis of building services engineering, science and design. It is awarded to a final-year student of a CIBSE-accredited building services course for academic achievements.

It also acknowledges the work of the university where the winner studies, and the essential role played by quality academic education in building services.

YEN stages first Careers Day

CIBSE's Young Engineers Network (YEN) hosted its first ever Careers Networking Day in October, to help support and boost the careers of student, graduate and apprentice engineers.

The event, which took place at Park Row, London, saw 13 engineering companies and employers come together to share information about their work and the opportunities they offer to graduates and early years engineers.

The young engineers benefited from the opportunity to speed network with employers, build their soft skills, hear from sector leaders and engage with the YEN Global committee.

The event was followed by the YEN Gala, attended by more than 220 young engineers, which featured an immersive DC Universe-inspired evening celebrating all young engineering heroes.

Linking to the CIBSE 125th anniversary theme, Gemma Taylor, YEN Global chair, called guests to 'inspire the next generation of climate heroes'. She said: 'We are the next generation of engineers; we are the ones who will engineer our future and fight the climate crisis and, without us, the industry could not evolve and grow.'

YEN is a growing global community of engineers in the first 10 years of their career, coming together to share ideas.

● For more information about YEN, visit **www.cibse.org/yen**


Left to right: Samreet Singh, CIBSE Ireland YEN vice-chair; Gemma Taylor, CIBSE YEN Global chair; Ryan Loney, CIBSE Ireland YEN chair; and Nizam Ahmed, CIBSE UAE YEN chair

IN BRIEF

New publication on medium voltage distribution

A new applications manual on medium voltage distribution has been produced by CIBSE Knowledge.

AM18.4 Medium voltage distribution: fault calculations is the fourth part of the medium voltage distribution series, and covers fault calculations and their application on protection devices for industry standard distribution configurations.

Energy efficiency and Building Safety Act top 2022 training

Courses covering energy efficiency, the Building Safety Act, embodied carbon, and heat networks are among the most popular CIBSE training courses for 2022.

These remote training courses, are also joined by the on demand training covering ventilation design, introduction to mechanical and electrical building services, and hot and chilled water pipework systems.

Overall, 1,456 people have received CIBSE training so far in 2022.

CIBSE Training also launched three new courses in 2022: Energy efficiency related Building Regulations: Part L; Introduction to the Building Safety Act; and Circular economy in lighting and building services.

The 2023 training brochure will be released in November. Visit **www.cibse.org/training**

Call for Training Peer Review Panel members

Are you passionate about development within the building services engineering profession? Apply to become a member of the Training Peer Review Panel and help develop and improve the training programme delivered by CIBSE Training. Visit **www.cibse.org/training/training peer review panel**

Clarification

In the interview with Professor Derek Clements Croome last month, the author Dr Yangang Xing should have had the title of co opted chair of the Building Intelligence Group.

Employees at FairHeat, the CIBSE Employer of the Year 2022

FairHeat triumph at CIBSE Young Engineers Awards

Heat network specialist also wins in small company category at annual employer awards

FairHeat has been named CIBSE Employer of the Year 2022 at the Young Engineers Awards, for its outstanding commitment to developing young engineering talent.

FairHeat also won the small company category once again, having taken the title in 2019 and 2021.

CWP was the winner in the medium company category, with Aecom taking the large company title.

Aligned to the CIBSE 1-2-5 challenges, employers were asked to demonstrate how they boost their young engineers and place them at the centre of their business, investing in their career progression.

FairHeat demonstrated its commitment to developing young engineering talent and creating opportunities for young people to thrive. A core principle is 'to develop the industry leaders of tomorrow'.

Of its 37 employees, some 70% are either in or have been through their graduate programme in the past five years.

In the past year, 12 of their young engineers reached out to their universities and presented building services as a career. As a result, FairHeat has hired nine new graduates to enrol in the 2022 scheme.

FairHeat has also co-founded Diverse Heat Network, a collection of organisations with a shared ambition to enable change and attract a diverse workforce to the sector. They run a summer internship programme and support secondments across other companies.

CWP's submission said: 'Our drive and passion is to provide opportunity and development for all'.

The company encourages all its young engineers to take part in careers fairs at local schools and colleges, offer work experience placements and deliver talks in schools.

It offers internal training, with each trainee being allocated a mentor. Once trainees have completed their HNC they have the option to progress to university, something which is open to all its engineers at any stage of their career.

Aecom's entry highlighted its culture of training development, which was established to support and boost early career engineers. It offers soft-skills training and aims to turn graduates and apprentices into STEM ambassadors ready to inspire the next generation.

They have a Young Engineers Forum, which now has more than 150 members across the UK and Ireland.

CIBSE President Kevin Mitchell emphasised the difference a supportive employer can make.

'In my experience, recognition at the early stages of your career can act as a motivator, contributing to a feeling of being valued, inspired, and supported within your field,' he said. 'My employer provided me with opportunities, just as our shortlisted employers are making a difference to their graduates and apprentices.'

The awards took place on 11 October at the RIBA, London. They were delivered in partnership with ACV, Ideal Heating, Lochinvar, Swegon, Viega and CIBSE Patrons.

● To find out about the winners of the Young Engineers Awards see page 18.

From left: Gareth Jones and Lucy Sherburn of FairHeat with CIBSE President Kevin Mitchell

From left: Mike Burton and Leon Bateson of Aecom, with Kevin Mitchell

Kevin Mitchell with Carl Standley, director at CPW

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WINNING TOGETHER

Inspiring engineers to collaborate on high performing buildings was the theme at this year s Young Engineers Awards. **Alex Smith** reports

The 27th staging of the Young Engineers Awards attracted more than 200 people to RIBAs headquarters to see the industry s best apprentices, graduates and employers rewarded for their talent and hard work.

The awards were presented by CIBSE President Kevin Mitchell FCIBSE. He triumphed at the first Graduate of the Year Award in 1995, so is the perfect inspiration for young engineers aiming to reach the top of their profession.

This year, eight graduate finalists faced the judges to try to impress them with their thoughts on what inspires engineers to work collaboratively and holistically to deliver high performance buildings.

The deserved winner was Sana Hafsa, a graduate of Heriot Watt University, Edinburgh, and, since July, a sustainability coordinator at AESG in the Middle East.

Runner up was Conor Deane, a graduate of the National University of Ireland, now working for JV Tierney & Co. Consulting Engineers. Eyob Kibrom, London South Bank University (LSBU) graduate, now employed by Aecom, was third.

In the Apprentice Awards, entrants submitted videos of themselves describing their achievements. Harvey Hudson, of Vital Energi, was CIBSE Apprentice of the Year Technician (Levels 3 4), while the CIBSE Apprentice of the Year Degree (Levels 5 7) accolade went to Louis Kimber, of Atkins.

Hafsa s passionate and riveting talk focused on how Heriot Watt students had collaborated to deliver an innovative solar powered demonstration home as part of the Solar Decathlon Middle East 2020. An architectural engineering graduate, Hafsa led a team of 120 cross disciplinary students from the UAE and Scotland to build the solar home in Dubai.

She told the audience that every successful project for a high performing building had a vision shared by all team members: With

Graduate winner Sana Hafsa with CIBSE President Kevin Mitchell FCIBSE and past ASHRAE President Sheila J Hayter

CIBSE YOUNG ENGINEERS AWARD WINNERS AND RUNNERS-UP

CIBSE ASHRAE Graduate of the Year 2022
Winner: Sana Hafsa, AESG and Heriot-Watt University
Second place (£600 prize provided by the CIBSE Patrons): Conor Deane, JV Tierney & Co. Consulting Engineers and National University of Ireland
Third place (£300 prize provided by the Manly Trust): Eyob Kibrom, Aecom and LSBU
CIBSE Apprentice of the Year Technician (Levels 3-4)
Winner: Harvey Hudson, Vital Energi
Second place: Xantha Smee, Otis
Third place: Daniel Bailey, Derry Building Services
CIBSE Apprentice of the Year Degree (Levels 5-7)
Winner: Louis Kimber, Atkins
Second place: Lewis Coleing, CPW
Third place: Matthew Nash, Jacobs

The awards ceremony was held at RIBA headquarters for the first time

a vision consistent through all the stages, from the briefing to actual operations, that is when you can create a truly holistic project, where every single discipline collaborates in the most efficient way possible.

The aim was to introduce timber and innovative M&E technologies into the UAE and for team members from academic disciplines to gain experience on a live project. The university built and designed the pilot home itself and gained the support of 40 partner organisations.

Hafsa said the vision had to encompass the views of every team member, which included academics from a range of disciplines, including structural engineering, mechanical engineering and data science. To create that building, we had to consider all perspectives, she added. They are all important.

Interactive workshops at the design stage ensured everyone had an input, said Hafsa. We want to make sure that the project we re creating has everyone involved from the start. For example, if you commission agents earlier, you are far less likely to have issues in your actual operation of the building. Feeding information from the end user back into the design process is also key, she added.

The project was successfully completed and demonstrated at Expo 2020 Dubai, where Hafsa appeared as a panellist in a Future Skills conference. The project is still live and the team hope that a developer will take it on to demonstrate new solar technologies.

Runner up Deane used an analogy of climbers scaling a mountain to demonstrate the challenge engineers face in delivering high performance buildings.

We re the mountaineers. We are a diverse group of people men and women from all cultures and nationalities, he told the audience. We are problem solvers, and we re creative and innovative. We think outside the box and are curious. He said it was up to engineers to lead high performance teams, and overcome the challenges along the way, which he summarised as the three Cs: climate change, comfort and costs comfort.

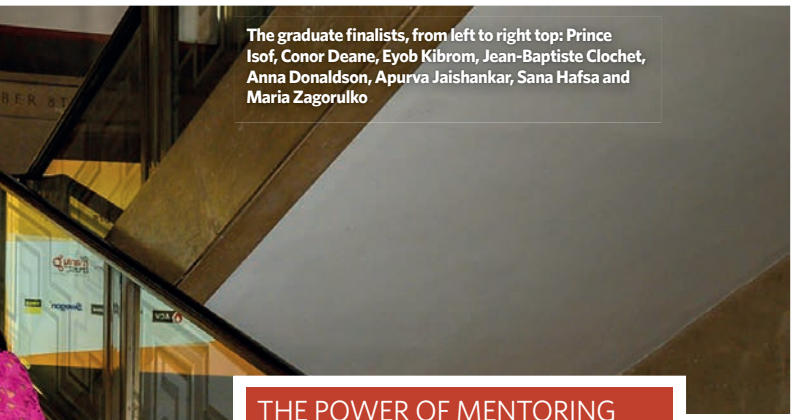
Without engineers, the summit would never be reached, said Deane, and he warned: If we don t act now, there may be no mountain to climb.

Kibrom s presentation was judged the third best of the evening. The LSBU graduate highlighted staff shortages in the industry and noted that 19.5% of engineers in the UK were set to retire by 2026. The experience gap could be solved by engineers sharing information and knowledge across generations and between disciplines, he added.

Disciplines have a lack of awareness of other disciplines. They work in their own bubble and have little say or knowledge about other disciplines, said Kibrom.

He suggested employers have a rotation programme across disciplines, and that companies identify and reward individuals for their contribution towards delivery of high performance buildings.

Hafsa will be enjoying a paid trip to the ASHRAE Winter Conference in Atlanta next February. Details of all the other winners and awards are in the panel opposite. CJ



The graduate finalists, from left to right top: Prince Isof, Conor Deane, Eyob Kibrom, Jean-Baptiste Clochet, Anna Donaldson, Apurva Jaishankar, Sana Hafsa and Maria Zagorulko

THE POWER OF MENTORING

Panellists, from left: Joe Russell, Laura Mansel-Thomas, Gemma Taylor and Mike Burton

While the judges decided on the winning graduate, CIBSE chief executive Ruth Carter chaired a debate between engineers on the power of mentoring to inspire the next generation.

Ingleton Wood partner and CIBSE Board member Laura Mansel-Thomas, CEng FCIBSE, said that while engineers were usually good at talking, it was listening that was the key skill for being a mentor.

'A mentor should be someone who can listen and anticipate,' added Joe Russell, SoPHE YEN chair and public health engineer at WSP, while Aecom director Mike Burton said that, as a mentor, he appreciated learning other people's perspectives.

On the question of having internal or external mentors, Russell said mentoring outside of work meant you weren't hindered by your workload. 'It's nice to have a break and separation from your job,' he said.

If you're not dealing with a mentor day to day, you can be much more honest, agreed Burton.

Gemma Taylor, MCIBSE, said she liked what she called 'unstructured mentorship', where you are learning something from others every day, without the formality of a one-to-one chat. 'It's not about putting too much pressure, but allowing yourself to absorb experiences,' she said.

Burton reminded the audience that the CIBSE Fellows network was, in part, a mentoring programme. 'That's available for all our CIBSE members. Do make the most of them,' he said.

For 2022, CIBSE s Build2Perform Live conference and exhibition has moved to ExCeL London and will be the biggest event of the year for the building services industry. **Alex Smith** scans the programme and picks out some of the highlights

EXCELLENCE IN ENGINEERING

Building safety, decarbonisation of heat and embodied energy are just some of the hot topics being tackled at CIBSE s Build2Perform Live taking place on 29 30 November at ExCeL London.

The largest building services event in the calendar is back with a bang after a three year hiatus. The move to ExCeL London coincides with the arrival of Crossrail at the venue, allowing delegates to reach Build2Perform from central London via Custom House station in a little over 10 minutes.

Visitors to the Build2Perform conference and exhibition will experience the full breadth of the building services industry: during the two day event there will be 60 hours of approved CPD, more than 80 speakers and around 60 exhibitors.

Build2Perform will also see the welcome return of the Society of Digital Engineering (SDE) Awards and the Building Simulation Group Awards, which has a Young Modeller Award as well as an overall Building Simulation Award. In the SDE awards, judges are looking for examples of digital excellence across the whole built environment industry (see panel).

The CPA's Peter Caplehorn

The conference programme kicks off on Day 1 with a panel discussion on the cross industry initiative behind the UK s Net Zero Carbon Buildings (NZCB) Standard.

Speakers will include Clara Bagenal George of Elementa and LETI, CIBSE s Julie Godefroy and Related Argent s David Partridge, who was appointed chair of the NZCB last month. The panel will discuss the latest developments on the NZCB standard and what it will mean for designers and installers.

In the morning, the HSE will be highlighting the most key aspects of the Building Safety Act and how the new regime will impact the design, construction and operation of all buildings not just those deemed to be higher risk. A keynote address before lunch will look at the role of the HSE and the Building Safety

A session from a previous Build2Perform Live

Regulator and will discuss how the golden thread will work. Another session will cover the requirements of the dutyholders who are responsible for the building s safety at different project stages.

Product safety is also tackled in a discussion featuring the Construction Products Association. It recently recommended a single standard for construction product competence that aims to ensure that anyone who supplies, uses or works with construction products is properly assessed and deemed competent to do so.

On Day 2, the requirements for fire safety information will be discussed, with an overview of BS 8644 1:2022. Mechanical building engineers have been getting to grips with the increasing electrification of buildings and a session on this topic on Wednesday will feature the authors of CIBSE s roadmap to electrification, TM67.

The discussion will cover electric vehicles and the opportunities and challenges around charging provision.

Also on Day 1 will be a session on Future Heat and what heating in new and existing homes and offices will look like as we journey towards 2050 net zero carbon targets. A session on heat pumps will feature a look at recent CIBSE guidance on designing heat pumps for homes and non domestic buildings AM16 and AM17.

As well as hosting the Digital Awards, the SDE will be running sessions on the software tools that can increase productivity, save time and cut costs. The Knowledge Toolbox on Day 1 will give an overview of the tools available and will demonstrate TM65 a calculation methodology for embodied energy.

The SDE will also explain how CIBSE s Software Verification Assessments (SVAs) work, and how the awarding of a SVA logo proves that digital products perform according to CIBSE guidance. There is also a discussion on the future of information management and exchange.

On Day 2, Clara Bagenal George and Will Arnold, of the Institution of Structural Engineers (IStructE) will provide the latest technical overview of work on calculating embodied carbon and will set out the urgent need to regulate. The Society of Light and Lighting will present its TM66 guidance on embodied carbon in lighting on the first day.

A session on overheating will feature a new report from Arup that has found that 90% of homes in the UK will overheat by 2050 (see news on page 9). Speakers will also look at the prevalence of overheating in existing stock and the Good Homes Alliance guidance on new build and existing stock.

Register for a free place at www.build2perform.co.uk CJ

Around 60 exhibitors will be at Build2Perform Live

THE SOCIETY OF DIGITAL ENGINEERING AWARDS RETURN

The fourth SDE Awards will be held at Build2Perform at ExCeL London and entries are now invited from across the full spectrum of the built environment.

This is a change from previous awards which have focused on Building Services specifically. The SDE wants to recognise the progress of digitalisation across the whole industry. The awards look to recognise anyone who works in the built environment who is contributing to the digitalisation of what we do, where we live and how we experience it. That could be a technician, engineer, developer, designer, contractor, manufacturer or any group or team who are making a difference in their field.

The awards will take the same format as in previous years. Entries will be accepted up until 14 November, when judging will start, and the winners will be announced at this year's Build2Perform event.

From all the category winners the Digital Champion of 2022 will be chosen. This will be the entry that judges feel best exemplifies what the Society of Digital Engineering stands for and whose contribution to industry deserves special recognition.

As well as the presentations in the two main theatres, there is a packed CPD programme over the two days across three theatres. It's the ideal opportunity to contribute to the 21 hours of CPD activity required by CIBSE every year.

To enter the awards visit bit.ly/CJNov22SDE.

Time to act on safety

A recent survey of building services firms reveals that 70% are doing nothing as a business to prepare for the Building Safety Act. Hywel Davies explains why this should be of serious concern to all *Journal* readers

Regular readers already know that the Building Safety Act, which became law more than six months ago, is the most fundamental reform of the regulation of building work in England and Wales since World War II.

It establishes the Building Safety Regulator (BSR), with a statutory duty to exercise its powers to [secure] the safety of people in or about buildings in relation to risks arising from buildings, and [improve] the standard of buildings . It also allows competence requirements to be imposed in relation to any building work regulated by the Building Act.

In spite of this, it is obvious that most of the industry is sleepwalking into the brave new world of the BSR, ignoring or unaware of the changes that will affect them soon. In conversation with a CIBSE Regional chair, it emerged that their organisation, a significant public sector building operator, had been advised by health and safety experts that they only had one building covered by the act.

It is obvious that most of the industry is sleepwalking into the brave new world of the BSR

There is a widespread myth that because the Building Safety Act is the government s response to the tragedy at Grenfell Tower, and that was a high rise block of flats, the act is all about making blocks of flats safer. Believe me, that is a fantasy, wishful thinking even.

While the act would not have happened without the dreadful loss of life at Grenfell Tower, it is formally the government s response to the *Independent Review of Building Regulations and Fire Safety* by Dame Judith Hackitt in 2018.

In her foreword, Dame Judith said: What is described in this report is an integrated systemic change, not a shopping list of changes that can be picked out on a selective basis. The government accepted the report and all its recommendations, and the act is introducing that integrated systemic change and it applies to all regulated building work.

Those who think I am a fantasist, making this up and that it s all about tall blocks of flats should turn to the consultation on implementing Part 3 of the act, which is about changing the Building Act 1984 and Building Regulations 2010.

This sets out how the government intends to implement the act in 2023. These are the government s words:

2.1 The Building Safety Act 2022 amends the Building Act 1984 to create powers to prescribe requirements on those who procure, plan, manage and undertake building work, also known as dutyholders. The proposals will set out a framework of duties for dutyholders, make clear who they are, and impose specific duties on them. These dutyholders will be the client, principal designer, designers, principal contractor and contractors.

2.2 Our proposals also include the competence requirements on anyone carrying out design or building work, and those who appoint them, to take reasonable steps to ensure that they are competent to perform their functions in relation to the design and construction of buildings.

Section 2.3 will set out proposed requirements which will apply in relation to any work or matter to which the Building Regulations 2010 are applicable.

So, there in black and white are the new dutyholder requirements to be set out in regulations,for any building work to which the Building Regulations apply . If your firm does such work, then the Building Safety Act will change the way you work. Clients that procure building work will have to start taking reasonable steps to ensure that [those you employ] are competent .

If your organisation is one of the sleeping 70%, you need to wake up now. Put section 2 of the consultation document in front of the key decision makers, and ask them what they are going to do, now, to prepare.

The new regulations are due next spring. It s time for all in the industry to act. Today.

- The CIBSE and Actuate UK responses to the consultation on implementation of Part 3 of the Building Safety Act is available at **bit.ly/CJNOV22HD1**
- CIBSE offers an introductory one-day course on the Building Safety Act. For more details see **bit.ly/CJNOV22HD2**
- Read coverage of the CIBSE FM Group's event on the Building Safety Act on page 24.

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

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DAME JUDITH S URGENT APPEAL

Dame Judith Hackitt and **Sir Ken Knight** told an audience at a recent CIBSE FM group event they must be ready to respond to upcoming consultations on the implementation of the Building Safety Act. **Juliet Rennie** reports

Dame Judith Hackitt has urged construction professionals to act now on building safety rather than wait for legislation supporting the Building Safety Act to be published.

At a CIBSE FM group event, Dame Judith, who chaired the review of safety following the Grenfell Tower fire, said it was important for the industry to share its expertise and knowledge by responding to the secondary legislation consultations, which are due in the coming months.

The event took place at Sodexo s London offices in September and was hosted by Sir Ken Knight, chair of the Independent Expert Advisory Panel at the Ministry of Housing, Communities and Local Government (now the Department for Levelling Up, Housing and Communities).

He started by reiterating the Building Safety Act as the foundation for the urgent cultural change needed to ensure better building safety.

Sir Ken emphasised that the scope of the Act and associated regulatory bodies extends to all buildings, not just those categorised as higher risk. Importantly, he said, residents in higher risk buildings will also have more say in how their buildings are kept safe, with the ability to relay safety concerns to the accountable person(s).

Sir Ken introduced Dame Judith Hackitt. She began by recognising the ongoing industry work being done to drive change, which includes the development of new competency frameworks and guidance for the built environment industry.

Dame Judith said the initial response to the Building Safety Act demonstrated a need to rebuild confidence in the investment sector. There is work to be done to change perceptions and regain trust, she said.

Concerning the new Building Safety Regulator, which sits within the HSE, Dame Judith alluded to the differences in approach that can be expected as part of the new regime. A retroactive adherence to rules will not fly; instead, the requirement will be to demonstrate how safety requirements are met before anything can be progressed.

Along with financial stakeholders, Dame Judith emphasised that the Building Safety Act is also about regaining public trust. Having strong regulations and regulators is important, but ultimately, it s trust in those carrying out the work that will make the difference.

Dame Judith urged the audience to engage with the ongoing government consultations around the secondary legislation.

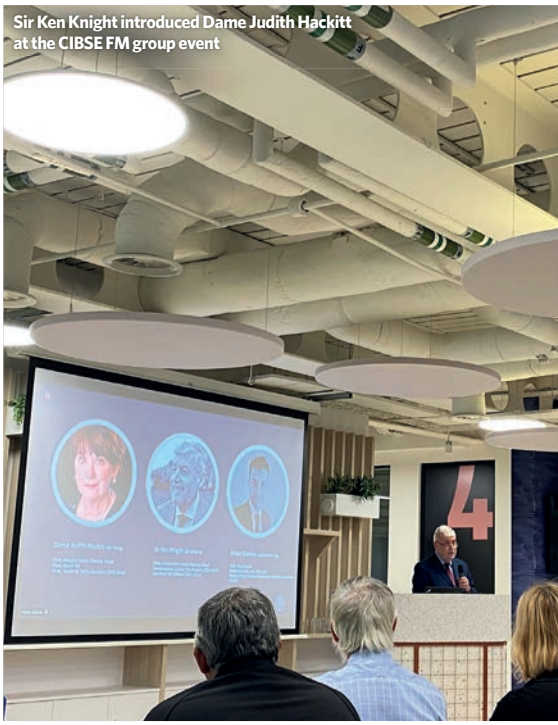
She highlighted the vital role of industry in sharing its expertise and knowledge, influencing how these changes are adopted, in practical terms. It will not be watered down, but Dame Judith said the industry can feed back on what they believe are the most realistic ways to enact these vital changes.

With that in mind, Dame Judith also strongly encouraged those concerned to act now, rather than wait for the secondary legislation. The Act applies to both future and existing buildings. There are a lot of lessons that can be learnt from the way the Regulator reacts to new buildings, regarding applying the same reforms to existing building stock.

Echoing Sir Ken s earlier reference to requirements around resident engagement, Dame Judith praised those in local authority and the construction sector who have started work on developing robust consultation processes with residents.

Addressing FMs specifically, Dame Judith highlighted that historically, the HSE has demonstrated a proportionate approach, and she believes this also applies to what is achievable within an existing building.

However, the responsibility to understand



Sir Ken Knight introduced Dame Judith Hackitt at the CIBSE FM group event

We need to bring together the requirements to reduce carbon emissions and address the need for improved air quality

what is required lies with the accountable person(s) and dutyholders. You will be required to demonstrate how you are managing safety in your building.

In summary, Dame Judith identified the six key questions that those working in the building environment industry need to be able to answer (see panel Do you understand the Building Safety Act? .)

CIBSE is totally committed to working with our members, their employers, government, including the new Building Safety Regulator, BSI as the National Standards Body and all interested parties to deliver a system of building legislation that delivers safe and sustainable buildings.

We need to bring together the related requirements to reduce carbon emissions from building stock and address the need for improved indoor environmental air quality, in our buildings in future.

It is essential that a systems based approach is adopted to address the interventions needed to remediate unsafe cladding and reduce carbon emissions from buildings, and that these are not addressed as separate issues. CJ

■ See the latest information from CIBSE on the Building Safety Act via **www.cibse.org/policy-insight/key-policy-areas/building-safety-act**

DO YOU UNDERSTAND THE BUILDING SAFETY ACT?

1. **Do you understand how the relationship with the Regulator is going to change and what it means to you and your organisation in terms of presenting your case to them?**
2. **What is your strategy in terms of improved resident engagement and ongoing communication?**
3. **What steps have you taken to document, report and store information relating to the safety of your buildings, ensuring it is digitised and accessible?**
4. **What are you doing about training your staff and understanding the required levels of competency to carry out your jobs?**
5. **What is your strategy regarding communication with stakeholders and your commitment to delivering improved safety?**
6. **Are you engaging with the secondary legislation and consultation process? This will help you to be better informed and to influence changes if you think there is something more workable.**

The importance of accreditation

Third party accreditation plays a key role in ensuring competence of smoke control specialists, says the Smoke Control Association s **David Mowatt**

The launch of the Building Safety Act, introduced in response to the Grenfell Tower tragedy and Dame Judith Hackitt's *Independent Review of Building Regulations and Fire Safety*, is the most significant reform of the industry in a generation and represents a new era in the design, management and construction of buildings in England.

As part of a raft of newly introduced measures and procedures, a Building Safety Regulator will be tasked with overseeing the safety and performance of all buildings, including making key regulatory decisions on residential high-rise buildings.

Though these changes have been well received by industry stakeholders there have also been questions around UKAS-accredited schemes, such as the SCA developed third-party SDI 19 Certification scheme, and the role they play in promoting industry competence.

In response, the government has now recognised the important role that third-party accreditation for the assessment of competence can play, stating: 'To ensure equivalence and consistency, we expect these organisations [which assess individuals as competent against their sector-specific competence frameworks] to be third-party accredited by a publicly recognised body such as UKAS or the Engineering Council.'

As part of a long-standing campaign to raise standards in the sector, all SCA members who install smoke control systems have long been required to apply for and receive SDI 19 IFC Certification scheme accreditation, demonstrating that they are suitably skilled and experienced in fire strategy verification, installation and commissioning.

As an independent UKAS-approved certification scheme facilitated by third-party certification provider IFC Certification, SDI 19 accreditation helps to raise the bar in terms of quality and competency and gives the end user an assurance that their safety critical system will be fit for purpose.

All SDI 19-certified contractors have demonstrated that their trained staff consistently adhere to industry best practice and fully appreciate the importance of correct installation, inspection and maintenance.

The SDI 19 scheme benefits end users, main contractors and their insurers by assisting in the selection of a competent and experienced smoke control contractor.

At the same time, consultants should be specifying this as a requirement in all specification documents.

The success of the SCA third-party scheme has demonstrated how self-regulation in the form of independent verification can make a real difference in the raising of industry standards, acting as a blueprint for organisations looking to build a robust competency framework aligned to Building Safety Act recommendations and guidance.

● **David Mowatt** is chair of the Smoke Control Association

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THE WHOLE CARBON PICTURE

New CIBSE guidance and an office design with 40% lower embodied carbon were among the highlights of a HVAC group event on whole life carbon, writes Waterman s **Matt Dickenson**, who hosted the event

Embodied energy is increasingly flagged as a major issue for engineers, as clients chase net zero targets for their buildings. As operational energy is reduced with more efficient building design, embodied carbon now makes up a significant proportion of a building s whole life carbon (WLC).

With the release of *CIBSE TM65.2 Embodied carbon in buildings: non-residential buildings* imminent, CIBSE s HVAC group led a timely event on embodied energy. I opened the evening by highlighting how vital embodied carbon analysis will be to reaching zero carbon goals.

Detailing what is included in a WLC assessment, Celine McLoughlin Jenkins, a graduate sustainability consultant at Aecom, emphasised why taking a holistic view provides a more complete picture of a building s carbon impact. She lamented that there currently isn t much scope to recycle or reuse MEP equipment.

CIBSE TM65 and the Greater London Authority s Whole Life cycle Carbon Assessments guidance (March 2022) were highlighted as key documents that reflect the increased visibility and importance of embodied carbon analysis. WLC analyses are rapidly becoming common requirements for planning permission; McLoughlin Jenkins cited the widespread opposition to plans for a new M&S store in London s Oxford Street because of the embodied carbon impact.

She concluded by summarising the four biggest contributors to embodied carbon: refrigerants, distribution routes, sourcing and weight.

Ankit Singh, technical director of sustainability at the Waterman Group, introduced the 8,700m² Edenica office development in the City of London, which he said would achieve an embodied carbon saving of 40% compared with LETI benchmarks.

Singh emphasised that a particular issue for offices is that tenants make significant changes to systems. With a standard ducted ceiling void system, as much as 50% of the services could be removed or altered by tenants, he said. Selecting strategies that remove that option minimises the post construction impact.

The 12 storey Edenica building hasn t compromised on operational emissions, said Ankit, with energy consumption expected to be lower than the UK Green Building Council s 2030 targets. Edenica features a mixed mode ventilation strategy, exposed thermal mass, and significant solar shading.

Yara Machnouk, an environmental design engineer at Elementa Consulting, gave a brief insight into CIBSE TM65.2, due to be published this winter. She said TM65 gives a framework for approximate embodied carbon in developments that only requires a limited set of manufacturers data. It allowed for flexibility, added Machnouk, offering different levels of calculation based on the amount of detail manufacturers can provide. She then highlighted key conclusions from *TM65.1 Embodied carbon in building services: residential heating* data, discussing the importance of heating systems, refrigerant leakage, and high performance building fabric.

Concluding the evening was Chris Newman, zero carbon design manager at Mitsubishi Electric, who discussed some of the challenges manufacturers have in providing embodied carbon data, including differing national standards. He touted the European market as being leaders in environmental legislation, and highlighted the new Product Environmental Profile in France that requires manufacturers to detail raw material makeup, manufacturing energy, and packing.

Newman described the benefits of standardisation and specificity that the regulation provides. CIBSE TM65 had made an effective start at providing a framework, he added, but there are still several assumptions that must be made, which makes universal adoption difficult.

One of the shortfalls of TM65 and Environmental Product Declarations, Newman said, was that they don t factor in site added refrigerant charge, which can make refrigerant heavy systems, such as variable refrigerant flow (VRF), appear to have a lower carbon impact than they do in reality. On a standard VRF system, additional refrigerant charge could make up more than 40% of a system s overall embodied carbon load. CJ

MATT DICKENSON ACIBSE is a mechanical engineer at the Waterman Group

BRINGING EQUITY TO THE WORKPLACE

A new tool from Well aims to improve equity, inclusion and accessibility in the workplace. **Dr Milena Stojkovic** summarises the Well Equity Rating framework and explains how it can be aligned with the Well Building Standard

Maggie's Manchester designed by Foster + Partners

A new tool for wellbeing is aiming to help organisations improve equity, inclusion, and accessibility in the workplace.

A beta version of the Well Equity Rating was launched last month by the International Well Building Institute (IWBI).

The rating provides a new framework of equitable policies, programmes and design interventions. It aims to encourage organisations to improve access to health and wellbeing, celebrate diversity, prioritise inclusivity, and promote sensitivity, while addressing disparities in populations that have been traditionally marginalised and underrepresented.

The tool will be the latest addition to the IWBI ratings offering, which currently includes the Well Health Safety Rating and Well Performance Rating.

The Well Equity Rating will consist of more than 40 features drawn from the Well Building Standard (Well), along with new pathways and beta features. The IWBI also published a new alignment tool that clarifies how the Well Equity Rating and the Well Building Standard will be aligned, thus streamlining the documentation submission and simplifying the transitioning between the two tools.

The features are classified into six action areas.

The User experience and feedback action area covers integrative design approach and administration of occupants surveys, whereas the Responsible hiring and labour practices action area covers the implementation of diversity equity and inclusion (DEI) support systems and responsible labour practices.

The Inclusive design action area focuses on accessible and universal design and enhanced acoustic, visual and thermal environment. The research that supported the selection of features is especially focused on the impact the indoor environmental quality (IEQ) has on marginalised groups, and on people who live with some type of disability.

For example, reduced or low speech intelligibility can negatively impact occupant satisfaction and wellbeing, especially for non native speakers and individuals with hearing loss. Similarly, prolonged exposure to bright or flickering lights can cause headaches, distraction, and lost productivity, especially for people who are neurodiverse or light sensitive.

Negative health impacts may also come from exposure to glare, and research shows that people with autism tend to experience greater discomfort, especially at work. The Health benefits and services action area covers human resources (HR) offerings including health benefits, flexible work, equitable working hours, parental leave, and so on.

It also includes a beta feature, Establish education and support , requiring financial support for education and/or mentoring opportunities to support career advancement and financial stability.

In addition, the Supportive programmes and spaces action area echoes the Well Building Standard credits, including restorative spaces, spaces for physical activity, preferred cleaning products and healthy nourishment.

Finally, the 'Community engagement' action area aims to promote a culture of community engagement and social responsibility that supports the broader community in which the organisation operates. Its features include community engagement, provision of community space and affordable housing, as well as the new Historical acknowledgement beta feature.

To be awarded the rating, projects must achieve at least 21 points, with all features accounting for one point, unless specified otherwise. To maintain the Well Equity Rating, projects undergo an annual renewal process.

The Well Equity Score is an organisation wide metric that represents the average number of points achieved in the Well Equity Rating across all subscribed locations, weighted by the number of occupants in each location. CJ

DR MILENA STOJKOVIC FCIBSE is associate partner at Foster + Partners and co-chair of CIBSE Health and Wellbeing Working Group

In celebration of ventilation

The first World Ventilation Day will see experts coming together to recognise the important work that is being carried out across the sector


Professor Cath Noakes

Set to take place on 8 November, World Ventilation Day is all about celebrating ventilation.

Initiated by a group of passionate researchers and professionals, including airborne infection expert Professor Cath Noakes FCIBSE, the campaign aims to raise awareness of the need for good indoor air quality in buildings for the health and wellbeing of occupants.

'We want to shout about everything that is good about ventilation, how we can help people to ventilate and clean the air in buildings better, and to recognise those who work to improve the comfort of people around the globe,' said the event's organisers.

A growing body of research shows that good ventilation is key to creating a sustainable and low carbon environment. However, this is so often poorly understood and usually only noticed when there is a problem.

Ventilation is just one element in enabling a building to perform well; it must be considered alongside energy consumption, pollution, noise, comfort, and safety. In designing buildings for the future and upgrading existing buildings to be sustainable, healthy, and safe, there are complex trade-offs to consider.

However, even simple actions can help enable better ventilation without increasing energy costs. Experts at World Ventilation Day will share resources and information to aid the effective ventilation of homes and workplaces.

The campaign was established by the Future Urban Ventilation Network, which is funded by the UKRI SPF Clean Air Programme. It brings together notable researchers, practitioners, and policy-makers to consider the complexities of enabling health-based building and city ventilation.

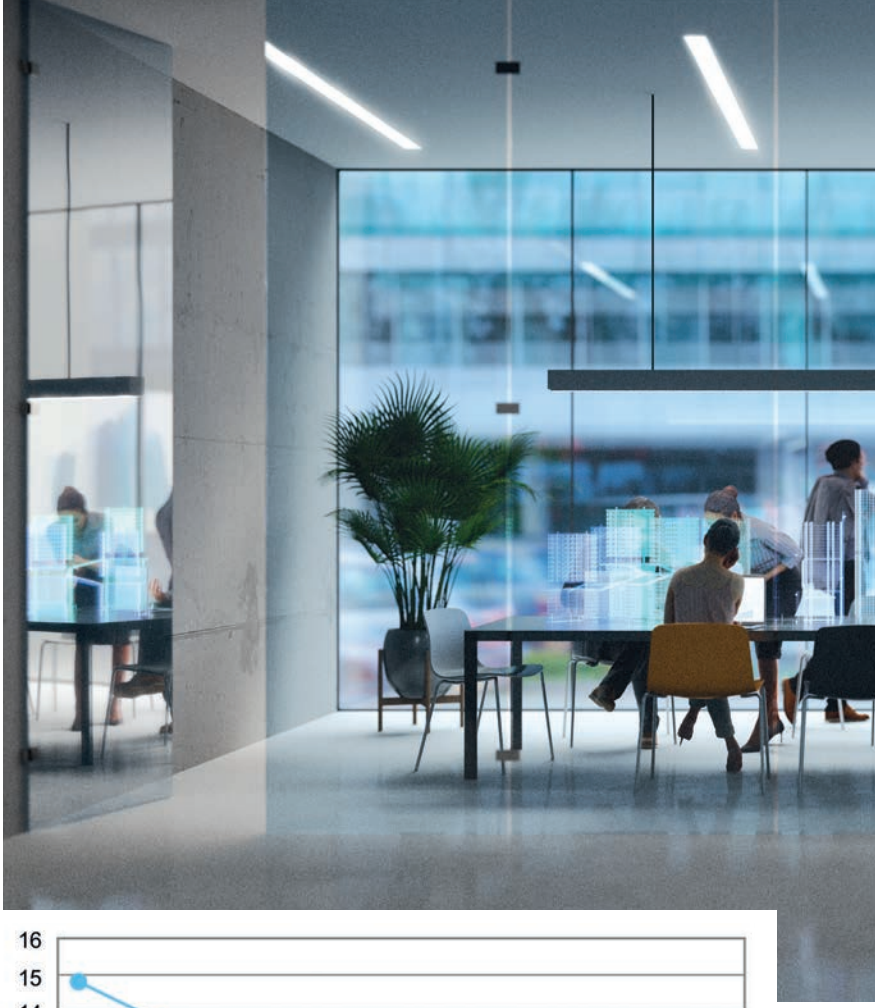
The network works alongside other bodies, including CIBSE and BESA, to highlight the need for better understanding across the whole of the building services industry.

They urge everyone to get involved, and to use #WorldVentil8Day to share what you are doing to celebrate. This may be through publishing key reports, standards, or studies, running CPD events, talks or seminars, or championing sustainable ventilation and air cleaning practices to help people manage indoor spaces. There is also a Twitter address at **twitter.com/WorldVentil8Day**

- **Professor Cath Noakes** is a prominent campaigner for good ventilation **twitter.com/CathNoakes**

A revision to the BCO guide to fit out comes after changes to office use in a post pandemic world. The ramifications for future office design are summarised in the new *Future of office densities* report

SPACE: THE NEXT FRONTIER



In 2001, average office density in the UK was approximately 14.8 m² per desk on a typical floor. By 2018, the British Council for Offices (BCO) found the average density was 9.6m² per desk.[1] This gradual densification made UK offices among the most densely populated in the world.

This summer, the BCO published a position paper[2] proposing new benchmarks for occupancy that reflect changes in office use in the aftermath of Covid 19. Now, new research has been released in the BCO s *Future of office densities* report to support the revised BCO guide to Fit Out recommendations.

However, recent definitive occupancy research showed that the average office has a 40 60% utilisation of its space, with mid week peaks of only 33%. The impacts of the pandemic and concerns about climate change mean work patterns and occupancy levels have changed, and the BCO says new guidance is needed on how to redesign and operate offices for this new normal.

As a result, the position paper proposes that the high density occupancy of 8m² net internal area (NIA) per work setting is withdrawn and that the effective workplace density for core design elements of 12.5 m² NIA per person is replaced with 16.7 m² NIA per person.

The original effective density was based on 10m² per workspace and 80% utilisation. The position paper now recommends that utilisation levels are reduced to 60%, which effectively means the BCO is proposing that density is now 16.7m² NIA per person.

The new report looked at the impacts of over densification (8m² per person) on UK offices in terms of performance and wellbeing, occupant expectations post pandemic, work patterns and setting, and the need to create offices that meet net zero carbon targets.

The researchers gathered evidence from quantitative and qualitative sources, then triangulated and interrogated the findings to arrive at the new recommendations.

There was an in depth analysis of a longitudinal dataset

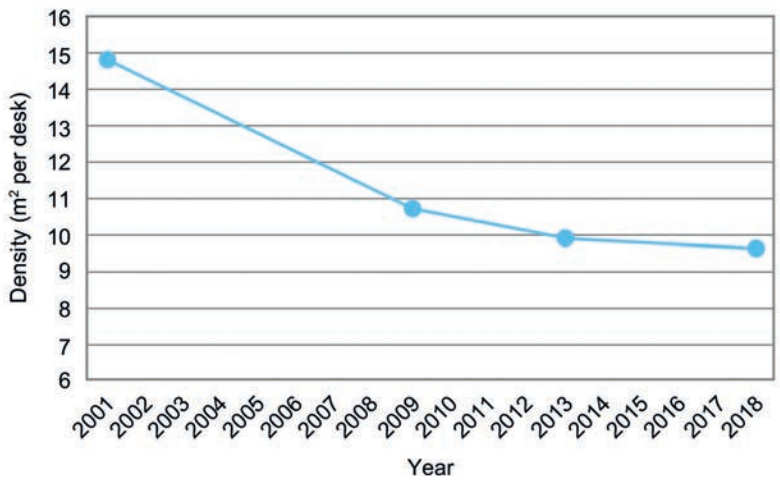


Figure 1: Benchmark density in UK offices over time (Source: Leesman)

of 13 offices, tenancies and floors spanning 21 years by Dr Roderic Bunn and an analysis of the Leesman Index database (which includes a subset of 74 buildings with measured density data).

The Leesman survey[3] was designed to enable occupiers to understand how the spaces that employees use impact their ability to do their work, and the key drivers for employee experience. The survey helps identify the important activities associated with respondents roles, and how well the workplace supports those activities.

Leesman s 2018 statistical analysis revealed a series of distinct patterns, which uncovered critical work activities and workplace features that determine workplace experience. These components are key drivers for employee experience. (See panel Factors contributing to workplace satisfaction).

The worst performing office areas with density related problems combined the following elements: high density permanent workstations, not enough toilets, limited personal space, few escape opportunities, open plan control zones unfit for reconfigurement, unbalanced temperature for gender difference, and high reverberation times. If uncontrolled, these factors adversely affected work activities.

Conversely, there can be adverse effects of an office of low density, for example, knowledge transfer between employees may be restricted.

Post pandemic, there has been a significant increase in agile/hybrid working arrangements. Interviewees estimated pre pandemic occupancy levels of 70% ± 10% and a likely future occupancy of 45% ± 10%. However, survey respondents estimated higher occupancy.

Pre lockdown occupancy levels were recalled as 81% ± 16%, and a future planned or anticipated occupancy level of 68% ± 18%. Not only are these figures higher than expected, but the range makes it difficult to pinpoint optimal future occupancy levels.

Respondents recognised a mid week peak, with current occupancy levels reaching 33%. The peak is expected to reach around approximately 50%. Organisations with pre Covid hybrid working are expected to cope better with the peaks.

In general, greater variations and uncertainties in utilisation create a higher management burden compared with the certainties that accompany high and predictable utilisation.

Based on the information collated, it appears that, previously, 10 ± 2 m^2 per person was the ballpark recommended planning density, where the person represents the number of people present rather than the assigned headcount.

Coincidentally, interviewees offered a range of 10 ± 2 m^2 per desk, mostly based on 1:1 desking, and acknowledged that densities will reduce if the office is not fully occupied. Survey respondents indicated that current office densities are 9.0 ± 2.4 m^2 per desk, and planned densities are slightly increased at 9.4 ± 2.4 m^2 per desk, based on 113 paired responses.

Implications for the BCO Guides

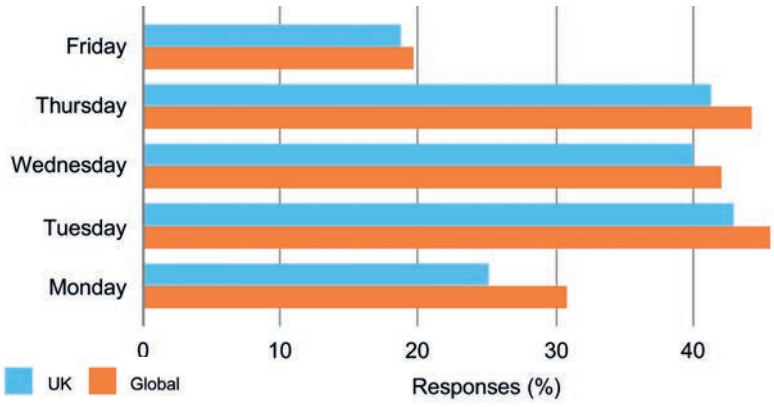


Figure 2: The weekdays that workers plan to be in the office (Leesman dataset Q3/2021 to Q2/2022: 27,611 global participants, 3,569 UK participants)

FACTORS CONTRIBUTING TO WORKPLACE SATISFACTION:

There are four worker activities and six workplace features that contribute most consistently to overall satisfaction.

Work activities:
- **Individual work, desk based**
- **Learning from others**
- **Relaxing/taking a break**
- **Thinking/creative thinking.**

Workspace features:
- **Noise levels**
- **Accessibility of colleagues**
- **General décor**
- **Desk**
- **General tidiness**
- **Small meeting rooms.**

Historically, density is associated with headcount per desk. In a more agile work environment, there is a difference between space per person and space per work point. Consequently, the report found that measuring density in m^2 per occupant was more relevant than m^2 per desk.

Most of the research shows that high density environments affect comfort, wellbeing and performance, but that with good design investment and careful management, these impacts can be mitigated.

It is expected that office space requirements will reduce in the future. The report suggests that those supplying larger developments and office buildings may find themselves under increasing pressure to subdivide floors as space requirements are lessened.

The analysis found that many organisations are reluctant to mandate the workdays on which employees should use offices as opposed to remote locations. This creates distinctly different high and low values of actual daily occupation. Occupiers are looking at those scenarios that will place pressure on their offices on particular days.

There will be days when occupancy levels will exceed the average. Equally, there will be other days when occupiers that are pursuing a net zero carbon agenda may want to cordon off areas or floors and rationlise their use.

The report says that to help mitigate the risk of insufficient base build elements, a 10m^2 per person starting density with a peak occupancy of 80% might be assumed, such that the effective density increases to 12.5m^2 per person. For buildings with higher occupancy levels on the non desk floors (for example, footfall due to visitors), an occupancy level of 100 120% or more may be required.

Following the study, no single density figure is offered by the BCO, rather a guide on key factors that impact on space and density, relevant to the density of specific workplaces. A density suggestion of 10m^2 per person is given, a ballpark figure for a starting point at the build base stage of office design. This can be adjusted for the needs of the organisation, dependent on the activities the space will be used for. **CJ**

References:

1 *Office Occupancy: Density and Utilisation, BCO 2018* bit.ly/CJNov22BCO1
2 *BCO (2022) BCO Guide to Specification Key Design Criteria Update 2022: A Position Paper.*
3 Leesman (2022) Leesman+ Certification. Available at: **bit.ly/CJNov22BCO2**

SIGNAL BOOST

Turning a radio transmitter station into a sustainable new school for Rugby involved vastly improving the historic fabric of the building while designing new teaching blocks to a high thermal performance to ensure top marks for low energy use. **Andy Pearson** reports

On the outskirts of Rugby is a collection of Grade II listed 1920s buildings that originally housed Rugby Radio Station's radio transmitter. First opened in 1926 to send radio messages to the Commonwealth, it continued to evolve so that at its zenith in the 1950s it was the largest radio transmitting station in the world.

Formerly known as C Station, it consisted of two main buildings; the taller Transmission Hall housed its large, very low frequency transmitter, while the shorter Power Hall was home to the generators.

When it was built, the building stood in fields circled by an array of 57 aerial masts, 12 of which were 250m high. Now, the radio buildings are in the centre of an emerging new mini town named Houlton, which is being jointly developed by Urban & Civic and Aviva Investors.

As part of the new development the listed radio station buildings have been innovatively incorporated into a new secondary school for 1,200 students in the heart of the development.

Architect van Heyningen & Haward's (vHH) design for the school is based on five blocks. It is a scheme of two parts: the two repurposed listed structures, along with three new blocks. All the conventional teaching spaces are grouped into two of the new blocks, one of which houses classrooms for teaching humanities, the other incorporating laboratories for science teaching. A sports hall makes up the third. The remaining functions are fitted into spaces in the existing buildings.

Minor adaptions enabled the Power Hall to accommodate the school's dining and assembly halls. More significant interventions were needed in the Transmission Building, including the addition of a new internal steelwork frame, threaded through the first floor slab, to provide an additional three storeys of accommodation for the teaching of art, music and dance, along with a new top floor, to replace the roof destroyed in a fire, which is now the sixth form space.

The Education and Skills Funding Agency's (ESFA) output specification set minimum energy performance requirements for the new buildings. However, there were no ESFA targets for the repurposed existing buildings, a factor that could have resulted in the school having to use more energy to maintain comfort conditions than it would, had these spaces instead been accommodated in

The new secondary school in Houlton, on the outskirts of Rugby

new school buildings, which would eat into its fixed operational budget.

Architect van Heyningen & Haward s solution was for the new blocks to maximise energy efficiency by aiming for fabric thermal efficiencies close to Passivhaus standard, while the existing blocks would be as energy efficient as possible within their heritage context. The rationale being that by building to best practice energy efficiency standards, the new blocks would use less energy than they would if they had been built to comply with the Building Regulations minimum.

The thinking was that the new block s low energy consumption would help offset the higher energy use of the repurposed buildings, with the result that the ongoing overall operational cost to the school would be similar to that of a new build school.

About a third of the school s accommodation is in the formerly unheated radio station buildings, so one of the design team s first tasks was to develop suitable improvements to the buildings envelope. Following a point cloud survey, the project s energy consultant, Etude, worked closely with the architect on developing modifications to the fabric to make it as energy efficient as possible.

Although Etude challenged vHH to find areas that could be insulated externally, Etude director Will South says internal wall insulation was the inevitable strategy . The problem with internal insulation is that it introduces the risk of moisture build up and potential damage to the 100 year old walls.

To assess the risk, Etude modelled the conditions using the dynamic hygrothermal simulation tool, WUFI. As a result of the modelling, the thermal performance of the walls have been improved using a breathing wall construction incorporating open wood fibre insulation, with the overall thermal performance designed to maintain a U value greater than 0.4W m 2 K 1 to help limit moisture build up.

Etude modelled the whole site, according to South. We used TM54 methodology with part dynamic simulation and part Passivhaus Planning Package (PHPP) . PHPP was used to calculate the predicted heating energy for the new buildings and the existing buildings. We find it more reliable for predicting heating energy and you re more in »

The more you can bring the loads down, the smaller the plant, which in historic buildings like these is really important as it reduces the extent of intervention required

Most of the leaking, single glazed windows were replaced with bespoke lookalike high performance units, and in some cases, with the addition of secondary glazing

» control of the assumptions, he explains. On the existing buildings, as the insulation increases he says PHPP gets more and more accurate because your temperature doesn t fluctuate as much .

Alongside fabric thermal improvements, the team also set out to minimise the existing buildings fabric air permeability. For the Grade II listed buildings an aspirational air permeability target of 3m³ h ¹ m ² was set with a backstop minimum of 5 m³ h ¹ m ², while for the new build an aspirational target of 1m³ h ¹ m ² at 50Pa was set with a backstop minimum of 3 m³ h ¹ m ².

Work to the existing fabric included removal of the historic plaster to expose the wall so that problem areas could be repaired. In addition, most of the leaking, single glazed windows were replaced with bespoke lookalike high performance units, and in some cases, with the addition of secondary glazing.

The fabric modifications were successful; tests showed the actual air permeability of the Power Hall was less than 3m³ h ¹ m ², while in the Transmission Hall it was still less than the 5m³ h ¹ m ². backstop.

The success in reducing the air permeability in each building to this extent shows what can be achieved in historic buildings like this, says Amy Punter, an associate director and historic building specialist at Hoare Lea, the project s MEP engineers.

The reason minimising air permeability is so important, is that it brings the heating loads down to a manageable level; without that we would have had to install considerably more plant, which would have been a real problem given its listed status, she says.

Etude and Hoare Lea worked in close collaboration. Punter says that while Etude was developing the energy targets, Hoare Lea was carrying out studies to assess the targets impact on loads and implication for plant sizes. The more you can bring the loads down, the smaller the plant, which in historic buildings like these is really important as it reduces the extent of intervention required, she says.

HANDLING AIR

The use of AHUs was contentious because the ESFA is not generally in favour of mechanical ventilation, says Punter. 'Because we were targeting an air permeability akin to Passivhaus standards in the new build blocks and were targeting significant reductions in the air permeability of the existing buildings, a need for mechanical ventilation was established, particularly when the benefit of heat recovery was taken into account in the energy consumption calculations,' she explains.

Air handling plant is located internally on the historic buildings to avoid external additions; air intakes and exhaust louvres are located in dummy windows to minimise visual impact. The air handling units each have an integral reverse cycle heat pump, which has the benefit of providing an element of cooling to temper the supply air in summer. Two air handling units also serve each of the new build teaching blocks; these are located in enclosed rooftop plantrooms to provide protection, reduce visual impact, and reduce long term maintenance.

The only space without mechanical ventilation is the sixth form space on the top of the Transmission Hall because it has opening windows on two elevations to make use of the opportunity to cross ventilate. All classrooms and areas with occasional high occupancy levels, such as the main assembly space, have option of opening windows should temperature and/or CO_2 levels get too high.

Historical equipment from the radio station has been left in situ

A computer generated image of the site

All teaching spaces in the historic buildings have mechanical ventilation, although the ESFA is not generally in favour of it. See panel below, Handling air .

The new blocks are orientated north south to reduce overheating risk and maximise the opportunities for winter solar gain. On the north elevation, windows are in line with the facades to maximise daylight in the classrooms, whereas on the southern elevation brick fins shade the triple glazed windows and their hinged side ventilation panels that allow additional natural ventilation.

The teaching blocks low energy design meant that their heat loads were low enough to enable heating using air source heat pumps (ASHPs). Wall mounted radiators sized for a 45°C flow temp heat the classrooms while ceiling mounted radiant panels, also sized for a 45°C flow temperature, are used to provide heat to laboratories and larger spaces. Heat pumps were a relatively unusual solution at the time and we were keen to show what a new build school could look like with this technology, but now most new buildings are being heated with these, says Etude s South.

Heating design guidance

He says that this project highlighted the need for design guidance to keep pace with the evolution of heating systems. In particular, he says there is an issue with heat emitter sizes designed for buildings with a very low heat load, which he says could lead to emitters being oversized .

South also says that design standards often assume new »

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The Power Hall houses the dining and assembly hall

» buildings lose heat at a faster rate than they do in reality, which reduces the need for redundancy in heating plant because redundancy has effectively been built into the fabric . As a consequence, he says there is often an opportunity to reduce the amount of the heating plant to help balance the cost of fabric enhancements. On the new build school blocks, it would probably be a week before they d notice the heat pump had failed, he laughs. On this project he says Hoare Lea did a really good job of striking the right balance .

Domestic hot water (DHW) is supplied using direct electric heating at point of use in the two new teaching blocks and the Transmission Hall. South says the project took quite a big hit with the ESFA for using electric.

Because measured hot water use by a school is quite a lot lower than the Part L assumption, you can end up in a situation where you pay for a lot of kit to make the production of something that you re not using much of, very much more efficient, with the result that the main cost is then circulating hot water around the school, he explains.

Because the school will not be fully occupied for several years, there was an additional benefit to only heating the water being used.

Gas is used to heat the new sports hall block and the two historic buildings. Three heating boilers and a gas fired direct water heater that provides hot water for the sports hall showers are located in the sports hall plantroom. Locating them in one of the new blocks avoided the need for a flue on the historic blocks.

The sports hall services are configured to shut off links to other buildings using valves and dampers to enable the community to use certain areas of the building out of school hours.

Soffit mounted, low temperature hot water radiant panels, based on a 70°C flow temperature, heat the sports hall and the double and triple height spaces in the historic buildings, including the assembly and dining halls.

The gas fired boilers also heat the domestic hot water, via a buffer tank, to the toilets and school s kitchen in the Power Hall building. South says the use of gas would be something we d look to change if we were designing the project now, because it would be possible to provide heat with a heat pump system .

The project used a design and build contract. Following an as built analysis, the design team concluded that in future they would provide contractors an energy consumption impact with all proposed value engineering options, and that they would monitor estimated energy consumption impact of any design changes proposed.

The final (as built) predicted energy consumption meets DfE requirements, and is in the 10th percentile for new schools, with an average heating energy demand of about 25 kWh m ^{2} per year for the new buildings.

What this project shows is that with a creative architect and innovative approach to low energy and building services design it is possible to repurpose almost any historic structure.

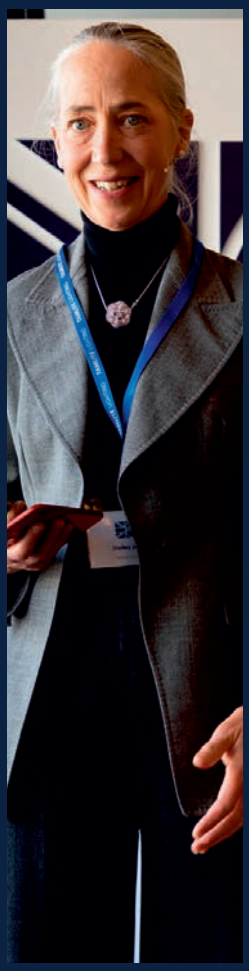
This is important because we need to prioritise the retrofit of existing building stock over demolition to help minimise the carbon embodied buildings and Houlton School shows that retrofit can deliver something unique and exceptional. CJ

Environmental performance data

Part of site	Existing	New		Notes
On-site installed energy generation	0	0	kWh·m^{-2} per year	Design ready for 400kWp array. 31kWh·m^{-2} · per yr
Heating and hot water load consumption (demand)	88.0	24.0	kWh·m^{-2} per year	PHPP predicted energy calculation
Total energy load	154.6	67.0	kWh·m^{-2} per year	PHPP and TM54 energy calc inc energy consumption. Metering in progress.
Carbon emissions (all)	8.1	3.6	kgCO_2 m^{-2}·per year	Uses 30-year projected average carbon factor for electricity.
Annual mains water consumption	2.34	2.34	m^3/occupant	Not calculated. Metering in progress.
Airtightness at 50pa	4.1	2.4	m^3·h^{-1}·m^{-2}	As built
Overall thermal bridging heat transfer coefficient (Y value)	0.028	0.034	W·m^{-2}·K^{-1}	Calculated
Overall area-weighted u-value	0.221	0.157	W·m^{-2}·K^{-1}	
Predicted design life in years	60			Standard value for carbon and lifecycle calculation

Tamlite launched the first in a series of Thought Leadership events

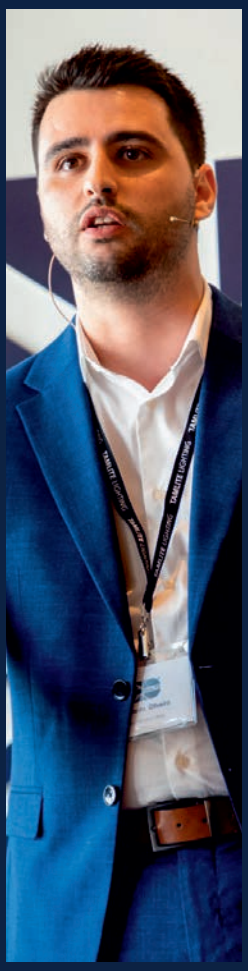
‘Let’s Talk About Light’



Dr Shelley James

Ruth Kelly Waskett

Andrew Bissell



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Despite the prevalence of LEDs, lighting still makes up a substantial proportion of energy use in buildings. Guests at the latest CIBSE roundtable discussed how operational and embodied energy use could be further reduced by smarter design and a circular approach to components

Against the backdrop of London s dazzling skyline, leading experts from the world of lighting gathered at *CIBSE Journal* s latest roundtable to discuss ways to reduce energy use. Tougher legislation, and educating and incentivising clients to choose lower luminance levels were some of the issues explored.

The event at the London Shard, sponsored by Tamlite, focused on the importance of lighting for a zero carbon future. It was agreed that, to decarbonise lighting, industry experts need to step up and take responsibility now, to help influence clients and drive change.

Andrew Bissell FSLL MCIBSE, partner at Ridge & Partners, began by outlining his involvement with the dark skies concept . This describes places where the night sky is relatively free of interference from artificial light. Historically, dark skies were considered only relevant to national parks, but Bissell said the concept can also be implemented in hotels, offices, airports and other building types.

We found that it s not just the big developments, such as power stations and highways, that are the problem; it s the millions of residential buildings. But the scale of this challenge is different, said Bissell, who is also president of the Society of Light and Lighting (SLL).

Lighting on a road can be changed quite easily through legislation, but how do you change domestic lighting? We need to think differently and work together to create a nicer, healthier environment in terms of people being able to sleep with no spill light into windows. We then end up with less energy use and that s a massive part of it. If the light is going where it should, less energy is used.

Bissell said that an eco tourism development in Saudi Arabia is the only client to date who is interested in employing the dark skies concept to a new building. The roundtable s participants agreed that one of the most effective ways to encourage clients to employ dark skies in new UK developments would involve the introduction of strict planning conditions.

Ruth Kelly Waskett MCIBSE FSLL, senior associate at Hoare Lea and a CIBSE board member, highlighted several challenges facing the lighting profession. The revision of *BS EN12464 Lighting of workplaces* means that illuminance levels need to be increased for older users who need more light. But this requirement works against the need to reduce energy consumption.

THE PANEL

From left: Anand Desai, Direct Synergy; **Sam Eyres,** principal (electrical engineer) at Ridge & Partners; **Ruth Kelly Waskett,** senior associate at Hoare Lea; **Paul Walsh,** associate at M2A Consulting Engineers; **Gareth Walsh,** electrical associate at HDR; **Alex Smith,** editor at *CIBSE Journal*; **Yasser Sweidan,** associate at CBG Consultants; **Hiten Kawa,** regional director at SVM Berkhamsted (hidden); **Farhad Rahim,** associate director, technical lead at Buro Happold; **Leneesh Sudhakaran,** technical director at Buro Happold (hidden); **Andrew Bissell,** partner at Ridge & Partners

Natural light, said Waskett, can unlock this challenge if we think of it as our circadian lighting. We therefore don t need to add extra illuminance to deliver circadian light artificially. Waskett also talked about the challenge of the Cat A office model, which sees landlords introduce lighting before space has been let.

Most of us are involved with projects like this, where we don t know where the desks in an office will be, said Waskett. Traditionally, we ve designed the lighting so that it delivers the same illuminance level everywhere. We must stop doing this now, and we need to do it in a different way.

While developers are responding to this problem to avoid wastage, Waskett is concerned about the smaller developments where this is not happening. In addition, there is often over lighting, where lighting is installed in between the task areas. Waskett stressed that users want a more visually interesting work environment, with layers of light and a hierarchy of illumination, not a uniform space. Bissell suggested that this is where manufacturers could help by guaranteeing three different lighting design styles. Part of the problem, said Bissell, is that manufacturers provide a grid of lights so a tenant can move into an office immediately but a tenant doesn t move in straightaway; the contractual process often takes much longer.

If manufacturers offered different lighting design styles, the question is whether the landlord would support it, because it does involve more work. I ve been saying this for a long time and so have many other lighting consultants, and it s not changing.

Anand Desai, founding partner at Direct Synergy, said that the reason this is not changing is because clients are so ingrained in the British Council for Offices (BCO) guidelines.

The attitude needs to change, people need to be educated to do this in different ways, said Desai. Start with a lower lighting level and integrate task lighting.

Farhad Rahim, associate director at Buro Happold, agreed, and said Buro Happold is already proposing low level lighting in many of its schemes, which a few clients are taking up. He added that it is common in European offices to employ low level lighting (about 200 lux) to light up a space and then add task lighting, which must be controlled with a second layer of power and supply. »

> It s not just the big developments, such as power stations, that are the problem; it s the millions of homes Andrew Bissell

"It s good to push things forward, but there must be education behind why it s being done. It should be about good design" · Andrew Bissell

» Task lighting gives people control of their own environment and they feel happier, and productivity will increase, but there s a reluctance to add that second tier of lighting purely due to cost, and this needs to change, said Rahim.

Waskett argued that we can t achieve lower energy use by light luminaire efficacy alone. Things must be done differently if we are to achieve change. She recommended that fewer fittings should be specified, and lighting consultants need to be more closely involved in the commissioning of controls.

She said the problem is that lighting experts don t have the privilege of continuing their appointment post occupancy. Therefore, they have no idea why some lighting doesn t work properly or in the most efficient way.

Bissell also cautioned that it is important not to become obsessed with figures to achieve a net zero carbon building, as it becomes a barrier to good lighting design. He cited a Cat A fit out in Birmingham that achieved a blanket lighting scheme with 120 lumens per watt that used 4.5 watts per metre square. Bissell s suggestions of first considering different scenarios of where desks might go near windows, for example before installing the lighting were largely ignored.

Everyone raved about this office because of the lumens per watt that was achieved, but the result was a five year step back. It s good to push things forward, but there must be education behind why it s being done. It should be about good design, said Bissell. You re not going to achieve anything with a single number; you might achieve slightly less energy being used, but it s still wrong.

Desai added that, with the targets of the regulations changing, clients will have to increasingly implement more energy saving measures in terms of the operational energy use of buildings.

***CIBSE Journal* editor Alex Smith (centre) listens intently to the roundtable discussion**

Traditionally, we ve designed the lighting so that it delivers the same illuminance level everywhere. We must stop doing this now Ruth Kelly Waskett

There s a lot of greenwashing, he said. A building may have been designed to be net zero, but five years down the line is it being operated as it was intended? That s why things like Energy Performance Certificates and Part L are important, because they ve been designed for operational compliance.

The discussion then turned to whether the circular economy is important when specifying lighting.

Waskett said it is hugely important. As a specifier, she can distinguish between products based on their embodied carbon and the provenance of all the materials, and how the fitting has been put together. She is also concerned about disassembly and ease of use.

Bissell agreed, and said that he knows of a manufacturer who will replace a light if the driver fails and ask for the broken one to be sent back. The manufacturer will then fix it and return it to the stock. Bissell believed that environmental, social, and governance (ESG) is behind this approach. This manufacturer s clients are looking for every possible way

Participants discussed the importance of the circular economy when specifying lighting

to be better and this is one way they can do that, he said. We must get back to a way of being able to change a lighting component and making it easy to do this.

Companies have realised the importance of this, and it will happen. We are now at a stage where we are suggesting that we design whole buildings with circular lighting components of a certain standard. It s not possible yet, but it will be.

It was suggested that the technical guide *TM66 Creating a circular economy in the lighting industry* could help to make this happen.

Bissell, who is involved in the TM66 guide, said: We have invited founding partners, manufacturers, consultants and clients to help fine tune and evolve this document, and the feedback has been very useful. For example, some manufacturers questioned why they should be marked down for using a plastic component if it lasts for 30 years and said that, instead, they should be marked up for having something that lasts so long.

As a result, we have been more pragmatic. I can see that, once TM66 is launched, it will really take off. There will be certain clients with ESG agendas who will insist on it and only target circular economy fittings. Once that happens, manufacturers and others will have to do it.

Waskett argued that incentives to retain equipment and re use it are also needed. Replacing lighting with LEDs is often suggested as the best and most energy efficient approach, but, according to Waskett, this isn t always the best solution. It takes expertise to suggest that existing equipment be retained.

The participants agreed that the decarbonisation of lighting needs to speed up and will only happen if it s a legal requirement. As lighting professionals, they need to take responsibility to inform clients about making the right decisions, and legislation will help to incentivise them.

Rahim concluded the discussion with an interesting conundrum for a lighting professional. He said he now tries not to light things up and is enthusiastic about dark skies and the mitigation of light spills. He argued that way markers and guidance lighting is more than enough to keep people safe. Constant illumination and uniformity should be avoided.

Dark skies are not just about seeing the stars; it changes people s perspective of the world. We sense how small we are, and we see the bigger picture, said Rahim. That s why dark skies are so important, it s not just for the environment, it s for the species and for our sanity. CJ

> Dark skies are not just about seeing the stars; it changes people s perspective of the world. We sense how small we are, and we see the bigger picture
> Farhad Rahim

> "There s a lot of greenwashing. A building may have been designed to be net zero, but five years down the line is it being operated as it was intended?
> – Anand Desai

PASS JUDGEMENT

Often slipping under the radar in building design, thermal bypass can result in major energy performance gaps. **Mark Siddall**, director of architecture and research at LEAP, discusses measures to mitigate this problem

The Passivhaus Goldsmith Street development in Norwich

Thermal bypass is a largely unregulated, little known phenomenon with the potential to cause failures in building performance. However, with the correct knowledge and skills, both in practice and onsite, failures in design and construction can be avoided and buildings can perform as predicted.

Founded upon sound physics, buildings that are built to the Passivhaus standard have been demonstrated to perform reliably as intended. However, this is far from the norm within the construction industry at large. There is an increasing recognition of the energy performance gap and the consequential development of means to reduce this.

One of the major contributors to the energy performance gap is faulty, ill considered design and construction that can result in a thermal bypass. A thermal bypass is heat transfer that bypasses the conductive or conductive radiative heat transfer between two regions. Defined in this manner, convective loops, which include both air infiltration and windwashing, constitute a form of thermal bypass. (See graphic for common languages, page 26, when talking about thermal bypass.)

Earlier this month, I completed a paper which draws together 68 years of research.

Summarising 170 peer reviewed papers and related documents, the paper establishes that thermal bypass, air movement across, within and behind insulation, can lead to about 10 times more heat loss than predicted leading to larger bills and CO_2 emissions plus drafts, discomfort, and mould. But this need not be the case.

Wind barrier at Larch Corner Passivhaus

Defective workmanship showing insulation gaps

Workmanship and buildability

As all good designers will appreciate, we can t entirely close performance gaps. We have to allow some tolerance. That s why, following research undertaken in Norway, the paper proposes a standard that limits the effect of air movement to 5% of the calculated U value.

But we first need to recognise that the ability of insulation to fill an air gap is dependent upon the standards of workmanship on site, and that these standards of workmanship are in turn heavily dependent upon the appropriate design, detailing and specification of an assembly.

Often overlooked, factors such as the level and flatness of a substrate can have

A thermal bypass is heat transfer which bypasses the conductive or conductive radiative heat transfer between two regions

a significant impact upon whether an assembly performs as predicted. Again, this is a large subject that is explored in much greater detail within the paper published by the Passivhaus Trust.

Using the example of deficient workmanship, which leads to a continuous air gap between the insulation and the substrate and an open joint leading to the outside at the top and bottom, heat loss from a wind washed wall (with a 4Pa pressure difference between top and bottom and a design U value of 0.21W $m^{-2} K^{-1}$) will be increased by an order of magnitude. The size of the air gap behind the insulation has a decisive and dramatic impact upon the thermal performance:

- 2mm air gap = 12% increase in heat loss
- 7.5mm air gap = 203% increase in heat loss
- 15mm air gap = 520% increase in heat loss

The paper goes on to explain how a highly insulated fa ade, poorly specified and suffering from poor standards of workmanship, has the potential to result in a 982% increase in heat loss. Where defective workmanship occurs, such as tuck ends, heat loss could increase by as much as 15%.

Types of thermal bypass

This type of heat transfer, known as thermal bypass, comes in two forms, open loop and closed loop thermal bypass.

Open loop:

Open loop bypass comes in two forms: air leakage, and wind washing. We can develop performance standards for each, and these are explored in detail within the paper.

Air leakage occurs when air moves through the building envelope. Although it is frequently regulated to reduce energy demand, its primary function should be to prevent moisture damage. The secondary consideration is thermal comfort, and the final consideration is energy efficiency. Unfortunately, Building Regulations in England and Wales, and Building Standards in Scotland, anchor airtightness to energy efficiency which means they consistently underestimate just how airtight structures need to be. If moisture risks are to be avoided, research suggest air permeability should be just 10% to 12.5% of the values currently required by Building Regulations in England and Wales.

Windtightness standards, which are designed to prevent undesirable wind washing, are completely ignored in national standards. Evidence shows it can increase heat loss by 660% compared to the design intent. This is particularly true for those areas of the building exposed to the greatest wind pressure differences, which include changes in geometry, such as corners, eaves, ridges, and verges. If performance gaps are to be within tolerance, these locations influence the standard of windtightness »

» we need to achieve. The standard of windtightness required can be correlated to the U value being sought and is discussed in greater detail within the Passivhaus Trust s thermal bypass paper.

Closed loop:

Isolated from forced convection, which is incurred by the wind or mechanical systems, closed loop bypass occurs within a cavity space. Though a familiar example would be air movement within double or triple glazed windows, this also happens in walls and roofs. This natural convection arises within insulation when the temperature difference between the cold and warm faces causes air to change density and generate sufficient force as to enable air movement to take place. The warmer air layer rises and consequently the colder, denser air descends. The net effect of convection upon energy demand is a function of the area affected, the temperature difference, and the duration of the cold weather conditions.

How do we prevent thermal bypass?

At a conceptual level, the ultimate goal is to completely encapsulate insulation between the air barrier (red) and wind barrier (blue), and to achieve a suitable standard of workmanship in the process (Figure 1). Implementing successful strategies that manage thermal bypass is somewhat nuanced, which is why the Passivhaus Trust s paper sets out a pragmatic framework that can be applied to building projects.

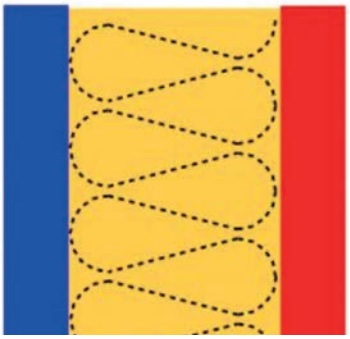


Figure 1: Insulation between the air and wind barrier

How can the paper help you with your project?

Whether it s a new build, a conversion or a renovation, the paper draws upon a sound evidence base that reveals simple, practical steps that policymakers, developers, certifiers, designers and constructors can take to create successful, high quality, high performance and robust buildings at speed and scale to meet climate targets. The paper provides new insights that build confidence and help you to make informed, intelligent decisions that will:

- Improve the health, wellbeing and energy security of building occupants and owners
- Reduce carbon emissions and fuel poverty
- Close performance gaps
- Avoid costly mistakes
- Protect the building fabric from moisture damage.

The paper isn t just about the problems caused by thermal bypass, rather it gives you all the tips and tricks you ll need for preventing thermal bypass risks, so that you can make informed, intelligent decisions about your projects.

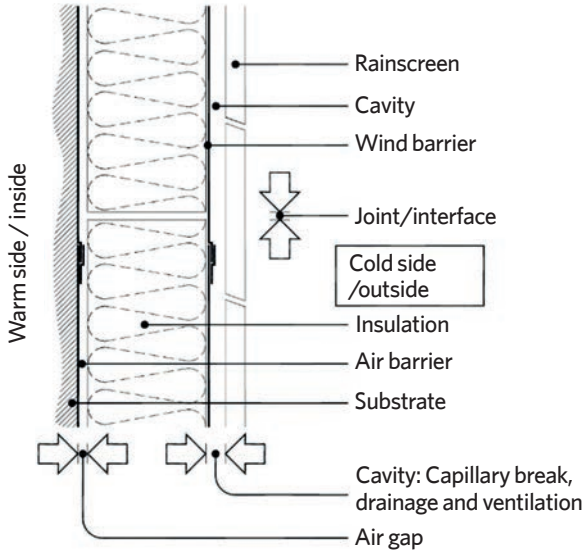
If you would like to learn more about thermal bypass and how you can address it, download the paper *Thermal Bypass Risks: A Technical Review* from the Passivhaus Trust website **bit.ly/CJNov22PT1**. CJ

MARK SIDDALL is a director of architecture and research at LovinglyEngineeredArchitecture.com.

TOWARDS A COMMON LANGUAGE:

Before getting into the detail, it is important that we develop common terms of reference and to do this we need to get our language straight.

- **Air gaps occur on the warm side**
- **Cavities are on the cold side**
- **Joints are between abutting interfaces**



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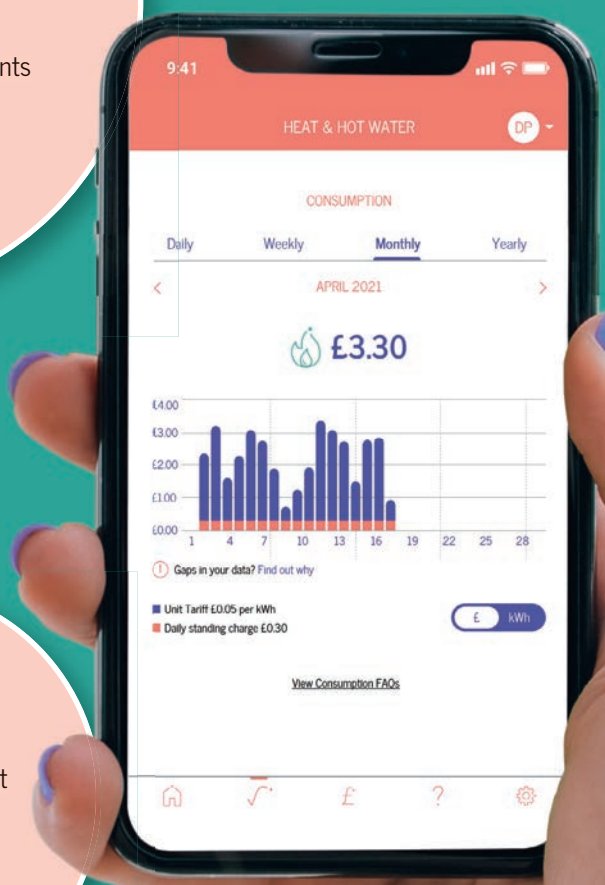

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Heat Networks - the no-regret heating solution

The 1970s OPEC oil embargos caused a profound change in Danish society. While the UK had oil, coal, gas and nuclear, Denmark was completely dependent on oil. Achieving a secure supply of low-cost energy became a national necessity, the pursuit of which has transformed Denmark from being an energy laggard to a leading exporter of energy technology.

At the time, the heat from Danish power generation was being discarded, but exploiting this wasted energy to heat Danish homes helped finance local heat networks that later evolved into regional heat networks. Denmark concurrently also found gas, so in competition with heat networks, gas network zones were also created.

Because we can't rely on the weather, renewables will always be scarce and therefore a costly resource that should be used sparingly to produce heat. As part of their decarbonisation, industry and transport will also be major consumers of renewable energy, notably hydrogen.

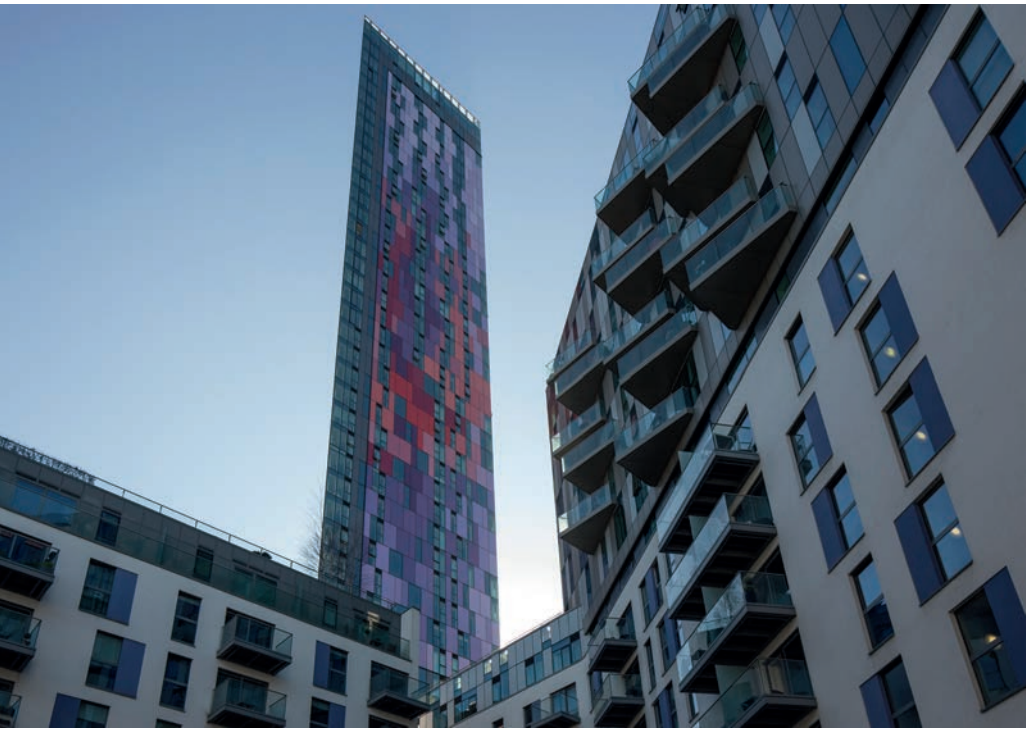
Unlike the UK, it is not acceptable to dump heat from Danish power generation. Indeed, even the waste heat from crematoriums is used to heat Danish homes.

Although fuel prices in Denmark have risen by almost 50% since 2012, in August 2022, heat from heat networks cost 7.4% less than in August 2021. Heat network prices remain on a par with those of 2012. The flexibility of heat networks to exploit multiple heat sources has protected Danish consumers against the extremes of gas price fluctuations.

Denmark is now in the process of converting its existing gas boiler zones to heat network zones. Heat networks currently cover 50% of the building heat demand and is expected to be expanded to 70% by 2045, with half of the heat to be supplied by ultra-low-cost waste heat. The Committee on Climate Change is recommending that the UK increase its heat networks coverage from the current 2% to cover 18% of the total heat demand.

From a consumer perspective, the gas boiler sized Heat Interface Unit (HIU), transfers the required heat to a traditional space-heating and hot-water system from the heat network, and does so extremely efficiently.

A good quality HIU will have a life expectancy of more than 20 years and should require minimal service, lowering operational and replacement costs for the consumer.



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SAV have operated within the building services sector since 1988. SAV specialises in renewable technologies and solutions from leading Scandinavian technology partners specifically designed for UK Heat networks.

SAV Trusted Technology Partner

Shade from adjacent buildings on high rise projects could have a huge impact on reducing energy cost and carbon emissions in warm climates, says **Muhammad Omer Safder**, who has modelled a 40 storey tower in the Middle East to show the potential savings

IN THE SHADE

Shading of the built environment has the potential to be one of the more significant decarbonising strategies and a driving force towards net zero carbon buildings.

Integrated systems, such as brise soleil or horizontal overhangs, can provide shade that reduces solar heat gains and, subsequently, building cooling loads. Adjacent buildings also offer shade that can reduce the amount of cooling required.

This article will look at the effect on cooling loads of shading on a high rise building from adjacent high rise towers and shading systems.

In our study, we modelled a 40 floor high rise office building in Abu Dhabi, UAE (ASHRAE climate zone 1A, B) with conditioned floor area of 57,900m^2, and analysed the impact of adjacent buildings shade on the cooling load of the object building. (See Figures 1 and 2.)

Building geometry and its energy model were built using Integrated Environmental Solutions (IES) applications ModelIT and ApacheSim. The energy simulation was performed using the Abu Dhabi annual weather file provided by the IES software library.

A high rise building model with and without shade was considered to evaluate the impact on cooling load and annual electrical energy consumption. The effect of recessed shade was also considered in the form of an external horizontal overhang (see Figure 2).

Shade on the east and west orientation of the building envelope (Figure 2) reduced the cooling load to 5.8% compared with a building without shade. The recessed shade further reduced cooling load to 6.62% of the building. Saving on the use of cooling system equipment such as chillers, pumps and HVAC distribution fans reduces the annual electricity consumption from 4,361,933kWh to 3,980,192kWh.

If the average cost per kWh of electricity is $0.10 (£0.08), the annual operating cost difference would be $38,175 (£30,472.81). Over the course of the project s operation for 10 years, the building will save AED 1.402 million (£304,728.12) in electricity costs. This strategy, implemented at master planning level, could have an enormous impact on energy savings.

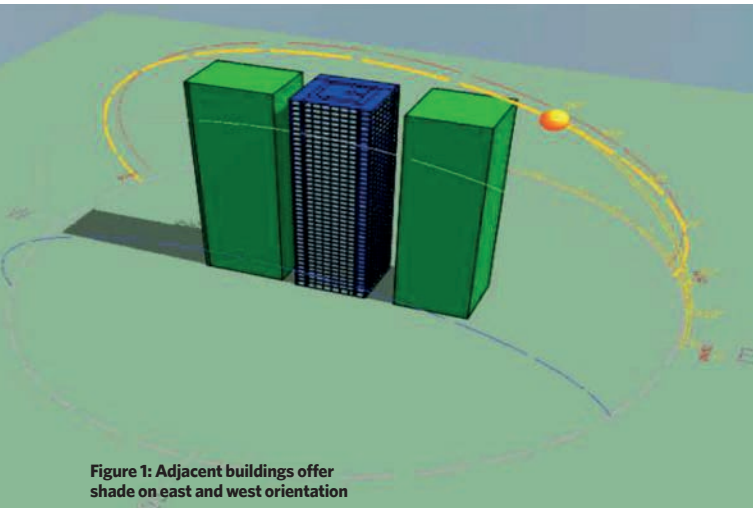


Figure 1: Adjacent buildings offer shade on east and west orientation

Holistic design approach in architecture

The shading effect varies for each project depending upon the distance from surrounding buildings, height of adjacent buildings, and layout.

External overhangs on glazing reduces the direct solar radiation into the space and can be particularly effective on the south orientation.

Similarly, fixed external shade needs to be evaluated based on the building orientation and impact on daylighting design. It is important to include the architectural external shade design for the perimeter zone thermal load calculations for correct air conditioning equipment sizing.

A passive shading strategy plays a significant role in achieving sustainability rating system credits, such as Estidama (Abu Dhabi Urban Planning Council). This strategy will help to achieve the requirements for credits in the Estidama building design tool, such as

Integrated systems and adjacent buildings can reduce solar gain in high-rises

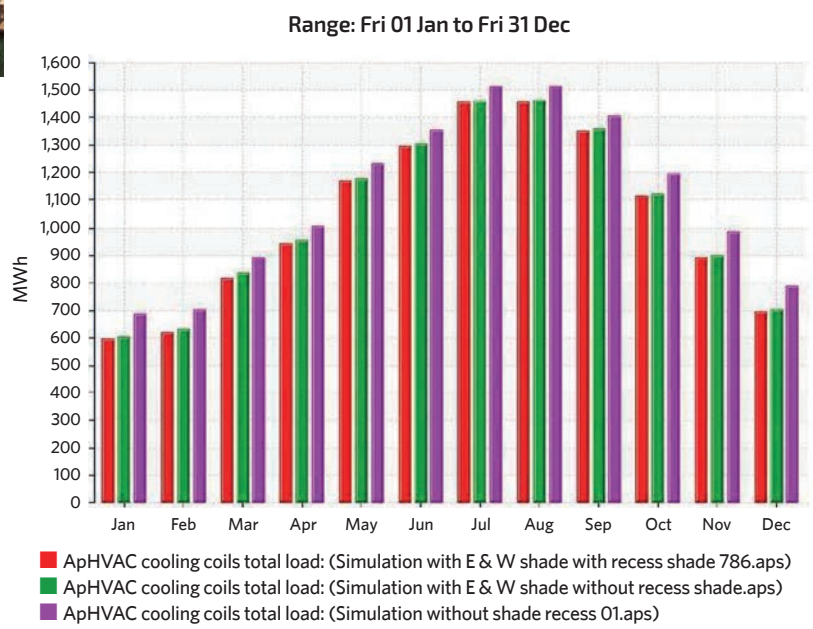


Figure 2: Cooling load graph with adjacent buildings shade, external glazing shade and without shade

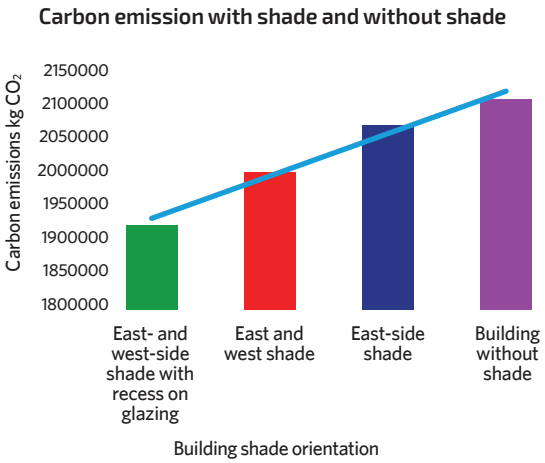


Figure 3: Carbon emissions graph with shade, recess and without shade

community strategy for passive cooling and cool building strategies.

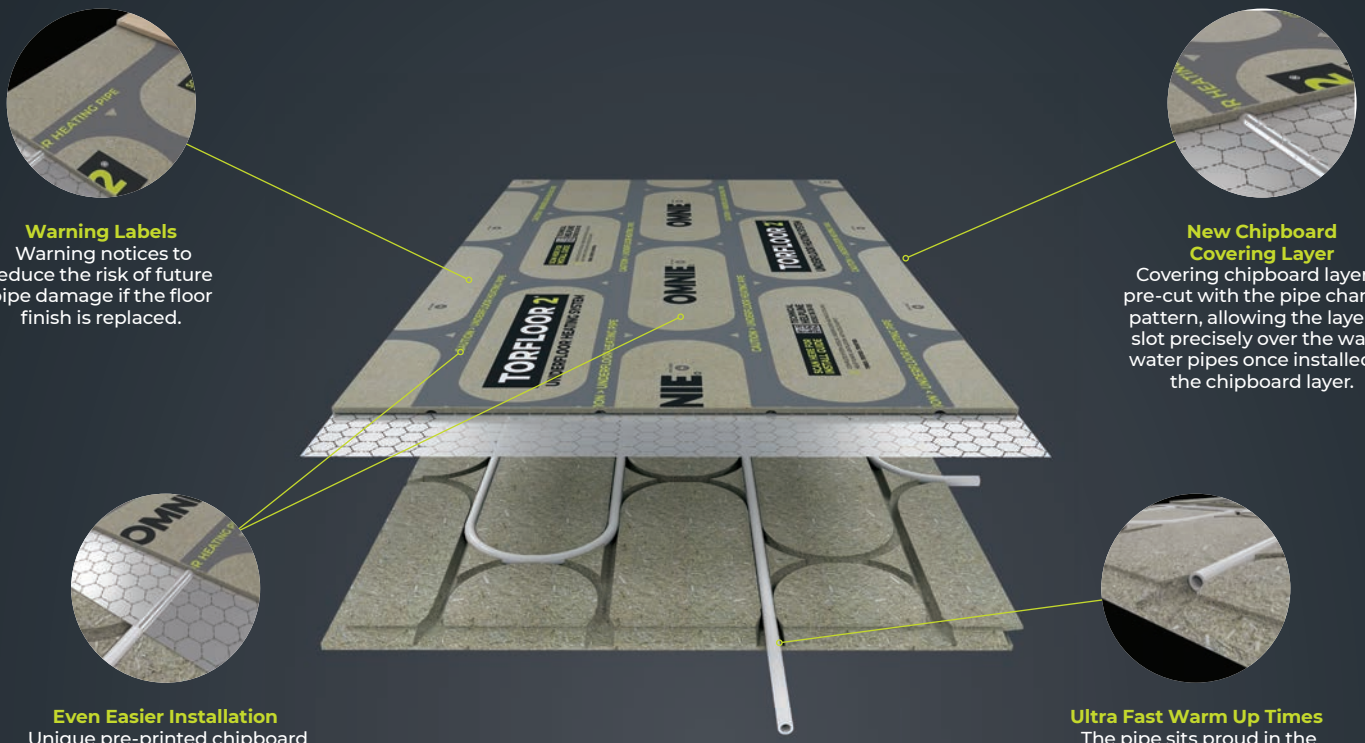
Based on a hypothetical office building with external shading on glazing and surrounding building shading, carbon emissions could be reduced by 184,380kg CO_2 per year, as shown in Figure 3.

Authorities can play a vital role in implementing shading strategies through local codes for new construction projects. Developing benchmarks for energy consumption and CO_2 emissions for different types of buildings can help the building sector meet decarbonisation goals by 2050. CJ

MUHAMMAD OMER SAFDER MCIBSE, MASHARE is founder and CEO at OS Engineering Consultants

Further reading:

1 Effects of shading on the energy consumption of high-rise office buildings in Hong Kong, Yu, C, and Pan, W, 2018
2 2018 Building Performance Analysis Conference and SimBuild co-organised by ASHRAE and IBPSA-USA.
3 Viability of exterior shading devices for high-rise residential buildings: Case study for cooling energy saving and economic feasibility analysis. *Energy and Buildings*, Cho, J, Yoo, C, and Kim, 2014.



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THE PROPANE ALTERNATIVE TO BOILERS

Could a new range of reversible air source heat pumps employing propane refrigerant reflect a growing shift towards low GWP gas boiler replacement solutions? **Phil Lattimore** reports on Swegon s Geyser Sky

The current energy crisis is putting an increasingly urgent focus on the economic, as well as environmental, imperative to consider replacing gas fuelled space heating and domestic hot water (DHW) with all electric alternatives.

Looking to address this growing demand for more environmentally friendly solutions, Sweden based manufacturer Swegon has introduced a new range of reversible air source heat pumps (ASHPs) that employs low global warming potential (GWP) natural propane (R290) as a refrigerant.

Swegon s Geyser Sky Hi HP R0 range of reversible ASHP solutions has been developed for homes and small commercial buildings, with the units capable of delivering high temperature hot water output at up to 78 C and designed to be suitable replacements for gas boilers, with a low ozone impact.

Using new generation inverter compressors to modulate heating or cooling capacity, the three strong range is designed to meet the highest seasonal European Ecodesign ErP efficiency standards, according to the manufacturer. The units can operate down to ambient temperatures of 20 C with outlet water at 60 C, Swegon says.

Propane refrigerant

With the phase down schedule for fluorinated greenhouse gases (F Gases) under EU regulations continuing to be implemented within post Brexit UK regulations, the requirement to reduce hydrofluorocarbon (HFC) refrigerants employed in heating, ventilation, air conditioning and refrigeration applications has seen a shift towards lower GWP refrigerants.

The target to implement a reduction of 55% of greenhouse gas emissions by 2030 has led to firms introducing natural alternatives such as CO_2 (GWP = 1), propane (GWP = 3) and ammonia (GWP = 0), which are not restricted under the F Gas regulations and have a far lower impact on ozone levels.

According to Stefan Lay, cooling and heating product manager for Swegon UK and Ireland, the manufacturer has opted for the natural gas propane for its thermodynamic properties, as well as its lower GWP.

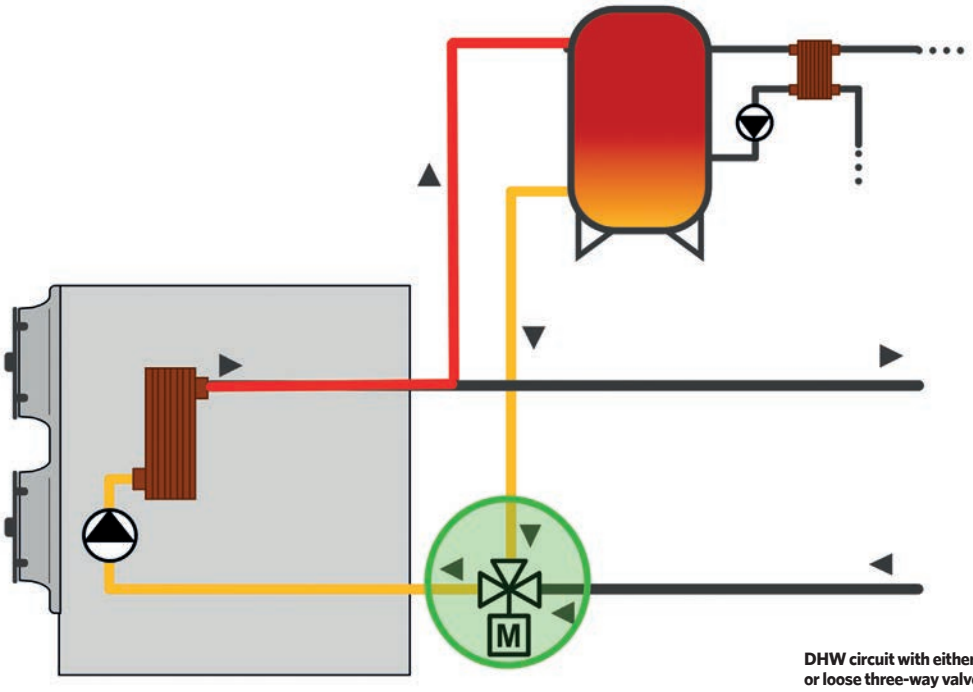
Propane was one of the naturally occurring refrigerant gases used in the early days of air conditioning and refrigeration, until non flammable and non toxic synthetic refrigerants were developed from the 1920s onwards, gradually replacing the natural gases.

Coming full circle, Swegon chose propane over CO_2, as use of the latter was considered to be more complex because of its extreme operating pressures and other properties. The company is currently investing heavily in developing a range of propane based solutions.

While the use of propane as a refrigerant is increasing within the sector, a key challenge recognised by the European Commission and the wider industry is the skills shortage for the safe and effective installation of low GWP refrigerants.

Skill is the key to any successful installation, and the UK industry is severely lacking in knowledge of chillers and heat pumps in general, says Lay. However, he continues: It will be the same as installing a normal unit, but with extra considerations as it contains propane, which is flammable. Installers and service engineers should complete additional training regarding the use of flammable refrigerants and be properly equipped to work safely with the unit.

»



DHW circuit with either integral or loose three-way valve option

» Lay acknowledges that some people may be wary of a propane refrigerant, based on its association with fires and barbecues and other gas fired equipment. However, he adds: The heat pump contains a limited charge of propane, which is not burnt but reused, with autonomous detection of leaks (at 10% lower flammability limit) coupled with a power shut down and ventilation procedure.

Propane has already been widely used in the retail sector, but is very new on the HVAC scene, so there may be some pushback [by potential customers].

Lay says the best approach is to give people confidence in how any propane refrigerant leak will be managed, while installers may be more comfortable employing specialist consultants to verify or sign off propane installations and complete site specific risk assessments.

The Geyser Sky Hi HP R0 units come with a dedicated refrigerant leak detector installed, which must be checked at least once a year for correct operation, and recalibrated or replaced where necessary. The installer must also carry out a flammability risk assessment and a classification of a safe installation zone, as required by standard EN378 3, says Lay. Swegon says the unit must not be installed in zones where a risk of stagnant refrigerant may be posed in the event of leakage, with fire extinguishers installed near the unit.

Investment

While Swegon s range promises an environmentally friendlier alternative to a standard gas boiler, ASHPs such as these units currently require more capital expenditure investment than their fossil fuel based counterparts.

Swegon s new range is available in three sizes, from 20kW to 30kW, starting at approximately £20,000, depending on the model: the Geyser Sky Hi HP R0 20 provides for peak load of 16.73kW cooling and 19.82kW heating*; the 25 model can deliver 22.5kW cooling and 25.02kW heating; and the 30 offers 27kW cooling and 30.79kW heating* capacity.

However, with the reversible units able to deliver both heating and cooling, their space cooling capability may be an increasingly appealing secondary function as seasonal temperatures rise because of climate change. Lay observes: Historically, we ve not been a nation that needs air conditioning or cooling generally, but over the past few years our summers have been getting hotter, and expectations are for that trend to continue.

> We need to invest in getting the message across about air source heat pumps and making it happen

There could be scope for future proofing [your building] with air conditioning, as well as providing a heating and hot water system. You get double bang for your buck.

Although these units are aimed at light commercial applications, they have been designed to be user friendly, with the inclusion of a 4.3 in touchscreen display, so could easily be used in larger residential applications. Lay expects UK demand where the market for ASHPs is far less mature than in Scandinavia to be rooted more in light commercial use than in the consumer market. He says the UK market is starting to become familiar with heat pumps and he predicts next year will see a big boom in sales. Within a year or two, he expects natural refrigerants, such as propane, to be in the market.

In terms of payback, Lay says current uncertainty surrounding energy prices makes it difficult to determine how soon this can be achieved. Efficiency does ultimately depend on how the units are installed, which is why the biggest focus in our industry needs to be on the installer, he says.

As manufacturers, we can tell you what this equipment is capable of doing, and the designers can specify the right units but the crux is when the machine goes in on site. Ensuring optimum performance is crucial, and we need to make sure that happens for customers who are perhaps unsure of the technology and its capability.

We need to invest in getting the message across about ASHPs and making it happen. We need support from government to help people understand the new technology what it does and how it works. CJ

*Based on EN14511 standards at 12/7/35 for cooling and 40/45/7 for heating

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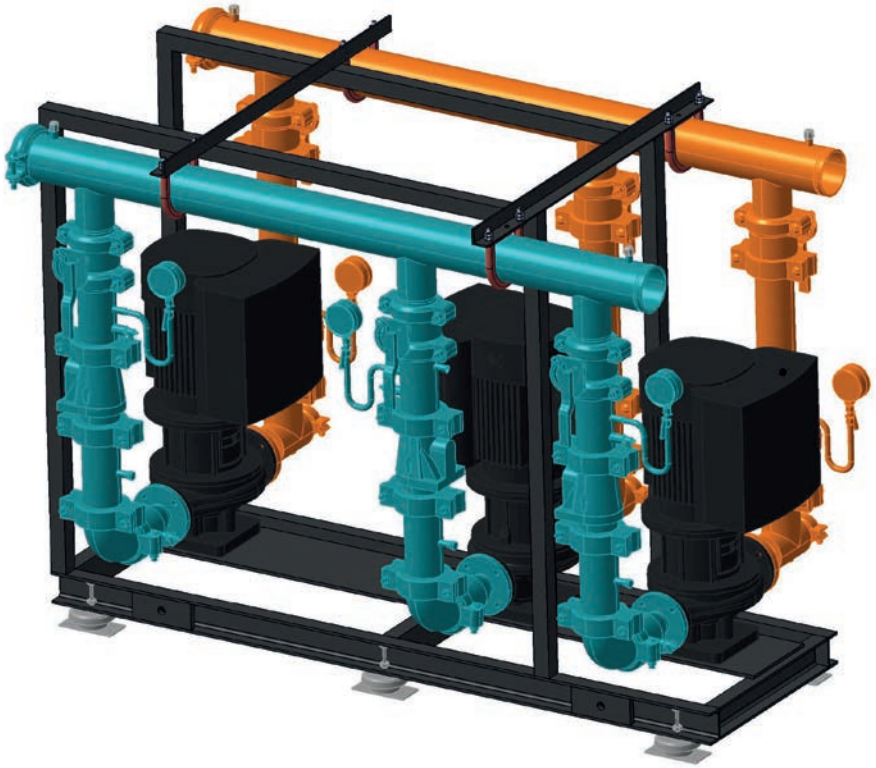

Grundfos ramps up packaged pump offering

Company responds to market demand for less waste and more certainty

Grundfos has developing a range of modular packaged pump systems under its Delta brand.

Also known as offsite build (OSB) or engineered to order (ETO), modular systems are designed, engineered and manufactured in a controlled factory environment.

The Delta systems are built, tested and pre-wired at Grundfos' 25,000m^2 factory in Sunderland. The Delta TIU (thermal interface unit) is aimed at offices, and district heating and cooling. The RAC (runaround coil units) is for air handling systems, and the HCU (heating and cooling unit) is appropriate for low temperature hot water, chilled water, district heating and cooling, and data centres.

Grundfos has delivered OSB-packaged products in Sunderland since 2012, but has only recently started offering standardising systems for the building services industry.

Initially, the company offered customisable HVAC pump systems, but the manufacture of these units was time consuming, labour intensive and relatively high cost, according to Pieter Swart, area sales development manager, at Grundfos. He said: 'We had to start from scratch for every system, so we looked at how we could improve the design and reduce the cost.'

Rather than offer fully bespoke OSB systems, Grundfos followed the 80/20 design concept, where 80% of the design has the same layout and components and 20% is customisable. For example, the Delta HCU standardised product has pumps, pipework, valves and a header, while a customised version might include the addition of controls, bigger headers or flushing valves.

Offsite building means reducing the number of deliveries to site by a fifth and cutting waste dramatically, said Swart. He claimed waste is only 2-3% in the factory compared with 20-30% on site. Factory conditions are also safer, he said: 'With hot works on site there is a potential risk of injury.'

There is also a big drive to reduce embodied CO_2, added Swart, especially in site deliveries: 'This doesn't just sit with consultants, but also the contractors. They're trying to reduce the carbon footprint and the risk of delays.'

Swart said it's difficult to put a number on the savings, as customers don't tell you what they have saved. 'However, we know there's a shortage of skilled labour, which has driven up labour rates on site. Clients have costs certainty and schedules. By going for modular, it's easier to meet deadlines. Delays don't impact that part of the business.'

The market has grown significantly in the past year, added Swart, who attributed this partly to the library of Revit drawings for the systems, ensuring a high level of detail for consultants very quickly.

Ideal Heating launches commercial heat pumps

Ideal Heating has introduced monobloc air source heat pumps for the commercial building sector. Featuring R32 refrigerant, the Ecomod range will be available in a choice of six outputs, ranging from 14kW through to 70kW, and can be cascaded to achieve higher outputs. The units are hybrid and bi-valent compatible, and free commissioning is available.

Mitsubishi Electric offers net zero advice

A white paper on how building managers can target net zero in their properties has been launched by Mitsubishi Electric.

Stranded assets: A roadmap to net zero for new and existing buildings offers advice on installing heat pumps and using heat recovery in the decarbonisation of heating and ventilation. It also has tips on adopting low global warming potential refrigerants. The roadmap includes questions that managers should be asking in the building and planning process, and suggestions for sustainable replacements.

Net zero design manager Chris Newman warned: 'With rising building standards brought in to help the industry reach net zero, we're seeing large numbers of spaces potentially becoming redundant due to energy inefficiency.'

EnviroVent moves to zero carbon HQ

Ventilation manufacturer EnviroVent has moved its 260 employees to a new purpose-built zero carbon building as part of its goal to reach net zero by 2030.

The 61,000ft^2 premises in Harrogate include solar panels, air source heat pumps, a mechanical ventilation heat recovery system, electric charge points, and responsive LED lighting. To offset any outstanding carbon, the firm is paying for 5,000 trees to be planted annually, removing around 1,500 tonnes of CO_2 from the atmosphere every year.

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Don t be binary on hydrogen

Hydrogen should be part of the solution to decarbonise heating in the UK, according to Hydrogen UK's Clare Jackson, who says we have no time to lose

Recent media reports have raised a number of objections to hydrogen s use as an energy source for domestic heating. They claim that it s more dangerous than natural gas, expensive, inefficient, not really low carbon and that hydrogen production won t be able to keep up with demand. Let s examine those accusations in turn.

Like anything intended for use in our homes, hydrogen boilers undergo rigorous safety checks before becoming commercially available. No system is entirely risk free and moving towards full electrification brings both safety and infrastructure development challenges. The many workstreams completed and ongoing under the H21 safety trials demonstrate that the technologies and processes are safe and can represent cost efficient decarbonisation options.

The companies developing hydrogen boilers have committed to ensuring that they will cost the same as natural gas boilers. Hydrogen itself is currently expensive because it s in the early stages of its development.

Technologies such as renewables and electric vehicles have benefited from government support to reduce costs; hydrogen needs similar backing to increase its financial viability. Once this support is in place, the industry will be able to deliver affordable, low carbon hydrogen to homes, with some estimates predicting hydrogen reaching cost parity with natural gas by 2030.

In terms of efficiency, hydrogen is an effective way of avoiding curtailment, which is a 100% efficiency loss. Constraint costs came to £1.2 billion in 2021 and are rising per unit of electricity curtailed. At the same time, the cost of transporting a MWh of hydrogen per 1,000 miles is eight times cheaper than that of electricity. A balanced approach combining electrification and hydrogen would mitigate demand peaks and could deliver system savings of up to £6.2 billion compared to pure electrification.

There are many ways to produce hydrogen, some using natural gas. The UK is introducing a low carbon hydrogen standard, which means that all hydrogen used to heat homes will be genuinely low carbon.

Hydrogen UK has calculated that the ever growing pipeline of hydrogen production projects in the UK totals more than 19.4GW of capacity. Longer term, up to 38 TWh of hydrogen could be available in the UK each year, enough to heat 3.2 million homes or all on grid homes with a hybrid heat pump system. We need to move away from either/or conversations about hydrogen and heat pumps or district heating. Consumers don t care and we ll need both options if we are to fully decarbonise domestic heating needs. Hydrogen has a key role to play alongside electrification and heat networks in decarbonising domestic heat and there are many advantages to implementing a mixed approach.

> Hydrogen has a key role to play alongside electrification and heat networks in decarbonising domestic heat

A mixed approach

The suitability of various low carbon heating solutions depends on the household and it s important that consumers are given a choice.

A total of 85% of UK homes are heated by natural gas boilers. Hydrogen boilers are a like for like replacement.

Similarly, there are 130,000 heating engineers registered with Gas Safe, who install and maintain the gas boiler systems deployed in homes. Transitioning this workforce over to hydrogen will be relatively simple to implement.

Hydrogen boilers are the same size and shape as natural gas boilers, and able to operate using the same flow temperatures. This allows energy efficiency upgrades to be decoupled from the heating system change, reducing disruption associated with a heating system change and avoiding the two financial outlays occurring simultaneously. If hydrogen ready boilers are installed, conversion from natural gas to hydrogen needs just a 30 minute visit from an installer to change three components, which costs around £100.

The widespread rollout of hydrogen within the heat sector would create new jobs and safeguard existing ones.

Global opportunity

The UK is well positioned to be a global leader in the development of hydrogen boilers, having already manufactured and demonstrated hydrogen ready boilers. With a strong existing installer base, and manufacturing and assembly lines in place, the UK could be a pioneer on the world stage.

Hydrogen UK firmly believes that we will need a range of solutions to decarbonise heat for homes, including heat pumps, hydrogen and district heating.

It s important that we leave all options on the table so that people can access a range of affordable and low carbon ways to stay warm.

CLARE JACKSON
is the CEO of Hydrogen UK

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Embrace the power to make use of waste heat

Denmark proposes injecting waste heat from the production of green hydrogen (and other products) into district heating networks. Sav's Adam Fabricius explains how

Net zero in Denmark is well under way, and for this to be cost effective the Heat Plan for Denmark recommends heat network coverage increases from 50% to 70%, by replacing existing gas heating zones. Half of this heat is to be supplied by waste heat from industry.

Now a new report from the Danish District Heating Association looks at how waste heat from Power to X (PtX) processes could be injected into heat networks to further reduce reliance on gas.

The term PtX refers to the use of green power to produce a product (X), like green hydrogen, e methane, e methanol or green ammonia.

All PtX processes require hydrogen, and electrolysis is therefore an important element in the green transition because it converts water into hydrogen and oxygen using green power.

PtX processes involve energy loss in the form of heat, and infrastructure is needed to collect that heat (Figure 1).

Sector coupling is a method of heat and power sharing between sectors and is key to achieving a carbon neutral Denmark by 2045.

PtX will have an important role to play in the decarbonisation of the transport of goods as well as the production of carbon neutral fertiliser for agriculture and carbon neutral forms of products such as steel, plastic and chemical products.

Unlike the UK, heat from Danish power generation cannot be dumped. So waste heat from PtX generation will need to be used. Even waste heat from crematoriums is used to heat Danish homes.

Analyses show an improved competitiveness of the electrolysis plant through the sale of heat to heat networks, longer operating hours and the utilisation of heat networks as a cooling mechanism to carry heat away from the PtX plant.

The report concludes that district heating can further contribute to the success of PtX. The cost of producing green hydrogen can be reduced if electrolysis and heat networks are coupled. The improved economics for the hydrogen producer can contribute to faster establishment and larger PtX plants.

Harnessing PtX waste heat for heat networks enhances integration across sectors such as electricity, heating, transport, and agriculture, meaning increased efficiency.

Integrating PtX with heat networks makes it more competitive, lowering the price by 5 10%.

Figure 2 is a case analysis showing the distribution of revenues after integration of a 20MW electrolysis plant with district heating. The figures show how integration improves the economics of the PtX plant. Sector integration is the reason for the increased hydrogen production and additional income.

Good energy planning is needed. PtX sites will have to be located close to existing gas zones that will need to be converted to heat network zones. CJ

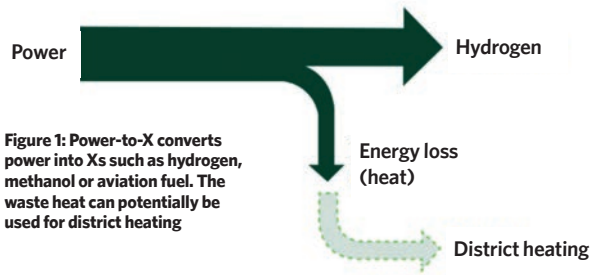


Figure 1: Power-to-X converts power into Xs such as hydrogen, methanol or aviation fuel. The waste heat can potentially be used for district heating

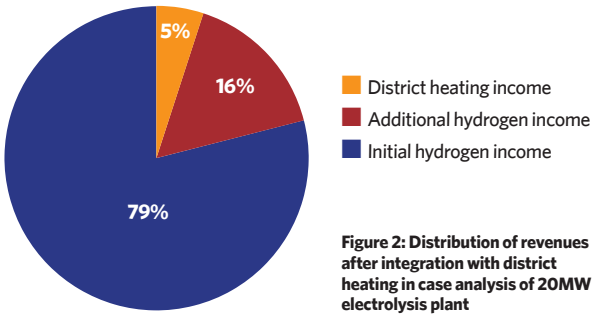


Figure 2: Distribution of revenues after integration with district heating in case analysis of 20MW electrolysis plant

Green hydrogen can be produced using energy from wind turbines

The unmistakable structure of Battersea Power Station is finally back in use and open to the public
Left: The atrium lets daylight seep onto the floorplates

POWER IS RESTORED

Battersea s iconic power station has reopened as a mixed use development incorporating an innovative services strategy that removed the need for heating and cooling in the gargantuan retail mall. **Andy Pearson** takes us on a tour

Battersea Power Station has finally opened its doors to the public for the first time in history. In the four decades that have elapsed since the power station ceased generating power numerous attempts at developing the site have failed.

The iconic landmark is Grade II* listed, which means the building had to be preserved in its redevelopment. The biggest challenges in terms of MEP were in maximising the net lettable areas and ensuring compliance with the building s Grade II* listing requirements, says Simon James, associate director at ChapmanBDSP.

The building services design also had to take account of the fact that the power station was built in two halves, decades apart. Designed by architect, Sir Giles Gilbert Scott, who also designed the red telephone box, Battersea A was completed and opened in 1933, with one turbine hall and two slender chimneys. It was not until 1955, when the eastern half of the building, Battersea B, was completed that the building acquired its familiar four chimney profile. The chimneys were needed to disperse the flue gases from the power station s pulverised coal fuelled boilers, which generated the steam that spun its giant turbines to supply a fifth of London s electricity.

Post industrial plans

Over the years, Battersea Power Station became an instantly recognisable feature of the London skyline, and starred on the cover of Pink Floyd s 1977 album *Animals*, for which it was photographed with the band s inflatable pig flying between its chimneys.

With operating costs increasing, however, and output falling with age, Battersea A closed in 1975, and Battersea B was decommissioned in 1983. The challenge then was what to do with this giant, brick built landmark in post industrial Britain.

A series of failed proposals for the 42 acre site followed the decommissioning of the power station. These included: Alton Towers

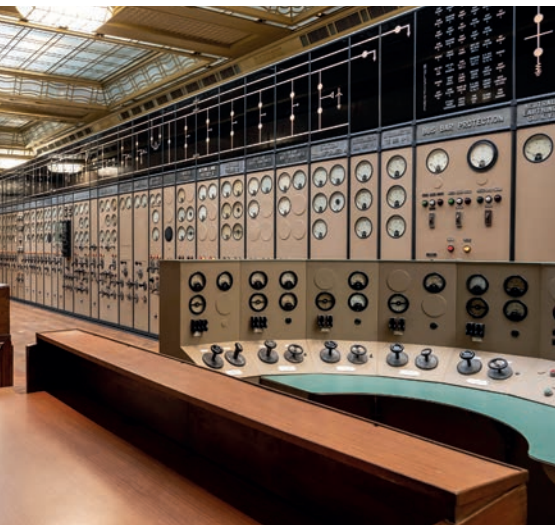
PROJECT TEAM

Client: Battersea Power Station Development Company
Architect: WilkinsonEyre
MEP consultant: ChapmanBDSP
Structural engineer: Buro Happold
Lighting designer: Speirs Major
Cost consultant: Gardiner & Theobald
Project manager: Turner and Townsend
Construction manager: MACE

> The plantroom is sandwiched between floors in the centre of the building for sound commercial reasons it helped maximise the lettable area

owner John Broome s plans to turn the power station into a theme park; a proposal for it to become the permanent home of Canadian entertainment company Cirque du Soleil; plans to turn it into a public park; and even a proposal to turn it into a football stadium to become the new home of Chelsea FC.

The two control rooms have been meticulously restored to be an events space and a cocktail bar



However, in 2012 a consortium of Malaysian companies bought the derelict site to turn the power station and its surrounding 42 acre site into a mixed use development incorporating residential, retail, office and leisure.

Phasing in change

In 2013, architect WilkinsonEyre and engineers ChapmanBDSP were appointed to restore and repurpose the power station structure under Phase 2 of the site s redevelopment.

Phase 1, Circus West Village designed by SimpsonHaugh and De Rijke Marsh Morgan was completed in 2017 and is now home to more than 2,000 people.

Phase 3, Prospect Place and Electric Boulevard, a new pedestrianised high street, is under construction, with more residential apartments, designed by Gehry Partners and Foster + Partners, as well as new retail space and a hotel, due to open shortly.

It is Phase 2, the repurposing of the power station, that is key to the scheme s

Three floors of retail space are accommodated in what was Turbine Hall B

success. At the heart of WilkinsonEyre's design is the central Boiler House, which now accommodates three floors of retail and leisure. On the third floor are two cinema screens, an events space and offices for flexible working. Floors five to 10 also accommodate 46,000m² offices.

Flanking the main power station walls, to the east and west, are the two giant turbine halls. These are now home to three floors of shops, restaurants and unique event spaces. Adjacent to the turbine halls are the meticulously restored original control rooms, and flanking each of the turbine halls are the former switch houses, which contain more residential apartments. Visitors are able to board a glass lift, Lift 109, to take them to the top of the north west chimney to enjoy views of London, 109m above sea level.

Pitch and plant

The giant double height plantroom takes up almost the entire fourth floor of the repurposed power station. It s probably bigger than a football pitch, says James.

It is sandwiched between floors in the centre of the building for sound commercial reasons; it kept the ventilation ducts to a manageable size, rather than having to deal with huge ducts dropping down from roof top air handling units (AHUs). It also had the benefit of freeing the roof from building services plant, creating space for more housing.

Putting the plantroom in the middle helped maximise the lettable area because smaller ducts go up and down from it, rather than having large ductwork dropping down the building from the roof, explains James.

The plantroom accommodates more »

A CHIMNEY-POTTED HISTORY OF BATTERSEA

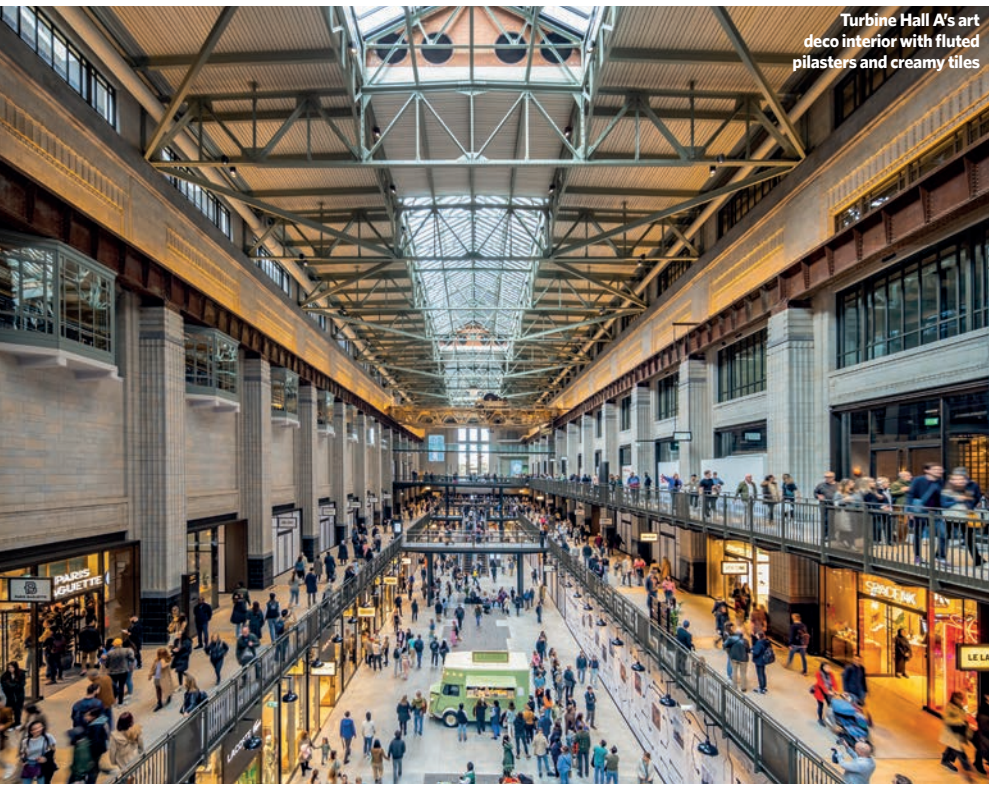
- The power station was conceived in 1927 by the London Power Company, to meet the capital's demand for electricity.
- It was designed by Sir Giles Gilbert Scott, the architect who designed Liverpool's Anglican cathedral, Bankside Power Station (now the Tate Modern) and the iconic red telephone box.
- The power station was built in two halves; initially, the western half of the power station was built, along with the SW and NW chimneys. This started generating electricity in 1933. The second half came into service in 1944, at which time a third chimney was completed, giving the building the moniker 'the 3-pin plug'.
- The power station survived the Blitz, possibly because the plumes of white vapour from the chimneys provided the Luftwaffe with a navigational landmark.
- The final chimney was added in 1955, when Scott's four-chimney design was finally realised.
- At its peak, the power station's total generating capacity was 509MW.
- The station ceased generating electricity in 1983.

» than 25 AHUs. Ventilation intake louvres are located in the wall on the western side of the plant floor, while the exhaust louvres are concealed in rooftop gardens above the turbine hall, to the east of the plantroom. Ductwork and piped services are distributed via risers concealed in the rectangular wash towers that form the base of each of the four chimneys and in four new access cores constructed in the centre of the building to accommodate lifts and stairs.

James says it was a challenge coordinating the various plant and pipework with the new supporting structure that now fills the space. Coordination was helped by the project being designed in BIM. At its peak, ChapmanBDSP had a team of 25 BIM operators working on the scheme.

A major challenge with this project is that there is no repetition in terms of risers and floor plates; everything is a bespoke design to accommodate the listed structure, he explains.

Battersea ceased generating power in 1983



Turbine Hall A's art deco interior with fluted pilasters and creamy tiles

Down in the basement

Heating and cooling for the entire scheme is provided by a new energy centre located in the building s basement. It was designed by Vital Energi and is currently being run by Equans.

The energy centre includes two 2MWe gas combined heat and power (CHP) engines, one 3.3MWe gas CHP engine and three 10MW gas fired boilers, plus seven 60m³ thermal stores and six 4MW chillers. Flues from the boilers and CHP engines use the power station s north east and south west chimneys.

James says ChapmanBDSP worked with Vital Energi to provide it with estimated energy loads for Phase 2 of the project: We designed the networks that distribute the LTHW [low temperature hot water] and chilled water from it using efficient variable volume systems.

Alongside the energy centre, the basement is home to the building s 19 electrical substations. Rather than incorporate standby generators, ChapmanBDSP has saved floor space by bringing in two separate electrical supplies. The project s 14MW load is supplied by two 7MW supplies taken from the Stewarts Road substation.

ChapmanBDSP s scheme also eliminates the need for heating and cooling plant to serve the two retail malls that now occupy the turbine halls, which flank the main Boiler House building.

Styling it out

The interiors of the two halls reflect their different ages: Turbine Hall A has an art deco interior with fluted pilasters and creamy tiles; Turbine Hall B was built after World War II and has a more utilitarian feel. Both turbine halls have the outlines of the generators that once filled the space with noise and movement picked into the floor finish.

We were able to thermally model the two turbine halls to demonstrate to the client that the thermal comfort aligned with CIBSE guidance, which saves on plant cost and energy use, says James.

Thermal mass, a small amount of solar »

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Luxury residential 'Sky Villas' are accessed via a glass lift at the base of one of the chimneys

» gain and some beneficial heat from the retail units will ensure visitors remain comfortable in winter.

Both turbine halls incorporate smoke extract fans at high level to pull smoke out in the event of a fire. These provide yet another example of ChapmanBDSP s approach to delivering value on the project.

Rather than install additional ventilation plant on the roof, ChapmanBDSP has used the smoke extract fans to increase ventilation rates, by helping pull air in through the main doors and exhausting it through the roof.

Because the Building Regulations call for fresh air to be supplied to the turbine halls, we have agreed with building control that we will use CO_2 sensors to run the smoke extract fans at low volume in the unlikely event that there are so many people in the turbine halls that CO_2 levels rise significantly, says James.

Cool control

Adjacent to the turbine halls are the original control rooms, with their walls of knobs and dials gleaming like new.

Control Room A is the most impressive, with the banks of breakers labelled with place names such as Carnaby Street illuminated by an ornate art deco glazed ceiling. This is a private events space that will be open to the public on certain occasions. Control Room B, which was built later, is more industrial in design and is now an all day bar.

These spaces were originally naturally ventilated. However, because both control rooms are listed, the spaces are now heated and cooled using conditioned air, supplied through existing grilles at high level to the space.

Worth the wait

It may have taken almost four decades and numerous failed development proposals, but Battersea Power Station is finally open to the public, The scheme will benefit the local and wider community, Londoners, and the UK economy, while saving and celebrating the building s original features bringing the structure to life once again. CJ

Thermal mass, a small amount of solar gain and some beneficial heat from the retail units will ensure visitors remain comfortable in winter

The last of the building's four chimneys was completed in 1955

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Hamworthy

THE CASE FOR CO_2 HEAT PUMPS

Gabor Baszormenyi, from Clade, argues that CO_2 should be the refrigerant of choice for heat pumps

Clade's Rowan CO_2 heat pump

Simple comparisons between CO_2 and other working fluids, such as hydrofluorocarbons (HFCs), can be misleading because CO_2's low critical temperature either requires differences in system design such as the use of cascade systems or the application of a transcritical system. As a result, like for like comparisons are not easy to make.

This article will attempt to set out the reasons why CO_2 should be the working fluid of choice for heat pumps in many applications, giving comparisons where possible.

The vapour compression cycle, as used in heat pumps and refrigerators, has an intertwined history, with refrigeration being the dominant service provided to date.

As a result, the terms 'working fluid' and 'refrigeration cycle' have become commonplace. In order that this article reflects the changing market, 'working fluid' and 'heat pump cycle' will be used.

The history of natural refrigerants

CO_2 was one of the very first working fluids to be used in a heat pump cycle. Subsequently, synthetic working fluids designed specifically for refrigeration were invented and employed.

These synthetic fluids have very high global warming potential (GWP; a measure of the effect on global warming, measured in CO_2 equivalence) and have high embedded carbon in production, but they are ideal for refrigeration. Over the past 10 years, CO_2 has come back as the working fluid of choice for many applications because it has excellent heat transfer properties, and engineering standards have advanced sufficiently to make it safe and economic.

The first CO_2 specific parts were developed in the 1990s, but it took several years for them to become commonly available. CO_2 technologies are now considered as 'standard', and component availability is much wider and developing in line with the market.

There are two key values for a working fluid that give rise to its behaviour: the critical point and the triple point (see Figure 1).

The triple point is the only temperature and pressure at which all three phases will exist. It is unique to a substance and can be used to identify it. The critical point is the highest temperature and pressure at which a pure material can exist in vapour/liquid equilibrium.

When compared with other working fluids, CO_2 has a high triple point and a low critical point, as shown opposite. »

There is no prospect of a regulatory change that could phase out or prevent the use of CO_2 and supply is plentiful

The thermodynamic properties of CO_2 versus other working fluids

At atmospheric pressure, solid CO_2 transforms directly to gas – something you might recognise from the dry ice effect used in theatres and at concerts. One of the complications with CO_2 as a working fluid is that the reverse is also true, and unskilled technicians can cause solid CO_2 to deposit if the pressure is not controlled properly during a service.

The critical point occurs at 31°C (see Figure 2). Above this point, the CO_2 is a supercritical fluid. This means there is no phase change when heat is removed from the transcritical fluid – we call this gas cooling. In a heat pump system, supercritical CO_2 will not condense until the pressure has dropped below the critical pressure.

No other commonly used working fluid has such a low critical temperature. The advantages this offers are discussed later in the article.

CO_2 has a GWP of 1, which is very low compared with other working fluids, such as R410A (HFC) or R448A (HFO) – see Table 1 on page 70.

Every system will lose some of its gas each year from service activities or from leakage between components. Manufacturers and those working with plant take considerable precautions to prevent this, but a 15% loss is not unusual. This loss of gas leads to fugitive emissions that must be accounted for in carbon footprint calculations. An example comparison is given in Table 1.

F Gas regulations have been steadily reducing the quantity of high GWP gases available and some of the worst are now banned. This trend is expected to continue to reduce fugitive emissions and emissions created during the manufacture of synthetic gases. Not only are they being regulated out, but there have also been significant price rises – in some cases by more than 300% – as supplies become restricted.

There is no prospect of a regulatory change that could phase out or prevent the use of CO_2 and supply is plentiful. Therefore, there is no stranded asset or cost increase risk associated with its adoption as a working fluid.

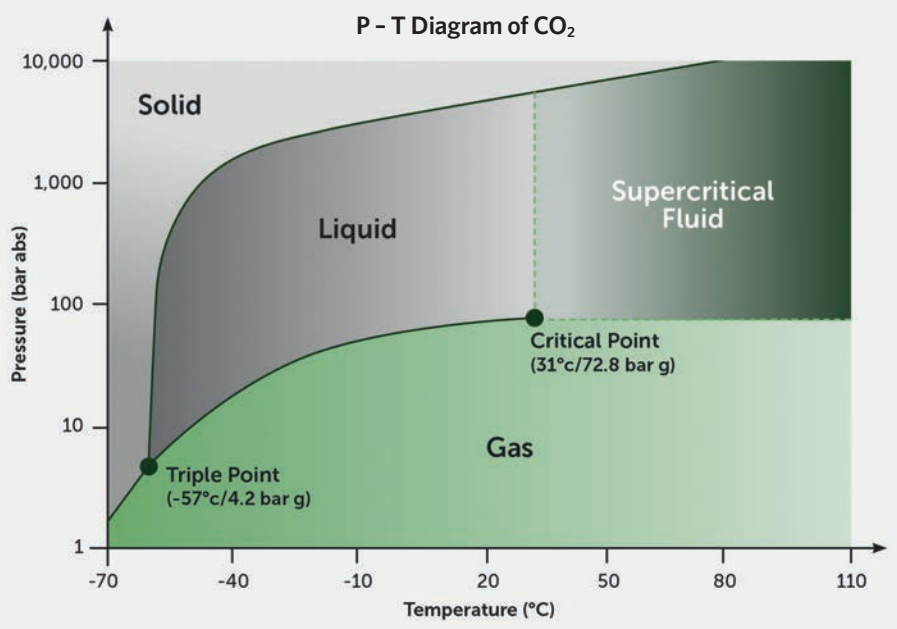

Figure 1: Pressure-temperature diagram of CO_2

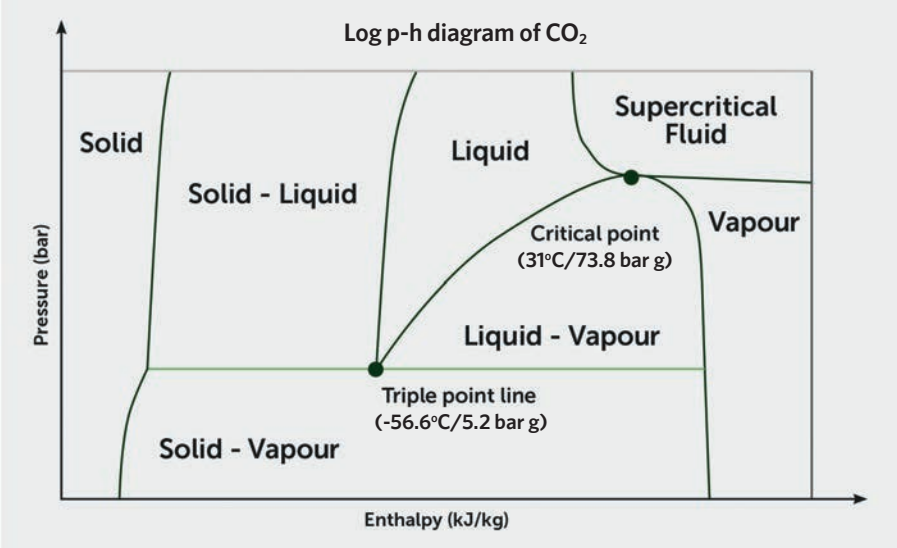

Figure 2: Log pressure-temperature diagram of CO_2

CO_2 is non flammable and non toxic

CO_2 is non corrosive, non toxic and non flammable. It is a stable molecule that does not decompose, either in the system or when accidentally released.

In comparison, a recent study by the University of New South Wales, in Sydney, Australia, suggests that elevated levels of high GWP HFC 23 (R23) in the atmosphere could be linked to the uptake of HFO 1234ze, which produces R23 as it decomposes in the atmosphere.

R23 has a GWP of 14800, making it among the worst gases for climate change.

CO_2 is an asphyxiant in large concentrations, so the use of detectors in confined spaces is normal. As the gas is heavier than air, it drops to the floor, where detectors should be placed.

The best placement for a CO_2 heat pump is outside, where the gas disperses naturally in the unlikely event of a severe leak.

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Working fluid	GWP	CO_2e for annual losses*
R744 (CO_2)	1	53kg
R410A (HFC)	2,088	110 tonnes
R448A (HFO)	1,387	74 tonnes
R290	3	159kg
*Calculation based on like-for-like volume of 354kg		

Table 1: Comparative fugitive emissions

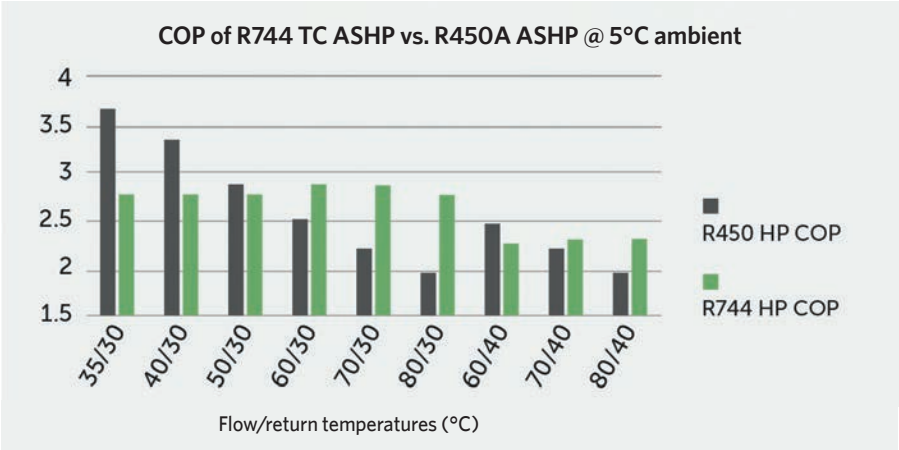

Figure 3: Performance difference between R744 and R450A in a heat pump at 5°C ambient temperature

CO_2 offers more efficient heat transfer

A huge practical advantage of CO_2 is the heat transfer in the gas cooler, which is typically a plate heat exchanger in a heat pump. In a condenser, a large fraction of the heat transfer surface is being used for phase change (condensation), during which the temperature remains constant, or only changes slightly, with some working fluid blends.

With CO_2, the temperature is changing during the gas cooling process in transcritical mode. This helps to achieve very high water temperatures that are not normally achievable in HFC systems, or can only be approached by using a de superheater, which further increases complexity. Where supply water temperatures are above 55 C, CO_2 heat pumps offer a better coefficient of performance (COP) compared with other technologies. CO_2 is a preferable working fluid to supply heat at high temperature levels.

Allowing for higher temperatures

The index of compression is very high for CO_2, so the discharge temperature is higher than for HFCs. Also known as the polytropic exponent, the index of compression is 1.289 for CO_2 and only 1.005 for R404A.

> The next energy transition is just starting and will be a period of rapid change in all respects technologically, socially and regulatory

A CO_2 heat pump in the factory destined for a school

A polytropic process is a thermodynamic process that obeys the relation:

$$pV^n = C$$

Where p is the pressure, V is specific volume, n is the polytropic index, and C is a constant. The polytropic process equation can describe multiple expansion and compression processes, which include heat transfer.

The value of n is different in different thermodynamic processes. The polytropic index is a measure of the work done by the system. Given a value for n, then the heat of compression may be determined using the following equation.

$$T2/T1 = (p2/p1)^{[(n-1)/n]}$$

where T is the thermodynamic temperature.

Where the numbers 1 and 2 denote the states at the beginning and end of the compression process, it can be seen that a higher value of n gives a higher differential in temperatures, thus CO_2 has a greater temperature difference than HFCs.

This means CO_2 can deliver useful temperatures for heating applications while drawing heat from air at normal ambient temperature ranges, all year round. The performance difference between CO_2 (R744) and a typical synthetic fluid (R450A) can be seen in Figure 3.

CO_2 systems producing high water temperatures have a higher efficiency than systems with other working fluids. However, many other factors in heat pump design also influence this. Different manufacturers will control the heat pump using proprietary algorithms and careful component selection, resulting in performance differences.

CO_2 is more dense than other working fluids, so the pipework, number of compressors, components and rack size are smaller in general (see Figure 4). For example, the required suction pipe cross section diameter for CO_2 is approximately half that required for R404A (for the same volumetric capacity). This is especially valid for large capacity systems that are likely to require more compressors and much larger diameter pipework if designed for HFC/HFOs.

Potential hurdles for CO_2 heat pump deployment

CO_2 is a great option for a heat pump working fluid. However, it faces two significant challenges from the buildings sector: building system return temperatures and oversizing.

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» Traditionally, heating systems have been designed for high temperature delivery, with a moderate difference between flow and return temperatures. This system design parameter exists in much of our building stock even the adoption of gas condensing boilers has had limited impact on this.

Any heat pump requires a different approach to design and commissioned temperatures. CO_2 heat pumps can deliver high flow temperatures, which are a better match for existing buildings but require a low return water temperature of around 35 C.

The oversizing of plant, pumps, pipes and heat emitters is widespread. Resilience and reliability are often cited as reasons, but the cause is also a lack of data driven design and poor design capability.

Oversizing leads to inefficient and malfunctioning systems, of which there are many examples. The marginal cost of oversizing heat pumps is significantly greater than for boilers.

This reinforces the need for a better engineering approach. With good engineering practice, both these challenges are overcome easily.

Higher temperature/pressure

The higher temperatures, pressures and complexity inside a CO_2 heat pump require special components, and experienced design and manufacturing, to ensure safety and efficiency. For most users or building operators, this should never be a concern, because the CO_2 heat pump comes as a single sealed unit only trained service personnel need ever touch the CO_2 side.

On larger heat pumps say, more than 800kW a separate evaporator and compressor will be necessary. In this case, specialists must be engaged to complete the installation and certify in accordance with the Pressure Equipment Directive.

Energy transition risk

The next energy transition is just starting, and will be a period of rapid change in all respects, including technologically, socially and regulatory. It will result in islanded assets that will have to be replaced well before their end of life.

The Montreal Protocol and the Kigali Amendment set out the reduction of harmful high GWP refrigerants. Over the lifetime of a commercial heat pump, which should be around 20 years, it is expected that regulations will accelerate the phase out process.

A HFC based heat pump installed now is likely to require replacement or modification before its end of life, increasing the total cost of ownership.

As part of an organisation s carbon footprint disclosure, it must account for all F Gas fugitive emissions. That is, the quantity of HFC, HFO and hydrocarbon lost from their systems each year because of leaks or service work. High GWP working fluids will result in a higher disclosure, affecting organisational carbon reduction plans and public disclosure.

CO_2 has a low GWP and is not subject to the Montreal Protocol, so is a safe technology to use when considering transition risk.

> A HFC based heat pump installed now would require replacement or modification before its end of life, increasing the total cost of ownership

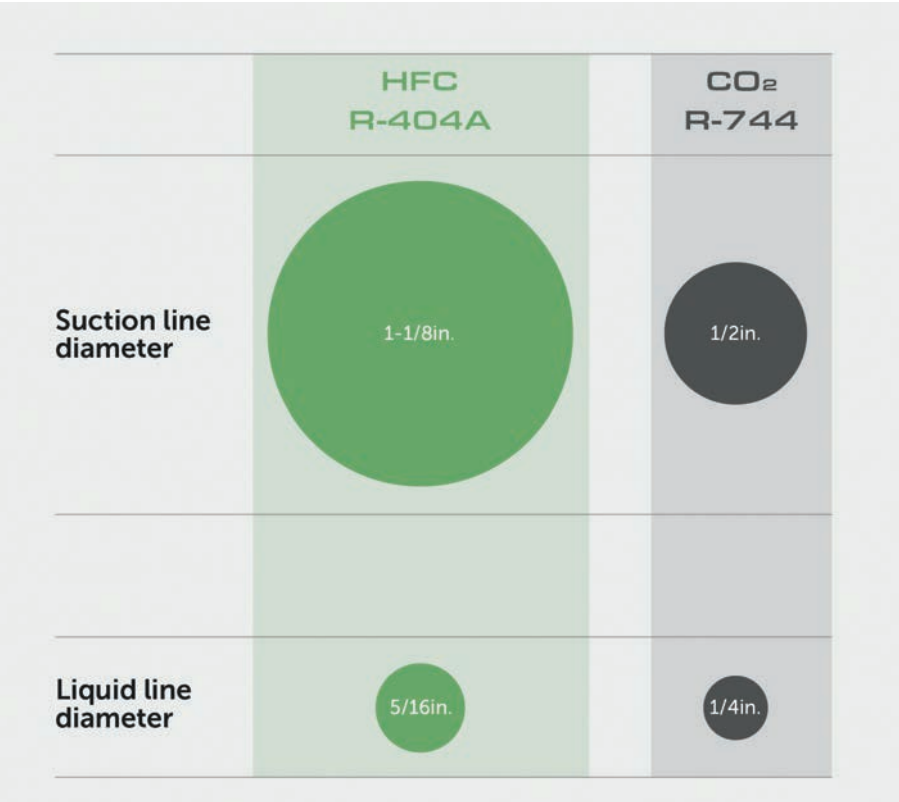

Figure 4: Suction pipe diameter required for CO_2 – which has greater density – is approximately half that of R-404A

Good system match

The high temperatures generated on the flow side and the low return water requirements make CO_2 a good match for future building systems. Whole heating system efficiency is improved when using a CO_2 heat pump, because the temperature difference between flow and return is larger.

Preparation for the energy transition is a huge challenge for all organisations. Selecting the right heat technology will have enormous long term effects, as penalties for emissions both in terms of the regulatory burden and additional cost will ramp up.

Heat pumps are widely seen as the most likely replacement technology for current heating systems. The use of CO_2 as the working fluid in these heat pumps has, thanks to technological and engineering advancement, now become possible.

CO_2 s thermodynamic properties, as laid out above, mean its performance is much greater than that of other commonly used working fluids.

Overall, the total cost of ownership of a CO_2 heat pump is likely to be significantly lower than the alternatives.

While, in some instances, there will be challenges in the deployment of CO_2 heat pumps, these can be overcome with good engineering practice and an experienced, qualified manufacturing and maintenance partner. CJ

GÁBOR BÖSZÖRMÉNYI, engineering manager and thermodynamics leader at Clade

Meet the new EHS Mono HT Quiet

High temperature, low Noise, optimal performance

Samsung's newest eco heating system is the ideal heating solution for Europe's residential renovation market. Durable and stylishly designed, this heat pump combines advanced features and new technologies to achieve hot water temperatures of up to 70°C[1] for domestic heating purposes. It operates at noise levels as low as 35 d(BA)[2] using a 4-step Quiet mode. It is also capable of reliably providing 100% heating performance* even at temperatures as low as -25°C[3]). Installation and maintenance of the unit is easy and hassle-free, with its internal parts being accessible via a side panel which can be removed by simply undoing 3 screws.

1. Leaving water temperature, when the outdoor temperature is between -15°C - 43°C. Results may vary depending on the actual usage conditions.
2. Based on internal testing of the EHS Mono HT outdoor units. The noise level is measured 3m away from the front of the outdoor unit, in an anechoic room with an outside temperature of 7°C. Results may vary depending on environmental factors and individual use.

*Efficiency ratio of heating output (capacity) versus power input (electricity). Internally tested under lab conditions based on EN 14511, results may vary depending on the actual usage conditions.

3. Based on internal testing on an EHS Mono HT outdoor unit (AE120BXYDGG), compared to a conventional EHS outdoor unit (AE120RXYDGG). Results may vary depending on the actual usage conditions

The Quiet Mark certificate is applicable for UK & EU territories only.

The Edge Suedkreuz development in Berlin was designed using nature-based architectural elements

The sheer number of timber beams on the office floors cover almost 40% of the soffit, restricting space available for the installation of building services

BERLIN COOL

The striking Edge Suedkreuz office development in Berlin required a space defying chilled beam system design that met the building s exacting ventilation, cooling and heating demands. **Andy Pearson** reports

Characterised by its atrium of flying staircases and timber clad concrete trees , the Edge Suedkreuz development in Berlin is inspired by an open ecosystem. Bringing nature based design into the workspace, sustainability and occupant wellbeing were a key focus for the building.

Berlin based architect Tchoban Voss Architekten worked with Buro Happold, structural and sustainability consultants, as MEP on the project. The scheme comprises two buildings, the smaller Solitaire Building and the larger seven storey Carr Building the focus of this article which is occupied by German energy supplier Vattenfall.

One of the Carr Building s features is that it was built using an innovative modular timber concrete hybrid structural system by CREE Buildings. The system was adapted by Buro Happold for this project to deliver on the developer s modular and sustainability aspirations.

Edge wanted to explore the use of prefabrication to help speed construction, while increased use of timber helps reduce the amount of carbon embodied in the building and, where visible, using natural materials helps to create a more desirable office environment, says Martin Elze, associate director of Buro Happold.

Timber is visible throughout the building: it includes timber framed floor to ceiling windows, trussed timber roof beams in the giant central atrium and, most significantly for the MEP engineers, exposed timber beams on the office floors to support the concrete deck of the floor above.

The sheer number of timber beams on the office floors, closely spaced at 1.35m centres, cover almost 40% of the soffit, restricting space available for the installation of building services. Because the space for installing the services was reduced, it was important to use a highly efficient, well coordinated building services solution to provide heating, cooling and ventilation, says Elze.

The solution to keeping the office floors comfortable was developing a bespoke, high capacity hybrid active chilled beam. The hybrid chilled beams have a fresh air connection with a heating/cooling coil. Two units are designed to slot between each structural timber beam, measuring 8,100mm long and together 800mm wide.

The units provide fresh air and sensible

The seven-storey Carré Building in Berlin

cooling and heating to the floors through a combination of induction and forced convection. The designed summer maximum temperature is 26 C for the offices. Elze says each of the units can produce up to 120W m^2 of cooling, or an average of about 70W m^2 over a floor plate, which he claims is enough for the majority of office spaces .

Office floors are designed to be predominantly open plan, so chilled beams are controlled in pairs, enabling conditions to be varied every 2.7m. You have the opportunity to install additional valves to control the units individually, which would allow a partition to be installed every 1.35m if needed, so it s a super flexible solution, says Elze.

The high capacity chilled beams also incorporate LED lighting and acoustic absorption along with some of the 17,000 sensors installed in the building, including presence detection and CO_2 monitoring to control fresh air supply rates. The LED lighting, manufactured by Signify, is bespoke to this project. Standard luminaires would not fit into the ceiling panel, Elze explains.

In common with other Edge buildings, occupants are able to control their immediate environment from their mobile phones. There is not a single switch in the building, everything is controlled by occupants using an app, so when you go into a room you can use your phone to adjust the temperature, Elze says. The building s smart controls also enable meeting rooms to be pre cooled, heated or ventilated before a meeting via the central booking system.

Fresh air ventilation rates are based on 45m^3 h^{-1} (12.5L s^{-1}) to meet WELL Certification requirements. This is about the same ventilation rate as Kategorie II DIN 16798 1 and about 16m^3 h^{-1} more than the minimum Kategorie III requirement. All air is returned to the rooftop air handling units/heat exchanger, via an exhaust air intake adjacent to the return air riser in the building s concrete core. There is no air recirculation.

Should any of the building s 2,100 occupants want to increase the amount of outside air on a floor they have the option of opening a window. The windows are interlinked with the ceiling panels to turn off the heating and cooling. It was a client requirement to have opening windows because people feel better and more in »

The solution to keeping the office floors comfortable was developing a bespoke, high capacity hybrid active chilled beam.

Office floors are designed to be predominantly open plan

» control of their environment if they can open a window, explains Elze.

To help limit heat gains on the office floors, the full height glazing incorporates solar protection film. This incorporates a small mesh to provide shading from inclined sunlight while allowing horizontal views out. It s a passive system that works like a louvre, says Elze.

In addition to the ventilation, the majority of the piped services are distributed to the floor plates through risers contained in the central concrete core. On leaving the riser, pipes and ducts enter the floor plates through the dropped ceiling of the adjacent toilet blocks.

On office floors, the ceiling height is 3.0m to the underside of the wooden beams, 3.05m to the underside of the chilled beams. However, in the toilet areas, the ceiling height has been dropped to 2.3m to create space to allow pipes and ducts to be re routed before entering the office floor.

Office floor plates are intended to be mostly open plan. There is, however, a central spine on each floor where the ceiling height has been dropped to 2.6m to enable ductwork and pipework to be distributed on the floors.

Elze refers to this as the corridor because the dropped ceiling follows the same linear route along the centre of the floor plates as a corridor would, should partitioning be installed. There is a 40cm space above the toilets to re route the services and bring them into order before they go into the corridor dropped ceiling, he says.

Internally, all of the office floors are linked by a giant, 1.600m², 26m high square central atrium that includes a series of striking timber clad concrete trees soaring up to 15m high. Special care has been taken to ensure a comfortable environment in this area (see panel, Cooling the atrium).

Managing the electrical loads

Beneath the building, a giant reinforced concrete underground car park connects »

COOLING THE ATRIUM

The central atrium features a series of flying staircases bridging between the floors and four free-standing timber-clad concrete 'trees'. The tallest of these is almost 15m high, the shortest 4.5m.

This atrium gives the building its character; it provides spaces for both formal and informal meetings, including seating spaces in the 'trees', along with seating on the ground floor for the cafe. The atrium also includes a loggia on level 5, where there is a sky lounge and access to an external roof terrace.

Detailed modelling simulations ensured comfort conditions are achieved through a combination of passive and active design solutions. These include moveable foils within the ethylene-tetrafluoroethylene (ETFE) roof pillows (ETFE material is extremely low weight compared to glass and offers exceptional light transmission) to control the amount of solar radiation entering the atrium in both summer and winter. There are also additional openings directly beneath the roof on the north and south elevations to exploit the wind direction to remove hot air from high levels in the space.

To ensure the atrium remains comfortable in summer, Buro Happold amalgamated various cooling systems, including: underfloor cooling; cooling from cylindrical air diffusers in the corners of the atrium; and displacement units set into the floor of the seating areas on the trees.

In addition, cooling units above the entrances supply conditioned fresh air; these are connected to roof-top air handling units via run-around coils.

'We did a lot of energy studies for the atrium in order to determine what cooling we needed; with energy simulation modelling we were able to trim the cooling down to figures that are sensible,' says Elze.

Cooling is provided by two hybrid cooling towers mounted on the roof.

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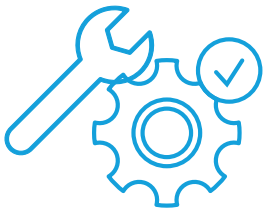

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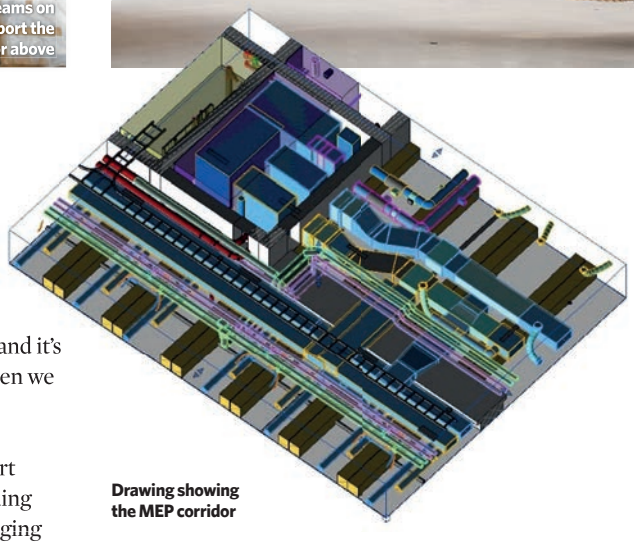
Exposed timber beams on the office floors support the concrete deck of the floor above



Drawing showing the MEP corridor

> The fire brigade is very sensitive when it comes to electric cars because it still doesn t know the best way to handle them Martin Elze

» the Carr Building to its smaller seven storey sister, the Solitaire Building. This can accommodate up to 218 cars and 300 bicycles. It incorporates an automated parking system to save space by double stacking parked cars one above the other.

Impressively, all the parking spaces incorporate electric charge points. Unfortunately, the city s electrical infrastructure did not have the capacity to power the building, its kitchen, the building services and to simultaneously charge more than 200 electric vehicles.

The building had a 7.5MW electrical connection, the maximum available. If everything in the building is running, its total electrical demand is predicted to be 6.8MW. Electric car charging adds another 1.5MW, taking total demand over the 7.5MW maximum. For 99% of the time, electrical demand is not an issue, but when the building is fully occupied, it s lunchtime so the kitchen is running at full capacity, and it's 40 C outside and the sun is shining, then we may need to act, Elze says.

In response, the BEMS constantly checks electrical demand. If it does start to come close to 7.5MW, then the building automatically starts to reduce the charging rate for the cars. We had to introduce some load management, so that on the rare occasions when everything is running, the car chargers will only charge at part speed, Elze says.

Interestingly, the basement is the only part of the building to have sprinklers fitted. The fire brigade is very sensitive when it comes to electric cars because it still doesn t know the best way to handle them especially an entire car park full of them which is why they have insisted we put in sprinklers, says Elze.

Alongside the electric cars, bicycles and sprinkler tanks, the basement also houses two combined heat and power (CHP) engines. We wanted to connect to the district heating in the city, but heat is still produced using coal in some parts of Berlin, so Edge decided to use CHP engines running on biogas to provide all of the building s heat and additional power, explains Elze.

Clearly, sustainability and occupant wellbeing are important drivers for the Edge Suedkreuz. The designers innovative response to these imperatives has resulted in the building being pre certified Platinum by the German Sustainable Building Council and pre certified Well Gold. CJ

CULTIVATING KNOWLEDGE

The University of Warwick s new Interdisciplinary Biomedical Research Building is designed to encourage the cross fertilisation of scientific ideas. Hoare Lea s **Ed Lucas MCIBSE** and **Ashley Bateson FCIBSE** describe the design strategy

The University of Warwick is committed to delivering world leading scientific research, and specialises in neuroscience, microbiology and infection, cell biology, and disease. Its reputation for supporting and facilitating research of the highest quality has now been enhanced by a £54m Interdisciplinary Biomedical Research Building (IBRB), which was completed in 2021.

Science is fundamentally a cumulative enterprise, and sharing information is essential to problem solving and developing solutions. The scientists at the University of Warwick understand the need for collaboration. The whole thing about science is that unexpected chance encounter, said one professor. That s absolutely No 1, because all the prepared encounters are boring.

To meet this requirement, the university commissioned a building that would bring together scientists from different departments and offer a purpose built space for the cross pollination of ideas. At the IBRB, microbiologists from the medical school and life sciences are brought together in their fight against human infectious diseases, with the hope that collaboration will bring innovation.

Architect Hawkins\Brown and building services consultant Hoare Lea were appointed to design the IBRB on the university s Gibbet Hill campus. The main contractor was Willmott Dixon.

The design

IBRB is a purpose built, six storey research and teaching building, with open plan write up spaces, a 400 seat lecture theatre, meeting rooms, and perimeter single occupancy offices. There is also a caf , kitchens and an atria with connecting stairs.

The building has two structural systems. The non lab side uses a timber solution glue laminated and cross laminated timber which provides a low carbon alternative to conventional materials.

The labs use a precast concrete structure, which was required to meet the science needs of the building. Where concrete is exposed to the workplaces, it has been finished to imitate the grain effect of wood, which offers a pleasing and calming effect on the eye.

PROJECT TEAM:

Client: University of Warwick
Architect: Hawkins\Brown
MEP engineers: Hoare Lea
Main contractor: Willmott Dixon
MEP contractor: NG Bailey
Project manager: Turner and Townsend
Floor area: 7,000m²

Timber was used in the construction of the non-lab areas of the IBRB

The servicing strategy is based on roof level plant with vertical distribution via a large accessible riser, dubbed the mega riser . Modern methods of construction have been employed in the form of prefabricated plantrooms, risers and horizontal distribution modules.

The prefabricated mega riser contains ventilation ductwork, lab gases, electrical distribution and fume extract. It is 22m high, with a cross section of 5m x 4m, and was craned through the roof and fully installed in two days; a conventional installation would have taken about 15 weeks.

The use of prefabricated services offered quality and safety benefits, reduced deliveries, cut the number and duration of trades on site, and de risked the programme.

Ventilation is provided by roof mounted air handling units linked to a demand led variable air volume system. This serves displacement ventilation terminals in the lecture theatre and write up spaces. The labs are provided with ceiling void mounted 4 pipe fan coil units, while single occupancy perimeter offices are naturally ventilated by opening windows. Heating and cooling are provided by roof level gas fired boilers and air cooled chillers.

Renewables are in the form of solar photovoltaic (PV) arrays, both horizontally mounted on the roof and in place of the plant screen that would have wrapped around the roof level plant.

Post occupancy evaluation

The university commissioned consultants Hoare Lea and architects Hawkins\Brown to undertake a post occupancy evaluation (POE) of IBRB.

POEs are exercises in real world lessons learned, where the success of a building and end user satisfaction can be assessed directly. They can be used to validate the sustainability objectives of a building, and represent opportunities to provide structured feedback to the project team and the client.

The POE at IBRB took the form of occupant surveys, interviews with focus groups including building users and members of the facilities management (FM) team and energy data analysis.

POEs offer designers and clients a better understanding of building design, operational and management issues what works well and not so well in practice. Insights gained from occupant and FM staff are invaluable.

Feedback indicates that the IBRB is considered a building that allows for good collaboration and creates a positive space

Ultimately, if lessons can be learned, POEs are a direct way to help us deliver better buildings.

The new building certainly fulfilled one of the client s expectations: two thirds of users considered that the building positively promotes the university as a world class institution, while 89% agreed that the building is a memorable and identifiable landmark . This is expected to help attract talented researchers and academics, because it creates an attractive place to work.

The overall feedback from the survey indicates that the IBRB is considered a building that allows for good team collaboration and creates a positive space for social interaction, with the kitchen and write up spaces being the most efficient social condensers.

Overall, the approach to the environmental strategy has been successful. The occupancy survey shows that 76% of users rate the overall comfort of the environment to be good or excellent , with 20% being neutral. The perception of air quality in the building is positive, with 74% of users rating it as good or very good .

A comment from the university s estates team described the building services strategy as uncomplicated , which, from a designer s perspective, is a compliment.

As always, however, there are important nuances in the details of the environmental strategy that are useful to understand. There was feedback that some localised parts of the building were too hot or too cold . Investigating the causes and optimising HVAC controls should help resolve these issues.

Measured energy consumption data has been obtained from Willmott Dixon s energy monitoring team and compared with the design stage estimated consumption, which followed the CIBSE TM54 modelling methodology. The total energy use intensity, extrapolated »

Pre-cast concrete was used for the construction of the labs

» from monitored data, is 380kWh m ^{2} per year. This compares with the TM54 design estimate of 294kWh m ^{2} per year.

It s worth noting, however, that a number of energy optimisation opportunities have been identified, including modifications to control regimes, which should reduce the actual energy consumption when implemented.

The energy usage patterns are particularly difficult to predict when modelling laboratories because there are so many variables affecting energy outcomes. Nevertheless, comparing the TM54 energy model with the measured energy consumption for the building is useful and the energy metering installations allow end use comparisons.

Analysis of the roof mounted solar PV energy generation showed it was close to the design estimate. One of the benefits of being involved in the POE is the ability to compare measured energy use with predicted use.

We found that some aspects of measured energy use, such as lighting and servers, are less than the TM54 energy prediction. Some other end uses, however such as hot water, cooling and auxiliary energy (fans and pumps) are more than the TM54 prediction. Undertaking real building energy analysis of the IBRB has proved beneficial in terms of learning how different engineering systems perform in practice.

Further opportunities for POE on other projects will help advance skills and accuracy in predictive modelling and capacity for energy conscious design. POE also helps identify the systems that need particular optimisation to improve energy performance.

Other lessons from the POE include the vital role that engagement with end users and maintenance personnel can have during the final fix of building services and fit out of equipment.

Normally, engagement with end users takes place during the design stage, but in a science and research building, with particularly complex installations, it s worth maintaining engagement with these stakeholders during procurement and delivery.

Detailed decisions on final installations, such as where to locate power sockets, storage units and equipment, should be determined in agreement with end users.

Another lesson is that arranging aftercare beyond handover is beneficial and should be considered. This can help resolve operational issues after the main contract is complete, including, for example, occupant issues such as optimising temperature setpoints, airflow rates and local draughts from ventilation systems. Detailed reviews of the energy use can also help identify opportunities for improving performance.

Only time will tell if the IBRB delivers on those chance encounters, resulting in groundbreaking research. What is certain from the feedback, however, is that it delivers a fantastic place to work. As one occupant reported: I love it it s a world class building and will help recruit world class people. CJ

Decisions on final installations, such as where to locate power sockets, should be determined in agreement with end users

End users have been very positive about the IBRB in the POE

ED LUCAS is a senior associate, and **ASHLEY BATESON** is a director, at Hoare Lea

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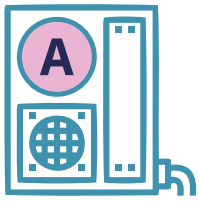

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THE LAB ON YOUR STREET

While hybrid working is seeing the demand for offices and retail go into retreat, the buoyant science sector is providing new potential tenants for building owners. Arup s **Tim Fry** looks at how the demand for laboratories is bringing discovery back into city centres

A new generation of scientific buildings is emerging in the heart of our towns and cities

When asked to picture a standard laboratory or research facility, the image that generally comes to mind is one of large, pristine, white buildings set in rolling hills, or dedicated knowledge parks, conveniently located right by a motorway.

However, a combination of creative post pandemic repurposing and considerable commercial property opportunity, coupled with the need to drive effective recruitment and retention, is beginning to challenge this concept.

The result is a new generation of scientific buildings emerging right in the heart of our towns and cities, creating new ecosystems through good connections with research hospitals and universities.

Uniting clusters of like minded individuals

As the technology sector did before, the knowledge quarter of science is spreading beyond traditional boundaries. It makes sense that these highly skilled, highly motivated and collaborative people are located near other science and healthcare researchers and investors, with social opportunities and access to good transport links. Furthermore, the city itself adds prestige and brand value.

A case in point is London s Francis Crick Institute, the MEP design that the team here at Arup delivered. Located in the centre of the King s Cross Knowledge Quarter, it boasts easy access to national and international railways. Having opened in 2016, it is now the largest biomedical research institute under one roof in Europe. Demand for new laboratory space within walking distance of the Francis Crick Institute is so strong that many office to laboratory conversions are being brought forward, as is the development of new build laboratory enabled office space.

However, unity is not the only driver. The pandemic has fundamentally altered how we live and work. Researchers and scientists are turning their backs on the out of town era, shunning the commute in favour of the urban experience that a city centre location offers. Businesses must respond to this demand, or risk losing out on hiring and retaining skilled employees.

Considerations when converting

Empty offices are a common sight in city centres, so it makes sense for landlords to capitalise on the rich territory of science labs. However, there are a range of factors to consider, when looking to absorb science into the existing fabric of a city.

While overcoming the technical, engineering and planning constraints may seem insurmountable, a dedicated multidisciplinary framework is often the key to successful retrofit assessments.

The process begins with an evaluation of the likely tenant profile, including the number of people who will use the facility, the division between offices and laboratories, type of science research and the potential mix of laboratory types (wet, dry, digital) on a typical floor.

Historically, the laboratory sector has used an informal set of criteria for design, including elements such as typical air change rate, additional services and the split between office and laboratory spaces. At Arup, we are currently exploring ways to conduct classification of the various levels of possible facility for different tenancy types.

Operating a life science facility is completely different from operating an office. There is an additional requirement for clinical (gases, cryogenics, and so on) deliveries and waste removal as well as associated delivery routes throughout the building.

The requirement for an external delivery access point and a dedicated goods lift is critical. Early identification of the limits of an office to pass this type of inspection will be a deciding factor to the repurposing of any building.

Another crucial component is the space for services in any one building. Higher air change rates and internal heat gains give rise to an increased demand on the heating, cooling, and ventilation systems.

Specific laboratory services, including fume hood extract systems and storage (cold rooms, freezers, chemicals, solvents, consumables), could result in previously lettable

space being given over to plant and equipment.

While shopping centres and retail units benefit from additional back of house space to accommodate these facilities, it can prove more challenging for traditional office environments.

Furthermore, the vibration performance of the existing structure may need enhancing for specific operations and the floor loading increasing in some cases too. Arup has developed simple retrofit solutions to improve both vibration performance and loading of existing structures if required, which has allowed more buildings to be considered for conversion to laboratories.

Validating the performance of the structure and installed services is key to inform suitability for science conversion, to address ongoing issues and reduce energy consumption and carbon emissions.

> While the idea of offices into laboratories may be in its infancy, the promise that it holds indicates that its heyday is on the horizon

Driving the sustainability agenda to a net zero lab

Retrofitting existing buildings is an important part of the sustainability agenda as it avoids the large embodied carbon costs inherent in building from new. This is assisting in making it more commercially attractive as an option and driving the development of innovative solutions to facilitate it.

In the UK, all buildings must be net zero carbon by 2050. Meanwhile, the UK Green Buildings Council estimate that 80% of 2050 s building stock already exists. It is true that labs use more energy per m² than offices. However, research is rapidly being conducted into how to minimise the energy demand by challenging the traditional design parameters and benchmark data of the power requirements. Indeed, Arup is currently funding research into actual in use laboratory energy consumption to support the development of more efficient laboratories.

A synergy of science and city

Conversions are nothing new. For centuries, city inhabitants have been repurposing their building stock whether that be churches transformed into houses, or shops into bars. While the idea of offices into laboratories may be in its infancy, the promise that it holds indicates that its heyday is on the horizon. There are no off the shelf solutions. Instead, these projects require carefully considered planning and execution. This, in itself, demonstrates potential for growth, as these buildings and their occupants adapt to seamlessly slot into the surrounding city. **CJ**

TIM FRY is science business leader at Arup

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LEVELS OF RISK

To understand how ventilation reduces Covid transmission, it is important to look at the level of risk as the number of building occupants increases, says **Chris Iddon**, who introduces a methodology that addresses the difference in personal and population risk

Since early in the pandemic, when genomic material of SARS CoV 2 (the virus that causes Covid 19) had been detected in air samples and well documented superspreading events were reported, there was an implication of long range airborne transmission. Accordingly, CIBSE advised increasing ventilation airflows as much as reasonably possible, taking into account occupant comfort and energy use concerns.

However, it is impossible to calculate a universal flowrate that would lead to a constant, universal reduction in transmission risk not least because the emission rate of viable virion from an infector varies over the time since infection. People also have different emission rates, ranging over several orders of magnitude. Equally, there is no knowledge on dose response characteristics of SARS CoV 2 in humans.

A further complication is that virions entrained in aerosols have additional removal mechanisms biological decay and deposition that are space volume dependent (see Why space volume matters, *CIBSE Journal*, June 2021). To overcome some of these uncertainties, Jones *et al* developed a relative risk index, which enables the analysis of the relative risk of long range aerosol transmission between a reference and comparator of an indoor scenario if the same infector is present in both scenarios (**bit.ly/CJNov22CI1**).

This method has been adopted by the CIBSE air cleaning guidance as a means of establishing relative risk reductions from different ventilation and filtration strategies (see A novel approach: air cleaning devices, *CIBSE Journal*, September 2021). However, the probability of the presence of infected people and the number of susceptible people increases with the number of occupants in a scenario, so population level risks are different. We have recently published a novel framework methodology to help determine this difference and give an insight into the absolute magnitudes of risk reduction.[1]

Assume an office space has 30m^3 of space per person and is ventilated at 10L·s^{-1} per person; would you rather spend eight hours in a five person office or a 50 person office? If you were to share either office with a single infector then, from a personal risk perspective, the 50 person office would be lower risk. This is because the virion removal equivalent flowrates in L·s^{-1} (ventilation, deposition, bio decay) are 10 times larger in the 50 person office, leading to a 10 fold lower concentration of virus in the air compared with the five person office. The inhaled dose and relative exposure index will be 10 times smaller in the 50 person office.

But what about population risk? There are 10 times more people in the 50 person office, so the presence of an infector is more likely and if an infector is present, there are more susceptible people sharing the scenario to infect.

The probability of sharing a scenario with an infector is dependent on the community infection rate (CIR) in other words, what proportion of the whole population is infected and could potentially share the space. If we »

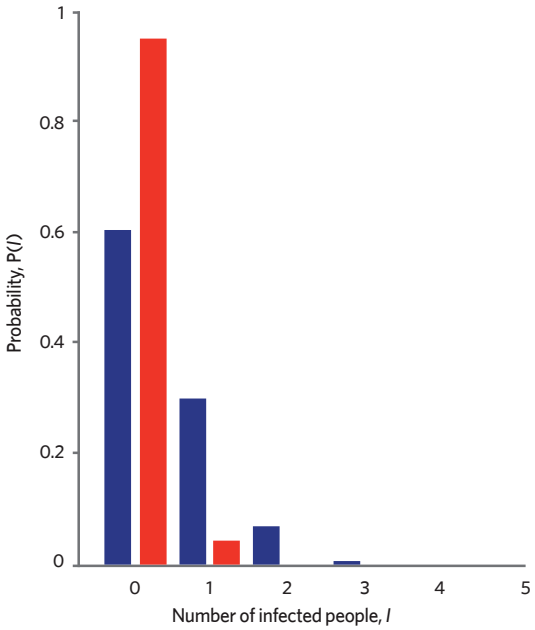

Figure 1: The probability of a number of infected people, *I*, present in the 50-person office (blue) and five-person office (red), when the community infection rate is 1%

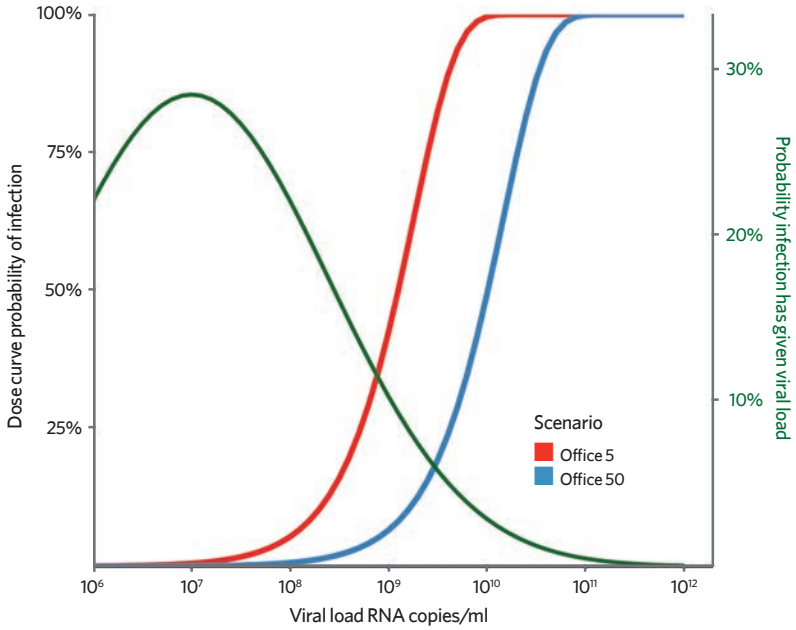

Figure 2: The red and blue lines are the dose response curves for the five-person office and 50-person office scenario, respectively. The dark green line shows the probability that an infector in the scenario has the given viral load (secondary axis)

» assume 1:100 people is infected, what is the most likely number of infected people in the 50 person and five person office?

We can think of this problem like pulling balls from a bag – given a bag of 990 red balls and 10 white balls, in random draws of 50 balls the most common number of white balls drawn would be zero. Using combination theory, we can predict the most likely number of infectors in a given scenario if we have the scenario occupancy and the CIR (see Figure 1).

Even if there is an infector present, the viral load of the infector will vary by several orders of magnitude. Viral load of infector is proportional to the amount of virus they can emit into the air. The more virus exhaled, the greater the concentration of virus in the air, which increases the inhaled dose of susceptible occupants.

A dose curve is used to predict what proportion of the susceptible occupants would be infected for a given dose. Because the removal mechanisms are 10 times greater in the 50 person office, the viral emission rate needs to be approximately 10 times larger to give the same probability of infection. Increasing removal mechanisms – for example, ventilation and filtration – has the effect of shifting the dose curve to the right. For low viral load infectors, the probability of infection is near zero, and for high viral infectors the dose is near 100% (Figure 2).

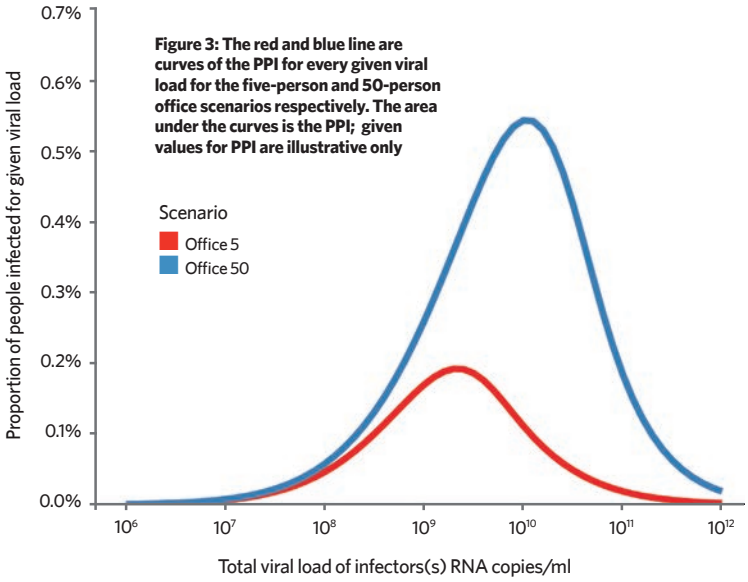

Figure 3: The red and blue line are curves of the PPI for every given viral load for the five-person and 50-person office scenarios respectively. The area under the curves is the PPI; given values for PPI are illustrative only

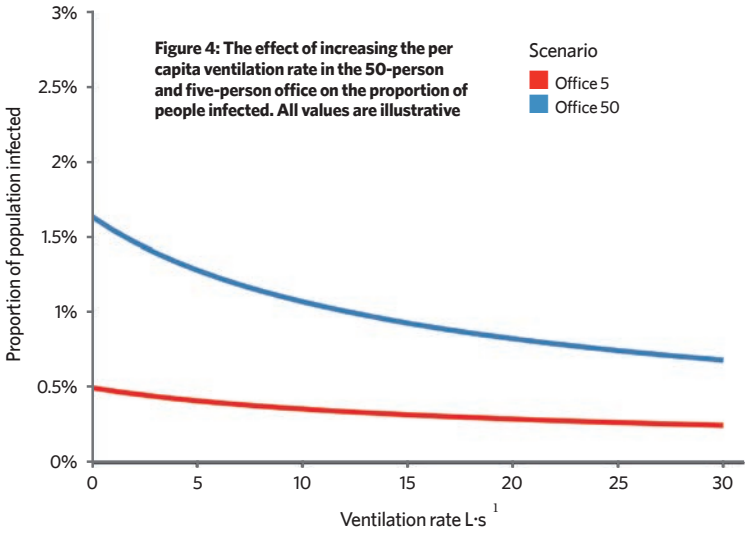

Figure 4: The effect of increasing the per capita ventilation rate in the 50-person and five-person office on the proportion of people infected. All values are illustrative

Output numbers from the model are for illustration only, but are useful to observe trends and understand absolute magnitudes

We have to make some assumptions on viral load to viral emission rate and dose response for these calculations (the limitations are considered in the paper), so output numbers from the model are for illustration only, but are useful to observe trends and understand absolute magnitudes.

We can approximately calculate the proportion of a given population, distributed in either five person or 50 person offices, infected for every given viral load.

The proportion of people infected (PPI) ≈ proportion of people susceptible x infection probability x probability the infector has the given viral load. This is calculated for each viral load and the resulting graph gives the total proportion of people infected as the area under the graph (Figure 3). For the given assumptions, at a population scale, the transmission risk in a 50 person office is about three times higher. This isn't a magnitude that would suggest there is advantage in dividing a 50 person office into 10 cellular five person offices, but this method could help explore which scenarios would lead to better reductions in long range airborne transmission.

Here, for example, improving a poorly ventilated 50 person office would lead to a greater PPI reduction than improving a poorly ventilated five person office, so could be useful when scheduling which scenarios within a portfolio should be targeted first for improvement.

We don't know absolute values, but it is useful to look at trends in PPI when we adjust various parameters. Increasing ventilation of poorly ventilated spaces reduces PPI more than increasing ventilation in an already well ventilated space (Figure 4). Reducing occupancy or increasing space volume per person also reduce the PPI.

This framework also shows that, in many scenarios, there are no infectors or an infector with a viral load so low that they don't emit enough virus to lead to long range infection of susceptible people. Then, ventilation has little effect. If an infector has a very high viral load, ventilation can't reduce infection rates much because the concentration in the air is too high.

A 'Goldilocks' zone exists between these two extremes where the situation is 'just right' for ventilation to have an effect. Then, improving poorly vented spaces has the greatest effect on the reduction of the long range transmission risk. At all times, the concentration of virus in air is highest in the exhaled puff, so the 'coffee breath' zone (close contact) is where exposure risk is greatest. CJ

CHRIS IDDON MCIBSE is chair of the CIBSE Natural Ventilation special interest group

References:

1 A population framework for predicting the proportion of people infected by the far-field airborne transmission of SARS-CoV-2 indoors. Building Environment, August 2022 **bit.ly/CJNov22C1** There is an open version at **bit.ly/CJNov22C2**

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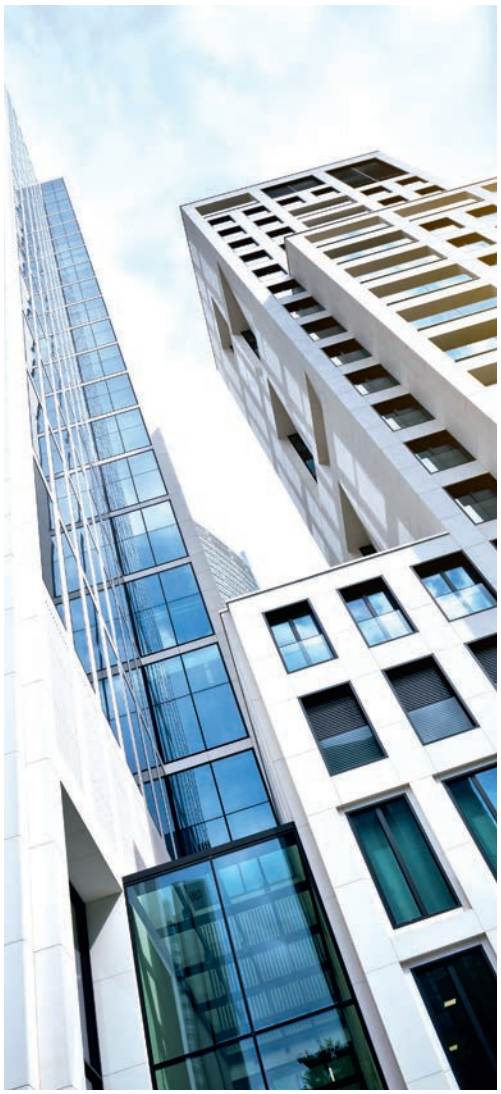

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EFFECTIVE SYSTEM DESIGN FOR UNDERFLOOR VENTILATION

Lower cooling load and better air quality are two of the benefits of a well designed underfloor ventilation system, says Trox UK s **Tim Tanner**

With interest in underfloor ventilation continuing to gather pace, this is an ideal time to review its potential and discuss key factors in successful system design.

Underfloor ventilation typically employs displacement air distribution with cool air delivered into the room via the floor void, through specially designed floor grilles.

The supply air pools slowly across the room and when the cooler air comes into contact with a heat load, such as a person, it rises towards the ceiling, where the system will include equipment for extraction.

This air movement method enables air velocities to be lower than for mixed air distribution systems, as there is no need to achieve coanda effect. In addition, the air supplied to the occupied zone does not have to be reduced to the lower temperatures necessary for mixed air distribution. For commercial premises, the temperature would typically be around 19 C, slightly cooler than the design temperature of the occupied zone.

As only the occupied zone needs to be supplied with conditioned air, overall cooling load can typically be lower, reducing the demand placed on chillers. This can be particularly beneficial in rooms with high ceilings. There may also be increased opportunities for free cooling (using fresh air) for much of the year. A 2002 study quantified potential energy savings of this system as being between 5% and 35%.[1]

Displacement approaches can also deliver air quality benefits. As the air rises, it can take certain contaminates upwards, out of the occupied zone for ceiling level extract.[2] Further benefits arise where the floor void can be pressurised to act like a plenum, with the air being balanced at each diffuser, thereby reducing the ductwork requirement. The need to work at height is also removed. Last, as floor grilles are often installed into floor tiles with little or no ductwork required (or designed as replacement 600 x 600 tiles), reconfiguration of spaces is made easier, cutting the costs of churn .

There are key design factors to consider:

A Trox FBA floor diffuser (above) and a Trox AFG static grille (below)

> Underfloor ventilation typically employs displacement air distribution with cool air delivered via floor grilles

Total cooling load: Displacement ventilation is recommended for cooling loads less than 40W/m² for comfort, however individual applications must be investigated to ensure comfort is achieved. The impact on the cooling load from switching from a mixed ventilation system to a displacement system must be considered, as it may mean that other HVAC components can be downsized.

Heating requirement: As the supply air needs to be cooler than the room air, this approach is only suitable for cooling with a supply temperature range of 2K to 4K. Heating is not generally recommended, although some floor diffusers, which incorporate a swirl unit and cause high induction, such as the FBA, left, could allow for heating in some applications.

Room height: As a considerable amount of mixing can occur in the region below the ceiling, because of the interaction between upward and downward moving buoyant air flows, this approach is most effective for high ceilings. Buoyancy driven ventilation is, generally, less effective where ceiling heights are low, for example less than 2.5m.

Adjacent zones: Displacement ventilation diffusers are ideal for spaces in which occupants move through the zone (transient). Cool air moves along the floor in a stratified flow with a relatively constant depth (typically about 200mm) with the maximum velocity in the stratified flow around 10% of this depth (approximately 20mm from the floor). So, occupants sitting in non comfort zones adjacent to floor diffusers could sense cool air at ankle level.

Acoustic performance: As diffusers are likely to be closer to occupants than ceiling/wall diffusers would be, and a sound path could be created between rooms sharing the same floor void, sound attenuation is an important consideration at design stage.

This is a brief introduction to effective underfloor ventilation, but TROX is happy to assist with all aspects of system design if you wish to evaluate this approach. CJ

TIM TANNER, product technical manager at air diffusers and attenuators, Trox UK

References:

1 R Brahme et al, 'IAQ, Energy and Cost Implications of Underfloor Air Distribution Systems', Proceedings: Indoor Air (2022), pp. 254-257.

2 There are, of course, a number of factors to consider in this regard. For example this technique may not be suitable for applications where the contaminates will be heavier than air. Sites such as laboratories, science campuses and hospitals require specialist air management systems such as TROX's LabControl systems.

Further information:

See case study 5.2 in *CIBSE TM 55:2014 Design for future climate: case studies that considers displacement application* and case study 7.2 in *TM40: 2020 Health and wellbeing in building services Underfloor Air Distribution Systems, Proceedings: Indoor Air* (2022), pp. 254-257.

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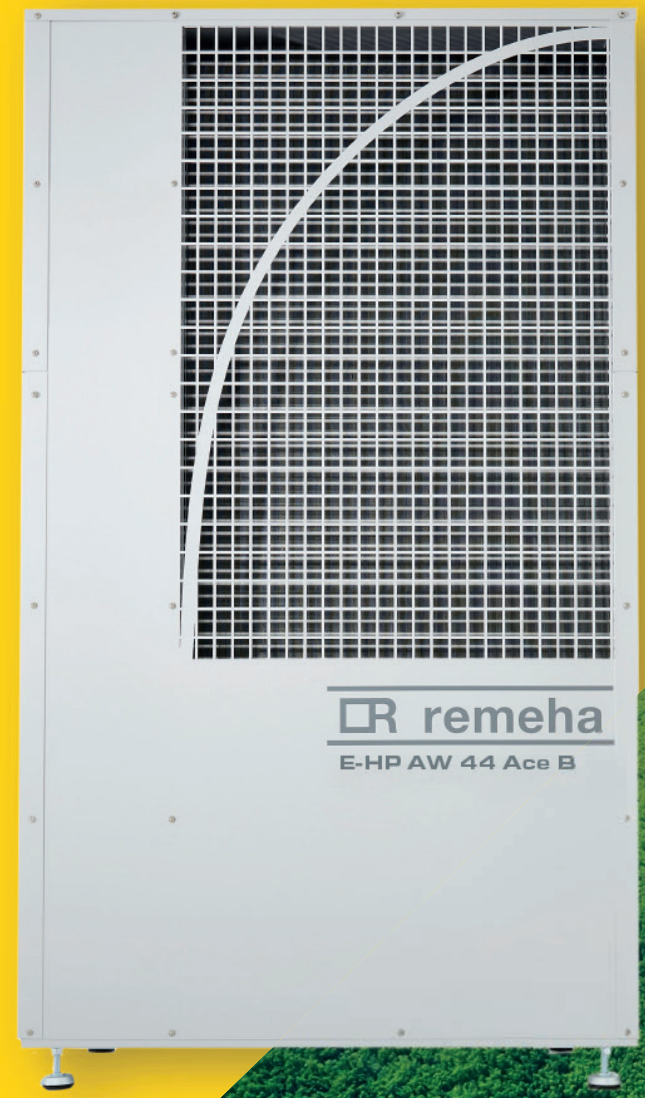

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Bivalent heat pump systems for heating and hot water

This module explores some of the options for providing a successful application of bivalent heat pump system to maximise performance and efficiency

When designing systems that include both an air source heat pump (ASHP) and, typically, a gas fired boiler in a bivalent system, the optimal operational conditions for both technologies must be considered so as to maximise heat pump utilisation while maintaining system performance and overall efficiency all while avoiding conflict in the bivalent system. This CPD will present some of the options that have been applied in practice to provide a successful application for bivalent heating and hot water systems.

A building fully served with ASHPs may well be able to achieve one of the lowest carbon footprints in new commercial building stock, as discussed in detail in the recently published CIBSE AM17 *Heat pump installations for large non-domestic buildings*.[1] As the ambient air temperature rises, so does the heating efficiency and capacity of an ASHP. Since space heating loads decrease as the external temperature rises, sizing an ASHP for peak load at a design temperature that occurs only rarely will result in a unit selection that is oversized for the majority of its operational life. In any case, it is not always possible to engineer all projects and meet budgets by solely employing ASHPs. This is particularly the situation with refurbishment and system upgrade projects, which often include inaccessible physical space, limited available electrical power, capital expenditure (capex) constraints, poor building fabric, or inadequate system infrastructure.

Amalgamating traditional heating with low and zero carbon technologies is a well established method to reduce the carbon impact of the heat generators, and is likely to include technologies such as combined heat and power (CHP), biomass, ground source heat pumps (GSHPs) and ASHPs integrated with a natural gas fired boiler. ASHPs and high efficiency condensing boilers or direct electric appliances in a bivalent system may offer a practicable solution to overcome project limitations while meeting heat demand more sustainably. The challenge, however, is to design the heat pump and boiler into a single, integrated system that successfully maximises the efficiency of both technologies.

If a combined boiler and heat pump system known as a bivalent system is considered as being appropriate for a specific building application, then ideally the preliminary sizing should maximise the contribution of the heat pump to the total load (while taking any limiting factors into account). AM17 notes that such a bivalent system will typically employ a primary and secondary heating generator. The primary system provides part of the peak load, with the secondary system supplying either the remainder of the peak load a parallel bivalent system so minimising the contribution by the secondary plant, or able to meet the entire load, under peak conditions an alternate bivalent system. As the primary and secondary generators are likely to be hydraulically connected, careful design is required to ensure that there is no unwanted impact on the efficiency or performance for either one.

As noted in CIBSE AM17, the use of an hourly load model can help in understanding the impact of different secondary heat source sizes when considering factors such as: »

- capacity/cost/availability constraints
- whole life carbon considerations
- a heat pump that is sized for a load that is only likely to be exceeded for a certain proportion of hours or when the ambient temperature exceeds or falls below a certain temperature
- the level of uncertainty in loads since an undersized heat pump will lead to over reliance on secondary systems.

ASHPs provide a particular challenge in a bivalent system when paired with condensing boilers owing to the different requirements for flow and return temperatures. Typically, heat pumps work best at lower flow temperatures (30 C to 50 C) and a flow/return temperature differential, Δθ, of 5K to 10K. While condensing boilers also operate more efficiently at lower temperatures, the Δθ range for a typical commercial boiler is 10K to 40K.

At its simplest, it may be convenient to design to a 10K differential which, coincidentally, is similar to the 11K Δθ, such as 82 C flow, 71 C return, as employed in older commercial heating systems. However, this loses the advantages derived from employing higher differential temperatures, which could include smaller pipe sizes, reduced volume flow and lower pump duties.

Employing a thermal store allows the accumulation of heated water, so flattening the peak demand, at the same time also providing opportunity to hydronically decouple the two generators while maintaining thermal connection. A thermal store allows lower capacity heat generators than would otherwise be needed, and will also reduce their on off cycling frequency, since at every on off cycle there is a decrease in overall efficiency as a result of start up losses. AM17 notes that an excessive number of on off cycles can damage the compressor (in a heat pump) as well as impact the efficiency, and manufacturers typically limit the number of on off cycles to a maximum (dependent on the system), which could mean that a heat pump may not restart within 15 minutes (or longer) of shutting off. The thermal store will also provide a resource for any defrost cycle for the heat pump.

Using a load assist method , the ASHP would run as the lead provider of heat to meet the base load, with boiler(s) used to assist as heat demand increases. However, the primary flow temperature and consequent temperature differentials must be suitable for both the ASHP and boiler technology. Running a full system with a Δθ of 10K would not be an issue for most boiler technologies, but it can reduce the performance of many ASHPs that typically perform better when operating with a Δθ of 5K to 7K. To ensure that the condensing gas boiler operates in a condensing mode, the return water temperature must remain under 54 C (and preferably lower). An example of a load assist arrangement is shown in Figure 1.

In this system, the ASHP is used to heat the thermal store, and then the heated water from the thermal store provides the lead heat source.

The thermal store discharge pump is modulated to match building load. It should never be allowed to fully deplete the resource of heated water from the thermal store, as this would disrupt the thermal stratification and potentially deliver a flow temperature that is below the maximum potential. To avoid this, the boilers should be cascaded on, to assist with the demand prior to the store being depleted.

The load ratio of boiler to ASHP in this arrangement would be project specific. If both the ASHP and boiler(s) are required to satisfy peak demand, any risks arising from the lack of redundancy must be considered.

The advantages of the load assist arrangement are flexibility and scalability, since both generators can run together or independently as demands fluctuate.

An alternative is the thermal store method that utilises a boiler and ASHP to feed into a common thermal store, and the heating power required to satisfy system loads is shared. The ASHP maintains a stratified warm layer at the bottom of the tank to heat the cool return. The boiler draws warm water from the top of this layer and raises its temperature to the target store outlet temperature.

Under non steady state load conditions, care should be taken to avoid the boiler being required to top up the temperature by less than 10K, otherwise a temperature overshoot could occur in the tank, since most condensing boilers are unable to operate with less than 10K Δθ. The introduction of a mixing valve to blend flow temperatures on the demand side of the thermal store can help resolve this.

The controls should ensure that the boiler contribution is held back until absolutely required. This is achieved through close monitoring of tank temperatures, at multiple points, together with the feedback of boiler and ASHP flow temperatures.

The injection method is very similar to the thermal store method. This approach uses the boiler(s) to boost the flow temperature to the required set point at times when the ASHP is unable to satisfy the demand. The system, illustrated in Figure 3, delivers heat from the ASHP to a return header prior to the low loss header (LLH). During periods of low or zero demand, the thermal store is charged by the ASHP, with a discharge pump injecting into the return header. This preheats the return to the LLH, which is then topped up by the boilers. When the thermal store is charged to a usable flow temperature, the system can hold off boilers until required. As the thermal store starts to deplete, the control system will actuate the boilers, providing a top up to the preheated water.

Typically, there is approximately 1% 2.5% drop in efficiency for a gas condensing boiler when preheating a 30 C return by 5K 10K, as a result of reduced flue gas condensation.

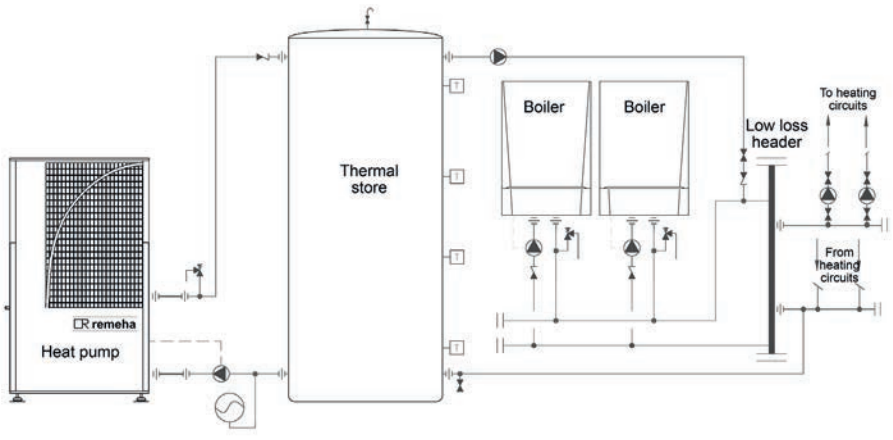


Figure 1: Example of a 'load assist' arrangement

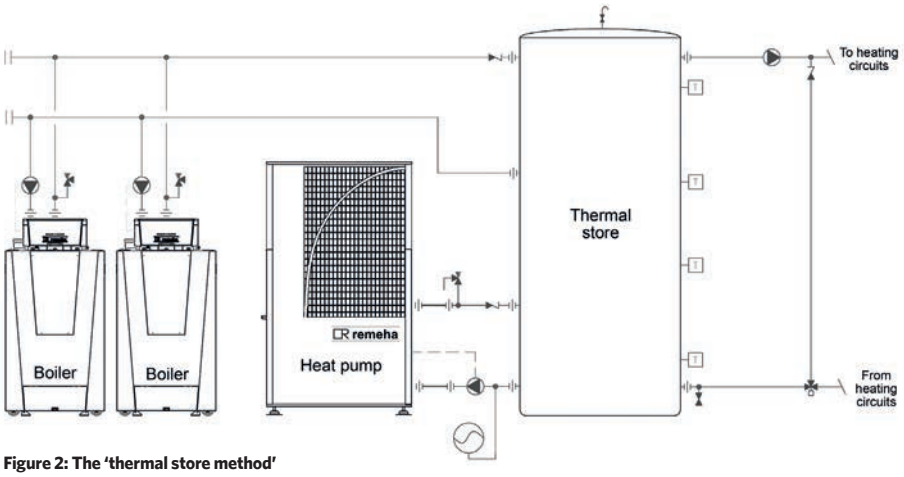
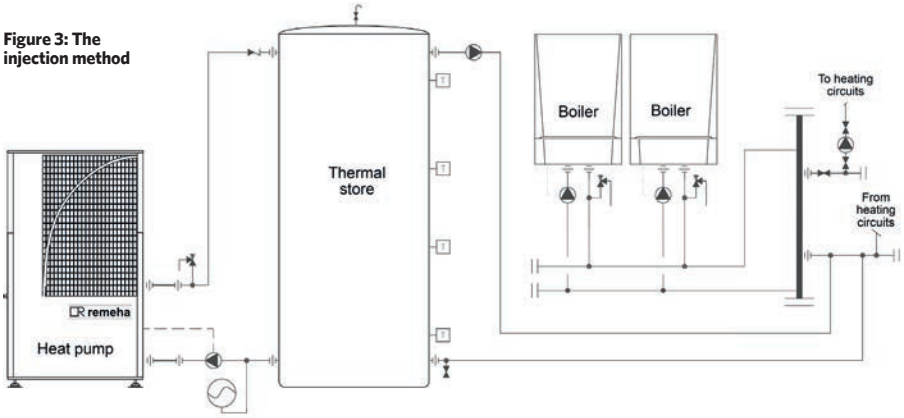


Figure 2: The 'thermal store method'

When considering domestic hot water (DHW) generation, there are a number of ways in which ASHPs can be used in a bivalent arrangement with traditional methods, such as gas fired condensing water heaters or direct electric solutions, to boost the DHW to usable and ultimately safe temperatures while also avoiding legionella propagation.

The efficiency of a heat pump will reduce significantly as the temperature difference increases between the evaporator (at the air source) and the condenser (heating the water). With the preferred ASHP Δθ typically being between 5K 10K, this will mean that multiple passes are needed to achieve the temperature increase

Figure 3: The injection method



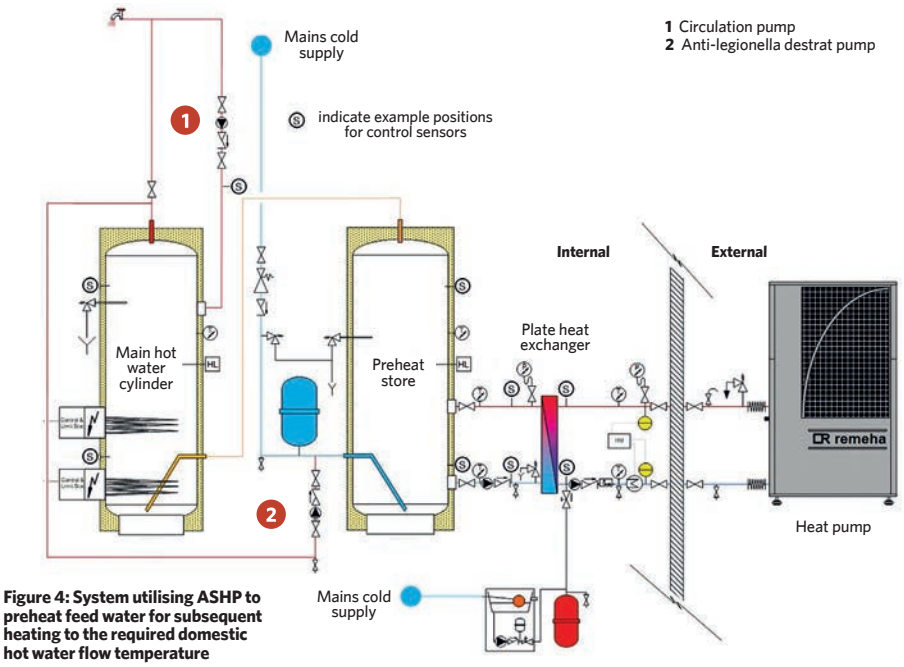


Figure 4: System utilising ASHP to preheat feed water for subsequent heating to the required domestic hot water flow temperature

to raise incoming water at, for example, 10 C to the required hot water temperature.

In a bivalent system, such as the example illustrated in Figure 4, an ASHP can preheat the incoming water in a cylinder, and an auxiliary cylinder or direct fired gas condensing water heater can then be used to boost the DHW temperature to meet the demand.

As with the space heating applications, to prevent an excessive number of stop start operations the ASHP should not be oversized. Understanding the DHW usage profile for the building is key to ensuring the optimum size. This includes daily demands, the peak hot water flow requirements and the time period between peak demands. Any DHW system in the UK should be designed to minimise the opportunity for legionella by ensuring that it meets the requirements of HSG 274.[2] For example, the system illustrated in Figure 4 must be able to carry out a pasteurisation cycle by heating the contents of storage cylinders to at least 60 C for at least one hour a day.

AM17 provides further information on the design of thermal stores, including the promotion of stratification; minimum number of temperature monitoring points through the height of the thermal store; and minimum volumes required to assist the ASHP during defrost cycles. A note of caution in AM 17 is particularly apposite in these times of turbulent energy prices: Should a gas boiler be selected as a secondary system, for example, fuel prices (or future fuel prices) may render the secondary system more economic to run than the primary system. The control system should protect the secondary system from being operated more often than intended, to prevent impact on projected/modelled performance and emissions.

Along with standalone, purpose designed ASHP systems, bivalent systems can offer the opportunity for efficiency gains and emissions reduction from heating in both existing and new commercial premises. The prospects for operational success will be dependent on how closely the design assessment of loads reflects the actual demand, and how well the installed system can be controlled in use to maximise the efficiency of the whole integrated system while still meeting the building s demands for heat.

With thanks to Andrew Green, technical director of Baxi Heating, for sharing the details of the systems presented in this article

Turn to page 84 for further reading and references »

Module 205

November 2022

1. Which of these was not specifically noted in the article as being a barrier to ASHP application in refurbishment and system upgrade projects?

- ☐ A Inaccessible physical space
- ☐ B Inadequate system infrastructure
- ☐ C Limited available electrical power
- ☐ D Opex constraints
- ☐ E Poor building fabric

2. What is the range of Δθ suggested for a typical commercial boiler?

- ☐ A 10K to 20K
- ☐ B 10K to 30K
- ☐ C 10K to 40K
- ☐ D 10K to 50K
- ☐ E 10K to 60K

3. What is the approximate maximum return water temperature required to provide condensation in a condensing boiler?

- ☐ A 30 C
- ☐ B 50 C
- ☐ C 54 C
- ☐ D 71 C
- ☐ E 82 C

4. Which of the methods described in the article specifically notes that the ASHP would run as the lead heat generator to meet the base load, with boiler power additionally used as heat demand increases?

- ☐ A AM 17 method
- ☐ B Condensation method
- ☐ C Injection method
- ☐ D Load assist method
- ☐ E Thermal store method

5. How often does HSG 274 require that at least 60 C is achieved throughout an indirectly heated storage vessel for at least one hour?

- ☐ A Once a day
- ☐ B Once a week
- ☐ C Once every month
- ☐ D Once every three months
- ☐ E This requirement is no longer needed

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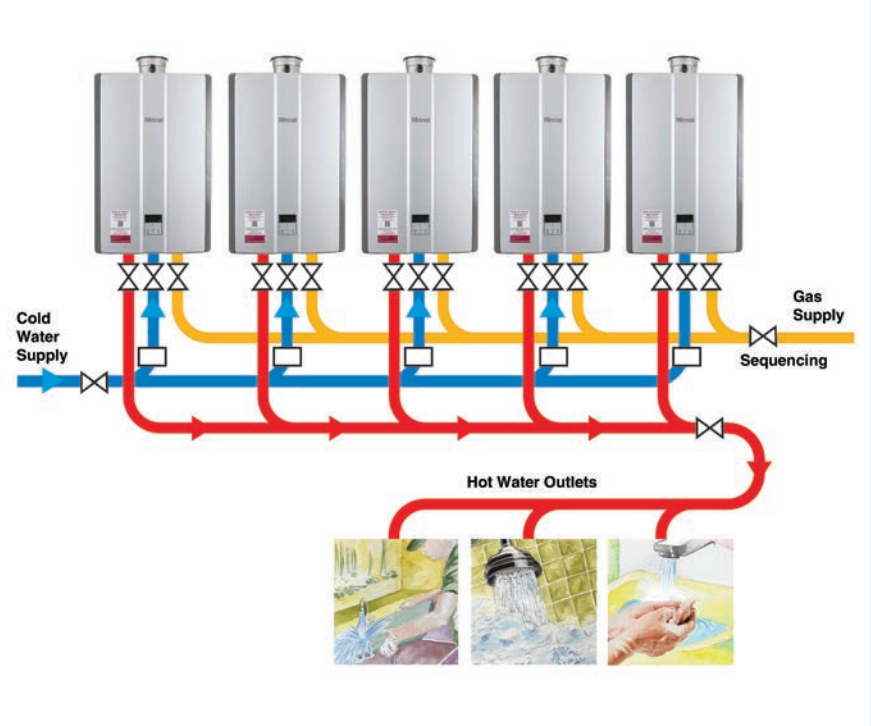
References:

1 CIBSE AM 17 *Heat pump installations for large non-domestic buildings*, CIBSE 2022.
2 HSG274 Part 2 *Legionnaires' disease Part 2: The control of legionella bacteria in hot and cold water Systems*, HSE 2014.

Products of the month

Rinnai announces new carbon cost comparison offer

Online form enables free appraisal of a site s heating and hot water system, and offers advice on improvements



To aid the reduction of the carbon footprints and fuel costs of all sites and applications, Rinnai has introduced a free online carbon cost-comparison form.

The form offers a free appraisal of any site's current heating and hot-water delivery system, along with recommendations for reducing the carbon load and associated operational fuel costs. System designers, consultants, contractors, and FM operators can simply visit the Rinnai website to complete the form. Rinnai then makes a thorough analysis and returns all data direct to the user.

This information gathering is very brief: current model and system, maximum gross input power, quantity needed, type of outlet (for example, shower, wash basin) and how many peak demands in a day. The data collected is then passed to the Rinnai technical team, who calculate the emissions and savings that can be made on carbon loads and fuel costs.

The Rinnai carbon cost-comparison form is a new addition to the suite of digital touchpoints Rinnai has available on its website. Customers are supported in making easy, specific design decisions.

The new form is set up to complement the new H3 range of Hydrogen, Hybrid & Heat Pump ranges. 'H3 offers proven reductions on working costs and quantifiable improvements in energy efficiency, as well as provision of a temperature-controlled end product, whenever the need arises,' said Chris Goggin, director of organisations at Rinnai.

'The user only pays for the fuel that's been used on a continuous flow system to heat the water when it is needed – not when on standby, as is the case in stored tank holding systems. This creates cost-effective and carbon-reducing solutions for systems on the gas grid,' he said. 'The new H3 calculation service will compare our complete array of hydrogen blend-ready water heaters, hybrid solar and heat pump systems, and stand-alone heat pump solutions, to provide our customers with low carbon solutions.

Rinnai offers comprehensive training courses and technical support in all aspects of the industry. Visit the website and go to the 'Help Me Choose' section.

The H1, H2 & H3 are Rinnai's answer to the energy question in the cost-of-living squeeze.

H1 – Hydrogen blends-ready, renewable liquid fuel-ready and electric water heating equipment.

H2 – Hybrid hot-water systems – including heat pumps, solar thermal, solar PV and electric.

H3 – Market-leading, low-GWP heat pumps.

This product portfolio is enhanced by design support and precise modelling of capital expenditure, operational expenditure and carbon, to establish the practical, economic, and technically feasible solutions needed for any site.

Rinnai has launched the expansive H3 offering to simplify the decarbonisation of any building and supporting sites with the decarbonisation pathways that exist now and in the future. The company has maintained and sustained a reputation for technological innovation and creating a healthier way of living for more than a century. Customers will be able to identify it as a trusted brand that delivers customer convenience and health.

Rinnai is constantly initiating new working behaviours and corporate practices that update and add to employee knowledge of product and manufacturing processes. The company employs 650 design engineers and reinvests 6% of annual sales revenue into R & D.

All major international economies are now seeking sustainable alternative energies that improve domestic energy security and negate the release of harmful emissions. Rinnai's H3 range of products coincides with the current internationally approved direction of future energy distribution and consumption.

H3 products consist of hydrogen, rDME, heat pump or hybrid options in all energy vectors – natural gas, electrical, rDME and BioLPG. All methods of heating and hot-water provision ensure lower carbon, leading to decarbonisation and a higher standard of living at affordable prices and costs. All models are designed specifically to reduce related costs and provide efficient working quality across an entire product life-cycle.

Internal practices are continuously refined to ensure Rinnai remains a leader in technological innovation, heating and hot-water dispersal. Rinnai's H3 range is designed to reflect the corporate values and direction the company is keen to project.

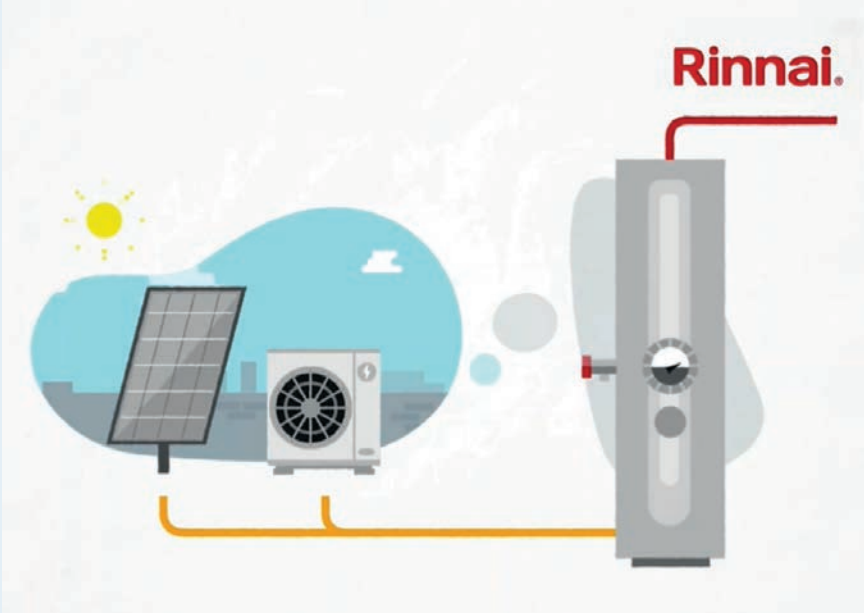
All sourced product materials, manufacturing conditions and effects on the local environment are issues under constant revision, and will be altered accordingly if found to be in non-compliance with Rinnai's promise to deliver cleaner living.

Find the cost comparison form at: www.rinnai uk.co.uk/contact us/ carbon cost comparison form

› Products of the month

Solar products added to Rinnai H3 range

Rinnai is moving into the next phase of its H3 product development with the addition of solar products



Installation of solar products is the next step towards decarbonisation for Rinnai customers. The Naked Energy award-winning range of VirtuHOT evacuated tube and PV tech is now available, each with specific benefits to suit any site or application, providing high-energy performance, low maintenance and reduced fuel consumption.

Naked Energy is a British design and engineering business, specialising in the development of solar thermal and solar photovoltaic thermal (PVT). Its mission is to change energy for good by supporting the decarbonising of heat. Naked Energy's high energy density solutions are capable of decarbonising heat cost-effectively and with limited space; its solar PVT technology delivers up to 3.5 times the carbon savings per m^2 compared with conventional solar PV.

Chris Goggin, Rinnai operations director, says: 'This is a genuine and unique innovation in marrying the technology of solar thermal products with continuous flow hot-water heating to minimise fuel and operating costs. The solar gains created by Naked Energy are supported by Rinnai innovations. This Rinnai technology, unlike other types of systems, can read the incoming water temperature and modulate to maximise the solar gains.'

All Rinnai and Naked Energy solar thermal products are precisely aligned with the hot-water heating systems and units, which are hydrogen blends-ready 20% and renewable liquid fuel (BioLPG) ready combustion technologies. The VirtuHOT solar thermal design will gain more solar energy from less space, while the Rinnai continuous flow water heaters will modulate to use less energy while creating more plantroom space.

Solar, water heater and hybrid technology is designed with efficiency and effectiveness in mind. The core design of VirtuHOT has benefited from multiple workshops with experienced installers, whose valuable insights have been integrated into design and innovation for transportation, installation and maintenance.

VirtuHOT saves up to 3.5x more carbon per m^2 compared with conventional solar technology. This, combined with the Rinnai continuous flow hot-water heating system, will save carbon created through any of the traditional storage-based systems, while also creating a market-leading low carbon solution that combines simplicity of installation with cost-effectiveness.

Rinnai water heaters will modulate from 58kW to 4.4kW, so the smart systems only use fuel to boost the temperature by the precise solar deficit – harnessing renewable gains and not compromising on performance. Greater returns from VirtuHOT delivers up to 50% greater financial returns per m^2 compared with conventional solar technology. Rinnai intelligent hot-water systems can save more than 30% in operational running costs when compared with storage systems. This all helps reduce fuel costs and the exposure to ever-increasing energy and climate change legislation.

A design-led architecture and turnkey solution makes VirtuHOT easy to install and keeps maintenance to a minimum. Rinnai water heaters come with a warranty of up to 10 years, are lightweight (one-man lift), can be sited internally or externally, and have a compact design (670x470x276mm).

The panels are higher energy density compared with other market-leading solar thermal panels. This means they will perform in any environment, with reduced scope one emissions by using 100% renewable energy.

The solar panels are versatile and easy to install, with simple modular assembly and integrated mounting with self-ballasting. Compatible with any roof type, installing the panels requires no roof penetration, and being only 26.5cm high, they are not obviously in view.

Goggin adds: 'Rinnai is publicly committed to creating a healthier way of living, and solar thermal power is an important support to decarbonisation.

'Rinnai UK can supply and design solar thermal and hybrid systems to support new and retrofit projects, lowering carbon and connection technologies and energies, for a low carbon future at any site.'

For more on the Rinnai product range, visit www.rinnaiuk.com

Products of the month

Rinnai s H3 products target customers off grid

Portfolio offers heating and hot water solutions for domestic and commercial use

Around 16% of UK properties are off grid and not connected to the national gas supply. Rinnai's new portfolio of H3 products aims to deliver heating and hot-water solutions for off-grid commercial and domestic properties.

Operations director Chris Goggin said the range is designed specifically to lower carbon and encourage greater cost efficiencies, while producing enhanced product performance.

Many off-grid properties are in rural locations. Rural homes often retain large internal and external spaces that encourage effective heat pump installation.

Heat pumps are a practical and economically feasible solution for home heating and hot-water delivery to properties not connected to the grid. Personal preference of decarbonising commercial and home heating and hot-water options will depend upon the location and condition of the home. It is likely that densely packed urban populations will require clean gas dispersal, whereas rural locations will necessitate a separate decarbonising response.

Currently, the UK government incentivises the purchase of heat pumps, offering £5,000 through the national Boiler Upgrade Scheme. Heat pumps offer immediate decarbonisation and provide comfortable property heat, as well as hot water, and are set to become a vital part of UK carbon neutral domestic energy options. A heat pump works by extracting heat from air outside and elevating its temperature using a compressor. Compressed heat is then dispersed indoors through radiators and underfloor heating. Residual heat is stored in a hot-water cylinder used for showers and baths. Heat pumps ensure that all home heating is carbon neutral.

Both the compressor and pump mechanism accept electricity. If installed correctly on to an appropriate property, a heat pump will prove to be an energy efficient, effective tool of decarbonisation that delivers satisfying levels of comfort to the end user.

Properties not connected to the main UK gas grid may also prefer alternative cylinder gases. Renewable DME (rDME) is a molecule-based fuel that can be produced through a wide range of renewable feedstocks, which allows for quick and long-term sustainable production. It contains a similar chemical composition to butane and propane, and can be mixed with liquefied petroleum gas in appliances for continuation in product operations.

For more information on the Rinnai product range, visit www.rinnaiuk.com

Jung Pumpen to offer site visits for pumping equipment

Compli 400 DrainMinor C

Wastewater and sewage system firm Jung Pumpen has announced that it will be offering site visits for customers of their wastewater and sewage pumping equipment. This will enable public health engineers to view pumping equipment easily and conveniently.

The offer will help to solve pumping requirements, and make installation and operation faster and more reliable. Latest product developments include the New Compli 400 sewage lifting station and the DrainMinor C dedicated Combi Oven pump.

To arrange a drop in visit, contact David Johnson on 07984 520515 or email davidj@pumptechnology.co.uk

Space saving water booster sets announced by Aquatech Pressmain

The Aquasub range of water booster sets is the latest addition to Aquatech Pressmain's portfolio. New smart, submersible water pumps have been released. With a new design, the pumps are placed into the water-storage break tanks. This means the unit is now small enough to fit through a door, making it ideal for use in any building that has restricted access to the plantroom.

For more information, email sales@aqpm.co.uk or visit www.aquatechpressmain.co.uk

Phased decarbonisation strategy aids schools journey to net zero

CIAT UK is collaborating with consultants and distribution partners to help schools transition to low carbon heating technologies.

The project follows Carrier's recent successful Public Sector Decarbonisation Scheme, with plans to work with more than 60 schools in London, the Midlands and Yorkshire.

'With many schools, the solution is to help them plan for a phased transition, with upgraded heating infrastructure put in place now, ready for the future switch from gas to heat pumps,' said James Hughes, commercial HVAC vertical market sales manager, Carrier and CIAT UK.

To learn more, visit ciat.uk.com/product/coadis line 900 cassette or ciat.uk.com/product/major line

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CIBSE Benevolent Fund
The Fund provides practical advice, information and financial assistance, in times of difficulty, for CIBSE members, former members and their dependent families worldwide. The fund is also open to former members of the Institution of Heating and Ventilating Engineers (IHVE) and the Illuminating Engineering Society (IES).

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If you are affected by unemployment, illness, debt or any kind of financial hardship, the Benevolent Fund may be able to help you.

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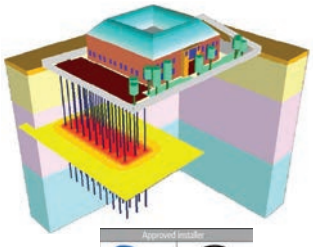

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Co-chairs of the CIBSE Health and Wellbeing working group Dr Marcella Ucci (left) and Milena Stojkovic

Health centred

Milena Stojkovic explains why CIBSE's Health and Wellbeing working group is raising its profile

Milena Stojkovic FCIBSE is an associate partner and senior environmental analyst at Foster + Partners, where she has worked for more than 10 years. She is also co chair of the CIBSE Health and Wellbeing working group alongside Dr Marcella Ucci, associate professor in environmental and healthy buildings at the Bartlett s UCL Institute for Environmental Design and Engineering.

The working group is running a session on day two of Build2Perform Live at ExCeL, London, which runs from 29 30 November. At the event, Stojkovic and Ucci will present an introduction to the working group. Penny Goodall Quraishi, director at the International Well Building Institute (IWBI) will discuss the new Well Equity rating (see page 28). This will be followed by an audience Q&A and a panel discussion, chaired by Julie Godefroy, CIBSE head of sustainability.

Here, we find out from Stojkovic about the groups aims and how important its work is in improving the built environment.

What is the aim of the CIBSE Health and Wellbeing working group?

To ensure broad coverage of health and wellbeing in a strategic and integrated way. The group supports CIBSE to ensure its activities including policy, guidance, research and awards criteria are in line with best practice. We aim to provide an outlook beyond engineering and beyond practitioners, by establishing links with research and academia, as well as other disciplines and industries. We hope to gain better external reach and visibility for CIBSE s work, and keep CIBSE members updated with new developments in this field. In addition, we aim to establish links with other membership associations and certification bodies.

What areas will you be focused on?

CIBSE already does a lot of work on health and wellbeing related subjects, with active workstreams and groups covering overheating, air quality, and lighting. The Health and Wellbeing working group will also look at broader issues, such as inclusive design and health inequalities. Overall, we aim to identify priority areas and upcoming challenges of significance to CIBSE members and society at large.

What events have you planned for the year ahead?

The group is organising a health and wellbeing session at Build2Perform 2022, with speakers discussing relevant topics. There will also be a panel discussion focused on emerging challenges and drivers for health and wellbeing, including regulatory or market opportunities (see above). The event will also be an opportunity to scope further activities for the group. Additionally, we will be publishing updates on new developments in the health and wellbeing space, including an upcoming *CIBSE Journal* article that will focus on inclusive design.

Is there any new CIBSE guidance in the pipeline?

We will be working with stakeholders to identify whether there is a need for new guidance. In the meantime, *TM40 Health and wellbeing in building services* and *TM68 Indoor environmental quality monitoring* are great resources, and open areas for future research. Also essential are all CIBSE publications on lighting, thermal comfort and air quality.

Is the group working with other disciplines?

The plan for the group is to have a multidisciplinary membership, and we are keen to work with other CIBSE groups including those with a clear health and wellbeing focus as well as with those who have a broader scope, such as facilities management and resilient cities. We are interested to hear from members about potential topics and opportunities for collaboration. As co chairs, Dr Marcella Ucci represents the academia side and I represent the industry, as a member of a global multidisciplinary design practice.

Is there a trade-off between reducing energy use and delivering healthy buildings?

Energy efficiency and health and wellbeing are integral parts of building performance, so poor energy performance or poor indoor environmental quality are not sustainable in the long term. When looking at buildings in use, poor commissioning and operations are usually causes of under performance, so addressing these can achieve improvements in both.

- For more information on Build2Perform Live, visit: **www.build2perform.co.uk**

EVENTS

NATIONAL EVENTS AND CONFERENCES

Facade Design and Engineering Awards 2022
3 November, London
The shortlist has been announced for these awards that recognise and reward excellence and achievements in façade engineering. Join the industry on the night to celebrate.
www.cibse.org/facadeawards

Build2Perform Live
29-30 November
The flagship event returns to a face-to-face event for 2022, at London ExCeL. The two days will feature a carefully curated CPD programme with 160 speakers and more than 70 exhibitors. Register your interest to be kept up to date:
www.build2perform.co.uk

CIBSE REGIONS AND GROUP EVENTS

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

SLL and South West: Re thinking the value of artificial lighting
2 November, Bristol
With speaker Graeme Shaw MSLL technical director at Zumtobel

SLL: Agile lighting research: Bridging the gap between research and practice
3 November
Online panel debate chaired by Ruth Kelly Waskett, senior associate, Hoare Lea and SLL immediate past president, and co-hosted by Shelley James, director, Age of Light Innovations.

SLL & NW: Back to Black Darkness as a tool for wellbeing
17 November
Fear of the dark often prevents truly sustainable lighting to be implemented. This talk will look at where these fears originate and the complexity involved in confronting them in design. With speaker Colin Ball, lighting director, BDP London.

CIBSE HVAC Group: FM for zero carbon
30 November
Evening of discussion with a panel of speakers on how proactive facilities management and building ownership is essential in reaching zero carbon targets. In person and online.

West Midlands: Building Regulations Approved Doc O Overheating Reflection on early use of the regulation
10 January
This roundtable discussion will bring together experts in the assessment of overheating.

CIBSE JOURNAL WEBINARS

The latest *CIBSE Journal* webinar, sponsored by Kohler, titled 'Getting the elephant in the room – effective design of resilient UPS facilities' is now available on demand. Register to watch this, and all other Journal webinars at **www.cibsejournal.com/cpd/webinars/**

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:

Designing water efficient hot and cold supplies
3 November

Earthing and bonding systems
8 November

Building services explained
8 November

Energy Savings Opportunity Scheme (ESOS)
8 November

Residential fire sprinkler design: BS9251:2021
9 November

High voltage (11kV) distribution and protection
15 November

Above ground building drainage
15 November

Energy efficiency related building regulations: Part L
15 November

Electrical services explained
22 November

Standby diesel generator
29 November

Heat Networks Code of Practice
30 November

Below ground building drainage
1 December

Mechanical services explained
6 December

Emergency lighting to comply with fire safety
7 December

Design of heating and chilled water pipe systems
12 December

Building services explained
13 December

Electrical services overview
15 December

Fire safety building regulations Part B
15 December

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

ONLINE LEARNING

CIBSE has a portfolio of online learning courses, which contain interactive content with quizzes and additional resources to support your learning.
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Membership webinars

CIBSE Membership host 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: CIBSE – Membership Briefing Sessions

Upcoming webinars:
- 15 and 22 November
- 6 and 13 December

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

Weather Data

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CIBSE supplies the industry's standard weather data files used in building performance analysis and simulation. The data files have been created to better represent our current climate and weather pattern.

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*All packages are available in EDSL Tas, EPW & Excel

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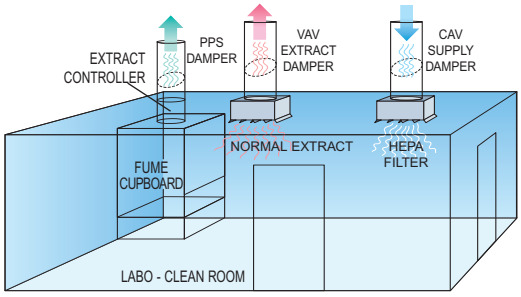

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