CIBSE JOURNAL

#Build2Perform

November 2017 www.cibsejournal.com

GETTING BIOMASS RIGHT FIRST TIME

DUBLIN GALLERY'S INVISIBLE SERVICES

KING'S CROSS ON TRACK FOR DISTRICT COOLING

CPD special

THE TIME TRAVELLER

How Henrik Schoenefeldt uncovered the secrets of Parliament's lost services

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Heritage trailblazer

CIBSE's new conference and exhibition Build2Perform Live will be showcasing some of the important work taking place in CIBSE's Societies, Groups and Regions.

Taking centre stage at Olympia London on Tuesday 21 November will be the Heritage Group, which will demonstrate how an understanding of historic building services can inform designs in the 21st century.

Our cover depicts Dr Henrik Schoenefeldt, who has been researching the services at the Palace of Westminster for six years. Work by Schoenefeldt has made sense of the labryinthine mix of tunnels, vents and voids that made up the original Victorian building services.

This work will enable consultants to reuse a large proportion of the Victorian ventilation system when they put together their plans for the multibillion refurbishment of the British parliament. Build2Perform will also feature English Heritage's Andrew More, who will discuss how engineers should approach historic buildings, make use of existing equipment and calculations, and understand the fundamental physics behind historic building design.

The next few months will be busy for those tasked with responding to the slew of consultations that were published alongside the government's long-awaited Clean Growth Strategy. On page 16, Hywel Davies picks out the highlights of the strategy that, thankfully, reaffirms Britain's commitment to the 2008 Climate Change Act, which sets binding targets for 2050 carbon reductions. The Strategy promises to review Building Regulations in relation to energy, improve the energy efficiency of commercial and industrial buildings, and promote low carbon heating, ventilation and air conditioning. As Davies says, there is much to commend in the document.

A summary of the related government consultations released alongside the strategy is also on page 16, alongside the January deadlines, enabling industry strategists to schedule their Christmas holidays around writing their responses.

If we are to adopt innovative low carbon technology to meet carbon targets, we must learn how to optimise the design, installation and operation of these systems correctly. On page 41, David Palmer describes a litany of design errors in his inspection of biomass systems, ranging from oversizing to an absence of buffer vessels. The good news, according to Palmer, is that many of the designs can be rectified – but why not get it right first time? Palmer is the author of *AM15 Biomass Heating*, which is the definitive guide to biomass design that can be freely downloaded at **www.cibse.org/knowledgeportal**

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Hywel Davies
CIBSE's technical director looks at what the Clean Growth Strategy means for building services

Isabelle Smith
Atkins' mechanical engineer on the digital revolution in construction

Liza Young
Our deputy editor speaks to Henrik Schoenefeldt about his work on historic services at Westminster

Tim Dwyer
Our technical editor's CPD module looks at the factors determining viability of small-scale CHP systems

CONTENTS

News

7 News
Industry responses to Grenfell review; Brexit halting projects; government failing DECs; help clean up London's air

14 CIBSE news
InTandem wins employer award; Oxford Night of Heritage Light; DE8 goes live; LG15 published

Voices

16 Going for clean growth
Hywel Davies looks at the Clean Growth Strategy

17 Feedback
Raising girls' Stem aspirations

18 Planning for a zero carbon future
Engineers must influence future infrastructure, says **David Fisk**

20 Get with the program
Isabelle Smith on the need for standardised manufacturing

81 Q&A
With CIBSE Graduate of the Year **Raphael Amajuoyi**

Features

22 Raphael finds a winning ratio
Liza Young reports on the battle to be named CIBSE Graduate of the Year

24 COVER FEATURE Turning back time
Henrik Schoenefeldt talks to **Liza Young** about helping uncover the forgotten voids at the Palace of Westminster

30 Digging deep for art
Chris Croly on the challenges of creating environmental control in the limited spaces of the National Gallery of Ireland

34 BIM about the house
Dan Rossiter applies BIM Level 2 to his own home

36 Capacity for change
Building services engineers should be helping clients minimise their peak-time energy bills, says **David Winton**

Read our complete list of CPD providers
with this issue or online at **www.cibsejournal.com**

Technical

SPECIAL FEATURES
Industrial/commercial heating and cooling

41 Bio degrade
The factors that cause biomass boilers to underperform

47 Heating news
A round-up of the latest heating regulations and product news

51 Where there's a wheel, there's a way
The popularity of thermal wheels is rising – here's why

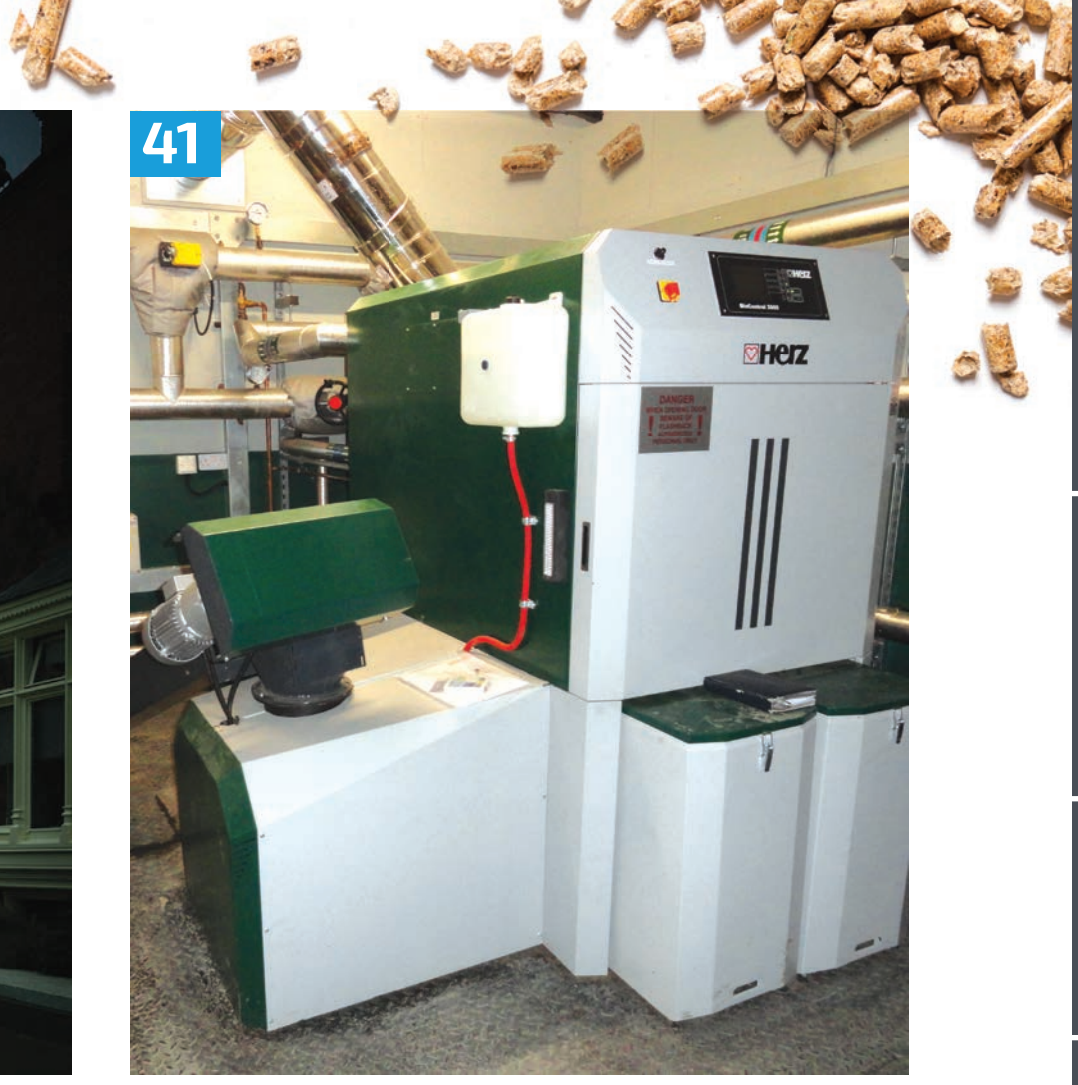
52 A winning formula
How the EndoTherm heating additive won over the sceptics

55 Set great store by
Ensuring thermal storage in a CHP system is sized correctly

59 Cooling news
The latest from air conditioning manufacturers

61 Leading wedge
Metropolitan's district cooling pod at London's King's Cross

68 Automatic savings
Air con climate-control solutions



CPD

71 Cost- and carbon-effective small-scale CHP
Assessing the viability for small-scale CHP solutions in the UK

Classified

76 Products
A round-up of systems and services for the industry

Jobs

80 Appointments
Jobs at **jobs.cibsejournal.com**

Events

82 Looking ahead
Build2Perform Live; New course: Fundamentals of Digitial Engineering (including BIM); CPD training; energy assessor training; CIBSE groups, regions and societies

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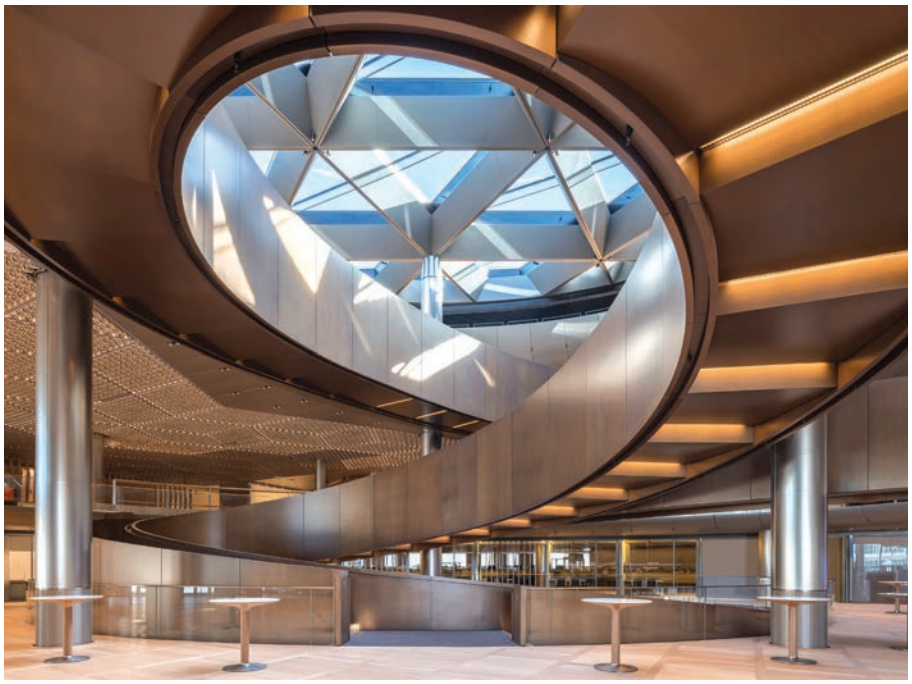

Bloomberg has unveiled its new BREEAM Outstanding European headquarters, which has achieved a record sustainability rating of 98.5%.

Designed by Foster + Partners, with Sweco as building services engineer, the building's deep-plan interior spaces are naturally ventilated through a 'breathing' façade, while integrated ceiling panels combine heating, cooling, lighting and acoustic functions in a petal-leaf design. The system, which incorporates 500,000 LED lights, uses 40% less energy than a typical fluorescent office-lighting system.

Smart CO_2 sensing controls allow air to be distributed according to the number of people in each zone of the building. Dynamically adjusting airflow is expected to save 600-750MWh of power per year, reducing annual CO_2 emissions by about 300 metric tonnes.

Grenfell response demands more robust building control

Concerns raised about roles and responsibilities in construction

A joint response to the independent review of Building Regulations and fire safety – set up in the wake of the Grenfell Tower disaster – has raised several concerns, including: weaknesses in the building control system; confusion around the way different regulations interact; and the need for building components to be tested 'in context'.

CIBSE is among 38 professional bodies supporting the submission, which is being led by the Royal Academy of Engineering and produced on behalf of the Engineering the Future alliance. It highlights the 'significant confusion' – particularly around the 'allocation of roles and responsibilities' – caused by the interaction of rules relating to building and housing. These include: the Building Regulations; the Regulatory Reform (Fire Safety) Order; and the Construction (Design and Management) Regulations.

The response raised concerns about parts of Approved Document B, which it said were unclear or insufficient for fire safety. It also pointed to serious problems with the building control system, and the issue of fee bidding between local authority building control and approved inspectors.

'The move to greater privatisation of building control generates the potential for significant conflicts of interest, putting independent assessment of regulatory compliance at risk,' it said.

CIBSE technical director Hywel Davies said the institution had 'a particular concern about the definition of roles and responsibilities in the construction and operation of buildings'. The lack of requirement for the demonstration of competence was also 'a serious concern'.

Insurers want action on combustible material

The Association of British Insurers (ABI) has called for a total revamp of the Building Regulations in the wake of the Grenfell Tower fire.

It has submitted a response to the post-Grenfell review of fire safety and building codes, led by Dame Judith Hackitt, demanding 'an immediate end to the use of combustible materials on the outside of new and refurbished buildings, and limiting the use of combustible material on the inside'.

The trade body also wants 'more robust testing regimes, to prove materials are not combustible and to replicate how these materials are used in real-world conditions'.

Like its building engineering counterparts, the ABI believes there should be greater clarity about 'roles and responsibilities' around the management of fire safety. It also repeated its call for sprinklers to be installed in all new schools, care homes, and warehouses larger than 2,000m².

'Grenfell represents a systemic failure of the protection of buildings from fire in this country,' said James Dalton, ABI's director of general insurance policy. 'This review marks a seminal opportunity to recommend substantial change that will fundamentally improve fire safety in England's buildings but, also, as a consequence, make these buildings more commercially attractive risks to insurers, increasing competitiveness and benefiting customers through an associated effect on premiums.'

Committee to probe future of F-Gas rules

The UK government has launched an inquiry into how leaving the EU will affect the country's efforts to reduce F-Gas emissions. The Environmental Audit Committee will also look at the future of the F-Gas Regulations.

'With Brexit looming, businesses need clarity on how the UK will reduce F-Gas emissions and on who will ensure the government meets its targets,' said committee chair Mary Creagh.

The UK is bound to the EU's F-Gas regulation (517/2014), which includes a target to reduce HFC use and sales by 79% by 2030.

The committee is inviting submissions by 6 November. It will consider if the F-Gas Regulation should be brought into UK law or if a new set of rules should be developed that go further.

Trade bodies back calls for tougher EPBD

Rehva has welcomed the stronger stance taken by the European Parliament over the review of the Energy Performance of Buildings Directive (EPBD), which could lead to a mandatory building inspection regime across the EU.

The European umbrella body for HVAC engineers and technicians said a new report reinforces the focus on indoor air quality and comfort in building refurbishment, and backs changes that would support wider use of building automation and control systems.

Rehva said the European Parliament should push for a 'mandatory and transparent framework for inspection' and urged it not to accept 'adequate advice' as an alternative to inspections of HVAC systems.

Poll shows Brexit uncertainty hitting construction projects

Exit from EU may force industry to train and invest in younger generations

Building projects are being cancelled and budgets cut because of Brexit, according to a poll carried out during UK Construction Week for Sky News.

More than half of the 2,500 senior construction managers surveyed said their business was being affected by the UK's vote to leave the EU. Of these, 75% said clients were delaying investment decisions and 33% put their problems down to a slowdown in the housing market. In addition, 45% of respondents said budgets had been cut and 29% had seen projects cancelled.

It was not all bad news, however, with 25% saying they had seen more foreign investment and 19% reporting projects brought forward. Around 64% also said Brexit would force the industry to solve its 'skills crisis' by training and investing in younger generations, while half said they would use more domestic suppliers and 34% said leaving the EU would cut red tape.

Peter Caplehorn, deputy chief executive of the CPA, told Sky News: 'We've seen a lot of commercial clients hesitating on developments, on production. Clearly that is now starting to work its way through and it affects everybody in the industry, mainly because of uncertainty. We need to go forward with a clear plan.'

MPs unveil Clean Growth Strategy

The government's Clean Growth Strategy was finally unveiled last month, after a lengthy delay. It lists investment measures for low carbon heat, plus nuclear power, off-shore wind and smart meters – and highlights the return to favour of carbon capture and storage (CCS). It also sets targets for upgrades to fuel-poor homes, but only where improvements can be justified as 'practical, cost-effective and affordable'. The aim is to bring fuel-poor and private-rented homes up to Energy Performance Certificate band C by 2030.

Measures also include a modest £10m investment in low carbon heat innovations for buildings in the domestic and commercial sectors, and a similar amount for building energy efficiency projects. Up to £20m will be spent on a CCS demonstration programme, and an Industrial Energy Efficiency scheme, aimed at improving the energy productivity of large firms, is also mooted.

See Hywel Davies' column on page 16 for more information on the Clean Growth Strategy.

MAX FORDHAM HELPS DELIVER POSTAL MUSEUM REFURBISHMENT

The revamped Postal Museum has opened to visitors after a £26m redevelopment, supported by the Heritage Lottery Fund.

Work on Calthorpe House, in Farringdon, included a roof replacement, construction of an extension, and demolition of walls and floors to create the 500m² exhibition space.

Part of the exhibition is the Mail Rail, on which visitors can enjoy a 20-minute ride through underground tunnels previously hidden from the public. The 10.5km network was built in the 1920s by Royal Mail, to transport four million letters a day around London. The line links six sorting offices with the mainline stations at Liverpool Street and Paddington.

Building services engineer Max Fordham and architect Feilden Clegg Bradley helped restore tunnels to create a 1km ride, which loops to a 2,000m² depot. The project team specified Viessmann boilers for the revamp.

Public buildings fail on efficiency

Display Energy Certificate data reveals non-compliance in central government buildings

Only 6% of central government buildings have achieved an A or B rating for energy efficiency, according to new research by Leeds Sustainability Institute and Leeds Beckett University. Not one central government building had a Display Energy Certificate (DEC) with an A rating, the study revealed, and 24% of buildings lodged had the lowest possible G rating.

The research covered DECs and Advisory Reports (ARs) for 104 buildings between 2008 and 2017. It revealed that only 42% were likely to meet a government target of A to D ratings by 2018. The building data is contained in the Non-Domestic Energy Performance Certificate Register.

Non-compliance with DEC requirements was endemic, the study found, with 80% of DECs and ARs not being lodged for UK central government buildings. ARs are site-specific documents that inform building managers and occupants how they can reduce energy use. The research paper *Does the UK government comply with Display Energy Certificates and Advisory Reports?* looked at the most common AR recommendations and found that few followed the 'fabric first' principle.

Read next month's *CIBSE Journal* for more on the paper.

Spie hit by £25m loss

Building services and FM contractor Spie lost £25m last year, on a turnover of £260m. It is understood the loss was primarily because of a major restructuring.

Chief executive Robert Goodhew said the contracting business incurred costs of £2.3m as a result of the restructure and had also been hit by 'legacy contracts'.

The group's operating profit was £1.6m before 'exceptionals' – down from £5.5m the year before – and staff numbers have been reduced.

Spie acquired the Trios Group for £21.4m and spent £6.7m on the acquisition of Environmental Engineering Services in 2016. As a result, the group now employs 3,600 staff in the UK, based in more than 20 offices.

Market facing a year of no growth, says CPA

A slowdown in office, retail and factory work means there will be no growth in the construction market next year, according to the Construction Products Association (CPA). Its latest forecast also warns that growth in the next two years will depend entirely on the pace of delivery of government infrastructure projects. Any further fallback in that area would lead to a 1% drop in construction output in 2018.

However, CPA researchers believe the market will rebound – with 2% growth in 2019 – as major rail, water and sewerage projects, such as HS2 and the £4.2bn Thames Tideway Tunnel, push up infrastructure output by 25%.

Housebuilding will continue to be a primary driver of growth, but the sharpest decline will be in the commercial sector, because of 'Brexit-induced wariness among investors', the CPA said.

London seeks support from industry to improve air quality

Planning system will ensure IAQ is taken into account in building projects

A deputy mayor of London has urged building services firms to help the city deliver better air quality for building occupants.

Speaking at last month's Building Engineering Services Association (BESA) conference, Shirley Rodrigues said indoor air quality (IAQ) would be a priority consideration in new planning laws for the city, and a crucial part of its Environment Strategy. She urged building services specialists to respond to the consultation process on changes to the London Plan and to share their expertise with policy-makers.

'IAQ is a relatively new area for us to understand and we want to talk to your industry about the right steps to take. We also need to make sure that people are provided with better evidence about the risks,' Rodrigues told the conference delegates.

'We are aware that air brought into buildings through their ventilation systems can contribute to health problems and we will use the planning system to make sure this is taken into consideration by everyone involved in building projects, including architects.'

Rodrigues, deputy mayor for the environment and energy, said she was particularly concerned about the impact of poor air quality on schoolchildren, and said 400 London schools had been identified as being at particular risk.

Her plea to the industry comes after Mayor Sadiq Khan published data showing every borough in London now exceeds World Health Organization (WHO) limits for PM2.5. These toxic air particles are linked to lung damage and elevated risks of respiratory and cardiovascular diseases, as well as cancer. Khan has pledged to spend £875m on air quality measures over the next five years.

Rodrigues told the conference that PM2.5 was responsible for 29,000 premature deaths in the UK every year.

CIBSE is working with CityAir, the City of London initiative to promote better air quality, to supply updated guidance to the sector. For details, visit **bit.ly/2haVD4v**

Air pollution killed 6.5 million in 2015

Air pollution was responsible for 6.5m deaths worldwide in 2015, with one million of these attributed directly to workplace air quality, according to research carried out by medical journal *The Lancet*.

In total, pollution accounted for an estimated nine million deaths worldwide – 16% of all fatalities – higher than the number resulting from smoking, hunger and natural disasters combined. It also led to 400,000 'preventable' deaths in the EU, with air pollution the biggest source of problems, accounting for 8% of all deaths in the European Union.

The UK, along with Germany, Italy, Poland and France, were the EU members with the worst air pollution-linked death rates. Heart problems, strokes, lung cancer and pulmonary disease were listed as the most common conditions exacerbated by poor air quality.

IN BRIEF

Foster + Partners blew budget by £95m

Architect Foster + Partners has been ordered to pay £3.6m for negligence over its design of a five-star hotel that was never built.

Entrepreneur John Dhanoa hired the architects in 2007 to design a hotel near Heathrow, asking for a £100m project to be built in time for the end of the 2012 Olympics. But Fosters blew the budget with its design spread over 13 storeys – including several underground – and pavilions enclosed in a giant glass biosphere.

When Fosters produced the £195m design in 2008, Dhanoa was told to apply for planning permission and was assured the scheme would be 'value engineered' downwards to the budget limit. The court awarded his firm, Riva Properties, £3.6m for money spent on the project.

ESOS audits drive savings for SMEs

Around 66% of the small and medium-sized enterprises (SMEs) that undertook an Energy Savings Opportunity Scheme (ESOS) audit say the process resulted in financial savings, government research has found.

ESOS aims to help organisations improve their energy efficiency by identifying the best opportunities to make savings. Two-thirds of the SMEs that took part made savings of more than £200, according to the survey. Only 9% of SMEs said they had conducted an ESOS audit, however, compared with 69% of larger companies. Four out of five of those who conducted an audit took action as a result.

Matthews heads up new T Level panel

David Matthews, chief executive of the Institute of Domestic Heating and Environmental Engineers, is to chair the building services T Level Panel.

T Levels are new-style vocational qualifications, each of which has a panel of industry professionals and employers to develop the content of the course. The building services T Level is one of the first to get under way.

'By combining practical skills training with real-world academic knowledge, the vocational student gains the best of both worlds,' said Matthews. The first of the new qualifications will be taught from 2020, with the full set of T Levels introduced by 2022.

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CIBSE's Build2Perform Live set to attract 1,500 visitors

Free event will feature over 20 expert sesions across two days

Build2Perform Live, the new showcase for CIBSE, will take place on 21 and 22 November at London's Olympia.

Free to attend, and featuring more than 20 sessions, this event has been designed as a platform for industry professionals to share best practice, as well as their experiences of how building services impacts all aspects of our working and living environments.

Topics include lighting spaces, wellbeing, BIM and digital engineering, natural ventilation and designing homes, and the event will feature representatives from CIBSE's volunteer groups, 19 CIBSE special interest groups, five societies and more than 50 exhibiting organisations.

With more than 1,500 visitors expected at Olympia, this is the largest event within its discipline in the UK. Attendance offers an opportunity to develop an understanding of the impact building services professionals can have on improving our built environment.

For the full programme and to register, visit **www.cibse.org/b2plive**

David Mather, of Cudd Bentley Consulting, will chair the YEN session

Tyréns takes stake in Hilson Moran

Hilson Moran designed the services at the Gherkin

Swedish multidisciplinary consultant Tyréns has acquired a stake in British building services company Hilson Moran, which will continue to operate under its own brand. The Hilson Moran management team will remain as shareholders.

Hilson Moran employs more than 250 staff in six offices in the UK and the Middle East, and generated revenue of around £24m in 2016. Tyréns has 2,200 employees in Sweden, Denmark, Estonia and the UK, and its turnover in 2016 was £169m. In 2011, Tyréns backed structural engineer AKTII in a management buyout from WYG.

Chris Plummer, managing director at Hilson Moran, said: 'Working with Tyréns means we can continue to offer the very best aspects of being an independent consultancy while being able to offer an interdisciplinary service with AKTII.'

Robin Adams, managing director at AKTII said: 'This is very welcome news for AKTII. Unlike traditional models, this strategic model will reinforce our disciplinary autonomy but with interdisciplinary access to new technologies, research, expertise and relevant markets, both regionally and internationally.'

UAE technical conference looks up

'Meeting Challenges in Tall Building Design in the Gulf Region' is this month's topic at the CIBSE UAE Region technical conference, which brings together experts from across the region for knowledge sharing and networking.

Held at the Westin Dubai Mina Seyahi Beach Resort & Marina, the event will include a keynote presentation from CIBSE President Peter Y Wong, and will offer a range of presentations looking at the task of delivering tall buildings in the Gulf environment. The event is part of the programme for the CIBSE Young Engineers Global Conference 2017.

IN BRIEF

Wood leaves Google to head for Guru

Decentralised energy solutions provider Guru Systems has appointed Conrad Wood as its new chief technical officer. He joins from Google, where he was site reliability manager.

Before joining Google, Wood founded Internet of Things firm SingingCat in Berlin, offering device management services for start-ups and the manufacturing industry.

Guru's systems are installed on more than 70 decentralised energy networks across the UK.

Sneyd takes top job at Hargreaves

Hargreaves Ductwork has appointed Andy Sneyd as its new managing director.

A chartered engineer and CIBSE Fellow – with more than 25 years of experience in the engineering, manufacturing and commercial sectors – Sneyd joins the company from Portakabin Group, where he was design and engineering director.

He was formerly head of design at Crown House Technologies, and President of the Building Engineering Services Association in 2014/15.

Bancroft wins ECA apprentice award

Jordan Bancroft, of Imtech Engineering in Nottingham, has won the 2017 ECA Edmundson Apprentice of the Year Award.

Bancroft, 23, who was trained by provider JTL, wins £1,500 and a study tour to Limoges, France, sponsored by Legrand.

The judges said they believed Bancroft would make an excellent ambassador for ECA and the electro-technical industry over the next 12 months.

Bancroft said it was 'an absolute honour' and paid tribute to the training and practical experience provided by Imtech and JTL, which he described as 'first class'.

The three runners-up, who each won £750 and a toolkit, were: Christopher Musson, of David Pearce Electrical Contractors; Charlie Nicholson, of NRT Building Services; and Ashley Osbourne, from Playfords.

IN BRIEF

Guide dedicated to Sensecall's memory

A long-standing member of the CIBSE Domestic Building Services Panel (DBSP), Brian Sensecall, has died.

He contributed to numerous international standardisation committees, including RHE24 and CEN228 over many years, as well as the Underfloor Heating Manufacturers Association.

His wealth of experience and contributions to DBSP handbooks will benefit readers for years to come. The DBSP will be dedicating the forthcoming *Domestic Heating Integration Guide* to his memory. He will be remembered for his warm, engaging and always ready-to-help-others personality.

Society welcomes new chair

Saverio Pasetto FSFE, façade technical director at Skanska, has been appointed chair of the Society of Façade Engineering (SFE). Taking up his position at the SFE AGM in September, Pasetto said he was looking forward to a year of even more technical evenings, factory visits and city walks. He will also be focusing on expanding the benefits of membership and developing the society's relationship with the Centre for Window and Cladding Technology and the European Façade Network. Visit **www.cibse.org/sfe** to find out more.

New data protection rules require 'opt-in'

With the introduction of the General Data Protection Regulations on 25 May 2018, CIBSE and CIBSE Services are reviewing their data protection procedures.

One of the biggest changes is the high standard being set for consent for the use of personal data, including email address, and the requirement for individuals to actively opt-in to marketing communications. A clear record of when and how opt-in consent is given is also paramount.

As a result, from 1 November 2017, we will be asking members and customers to 'opt in' to receive marketing communications ahead of the 25 May 2018 deadline.

Visit **www.cibse.org/GDPR**

Oxford shines in third Night of Heritage Light

Society of Light and Lighting event included schoolchildren's designs

Some of Oxford University's most recognised buildings were transformed in a dramatic display at the third Night of Heritage Light (NOHL) on 29 September.

The Society of Light and Lighting (SLL) event involved teams of volunteer designers using their technical and artistic skills to demonstrate creative and technical possibilities.

The sites were: Ashmolean Museum, Radcliffe Observatory, Radcliffe Humanities, Radcliffe Camera, the Museum of the History of Science, the Museum of Natural History and the Pitt Rivers Museum.


Oxford University Museum of Natural History

The event demonstrated the impact of lighting on architecture, transforming the shadowy presence of buildings in the dark into assertive and vibrant icons.

For the second year, the project also included the Pockets of Light programme, which involves schools and aims to engage young people in lighting.

Students from the City of Oxford College, St Gregory the Great secondary school and North Kidlington primary school, were challenged to come up with their own designs for the quad of the Bodleian Library.

More than 60 were submitted, with a winner from each school selected and brought to life on the night by a team of lighting experts.

Richard Caple, SLL president, said: 'The Night of Heritage Light has become a fixture in the society's calendar as a celebration of what our work is all about – the art and science of light.'

The event featured local lighting companies and designers including DPA, Hoare Lea and LuxPopuli, and the design themes were focused around the history and function of the buildings.

NOHL and Pockets of Light were held in association with the Oxford Curiosity Carnival, an event giving members of the public a chance to find out what research is about, and how it affects our lives.

Lighting for transport buildings guide published

CIBSE has published its *Transport Buildings* (LG15) lighting guide.

LG15 has been produced to assist designers working in transport to create energy efficient lighting that enhances passenger experience.

The recommendations are aimed at those who have some experience but need a deeper understanding of the specific requirements of transport lighting applications.

It is also useful for clients commissioning designers, because the guide sets out key considerations that could form part of a working brief.

The guide covers all public areas of transport buildings and related access, such as airport terminal forecourts and railway station platforms. Requirements – which differ from the general recommendations of the Society of Light and Lighting *Code for Lighting* – are set out for staff areas used for operational purposes, where specific tasks require particular lighting.

Modes of transport included are rail, road, air and water.

Guidance is also given in respect of the interface between road and rail vehicle lighting and the transport installations they serve.

The guide includes reference to the exterior lighting requirements of BS 5489 and emergency lighting as defined by BS 5266.

LG15 is available through the CIBSE Knowledge Portal **www.cibse.org/knowledge**


InTandem's Bradley Mackfall, Jon Belfield and Wendy Belfield with CIBSE President Peter Y Wong


Elementa Consulting

InTandem Systems takes Employer of Year crown

Awards recognise employers that develop the engineers of the future

InTandem Systems, Norman Disney and Young, and Elementa Consulting have been recognised for their exceptional commitment to mentoring newly qualified engineers at the Employer of the Year awards 2017.

The winners were announced at the Institute of Mechanical Engineers in October, as part of the wider CIBSE Young Engineers Awards.

InTandem Systems won the small employer category and was also named overall champion.

The firm impressed the judges with its commitment to nurturing and retaining young talent; 44% of its staff is under 30, and its in-house fully equipped BEMS training room has been built to support and progress staff to BEMS engineer. As much as 12% of the team is on an apprenticeship programme, with the rest doing some form of training or development.

Wendy Belfield, of InTandem Systems, said: 'When InTandem was formed in 1997, we soon recognised the importance of staff and skill development if we were to build and grow a sustainable business. The whole company understands the importance of disseminating knowledge to school, college and university work experience students, apprentices, undergraduates and ex-service personnel. The award is recognition of how far we have come on this journey and the personal satisfaction and commercial sense this approach to training brings.'


Norman Disney and Young

The award in the large employer category went to Norman Disney and Young, which has developed bespoke training and mentoring regimes for engineering graduates. It also runs a graduate rotation scheme where staff gain experience in a number of disciplines.

Elementa Consulting won the medium employer category. The firm has a strong mentoring scheme, with young engineers having access to senior members through presentations and workshops.

The Employer of the Year awards are sponsored by Andrews Water Heaters, Kingspan Industrial Insulation, Swegon Air Management and the CIBSE Patrons.

Latest addition to CIBSE's Digital Engineering Series now live

DE8: *Project Information Requirements* is intended for those that specify, commission and use Project Information Requirements (PIRs), also known as Plain Language Questions (PLQs).

A free-to-all template associated with DE8 – intended to help users put theory into practice – is also available.

A PIR document may take any one of a number of forms; there is no prescribed right or wrong way of creating a PIR.

This guide is written to cover only those aspects of a PIR that would pertain to the building services and their related systems in terms of a constructed asset.

The PIR document should set out to ask for specific information and data relating to an asset or assets owned or operated by the organisation. This set of requirements will feed into the Employer's Information Requirements (EIR) document.

The purpose of the PIR is for the employer to ask, in simple and understandable terms, what information is actually required at each stage of the design and construction process.

DE8 – together with the rest of the Digital Engineering Series – is available at **www.cibse.org/des**

Referees sought for 2018 symposium

CIBSE has received a record 200 submissions to the 2018 Technical Symposium, to be held on 12-13 April at London South Bank University.

Around 90 of these will be commissioned into full papers, and CIBSE is seeking volunteer referees to help peer review first drafts of the papers and posters. Any Members or Fellows who would like to review submissions can register their interest at the 'Become a reviewer' link at **www.cibse.org/symposium**

For more information and tickets visit **www.cibse.org/symposium**

Going for clean growth

The Clean Growth Strategy commits the UK to binding emissions targets until 2050. Hywel Davies looks at what it means for building services

The long-awaited announcement setting out how we will meet the fourth and fifth carbon budgets has finally been published. The Clean Growth Strategy[1] aims to link growth in the UK's gross domestic product (GDP) with reducing greenhouse gas emissions and delivering an affordable energy supply for businesses and consumers.

The 163-page strategy firmly commits the government to the 2008 Climate Change Act, which sets binding and challenging targets for the country to reduce emissions until 2050. It offers welcome clarity as we look forward to buildings and energy-related regulation in the UK after 2019. The Strategy's executive summary suggests the 'strategy for clean growth starts from a position of strength,' noting that the UK is set to outperform the first three carbon budget targets, while GDP grows over the same period. It also accepts, however, that meeting the fourth and fifth budget targets will be harder.

Energy and fuel efficiency have improved in recent years: household energy consumption has fallen by 17% since 1990; cars are up to 16% more fuel efficient than in 2000; and low carbon technology costs have fallen significantly.

The Strategy does not acknowledge that many of these gains arise from European provisions, such as the Energy Related Products Framework Directive (or ErP Directive) or the Energy Performance of Buildings and Energy Efficiency Directives. Take up of LED lighting across Europe has particularly helped reduce domestic energy use.

But the Strategy builds on all these measures, bringing aspects of them into energy and building policy outside the EU. There is also a specific commitment to higher standards from April 2018, with new rules for domestic boilers increasing the efficiency of replacement gas boilers to 92% and

BOILER PLUS

Boiler Plus amendments to the standards for replacement boilers installed in existing dwellings:

- **All gas- and oil-fired boilers must be installed with thermostat and timer**
- **All replacement gas-fired boilers must have a minimum efficiency of 92% ErP4.**
- **Gas-fired combination boilers must have at least one of the following controls: flue gas heat recovery; weather compensation; load compensation; smart thermostat with automation and optimisation.**

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

Government consultations

Documents on energy use in buildings were issued alongside the Clean Growth Strategy

Reform of the Green Deal Framework
A call for evidence on all elements of the current Green Deal Framework, to help improve it and make it fit for future purpose.
Issued: 12 October 2017
Respond by: 23 November 2017
More information: **bit.ly/2i45poY**

Leading by example: cutting energy bills and carbon emissions in the public and higher education sectors
The government is seeking evidence and views about the action required to deliver an ambitious decarbonisation programme across the public and higher education sectors in England over the next 10 years.
Respond by: 7 December 2017
More information: **bit.ly/2yPTViW**

Industrial heat-recovery strategy
Government plans to introduce a support programme to increase industry confidence in identifying and investing in opportunities for recovering and reusing waste heat from industrial processes, and increase the deployment of recoverable heat technologies.
Respond by: 4 January 2018
More information: **bit.ly/2iwlCH9**

Streamlined energy and carbon reporting
The reform package will reduce administrative burdens, raise awareness of energy efficiency, reduce bills, and save carbon. This consultation seeks views on the proposals for Streamlined Energy and Carbon Reporting within the Companies Act 2006 business reporting framework.
There is a launch event on Thursday 9 November at BEIS Conference Centre.
bit.ly/2h77EYF
Respond by: 4 January 2018

Building a market for energy efficiency: call for evidence
The government is seeking evidence and views on additional measures and incentives that could encourage home-owners to invest in energy-efficiency improvements.
Respond by: 9 January 2018
More information: **bit.ly/2iyuqMX**

For details about the consultations issued alongside the Clean Growth Strategy visit: **bit.ly/2gBg1v0**

requiring replacement installations to incorporate certain controls[2].

Chapter 4 of the strategy describes 102 policies and proposals, covering:

- Improving business and industry efficiency, and supporting clean growth
- Improving our homes
- Accelerating the shift to low carbon transport
- Delivering clean, smart, flexible power
- Enhancing the benefits and value of our natural resources
- Leading in the public sector

A third of the proposals relate to improving homes and businesses.

> "The Strategy does not acknowledge that many of these gains arise from European directives"

There is a repeated commitment to review Building Regulations in relation to energy use, subject to the outcome of Dame Judith Hackitt's independent review of the regulations and a clear proviso that any changes must be 'cost-effective and affordable', as well as 'safe and practical'.

There is an emphasis on improving workmanship standards. Wider consequential improvements – which have been the cause of much previous debate – are expressly ruled out, although the improvement that gained widest support is now being implemented in the strengthened replacement-boiler requirements (see 'Boiler Plus' panel).

With renewed commitment to the Climate Change Act, and an acknowledged need to cut emissions, install low carbon heating and cooling, and make our buildings much more efficient, there is plenty to support. Whether delivery can match ambition remains to be seen, but there is much here to help offer certainty and a clear way forward for the building services sector over the next few years.

IMPACT ON BUILDING SERVICES

Chapter 4 of the Clean Growth Strategy sets out a range of potential policy measures. Some, such as ending the Carbon Reduction Commitment (CRC) scheme, are more clearly defined than others – for example, decarbonising off-gas grid buildings. These are the policies aimed at improving energy effiency in homes and businesses:

Unlocking business energy efficiency
Supporting a 20% improvement by 2030; review of the Enhanced Capital Allowance product list; closure of the CRC scheme and increases in Climate Change Levy; building on, and comprehensively assessing, the Energy Savings Opportunity Scheme (ESOS); streamlining energy and carbon reporting after the CRC; offering advice to small and medium-sized enterprises (SMEs) to encourage uptake of energy efficiency; improving the energy efficiency of commercial and industrial buildings; consulting on improvements to Building Regulations to promote low carbon heating, ventilation and air conditioning systems in new commercial buildings; phasing out high carbon fossil-fuel heating in commercial premises off the gas grid.

Improving our homes
Confirmation of the role of the Minimum Energy Efficiency Standard (MEES) in upgrading rented homes, and potentially raising the standard in future, including for social housing and fuel-poor homes; encouraging financing for green upgrades and reforming the Green Deal; supporting implementation of Each Home Counts and provision of a new advice scheme for energy efficiency; action to raise the quality of domestic energy improvement works; improved standards for replacement boilers from April 2018; renewed commitment to offer smart meters to all homes by 2020; encouraging uptake of cleaner heating systems.

The Strategy also looks at low carbon transport, clean power, natural resources and the potential leadership role of the public sector.

References:

1 **www.gov.uk/government/publications/clean-growth-strategy**

2 Heat in Buildings – Boiler Plus can be found at **bit.ly/CJNov17BP** along with a link to the amendments to the domestic compliance guide.

FEEDBACK

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Aiming high

In March this year, as a Stem Ambassador, I ran a three-hour session for 11 girls in Year 5 – aged nine to 10 – to help raise their Stem aspirations. I remarked that I felt sexism might be worse now than when I was at school in the 1960s-70s. Today, I saw Girl Guiding's *Girls' Attitudes Survey*, which suggests to me that this is the case (see **bit.ly/CJNov17letters**).

I found these highlights on that link particularly appalling:

- **30%** of girls aged 11 to 16 think computing is more for boys
- **37%** of girls aged 11 to 21 say their confidence would be better if there were no gender stereotypes
- **44%** of girls aged 11 to 21 have seen statements about women or girls on the news or social media in the past week that they thought were sexist.

At the end of my three-hour session, covering the full Stem spectrum, I mentioned there are nurse practitioners who take a vein from a leg for use in heart surgery. 'I would really like to do that,' said one girl. 'Why not set your sights higher and become a surgeon?' I asked.

While not inspiring her to be an engineer, the country needs more and more nurses, as well as doctors. I would urge anyone in our institution to become a Stem Ambassador, because it is so rewarding.

Rob Farman MCIBSE

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Laying the groundwork for a zero carbon future

The UK must plan its infrastructure now if it is to decarbonise its energy, and engineers have the chance to tell ministers what is required, says David Fisk

The government's new Clean Growth Strategy[1] may extend to 2035, but there are unanswered questions about how we will service buildings in a nearly zero carbon future.

The Climate Change Act emissions target implies there is not enough gas left within the carbon budget to heat homes and offices in a country with a population of 65 million, which is expected to reach more than 74 million by 2039.[2] So what is supposed to happen? In its *Visions and Priorities*[3] document – published a day after the Clean Growth Strategy – The National Infrastructure Commission (NIC) invites your views.

Unlike some sectors of the economy – such as transport – low carbon heat is not short of technical solutions for reducing its carbon emissions. These range from heat pumps and heat from combined heat and power (CHP), to using hydrogen produced when sequestrating carbon dioxide. All these options imply large-scale, complementary infrastructure investment, running into billions of pounds – hence the interest of the NIC.

Its report reaffirmed the Clean Growth Strategy view that the only effective decarbonisation strategy is a 'least cost' one. That is not penny-pinching. Only total global emissions count as far as the planet is concerned, and only cost-effective solutions will be taken up by other countries to lower global emissions.

The consequence of driving cost-effective decarbonisation of heat is that, inevitably, we generate a heterogeneous mix of approaches. Real costs vary widely depending on local conditions such as built-form density, climate and access to renewable sources of energy.

Presumably, the whole transformation could be done under a government grand plan – but without the discipline of competition between different solutions at the local level, it risks suppliers simply printing money at the taxpayers' expense.

This leads to a second issue: how to incentivise and finance solutions that are locally optimum, as we know pushing a one-size-fits-all technological approach would cost a fortune.

"The only effective decarbonisation strategy is a 'least cost' one. That is not penny-pinching"

The government has set up a Green Finance Taskforce[4] to look at the issue, and – after the privatisation of the Green Investment Bank – the NIC invites responses on whether other mechanisms might be necessary.

The only common factor across future environmental services technologies is the imperative to reduce the core energy demand. UK experience of incentivising investment in energy efficiency is, at best, mixed; at worst, interventions have been counterproductive. It's no surprise the government plans to reform the Renewable Heat Incentive, for example.

Reflecting on the past decade's experience – and the similarly patchy success for schemes abroad – what do services engineers think is the most effective approach? How would that approach tease out the best local, whole-system solution? There is little point incentivising electric heat pumps or hydrogen fuel cells if there is insufficient infrastructure to supply them.

Worrying about 2035 and beyond in the current economic climate may seem something of a luxury. The infrastructure being built now, however, will still be in use in 2050, so it is very important for clients that we do not strand their assets because of a lack of foresight or future-proofing.

For example, the Clean Growth Strategy and the NIC both point to the inconsistency of a decarbonising strategy that continues to expand the natural gas network. How then should we deploy infrastructure to retain sufficient local flexibility in the years ahead?

The NIC consultation ends in January, ready for the first National Infrastructure Assessment in spring. If the construction industry wants the infrastructure to be in place for its optimal 2050 solutions, it needs to input into the process now.

DAVID FISK FCIBSE
is emeritus Professor at the department of civil and environmental engineering, Imperial College London

References:

1 *Clean Growth Strategy*, Department for Business, Energy & Industrial Strategy (BEIS), October 2017, **bit.ly/2zwLgz0**

2 *Overview of the UK population*, Office for National Statistics, July 2017, **bit.ly/2h2Qhbu**

3 *Congestion, capacity, carbon: priorities for national infrastructure: Consultation on a National Infrastructure Assessment*, National Infrastructure Commission 2017, **bit.ly/2hYD03n**

4 *Green Finance Taskforce*, BEIS July 2017, **bit.ly/2zJ1p5d**

Get with the program

A standardised manufacturing process, with less focus on bespoke designs, is essential if we are to accelerate automation, says Atkins' Isabelle Smith

The shift towards digitisation is radically changing the way we work and, together with automation, is set to have an impact on all facets of building design, construction and management. Buildings have thousands of components, and designers prepare calculations to size and select every one – so we have been advocates of automation for decades. With such a complex end product, however, no one tool – or even set of tools – has come close to being the answer to design automation. I have no doubt such a tool will be a reality soon – but what will it look like? Other industries can give us an insight into the possibilities.

Electronic chips are designed by computers, using algorithms to optimise the layers and distribution of wires, before being manufactured robotically. The car industry gives power to the buyer, allowing them to pick off-the-shelf options, through a visual interface, to create their own design. This illustrates the dual goals of improved accuracy and productivity, with greater customer usability and choice.

I see a future in which a 'master' model re-engineers optimised designs to rapidly reflect changes. It would enable clients to simulate different options through a virtual reality interface, with a dashboard of key information: capital expenditure, operation expenses, construction time, user wellbeing, energy and carbon. This master model would then be used for offsite fabrication and ongoing asset management that reacts automatically to plant performance and occupancy evaluation.

Today, the building services industry does not have an integrated digital design process; it has multiple tools that operate in silos, speaking different languages on different platforms. We must learn from our experience of building management system (BMS) software and ensure our tools work together, using a common language and platform. An open-source approach, with collective software and engineer collaboration, is key to driving joint innovation and ensuring long-term viability.

There are semi-automated tools – for example, daylight and thermal modelling, plantroom sizing, emitter sizing and routing – but a robust and seamless process is still a very long way off. To encourage this, we must change the way we build, and focus on bespoke designs to accelerate automation and digitisation around standardised and modular component manufacture and installation. This will need buy-in from manufacturers and regulations that enable innovation, while streamlining the industry.

"The industry has multiple tools that speak different languages on different platforms"

Standardised manufacturing, paired with parametric design, will be key to automation. The water industry has tools that create regulation-driven models in seconds, based on a few, key user inputs (see **www.dynamic-objects.co.uk**). When producing off-the-shelf components from a predefined library – such as sewer pipes and storm-water tanks – the output is intrinsically linked to a master model, CAD drawings, and a bill of materials that includes cost and embedded carbon information. If we move towards standardised manufacturing, this could be our first step to automated design.

We are also seeing a move towards human-centred design and wellbeing (see **atkins-hcd.com**). Automation that optimises design from learned behaviour will put occupancy evaluation at the forefront of design. Integrated design apps are now equipping architects and building services engineers with predicted information about the wellbeing of future users. Digitising and automating design – and, especially, asset management – will result in an even greater quantity of data. This will exacerbate challenges around storage, analysis, accountability and security, and will need to be regulated.

Primarily, there needs to be a change in attitude for automated design and build to become commonplace. Users and clients will expect rigorous review and testing if they are to have sufficient trust in the output. Designing trustworthy technology will be critical to the success of the next generation of automation, and whole-team collaboration will be needed to mitigate uncertainty.

Automating building engineering will result in changing job roles, leading to a significant skills mismatch across the industry. It is likely that the digital engineer will replace traditional engineering roles as technology drives design. How we procure and cost projects could also change significantly, as the certainty of cost will be much higher at a very early stage. The existing design phases may become defunct, as planning and procurement stage-gates adapt to a rapidly moving design process.

Digitisation and software will be the new differentiators and, increasingly, the focus of competition, so it is paramount that the industry adopts this new pace and style of automation. Great engineering can coexist with automated design, but there will be hurdles to overcome.

CIBSE's Society of Digital Engineering offers a platform for the industry to discuss, collaborate and share. Visit **www.cibse.org/sde**

ISABELLE SMITH MCIBSE is a mechanical engineer at Atkins

Kiyomi Honjigawa said, for her, beauty could be found in a plant room

Ana Recio compared engineering to a flower in her presentation

RAPHAEL FINDS A WINNING RATIO

Creativity in engineering was the topic addressed by eight finalists at the Young Engineers Awards last month. **Liza Young** listened to their speeches

Eight inspiring young engineers took to the stage in October, vying to become CIBSE Graduate of the Year 2017.

Raphael Amajuoyi, graduate consultant within the energy and sustainability development team at Hurley Palmer Flatt, won the title after giving a calm and collected presentation.

Ana Recio, graduate mechanical engineer with the Arup buildings team, was first runner-up, with Kiyomi Honjigawa, graduate engineer at Buro Happold, taking third position. In their five-minute presentations, the finalists had to answer the question: Is engineering an art, and should building services professionals be more creative in the way they approach projects?

Raphael Amajuoyi receives his award from Ashrae president Bjarne Olesen

Amajuoyi – who was first behind the lectern – asked the audience to pick a rectangle from a selection shown on the screen. He said most engineers would choose one based on the ratio of 1:1.618, which dates back to Italian mathematician Fibonacci and his sequence. He said Fibonacci's sequence was used to create what we now know as the golden ratio, which produces the golden spiral.

'We see examples of these in nature. We see its presence in art, in architecture and engineering. While engineering is an art, it is science based,' said Amajuoyi, who achieved a BSc in architectural engineering and design management, and an MSc in low-carbon building design and modelling from Loughborough University.

As much as 90% of the information that reaches our brains comes from vision alone, leaving the other senses to make up the other 10% of the picture, said Amajuoyi. 'We process visuals at least 60,000 times faster than we would text. It clarifies context, it allows context to be taken onboard quicker, and it helps with understanding and simulation of knowledge. But our eyes are susceptible to illusion – hence the importance of science in engineering.'

Amajuoyi showed the audience a checkerboard with squares that appeared to be different colours, but which were actually the same shade when connected.

'Being creative isn't necessarily about flashing lights and fireworks,' he said. 'You can demonstrate creativity using BIM to show the client that you can fit a generator into an existing plantroom, or for clash

Final line-up (from l-r): Arton Merovci, Lucas Van Laak, Baoying Tong, Raphael Amajuoyi, Sharon Kidaha, Kathleen Hetrick, Ana Recio and Kiyomi Honjigawa. For more about the eight finalists, see 'Time to Shine', *CIBSE Journal*, October 2017

detection. These tools help building services professionals be creative in their projects.'

'Engineers create, and that in itself is a form of art,' Amajuoyi added.

Quoting Ove Arup, Recio said: 'Engineering is not science; it's the art of arriving at a good solution. And this is a creative activity involving imagination and intuition.'

As an artist, Recio said she expressed herself through painting and sketching – but that wasn't enough. She wanted to transform her ideas into something tangible, and contribute to what Picasso called 'washing the dust of daily life off our souls'.

She decided to blend her scientific mind with her creative art by studying architecture and environmental engineering at the University of the West of England.

In her current role with Arup buildings team, based in Bristol, Recio explores ideas by sketching – 'an essential tool for building services engineers to foster creativity and imagination, and communicate our ideas with others'.

Working on the £50m restoration of Bristol's Victorian Colston Hall concert venue was, she told the judges, a perfect example of combining art and design theory to create inspiring spaces that foster creativity within them.

'For me, engineering is the art of using creativity to find good solutions,' Recio added. 'Engineering is like a flower. An idea can grow into a building; however, its stem needs to be strong enough. It needs to promote growth through a combination of engineering, creativity and innovation.'

Honjigawa, who joined Buro Happold's Edinburgh Office in 2016, said that to formulate her answer to the question, she had put it to the engineers of the future – today's children. One child said: 'Art is being creative and expressing your feelings. Engineering is building and designing things', while another said: 'Art is everything. It's how the viewer interprets it.'

'Good art should elicit an emotional response from the viewer,' said Honjigawa 'Although I don't appreciate fine art, to me, a bunch of pipes and ducts in a plantroom is a thing of beauty. To me, beauty was not found in the classic artistic design sense, but it was beauty in functionality; beauty in coordination; beauty in form; and beauty in the way it brings buildings to life.'

Another child had said: 'Engineering is art because engineers build things, which uses creativity, and so does art.' Honjigawa added: 'It's not artists that are going to save the day – it's engineers. Creative engineers, but engineers that do engineering.'

Jo Harris, of Eli Lily – a member of the CIBSE FM Group and chair of the CIBSE maintenance task group – gave the IMechE annual lecture after winning the Construction and Building Services Division Award 2017.

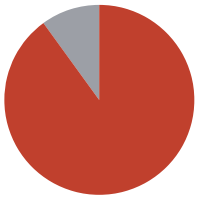
Throughout her career, her driving aim has been 'improving operation, challenging the individual culture and improving collaboration'. She added that one of the key aspects of building services is asset management, not just facilities management.

'Our technology is talking to us, and we have to start listening,' Harris said. 'To be a good engineer in the future, we need to understand other disciplines, and the impact your niche has on other specialties.'

She urged everyone to communicate more and share good and bad experiences by contributing to guides. 'Take your good practice and share it, otherwise it'll never improve.' CJ

> "Being creative isn't necessarily about flashing lights and fireworks; you can demonstrate it when fitting a generator into a plant room in BIM"

The eyes have it



As much as 90% of the information that reaches our brains comes from vision alone, leaving the other senses to make up the other 10% of the picture, said Amajuoyi

BACK TO THE FUTURE

The Palace of Westminster's vast hidden infrastructure will play a vital role in its refurbishment. **Liza Young** speaks to Henrik Schoenefeldt, the man tasked with uncovering the tunnels and voids

I'm on my hands and knees, crawling in pitch black through a narrow tunnel – this tour of the Palace of Westminster is not for the claustrophobic. Although it feels like we're in a basement, we are closer to roof level, examining an original Victorian valve in an air duct 12m above the heads of members of parliament.

My tour guide, Dr Henrik Schoenefeldt, has been seconded to the Houses of Parliament to lead an ambitious research project looking at how its labyrinthine, 19th century ventilation system could be used in the historic building's restoration. The renovation work could cost up to £5.7bn and take 32 years – or it could cost £3.5bn if MPs choose to decant to temporary offices while it is being carried out.

Schoenefeldt's extensive knowledge of the building's ventilation infrastructure will help designers explore the possibility of reusing historic shafts and principles to create a sustainable heating and ventilation strategy for the 21st century. BDP, which won the interdisciplinary contract for the restoration project, will be looking at these scenarios as part of a design team that includes Hoare Lea.

A monumental task

Uncovering the Palace's network of historic ventilation infrastructure was no mean feat. The original services were never logged, and no-one has attempted to map them until now. It took Schoenefeldt four years to map more than 2,000 vertical shafts, smoke flues and ventilation channels – some up to 200m long.

In the 1840s, physician David Boswell Reid devised the building's central air system. This admitted fresh air via shafts inside the Victoria Tower, before distributing conditioned air through an extensive network of air mains in the basement. His plan was to collect the smoke and vitiated air from the entire Palace at roof level, and discharge it centrally, via the tall tower above Central Lobby.

Reid's original sketches show an enormous network linking the smoke or

BRIDGING RESEARCH AND PRACTICE

Schoenefeldt hopes to bridge the gap between scholarship of historic environments and building practice through a series of initiatives. As well as running workshops for architects and building services consultants, he is working on conservation management plans to help owners, managers and assessing authorities make sound decisions about conserving and managing heritage buildings.

'Typically, kit is put into buildings rather than working with the inherited infrastructure, which is an enormous resource. If you understand how they were operated, you can build on them,' he says.

Schoenefeldt is also keen to embed his research methodology into education. He has developed a new module – Understanding historic buildings and past environmental technologies and strategies – for the MSc programme in architecture and sustainable environment at the University of Kent.

'It will help future services engineers or conservation architects to learn how to study – or at least understand – some of the principles when they come across such buildings,' says Schoenefeldt, who was recently made National Teaching Fellow, in recognition of his contribution to developing new ways of embedding research and sustainable practice into the teaching of architectural design.

Schoenefeldt is also hoping to establish a research student engagement initiative as part of the CIBSE Heritage Group. The programme aims to establish a more active forum for the study of historic environmental principles, through a series of workshops in 2017-18 to bring together students, group members, academics and the wider CIBSE community.

'I feel very strongly about it,' says Schoenefeldt. 'It's a great opportunity for research to have a direct impact on practice.'

air flues of every room to the Central Tower. The channels covered long distances, with the main ones measuring 150-200m.

The thousands of vertical shafts inside the walls delivered fresh air to various chambers at every level. These connected to horizontal air channels, running parallel to the Palace's smoke flues, which linked to the central extract system at the roof. A mezzanine floor was inserted below the roof level to collect hot air and smoke from every room in the Palace, and convey it to ventilation turrets.

'Some fire channels are so large that you could stand up inside and walk through them over several hundred metres, uninterrupted,' says Schoenefeldt, who has studied the Victorian system since 2011.

Even more space was needed for cooling – using water sprinklers or circulating cold water from wells through heating pipes in the air chambers – humidifying or heating the supply air. In the House of Lords, fresh air was collected and conditioned in air chambers below the principal floor, and these were linked – through vertical shafts and flues – to the basement, galleries or ceilings. 'Some are shallow voids measuring less than a metre in height, while others extend over two storeys. In some spaces, we had to crawl, but many are tall enough to stand in,' says Schoenefeldt.

The Victorian ductwork is composed of heavy stonework, which forms an integral part of the building's physical fabric. Air chambers are hidden within the depth of the floors, and vertical and horizontal air flues are built in brick or carved into masonry walls. In some areas, less than 50% of the walls are structural, while vertical and horizontal ventilation shafts take up a quarter of the building's internal volume.

Critical reconstruction

Before the historic infrastructure can be reused, designers must understand how it was operated, says Schoenefeldt, adding: 'Intentionality cannot be deduced by looking at the physical features you see today. You need to understand the thinking behind it.' He calls this method critical reconstruction, encompassing anatomical reconstruction, historical performance and technical evolution. (See panel 'Critical reconstruction').

'Like a palimpsest, the Palace of Westminster has generations of different systems piled on top of each other. The building evolved so much over a period of 100 years that you have to unravel the layers to understand how and why it changed,' he says.

> "Like a palimpsest, the Palace of Westminster has generations of different systems piled on top of each other" – *Henrik Schoenefeldt*

In the 1800s, people – not computers with sensors or actuators that opened and closed dampers – operated the system. They did this manually by taking readings with thermometers, and analysing them. Instead of algorithms, they had guidelines and made adjustments if the temperature fell by – or exceeded – a certain level. 'Today, facilities managers are quite disengaged from their buildings, because computers are doing the data gathering,' Schoenefeldt says. 'Back then, the team intuitively knew how the building was behaving.'

Half a dozen people in the chambers were in charge of performing operational procedures, coordinated by a superintendent, while a Serjeant at Arms in the Commons fed qualitative data to a technical team when members complained about their environment. This process of user feedback continued until the 1940s.

Professional rivalry between architect Charles Barry and Reid meant »

» the idea of discharging smoke and air centrally through one tower was abandoned after six years of planning, and a wall was constructed in the middle of the central chamber, separating the Commons – which remained under Reid's control – from the Lords' side of the building, where the responsibility for the ventilation had been transferred to Barry's team.

However, the infrastructure established by Reid was not discarded. Instead of being connected to the Central Tower, it was sub-divided into multiple local systems, each with separate ventilation turrets that were added to the roof of the Palace between 1846 and 1854. Each turret had an iron smoke flue running through the centre of the air shaft, allowing the waste heat of the smoke to enhance the convection of vitiated air without mixing the two.

Just five years later, the decentralised system was reversed – the basement was changed from being the main supply to the main extract channel, while the inlet shafts were turned into stacks with coke fires at the base. This was done because they had trouble forcing enough air through the long passages, and because of problems with synchronising the supply and extract. 'They used the same infrastructure, but operated it differently, showing the flexibility of the system,' says Schoenefeldt.

"Schoenefeldt's research has shown that the Victorian stack ventilation system – used over nine decades – was highly sophisticated"

CRITICAL RECONSTRUCTION

Through his work on the parliament project, named 'Between heritage and sustainability – restoring the Palace of Westminster's historic ventilation system', and funded through a grant from the Arts and Humanities Research Council, Schoenefeldt has created a research method:

- **Design development – focusing on the use of scientific working methods in the design process**
- **Anatomical reconstruction – uncovering the historic design process and the thinking behind its anatomy via original drawings and onsite surveys**
- **Performance analysis – understanding how the system performed using benchmarks set at the time**
- **Continual evolution – after it was finished, the system continued to evolve over a period of 90 years, as technology and measurement methods advanced, and scientific theory changed**
- **Critical restoration – building on a critical understanding of the design and behaviour of the historic systems, the project will investigate how far the historic stack system could be revitalised in conjunction with the restoration programme.**

Building on Victorian principles

Only after gaining an insight into how the Victorian system was originally used can we revisit it in light of current technology and controls, says Schoenefeldt.

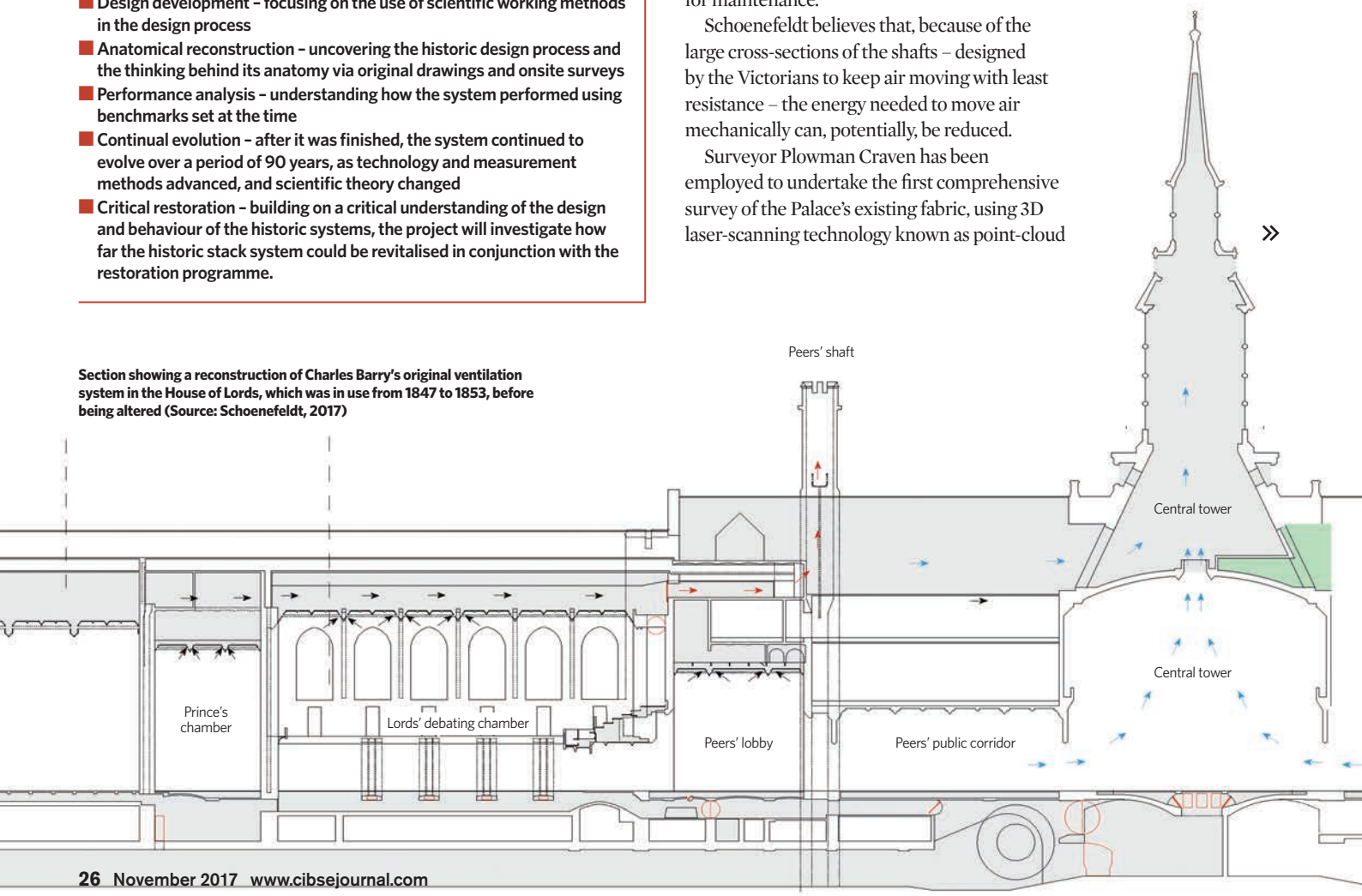
Reid's system relied on large quantities of waste heat – from gaslights, coke fires and fireplaces – to enhance airflow. 'The technological shift is one of the biggest challenges of translating these principles; we no longer have the large quantities of heat available that would produce strong draughts,' says Schoenefeldt. 'When we reuse it today, we need to understand that a modern stack-ventilation system operates differently from a historic one.'

One of the options to be explored is reinstating a stack-driven system that uses the historic infrastructure. 'I imagine a mixed-mode system, using stack ventilation principles integrated within a mechanical system, so you can switch between the two,' he says.

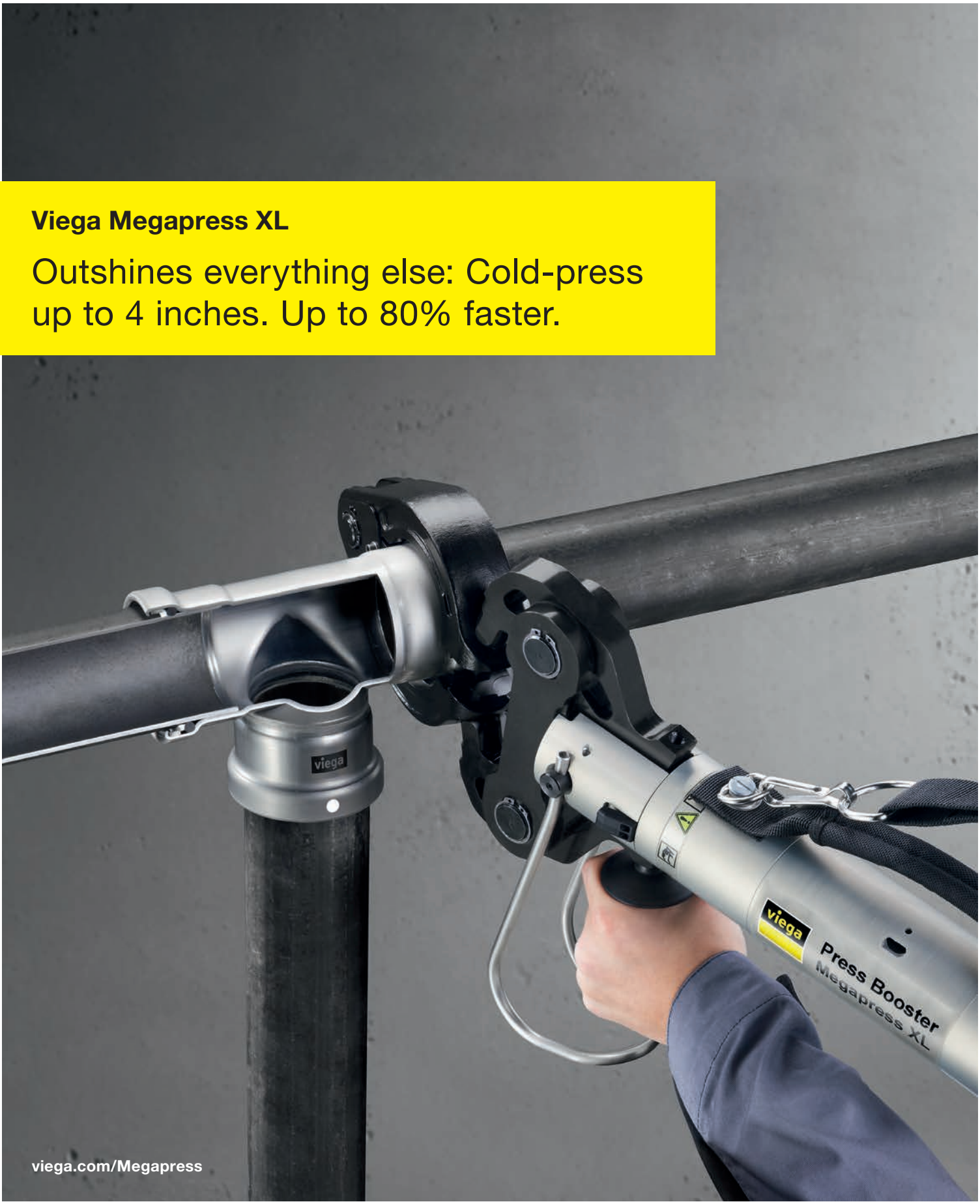
Another scenario would be adopting the roof mezzanine as an environmental service floor, to accommodate modern environmental services in a way that they can be accessed easily for maintenance.

Schoenefeldt believes that, because of the large cross-sections of the shafts – designed by the Victorians to keep air moving with least resistance – the energy needed to move air mechanically can, potentially, be reduced.

Surveyor Plowman Craven has been employed to undertake the first comprehensive survey of the Palace's existing fabric, using 3D laser-scanning technology known as point-cloud »



Section showing a reconstruction of Charles Barry's original ventilation system in the House of Lords, which was in use from 1847 to 1853, before being altered (Source: Schoenefeldt, 2017)



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Cold press technology for large dimensions

Viega Megapress delivered a great leap forward by making it possible to cold-press thick-walled steel tube. Now the technology has taken another advance with the launch of Megapress XL that introduces the larger press-connection sizes of 2 ½, 3 and 4 inches. To facilitate pressing, Viega has unveiled the new Pressgun Press Booster, a special force amplifier that works with Viega press machines to provide the necessary power during pressing as well as providing a 80% faster and 100% safer connection of these three new dimensions. **Viega. Connected in quality.**

» scanning. This will yield data for the production of a virtual model, which the designers in charge of implementing the restoration programme will use.

Model democracy

The model will feed into a BIM simulation of the Palace's ventilation network, says Schoenefeldt, whose research provided the foundational knowledge for the 3D point-cloud survey. This involved reconstruction of the original system design – including many of the lost features – based on archival research, plus site explorations and photographic surveys of the surviving features inside the Palace. These plans were then used to guide Plowman Craven in its systematic scanning. Before this, only a small amount of historic ventilation network had been covered by the 3D point-cloud survey.

Schoenefeldt is now working with BDP to develop a methodology for an extended survey of the complex network of voids not included in the scans undertaken by Plowman Craven. The pilot will be used to test and refine the methodology. 'The Palace offers a huge resource of spaces,' he says. 'Once designers understand what the infrastructure can offer, they can reinterpret the historic system.'

Schoenefeldt's research has shown that the Victorian stack ventilation system – used over nine decades – was highly sophisticated, having undergone continuous refinement involving several generations of scientists and engineers. Today, engineers face a new challenge: reimagining the dark, extensive voids for use with modern controls and technologies, to ensure the home of parliament can begin a new chapter. CJ

Schoenefeldt's tour included a trip to the basement air shafts

BUILD2PERFORM LIVE

On Tuesday 21 November, from 2-4.30pm, CIBSE's free-to-attend Build2Perform event will feature a conference segment entitled 'Making heritage buildings perform'.

Dr Henrik Schoenefeldt will share current research into the 19th century building services at the Palace of Westminster. He will discuss his research of the original stack ventilation system, explore how far it could be re-used, and share new insights into the historic methods of building performance evaluations.

In the 2.45-3.30pm slot, CIBSE Heritage Group chair Dr Neil Sturrock will lead a session on what we can learn from the building services in historic buildings. This will include an in-depth study of a public building from the 1850s, which reveals marked similarities with an exemplar from the 21st century.

In the 3.45-4.30pm slot, Andrew More, senior building services engineer at Historic England, will discuss how to deal with historic buildings, including fundamental concepts and rules of thumb.

To register and for details, visit www.cibse.org/b2plive

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DIGGING DEEP FOR ART

Refurbishment of the National Gallery of Ireland required tight environmental control in the galleries, but there was minimal space to make this happen, writes **Chris Croly**

Supplying a historic building with modern services can be one of the toughest briefs a consultant can face. The refurbishment of the National Gallery of Ireland in Dublin was no exception.

Close environmental control of galleries containing priceless artwork had to be achieved without altering the building fabric or distracting visitors with unsightly distribution routes and air terminals. The main plant had to be located outside the galleries and no water services were allowed to pass through or near the gallery spaces.

There was a roof space that could be used for air handling plant, but it wasn't large enough so the large ductwork systems couldn't get in or out of the plant area. The historic glazed roof also had to be retained, which meant having to protect artworks from daylight and potentially 300kW of heat gains.

The brief required the environmental control to be as good as that of a new-build art gallery, and with better energy performance.

Existing services

The project comprised the refurbishment of the Dargan Wing, completed in 1864, and the Milltown Wing, completed in 1903.

A network of cast-iron heating pipes provided background heating to the galleries, while quality natural light was a key feature of the original design – although some of the windows have been blocked up over time. These missing windows were rediscovered by the project architect and restored, to return the gallery to the naturally lit state first intended.

The 600m² single-glazed roof of the Dargan Wing had to remain, which meant the daylight and heat gain needed to be tamed. As well as the effect of solar gain on air temperatures, BDP engineers were concerned radiant heat from the roof glazing would affect surface conditions of the paintings, while – in winter – radiant cooling would affect the canvas and frames.

The solution was to replace the large areas of glass within the gallery roofs with a high-performance glazing that incorporated micro louvres within panels. These louvres diffuse light to reduce peak solar radiation on paintings and have a UV transmittance of less than 1%. They produce a glazing g-value of 0.14, which reduces solar gains by 80% compared with the historic glazing. They also reduce heat loss by almost 70%.

The top floor of the Milltown gallery is made up of a series of six inter-connected galleries of around 10m x 10m in size.

The roof of each space (known as a pod) is almost entirely glazed. The glazing is raised above

PROJECT TEAM

Client: The National Gallery of Ireland and the Office of Public Works
M&E: Building Design Partnership (BDP)
Architects: Heneghan Peng Architects
Conservation architects: Blackwood Associates
C&S: Michael Punch & Partners
QS: Aecom
Main contractor: John Paul Construction
Mechanical contractor: Winthrop Engineering

the roof of the gallery to 'pop-up' above the roof. The glazing required additional consideration because a lower floor-to-ceiling height made the solar gain more critical. This glazing was divided into two layers to form a twin-roof construction, with controlled natural ventilation in between to moderate the glass temperatures (See Figure 1).

A blind was fitted between the layers of glass and can close automatically if the lighting level measured within the gallery reaches a level at which paintings may be damaged. The BMS can close these blinds during extremely warm conditions, to reduce system loads.

A new location was required for the heating plant, combined heat and power (CHP) unit, ice banks, fire-suppression misting system and electrical switchgear. The plant could not be put on the building's roof so the decision was made to put it underground.

The plant room is hidden below the grass courtyard in front of the building (see main picture). It was possible to conceal some air vents in the vertical steps between the grass and the paving, while the two flues run 50m below the building to pick up a small, historic void leading to the roof.

Use of building information modelling (BIM) was essential because of the limited space available for services. The roof air handling plant is a case in point, with a virtual game of Twister played until a satisfactory plant room arrangement was achieved.

The roof plant room available was roughly half the size that would normally

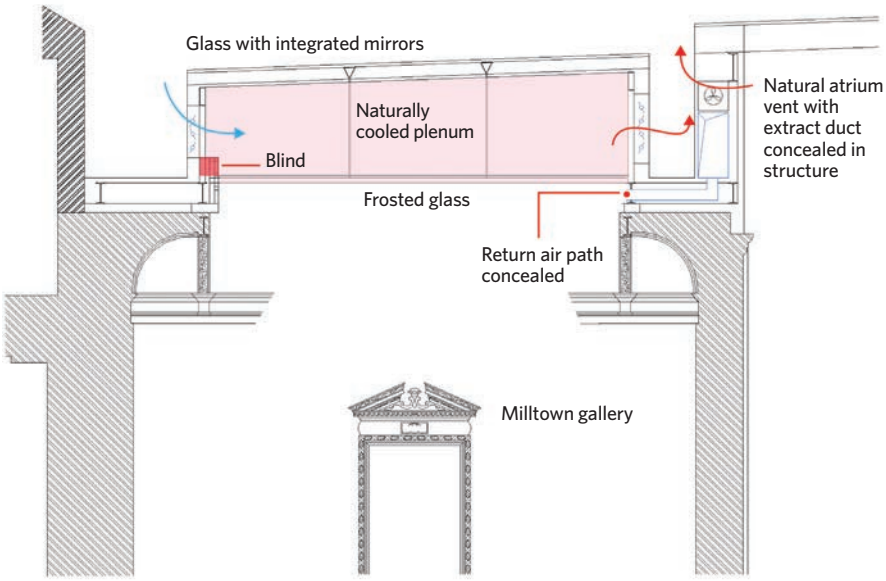


Figure 1: Milltown Gallery showing 'pop-up' roof and ventilation strategy

> "Burying the new supply ducts under the basement allowed the services to unfold and route directly below the galleries they served"

be considered, and there was a significant change of level in the middle. Space was made even tighter by the main duct riser also being in the centre. The change in levels and central riser were addressed by folding the ductwork back on itself to pick up zone-conditioning equipment before heading down the risers.

Once on site, the mechanical contractor, Winthrop Engineering, quickly realised that a Revit model would allow improved analysis of the spatial requirements of the services systems and so it modelled large sections of the building.

Distribution options

Horizontal distribution of services within the galleries was not possible, but a number of small, vertical distribution options were identified into which the supply ducts could be installed but with very little spare space. These included a void behind the stairs and a small recess where a window was once installed.

It was acceptable to form a new compact riser from the plant room to ground level, but not to exit the riser at any point within the building. The only logical option was to bury the new supply ducts under the building's basement. This allowed the services to unfold and route directly below each of the galleries that they served.

Duct runs from the air handling unit to terminal units were up to 90 metres long. In conjunction with the response time of the gallery, the time lag between the control action at the plant room and the controlled space needed careful consideration. Fine-tuning of the BMS proportional integral derivative (PID) loops was required to obtain optimum balance between stability and response.

The supply air to the Dargan Wing terminates largely behind the historic iron grilles placed under perimeter benching, which originally allowed heat from the traditional, exposed, cast-iron pipe heating system to enter the space. Discrete displacement grilles were fitted behind the historic ones, and the air distribution system is invisible to the visitor. In the Milltown Wing, new grilles have been installed in the original service voids in the ground-floor galleries, while floor grilles serve the first-floor galleries.

Finding routes for the air returning to the plant room was equally complex, as all the vertical risers had been filled with supply ductwork. »

Return air from the large galleries on the ground floor was allowed to flow up the stairwell and through the upper galleries. While this avoids return air ducts, it introduces complex airflow patterns in the upper gallery that had to be verified in a detailed computational fluid dynamics (CFD) study.

Return air exits through existing openings in the ceiling decoration of the upper floor galleries, thereby avoiding the need for visible return grilles in most locations.

The main return air ductwork from the Dargan Wing was isolated from the plant room by a large glazed ceiling. The issue was how to incorporate ductwork across this space because even a hint of shadow crossing above the ceiling glazing would be unacceptable.

Many an exasperated engineer has suggested to an architect the only way to meet the criteria for invisible services distribution is to construct the services from glass. In the case of the National Gallery, it was decided this was the best solution, and a glass duct was installed that allows return air to be transferred back to the plant room without being seen from the galleries below.

While the use of specialist glazing, variable air volume (VAV) air control and an enhanced enthalpy-based, free-cooling routine were implemented, the provision of 24-hour/365-day close control remains an energy-intensive process. So it was critically important heat and cooling was carefully selected.

The close control of humidity and temperature within a historic gallery needs year-round heating and cooling, which are either simultaneous or alternating within a relatively short time period.

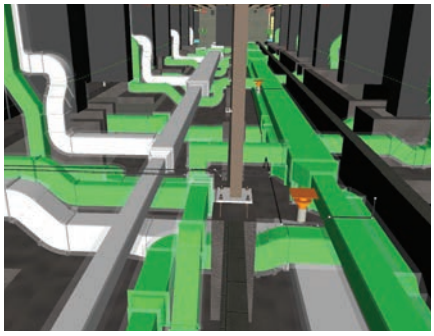
A four-pipe heat recovery chiller allows waste heat from the cooling process to be used to reduce heating demand, but it can also operate in air source heat pump mode when serving a heat load alone.

Combining the chiller with an ice bank generates ice during the night, while the heat from the refrigerant condenser can be used when it is more likely to be required, because of cooler temperatures at night. The ice bank also smooths the electrical demand on the grid, which is important in a country that has set a target to achieve 40% of its electricity from renewable energy sources by 2020.

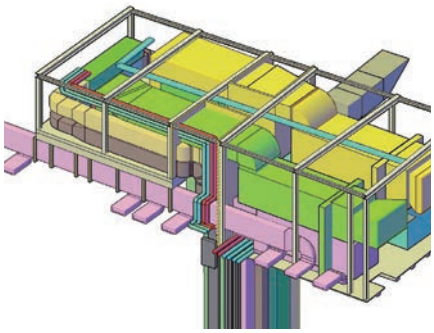
A 150kWe CHP system runs continuously and supplies the majority of heat for the refurbished galleries, with excess heat transferred to the adjacent Millennium Wing – existing galleries that did not form part of this project.

The system does not have a heat dump to remove any unwanted heat to the external air. Because galleries always have a de-humidification load, they have an all-year round reheat load that the CHP unit can serve if carefully sized.

The pop-up pod glazing of the Milltown Gallery needed special consideration



New supply ducts were buried in the basement



A BIM image of the uneven levels within the plantroom

> "The system does not have a heat dump but is sized so all of the heat from the CHP is used"

Monitoring has confirmed that all of the heat produced is used within the galleries for heating, hot water and reheat as a function of the dehumidification process.

The efficiency of the electrical grid in Ireland is improving and, as it does so, the environmental benefits of the CHP unit will decrease – but the environmental benefits of energy from the heat pump will increase. The systems in the gallery are designed to change priority from the CHP to the air source heat pump as this transition occurs.

Results

We have been monitoring the galleries remotely for nine months. It has revealed an excellent level of temperature and humidity control has been achieved in the historic galleries.

The CHP has proved to be appropriately sized, with all of its heat usefully employed with the unit running continuously. Roughly 20% of the heat available is transferred to the adjacent existing Millennium Wing, helping to reduce the environmental impact there.

Very occasionally the output from the CHP unit dropped to about 80% of its maximum output when there was a control problem with the valve that sends excess heat to the Millennium Wing but it is clear from monitoring through a winter and summer condition that the gallery provides a meaningful load for the heat, all year round.

The Baroque room

"Visitors will be almost unaware of the intricate servicing system providing close control to the galleries"

For the first few months the contractor had set the CHP unit up to only run during the day but having spotted that we got it running 24 hours a day and then checked that the heat was still used during the night.

It wasn't a surprise that all the heat was used as we had good data for the heat loads in the Millennium Wing before starting the design. This gave us an insight into what the additional loads in the refurbishment were likely to be (along with our simulations).

A visitor to the galleries will be almost unaware of the intricate servicing system providing close control to the galleries, with most of the equipment buried under the building and threaded through its structure. They can focus on the art, while the engineer takes care of the hidden services. **CJ**

CHRIS CROLY is building services engineering director at BDP

ENHANCED CONTROL

Galleries are traditionally controlled by a single sensor in each space, which can lead to local variations in conditions. These variations are normally minimised by supplying airflow rates that are much larger than required, continuously for the majority of the year. This over-provision of air is very costly from an energy and environmental perspective, but this is of secondary importance when control of environmental conditions is so vital.

In a historic building with voluminous spaces and large areas of glazing, local variations in conditions are expected to be more severe than in a purpose-built facility. An array of sensors was placed in each space and a bespoke control routine was developed to ensure they kept within range while minimising the air volumes. This reduced dramatically the fan energy required.

The control routine adjusts the temperature and humidity to maintain the centre-point condition (the midpoint of the highest and lowest sensor reading, not the average) at the required set point, then adjusts the air volume to control the bandwidth between these points at the condition limits. This method uses the minimum airflow possible to ensure all points are maintained within the acceptable band. A pressure-independent variable air volume system is then used to limit fan energy by minimising air volumes and fan pressures.

Several of the galleries are particularly tall to accommodate very large paintings, so sensors were also placed at high level, to monitor stratification and ensure the paintings are not subjected to significant variations in condition with height. With more sensors, there is a higher potential for them to fail or go out of range, or to be located in the wrong position for the hanging of a painting in a temporary exhibit. So a 'hot swap' solution allows a sensor to be unplugged for recalibration or replacement. The controls system will automatically detect that a sensor has been removed and adjust to compensate.

The sensors consist of probes mounted within wall pockets and measure an accurate air condition without any influence from the historic structure. It was important that the sensors were not visually intrusive and that the mechanism used to secure them was not visible. A bespoke solution used magnets to secure the face plates invisibly.

BIM ABOUT THE HOUSE

After spending a considerable sum of money on his new home in 2015, BRE's **Dan Rossiter** was shocked to be handed a set of disparate pieces of paper as the sum of available information. Wanting a better process, he looked towards BIM Level 2

When people ask me what I do, I tell them I am a communicator. I develop and deliver building information modelling (BIM) education material for BRE; participate in research projects around competency with Cardiff University; and champion awareness and upskilling within the UK BIM Alliance. Put simply, my role is to turn technical jargon into engaging, plain language. However, I had never actually put it into practice.

Don't misunderstand – I'm no novice. Before joining BRE, I acted as client and lead designer for Cardiff city council, where I created 3D graphical models to produce drawings, room data sheets and specifications. However, none of it was technically BIM.

So I wanted to produce BIM Level 2-compliant information to prove I had the skills and capability to practise what I preach. At the same time, I had just bought a new home that I needed to manage. As if struck by lightning, an idea came to my mind; why don't I model my own home to BIM Level 2?

This appeared to be a challenge at first. After all, industry case studies are based on large prisons, listed libraries and new builds. Could BIM Level 2 even work for a two-up, two-down terrace in South Wales? The answer, of course, is yes. After all, BIM is just the effective use of structured information to produce and manage asset information – and that is what I needed for my home.

So, as with any project, I started with a brief. I formed my employer's information requirements (EIR) – what I wanted to know and how I wanted it formatted. To do this, I had to think about model purposes, to register what is in my home and what information I needed to repair or replace elements.

Based on these purposes, I then considered what information I needed to satisfy them. This meant my EIR was lean, and only asked for what I needed to manage my home. Then, before I modelled a single object, I planned my approach with my own BIM Execution Plan.

Abraham Lincoln once said: 'Give me six hours to chop down a tree and I will spend the first four sharpening the axe.' These are wise words that I followed; after all, I wasn't getting paid for this – it was being done out of hours, using up my precious evenings and weekends, so what I did had to be right first time.

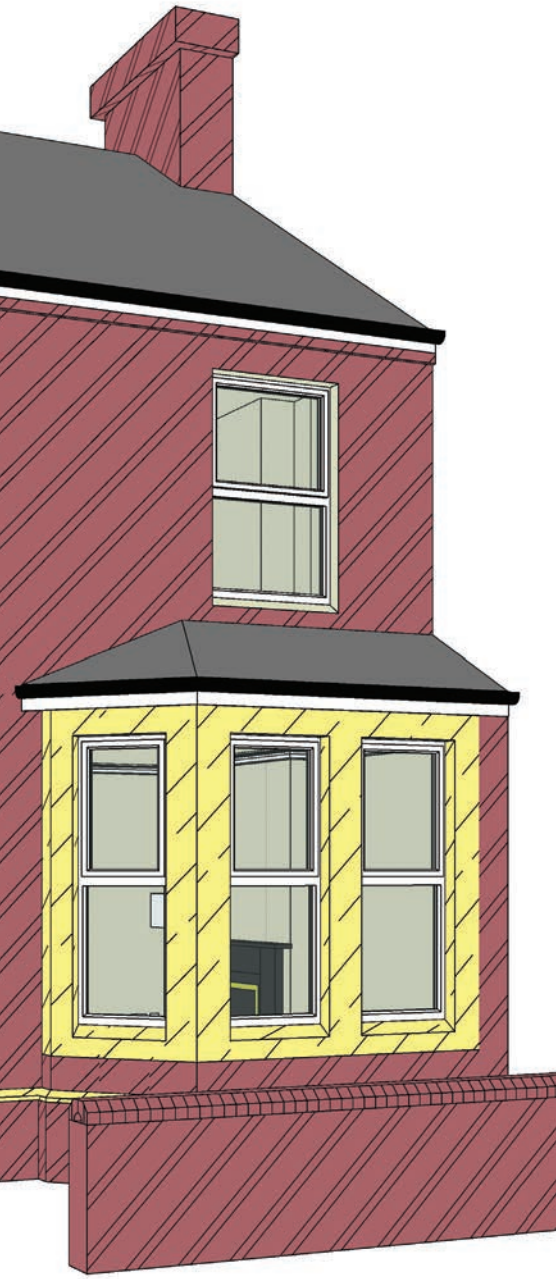
How did I do it? I followed the national standards, but there were several challenges in that.

Graphical model

Because of my naivety, I encountered several obstacles to producing my graphical model – the first being that my house isn't straight. Surprisingly, a terrace built more than 100 years ago doesn't have perfectly straight walls and right angles. This made modelling my home in a cold, harsh, virtual environment difficult.

In my BIM Execution Plan, I had given myself a tolerance of +/-5mm – which helped – but there are certain issues that tolerance alone cannot overcome. Take my front elevation, for example. I did what any good surveyor would and counted the brick courses. However, it transpired that, within the brickwork, I had a 'pig' – the brick courses on one side of my door did not align with the other. This meant my measurements were 75mm out because I was counting the wrong side.

The benefit of creating this model is that I now have accurate geometry that could be used for several additional purposes. For example, it is possible to walk around my home in virtual reality thanks to VIMtrek,



which has made my home into a virtual environment on the Samsung Gear.

In addition, 360º views are available on the blog, so anyone can experience my living room and attic for themselves. Just imagine how this technology could revolutionise the home buyer's market if you could experience a potential new home without leaving the comfort of your current one.

Non-graphical information

Another challenge I had was structuring information so I could export it into IFC – an open file format – to create Excel COBie files in compliance with PAS 1192-2 & BS 1192-4.

Producing the graphical model was easy: populating it with good information, however, was a challenge. In the first instance, some properties needed to be named following a specific convention, which meant a lot of model and object configuration. But limitations in the software meant some of these properties had to be addressed through bespoke mapping workflows.

Support information wasn't easy to come by and – in order to export as much COBie information as possible – I had to reverse-engineer programming code to determine which properties could be used, and which would take priority over another. In addition, there are rules on what values are permitted within COBie fields, as outlined within the United States National BIM Standard. For example, all my date information had to be formatted as YYYY-MM-DDTHH:MM:SS

> "This technology could revolutionise the home buyer's market if you could experience a potential new home without leaving your current one"

The advantage of this non-graphical information is that I now have all the maintenance information for my home structured in a consistent format. Because of the level of discipline needed, I also have incredibly compact model files.

After their export into IFC, all the graphical and non-graphical information about my home takes up less room on my phone than 'Brit pop' band Blur's *Coffee and TV* MP3 file.

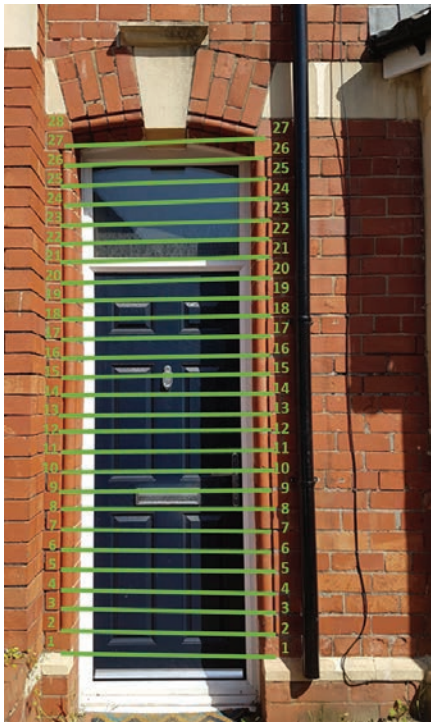
Documentation

Another challenge for me was that – because I have done this work for myself – I have no office standards, methods and procedures to follow. As such, I have had to rely on national ones.

The advantage of this is that I have exposed myself to dozens of standards I never knew existed, including: room number (ISO 4157-2); drawing borders (ISO 5457); title blocks (ISO 7200); and CAD fonts (ISO 3098).

I have managed to produce a full set of BIM Level 2 graphical models, non-graphical information and documentation about my home.

Some people might say that BIM only applies to new-build or central-government projects, but – to be perfectly honest – there really is no BIM like home. **CJ**



The brick courses on the house did not align

Rossiter's blog, There's No BIM Like Home – from where his BIM Level 2 graphical models, non-graphical information and documentation can be downloaded – is at **www.bimblog.house**

DAN ROSSITER is a chartered architectural technologist and senior BIM communicator at BRE

CAPACITY FOR CHANGE

The cost of supplying energy at peak times can result in large customer bills – but engineers can help clients understand their energy use better and avoid unnecessary charges, says Energy Check's **David Winton**

When considering a building's energy use, it is also important to think about the type of energy contract that the end user will be signing up to. Energy costs can be almost three times higher between 4pm and 7pm than at other times of the day, and some nasty surprises can be hidden in the monthly bills.

There are many different contracts available to customers, but this article will look at just two and concentrate on one.

The first is a fixed contract, which is basically a set unit rate that incorporates all wholesale, retail, non-commodity costs – and, of course, the supplier takes the risk of prices fluctuating. This contract type can hide issues and limit opportunities to make big savings.

A pass-through contract, however, breaks down all of these costs, so the customer knows exactly what they are being charged for each element. This enables them to take steps to reduce these outgoings. Depending on suppliers' product offerings, clients on a half-hourly meter can get a pass-through contract instead of a fixed one. Some customers like to get a fixed rate, however, because it avoids the risk of increasing charges – whereas a pass-through contract will just 'pass through' those charges at the current rates.

4-7pm

Costs can be almost three times higher between 4pm and 7pm than at other times of the day

Pass-through charges

With a pass-through contract, all non-commodity charges are itemised and passed through to the customer at cost and based upon their use. These charges include:

- Distribution use of system (DUoS)
- Transmission network use of system (TNUos)
- Balancing services use of system (BSUoS)
- Renewable obligation
- Feed-in Tariff
- Climate change levy
- Capacity market charges
- Contract for difference charges.

This article will focus on DUoS, TNUos and capacity-market charges.

DUoS

Distribution use of system charges are applied to customers' energy contracts to recover the costs incurred by distribution network operators' (DNOs) in maintaining the network. These include standing charge, capacity charge, and time-band charges – red, amber and green.

Standing charge

This is applied to recover the costs associated with supplying electricity (or gas) to a property.

Capacity charge

Based on the supply capacity – measured in kilovolt amperes (kVA) – that the customer is allocated for their connection from the substation. For more than 50% of customers we deal with, the allocated capacity is more than 20% higher than their peak demand over the previous 12-24 months. The capacity charges are dictated by the DNOs and are affected by location. Generally, costs are between 2.5p/kVA and 4p/kVA per day.

Time-band charges – red, amber and green

The aim of these charges is to restrict peak-time usage of half-hourly industrial and commercial customers. By charging an increased rate during certain time bands, customers are encouraged to reduce their energy consumption during these periods. Time bands are dictated by DNOs and the associated rates can vary, with typical examples below:

Time-bands

Period	Typical time bands	Typical rates
Green	11pm - 7am	0.005p/kWh to 1.05p/kWh
Amber	7am - 4pm & 7.30pm - 1pm	0.2p/kWh to 1.6p/kWh
Red	4pm - 7.30pm	4p/kWh to 11.5p/kWh

TNUoS charges

End users are subject to transmission network use of system charges to recover the costs associated with installing, operating and maintaining the National Grid transmission network.

TNUoS is billed using 'triads' – three half-hour periods during winter when demand on the UK's transmission network is at its highest. Triads are calculated using a fairly complex methodology stipulated in the Connection and Use of System Code (CUSC), and are derived from a forecast of how much it will cost National Grid to maintain local networks, based on demand in that particular area.

Triads generally fall between the hours of 4pm and 7pm (red band), from November to February. The charges are calculated on a £/kW basis in April every year, using the customer's average maximum demand across the three triad periods – and, again, the charges vary by location. They are anticipated to increase over the coming years (See Table 1 below).

> "Forecasting building energy use isn't easy as there are so many variables that can affect consumption"

Capacity-market charges

These are added to end-users' bills to mitigate the cost of providing electrical capacity to cover any shortfall in demand during peak periods. This ensures that a generation source not normally used because of high costs or inefficiencies could be called upon to supply power to the National Grid when required.

Currently, these charges are minimal, but they are forecast to increase sharply because of the number of projects that are likely to be approved for construction and implementation. The costs will rise quickly initially, and then gradually increase over the longer term. Energy company Smartest Energy expects customer charges to be in the region of 11p/kWh, charged on all kWhs used between 4pm and 7pm during the months of November to February.

Energy costs

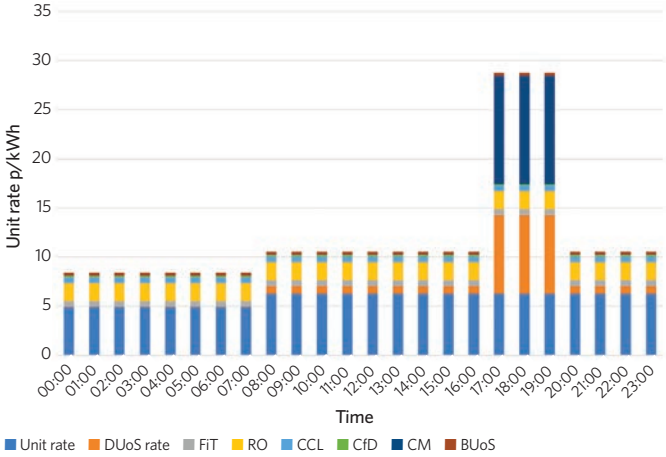
Taking all of these aspects into account, we can plot a typical customer's potential energy costs for a day in December 2018. »

Table 1

Zone	Zone name	2016/17 (£/kW)	2017/18 (£/kW)	2018/19 (£/kW)	2019/20 (£/kW)
1	Northern Scotland	29.79	18.67	21.34	26.65
2	Southern Scotland	31.84	20.42	23.73	29.23
3	Northern	36.29	32.79	37.66	41.56
4	North West	40.09	39.68	44.02	49.35
5	Yorkshire	40.48	40.16	44.75	49.84
6	N Wales and Merseyside	39.99	42.25	46.60	52.21
7	East Midlands	43.35	43.74	48.71	53.82
8	Midlands	43.96	45.07	49.86	55.37
9	Eastern	45.68	45.97	50.39	55.38
10	South Wales	41.82	42.41	47.47	53.33
11	South East	48.41	48.93	53.78	58.89
12	London	51.25	51.76	56.49	61.83
13	Southern	49.11	49.71	55.22	60.26
14	South Western	48.38	49.09	54.70	61.15

Half-hour demand tariffs, forecast [National Grid]

Figure 1: Energy costs – typical day in December 2018

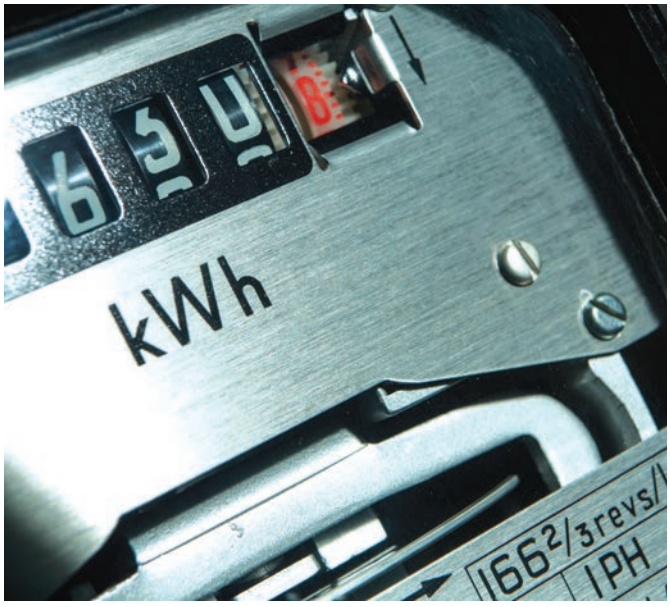


As can be seen from Figure 1, businesses face high costs for energy use during the hours of 4pm and 7pm. But this does not take into account the TNUoS charges, which are also based on consumption during these peak power-price hours.

Take the following scenarios for the South East of England, for instance:

1. Maximum demand during triads averages 600kW and will be charged at a rate of £53.78; there will be an annual TNUoS charge of £32,268
2. Max demand during triads averages 100kW and will be charged at a rate of £53.78; the annual TNUoS charge will be £5,378
3. Max demand during triads averages 0kW, at a rate of £53.78. There will be no annual TNUoS charge.

It is clear that there needs to be a concentrated effort to avoid energy use during these peak power-price hours.



There needs to be a concentrated effort to avoid energy use during peak power-price hours

What this means for building services engineers

Forecasting building energy use isn't easy, as there are so many variables that can affect consumption. After a construction project is completed, there needs to be support for the customer in understanding their use.

kVA capacity

Making a good assessment of a building's kVA capacity can lead to a more cost-effective connection and ensure the client is not being charged for capacity they will never use. Reference to similar buildings and recording actual data will help to keep costs to a minimum.

We recently looked at a stadium that had a capacity of 1,647kVA – but it never used more than 630kVA. Reducing the capacity to 800kVA would still leave it with 22% spare volume and would save the client £10,000 per year. Over the past 10-20 years, this represents 8% of their total electricity bill. Of course, customers may have plans to expand, and this should be taken into account when looking to reduce their capacity, as it can be very costly to get back. The DNO may allocate the capacity elsewhere and, if the customer wants to reinstate it, there may be a need for network upgrades.

Peak power-price hours

As outlined earlier, there is a huge difference in electricity prices between 4pm and 7pm, so there is scope for building services engineers to make a real difference to their customers' long-term operational expenditure. When specifying and designing systems, ask yourself some simple questions:

- Can time controls be used to switch off non-essential supplies/equipment during those hours?
- Can the running of systems be modelled and different timings trialled to seek the most cost-effective solution?
- If services can't be switched off for three hours, can they be used intermittently?
- Has the customer been advised about the impact of these peak power prices, and asked to consider this in understanding/forecasting how they intend to operate their building and processes?
- Is there technology that could help avoid these charges?

Technology that can help

There are simple measures you can take to help customers avoid the peak power-price hours. Many suppliers offer a free triad-alert service, which warns of the possibility of a triad period occurring – for example, a cold day in winter during the hours of 4pm and 7pm. These alerts can be given up to 24 hours in advance to encourage the facilities team to reduce energy consumption in the building.

General energy-efficient products – such as LED lighting and lighting controls – can reduce consumption during these hours, and thought should be given to renewable technology, such as solar photovoltaics (PVs) and/or combined heat and power (CHP) units.

Storage is becoming more financially viable, but a building with no space for a battery system will incur additional costs if one has to be installed post-completion. A battery-storage system could charge up during the night – when electricity is cheapest – and release its energy during the hours of 4pm and 7pm, to eliminate the need for grid electricity. This would help the customer avoid capacity-market, red-band and TNUoS charges. Some companies offer battery-storage systems under a 'power purchase' agreement for 15 years, so the client pays a lower rate for their energy during 4pm and 7pm and hedges against the risk of increased peak-power prices. CJ

DAVID WINTON is chief executive officer at The Energy Check

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BIO DEGRADE

Successful design of biomass boilers requires a systems approach, says **David Palmer**, who considers how factors such as oversizing, lack of thermal stores and poor flue-system design can cause boilers to underperform

There is a problem with biomass systems. Many stand abandoned in plantrooms, or are failing to produce the expected energy savings, according to a study of networks installed since 2009. Without remediation, those that have not been switched off already will underperform for the rest of their 20- to 25-year lifespan.

This article is based on the results of my inspection, analysis and rectification of 80kW-2MW biomass systems, installed in 150kW-8MW boiler houses in the UK and Ireland.[1] Many of the findings and some of the advice are equally applicable to combined heat and power (CHP) systems. Detailed analysis of 30 faulty boiler houses has identified why the biomass systems failed; the good news is that the performance of many can be improved.

88%

The possible seasonal efficiency a biomass boiler – irrespective of type – can achieve if a properly sized thermal store is incorporated into the system

Understanding biomass

Taking a systems approach is key to understanding biomass. Focusing on underperforming boilers as stand-alone entities – considering parameters such as load percentage, flow and return temperatures, and emissions – may allow quantification of a boiler's instantaneous performance, but it may do little to help identify why a boiler is not performing optimally.

A full understanding can be gained only by considering the system in which a boiler is installed – from boiler-house air inlets to the flue outlet; from fuel reception to fuel delivery into the boiler; and how a boiler system is integrated hydronically into the overall system, and controlled.

An analysis of how well a building's load profile is matched to a boiler and thermal store combination is also important in knowing why boilers underperform.[2] Taking measurements, analytical calculations, and system modelling are integral to understanding and quantifying the performance of biomass systems. Their successful design, whether for a new-build development or retrofit, also requires a systems approach. A high proportion of biomass set-ups appear to have simply been bolted on to a traditional boiler-house design – as if they were fossil-fuelled boilers – without the necessary understanding of the design and integration features required for a successful installation.

Key to knowing how well a boiler is hydronically integrated is to observe – and measure – temperatures and flow rates, before modelling »

An example of a biomass flue that is too short

» the boiler in its installed system (equally applicable to CHP systems). This approach allows reasons for underperformance to be determined, while identifying other shortcomings in boiler-house systems.

Most of the inspections of problem boiler systems have been carried out since the publication of CIBSE AM15, and have served to validate the advice and guidance in this publication – with one notable exception.

Chapter 7 of AM15 contains suggested hydronic system arrangements covering parallel-connected set-ups, followed by series-connected ones – and giving equal weight to each arrangement. In practice, and as a result of monitoring the performance of systems that I have designed – as well as of analysing underperforming systems – I have found that series connection of a biomass system in the main return header before any fossil-fuelled boilers should always be considered first (this also applies to CHP systems).

The successful implementation of series-connected systems requires a different understanding of how to connect boilers into boiler-house systems. Simple nodal analysis, or more extensive boiler-house modelling, must be used to identify the flow rates and temperatures needed to achieve maximum biomass heat injection into the return header.

Irrespective of whether boilers are designed to operate without a buffer vessel or thermal store, 27% of the boilers examined have been sized as if they were fossil-fuelled. This oversizing, together with the poor turndown ratio of most boilers, means they spend much of their operating time in slumber mode, or switched off, reducing their seasonal efficiency. Oversized boilers are usually too large to meet the lower loads encountered in spring, summer and autumn in any application that does not require 24-hour heating. For much of the year, the load on a building is no more than 30% of the winter peak load, so – with boiler turndown ratios of between 3:1 and 4:1 – a boiler sized on peak load will spend much of its operating life in slumber mode or switched off. Where no thermal store exists, retrofitting one will always produce an improvement in seasonal efficiency. If a boiler system without a thermal store had been sized by matching a load profile to a combination of a smaller boiler plus thermal store, much improved seasonal efficiency would have resulted.

> "Oversizing, together with the poor turndown ratio, means boilers spend much of their operating time in slumber mode, or switched off, reducing their seasonal efficiency"

Installing a thermal store

Irrespective of the type of biomass boiler, a properly sized thermal store will always achieve the highest possible seasonal efficiency – in practice, up to 88%. Similarly, the addition of a thermal store to a CHP system will result in a greater percentage of its heat being used – rather than dumped – improving the financial return on the system.

As much as 30% of the boilers examined had overheated. In some cases, the cause was the absence of a buffer vessel, or failure to arrange for heat to be removed from the boiler when it is entering slumber mode or switching off. In others, it was because of the absence of air-inlet ventilation louvres (two boiler houses), undersized air-inlet louvres, or because the flue system was designed incorrectly – again, failing to remove heat from the boiler.

Consistently, it was found that flue systems had not been designed to EN13384-1, and that design methods for gas boilers had been used. In 35% of systems, the vertical flue was much too short and, in some cases, the horizontal flue pipe was much too long. Singly or together, »

A boiler and undersized wood-pellet store

30%

Proportion of boilers examined that overheated. Often the cause was no buffer vessel, or failure to remove heat when the boiler entered slumber mode or switched off

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» these features result in too little draught being available to evacuate gases after boiler shutdown or in slumber mode, when the boiler's own flue fan has switched off or dropped to minimum speed. Biomass boilers – unlike fossil-fuelled ones – may continue to burn fuel for up to two hours after the last load demand, so the flue system has to continue supplying adequate draught in the absence of a contribution from the boiler fan.

Incorrectly designed flue systems are characterised by severe tar accumulation in the flue, significant particulate and tar deposition in the flue pipe, and creosote contamination of the flue condensate. Terminal fans installed to overcome inadequacies in the flue system caused boiler overheating or were completely ineffective. The absence of a draught stabiliser can contribute to overheating in windy conditions.

Where a flue system is found to be inadequate, there is no option but to rectify the deficiencies identified. However, depending on the biomass system geometry and building or planning constraints, this may not be possible. Some manufacturers provide free software based on the methods of EN13384-1 allowing reverse design checking of a flue system.

33%

The proportion of biomass boilers unable to deliver their full output

Many biomass systems had issues with fuel delivery, storage and extraction to the boiler. Fuel-storage problems included undersized fuel stores, structurally unsound fuel floors, the presence of hazardous spores on woodchip fuel, and unventilated stores. A lack of ventilation in wood-pellet stores can result in dangerous build-up of carbon monoxide (CO). The worst example of this was CO migration into the basement of a building, which required fire services to pump out the gas. This was remedied by installing continuous-extract ventilation.

The most significant and frequent finding for underperformance was directly attributable to parallel connection, which was the case for 50% of the boilers examined. Other hydronic issues affecting performance were present in 40% of systems, with 33% of boilers unable to deliver their full output.

In 23% of systems, seasonal efficiency was degraded by the selection of a boiler that is lit continuously, rather than opting for a fully automatic one. A boiler system that operates 24/7 is inconsistent with a load profile that demands heat for no more than 40 hours a week. **CJ**

The second article in this series will cover: issues surrounding the design and integration of biomass systems into boiler houses; insight gained by mathematical modelling of boiler houses; practicalities of system remediation; options for covering remediation costs; and measures to improve biomass system performance.

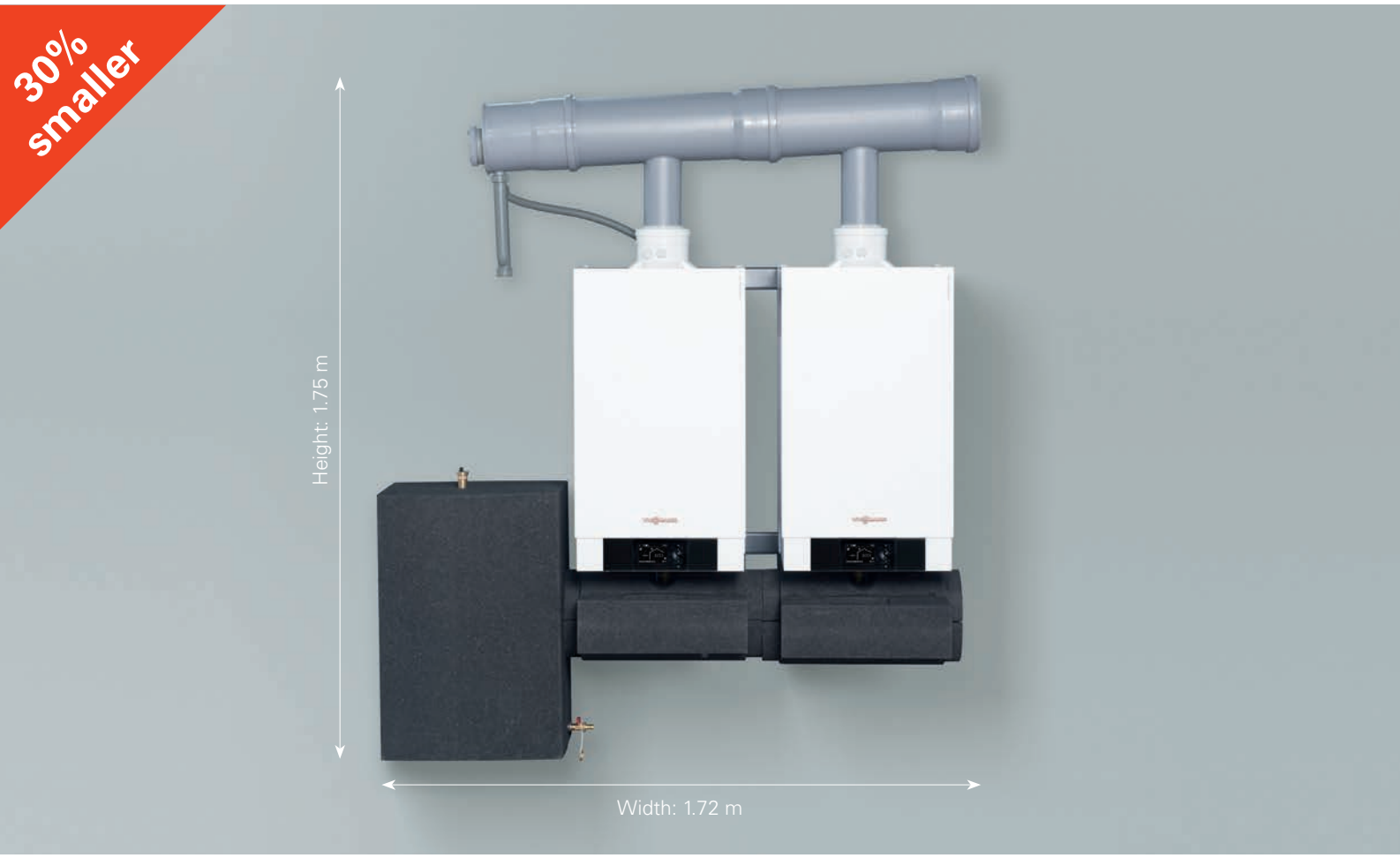
DAVID PALMER is a director at Campbell Palmer Partnership, and principal author of CIBSE AM15: *Biomass heating*

Notes

1. All references to boilers in this article are to biomass boilers.
2. The biomass decision support tool, available on the Carbon Trust website, was designed for this purpose.

"Incorrectly designed flue systems are characterised by severe tar accumulation in the flue and creosote contamination of the flue condensate"

New Vitodens 200-W cascade 30% smaller, 50 % faster



Fitting Viessmann commercial boilers has never been easier, thanks to the new Vitodens 200-W compact cascade system, which saves significant space within the plant room and halves installation time.

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New rules for ceiling panel thermal outputs

Standard ensures all parties use the same criteria to test, measure and present data

Revised standard EN 14037-5:2016 – introduced last November – aims to change how thermal output is measured for closed ceiling panels, grids or lay-ins.

When working with manufacturers, specifiers should make certain they are working to the new standard to ensure the correct outputs can be compared between manufacturers, on a like-for-like basis, according to Nigel Coston, technical, product and marketing director at Zehnder Group UK.

Heat outputs derived under EN 14037-5 *Free hanging heating and cooling surfaces for water with a temperature below 120°C. Open or closed heated ceiling surfaces. Test method for thermal output* will be lower than for predecessor EN 14037-2 (pre-fabricated ceiling mounted radiant panels for space heating) when the flow temperature is > 50°C, as a factor of 1.1 is used – for EN 14037-2 – in output values, said Coston. (See panel below).

Thermal output data is publicised by manufacturers as a primary indicator of product performance and also influences buying decisions. Specifiers look at this data to judge efficiency, reliability and cost-effectiveness. 'But because the new standard effectively decreases output figures, some manufacturers choose to continue following EN 14037-2, arguably to give themselves a favourable market advantage,' said Coston.

'This leads to products being judged on output data using different measurement criteria, meaning that buying decisions are based on inaccurate comparisons.'

Although a voluntary technical standardisation, adopting the standard will ensure comparable data across the industry. 'If a test standard is not stated, it is a fair assumption that outputs are not worth the paper they are written on and need validation,' said Coston.

Radiant panel heating ceiling at Douay Martyrs Catholic Secondary School, London

EN 14037-5 EXPLAINED

Developed by the European Manufacturers of Ceiling Panels, thermal output is stated in W·m^{-2} in EN 14037-5. The standard was preceded by EN 14037-2, introduced in February 2003, which states output as W·m^{-1} for free-hanging radiant ceiling panels.

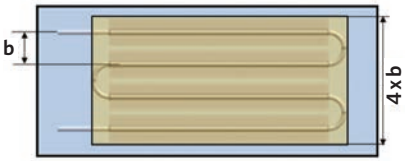
Both EN standards differ in how heat outputs are derived, based on calculating the panel area, which results in the output figures being lower when EN 14037-5 is adopted.

There are a number of steps to be taken when calculating output according to the new standard. First, the 'active surface' of a ceiling panel – or ceiling grid – needs to be determined, to give the necessary output information.

EN 14240 standard for closed ceiling cooling capacity considers the active length – namely the pipes and the heat exchanger strip between pipe end panel plate, for example the aluminium foil, whichever is longer. The active width is derived by multiplying the number of pipes by the spacing between each pipe (see diagram below). By adopting the active surface area defined in the EN 14240 standard, it allows for appropriate scaling for heating output to be accounted for.

This differs from the EN 14037-5 testing standard, which considers the active surface to be the whole module – or panel – area, when installed within a ceiling grid and would not provide the output of the active area.

The active surface is calculated by multiplying the active length by the active width.



What ErP means for radiant heaters

With the ErP Directive coming into force on 1 January 2018, all radiant tube heaters and tube heater systems will be required to have a minimum seasonal efficiency of 74%, and NO_x emissions of 200 mg·kWh^{-1} or less, based on gross calorific value. Seasonal efficiency is calculated from radiant efficiency, thermal efficiency and electrical power consumption.

These minimum criteria are applicable for both new installations and when replacing existing products.

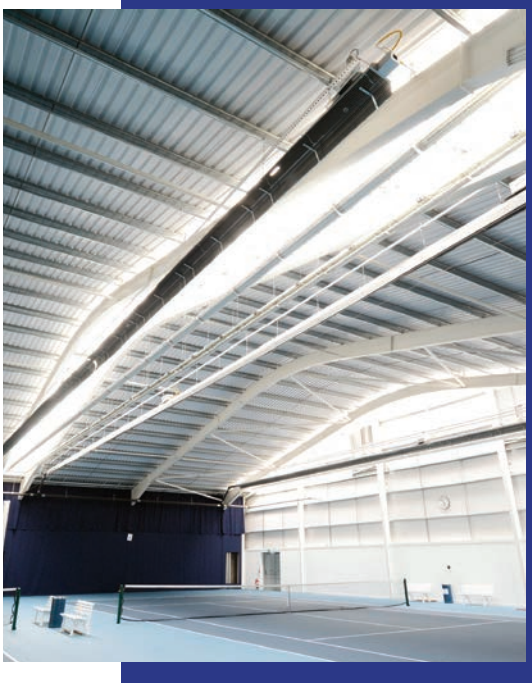
The Ecodesign regulation (EU) 2015/1188, along with the implementing Directive 2009/125/EC, is EU policy aimed at improving the energy efficiency and other environmental performance criteria for energy-related products (ErP), such as gas-fired overhead radiant tube heaters.

For this regulation, products have been divided into product groups, or 'lots', with gas-fired overhead radiant tube heaters, tube heater systems, and gas-fired luminous plaque heaters all contained within Lot 20.

Lot 20 gives the minimum energy efficiency and environmental values for each heating technology.

'Following the UK vote to leave the EU, all Ecodesign requirements will still have to be complied with because it could take up to two years to negotiate an exit,' said Daniel Wild, senior development engineer at Nortek Global HVAC. 'Even then, unless new legislation is introduced, ErP will continue to be a method for reducing the environmental impact of heating technology.'

Radiant tube heater at Edgbaston Priory Tennis Club in Birmingham



Guardian watches over hot water at Wellcome Trust HQ

The Wellcome Trust has monitored the low temperature hot water (LTHW) of its 10-storey headquarters in London using the Hevasure water-monitoring system.

Guardian Water Treatment – which has been involved at the Wellcome Trust through Optimum Group Services since 2016 – carried out the water maintenance.

Wellcome and Optimum decided to monitor the LTHW system in February 2017. The Hevasure system gathers real-time, continuous data on a range of parameters – from dissolved oxygen levels to pressure variables. The following is a snapshot of what was recorded over a six-week period, from 14 June to 31 July:

- Pressures remained positive at all times, but fluctuated more than is ideal so it was recommended that the expansion vessel be checked
- Conductivity measurements showed inhibitor levels were lower than recommended so these were topped up; a water sample was then taken for analysis
- Planned maintenance activities were carried out and could be identified by an increase in dissolved oxygen (DO)
- DO levels returned to acceptable levels quickly after works had been completed
- Corrosion rates of steel are very low, indicating that the chemical inhibitors are maintaining control.

Steven Booth, associate director for Guardian Water Treatment, said the readings showed a water system in good health, and added: 'By identifying the smallest of issues, larger problems can be avoided. Checking an expansion vessel and topping up inhibitor levels are quick-fix jobs.'

Continuous checking meant the end user had a complete overview of their system, reducing the need for expensive consultants to check water conditions. 'The risk of corrosion and subsequent breakdown is reduced dramatically,' said Booth.

'By having a proper understanding of the condition of a water system at any given point in time, potential issues can be caught before they become real problems, helping contractors and maintenance staff deal with the root cause.'

Regulations ensure only ultra-low NO_x products are manufactured in the UK

End of the line for Ideal boilers that do not meet ErP regulations

Ideal Commercial prepares customers for regulations

In preparation for the latest Energy-related Products (ErP) regulations coming into force, Ideal Commercial is discontinuing its standard-efficiency, pressure-jet oil- and blown-gas boilers with outputs of less than 400kW.

Under the 2015 ErP rules, such boilers are allowed to be sold without a burner as a replacement part, in a like-for-like scenario, but this will end on 31 December 2017. Any products placed on the market before this deadline can still be sold, however, and there is no change to ranges with outputs over 400kW.

As a result, Ideal Commercial's Falcon and Harrier ranges – plus one model from each of its Viceroy and Vanguard L ranges – will be discontinued. Customers will still be able to order replacement parts after the December deadline, however.

The aim of the new regulations is to ensure only energy-efficient, ultra-low-NO_x heating products are manufactured, specified and installed in the UK.

Darren Finley, chief commercial officer at Ideal Commercial Boilers, said: 'We want our customers to be prepared for the regulations. We're encouraging them to use this as an opportunity to explore newer technology.'

He added that it was also an opportunity to move away from older models, and introduce newer solutions that will not only minimise emissions, but also cut costs for the end user.

Bullet-proof district heating pipes raise the temperature

CPV has updated its range of district heating pipes to include reinforced options Hiline FibreFlex and FibreFlex Pro.

The manufacturer says the flexible, pre-insulated pipes – featuring reinforced polymer – can be used with operating temperatures and pressures experienced in traditional steel systems. CPV said the pipes would be suitable for constant temperatures up to 95°C with excursions up to 115°C.

The three flexible polymer service pipes now available feature a composite polymer service pipe encased in a layer of polyurethane-foam insulation, which is protected by a corrugated outer layer of low-density polyethylene.

The reinforced service pipe options incorporate an aramid mesh – a material used in bullet-proof vests – that enables systems to withstand higher temperatures and pressures than conventional networks. A reduced wall thickness also means there is more space for insulation.

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WHERE THERE'S A WHEEL, **THERE'S A WAY**

The thermal wheel is rising up the ranks of popularity as the cost of cross-plate heat exchangers and run-around coils increases, says Fläkt Woods' **Chris Jones**

Once the preserve of specialist applications because of their higher cost than traditional cross-plate heat exchangers or runaround coils, thermal wheels are becoming leading components of a trend towards heat recovery, following more stringent EU regulations.

The industry accounts for around 15% of the total energy consumption across the EU, so further changes to the Ecodesign Directive will be introduced from January 2018, which will see higher efficiency requirements for energy-related products (ErP).

Initially adopted by the EU in 2009, the Ecodesign Directive 2009/125/EC applies to energy-related products sold in the domestic, commercial and industrial sectors in the European Economic Area.

The directive involves dozens of product groups, called 'lots'. Last year, a requirement was introduced – in accordance with Lot 6 – for all ventilation units with two directions of airflow to have a heat recovery system.

The minimum levels of efficiency in energy recovery were also increased. From January 2018, to obtain a CE mark and be legally sold, ventilation units in the EU market will need to achieve even higher efficiencies.

Historically, the cross-plate heat exchanger was a popular choice because it was a relatively low-cost solution, but this advantage has since been lost in the drive for higher efficiency.

To meet the ErP requirements both now and in the future, cross-plate heat exchangers have had to become more efficient.

The ErP regulation applies to air-handling units (AHUs) used in existing buildings, as well as new-build projects. Any replacement cross-plate heat exchanger AHU would need a plate of a minimum 73% efficiency when the new legislation comes into effect. This would require a lot more space than an existing unit, which is likely to have a heat-recovery efficiency of around 50% in line with the Part L regulations set in 2013; so replacement AHUs may not fit into their current spaces.

The cost of run-around coils has also increased, with design and manufacturing changes again being required to improve efficiencies in line with ErP regulations.

Previously, run-around coils offered only 45% efficiency, but upcoming ErP changes require these systems to increase their minimum thermal efficiency to 68%.

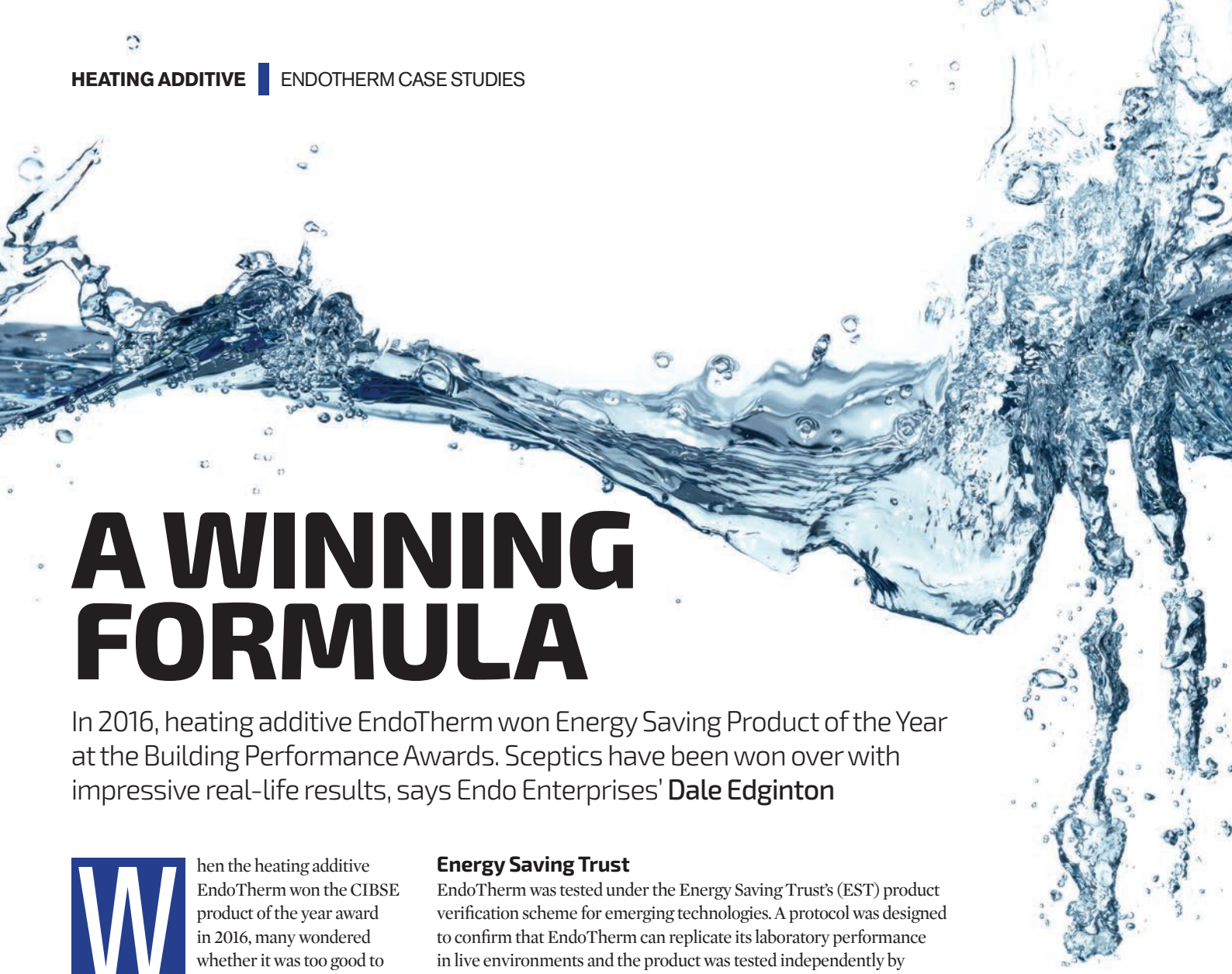
In comparison, the thermal wheel efficiency required by Part L 2013 was 65%, so meeting the new ErP requirement of 73% has resulted in a much smaller – if any –increase in unit costs because, typically, wheels are more than 70% efficient.

Historically, contamination was a concern with thermal wheels because the recirculation of air could lead to a build-up of odours and an unhealthy indoor environment, particularly in offices, healthcare facilities and schools. However, advances in manufacturing methods have reduced this risk. For example, thermal wheels with a molecular sieve coating limit adsorption to particles smaller than around 3 angstrom (Å). As water vapour has a kinetic diameter of 2.65Å, it is strongly attracted to a 3Å transfer media.

Practically all substances regarded as contaminants in the air-handling context are larger than 3Å, meaning they pass through the heat exchanger and are carried away with the exhaust air. Thermal wheels offer high efficiency and versatility, and have become a financially viable option for both standard and hygiene applications. **CJ**

Thermal wheels with a molecular sieve coating limit adsorption to particles smaller than around 3Å

CHRIS JONES is product manager at Fläkt Woods



A WINNING FORMULA

In 2016, heating additive EndoTherm won Energy Saving Product of the Year at the Building Performance Awards. Sceptics have been won over with impressive real-life results, says Endo Enterprises' **Dale Edginton**

When the heating additive EndoTherm won the CIBSE product of the year award in 2016, many wondered whether it was too good to be true. The claim was that when used in a wet heating system it could improve performance by up to 15%. Despite EndoTherm mirroring these performance claims in independent testing before its 2014 launch, many regarded it as snake oil.

EndoTherm works by reducing the surface tension of water by 60%. A liquid with a reduced surface tension has a lower contact angle and improves the thermal contact area (sometimes known as the wetted perimeter) on the inside of system materials.

Wet heating systems dosed with 1% of EndoTherm will experience an improvement in system efficiency of 5-8%. This can be up to 15% in systems using condensing or modulating boilers. (See Panel 'How it works'). Not all systems will save the same amount because of the many differing variables between buildings and their heating systems.

Endo overcame suspicion by allowing customers to pay only if the product made savings. Over the last four years, EndoTherm has been installed in more than 10,000 buildings, across 15 countries. It now has more than 200 commercial case studies supporting its claims. Here are some of them:

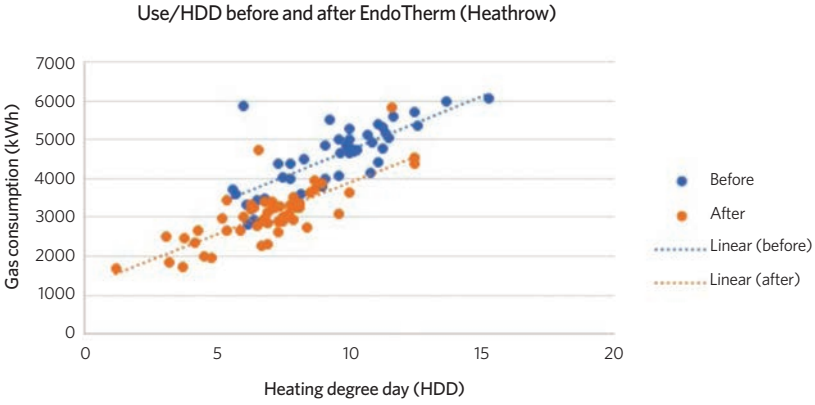
Energy Saving Trust

EndoTherm was tested under the Energy Saving Trust's (EST) product verification scheme for emerging technologies. A protocol was designed to confirm that EndoTherm can replicate its laboratory performance in live environments and the product was tested independently by consultants Atega at Fanhuelog Sheltered Accommodation Scheme, in South Wales, operated by Trivallis Housing Association.

Remote monitoring was installed at sites with a similar occupancy. Thirty-second readings were taken for internal temperature, external temperature, system flow/return temperatures and gas consumption over a 12-month period.

All sites were powerflushed and control sites were redosed without EndoTherm and compared with sites where EndoTherm had been installed. Over a six-month period, sites with EndoTherm saved 21.34% on average. The control sites, after only being power flushed, saved 7.35%. The subsequent savings of systems with EndoTherm was 13.99%.

EndoTherm is the first technology of its kind to be recognised by the Energy Saving Trust as a heating additive.



HOW IT WORKS

Savings from EndoTherm manifest themselves in a number of ways:

Systems heat up quicker
The inclusion of EndoTherm reduces the impact of steam bubbles restricting heat transfer in nucleated boiling sites, so allowing water to heat up quicker.

Nucleated boiling
The improvement in thermal contact area effectively increases the size of the emitter, improving heat transfer efficiency. EndoTherm-dosed systems reach the thermostatically set temperature quicker, which ultimately reduces the boiler operation time for each cycle.

Extended heat retention
Testing on EndoTherm dosed systems shows they cool down over a longer time period, increasing the time between cycles and reducing the number of cycles over a given time period.

The improvement in heat transfer continues when the boiler is off or on low power. The heat continues to transfer into the room more efficiently, maintaining the desired temperature band over a longer time period.

Increase in the ΔT or flow/return of the bulk water
The increase in heat loss from the system emitters reduces the temperature of the bulk water as it returns back to the boiler. This creates a larger ΔT within the system. This cooler return allows modern boilers to condensate more and recover more latent heat from the water, reducing the workload of the boiler to heat the water back up. EndoTherm does not improve boiler efficiency; it provides conditions that allow them to operate more efficiently. In condensing boilers this will manifest itself in a reduction in flue gas temperatures.

Sainsbury's

Sainsbury's became aware of EndoTherm following the CIBSE award win. After initial technical discussions, Sainsbury's decided to trial EndoTherm in its biomass fleet because the boilers have considerable quantities of instrumentation to measure accurately any efficiency gains. It is worth noting that non-modulating biomass systems will not be affected by reduced cycle times, so the expected saving in these systems is 5-8%.

Trials were done initially on four stores using a seven-day before and after comparison to ensure similar trading and climatic patterns. These averaged a 5% improvement in fuel use with a range of 2-14%. It was also noticeable that flue temperature reduced, with systems featuring the largest reductions in flue temperature also having the greatest efficiency improvements. The assessed payback was slightly more than 12 months.

Subsequently, Sainsbury's has rolled out EndoTherm to all its biomass boilers and monitored performance through February and March. The result seen in the original four-store trial has been replicated in the roll-out, with a 5% improvement in fuel efficiency (73-78%) with a similar range across boilers. Performance was assessed between 2016 and 2017.

Innovation Gateway – 2Degrees (Royal Bank of Scotland/Heathrow Airport)

EndoTherm joined the Innovation Gateway in October 2015 as part of the Bristol Go Green Challenge. EndoTherm was subsequently trialled in three bank branches in the Bristol area over a 12-month period.

As part of the trial protocol, each branch was powerflushed during the installation. No other changes were made. Monthly gas meter readings were compared with the same time period in the previous year. The average improvement was 29.25%, saving a total of £1,500 and more than 10 tonnes of CO_2.

EndoTherm was then trialled by another Innovation Gateway member, Heathrow Airport. The trial took place at the airport's engineering compound using methodologies set out by the International Performance, Measurement and Verification Protocol (IPMVP).

The two-month trial, comparing use immediately before and after installation, identified a saving of 20.1%. This is a saving of £955 or 7.4 tonnes of CO_2.

Emcor UK (United Utilities)

EndoTherm was introduced to Emcor UK and a trial was set up at the security centre of the United Utilities headquarters in Lingley Mere, Warrington. After three months, the trial was proving a success and more buildings were dosed. After six months, the entire site had been dosed with EndoTherm.

After 10 months, the performance of the site was reviewed and showed an average improvement of 15.51%. This was a cumulative saving of £10,896 and the carbon dioxide saving was 99 tonnes. Emcor UK has 351 further sites where EndoTherm could be used.

What's next?

EndoTherm is continuing to engage with national bodies to validate findings and build confidence around the technology.

This year also saw the launch of EndoCool for chilled water systems, which has achieved excellent early trial results. We will continue to develop this new product sector. CJ

Dale Edginton is product manager at Endo Enterprises

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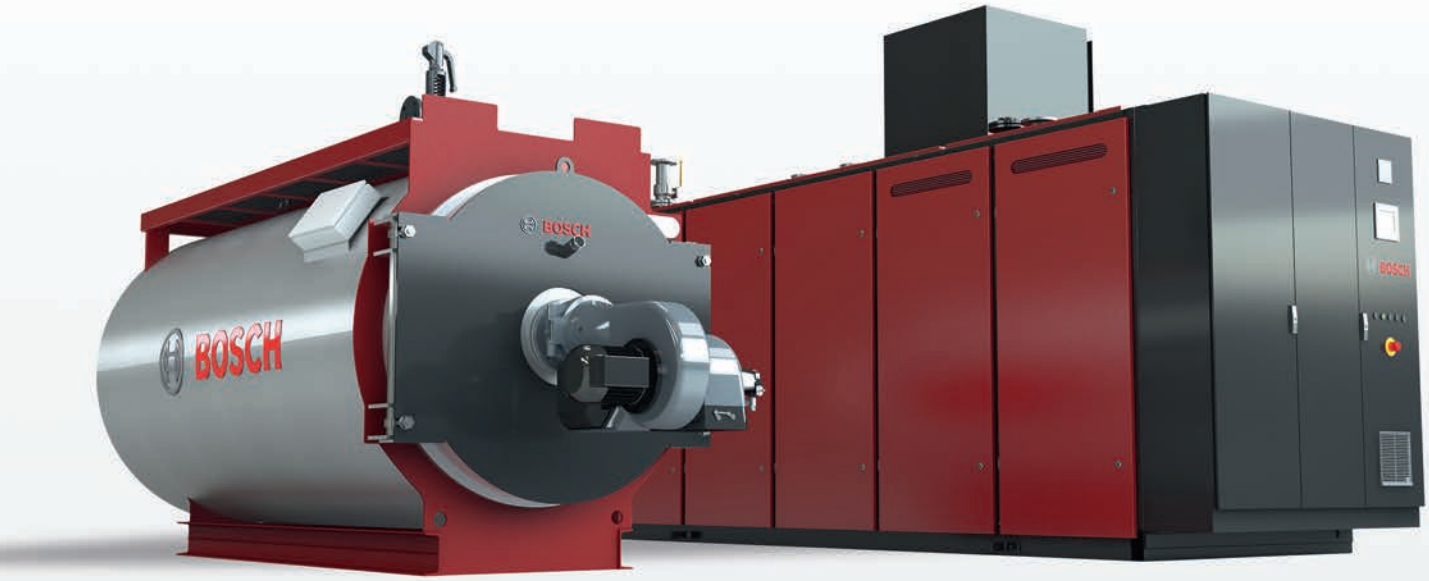

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SET GREAT STORE BY

Ensuring the correct size of thermal storage in a CHP system is vital, if the system is to achieve optimum performance, says Elco's **David Sadler-Smith**

The benefits of combined heat and power (CHP) are well documented: reduced carbon footprint, increased efficiency and lower running costs. Plus, it provides organisations with more control over future energy usage.

However, the cost of installing a CHP unit is significant. Even at a commercial level – up to 50kW –the investment requires careful consideration for any organisation, where the long-term savings must justify the capital expenditure. Consequently, it is imperative the design and installation of the technology take into account all approved industry guidance, such as CIBSE's *AM12 Combined Heat and Power for Buildings*, as well as the specific advice on offer from well-established manufacturers.

This measured approach is particularly important when using CHP alongside gas condensing boilers. Such a set-up is commonplace, given there is always a need for inherent backup for scheduled maintenance or an unexpected breakdown. So, the first consideration for any application is to identify whether the property requires a power-led or heat-led (thermal) CHP installation. For the vast majority of CHP commercial applications in the UK, such as nursing homes, leisure facilities or hotels, it is necessary to maximise efficiency when supplying heating and hot water. This is defined as a heat-led system.

A heat-led system design should aim to use 100% of the heat generated. This maximises efficiency levels and cost savings by avoiding unnecessary wastage. Achieving this balance requires a CHP module to be sized correctly – and this is where mistakes can be made.

14-17 hours

The correct approach for any heat-led CHP system is to target a running time of 14-17 hours per day (as highlighted in AM12)

Unfortunately, there are likely to be plenty of applications where CHP units have been sized incorrectly, or specified to 'tick a box' for Part L compliance, rather than deliver an effective long-term strategy.

As a result, backup boilers are often left to 'pick up' the load, causing the CHP unit to be taken out of the heating equation altogether. The correct approach for any heat-led CHP system is to target a running time of 14-17 hours per day (as highlighted in AM12).

To achieve the required run time, a reasonable rule of thumb when sizing a CHP unit is to deliver around 20-30% of the design thermal load. This allows a module to run effectively during the summer months, when the heating load can drop to as low as 15-20% of the total design load. However, there are limitations with this method and a more thorough approach is needed to establish the daily load profile of the building first, as it will always define the specific heating requirements.

For refurbishment projects, these requirements can be easily obtained from existing monitoring systems, such as BEMS, energy bills, meter readings or on-site audits. For new builds, previous data from similar buildings will still give a good starting point. The completed information is used to calculate the site's base heating load profile, showing a regular pattern on a half-hourly, daily, weekly and monthly basis – and the more accurate the data, the more accurate the CHP sizing.

If a CHP unit is too big, there are likely to be long periods when it could stand idle, wasting capital

expenditure. By contrast, if a unit is too small, the technology's potential will be underused, requiring back-up boilers to supplement the load.

Sizing thermal stores correctly

Another critical aspect of a CHP system is the selection and sizing of buffer vessels and thermal stores. At this stage, it might be useful to clarify these two products. A buffer vessel offers some thermal storage but is principally designed to give a buffer effect between the CHP and the heating system. This protects the CHP unit from switching off prematurely because of short-term increases in return temperature.

Thermal stores are designed to hold excess heat produced by the CHP when the building's heat demand is insufficient. Installed between the flow and return circuits, while remaining full of water at all times, this reservoir of heat can be called upon when the building's heat demand increases. Typically, a thermal store is far larger than a buffer vessel and often incorporates its functions within it.

For this reason, a large thermal store is becoming more common, with the purpose of giving a CHP module the opportunity to achieve optimum running conditions. Figure 1 shows how a typical daily load profile can be satisfied by a relatively low-power CHP unit.

However, when the domestic hot water load is adapted so a CHP module runs for the recommended 14-17 hours per day, there is inevitably a disparity between the actual load and the unit's thermal output (see figure 2).

To alleviate this, the load profile needs to be 'smoothed' and allow for continuous CHP operation. Consequently, a large, stored volume of primary water (thermal store) is required to allow the CHP to discharge hot water during low system demand. This stored volume also supplements CHP output when there are peaks in demand.

From this example, it is clear to see how sizing a thermal store correctly introduces several benefits. First, it allows heat demands greater than the maximum output of the CHP to be met by using the heat stored from the CHP unit. This reduces the use of boilers and increases CHP running hours. Second, it enables heat demands lower than the minimum turndown to be met; once again, reducing the use of boilers and increasing CHP running times. A major benefit of both is that a CHP unit can operate at full output rather than at part-load conditions – improving efficiency and reducing operating costs.

When it comes to sizing a thermal store, remember - the 'standard' model supplied by a manufacturer is not always compatible with a well-conceived system design. Instead, the annual usage of a building needs to be considered, and an hour-by-hour operating model constructed. At this stage, it is often prudent to speak to the specified manufacturer to ensure the CHP and thermal store size are in alignment.

The Association of Decentralised Energy (ADE)[1] recently outlined that Britain is at risk of missing out on savings of £750m a year by ignoring CHP technology. It also highlighted the potential of CHP when it comes to energy (heat) production. Furthermore, it also helps explain why so many UK projects are looking to the technology to save on costs and reduce carbon footprint.

Of course, all of this potential can be wasted and lost if a system is not designed correctly from the outset. Maximising CHP running time, correctly sizing the unit and matching it with a suitable thermal store are all essential areas that must be considered from the outset. Only then can an organisation make true use of CHP's potential and reap the long-term benefits on offer. **CJ**

> "Unfortunately, there are likely to be plenty of applications where CHP units have been sized incorrectly, or specified to 'tick a box' for Part L compliance, rather than deliver an effective long-term strategy"

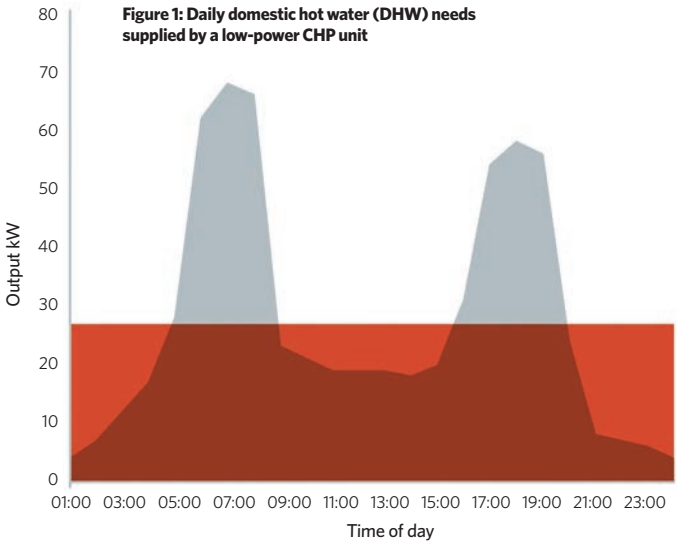

Figure 1: Daily domestic hot water (DHW) needs supplied by a low-power CHP unit

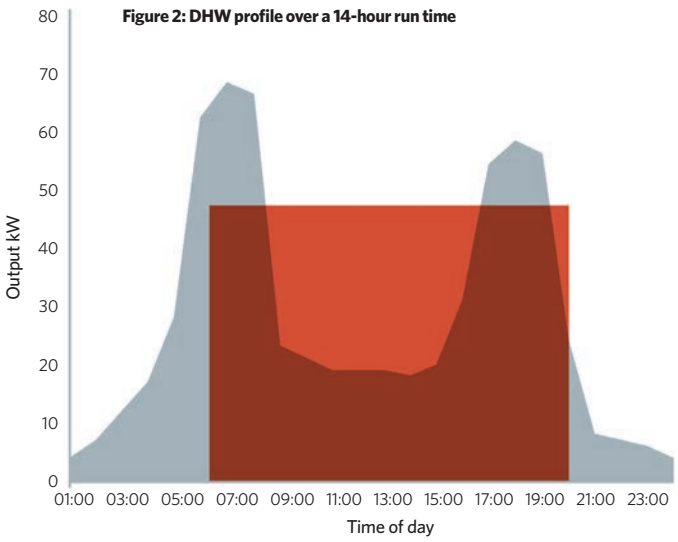

Figure 2: DHW profile over a 14-hour run time

DAVID SADLER-SMITH is solutions centre manager at Elco Heating Solutions

References:

1 *Lightening the load: How CHP helps win the global race for a competitive, low carbon economy*, Association for Decentralised Energy **bit.ly/2zvffrC**

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Mission-critical cooling on the march in America

Servers give off immense heat, which could affect their efficiency

The North American market for 'mission-critical cooling' is growing at 12% per year, and is forecast to be worth US$2.9bn by 2022, according to a Bsria market intelligence study.

It showed the market is being driven by the need to improve energy efficiency and reliability, and to reduce downtime, as well as operating costs.

'With the need for data, high-performance computing, wireless communication, the Internet of Things and streaming rising dramatically in our digitally connected world, data centres and servers have become a necessity, with mission-critical cooling going hand-in-hand with them,' said Bsria's Raphael Chalogony.

Mission-critical cooling is a method of cooling servers, computer systems and telecommunication equipment to precise temperatures, as per set standards.

Such servers are used to organise, process, store and distribute large amounts of data, and can be configured in single-rack data closets or large data centres with hundreds of racks. This equipment uses large amounts of power and gives off immense heat, which could affect its efficiency and function. Downtime could be very expensive and disruptive, so mission-critical cooling is an essential part of data centres.

'Though traditional cooling still has a lion's share of the market, other – more efficient – cooling solutions are growing rapidly as companies try to reduce cost and energy consumption,' said Chalogony.

'The market is currently dominated by established suppliers of cooling equipment, but a number of new suppliers are entering the market as new types of cooling are introduced.'

Going round in circles at the BBC

As work continues to transform the BBC's Television Centre in White City into a mixed-use development – featuring housing, offices, hotels and leisure facilities – Rehau is delivering heating and cooling solutions for its new apartments. The firm's underfloor heating has been installed in nearly 250 units by Anders Heating Company.

In many corridors, the manufacturer's chilled-ceiling system is also supplying the necessary cooling, while its panels – with integrated loops of pipe circulating chilled water – have replaced conventional plasterboard to deliver radiant cooling.

The 'doughnut' shape of the Norman & Dawbarn-designed building presents many challenges for the project's M&E contractors, because so many internal walls are curved. So flexible polymer pipework was appropriate for the distribution of the water supply, according to Rehau.

Its technical specification team is working on the project with consultants Arup, client Stanhope and M&E contractors ImTech, ESG and Piggott and Whitfield. Work began on site in May 2016, and the project is scheduled for completion in 2020.

Daikin reaches 1,000 mark in R32 training

Since its 'R32 system installations – are you ready?' course was launched last November, Daikin UK has trained 1,000 installers on the use of R32 refrigerant.

The course equips installers with the essentials on installing, commissioning and servicing R32 systems, in line with the 2015 F-Gas Regulations and EN378 update. It also features a question and answer session on safety considerations, including transporting and storing R32.

Forthcoming courses are scheduled to run in Woking, Glasgow, Bristol, Manchester and Birmingham.

Mitsubishi Electric's new R32 units have i-see sensor

Mitsubishi Electric has launched a new range of wall-mounted air conditioning units using R32 refrigerant.

The M Series MSZ-LN is the first product in the company's UK offering to use R32, which has a low global warming potential (GWP). A key objective of the 2014 EU F-Gas Regulation is reducing F-gas emissions by 79% between 2015 and 2030.

'R32 units have been available in Japan for more than two years, and we have taken that knowledge and experience and refined it into this offering,' said Donald Daw, commercial director for the company.

The units, from 2.5kW to 6.1kW, have a built-in Wi-Fi interface, and an i-see sensor that monitors room occupancy, position and body temperatures, to deliver customised comfort.

Small yet powerful

Panasonic has redesigned its Mini VRF heating and cooling units to produce a compact Mini ECOi series. The new models – for residential and light-commercial applications with restricted external space, such as apartments with small balconies – include 4HP, 5HP and 6HP versions.

The single fan 4HP units achieve a maximum energy efficiency ratio (EER) of 4.50 and a maximum coefficient of performance (COP) of 5.19, thanks to a new twin-rotary compressor with wider inverter control, for improved partial load management.

They also have a bigger fan motor than previous models, a larger fan diameter of 540mm, and a new fan design to ensure lower airflow and electrical consumption. The technology is capable of delivering a high external static pressure of 35Pa.

LEADING WEDGE

A sliver of land between a rail line and offices was the only site available for a cooling centre at London's King's Cross. Metropolitan Infrastructure's **John Marsh**, tells how it overcame space constraints to supply up to 12MW of cooling

District cooling is an energy-efficient way of maintaining optimal ambient temperatures inside buildings, and it is not a new technology. Systems are common in the Middle East, where year-round heat makes it an obvious choice, and they have also been implemented in Scandinavia, Germany and France. In the UK, however, there has been a lack of momentum behind district cooling – until recently. The drive for low carbon – or, in London, zero carbon – development is providing the impetus to transform this situation. Indeed, a planning stipulation for the 67-acre London King's Cross redevelopment was the harnessing together of heat, power and cooling – or 'tri-generation'.

The energy centre at King's Cross that supplies district heating has been operating since 2014, and now the infrastructure for the cooling network is about to go live on the site. At the heart of Metropolitan Infrastructure's new network is the 'cooling pod'; housing six chillers, it will generate 9MW of cooling to the development north of Regent's Canal. The network will serve four commercial and three residential buildings, and has been designed to allow expansion at a later date.

The cooling pod is part of the utility infrastructure at King's Cross delivered by Metropolitan, which includes district heating, electricity, ultrafast fibre broadband, gas, water, and wastewater.

Cooling capacity, determined by the available energy generated by the energy centre, is 12.5MW, with an effective 9MW available – 6.5MW of which will be used for commercial cooling and 2.5MW for residential.

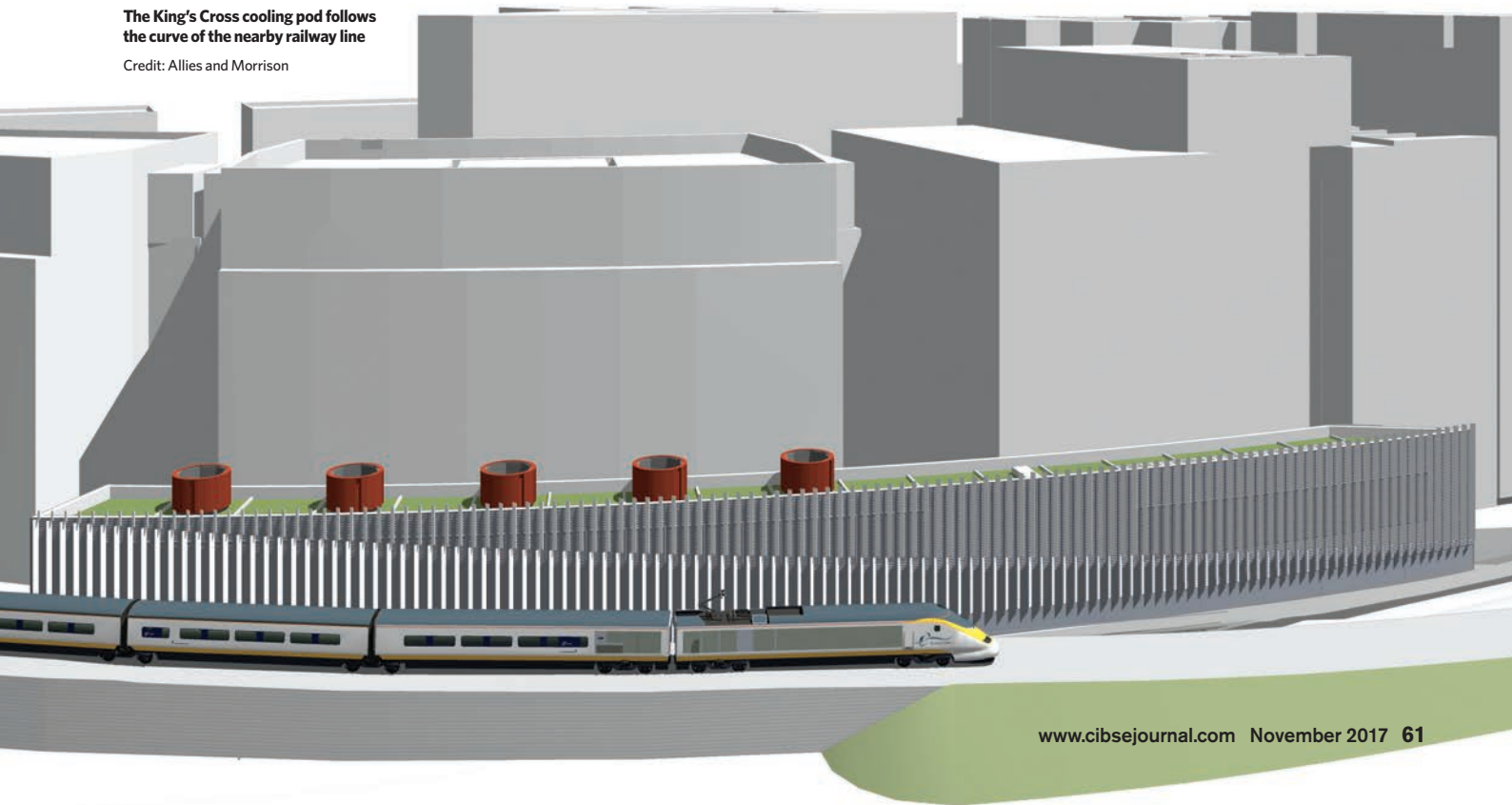
Design challenge

The profile of King's Cross, with its high-value housing and requirement for cooling, triggered the development of the cooling pod. Argent – the developer working on behalf of the partnership – commissioned the provision of plant and the network within the development. Metropolitan worked with Argent to assess how much cooling could be produced and where this would best be used on the site (See panel: 'How the energy company services company works').

The site for the cooling plant was the last area to be designated in the plans. It occupies a crescent-shaped piece of land in the north of the King's Cross development, sandwiched between an office development and the HS1 Channel Tunnel Rail Link (CTRL) – the only remaining strip of land available. The site is constrained by a CTRL fence, which separates it from the HS1 assets, a CTRL maintenance access area and offices on the Eastern side. Consequently, »

COOLING POD SPECIFICATION

1 x 1.4MW absorption chiller
3 x 3MW water-cooled electric chillers
2 x 1MW dry air-cooled chillers
5 x 2.5MW heat-rejection cooling towers
2 x 30m³ thermal stores
2 x 2,500kVA transformers



The King's Cross cooling pod follows the curve of the nearby railway line

Credit: Allies and Morrison

» the Metropolitan project team faced several design, engineering and building challenges, including: designing the plant in a confined space; preventing chiller noise from disturbing office workers; and ensuring 'pluming' from the cooling plant did not interfere with train operation.

To maximise floor space in the cooling pod the first floor of the two-story building was cantilevered over the access road to maximise floor space.

The pod's proximity to the HS1 line presented a significant complication: Network Rail was concerned that 'pluming' would drift across the railway line and obscure train drivers' sightlines to signals. It was agreed significant financial penalties would be imposed if trains were disrupted by pluming. Given the potential costs of failure, the final design solution eliminated this risk.

The cooling pod

To ensure the network delivers cooling even when the energy centre is working at full capacity there are three types of chiller in the system, each providing chilled water. There is one absorption, three electric and two air-chilled chillers. The absorption chiller generates chilled water when the external ambient temperature is 17°C or higher and heat is available from the combined heat and power (CHP) engines, housed in the main energy centre. Absorption chillers use hot water to generate chilled water via a chemical process, so they can operate when the CHPs are supplying heat in the summer months and generating electricity.

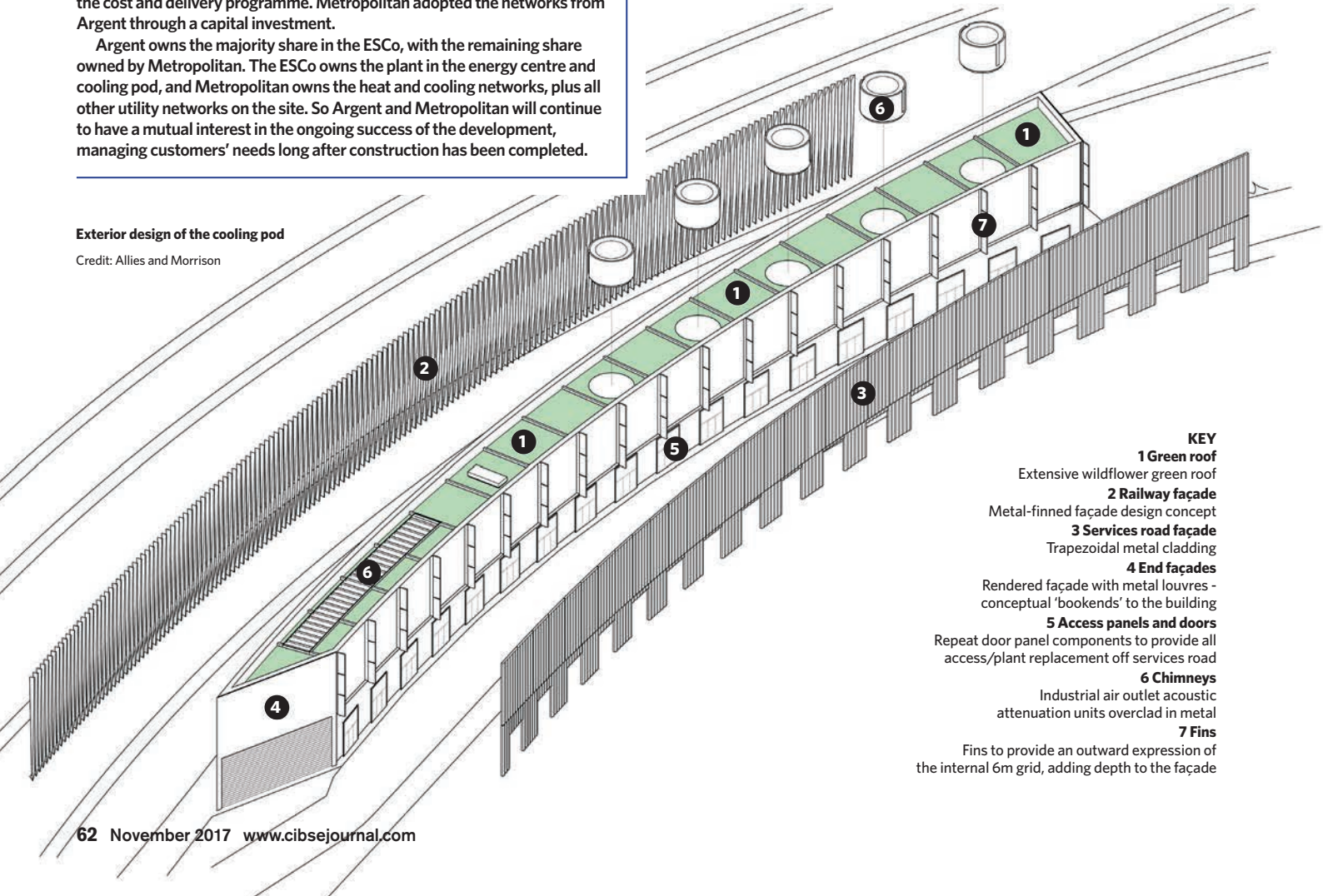
Tri-generation is a cost- and carbon-efficient way of producing electricity and chilled water. The temperature threshold for using the absorption chiller is set at 17°C; below this, there is a risk of pluming.

When the absorption chiller is not able to fulfil the entire cooling demand, and the ambient air temperature is higher than 17°C, water-cooled, electric, vapour-compressed chillers will generate chilled water. The electric chillers on the ground floor reject heat using water evaporation into the atmosphere via five open-circuit cooling towers on the first floor of the pod. These towers will not be operated when the ambient temperature is lower than 17°C, because pluming from the evaporated water could occur. Finally, two air-cooled chillers will generate chilled water when the external ambient temperature is below 17°C. These chillers reject heat by blowing ambient air over the condensers, which reduces the risk of pluming but is less energy efficient. »

HOW THE ENERGY SERVICES COMPANY WORKS

A fully managed energy services company (ESCo) is part of the solution for local delivery of district heating and cooling. Ownership of the infrastructure at King's Cross is a long-term partnership between Metropolitan and Argent, the lead developer. Metropolitan designed and installed all of the utility, heat and cooling networks, while Argent controlled the cost and delivery programme. Metropolitan adopted the networks from Argent through a capital investment.

Argent owns the majority share in the ESCo, with the remaining share owned by Metropolitan. The ESCo owns the plant in the energy centre and cooling pod, and Metropolitan owns the heat and cooling networks, plus all other utility networks on the site. So Argent and Metropolitan will continue to have a mutual interest in the ongoing success of the development, managing customers' needs long after construction has been completed.



Exterior design of the cooling pod

Credit: Allies and Morrison

The main energy centre that supplies hot water to the absorption chiller

» To mitigate noise from the plant and avoid disturbing the occupants of nearby offices, the air-cooled chillers and the cooling towers have acoustic air-intake louvres, acoustic shrouds and roof-mounted acoustic cylinders. The water-cooled electric chillers, meanwhile, are in acoustically treated bays.

Chilled water is pumped from the cooling pod via underground, pre-insulated Logstor Series 1 pipework, with an internal diameter of 450mm and an external diameter of 560mm. Its primary flow and return temperatures are 6°C and 12°C respectively. Within each building served, the primary cooling network terminates at a primary plate heat exchanger, which offers a hydraulic break between the primary and secondary networks, as well as a bulk-metering point. Services design engineers are responsible for designing the secondary cooling network within each building, subject to Metropolitan's requirement of a secondary cooling temperature of 8°C flow and 14°C return.

The cooling system is controlled by a building management system designed to meet the specific requirements of the cooling pod and to manage the appropriate deployment of each type of chiller. The control system is open protocol, to allow operation alongside the energy centre, and offers local and remote communications. This ensures maintenance teams are fully aware of plant condition and operation.

> "The electric chillers on the ground floor reject heat using water evaporation into the atmosphere via five, open-circuit cooling towers"

Advantages for customers

A centralised cooling system servicing a building removes the need to install and manage discrete systems, resulting in capital and space savings. It also enables the building to achieve a higher BREEAM rating, and running costs are expected to be lower.

Residential customers of the district heating network at King's Cross are protected by the scheme's membership of the Heat Trust, an industry-led, self-regulatory initiative that recognises best practice. Although there is currently no code of practice for cooling networks, stringent tests during the commissioning phase ensure the cooling pod performs as designed. Each major piece of plant is tested and commissioned individually, then proven again under the requirements of the energy control system.

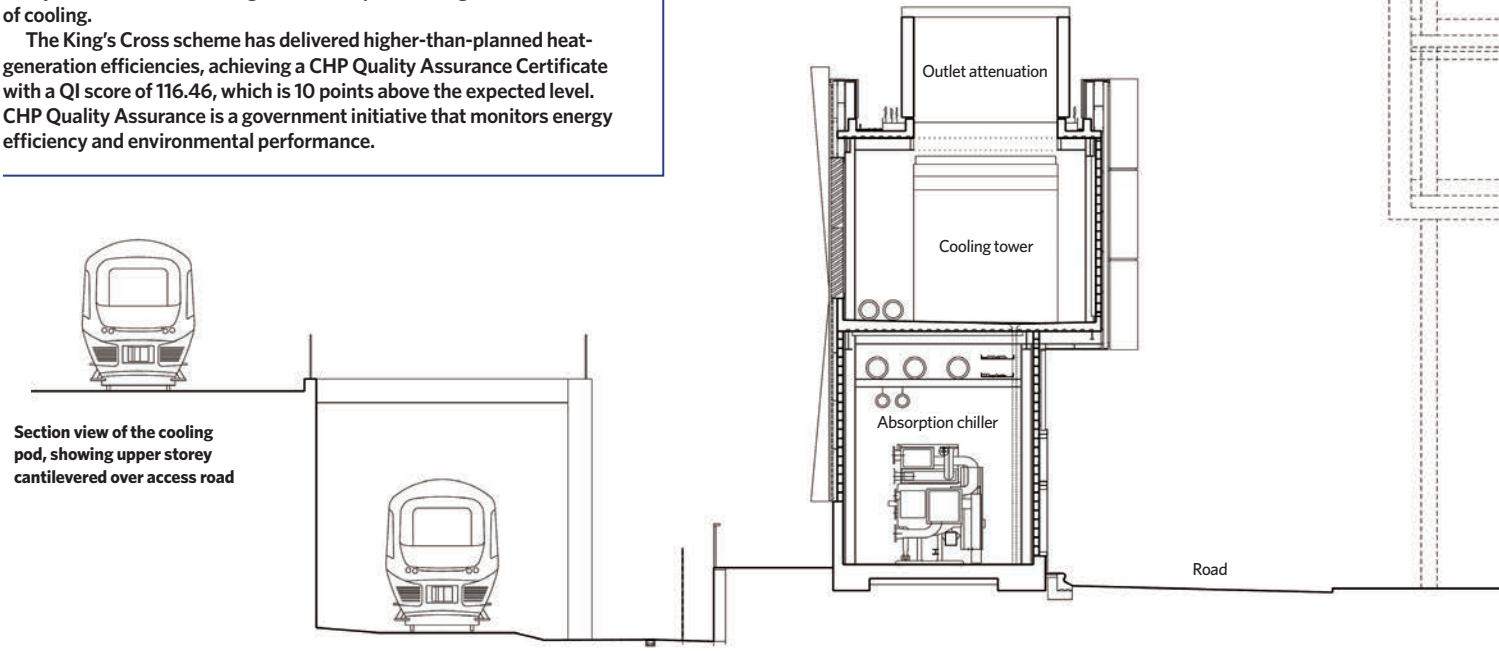
The benefit to those living and working nearby is that they have an aesthetically striking building on their doorstep, which also gives rail rail travellers from Europe a stunning first impression of the King's Cross development. CJ

JOHN MARSH is operations director at Metropolitan Infrastructure

KING'S CROSS ENERGY CENTRE

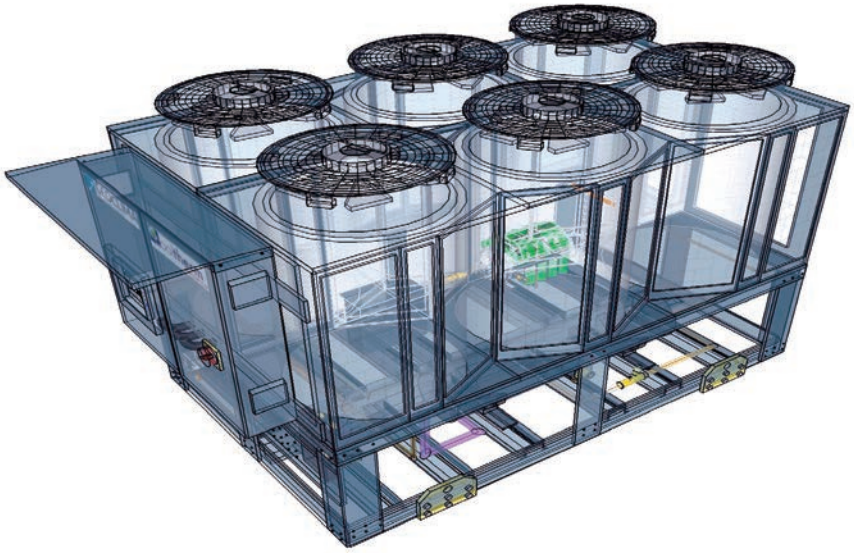
The energy centre at King's Cross consists of: two 2MVA combined heat and power (CHP) engines; three 10MW gas boilers; two 3MW gas boilers; and two 75m³ thermal stores. It meets 99% of the development's current heat demand, with a 50% saving in carbon emissions over traditional utility solutions. The CHP engines also help drive the generation of cooling.

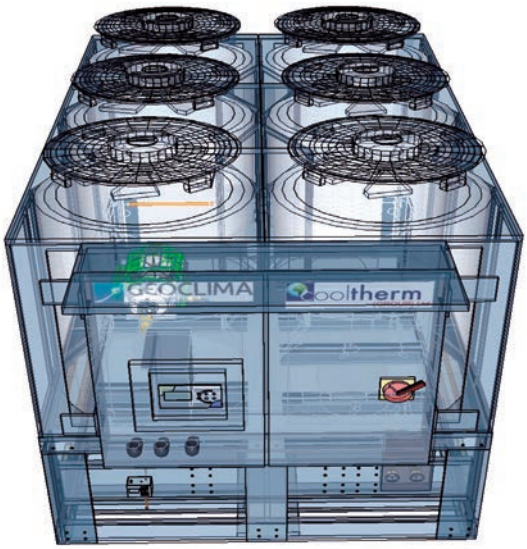
The King's Cross scheme has delivered higher-than-planned heat-generation efficiencies, achieving a CHP Quality Assurance Certificate with a QI score of 116.46, which is 10 points above the expected level. CHP Quality Assurance is a government initiative that monitors energy efficiency and environmental performance.



Section view of the cooling pod, showing upper storey cantilevered over access road

EVERY CHALLENGE...





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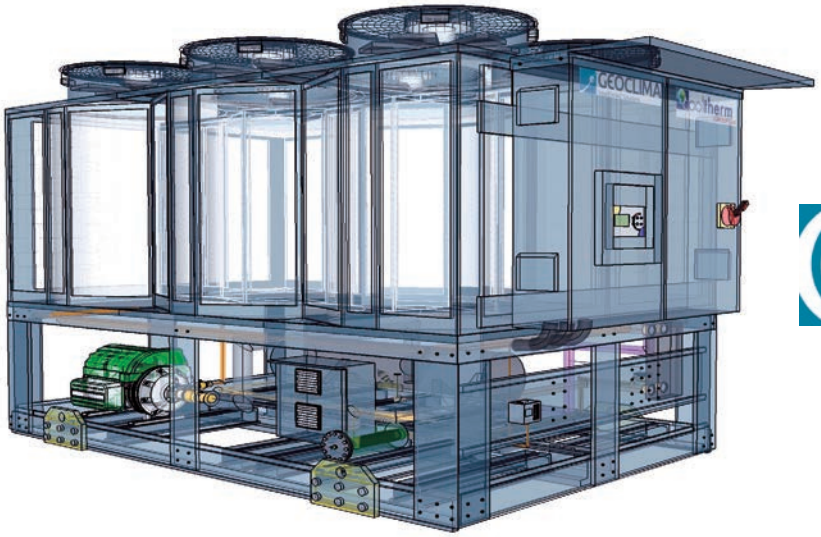

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AUTOMATIC SAVINGS

Auto-cleaning accessories for ducted air conditioning units can cut maintenance times and save energy, says **Martin Passingham**, product manager for DX at Daikin UK

The dust box is emptied via a 1.7m hose, which is connected to the unit via the white port circled in red

Energy-efficient climate-control solutions are essential for reducing the running costs and environmental impact of buildings. Influencing the direction of the sector, legislation – such as the F-Gas regulations – has resulted in the phase out of high global warming potential (GWP) refrigerants.

To future-proof against evolving legislation, low-GWP options that offer superior energy-efficiency capabilities – such as those incorporating R32 refrigerant – should be used. Beyond this, it is important for engineers to consider the maintenance of a system, and how this impacts upon energy consumption.

Over time, ducted air conditioning units collect dirt and debris on filters and other surfaces, as well as in the drip tray. This forces the unit to work harder to draw air through the filters' less porous structure and can reduce airflow across the coil, leading to the system using more energy to deliver the required cooling. Not only can this result in the premature replacement of system compressors, but it will also produce more internal condensate, which risks overflowing blocked drip trays and, potentially, causing damage to the ceiling. Another consequence is that contaminants can be blown into the room, reducing indoor air quality. Furthermore, it can result in an extra, unnecessary load on the compressor, which will negatively affect the system's energy efficiency.

A dirty filter can result in expensive repairs and increase energy costs by up to 20%. This impacts significantly upon commercial environments, such as hotels, where climate controls are in constant use. A system breakdown could mean rooms left empty for up to two days while repairs take place.

To avoid these issues, manual cleaning of the filters should take place between four and, potentially, 12 times a year. A labour- and time-intensive process, it involves removing the filter, cleaning and replacing it, then cleaning the surrounding area that has become dirty because of dust fall. This seemingly simple task can take more than an hour, which often leads to it being rescheduled as the need to use the rooms takes priority.

The cost is around £20 per unit per clean, or more – a significant outgoing for hotels and large retail properties. Auto-cleaning duct accessories offer an alternative solution, to help reduce maintenance costs and improve the energy efficiency of units.

Auto-cleaning solutions

The 200mm-deep, Daikin Auto-Cleaning Duct Accessory can be attached to the back of the ducted unit and, effectively, hidden from view. It collects dirt and debris in a dust box, which can be emptied with a standard vacuum cleaner, thereby minimising maintenance and ensuring the system operates at maximum efficiency. The process takes a few minutes and can be incorporated into a building's daily cleaning practices, reducing the need for onsite manual cleaning.

An indicator highlights when the dust box needs emptying, and access for dust extraction is through the extraction port, which is connected to the box with a 1.7m hose. The unit should be auto-cleaned every week to ensure the filter remains dust free. In one hotel, installation resulted in a 20% energy saving over a slim duct unit, which was manually cleaned every three months.

The additional capital for auto-cleaning is dependent on the specific project. However, typically, the return on investment is around two years, based on hotel manual cleaning cycles, energy savings and increased system reliability.

The vacuum device will only be used, say, once a month, so will have a lifespan similar to other direct expansion (DX) equipment, if used correctly. If there is an issue, however, it is available as a spare part.

The regular cleaning and maintenance of ducted unit filters is vital to ensuring the system's energy efficiency throughout its lifetime. Auto-cleaning accessories save significant cleaning costs and limit the risk of system breakdown, while improving energy consumption. CJ

The Daikin unit has been installed at a Holiday Inn Express

MARTIN PASSINGHAM is product manager for DX at Daikin UK

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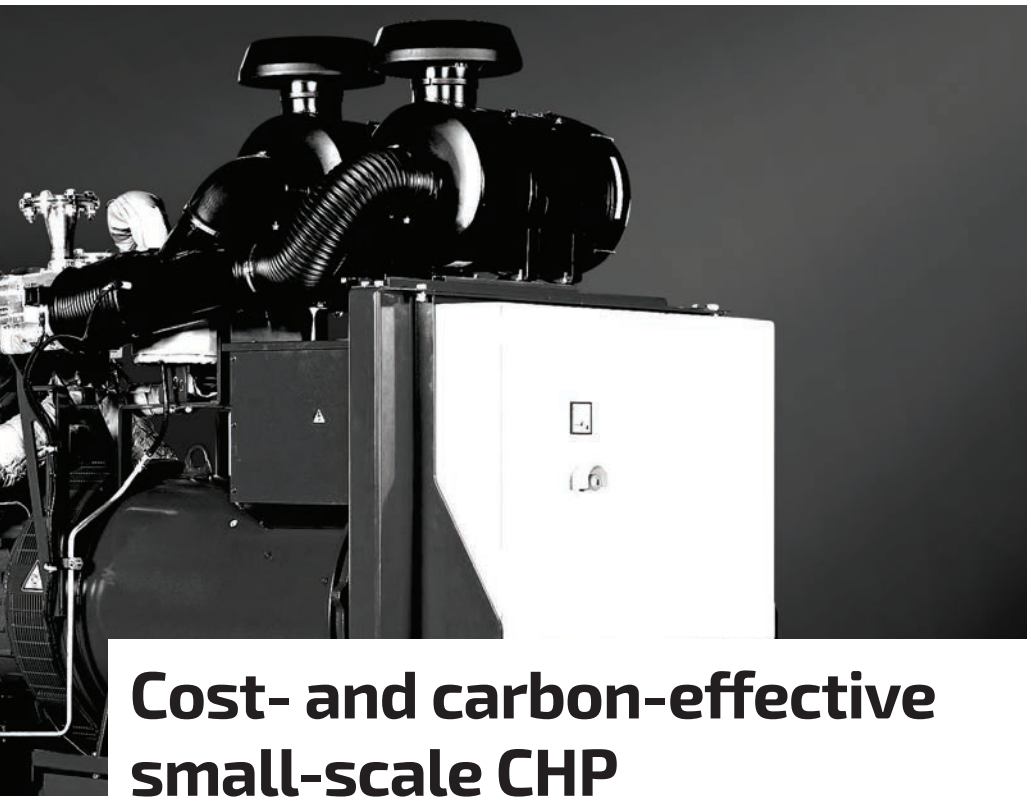

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Cost- and carbon-effective small-scale CHP

This module considers the factors involved in assessing the viability for small-scale combined heat and power (CHP) solutions in the UK

Despite the carbon intensity of the UK's grid-supplied electricity hitting all-time lows over the past few months, there are still good opportunities to apply small-scale combined heat and power (CHP) for commercial and institutional applications in the country, both to save money and reduce carbon emissions.

This article will develop aspects of earlier articles covering CHP, particularly in relation to assessing the viability for small-scale CHP in the UK (See Module 98, August 2016 for complementary information).

A 2015 report produced to meet the requirements of the EU Energy Efficiency Directive[1] – the *National Comprehensive Assessment of the Potential for Combined Heat and Power and District Heating and Cooling in the UK*[2] – concluded that to achieve the energy goals, significant investments needed to be made in new low-carbon technologies, renewable energy, energy efficiency and grid infrastructure. The report considered that there was technical opportunity in the UK for more than 390TWh per year of CHP to supply commercial, public and residential applications. It indicated that there was even greater potential benefit if the heat output from CHP were used in conjunction with heat pumps to increase the temperature.

The application of small-scale CHP effectively brings an efficient micro power station to a building or small estate that can provide electricity and heat locally to a site that is normally also connected to the electricity supply grid.

Small-scale CHP (such as that in Figure 1) saves primary energy, as the heat rejected by the cooling system of the CHP engine is being used on site (typically in the building's heating or hot-water system) rather than, in the case of a centralised power station, being rejected to atmosphere, as in the example in Figure 2.

Additionally, the power distribution network suffers losses because of technical reasons (for example, cable resistance and transformers) and non-technical losses (including theft and mis-metering). UK grid electricity is distributed through licensed distribution network operators (DNOs), each being responsible for a regional distribution services area. The UK's power networks aim to keep the overall grid distribution losses to a maximum of 6%.[3] As indicated in Figure 3, the UK grid delivers electrical power to end users at an overall primary fuel efficiency of approximately 31%[7] (this is an average value). The coal-fired power stations that feed the grid have thermal efficiencies at around 35%, and the combined-cycle gas turbine (CCGT) stations have near 50%.[4] At times of peak electrical demand, there is increased use of the less efficient power sources so that the grid load can be satisfied, and the resulting specific primary energy cost – and associated carbon emissions – increase. Coal-fired stations accounted for 9% of electricity generation in 2016, down from around 23% the year before, and 21 April 2017 was the first day in the history of the grid[5] that there were no coal-fired power stations feeding the grid, as gas and renewables (including nuclear) were able to meet demand.

The recent report by the Association for Decentralised Energy (ADE), *Lightening the Load*[6] examines the opportunities for CHP throughout the 2020s and 2030s. It notes that previous UK government electrical-generation carbon-emissions predictions indicated the carbon capture and storage »

Figure 1: A 20kWe, 44kWth reciprocating engine CHP unit (1,625mm high, 858kg weight)

» technology (as part of centralised CCGT installations) would be mature technology in the 2030s. However, this expectation is no longer in place. The ADE report contends that although average grid emissions may fall, gas CHP will probably continue to reduce carbon emissions by up to 30% far into the 2030s, as long as there is other, less efficient centralised gas generation to displace. It suggests that the evidence is that the use of local gas CHP largely only displaces other gas power plants and rarely displaces either the lower carbon factor intermittent renewables or nuclear power stations.

For economic sizing, CHP units are typically applied as heat-led devices, so the thermal output should normally match the base heating load of the building, system or process to maximise the annual CHP running period. The traditional cost-effective CHP would operate 5,000 to 6,000 hours per year. The base electrical load should be carefully considered to minimise the electricity exported to the grid as, in the UK, there is currently little or no financial incentive in doing so. As a primary heat-producing device, CHP connects to a heating system just like a boiler. However, CHP would not normally be expected to meet the total heating requirement of a building, so it must be accompanied by boiler plant to meet at least peak heat demands. This can also offer opportunities for 'smart' operation of the CHP plant so that it could run at times when there is nationally high demand on the electricity grid. This can provide an environmental benefit and, potentially, increased financial benefits if a dynamic electricity tariffing system was in place. This could mean that, at times of 'surplus' grid electricity, the building's alternative high-efficiency heat sources (such a thermal stores and condensing gas boilers) would meet the heating load while the CHP was switched off and the grid supplies the electricity (see the panel below for an outline of the electrical operation of a CHP unit).

A thermal store – an example application is given in Figure 4 (taken from CIBSE AM12 *Combined Heat and Power for Buildings*) – is always recommended to provide thermal inertia, to smooth out the heat demand and extend the opportunity to use the CHP heat as opposed to employing boilers.

The use of the thermal store will maximise electricity production by keeping the CHP running in times of lower thermal load.

The heat from the CHP can also be used to preheat the cold water supply to direct-fired water heaters – another example of a thermal store. This is a solution that is used by many hotel groups.

There are several drivers for installing CHP – such as financial savings and environmental benefits – but UK government policies are also encouraging the use of CHP to meet the relevant building regulations and local planning requirements. CHP qualifies as a carbon-reducing technology because, when installed and operated effectively, it can reduce carbon emissions as well as energy costs, compared with when using grid electricity and separate heating systems. To encourage the most beneficial application of CHP, the UK's voluntary CHP Quality Assurance (CHPQA) programme[9] certifies the CHP inputs and outputs as being able to deliver 'Good Quality' performance. CHPQA provides the certification to confirm eligibility for a range of UK government financial benefits. The CHP plant is evaluated on its fuel use, power generation and heat supply, and given a Quality Index (QI) and power-efficiency rating. UK building regulations make specific provisions for the appropriate inclusion of CHP. For example, in England and Wales, the *Non-domestic Building Services Compliance Guide*[10] requires CHP plant in new and existing buildings to have a minimum annual CHPQA Quality Index (QI) of 105 and power efficiency greater than 20%. It also mandates that there should be a control system that, as a minimum, ensures the CHP unit operates as the lead heat generator and that metering is installed

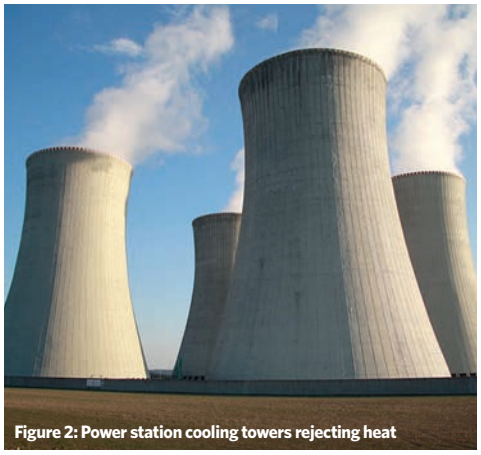
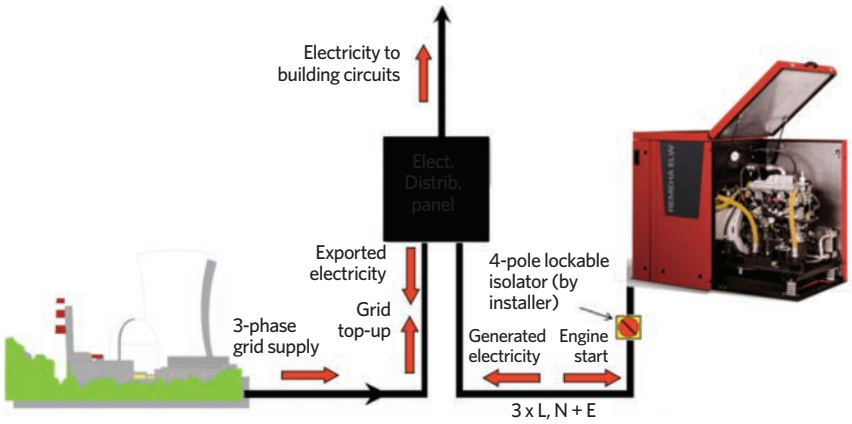


Figure 2: Power station cooling towers rejecting heat

THE ELECTRICAL OPERATION OF A SMALL-SCALE CHP

The CHP plant draws electricity from the grid to start the engine, initially acting as an induction motor. When up to operating speed (1,540rpm) and electricity is being generated, three-phase electricity is fed from the unit into the distribution panel to meet the demand in the building. If the building requires more electricity than the CHP is generating, power is drawn from the grid. For example, if the building requires 10kWe and the CHP is generating 5.5kWe, then the grid only supplies 4.5kWe. In this way, the CHP displaces the more costly electricity that would normally be supplied by the grid. If the building does not require all the electricity generated by the CHP, the surplus can be exported into the grid.



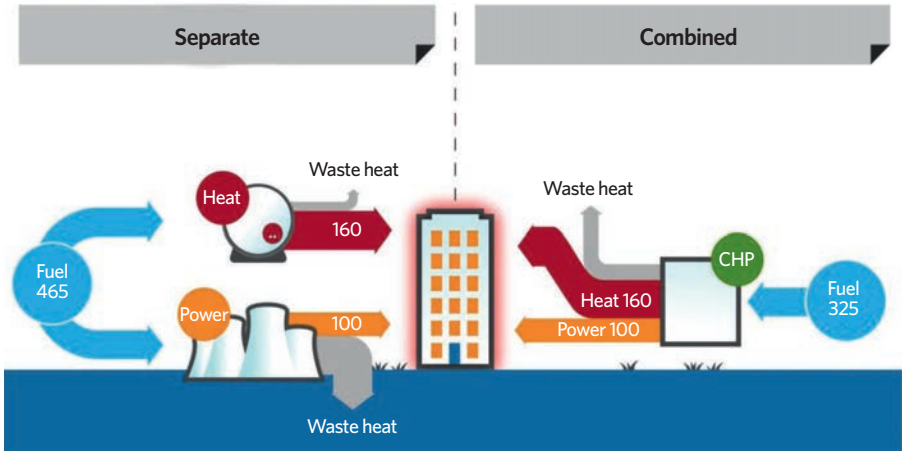


Figure 3: Primary fuel consumption for building with grid-supplied electricity, compared with well-operated local CHP to deliver same overall heat and power (Source: UK Department for Business, Energy and Industrial Strategy[7])

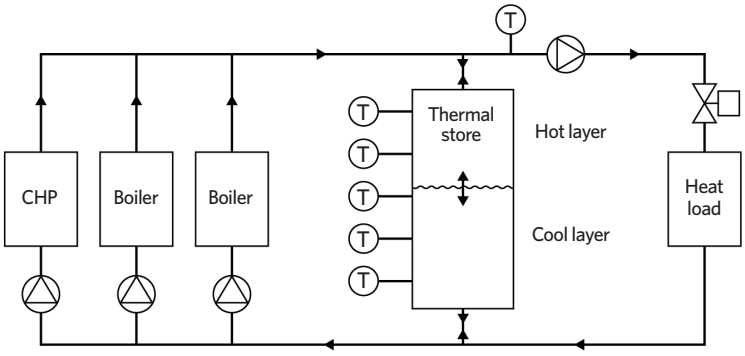


Figure 4: CHP and boilers connected in parallel with a thermal store (Source: CIBSE AM12,[8] page 42)

to measure hours run, electricity generated and fuel supplied to the CHP unit. It requires that the CHP plant should be sized to supply not less than 45% of the annual total heating demand (that is, space heating, domestic hot water heating and process heating). However, it does include the caveat that 'unless there are overriding practical or economic constraints' that could provide the opportunity for smart operation of the CHP installation together with high-efficiency boilers.

The *National Comprehensive Assessment of the Potential for Combined Heat and Power and District Heating and Cooling in the UK* provides an extensive account of the UK policies that support high-efficiency CHP. It notes that the fiscal and financial support mechanisms designed to improve the economics of developing and operating CHP plants require that the plants be certified, either fully or partly, as 'Good Quality' by CHPQA.

CHPQA certification may be used to support a claim for a range of benefits, including:

- Exemption from the main rates of climate change levy (CCL) and fuel-oil duty
- Exemption from the carbon price support (CPS) tax
- Enhanced capital allowances (ECA)
- Exemption from business rates of power-generating plant and machinery.

CHP can deliver CO_2 savings – but only if it is actually operating, and in an appropriate manner. An example of a real application of CHP in two hotels, as shown in Table 1, can illustrate the importance of correct CHP selection.

Project	Number of rooms	Design operating hours/unit	Actual operating hours/unit	Design CO_2 savings	Actual CO_2 savings
London hotel	86	24	10	30 tonnes	12.5 tonnes
Croydon hotel	168	24	24	30 tonnes	30 tonnes

Table 1: Comparison of CHP installation in two hotels

Both hotels are owned by the same company, and each has two CHP units rated at 5.5kWe, with an anticipated annual emissions saving of 30 tonnes CO_2 for each hotel. However, in operation, the smaller hotel does not have enough hot-water demand to keep two CHPs operating, so the running hours, and the CO_2 savings, are much less than expected. One CHP would probably have operated almost constantly and, therefore, would have delivered more CO_2 savings than two units running part-time. Oversized CHP will never deliver as expected, so matching the CHP size to the magnitude and frequency of heat load is critical.

To establish an initial and indicative idea of the opportunity for effective CHP, the UK's Department for Business, Energy and Industrial Strategy (BEIS) offers a CHP Site Assessment Tool (at **http://chptools.decc.gov.uk/CHPAssessment**). This uses net present value techniques to give an early idea of CHP viability. As an example, if a 5,000m², 500-person, 1990s office in the Midlands is modelled in the tool, it provides a forecast for applying reciprocating engine CHP units – as shown in the abstracted information in Table 2. In this particular case, it indicates that both a single 25kWe CHP and a 50kWe CHP could provide economic solutions and would merit further investigation.

■ Turn to page 74 for further reading and references.

	Option 1	Option 2
CHP capacity	25kWe	50kWe
Electricity generated (annual)	104MWh	158MWh
Useful heat recovered (annual)	159MWh	246MWh
CHP fuel consumption (annual)	343MWh	530MWh
Primary energy savings (annual)	142MWh	214MWh
CHP capital costs	£43,000	£78,000
Annual cost savings	£7,000	£11,000
NPV	£15,441	£11,138
Payback period	6.3 years	7.5 years
CO_2 emissions saving v average UK grid	9%	12%
CO_2 emissions saving v fossil-fuel grid	11%	16%
CO_2 emissions saving v best available grid technology	8%	10%

Table 2: Example abstracted output from BEIS CHP online appraisal tool (The first two options, of five from the model, are shown)

Module 117

November 2017

1. **For how much annual CHP load was there thought to be a technical opportunity in the UK?**

☐ A 90TWh

☐ B 190TWh

☐ C 290TWh

☐ D 390TWh

☐ E 490TWh

2. **What was the first date that there was no coal-fired power stations feeding the UK grid?**

☐ A 21 January 2017

☐ B 21 February 2017

☐ C 21 March 2017

☐ D 21 April 2017

☐ E 21 May 2017

3. **What saving in CO_2 emissions does the ADE report suggest would be possible in the 2030s by using CHP (compared with grid)?**

☐ A 10%

☐ B 30%

☐ C 50%

☐ D 70%

☐ E 90%

4. **What is the required minimum CHPQA Quality Index in the *Non-domestic Building Services Compliance Guide*?**

☐ A 1

☐ B 1.5

☐ C 100

☐ D 105

☐ E 150

5. **In the office example, what was the predicted payback period when a 25kWe CHP unit was used?**

☐ A 3.3 years

☐ B 4.3 years

☐ C 5.3 years

☐ D 6.3 years

☐ E 7.3 years

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Further reading:

Most of the listed references provide useful, more detailed information on the assessment and application of CHP. CIBSE AM12 is freely downloadable for CIBSE members and provides a comprehensive source of knowledge and information.

References:

1 EED, Directive 2012/27/EU – **bit.ly/CJNov17CPD**

2 *National Comprehensive Assessment of the Potential for Combined Heat and Power and District Heating and Cooling in the UK*, Ricardo-EAA for DECC, December 2015 – **bit.ly/CJNov17CPD2** accessed 11 October 2017.

3 *UK Power Network Losses*, UK Power Networks, 2016, **bit.ly/CJNov17CPD3**, accessed 11 October 2017.

4 *DUKES chapter 5*: statistics on electricity from generation through to sales – **bit.ly/CJNov17CPD4** – accessed 11 October 2017.

5 **bit.ly/CJNov17CPD5**

6 *Lightening the Load: How CHP helps win the global race for a competitive, low carbon economy*, ADE, July 2017, **www.theade.co.uk**

7 **bit.ly/CJNov17CPD6** – accessed 11 October 2017.

8 CIBSE AM12 Combined heat and power for buildings, CIBSE 2013.

9 **bit.ly/CJNov17CPD7** – accessed 4 March 2016.

10 *The Domestic Building Services Compliance Guide*, available via **bit.ly/CJNov17CPD8**

GREEN INFRASTRUCTURE DESIGN CHALLENGE

Challenge launch event:

21 NOVEMBER 2017, 13:00–13:45

Build2Perform Live, Olympia

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The objectives of this challenge are to:

- showcase opportunities to improve the liveability of our cities through GI
- demonstrate how GI can make an area an attractive place to work
- demonstrate how GI can contribute to improved health and wellbeing
- improve energy efficiency and climatic resilience

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Call 08703 330 070 or visit www.netweber.co.uk

Innovative underfloor air conditioning for Plexal

AET Flexible Space supplied a bespoke underfloor air conditioning system to the Plexal innovation centre at Here East, Queen Elizabeth Olympic Park.

AET Flexible Space supplied and commissioned a total of 13 downflow units (CAM-V) and 146 slimline TUS-EC fantiles to the new 50,000ft^2 workspace located on the ground floor, and on an additional mezzanine level of the former Olympic Press Centre building. The CAM-V receives used air back at high level for re-conditioning.

Call 01342 310 400 or email aet@flexiblespace.com

Future Designs Angol

With a sophisticated inspiring design to fit elegantly into reception, office space and break-out areas, Angol offers high-performance LED illuminance. Options for the product include indirect/direct source, suspended or surface fix. It is available as cool, warm or tuneable white.

Benefits include versatile design, which lends any space a clean and crisp feel, and lighting control systems link-ups. It also meets or exceeds ECA qualifying criteria and part L threshold, is easy to maintain, and has a long life of more than 50,000 hours.

Visit www.futuredesigns.co.uk

New Evinox ModuSat XR takes HIU efficiency to another level

Evinox has extended its best-selling range of ModuSat heat interface units with the introduction of the new ModuSat XR and ModuSat XR- Eco twin-plate models. Offering both indirect space heating and domestic hot water, ModuSat XR units are ideal for use in modern, efficient district and communal heat networks. All units deliver fast, dynamic, domestic hot water response, and the ModuSat XR-Eco models also give ultra-low DHW return temperatures to the primary heat network.

With extensive experience in the design and application of HIU's across thousands of UK wide installations, Evinox has made significant advances in the performance of its latest range, aiming to help improve the overall efficiency of heat networks, while retaining high levels of user satisfaction and comfort levels.

Evinox believes independent testing is important for the UK HIU industry; the latest ModuSat XR and XR-Eco models have been developed with these new standards in mind.

Call 01372 722277, email info@Evinox.co.uk or visit www.evinoxenergy.co.uk

Introducing FlowDisc

Comfort and productivity is constantly affected by background noise; HVAC equipment is often considered the cause. FlowDisc is a ceiling diffuser, designed to cause little disturbance to its surroundings. A foam insert acts as a cushion to supply air. Its attractive look makes FlowDisc a perfect, high-end bathroom extract in luxury hotels and apartments. An option that satisfies the demands of designers for a diffuser that is quiet, clean and easy to install and maintain.

Visit https://swegonair.co.uk/

Efficient water heating from Elco

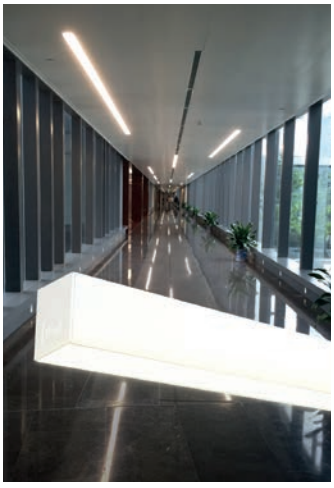
Elco Heating Solutions has launched the Trigon XL WH – a condensing direct gas-fired water heater capable of instantaneously supplying large volumes of hot water in commercial applications.

The range comprises of seven models with outputs from 150kW to 570kW, each version offering class-leading efficiencies up to 110%, robust performance and NO_x emissions as low as 34mg/kWh.

It gives a continuous supply of hot water at recovery rates of up to 9,257 litres per hour.

Visit www.elco.co.uk

Seamless LED lighting system from Luceco



Contour from Luceco is the ideal linear fluorescent luminaire replacement where continuous runs of illumination are required in retail and commercial environments. The LED lighting system consists of connectable modules offered in 600mm to 1,800mm lengths that can be surface-mounted, suspended or recessed. Seamless runs of energy-saving, cost-effective LED lighting can be created with interconnecting power and module connectors.

Manufactured as a premium aluminium extrusion with high-quality polycarbonate opal diffuser, micro prism or asymmetric optic distribution options, Contour has a full range of illuminated interconnecting modules, as well as an integrated driver with quick electrical connectors for ease of installation.

Contour has a five-year extended warranty and offers more than 50,000 hours operational life, with no maintenance over the lifetime of the luminaire, an important factor when considering applications such as retail environments where 24 hours a day operation may be required.

Call 01952 238100, email uk_sales@luceco.com or visit www.luceco.com

Press system for thick-walled steel pipes delivers time savings of as much as 80% compared to welding

Viega has extended its range of Megapress press connections with an innovation engineered for larger thick-walled steel pipework. The new cold applied Megapress XL system is safer, cleaner and delivers time savings of up to 80% when compared to welding.

Megapress XL allows thick-walled steel tube with diameters between 2.5 and 4 inches to be press connected. The specially engineered sealing element within the connector ensures a robust, leakproof seal on a range of materials, including seamless, welded, black, galvanised, epoxy-resin-coated and industrially painted tube.

As a cold applied press connection system, Megapress XL eliminates the fire and burn risks associated with welding and the heavy machinery needed to create a threaded tube.

The zinc-nickel coated steel connectors are suitable for applications, including heating and cooling systems, and is rated for operating temperatures up to 140°C.

Visit www.viega.co.uk/megapress-xl

Mikrofill at Aureus School

Aureus School is a Stem-specialist mixed school that creates choice for the wider community in southern Oxfordshire.

In 2016, established services contractor J & B Hopkins was appointed as the mechanical and electrical contractor for the school's new build works. Domestic hot water requirements were covered by the installation of two Mikrofill Extreme 500-litre loading cylinders. The Extreme is a hot-water generator that combines the advantages of an instantaneous hot-water heater and a storage system, creating perfect harmony between a condensing boiler and a hot-water cylinder.

Each stainless steel unvented loading cylinder can produce more than 2,500 litres per hour and 845 litres in a 10-minute peak period at 60°C. In addition, a Mikrofill 1,000/2 pressurisation package was installed to unvent the indirect LPHW circuits.

Call 03452 606020 or visit www.mikrofill.com

Thermokey UK opens for business

Thermokey is pleased to announce the opening of a new UK branch.

UK manager, David Birch, said: 'We are here to market the whole Thermokey range of industrial heat exchangers and to provide technical support for both our existing and new customers. We also have warehousing to allow holding of deliveries from Italy before routing to site.'

Thermokey, operating from a 32,000m^2 facility in north-east Italy, is a market leader in commercial and industrial heat exchangers for air conditioning, refrigeration and industrial process cooling. With 25 years of success, it is the only company to offer aluminium micro channel cores for HVAC in sizes up to 6m long.

With TUV and ISO 9001-2008 quality standards – and complete in-house production – tailor-made and standard dry coolers, condensers and unit coolers are offered in sizes up to 2,200KW. The largest UK project to date was the supply of 40 dry coolers for the Uskmouth power station in Newport, Wales.

Call 01732 782 685 or email david@thermokey.co.uk

Tekla software improves FP McCann's workflow

Following the industry's push towards BIM level 2, FP McCann has incorporated a variety of Trimble's Tekla software to meet this requirement and satisfy its manufacturing needs. Although it has been a learning curve, the software has enabled the UK's largest manufacturer and supplier of precast concrete to increase efficiency across the business.

Through its quarries, surfacing, readymix and precast concrete plants, FP McCann supplies a wide range of heavy building materials to the construction industry.

Visit www.tekla.com/uk.solutions

New MD range of high-efficiency condensing gas boilers

Adveco has announced the launch of its new MD high-efficiency condensing gas boilers, expanding its product range with higher-capacity, floor-standing, central heating appliances for the UK, Netherlands, and Belgium markets.

Supplied with a 10-year heat-exchanger warranty – and manufactured to the highest standards by a well-respected European manufacturer with more than 50 years of experience in boiler production – the MD offers an efficient, reliable, and low-emission heating solution for large applications.

Call 01252 551 540 or visit https://adveco.co/

Geniox – The next generation of air handling units

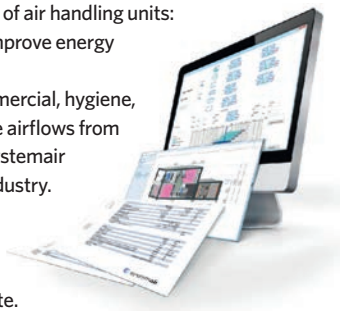
Ventilation company Systemair has launched its next generation of air handling units: Geniox. The motivation behind the new units is an ambition to improve energy efficiency in ventilation systems.

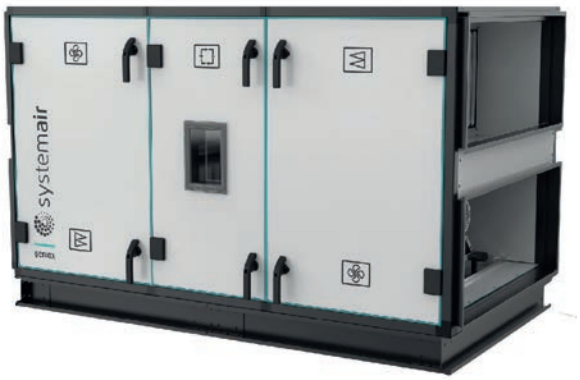
Geniox offers an energy-efficient ventilation solution for commercial, hygiene, marine and industrial applications. The Geniox family can handle airflows from 750-70,000m^3·h^{-1} (0.2-19m^3·s^{-1}). This level of flexibility means Systemair can offer an optimised solution regardless of your project and industry. Geniox is configured in the SystemairCAD design programme.

The SystemairCAD allows you to optimise the air handling unit to your needs and to the lowest possible energy consumption, and can be downloaded from the Systemair website.

The Geniox range is certified by Eurovent and has 60mm double-skinned panels as standard.

Visit info@systemair.co.uk





systemair

Change of role for Carroll at Geze UK

Geze UK's external sales team has welcomed the appointment of Luke Carroll as sales manager for Window Technology Systems.

Carroll joined the company in 2011 as a member of the technical support team, moving to the estimating department three years later, before going into sales.

He will look after the southern region, managing key accounts, providing customer training, specifying window technology and raising awareness of the Geze Window Technology portfolio.

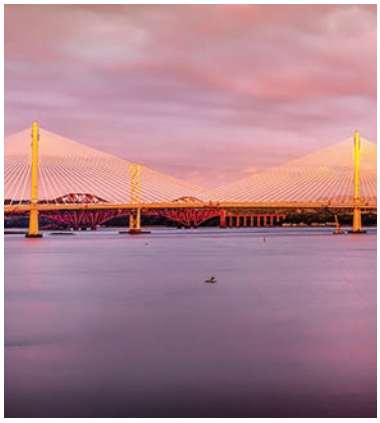
Call 01543 443000, email info.uk@geze.com or visit www.geze.co.uk

AGM celebrates its 45th anniversary with new factory for Aquatech Pressmain

Aquatech Pressmain – Aquatronic Group Management's (AGM's) brand of water pumps and pressurisation units – can be found all over the world, enabling water to flow in buildings such as Tate Modern, Heathrow Airport and the Burj Al Arab in Dubai.

The new factory in Essex provides a state-of-the-art facility for Aquatech Pressmain to meet the challenges of leaving the European Union and the next 45 years.

Call 01206 215100 or visit www.agm-plc.co.uk



Spanning the years

The Queensferry Crossing, near Edinburgh, attracted global attention when it opened recently. With an impressive span of 1.7 miles, this is the longest bridge of its type in the world.

Many clever engineering techniques were employed during its construction, and keeping the bridge operational at all times is a Hydro MPC-E a Grundfos variable-speed three-pump booster set. This ensures any and all roadway surface washdown requirements can be dealt with quickly and effectively.

Call 01525 850000, email grundfosuk@grundfos.com or visit www.grundfos.co.uk

DIRECTORY Your guide to building services suppliers

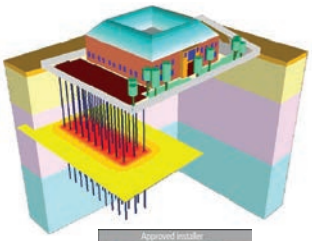
Tel: 020 7880 6217 Email: callum.nagle@redactive.co.uk

Air Handling

Air Conditioning

Air Conditioning

Energy Efficiency



Design Coordinator (M&E)

London, £40-£50k

Galliard Homes

With an impressive portfolio of award winning developments, Galliard is proud to be considered as London's leading property developer.

Due to growth we are currently looking to recruit an experienced Design Coordinator (M&E) to come and deliver the M&E design aspects on our projects. You will Liaise and manage contractor relationships including management of design review process, leading meetings and responding to queries and concerns.

The successful person must have/will be;

- Previous experience of working in a M&E consultancy environment with an electrical bias
- The relevant qualification BTEC/ONC/HNC/Degree in electrical engineering or building services engineering
- An understanding of efficiency/sustainability
- Previous experience of working on complex M&E design projects
- Excellent communication skills (written & verbal)
- Results focused with the ability to work autonomously
- Excellent knowledge and understanding of BREEAM and RIBA
- Strong problem solving skills and understanding of the best practice in Construction Design Management
- Knowledge on Revit MEP (BIM), 2D/3D modelling is highly desirable

In return you will be entitled to:

- 24 days holiday
- Competitive salary
- Private healthcare and pension

If you feel you have the skills and experience required to excel in the role of Design Coordinator, we want to hear from you.

Please send your application with CV to: ClaireGriffiths@galliardhomes.com

b-a-r beeby anderson recruitment

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

FM Team Leader (M&E)

London, £60 - £70k + benefits

A global engineering consultancy that specialise in M&E Engineering are seeking an experienced FM Leader to join their facilities division providing specialist advice and solutions on all aspects of building aftercare. You will be working closely with new and established clients, taking, and interpreting briefs, and advising on the best solutions regarding maintenance, life-cycle, operations, and commercials. This is a great opportunity to join a forward thinking and innovative company that is dedicated to improving the built and natural environment. Ref: 4643

Mechanical Engineer

London, £35 - £42p/h

A CIBSE Accredited design consultancy are looking for a senior mechanical engineer to assist them on commercial CAT A CAT B projects in London. This assignment will last a minimum of six months with a strong possibility to be longer. You will need to be degree qualified and ideally be Chartered (but not a necessity). Immediate Start. Ref 4566

Head of Engineering

Jersey, £90 - £110k + benefits

An exciting opportunity for an experienced Head of Engineering has arisen with a global company to lead an internal engineering division that deliver a wide range of projects valued from £100K to £30M. You will be Mechanical bias and responsible for the creation of a technical edge to the business. This will involve management of a small team of in-house personnel and shaping them into a strong collaborative technical group with an innovative culture. Ref: 4501

Electrical Engineer

London, £38 - £42p/h

I have a requirement for a contract electrical engineer to work on a long-term contract in London. You will provide designs from conception through to completion on high end commercial projects. The work is predominantly low voltage, lighting, electrical power distribution, and alarm system designs. Similar experience is essential. Immediate start. Ref 4636

Senior Mechanical Engineer

North London, £45 - £55k + benefits

Multidisciplinary consultancy urgently seeks a senior mechanical engineer to directly assist one of 4 partners within a growing office. My client is medium in size employing over 70 staff, soon to be over 100 with two new offices opening. They currently work on some of the largest Commercial, Mixed-Use, Hotel, and Residential projects in London and promise a clear career path with an excellent salary/package. Ref: 4624

Principal Electrical Engineer

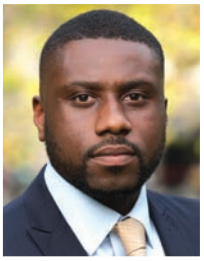
London, £55 - £60k + benefits

Brilliant opportunity for an inspirational and ambitious principal electrical engineer to join a highly regarded, dynamic, global consultancy in London who employ well over 500 staff across the globe. They are currently working on one of the largest and most iconic commercial projects in the UK, and due to this complex and technically engaging project along with an impressive order book of projects are actively looking for a principal electrical engineer to join this established team. BAR 4663

Thinking of your future

www.b-a-r.com

The Stratford scheme on which Raphael Amajuoyi is working



Making headway

CIBSE Graduate of the Year 2017 Raphael Amajuoyi explains how he deals with working in a dynamic environment and why change is integral to the industry

After achieving a BSc in architectural engineering and design management, and an MSc in low carbon building design and modelling, both from Loughborough University, Raphael Amajuoyi joined Hurley Palmer Flatt as a graduate consultant. He uses his academic knowledge to advise clients and design teams on low energy and sustainable development projects.

Q What was it like to win the award?

A It feels amazing. I was up against impressive competition with the other finalists – some coming from as far as Sydney and Los Angeles – showing they have what it takes to walk away with the ultimate prize. A great deal of effort and time had gone into submitting my entry in August, and I was delighted to be shortlisted as a finalist. Going on to win is great.

Q What inspired you to become an engineer?

A As a child, I was influenced by more than one culture. Spending my childhood in London, I became accustomed to conservative architectural influences. I was fascinated by historic buildings, built several centuries ago, and remember being dumbfounded by how they remained intact for such a long time. My teenage years were spent in Africa, where I was introduced to a completely different architecture style. Cities with newly formed economies are developing at a rapid rate, with over-the-top buildings. Inspiration in architecture and engineering comes from how both styles can be harmonised – the way historic buildings and new-build developments are coming together to redefine the city's skyline.

Q Has your view of the industry changed since you graduated?

A Yes, definitely. As with any simulation process, true insight only comes once you have real industry experience. I am involved in providing consultation through meetings and workshops, which help in developing my understanding of energy and sustainability. This experience continuously challenges my initial expectation, which I thought would only involve report writing and offering recommendations.

Q What are you working on now?

A Since joining Hurley Palmer Flatt in September 2015, I have been involved in residential, commercial and mixed-use projects within the UK and across Europe. I am currently working on a multi-tower, mixed-use development in the East Village, Stratford City (on the same site as the London 2012 Olympic village). It features more than 400 residential apartments, retail and shared-amenity spaces. As part of my responsibility, I have assisted with consulting the client and design team on the risk of overheating in a sample of apartment types, as well as in the retail and shared-amenity areas.

Q What are the biggest challenges in building services design?

A In such a dynamic environment, 'change' is one of the few constants. A three-bedroom apartment can be south-facing, moderately glazed, with a mechanical ventilation heat recovery unit today and, by tomorrow, be redesigned to a two-bedroom apartment, east-facing, highly-glazed with natural ventilation. These changes have an influence on the building services design.

The biggest challenge for me is being prepared to adapt to the dynamic nature of projects, especially during conceptual design stages, when ideas are susceptible to change.

A great tool to develop and deploy is visual representation – by using pictures we paint a thousand words. The majority of people can visualise a window, a kitchen or bathroom – but when it comes to hidden items, such as pipework, cabling or fan coil units, it's a different story.

Q What would you like to do in the future?

A I look forward to developing my career as an energy and sustainability development consultant. I also hope to gain experience in business development through a client-facing role, offering our capabilities to a wider audience across Europe and other parts of the world. I believe the potential for the built environment has only just begun, as several countries in the developing world are yet to benefit from what sustainable/low or zero carbon buildings have to offer.

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

A If you are looking for a career path that is truly rewarding, look no further. There is no better feeling than being involved in a project, irrespective of the scale of your contribution, and seeing it being constructed – or, better, completed and in-use. As with any career, it comes with its challenges, but these are heavily outweighed by the benefits. Take a look around you and decide for yourself.

RAPHAEL AMAJUOYI is a graduate consultant within the energy and sustainability development team at Hurley Palmer Flatt

EVENTS

HIGHLIGHTS

Helen Loomes, of Trilux, will speak at Build2Perform

Build2Perform speaker Itai Palti, founder of Conscious Cities

Dwight Wilson, Imtech Engineering, will speak at Build2Perform

NATIONAL EVENTS AND CONFERENCES

Build2Perform Live
21-22 November, London
This free, two-day, interactive event is dedicated to helping built-environment professionals – and the wider supply chain – improve efficiency and save money through effective building services. This new event offers multiple seminar streams, encompassing an entire floor of London's Olympia Exhibition Centre.
www.cibse.org/b2plive

CPD TRAINING

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

Designing water-efficient hot and cold supplies
8 November, London

Standby diesel generator
9 November, London

High-voltage (11kV) distribution and protection
10 November, London

Mechanical services explained
14-16 November, London

Fire smoke control: matching the method to the building
15 November, London

Building services explained
15-17 November, Manchester

Practical approach to LV fault analysis
17 November, London

IET wiring regulations
21 November, London

Electrical services explained
21-23 November, Manchester

Practical controls for HVAC systems
22 November, London

Lighting: legislation and energy efficiency
24 November, London

Introduction to combined heat and power
24 November, London

Gas safety regulations (designing for compliance)
27 November, London

Air conditioning and cooling systems
1 December, London

Fire safety in the design, management and use of buildings: BS 9999
1 December, London

ENERGY ASSESSOR TRAINING

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

Fundamentals of digital engineering (including BIM)
6 November, London

Air conditioning inspection for buildings
14 November, London

LCC building operations and DEC
20-22 November, Birmingham

Heat Networks Code of Practice
21-22 November, London

ISO 50001:2011
21-23 November, London

Air conditioning inspection for buildings
28 November, Manchester

LCC building design and EPC
28-29 November, London

CIBSE GROUPS, SOCIETIES AND REGIONS

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

HCNW: Energy economy environment
7 November, High Wycombe
Asking questions around energy resources, renewable energy, and energy profits in relation to climate change.

North East: The role for energy storage (in all its forms)
7 November, Newcastle upon Tyne
Considering the role and economics of integrating energy storage in our homes and buildings, with speaker Nigel Banks, of Keepmoat.

FM Group: Hays UK salary and recruiting trends 2018 guide
7 November, London
With Pippa Morgan, CBI head of education and skills, and Gaelle Blake, director, Hays.

HCNW: The legal angle
9 November, London
This interactive workshop, with speaker Stephen Rockhill, suggests a collaborative approach between lawyers and engineers.

Yorkshire: Yorkshire Awards
10 November, Leeds
Returning for a second year, the Yorkshire Awards will celebrate achievements in the region, with guest speaker Peter Head, civil and structural engineer, and founder and chief executive at the Ecological Sequestration Trust.

SoPHE: Water pressure control in tall buildings
15 November, Manchester
With speaker Andrew Stokes-Roberts, of Honeywell.

West Midlands: Legionella control
15 November, Birmingham
Understanding the bacteria and the conditions it needs to proliferate, and a look at a range of control measures.

Yorkshire: Well Building Standard
22 November, Leeds
Andy Chell, from Lumilow Lighting, will look at the Well Building Standard, with a special focus on light.

SoPHE: Sprinkler systems within high-rise residential blocks
22 November, Birmingham
Presentation, by ProjectFire, on sprinkler systems within high-rise residential blocks, covering water supplies and storage.

West Midlands: Membership briefing
29 November, Birmingham
Briefing with a focus on Associate and Member grade applications, and registration with the Engineering Council.

SLL: Light Bites
30 November, Dublin
The second of the SLL Knowledge Series events, with peer-reviewed, bitesize presentations on the topics of design, specify, build, and future.

ANZ: WA Chapter annual Christmas lunch
1 December, Crawley, WA
With guest speaker Kieran Kinsella, of the Metropolitan Redevelopment Authority.

HCNW: HCNW papers
4 December, London
Inviting regional members to submit papers and presentations.

Yorkshire: Social – end-of-year wrap-up
5 December, Leeds
An informal social event, with short presentations from five speakers.

New course: Fundamentals of digital engineering (including BIM)

6 November, London; 6 December, London; and 24 January, Birmingham

Launched by CIBSE, this course brings together content from the hugely successful CIBSE BIM Roadshows into a one-day training course, allowing engineers – and the wider supply chain – to learn about digital engineering in practice.

From pre-concept to completion, presenters will use a case study to demonstrate the real-world application of digital technologies and workflows. Discover, for example, how to implement building information modelling (BIM) throughout each stage of a project. The course is designed to help attendees identify any knowledge and skills gaps, as well as to plan how to incorporate and implement BIM into their business.

Carl Collins, digital engineering consultant at CIBSE, is the speaker for this training course, and will be speaking in the BIM & digital engineering sessions at Build2Perform Live too. See **cibse.org/b2plive** For information and to book, visit **www.cibse.org/Digital-Engineering-Training**

CMR in complete control

CMR Controls manufactures low air pressure and air volume measurement sensors and control systems for standard air conditioning, clean rooms, sterile laboratories, containment facilities, and fume cupboard extract systems.

DPC CONTROLLER

Fast and accurate controls to drive high speed dampers or invertors. Full PID stand alone controls with BMS interface.

DPM PRESSURE SENSOR

Panel Mount Pressure or Velocity Transducers with remote alarms, analogue and digital interfaces. Traceable calibration certificates supplied as standard.

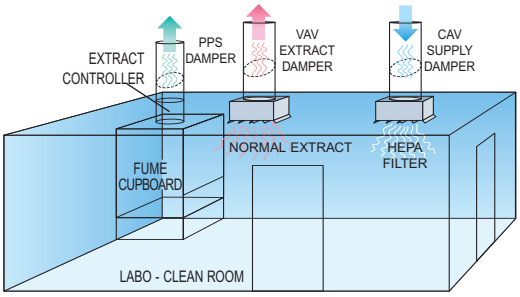
CAV AND VAV DAMPERS

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

Metal Damper

AIR MANAGEMENT SYSTEM

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



PPS EXTRACT DAMPER

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

PPS Damper

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CMR CONTROLS

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E-mail: sales@cmr.co.uk

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