CIBSE JOURNAL

The official magazine of the Chartered Institution of Building Services Engineers

June 2011

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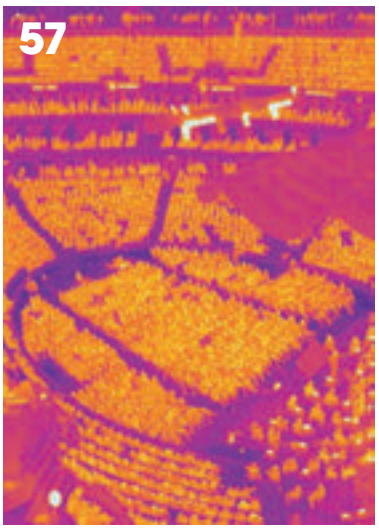

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CLASSIFIED

PEOPLE AND JOBS

CIBSE JOURNAL

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Editorial
Editor: Bob Cervi
Tel: 01223 273520
Email: bcervi@cibsejournal.com
Reporter: Carina Bailey
Tel: 01223 273521
Email: cbailey@cibsejournal.com
Senior designer: David Houghton
Technical editor: Tim Dwyer

Advertisement sales
Sales manager: Jim Folley
Tel: 020 7324 2786
Email: jim.folley@redactive.co.uk
Sales consultant: Mark Palmer
Tel: 020 7324 2785
Email: mark.palmer@redactive.co.uk
Sales executive: Darren Hale
Tel: 020 7880 6206
Email: darren.hale@redactive.co.uk
Recruitment sales: Stephen Fontana
Tel: 020 7324 2787
Email: stephen.fontana@redactive.co.uk
Advertising production: Jane Easterman
Tel: 020 7880 6248
Email: jane.easterman@redactive.co.uk

For CIBSE
Publishing co-ordinator: Nicola Hurley
Tel: 020 8772 3697, email: nhurley@cibse.org

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Tel: 020 8675 5211. www.cibse.org

Subscription Enquiries
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Nicola Hurley at nhurley@cibse.org or telephone 020 8772 3697.Individual copies are also available at a cost of £7 per copy plus postage.

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The logic of putting green before growth

So now we know. Fierce opposition within government to the adoption of tough new targets for cutting UK carbon emissions has been pushed aside – despite that opposition being led by such heavyweights as Chancellor George Osborne and Business Secretary Vince Cable. They might argue that the new targets could put the nation's recovery at risk. But it seems that the strong lobbying of David Cameron by environmental campaigners in recent weeks may have pushed the Prime Minister towards accepting the need to sometimes put 'green' ahead of 'growth' in economic policy.

And so he should. The government's new commitment to seek to cut emissions by 50% in 2027 – part of a new 'fourth carbon budget' for Britain – is the only logical step forward if the UK is to realistically achieve the long-standing target of an 80% cut by 2050. So far so good. But the actions needed to make these targets a reality could still be undermined by ministerial hostility to key policies – one recent example being the government's apparent rejection of calls to amend the Energy Bill to include government proposals to extend mandatory Display Energy Certificates to commercial buildings. This is a lost opportunity to bring such a significant change into force speedily, rather than risk letting its implementation date disappear into the future.

> Ministers need to display a commitment to the speedy implementation of key green policies

Before the announcement of the carbon target for 2027 the Green Alliance, which represents more than a dozen leading environmental groups, wrote to Cameron to warn against green policies being 'endlessly debated and watered down' by ministers. Cameron may rightly respond that the fourth carbon budget shows the government is still on track. But to be truly on target, ministers need to display a commitment to the rapid implementation of key green policies in the built environment.

Ministers must also halt the dilution of crucial initiatives, such as with the recent downgrading of the definition of 'zero carbon' new homes. Only then will the government sound sincere in its declared ambition to be the greenest ever.

Bob Cervi, Editor
bcervi@cibsejournal.com

NEWS

All the latest developments from around the building industry

In Brief

SOLAR FEED-IN REVIEW 'A RISK'
The success of commercial solar panel schemes is being put at risk by the government's review of feed-in tariffs, according to the Electrical Contractors Association (ECA). The government reduced subsidies for solar arrays above 50kW – but the ECA says the limit should be 150kW to encourage community projects such as panels on schools and local authority buildings.

'LOOK AND LEARN'
The government should learn some lessons from its involvement in the Private Finance Initiative programme, according to the National Audit Office. Ministers should use better arrangements to 'test, challenge and, if necessary, stop projects', said the NAO.

GREEN LIGHT FOR PILOT
Plans to build a £6m low-carbon pilot housing scheme have been given the go-ahead. The AIMC4 consortium will build 17 homes, each in a different location, as part of the trial. All of the homes, will be built to Level 4 of the Code for Sustainable Homes.
See the Housing Special starting on page 32

Backing for DEC strategy

Leading industry bodies say roll-out of certificates should not be voluntary

There is growing support for the roll-out of mandatory Display Energy Certificates (DECs) into the private sector.

The UK Green Building Council and British Property Federation have added their names to an open letter – also signed by representatives of British Land, Land Securities and Hammerson among 19 other leading industry figures – encouraging the government to extend DECs to cover private properties.

Currently DECs, which measure a building's energy efficiency, apply only to public buildings. The bodies called for the government to enable the Energy Bill currently going through Parliament to be used to legislate for the roll-out of DECs

The letter states: 'Unfortunately, a voluntary approach to take-up in the private sector will not work, because without that level playing field there is a reputational risk for those businesses that voluntarily adopt certification and achieve poor ratings.

'Therefore, as representatives of the commercial property sector, we believe it is vital that government extends mandatory DECs to private sector buildings. We do not believe this will provide an undue burden on businesses of any size, as evidence demonstrates that savings resulting from the application of this scheme significantly outweigh any costs, from year one. Indeed, DECs for small businesses could be automated and even provided free of charge, based on existing energy bills.'

'A voluntary approach to take-up in the private sector will not work'


Andy Ford, CIBSE president, says the sector needs to support the roll-out of DECs

Andy Ford, CIBSE president, said: 'CIBSE welcomes the support of leading players in the property sector for the further roll-out of DECs.

'Those at the forefront of the property sector understand the need to manage and benchmark emissions from buildings.

'But we need the whole sector, not just the leading players, to do this – and CIBSE is committed to working with the sector to identify opportunities to improve energy performance of existing buildings.

'DECs offer a cost-effective energy management tool to motivate improvement and reduce energy costs to businesses.'

CIBSE has also completed an analysis of the first 45,000 DECs, and in particular the benchmarks used to calculate the DEC ratings. The review found that the benchmarks are generally fit for purpose and accurately reflect the performance of the building stock (see page 28 of the May *Journal*).

'World-leading' carbon target wins backing

- **Government accepts committee proposal for a 50% cut in CO_2 emissions by 2027**

Industry figures have backed the government's announcement that it has accepted a proposed target to cut greenhouse gas emissions to 50% of their 1990 levels by 2027.

The proposal, set out by Energy and Climate Change Secretary Chris Huhne, is in line with advice from the independent Committee on Climate Change. It sets a 'fourth carbon budget' of 1,950 $MtCO_2e$ for the period that will span from 2023 to 2027, putting the UK on course to further cut emissions by at least 80% by 2050, according to Huhne.

The government hopes the carbon budget will place the British economy at the leading edge of a new global 'industrial transformation', and ensure low carbon energy security and decarbonisation is achieved at least cost to the consumer. The UK Green Building Council (UKGBC) has strongly endorsed the government's commitment to low carbon, saying that the built environment has to be at the heart of the UK's strategy for meeting that target.

Paul King, its chief executive, said: 'This is a world-leading target – and absolutely the right decision. Government has shown it still has the ambition, but the proof of the pudding will be in the policies – 43% of carbon emissions in the UK come from the energy we use in our homes and buildings and this is where the most cost-effective, pro-business carbon savings are.

The Electrical Contractors' Association (ECA) urged the government to prioritise financial support for installing high-tech energy efficiency improvements.

Paul Reeve, its head of environment and safety, said: 'So far, the Green Deal has focused on 'passive' elements like improved glazing and insulation. Some of these measures have payback periods of over a decade; a significant burden for a homeowner.

'Properly installed 'active' energy efficiency improvements on the other hand, such as LED lighting and smart control systems, can pay for themselves in half that time or less. It would be ridiculous if the government only offered Green Deal loans for the passive, long-term measures when there are investments that mean homeowners will have lower energy bills and smaller carbon footprints in five years.'

'It would be ridiculous if the government only offered Green Deal loans for the passive, long-term measures when active improvements can pay for themselves'

For more information visit:
www.decc.gov.uk

Low carbon 'transition'

The package also includes measures to minimise costs of the low-carbon transition to industries exposed to international competition:

- **In line with the Coalition Agreement, the government says it will continue to argue for an EU move to a 30% target for 2020, and ambitious action in the 2020s. Progress in EU climate negotiations will be reviewed in early 2014. If at that point the UK's domestic commitments place it on a different emissions trajectory than the EU Emissions Trading System trajectory agreed by the EU, the government says it will revise its budget to align it with the actual EU trajectory.**
- **Before the end of the year the government will announce a package of measures to reduce the impact of policy on the cost of electricity for energy-intensive industries and to help them adjust to the 'low-carbon industrial transformation'.**

Green bank 'must borrow'

The UK could lose out on hundreds of billions of pounds of vital investment in green energy projects if the government waters down its plans for a Green Investment Bank, MPs have warned.

The coalition government promised to establish a Green Investment Bank and the Chancellor pledged £1bn to capitalise it in the Spending Review, together with unspecified proceeds from the sale of government assets.

But there have been reports of disagreement within government as to whether it should be a fully fledged

investment 'bank', able to borrow money and raise further capital – or simply a 'fund'.

Chair of the Environmental Audit Committee, Joan Walley MP, said: 'If the government is serious about being the "greenest ever", the Chancellor must ensure the Green Investment Bank can do what it says on the tin and raise extra capital like a real bank. The UK desperately needs a game-changing injection of private sector investment if we are going to meet our climate change targets and move to a green economy.'

In Brief

BUSINESS GROWS IN CAPITAL
Office space in London continued to outperform all other sectors and regions of the UK's commercial property market during the first three months of 2011, according to the latest RICS UK Commercial Market Survey. Demand for office space in Greater London rose dramatically during Q1 2011, with 43% more surveyors reporting increases in demand.

AECOM LEAVES LIBYA
Engineering services company AECOM has reported a 21% increase in revenue – despite leaving one of its major markets due to political instability. Aecom left Libya in the second quarter of its financial year but its revenue increased to £1.9bn. However, its net income dropped 2% – from £59m to £58m. The company says it is poised for 'continued strong performance'.

MOTT PROFITS UP
Mott Macdonald increased its pre-tax profit last year, despite the engineering group's revenue remaining static. Pre-tax profits grew from £45m to £49.3m on a turnover of £1.035bn – an increase of 2%. In the UK, revenue was down, and the company has been forced to cut staff by 10% over the last two years. Uk business now only accounts for 33% of the company's turnover – five years ago the figure was 60%.

From April 2018 it will be illegal to rent out a house that has lower than an E energy rating, under the proposals

Rental properties to be subject to E energy rating

- **Minister says at least 682,000 properties will have to be improved under the plan**

Properties with an energy rating lower than E will become ineligible for the rental market in five years' time, the government has announced.

Energy Secretary Chris Huhne, in the second reading of the Energy Bill in May, announced that under the Green Deal:

- From April 2016, landlords will be unable to refuse 'reasonable requests' from tenants or local authorities acting on their behalf to carry out improvements on properties; and
- From April 2018, it will be illegal to rent out a house or business property which has less than an E energy efficiency rating. The government says this will ensure that at least 682,000 properties will have to be improved.

'There are far more carbon emissions emanating from the owner-occupied sector'

From next year the Green Deal will allow property owners to access finance to pay in advance for improvements. The money will be able to be repaid over 25 years, offset against fuel bills.

The government has stated that the initiative 'will help the most vulnerable, as more than a quarter of a million of the worst-insulated rented homes are classified as fuel-poor.'

Ian Fletcher, director of policy at the British Property Federation, said: 'Some will also query why the department is placing so much stall on the private rented, when there are far more carbon emissions emanating from the owner-occupied sector. '

Fletcher added: 'Regardless, it is important that landlords start to consider whether they will be caught and have their plans ready for when the Green Deal goes live next year. The government has binding climate change commitments and landlords are party to those.'

Movers & Shakers | The latest appointments in the sector

Malcolm Wallace has returned to work at Arup after six years working independently in Africa. He joins the firm's Toronto office as an electrical engineer.

NG Bailey has announced **Sean Wickens** as a key appointment to its executive team. Wickens was formerly business development director at Carillion plc's planned maintenance division.

BHE Services (Bolton) has announced the appointment of **Daniel Silcock**, who will now head the company's recently launched renewable energy services division.

Daikin UK has appointed **Andrew Crown** as commercial manager of its heating and renewables division. The move is part of the company's drive to grow its domestic heating and renewables market.

Brian Price has stepped down as managing director of boiler supplier Remeha after 21 years at the company.

Mark Northcott, formerly commercial products director at Remeha, has been promoted to managing director of the boiler supplier.

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DAIKIN

Convertible schools planned

Liverpool council is considering plans to build four secondary schools that can be easily converted into commercial properties if they are are no longer needed.

The structures, which are being proposed in response to the *Sebastian James Review* on standardisation and cost-reduction, are more usual in airport and sporting facilities, with a detachable interior and modular units that can easily be taken apart and re-assembled.

Liverpool council is asking for help from the private sector, having lost more than £300m in funding when the Building Schools for the Future (BSF) scheme was cancelled last year. It will also raise money through selling land and will apply for education department funding.

BSF project director Ron Rampling said: 'Liverpool has experienced 12 years of falling pupil numbers and now they're building up again, but in different areas. These models mean that if, for some reason, the population shifts, what you're left with is not a duff school but a very attractive commercial space.'

Five-year plan for BIM development

The government is expected to announce its five-year plan to ensure building information modelling (BIM) becomes an inherent part of the construction sector this month.

Chief construction adviser Paul Morrell spoke about the benefits and challenges of BIM at a roundtable debate, hosted by National Building Specification (NBS) at RIBA's London headquarters. Morrell also revealed for the first time that BIM is set to apply to government projects worth about £5m, rather than £50m, as previously suggested.

'There's a huge gulf between those who get it and those who don't,' said Morrell.

Morrell suggested that those who failed to adopt BIM risked being 'Betamaxed out' of the process, adding that the five-year phase-in will allow industry to adapt.

CIBSE leads the way on Part L changes

A new working group will look at cutting carbon further in non-domestic buildings

CIBSE is leading the non-domestic working group advising the Department for Communities and Local Government (CLG) and Building Regulations Advisory Committee (BRAC) on planned changes to Part L of the Building Regulations.

Dr Foroutan Parand, head of building physics at URS/Scott Wilson, is chairing the group, which is made up of a cross-section of industry participants.

Part L of the Building Regulations is being used as one of the measures to achieve the government's commitment to an 80% reduction in carbon emissions by 2050, as contained in the Climate Change Act and elaborated in the UK Carbon Plan. For new buildings, the Part L review is particularly important as it paves the way for zero carbon emissions buildings planned for 2016 (domestic) and 2019 (non domestic) buildings, says CIBSE.

The working group will look at the potential to further reduce carbon emissions from new and existing non-domestic buildings within the broader policy constraints set by the coalition government, and will be reporting to BRAC in July 2011 with its recommendations.

Dr Parand said: 'Buildings are responsible for more than 45% of UK carbon emissions. Reduction of energy consumption in buildings not only reduces their harmful impact on the environment, but will also help improve the security of supply as well as reducing energy cost burden on households, businesses and industry. The challenge is to achieve this without increasing the regulatory cost burden – a true win-win situation for all. I am delighted that I have been given this important task at such a crucial time for developing the UK route map to zero emission buildings.'

Foroutan Parand is chairing the group

'The challenge is to achieve this without increasing the regulatory cost burden – a true win-win situation for all'

A full public consultation is scheduled to be launched by CLG towards the end of the year. Parallel groups are looking at domestic standards, compliance and performance, and potential links between the

For more information visit:
www.cibse.org

ODA performance 'game-changing'

The Olympic Delivery Authority (ODA) is setting a fine example on sustainable building standards and should be emulated by the entire construction sector. That is the view of the London 2012 Organising Committee (LOCOG), which has published a sustainability report that predicts a low carbon Games.

The report states: 'Through the use of a groundbreaking carbon footprint methodology to inform LOCOG 's venue design, choice of overlay materials and procurement strategy, LOCOG has halved one of the largest segments of footprint – more than 100,000 tonnes of carbon emissions avoided.'

LOCOG 's chief executive Paul Deighton added: 'Not only have they delivered wonderful facilities ahead of schedule and under budget, they have also delivered unprecedented sustainability standards through a rigorous approach involving on-site teams and management. The ODA's performance in this area should be game-changing for the construction industry. I look to the government, the mayor of London and construction firms to follow the ODA's example.'

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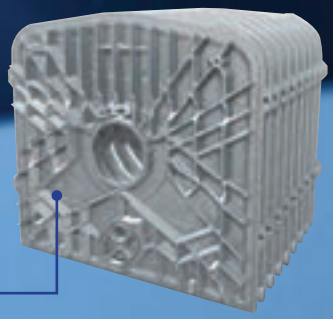

Tel: 020 8675 5211 | **Fax:** 020 8675 5449 | **Email:** secretary@cibse.org
President: Andy Ford CEng FCIBSE BSc Eng | **Chief executive:** Stephen Matthews

Future positive

Young engineers meet to discuss their activities and the wider sector

The first ever CIBSE Young Engineers Network (YEN) Conference took place in April, in Edinburgh. The event brought together chairmen and vice chairmen from regional centres, and gave an opportunity for some of the most active young engineers to discuss their work and the wider activity of the network.

The conference discussed ways to support and engage the work of younger engineers at an international and regional level. Attendees shared ideas and experiences of running events and activities for younger engineers, of working with other professional groups, and of engaging the wider CIBSE membership. They also agreed that YEN would nominate their own representative to its council.

Rob Manning, outgoing CIBSE president, outlined the work of the Institution and the strategic plan for the next five years, emphasising the importance of younger members to that plan.

Neil Thompson, from YEN London South Bank University Centre, said: 'I think, as young people entering the engineering profession, we should be encouraged to take part in shaping the industry that we work in, so I am here to help us tackle that problem.'

There was also a site visit to the Royal Commonwealth Games Pool, which is currently undergoing a major refurbishment, 40 years after the Games for which it was first built. Alan McCullough, project manager for main contractor Graham Construction, and Janice Foster of engineers Buro Happold, guided the group around the site as they saw how this Grade-A listed building is being remodelled to meet the needs of today's users. Even on such a sensitive piece of architectural heritage, the use of renewable energy and reduction of energy demand were prominent.

The first ever CIBSE Young Engineers Network Conference drew attendees from across the regions

'We should be encouraged to take part in shaping the industry that we work in'

The CIBSE YEN Conference was made possible by the generous support of Baxi Commercial Division, Heatrae Sadia, CIBSE Patrons and CIBSE Scotland. The site visit was organised with the support of Graham Construction. Young Engineers' Network Centres are particularly intended to bring together engineers in the earlier stages of their engineering careers, generally those under the age of 35, although there is no formal age restriction.

For more information visit:
www.cibse.org/yen

Bronze medal and Benevolent Fund award

John Benn was awarded the CIBSE Bronze Medal Award in December. It was presented to him at his home in January by Keith Maloney, chairman of the Merseyside and North Wales Region.

In 2000, he was diagnosed with spastic paraparesis, or FSP, and in 2007 he became wheelchair-dependent and unable to attend CIBSE regional meetings or social functions. John is married to Angela, his registered carer, and after a very successful career in building services engineering, has recently retired from Gifford Consulting Engineers in Chester.

The CIBSE Benevolent Fund Trust was delighted to make a contribution to John and his family, for the purchase of a specially adapted multi-functional mobility chair, which has made life so much easier for the family in general, and John in particular.

This support reflects the work of the fund, which relies on voluntary contributions from the CIBSE membership in general (some 50% of total funds) and revenue from regional and social activities, involving members, friends and supporters in the industry. Single donations and legacies are most welcome. For more information about the work of the Trust Fund, visit **www.cibse.org/benfund**

Two fine Fellows

Two CIBSE members were awarded Honorary Fellowships at the AGM in May, in recognition of their commitment and contribution to the Institution: Terry Giles, left, and John Armstrong, right, with Rob Manning, past president.

Diary date

CIBSE Technical Symposium
In association with De Montfort University
6-7 September, Leicester
www.cibse.org/events

Win a trip to Chicago!

This year's Graduate of the Year award is now open for entries.

The award, sponsored by Baxi Commercial Division, is now in its 16th year and is established as one of the industries most sought-after accolades. This year's first prize is a trip to the ASHRAE Conference in Chicago.

To be eligible to enter, you must have graduated in a building services-related

discipline within the last two years. Those shortlisted will be invited to give a short presentation, in front of the judging panel and audience, on 6 October 2011, at the Institution of Mechanical Engineers, in London. The topic for the presentation will be confirmed in advance to those shortlisted.

The event will be followed by an evening reception hosted by CIBSE's Young Engineers Network. For more information, and an application form, visit **www.cibse.org/awards**

Undergraduate Award 2010 entries sought

Entries are now open for this year's CIBSE Undergraduate Award 2010, sponsored by Hays Building Services.

The award, with a first prize of £500, and runner-up prize of £100, is open to all students in the final year of their BSc, BEng, MEng or MSc courses and provides a great opportunity to get recognised at a national level.

To enter, please send us a 2,000 word synopsis of your final year project. Judges will be looking for clear, easy to read submissions with a strong theme and sound understanding of engineering science, design, and originality. The closing date is 29 July 2011. **www.cibse.org/awards**

Coalition consults on efficiency plan

Key decisions still to be made on policy to fund energy improvements in homes

"Green Deal" is a flagship policy to enable property owners and tenants to fund energy efficiency improvements through funding which will be legally associated with their energy meter and repaid out of the cost savings resulting from the installed Green Deal measures. It is a key element of the Energy Bill currently passing through parliament.

Green Deal is intended to be open to both domestic and non-domestic properties, and to owner occupied and other forms of tenure.

The Department for Energy and Climate Change is consulting on various aspects of the policy, including accreditation of Green Deal advisors to advise on measures which could be installed in a property and deliver sufficient energy savings to meet the requirement for the savings to exceed the repayment costs of the Plan.

It is also working on details of the measures, which will have to be permanent installations, but it is not yet clear what permanent might mean in this context.

A commercial working group is looking at how this might all work in a mixed use, multi-tenanted commercial property, considering who might have to consent, what might constitute reasonable grounds for withholding consent, and exactly how the repayment arrangements might work in this market.

> 'Green Deal has the potential to have a major impact on the work of building services engineers'

This also connects to the current review of Part L of the Building Regulations, where the Green Deal could potentially fund consequential improvements required by the Regulations.

There is still a great deal to be decided, and the various discussions still have some way to go, but Green Deal has the potential to have a major impact on the work of building services engineers. As the policy develops information will be made available on the Consultations section of the Knowledge Bank on the CIBSE website.

For more information visit:
www.decc.gov.uk

Heritage chair stands down

Brian Roberts has stood down as chairman of the Heritage Group after 29 years in the role. The group, which was the first CIBSE special interest group to form, started life as the IHVE Archaeology of Building Services Working Party in 1973, taking its current title in 1982 when Brian became its first chairman.

As well as being chairman, Brian has been the very backbone of the group and his output of lectures, papers and books on the history and development of building services engineering has been prodigious. His book *Building services engineering – a review of its development*, written with Neville Billington in 1984, is generally accepted to be the most important reference book for any study of the history of our industry.

Brian Roberts (right) is presented with his certificate by new chairman Dr Neil Sturrock

As well as scores of published papers, Brian has produced about 90 electronic books – all of which are available to download from the Heritage Group's website at **www.hevac-heritage.org**

He also authored the CIBSE centenary book, *The Quest for Comfort*, in 1997, which, thanks to sponsorship, was presented free to every member.

By way of a thank-you, the Heritage Group committee presented Brian with a framed certificate and a scale model of a boiler, made by group member Andrew More. Brian still intends to stay active on the committee as editor of its newsletter.

New members, Fellows and Associates

FELLOW

Frankie Chan Cheung Sha Wan, Hong Kong

Frankie Chan is operations director of the Trane Hong Kong office, overseeing the service and contracting business in Hong Kong. He has more than 20 years' experience in the building and construction industry, and is particularly interested in building energy management.

Jianlei Niu Hunghom, Hong Kong

Prof Jianlei Niu is associate head of department of building service engineering at Hong Kong Polytechnic University. He has more than 25 years' experience in research, consultancy and teaching. Under his leadership the university's research is becoming internationally recognised.

Christopher Twinn Woodford Green, UK

Chris Twinn is a director and senior sustainability consultant with Arup, working in the UK and China. He has delivered many low and zero carbon projects and has a particular interest in behavioural issues and reducing costs through sustainable methods.

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SKILLING UP

Achieving the green agenda means having the right toolkit – which is where a new academy for environmental technologies comes in, writes **Keith Marshall**

With so much focus on budget deficit reduction, it's sometimes too easy to overlook other pressing concerns facing the UK. From the many challenges to be met over the coming years, the task of ensuring we have a sustainable, low carbon economy – along with the skills to support it – remains a defining issue.

It is accepted that there need to be alterations in how we use energy and water in our homes and commercial buildings, if we are to meet this challenge, but how? Inspiring individuals to change their approach to energy conservation provides part of the answer. The other critical part is ensuring we live in a nation with effective environmental technology infrastructures that are fit for purpose in the future low carbon age. It is an issue we cannot afford to lose sight of and, thanks to a new skills academy for the sector, we won't.

The National Skills Academy for Environmental Technologies (NSAET) will transform the ability of businesses in the sector to meet the increased demand for the design, installation and maintenance of renewable technologies in the UK. By providing a single focal point for green skills and qualifications in the building services engineering sector, the new academy will be the route to ensure that the UK's workforce can deliver the low carbon strategies needed for the future.

As an employer-led Sector Skills Council, we strive to further the skills of the plumbing, electrical, heating and ventilating engineers in the sector. We recognised some time ago the role these individuals would play in helping to reduce the use of non-renewable natural resources by driving the adoption of environmental technologies in the built environment. The new academy will support them in doing this, as well as help the sector achieve the right mix of competences required by identifying skills needs, creating qualifications standards, and ensuring suitable training provision is available.

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> Delivering a mix of skills and knowledge is essential to creating long-term sustainability and wealth in the UK's emerging low carbon economy

Working to meet the needs identified by employers, the new academy will equip the sector workforce with the right level of product knowledge and design skills to make sure the most appropriate environmental technologies are used in the best way for each building. It will also ensure maintenance skills are in place so renewable technologies continue to deliver full, cost-effective benefits throughout their lifespan.

In addition to improving skills and training, the new academy will also focus on increasing business knowledge. The next generation of jobs in the sector will revolve around dealing with renewable technologies, so the new academy will work to ensure the sector's workforce is aware of the business opportunities that could arise from the installation of them. It's important to engender a spirit of entrepreneurship among businesses and their employees, so they feel comfortable embracing both new ways of working and new technology. In this way, they don't stand still and risk business obsolescence, but continually seek to strengthen their position in the marketplace and adopt new environmental technologies as they are developed.

Delivering this mix of skills and knowledge isn't just important for the building services engineering sector; it is essential for unlocking the innovation and skills essential to creating long-term sustainability and wealth in the UK's emerging low carbon economy. This is not only a time of challenge, it is also one of opportunity for those who can step up and take it.

● **KEITH MARSHALL OBE** is chief executive of SummitSkills, the Sector Skills Council for the building services engineering sector

IF MONEY IS KING, CARBON IS QUEEN

We cannot wait for government to take a lead on sustainability, says **Bob Arthur**

This is a pivotal decade in meeting the requirements of the future, one in which we will need to halve our carbon emissions with a growing population. It has been said: 'We shape our buildings; thereafter, they shape us.' Never has this been more relevant to how we build. We need robust systems, and these need to be demonstrable, as speed of communication will quickly expose compromise.

Many of us think we just need to wait, and legislation will move us in the direction we need to go. But our industries need to accept that government will not make all the decisions for us.

We need to recognise the business opportunities that the 'green agenda' offers to generate a sustainable future. We should all be able to assume that, when we purchase a product, it comes from a sustainable source. Increasingly, companies are producing a position statement on 'corporate responsibility and sustainability' (CRS). These are rapidly replacing the old 'corporate social responsibility' statements. Having a CRS makes good business sense and can enhance image and reputation. And we do need to be sustainable.

> It is clear that businesses will make the change on the green agenda, not consumers – history shows us this

Current projections suggest that, in the near future, we will need more resources than our one planet can support to sustain the population. It is said that 2015 is the tipping point for global temperature, so time is against us. However, we all own the problem, and we can help to manage global warming and CO_2 emissions. Paul Morrell, the government's chief construction adviser, spoke recently at a Marks and Spencer seminar. The final points he made are relevant here: we need a plan and a programme to deliver it; we need institutions that can look to the future; and we need to measure, to do, to measure, to do – and to keep going. As Morrell puts it, if money is king, then carbon is queen.

● **BOB ARTHUR** is chairman of the Federation of Environmental Trade Associations (FETA) and president of the British Refrigeration Association. He works for Marks and Spencer. This is an extract from his speech to a recent FETA event

MANUFACTURER'S VIEWPOINT

Don't let the drive for energy efficiency leave occupants hot and bothered – achieving comfort and efficiency is both desirable and possible, writes **Martin Fahey** of Mitsubishi Electric, sponsor of this column

The technical definition of indoor air quality (IAQ) is that it should offer building occupants a pollutant-free, thermally comfortable and breathable environment. But most people can tell if a room is too hot, stuffy or draughty. The challenge is to reduce carbon emissions and energy use, while providing a healthy and comfortable environment.

Rules on ventilation of domestic and commercial buildings are covered by Part F (2010) of the Building Regulations. The legislation is prescriptive rather than descriptive, so designers can select from a number of technical solutions to find the right balance between comfort and efficiency.

> We can no longer simply install more equipment or use more energy to address the needs of a "leaky" building

We are fortunate in the UK that our climate allows for use of 'free cooling', and this should always be the preferred option for most domestic properties. But for commercial buildings, their size, design and layout mean that some element of mechanical ventilation is often necessary.

One technique that is becoming increasingly popular with designers is a ventilation system with heat recovery capability, because it offers good ventilation with excellent energy efficiency. By using already-cooled air to temper inputted fresh air, this system can reduce overall cooling loads by up to 20%.

Heat recovery units reduce the overall energy costs by extracting stale air from the building and recovering the heating or cooling energy to either warm or cool incoming fresh air. Using this method, a good heat recovery ventilation system can save up to 30% on initial capital costs of heating and cooling plant, as well as giving excellent long-term lowered energy costs.

The use of free cooling and heat recovery are important approaches to creating energy efficient and comfortable living and working environments.

These techniques embody the application of the energy hierarchy. First we need to reduce the need for building energy consumption with airtight construction, good insulation and efficient building materials. We should then identify and deploy energy efficient products and techniques (including heat recovery).

This second step can often be overlooked: but the choices of what solution to install from new – or to offer as a replacement for existing systems – will have a major bearing on emissions generated from the building during its lifetime. Only once these steps are taken should low or zero carbon technologies be considered.

Manufacturers, designers, installers and building operators all need to take responsibility for identifying and using energy efficient methods. We can no longer simply install more equipment or use more energy to address the needs of a 'leaky' building.

THE SUM OF ITS PARTS

Building Regulations seem to be in a constant state of change. **Hywel Davies** explores what's next up for review

Late last year the Department for Communities and Local Government (CLG) published a programme for reviewing the Building Regulations, which came out of several hundred responses to a call by the new minister Andrew Stunell for ideas for change.

The review timetable sets out several workstreams, including the latest review of Part L. A particular emphasis of the programme is 'a significant deregulatory workstream', which will focus in particular on Part P, which covers domestic electrical installations. Part P was introduced in 2005 in an attempt to reduce the level of incidents arising from poor electrical installation work in homes.

On Part P, responses to the minister's call for ideas were evenly divided between those who favour the status quo and those who either consider Part P to be unnecessary, or argue that electrical work should be treated in the same way as gas work, and only suitably qualified and registered people should be allowed to work on electrical installations. But a clear majority of those commenting on the Your Freedom website supported revision of the existing regulations.

The majority view was that the cost of demonstrating compliance, either in building control fees or registration as a competent person, is an unfair burden on those who seek to comply, who tend not to be those who are most likely to carry out unsafe or sub-standard work.

As a result of this, CLG plans to review the outcomes of introducing Part P to establish whether the regulations have had the desired effect. They will also review the implementation and compliance mechanisms to 'determine whether there is any case for change'.

The deregulatory strand will also look at rationalising Parts K (staircases and balconies), M (access to buildings) and N (glazing), where there are concerns about possible conflicts and contradictions between these parts and a 'desire to reduce the regulatory burden'. There is also a relatively high level of queries from both industry and building control professionals, which suggests that there is scope for review of these parts, but only to address these concerns and not to undertake a wider review.

The Part L work strand will also consider, among other issues, the various responses received that advocated introducing security requirements into the regulations under the provisions of the Sustainable and Secure Buildings Act 2004.

A further task for 2011 is to review the existing regulations against the Construction Products Regulations and to consider the impact of the new Eurocodes on Parts A and C.

The purpose of all this work is to decide where there is a case for further changes in 2013. Any such changes will have to be consistent with the 'one in, one out' principle and the overall deregulatory tenor of the current administration.

What is becoming increasingly clear is that even where there is a consensus of industry leaders who support regulation – and a clear argument for the benefits of such rules – the challenge for all those who seek to improve the Building Regulations will be to demonstrate the clear cost benefit case for future changes. Are CIBSE members up for the challenge?

WEB LINKS

To see the full CLG plan, *Future changes to the Building Regulations – next steps*, visit **www.communities.gov.uk/publications/planningandbuilding/buildingregsnextsteps**

HYWEL DAVIES is technical director of CIBSE

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Pre-cast walls, floors, ceilings and columns have been used in the construction of Shafton school in Barnsley (see the case study on p26)

OFF THE WALL

Prefabricated buildings and services can save time and money but their popularity has waned in the recession. **Mark Jansen** finds, though, that off-site solutions are firmly on the agenda of developers

BDP

> When you go off site, all the reconditioning, the snagging and all the rest of it, is done in the factory

On the face of it, prefabrication is a no-brainer. The off-site manufacture and quick installation of whole buildings, or parts of them, is said to offer better build quality and shorter project times. So why has this process so far apparently only had limited impact in the industry?

Alistair Gibb, professor of construction and engineering management at Loughborough University, estimates that prefabrication, in its many forms, is used in no more than 10% of construction projects. Gibb, who previously had a career in engineering and project management with John Laing, Taylor Woodrow and Sir Robert McAlpine, backs the use of prefabrication, but says its adoption has been held back by cost issues and the recession.

'There was a significant increase [in the use of prefabrication] a few years ago, but it has been severely disrupted,' says Gibb. 'What tends to happen is there is an increase in off-site solutions during boom periods when labour is cheap and people need things doing quickly – some of the earliest uses of toilet pods were in the commercial building boom of the late 1980s.

'But when labour prices come down, it's not uncommon for the quantity surveyors, or people bidding for work, to say they can buy labour for less than the factory costs.'

Gibb also claims that many project teams simply 'do not know how to accurately assess the cost' of prefabrication versus traditional methods. While many say that off-site is 5% more expensive, Gibb argues that these comparisons are based on first price rather than outturn costs, and ignore the extra expense of problems that occur with traditional on-site methods, such as 'rework, interface coordination problems, delays and disruption'.

These are left out of bid prices on the assumption they will be covered in subsequent claims for variations. But, says Gibb, 'when you go off site, all the reconditioning, the snagging and all the rest of it, is done in the factory.'

Gibb adds that the stop-start nature of the private housing market has also worked against prefabrication, because factories need long-term commitments from buyers to invest in production facilities. 'I wouldn't argue that off-site is the answer for every situation, but it deserves a bigger share of the market than it's getting at the moment, without a doubt. I think the reason is people can't work out the real value of it.'

Model approach

Despite the industry's apparent record of resistance, there are signs that the 'prefabricators' are beginning to win the argument. Two major developers say they definitely expect to use more prefabrication once the market picks up.

'Previously, the cost may have been higher than doing the work on site, but perhaps what hasn't been properly recognised is the efficiencies achieved,' says Neil Pennell, head of sustainability and engineering at Land Securities.

'The prefab shops have improved over time; they've got larger and they're using more productive processes. They are providing a wider range of solutions and they do the work in the best possible conditions to achieve higher quality.'

Pennell has toured the construction site of the 310-metre Shard at London Bridge and been impressed by the use of prefabrication by the contractor, Mace. Tall buildings face potential problems in having to move large numbers of workers around the site quickly and efficiently, especially before the lifts are installed. Mace has reportedly reduced the number of men installing equipment on the site from an estimated 400 to just 80, thanks to prefabrication of items such as pump rooms, whereby water pumps for heating and chilled water are being brought into the site in pre-assembled groups, while risers are being dropped in several floors at a time.

Pennell points out that this requires careful planning, with walls left unbuilt until large items of prefabricated equipment have been brought inside. 'What you're fighting against is that the people who design the building don't always think about how you'd get more prefabricated stuff in by leaving walls down – the people in charge of those processes are often a bit divorced from the building's services.'

Mace declined to comment, but Pennell believes its approach at the Shard may point the way to the future: 'There's been quite a lot of interest from the industry in what they're doing.' Land Securities has begun piling work at its own 38-storey tower at 20 Fenchurch Street in the City of London, and various construction contracts are being tendered. It's too early for specifics, but Pennell says: 'There will probably be a lot of opportunities for prefabrication in the risers, a bit like the Shard's approach.'

Pennell stresses that prefabrication is not new, and almost every conceivable building item has been prefabricated in the past.

The Shard in London, currently under construction, has a range of prefabricated building features

But what has changed is that contractors and developers are now seeking to maximise its use on projects.

'People are starting to see how much they can prefabricate. The cost effectiveness is getting better and there's more scope to widen the amount of prefabrication you use, especially if you can influence the early design of the building,' says Pennell. But he adds: 'There always seems to be a shortage of skilled people to deliver these new buildings. People are thinking about it more because of these drivers.'

> The problem is that people can't work out the real value of off-site prefabrication

Future growth

Paul Edwards, head of sustainability at another major developer, Hammerson, also predicts a rise in the use of prefabrication. 'We're not doing it at the moment because there's no [new] construction going on in our world, but that doesn't mean we won't be in the future,' he says.

'We are interested in it and have looked at it several times for different reasons. I think it is something we'll get involved in,' says Edwards, who emphasises the benefit of reduced site waste, which will become more important as landfill costs rise: 'Waste is going to cost a lot of money.'

Speed of construction, more consistent build quality and improved safety are also cited by Edwards as reasons for

Case study Modular corridors fitted to new hospital

NG Bailey is supplying 500 prefabricated, multi-service corridor modules to the site of the new Aberdeen Royal Infirmary, currently under construction. Each module is 50 to 60 feet long and comprises a steel frame with services running through it.

The modules arrive with pieces of partition wall or ceiling already attached, which further reduces the number of trades working on the site. 'This way, the quality is guaranteed. You don't have a contractor who is responsible for services blaming the facade contractor if it's not built correctly,' says Steve Parr, NG Bailey's business transformation and supply chain director, who is responsible for managing its off-site business.

The modules are manufactured at NG Bailey's factory in Oakenshaw, Bradford. Building services engineers working with this form of prefabrication need to design their systems with production in mind, says Parr, with pipework and cables routed in alignment with the modules. The infirmary's plant rooms are also being built off site.

This level of prefabrication demands that detailed designs are agreed before work begins – something Parr describes as a whole new way of thinking for the industry: 'Many projects kick off with the designs not complete and things are done on the hoof. If you're designing for off-site manufacture, things have to be done up front. It's a completely different behaviour and process.'

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A computer image of Aberdeen Royal Infirmary, which uses modular construction

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> People who design buildings don't always think about how you'd get more prefabricated stuff in them by leaving walls down

choosing off-site manufacture. In addition, prefabricated concrete panels offer a better finish than those made on site, which is useful if the surfaces are to be left exposed to help with cooling.

Yet Edwards warns that decisions about prefabrication on future Hammerson projects 'will come down to cost as well, and not enough is known about that as yet'.

URS-Scott Wilson is hoping to use building information modelling (BIM) to close the gap between designers and contractors, which will aid off-site construction. 'BIM allows people to get more detailed information at an earlier stage of the design, which will help with prefabrication,' says Peter Sutcliffe, the group's head of building services. 'The major sub-contractors are all looking to maximise prefabrication, which makes a lot of sense,' he adds.

While prefabrication of risers is already commonplace, Sutcliffe says a new growth area is the prefabrication of building services in ceiling voids. URS-Scott Wilson is also doing more prefabrication of plant rooms and entire buildings. For example, it recently provided prefabricated energy centres for four new Tesco stores that comprised CHP units, absorption chillers, pump sets, buffer vessels, water treatment and pressurisation equipment. The final assembly was completed in the stores' car parks.

URS-Scott Wilson took this approach because of the benefits of shortened build times for the programmes. Tesco can build a new store in 26 weeks, yet it can take 20 weeks just to source the engines for the plant room, Sutcliffe says. Therefore the client opted for prefabrication.

URS-Scott Wilson is currently working on designs for a student accommodation project where both the superstructure and the mechanical and electrical services will be prefabricated, although Sutcliffe is unable to divulge details of the venture. He adds: 'We are finding this more and more – as people tighten the build programmes, prefabrication is the only way out.' **CJ**

Case study Schools go for pre-cast solution

Prefabrication has been embraced by the Barnsley Building Schools for the Future programme, where four schools have been built using pre-cast walls, floors, ceilings and columns from Laing O'Rourke's Design for Manufacture and Assembly (DfMA) range.

Carlton school was completed in 2010 using a prototype of DfMA, while Green Acre, Springwell and Shafton are using the latest version. Windows can be supplied prefitted, and conduits for power cables are pre-cast into the slabs.

The Barnsley schools were designed by BDP using the DfMA range. James Warne, environmental engineering director at BDP, says the panels offer significant energy savings, with integrated insulation providing a U-value at least 20% above the Part L 2010 requirements.

The DfMA walls are load-bearing, which reduces the need for a frame to be built separately before cladding. Warne argues that this offers dramatic savings on materials and suggests that 30% of materials delivered to traditional construction sites are thrown away.

DfMA offers a choice of five window openings, and their environmental performance is already predetermined at a minimum 2% daylight, meeting BREEAM requirements. 'Part of the attraction is that pre-determined result,' says Warne.

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DfMA has been used for Shafton school in Barnsley

BDP assisted Laing O'Rourke in developing DfMA, and the range was named Passive (energy-related) Product of the Year in the CIBSE Building Performance Awards 2011. Anna Winstanley, director of strategic design at Laing O'Rourke, says: 'The architects are able to produce bespoke designs while adopting a consistent approach to the structure and the M&E.'

DfMA has also been used for student accommodation for Imperial College, London, in the construction of the University Hospital of North Staffordshire, and to create offices for the Ministry of Defence.

DfMA has yet to be sold to commercial developers, although Winstanley is convinced that this is due to the recession and acceptance is just a matter of time: 'We were looking at an office project in the City of London, but it was stopped because of the recession. I've no doubt the industry recognises this as the way forward.'

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SPOTLIGHT ON LEARNING

A new version of *Lighting Guide 5* from the Society of Light and Lighting takes on board major changes in the needs of educational environments, writes **Iain Macrae**

The 1991 guide to lighting in educational establishments was clearly well out of date by the time a review of the document was initiated in the late 2000s. In the intervening period, building design and teaching practice had changed considerably – indeed, teaching now encompassed interactive learning, group work, practicals and e-media.

The review also had to take on board the UK government's policy agenda, which at the time was full steam into a massive school building programme, with new financing and a drive to reduce carbon. This entailed a push towards daylight strategies, lighting controls and efficient electric lighting.

In addition, the education sector needed a vehicle to update its own lighting guidance without investing too much resource, as the Lighting Building Bulletins were also very much out of date. The new guide had to solve both lighting and energy concerns, while still providing a good environment to learn in.

A major priority of the revisions had to be the changes in teaching styles. The recently published *Lighting Guide 5: Lighting for Education (LG5)* from the Society of Light and Lighting sets out to cover any space where learning takes place – no small task in itself, as learning spaces appear in schools, further education, higher education, offices, hotels and healthcare buildings.

Teaching within a building can take place anywhere, from corridors to sports halls to drama studios. Outdoor learning is also common. The new guide focuses on these types of spaces, leaving the non-teaching spaces to the other guides and the SLL Code for Lighting. Changes in European standards also had to be taken on board. In addition, research into daylight has established a link between high levels of daylight and learning achievement.

The new guide recognises that learning takes place by communication between people, from written texts and pictures, and from interaction with objects and technology. It therefore challenges horizontal illuminance and simple uniformity, and introduces cylindrical illuminance and a modelling index – measures more useful for facial recognition.

This enables better communication for all, including those with hearing impediments who need to lip read.

LG5 also balances the need to control glare. More light to the face can mean higher glare, often a concern in display screens, but research into new screen technology indicated that new thinking was needed here, too. It is now well recognised, of course, that we perform better and stay more alert when exposed to good levels of daylight. At the same time, control is also important to avoid glare and solar gain.

A focus on good daylight design can also, of course, lead to savings in energy use. In addition, such a focus can enhance health and well-being for students and help them achieve higher levels of attention and educational attainment. It should be no surprise, therefore, that daylight design comes first on the guide's priorities for building designers.

LG5 reflects the widely held view in the sector that clients should employ a professional lighting designer, and employ them early, even before the point that the architecture is massed and orientated. Then keep them on the team throughout the

Circulation spaces are often double that of older designs

Thorn/Cundall

Above: *LG5* re-emphasises good face-to-face communication by lighting faces, regardless of height Right: A school dance studio, where lighting has to work with the mirrors

design process to ensure daylight is where it deserves to be – high on the priority list and used where it is needed – in all learning environments.

But good design also entails removing daylight when the need arises. *LG5* sets out new targets for the Daylight Factor and offers insight into newer daylight design methodologies for the professional to investigate.

When it came to energy efficiency in lighting, the team behind *LG5* wanted to take a different approach to the minimum performance standards set by the Building Regulations. It was felt that these standards often ignore the benefits of daylight and the savings they can provide.

As a result, *LG5* takes into account the Energy Performance in Buildings Directive, and the Lighting Energy Numeric Indicators, and aims to bring user comfort firmly back into lighting design, while using simple and sensible lighting controls to reduce overall energy use.

LG5 sets a new challenge to building designers to push the design limits further. The aim is to make designers think more about how spaces will be used and to potentially change the way buildings are massed. This is not intended to be a comfortable challenge. But who said design should be easy?

The *LG5* team set the energy values from the EN15193 European standard as a base target – that is, one that should be surpassed – and added higher numbers for 'good' and 'excellent' energy performance, similar to the BREEAM philosophy. At the same time, *LG5* aims to allow room for manoeuvre on good design, including comfort issues.

If it remains unclear how a given space is intended to be used, then the Building Regulations may be an easier starting point. Even so, for all educational spaces there has to be a use and a philosophy of use in mind, and so applying EN15193 makes much more sense.

Computers and electronic screens are, of course, now widely used in learning environments. Most modern screens with the right software can cope with luminances significantly higher than the current Lighting Guide 7 might suggest. *LG5* offers new numbers on this area, in a table that is a long way into the guide – and deliberately so, since the key message of the guide is: *design for the human need first*.

> The new guide reflects the view that clients should employ a professional lighting designer early – even before the architecture is massed and orientated

LG5 also re-emphasises that good face-to-face communication drives good learning, so lighting the face, wherever it may be, at whatever height and facing in whichever direction, is key to promoting learning.

In the current climate, with the school building programme cut to the bone and the university sector under pressure, it might seem an odd time to launch a lighting guide based around education. But, of course, education goes on – if not in new buildings, then perhaps in refurbished ones – and the provision of good lighting provided by professional designers has to be a priority. **CJ**

IAIN MACRAE is head of global lighting applications management at Thorn Lighting and is president-elect of the SLL

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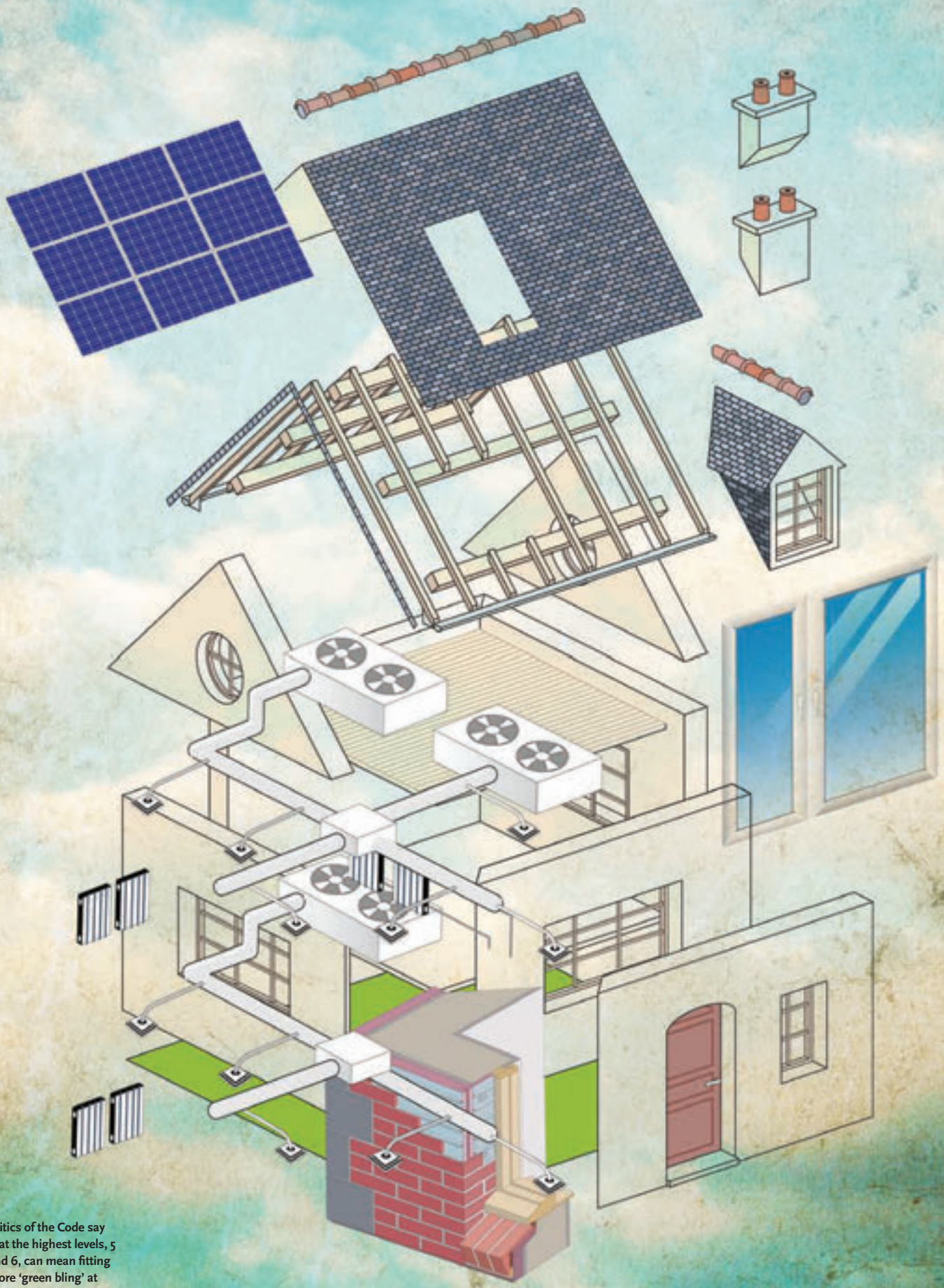

Critics of the Code say that the highest levels, 5 and 6, can mean fitting more 'green bling' at unnecessary expense

RAISING THE BAR?

Key driver of eco-housing or bringer of green bling? The Code for Sustainable Homes has many supporters and detractors. But, as **Andy Pearson** explains, it is facing an uncertain future

When it was launched in December 2006, the government declared that the Code for Sustainable Homes would drive a step-change in sustainable home-building practice. This comprehensive new method of assessing a home's green credentials was intended to become the single national standard for sustainable homes. As such, it was intended to be the reference for designers, builders and, more importantly, home buyers to help them select the most sustainable residence.

Much has happened in the four years since its publication. The majority of home owners are still unaware of the Code's existence. Rather than becoming the cornerstone of sustainable home design, many designers and builders are now highly critical of the document, claiming its application has resulted in unnecessarily expensive homes with questionable sustainable credentials.

However, for others, despite its faults, the Code has become a fundamental tool in the provision of eco-friendly new homes. So how valuable is the Code in the promotion of sustainable housing?

The Code was developed to support the government's target for all new homes to be zero carbon from 2016. As such, its six levels have been aligned with step changes to Part L of the Building Regulations – the section that deals with the conservation of fuel and power.

While compliance with the Code is not mandatory, the carbon emissions requirements of each Code level effectively become mandatory through their inclusion in Part L. Aside from carbon emissions, the criteria for Code compliance are more onerous and include a much broader sustainability agenda than is required under current building regulations.

Michael Birnie, sustainability team leader at ECD architects, backs the Code and says he believes it has brought significant benefits: 'It has raised awareness of a wide range of issues that house builders would not have otherwise considered, including reductions in waste, water and improvements in user comfort.'

He says the cost of Code compliance to developers, particularly for less-rigorous Code levels, is manageable: 'As with anything new, there were additional costs at the outset, but the Code impacts everyone and so has helped to develop a supply chain to bring down costs.'

Mendip Place in Essex incurred 'considerable' extra expense to achieve Level 6 of the Code, according to a designer on the housing project

REGULATIONS
HOW THE CODE HAS CHANGED ... AND WILL CONTINUE TO DO SO

The Code measures the sustainability of a new home against nine categories of sustainable design, rating the 'whole home' as a complete package. It covers: energy and CO_2 emissions; water usage; materials; flooding and flood prevention; waste; pollution; health and well-being; management and ecology. It applies in England, Wales and Northern Ireland.

In November 2010 the government updated the Code to include changes to the Building Regulations and changes to SAP, the compliance software. Ant Wilson, a director at consultant AECOM, says further changes are likely in future. Recent and forthcoming changes to the Code include:

- Minimum mandatory emissions standards for Code Levels 1, 2 and 3 were dropped in November, as these are met via compliance with the revised Building Regulations;
- Credits for specifying low-energy lighting were dropped from the Code because the incentive for this is covered by Part L. Instead, credits are now offered for energy display devices; and
- The minimum Fabric Energy Efficiency Standards in Part L have been adopted by the Code.

Andrew Eagles, managing director of training and advisory consultancy, Sustainable Homes, says that additional Code requirements provide significant benefits, which ensure a property will have better than minimum daylight and sound insulation requirements.

'In the dash for low carbon, other environmental issues can be forgotten,' he says. And, like Birnie, he says the cost of compliance at Level 3 should not be an issue. 'When it came out people said it was madness to achieve Code Level 3 because compliance would cost an extra £6,000 to £7,000 per house because the sector was not ready for it. Yet, within a year-and-a-half it was actually costing less than £3,000 and it was not as difficult to achieve as developers had first thought.'

But Neil May, chief executive of materials and construction systems supplier Natural Building Technologies, is no fan of the Code: 'The Code is not useful at all – it has led to a lot of poor buildings built with inappropriate technologies at high cost with high future maintenance costs and risks.'

May insists that some categories, such as energy, water, green materials and surface run-off, use tools 'which are just wrong and so lead to perverse outcomes'. The complexity of the assessment process, claims May, results in companies spending more on box ticking than on the green measures themselves.

> The Code has raised awareness of a wide range of issues that house builders would not have otherwise considered

'Rather than increasing knowledge about a building's sustainability, it has led to less understanding because of the complexity of the process, the emphasis on green bling and a lack of monitoring and feedback,' he says.

Green bling, in May's view, is more likely to be present on Level 5 and Level 6 homes as expensive renewable technology. However, May says there is no need for Level 5 or Level 6 homes at present. 'We need to focus on trying to walk before we try to fly supersonically; we also need to look at issues of human behaviour and culture before we start trying to solve things with complex technology,' he says.

Eagles is in agreement with May on the complexity of compliance: 'I think it's bureaucratic and that needs addressing.' However, the Code has been beneficial in tackling carbon emissions, dealing with matters such as reducing flood risk, and issues like the provision of sound insulation and ecology. 'It provides a real benefit over and above simply focusing on carbon,' Eagles adds.

On the subject of cost and Code Level 6, Eagles says costs will come down over time. 'When I was on the steering group that oversaw development of the codes, Level 6 was intended to be something to aim for in 2016 and beyond'. He estimates that Level 6 can add up to £30,000 to the cost of a house. 'Yes it is expensive but nobody is saying CL6 is required right now,' he explains.

One architect who has been involved with

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In the future, new buildings may no longer be subject to the Code if the government proceeds with its proposal for the Building Regulations to incorporate the Code

> The Code has led to a lot of poor buildings built with inappropriate technologies at high cost with high future maintenance costs and risks

what is believed to be the first 'affordable' housing scheme nationally to have achieved 'zero carbon', or Level 6 under the Code, points to the extra costs associated with the development, Mendip Place in Chelmsford, Essex.

Jon Boon, a partner of consultancy Ingleton Wood who led the Mendip Place design team, says: 'From our experience at Mendip Place, Code 6 brings some excellent environmental benefits. However, considerable extra expense is involved which does not necessarily benefit either the residents or the environment.'

An example of extra expense is the requirement to provide all of the dwellings' energy requirements from on-site sources. 'For Mendip, this involved a large photovoltaic installation at substantial cost – arguably the same environmental benefit could have been obtained from connection to a green energy supplier,' says Boon.

In addition, to achieve the requirement for zero net CO_2 emissions, the development has a communal biomass heating system. According to Boon, this also involved 'additional costs over and above conventional individual heating systems'.

Boon argues that Passivhaus is a more economic solution than designing to the Code: 'The best value solution for low-energy housing is to design to Passivhaus standards, where costs are focused towards achieving a high-efficiency envelope, therefore reducing energy costs and CO_2 emissions.'

This solution, says Boon, will achieve Level 4 or 5 under the Code energy credits, which can then be supplemented by other Code credits to meet funding or environmental targets.

'In our view, this should be the future driver towards low-energy housing – a new approach utilising modern construction methods, detailing and materials to achieve highly insulated, energy-efficient envelopes by moving away from the old energy-inefficient ways of building and using eco-bling to make up the difference.'

This 'fabric-first' approach has already found favour with some of the major housebuilders including Crest Nicholson, Barratt and Stuart Milne with their participation in the AIMC4 Partners in Innovation project. The consortium is working on developing a fabric-only solution to meet the energy requirements of Code Level 4 and beyond.

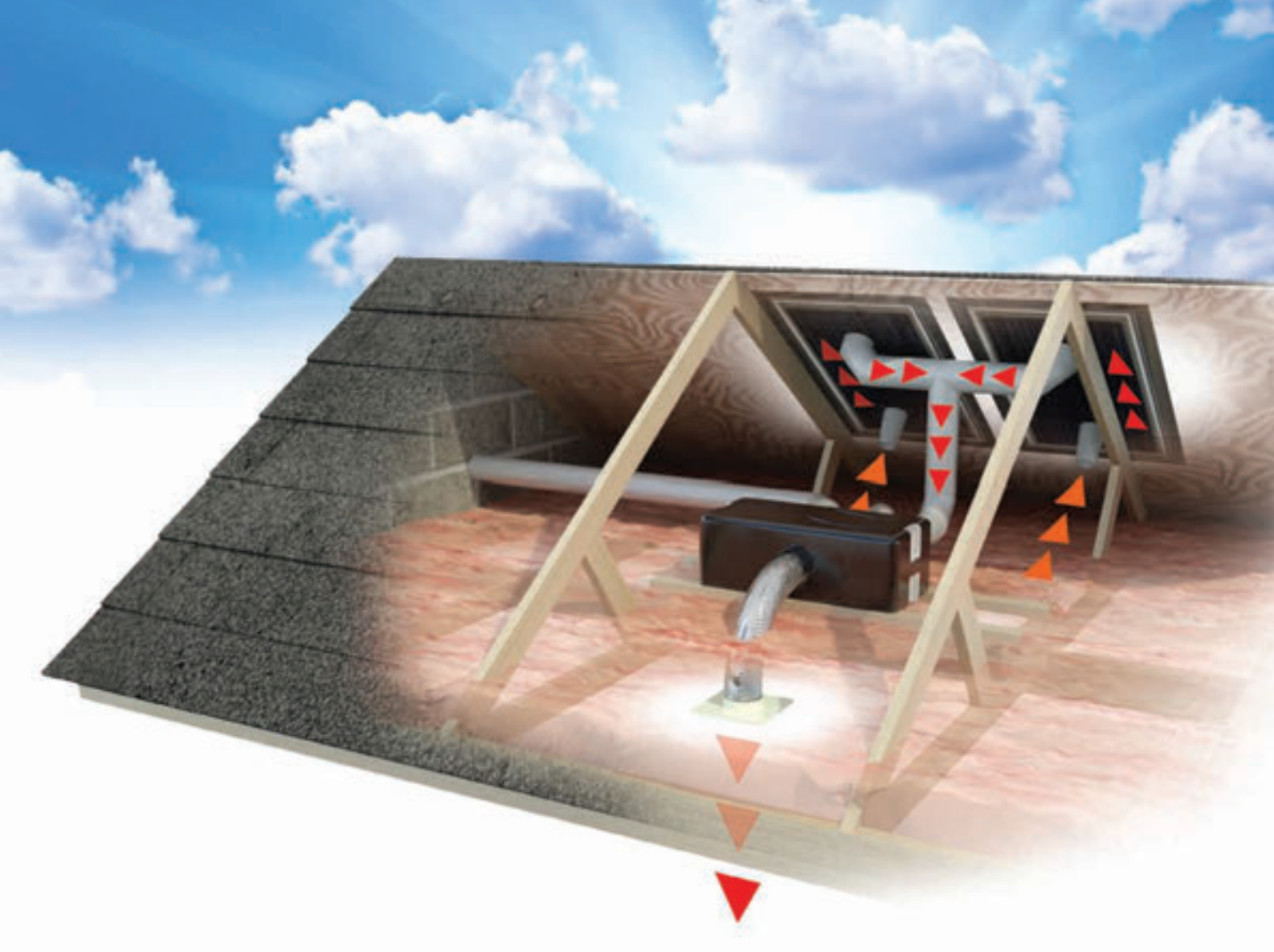
'AIMC4 is targeted specifically at the energy requirements of 2016 and zero carbon, because if you look at housing developments over that timeline, the most challenging and expensive area we have to overcome is energy,' says Elizabeth Ness, group sustainability executive at house builder Crest Nicholson.

The consortium is looking at a variety of different construction methods that are being trialled on various exemplar schemes to ensure the solution is deliverable economically nationwide. Says Ness: 'By the time we get to 2013, by driving these exemplars forward and by working with our supply chain, we will have engineered out the added on cost, so when we deliver in 2013 it will be the same cost as if it was Part L 2010.'

More recently, the government announced a controversial change to the definition of 'zero carbon' homes. In March ministers announced that 'housebuilders will only be accountable for those CO_2 emissions covered by Building Regulations'.

Birnie argues that this could lead to two separate definitions of 'zero carbon': Code Level 5 would equate to being 'zero carbon' compliant, while Level 6, which includes unregulated loads, would be 'zero carbon plus'.

There have also been reports the government is considering incorporating the Code into the Building Regulations. However, the Building Regulations do not cover issues such as cycle storage or the responsible sourcing of material, unless these become a planning requirement. 'A lot could get lost,' says Birnie. **CJ**



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Solar panels are fitted to new housing in Woking, Surrey

LEVEL ACHIEVEMENT

An English local authority says it is blazing a trail in the sector with its financing of an 'affordable' homes development that is also highly sustainable. **Mark Jansen** reports

It helps to have friends in high places. Woking Borough Council is unusual among UK local authorities in having developed 'affordable' housing that has been built to such high sustainability standards: the homes are all at Level 5 of the Code for Sustainable Homes, one grade below the maximum Level 6. This achievement is very much down to chief executive Ray Morgan, who was one of the driving forces behind the council's climate change strategy, launched in 2000.

Under this strategy, the council has to consider sustainability and CO_2 reduction in every decision it makes. Morgan, who was formerly the council's chief finance officer, set up a wholly-owned subsidiary company, Thameswey, to deliver the strategy.

Thameswey operates as an energy services company and runs 13 combined heat and power (CHP) schemes in the Surrey town, which supply heat and power to the council's own offices and buildings, as well as a number of council homes and private businesses in the area. Thameswey also runs a CHP plant in Milton Keynes

All images: Woking Borough Homes

New housing, commissioned by Woking Borough Homes, had a brief to meet Level 5 of the Code for Sustainable Housing

AIR TIGHTNESS

Target thermal transmission values

Measured air permeability, based on two tests of completed houses, was 2.1 cu m/sq m/hr for a three-bedroom house and 3 cu m/sq m/hr for a five-bedroom house

The heat loss parameter, expressed per unit surface area of the building envelope, is between 0.61 and 0.68 W/sq m K

Projected U-values:

External walls = 0.15 W/sq m K

Roof = 0.10 W/m sq m K

Ground floor = 0.13 W/ sq m K

Windows = 0.78 W/ sq m K

Doors = 1.00 W/sq m K

'Invisible' solar panels on the Brookwood Farm development in Woking, Surrey

that supplies 1,000 apartments. The houses were commissioned by Woking Borough Homes (WBH), a subsidiary of Thameswey that is tasked with providing affordable homes in the area.

Back in 2008, when WBH was contemplating a new housing development at Brookwood Farm in Knapp Hill, Woking, Morgan intervened personally to insist they be built to Level 5 of the Code.

The scheme was completed in September 2010 and comprises 10 semi-detached homes, six with three bedrooms and four with two bedrooms (available on a shared ownership basis), plus two detached five-bedroom homes that were sold on the open market for £615,000 each, which helped towards the cost of the 'affordable' properties.

> What we're trying to do here is a very low-key form of social engineering [on energy reduction]

John Thorn, group managing director of Thameswey, and Jim Walter, the council's project manager for Brookwood Farm, are both concerned that there are few signs that many other councils are ready to follow Woking's lead.

'A lot of people from other councils have come to see the development, but because they don't have a similar climate change strategy to Woking, nor the political support, very few of them can replicate what we've done,' says Thorn.

Although the land was gifted to Woking Borough Homes by the council, Thorn insists that the council does not subsidise Thameswey's environmental activities. It borrows money from the council at 7% interest. The result is a range of benefits, he says: 'Council tax payers get a profit on the loan to Woking Borough Homes, there's a CO_2 reduction and affordable homes are available in the borough.'

However, some may question just how affordable these homes are, with the two-bedroom properties each priced at £286,000, and the three-bedroom ones at £350,000. Yet there has been no shortage of potential buyers, with offers made on all the homes within days of their completion.

The Code 5 homes use insulated concrete, which is poured between two layers of polystyrene, producing low U-values, says Walters. They also have

Code Level 5 How Brookwood Farm measures up

Brookwood Farm scored 92 points out of a possible 100 under the Code for Sustainable Homes, sufficient for a Code 6 rating, although only a Code 5 was applied for and awarded, according to project manager Jim Walter. High-scoring features include:

Dwelling emission rate: 14 credits out of 15, with a target emission rate of 19.2 – 23.2kgs of CO_2/sq m per year and a dwelling emission rate of below zero, which means no net energy use, thanks to the PV installations (see table three).

Environmental impact of materials: 13 credits out of 15, at least three from a list of five building elements (for example, walls, windows) must achieve a Green Guide rating of A+ to D

Health and wellbeing: Ten out of 12, with high scores for meeting Lifetime Homes principles and good insulation.

Management : Nine out of nine, with guidance for occupiers on using the homes efficiently, Considerate Constructors Scheme and on-site security.

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> Council tax payers get a profit, there's a CO2 reduction and affordable homes are available in the borough

a 'cold roof' design, with loft insulation above the ceiling but none in the eaves. The lofts provide essential cold storage space for the inverters, which convert electricity from the photovoltaic cells on the roof from direct sunlight into alternating current and must be kept cool. Doors and windows are triple-glazed.

Each pair of semi-detached houses has a 7kW peak photovoltaic (PV) array on the roof. Thameswey will own the electricity generated and sell it back to the occupiers at a profit, as well as claiming a feed-in tariff through the government. Only the two market-price, five-bedroom houses have solar thermal panels for hot water, in addition to their PV, because of a lack of roof space.

The PV panels are integrated with ceramic slates. Walter says the slates do not overlap and aluminium strips are placed beneath them to keep the roof watertight. This saves around 30% on materials and embodied energy.

Space heating comes from a mixture of occupiers' body heat and an underfloor heating system, fed by hot water from a small gas boiler of just 40.3k Btu/hr. There is a thermostat in each room to control the internal temperature; it takes around 24 hours for the underfloor heating to deliver a marked change in room temperature, which Walter says discourages the common but wasteful practice of frequent adjustments. The houses have mechanical ventilation with heat recovery to prevent condensation problems caused by the air tightness.

Rainwater is harvested and stored in 5,000 litre tanks, one for each house, which supply water for the toilets, washing machines and garden hosepipes. Walter says enough should be harvested to meet all of a family's non-drinking water needs. Consumption of potable water is limited to 80 litres per person, per day, using reduced flows on the showers and wash basins. For example, the kitchen sinks will deliver no more than four litres of water per minute, and the showers six litres.

Walter claims that most of the energy-saving features are almost impossible for the occupiers to interfere with. He spends time with each occupier to explain how

they work, often making several visits. Thorn and Walter admit they can't stop a buyer from installing energy guzzling gadgets, such as plasma televisions, but they hope the tenants will listen to their advice.

Thorn stresses that the houses have been designed to look entirely 'normal', complete with a fake chimney on top, made from plastic. Only five or six of the many people that have enquired about buying one have been specifically interested in their energy efficiency.

However, they should be pleasantly surprised by the low energy bills, projected at £186 per year for heating, £108 for hot water and £58 for lighting, in a three-bed semi with a 96 sq m floor area. 'What we're trying to do here is a very low-key form of social engineering,' Thorn explains.

The entire development is subject to a two-year study of predicted versus actual energy consumption by Surrey University. No results are publicly available as yet, although Thorn says 'it does look like it is working' and promises to reveal all when the study is finished.

Building to Code Level 5 instead of current building regulations added 23% to the cost of the scheme, Thorn says, although Walter adds that this could probably be reduced to 15% extra if the council were to build more, thanks to the experience it has gained. However, Woking Borough Homes has lowered its sights for the time being, with plans to build 43 flats to Code Level 4. Thorn says a recovery in the property market will probably be needed before there are funds to build more Code 5 houses. Until then, Brookwood Farm offers a glimpse of the future. **CJ**

PROJECT TEAM

CLIENT: Woking Borough Homes

BUILDER: Lacey Simmonds Homes

ARCHITECT: Lacey Simmonds Homes

ENERGY CONSULTANT: Ramboll

PARTNERSHIP

A CIBSE award-winning housing association has shown how the refurbishment of existing properties can bring dividends for both client and tenants, writes **Andy Pearson**

'This project never started out as a carbon-cutting challenge,' says Matthew Bush, sustainability manager at the Metropolitan Housing Partnership (MHP), referring to the social housing provider's whole-house approach to refurbishing its Victorian properties. However, despite his assertion, the initiative has been so successful in cutting carbon that the team behind the initiative won both Carbon Champion and Public Sector Client of the Year categories at this year's CIBSE Building Performance Awards.

Rather than setting out to save carbon, the project originated as a pragmatic response to MHP's commitment to meet the government's Decent Homes Standard and reduce its maintenance costs. This standard was introduced to ensure all social housing is warm, weatherproof and has reasonably modern facilities, including kitchens and bathrooms.

The standard is relatively straightforward to implement on large estates or in blocks of flats, where refurbishment is simply a matter of replicating the same solution in identical properties throughout the scheme.

The challenge for Metropolitan Housing Trust London, part of MHP, was that many of its worst-performing homes were Victorian street properties, most of which were formerly private homes purchased under a variety of government initiatives and funding opportunities. Typically, these properties were constructed from brick single-skin external walls, slate-tiled roofs and single-glazed timber sash windows.

Some of these houses had been modified in the past or converted by the previous owner; others remained untouched; while some had the additional burden of being situated in conservation areas. As a result, MHT London had more than 600 individual properties, pepper-potted around Haringey, North London, in varying sizes, styles and layouts and states of repair.

For the majority of these homes, a significant amount of work was required to meet the Decent Homes obligation. Any such work would be disruptive for the residents. What's more, from the MHT London's perspective it was difficult to programme the works around the residents, which added to the costs.

Metropolitan Housing Partnership staff Nishat Riaz (left) and Steven Devonport at a refurbishment project

In response, MHT London set up a small regeneration team called the Neighbourhood Investment Unit (NIU), which includes a resident liaison officer and two building surveyors (one senior). The idea was to tackle these properties in-house so, with the exception of structural issues, consultants are rarely used.

Rather than carry out works piecemeal, the team decided on a comprehensive refurbishment of the whole property

APPROACH

> This type of whole-house approach to refurbishment is pretty unique

involving energy efficiency upgrades, Decent Homes Standard works and general property improvement to take the homes well beyond the Decent Homes Standard.

'We decided to do everything at once,' says Bush. Carrying out all improvement works in one hit minimised inconvenience to the residents and it made long-term business sense by eliminating the need to keep returning to the property.

The NIU put in place a programme of works that involved decanting residents for a 14-week period. However, before they moved to temporary accommodation, the residents chose their kitchen units, flooring and decoration throughout the property. 'This whole-house approach is pretty unique,' says Bush.

The works have been developed as a package that can be replicated time and again, rather than as an exemplar that will be too costly or risky to be delivered across all properties. Starting at the top of a house, the roof was repaired or replaced if necessary and the walls stripped back to the brickwork. In some instances rooms were remodelled and layouts changed to make the dwellings more suitable for contemporary

> We did what we could realistically do to future-proof each home

lifestyles. External insulation was applied to walls where practicable. When this was not the case, for example on dwellings in conservation areas, 60 mm-thick Kingspan Kooltherm K18 insulated dry-lining plasterboard was added to the external walls internally.

In addition, 300 mm insulation was installed in the loft and 100 mm beneath the suspended timber ground floor. 'The focus was on improving the fabric energy efficiency of the building, to provide our residents with a good quality, energy efficient, refurbished home,' says Bush.

In terms of services, the whole-house refurbishment involved the removal of all wall-hung gas fires and electric heaters. These were replaced with an energy efficient, gas-fired central heating system incorporating an A-rated condensing boiler and thermostatic radiator valves. The building's entire electrics were also replaced and, where appropriate, low-energy light fittings installed.

Replacement double-glazed windows were also fitted. Where a home was in a conservation area, identical double-glazed timber replacement sash windows were installed. Additional sound insulation was also added to the separating walls and floors of flats. The kitchen and bathroom was stripped out and replaced. 'We did what we could realistically do to future-proof each home,' explains Bush.

The works were carried out by contractor Apollo Property Services Group, under a partnership agreement. Having an in-house team and partnering with a contractor has ensured programme flexibility and consistency of service delivery on such a complex series of projects. This arrangement has been so successful that programme time has reduced from the initial 14-week refurbishment programme to 12 weeks, with a corresponding reduction in costs.

According to Bush, initially costs were typically £60,000 per home. However, cost savings and programme efficiencies have helped drive this down to £50,000 per home. 'In addition to minimising inconvenience to the residents, the time and cost savings enable the Trust to refurbish more properties with the same budget,' he explains.

To help residents get the best out of their newly refurbished home on their return, MHT London provides them with a simple manual that explains how to use the heating system efficiently and gives other energy saving advice. 'You can do a fantastic refurbishment but you need the residents to make the best of the designs to realise the benefits fully,' says Bush.

Funding for the programme is mainly through MHP's own reserves, topped up with grant funding through initiatives like the Carbon Emissions Reduction Target (CERT), where these are available. To date the programme has carried out more than 300 of these refurbishments at a rate of about 60 a year. Typically these achieve a SAP rating of 80, with primary energy use at 164 kWh/m sq per year, and carbon emissions of 2.3 tonnes per year. For the residents, this equates to typical annual fuel costs of around £457.

What's more, from the MHP's perspective, once the properties have been refurbished, day-to-day maintenance costs are reduced. **CJ**

Case study Funding supports Passivhaus project

Metropolitan Housing Trust London's Neighbourhood Investment Unit (NIU) was successful in its bid for funding under the Technology Strategy Board's Retrofit for the Future projects. The London project, at 10 Hawthorne Road, aimed to take the NIU's existing approach to renovating an Edwardian, mid-terrace property located within a conservation area and expand on it by implementing a Passivhaus-style, super-insulated, super-airtight retrofit to achieve an 80% carbon reduction. The project was completed in December 2010 and is being monitored by University College London

The house was originally built as two separate flats but it will be converted into a single home under this project. The scheme comprised solid brick external walls, a suspended timber ground floor and an un-insulated loft. The original sash windows had previously been replaced with uPVC windows, which had been fire damaged.

MHP worked with Anne Thorne Architects, services and structural engineer King Shaw Associates, and contractor Sandwood Design and Build, to develop an air-tight scheme with high levels of insulation.

The Passivhaus Planning Package was used to model the existing house to enable the design team to study the effect of different insulation, ventilation and heating solutions.

The main elements of the retrofit solution are shown below.

Element	U-value w/m2K	Retrofit solution
Front wall	0.21	The house was in a conservation area so the front elevation was insulated internally
Party walls	0.31	The walls were insulated to prevent heat being lost to neighbours
Rear walls	0.15	High levels of external insulation added
Ground floor	0.18	Existing timber floor replaced by a new insulated ground floor slab
Loft	0.11	Sheep's wool insulation laid over the existing ceiling joists
Windows	0.75	Triple glazed timber windows
Airtightness		A draft-free layer is formed from a continuous layer of internal plaster linked to building membranes within the walls, ceilings and floors
Heat recovery ventilation		A mechanical heat recovery ventilation system supplies clean air to the living areas and extracts from the bathroom, and kitchen
Top-up heating		Heat is provided by the occupants and their electrical goods. A small amount of additional heat is delivered with the fresh air, while small radiators fed from the hot water tank provide heat when it is very cold Hot water is provided by a gas boiler with integrated, roof-mounted solar thermal panels

HOLISTIC GAINS

Electrical building services engineers can help cut CO2 emissions, energy use and costs by applying a 'whole-life total ownership cost' approach, write **Tony Sung**, **Ya Ping Du**, **Marty Barrett** and **Laurie Brady**

Although many buildings use electricity for 24 hours every day of the year, the price of electricity that the building user pays to a supplier may be different depending on the time the electricity is being used. In some countries, the price of electricity during peak time may be 150% of the price of electricity at off-peak. There is also a difference in the content of CO2 emissions between peak and off-peak periods.

Soon it may be possible to apply smart meters in conjunction with a good energy management system to optimise the energy benefiting from the least expensive tariffs at the time of the demand. In the form of a generalised but simplified form of optimisation equation, this would be to minimise, say, the objective function[1]

$\Xi(y)$:

$$\Xi(y) = f(x_1, x_2, x_3, \ldots, x_n)$$

where y = maximum energy efficiency % of the electrical distribution system

Subject to:

m number of relationships governed by $\leq$ inequalities

$$a_{11}x_1 + a_{12}x_2 + a_{13}x_3 \ldots + a_{1n}x_n \leq p_1$$
$$a_{21}x_1 + a_{22}x_2 + a_{23}x_3 \ldots + a_{2n}x_n \leq p_2$$
$$\ldots$$
$$a_{m1}x_1 + a_{m2}x_2 + a_{m3}x_3 \ldots + a_{mn}x_n \leq p_m$$

r number of relationships governed by $\geq$ inequalities

$$b_{11}x_1 + b_{12}x_2 + b_{13}x_3 \ldots + b_{1n}x_n \leq q_1$$
$$b_{21}x_1 + b_{22}x_2 + b_{23}x_3 \ldots + b_{2n}x_n \leq q_2$$
$$\ldots$$
$$b_{r1}x_1 + b_{r2}x_2 + b_{r3}x_3 \ldots + b_{rn}x_n \leq p_r$$

s number of relationships governed by $=$ equalities

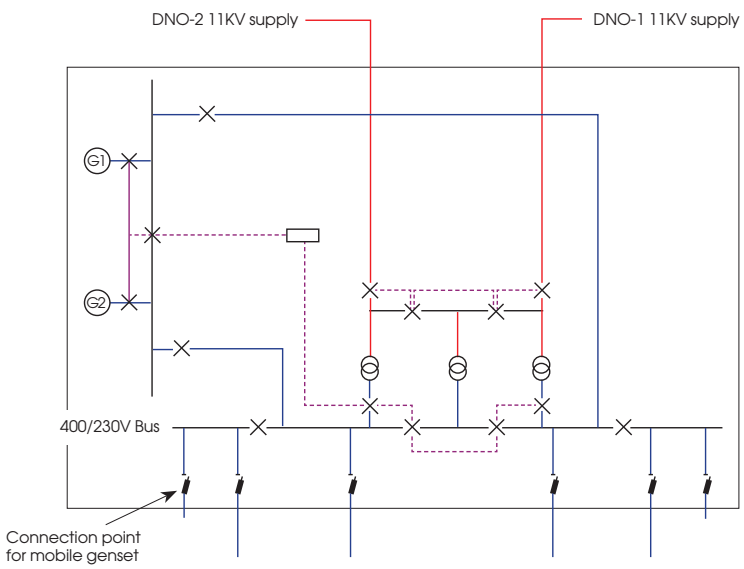
$$c_{11}x_1 + c_{12}x_2 + c_{13}x_3 \ldots + c_{1n}x_n = e_1$$
$$c_{21}x_1 + c_{22}x_2 + c_{23}x_3 \ldots + c_{2n}x_n = e_2$$
$$\ldots$$
$$c_{s1}x_1 + c_{s2}x_2 + c_{s3}x_3 \ldots + c_{sn}x_n = e_s$$

We need to apply some non-negativity restriction, for example, x_1 is the professional fees of the electrical building services engineer, x_2 is the size of an HV/LV transformer, x_3 is installation cost etc. These variables should not have a negative value:

$$(x_1, x_2, x_3, \ldots, x_n) \geq 0$$

The above generalised equations are all-encompassing for the whole electrical installation. By breaking it down into smaller manageable chunks, electrical building services engineers can offer a best-value engineered whole-life building carbon and energy ownership system to the client. This article analyses the supply arrangement for a fictitious building to illustrate how to carry out this best-value engineering design exercise using the whole-life total ownership cost (WLTOC) design approach.

Figure 1: Three-transformer (150% rated) dual primary dual secondary supply



The supply schematic for this building is shown in Figure 1. The client's brief is to provide maximum up-time catering for the following failure scenarios:

a. One HV feeder failed – the other HV feeder to step in via the changeover switch, 100% supply restored via the healthy standby transformer, the system can be classed as having a permanent and healthy supply;
b. One transformer failed – LV supply to affected area via the healthy standby transformer, 100% supply restored, the system can be classed as having a permanent and healthy supply;
c. One HV feeder/One Transformer/ Changeover switch failed – one standby generator set steps in, 100% supply restored with 50% of the supply being classed as a temporary supply; and,
d. Two HV feeders/three transformers failed – two standby generators step in, 100% supply restored and the system is classed as having two separate temporary supplies

To cater for the above scenarios, the required rating of equipment would be:

Tx1 = Tx2 = Tx3 = 800kVA (each has a prospective fault MVA = 13.4)

G1 = G2 = 800kVA (each has a prospective fault MVA = 5.4)

The following will examine the costs and CO_2 emissions associated with the no-load and on-load losses of the proposed arrangements. Table A shows the typical losses for different energy efficiency class transformers.

For the purposes of this article, it is assumed that the average daily load profile of the building is operating at a power factor of 0.95 lagging, at 105% load for 1.5 hours, 90% load for 14.5 hours and 25% load for the remaining eight hours. Since the on-load losses are related to the loads that are switched on, it will either increase or decrease in proportion to the square of the load current when the transformer is supplying loads at above or below the rated value of the transformer. Table B shows the on-load losses adjustment factors for 105%, 90% and 25% load factors.

A flat rate electricity tariff of £0.25p per kWh is used as the average price over a total building life period of 25 years. The price is averaged to include the relevant maximum demand and standing charges, and climate change levy.

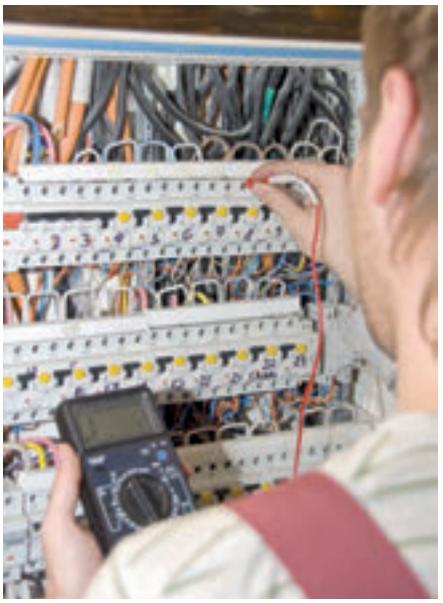
Since the standby transformer is permanently energised to be ready for stepping in at any time, its standby energy cost is

$$Cost\_yr_{run} = £kWh \times \frac{\left[(hours_{off\_load} \times No\_Load\_losses)\right]}{1000} \times 365$$

the annual running cost for the two duty transformers can be estimated by the expression*:

$$Cost\_yr_{run} = £kWh \times \frac{\left[(hours_{On\_load} \times Load\_losses_{FL}) + (hours_{off\_load} \times No\_Load\_losses)\right]}{1000} \times 365$$

*www.leonardo-energy.org uses a different expression to arrive at a more accurate total life-time cost of the transformers: $TCO = PP + A \times rated\_no\_load\_losses + B \times rated\_on\_load\_losses$ where TCO=total life-time cost, PP=purchased price, A=tariff rate for no-load operation, B=tariff rate for on-load operation. Readers who are interested in the method should refer to the report given in the Leonardo-energy website.



Electrical engineers are well placed to offer a best-value, whole-life approach

Table A: No Load and On Load losses for 800kVA transformers to EN50464-1[2]

Transformer	Energy Class losses	A (W)	B (W)	C (W)	D (W)
800kVA	No Load On Load (100%)	A_o=650 A_k=6000	B_o=800 B_k=7000	C_o=930 C_k=8400	D_o=1150 D_k=10500

Table B: On-load losses adjustment factors

Demand in kW 800kVA	No of operating hours	kWh/day	On-load losses Adjustment factor	No-load losses adjustment
0.95 x 1.05 x 800 = 798	1.5	1197	1.05^2 = 1.1025	Not applicable
0.95 x 0.90 x 800 = 684	14.5	9918	0.9^2 = 0.81	
0.95 x 0.25 x 800 = 190	8	1520	0.25^2 = 0.0625	

Table C: Comparison of WLTOC for different energy efficient class transformers

Transformer	Energy Class losses	A (W)	B (W)	C (W)	D (W)
800kVA	No Load On Load (100%)	Ao=650 Ak=6000	Bo=800 Bk=7000	Co=930 Ck=8400	Do=1150 Dk=10500
Annual running cost	No Load (24 x 365)	£1,423.5	£1,752	£2,036.7	£2,518.5
	On-Load (1.5x1.1025 +14.5 x 0.81 +8 x 0.0625) x365	£7,609.5	£8,877.8	£10,653.4	£13,316.7
Purchase price (PP)	(assumed cost only)	£14,000	£11,000	£8,500	£7,000
WLTRC* Over 25 years	25(cost of No load + On Load losses)	£35,587.5 £190,237.5	£43,800 £221,945	£50,917.5 £266.335.0	£62,962.5 £332,917.5
WLTOC over 25 years per duty Tx	PP + WLTRC	£239,825	£276,745	£317,752	£395,880
kWh losses per year per duty Tx	(annual cost of No load + On load losses) / 0.25	36.13MWh	42.52MWh	50.76MWh	63.34MWh
CO_2 emissions on losses over 25 years per duty Tx	0.4 x kWh losses x 25 (**Assume 0.40 kg/kWh)	361.32 T	425.92 T	507.60 T	633.41 T

* WLTRC is the Whole life total running cost = TLTOC-PP
** It is assumed that within the next 25 years the UK will have achieved a higher than expected CO2 emission reduction target; the carbon content of the grid electricity is therefore assumed to be lower than 0.59kg/kWh on average. An arbitrary 0.4kg/kWh figure is adopted for the purpose of illustrating the Whole-life total ownership cost (WLTOC) design approach in here for a more conservative result.

Table D: Comparison of WLTRC and CO2 emissions for the fictitious building adopting different energy efficient class transformers

Transformer	Energy Class losses	A	B	C	D
Purchase price (PP) for 3 off Tx	(assumed cost only – professional fees included)	£42,000	£33,000	£25,500	£21,000
WLTRC Over 25 years	25 x (cost of 3 x No load + 2 x On Load losses)	£487,237	£575,290	£669,412	£840,710
WLTOC	PP + WLTRC	£529,237	£608,290	£694,912	£861,710
CO_2 emissions on losses over 25 years	0.4 x kWh losses x 25 *Assume 0.40 kg/kWh	779 T	920 T	1,071 T	1,345 T

*See note for Table C (**)

The WLTOC for two 100% rated duty and standby transformers is summarised in Table C for different energy efficient class transformers.

Since the system has three transformers, the overall WLTRC and CO2 emissions of the transformers for this building can be shown to be (see Table D):

Table D gives the practical realisation results of optimising the sub-function

$$\Lambda(WLTRC(CO2\_emissions)) = f(Tx\_size, op\_hours, CO2\_kg/kWh, life\_time\_yrs, load\_factor, no\_load\ and\ on\_load\_losses, tariffs, pp)$$

Even if we reduce the average electricity tariff to £0.18 per kWh for the 25 years whole-lifetime period, the payback for a one-off marginal capital cost of £12,000 to purchase the more energy efficient B class transformer will take no more than five years. It can be said that under the right circumstances – that is, where a client can invest upfront to cut CO2 and reduce future electrical bills – the

electrical building services engineer (say, with a class B transformer) can provide the building with a minimum return on investment of £10.61k and 17.82T CO2 per annum. Not only will this achieve a much better energy and CO2 rating than any renewables that can be purchased at £12,000 at the time this article is written, it is also the most reliable and sustainable solution for the life of the building.

Conclusion

This article has shown how electrical building services engineers can use the WLTOC design approach to deliver the best value electrical supply design scheme in terms of both cost and CO2 emissions-reduction in the long term. Based on the same optimisation technique, engineers can apply a similar calculation to select more energy efficient motors, cables[3] and lighting installations together to achieve a much-improved carbon and energy rating for the building.

The supply grid outside the building will also receive knock-on benefits of a reduction

The 'whole-life total ownership cost' approach can deliver the best value electrical supply design scheme

of losses and and cut in CO_2 emissions. As these losses are normally attributed as business energy use that are not subject to Building Regulations constraints, it is strongly recommended that electrical building services engineers develop and implement the WLTOC solution for new-build or rennovation projects.

The simplified example of a three-transformer scheme is used above to illustrate the principle of WLTOC, engineers can also consider a two-transformer design option for such a building. This option can provide added advantages whereby the resulting changeover control system is less complicated, and less space is required in the substation. These advantages were not included in the comparison tables and they can be a significant factor contributing to the final decision taken by the project team.

One small drawback of applying the two-transformer option is that it will necessitate a substantial increase in the full-load power rating of the transformers. This will impose a much higher fault current rating to the transformers, as well as to the rest of the electrical system in the building. To aid engineers in checking the maximum fault level in electrical systems, an article was published the September 2010 issue of *CIBSE Journal* that presented a Fault MVA calculation method to help verify fault level calculations done to comply with BS7671:2008 and BS EN 60909-0:2001.

Finally, although the transformer purchase prices (which include a professional fee for the electrical building services engineer) were based on assumptions made by the authors, the WLTRC and CO_2 emissions results are based on typical building operating hours and EN50464-1. Therefore the outputs of this article are well within acceptable accuracy limits for real world practical applications. **CJ**

● **DR TONY SUNG** is from the CIBSE Electrical Services Group, **DR YA PING DU** is at the Hong Kong Polytechnic University, **MARTY BARRETT** is from Dublin Institute of Technology, and **LAURIE BRADY** is at Liverpool John Moores University

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THERMAL COMFORT

MASTERCLASS
Professor
Doug King

This month's article takes a few steps back to re-examine the fundamentals of 'operative temperature' to see how we can move forward with low-energy heating and cooling systems

As warm-blooded animals, humans produce their body heat internally. But this means that their internal organs need to be regulated within the fairly tight temperature range of 36.5C to 37.5C. If our core temperature drops below 35C, we suffer from hypothermia; and if it rises above 37.8C, we are said to be suffering from hyperthermia, sometimes called heat stroke.

Mild hypothermia is characterised by shivering and a loss of coordination. Severe hypothermia, where the core temperature falls below 28C, causes irrational behaviour and leads to death if unchecked. Nevertheless, people have recovered from profound hypothermia, with temperatures as low as 20C.

Hyperthermia is characterised by hot, dry skin, but the loss of mental faculty happens at a much smaller deviation from the norm than for hypothermia. By the time the core temperature rises to 40C, the condition is life threatening. Clearly humans are much more susceptible to overheating than to the cold. So we need mechanisms to lose heat to the environment in order to remain cool, but not lose too much heat or we become over-cooled.

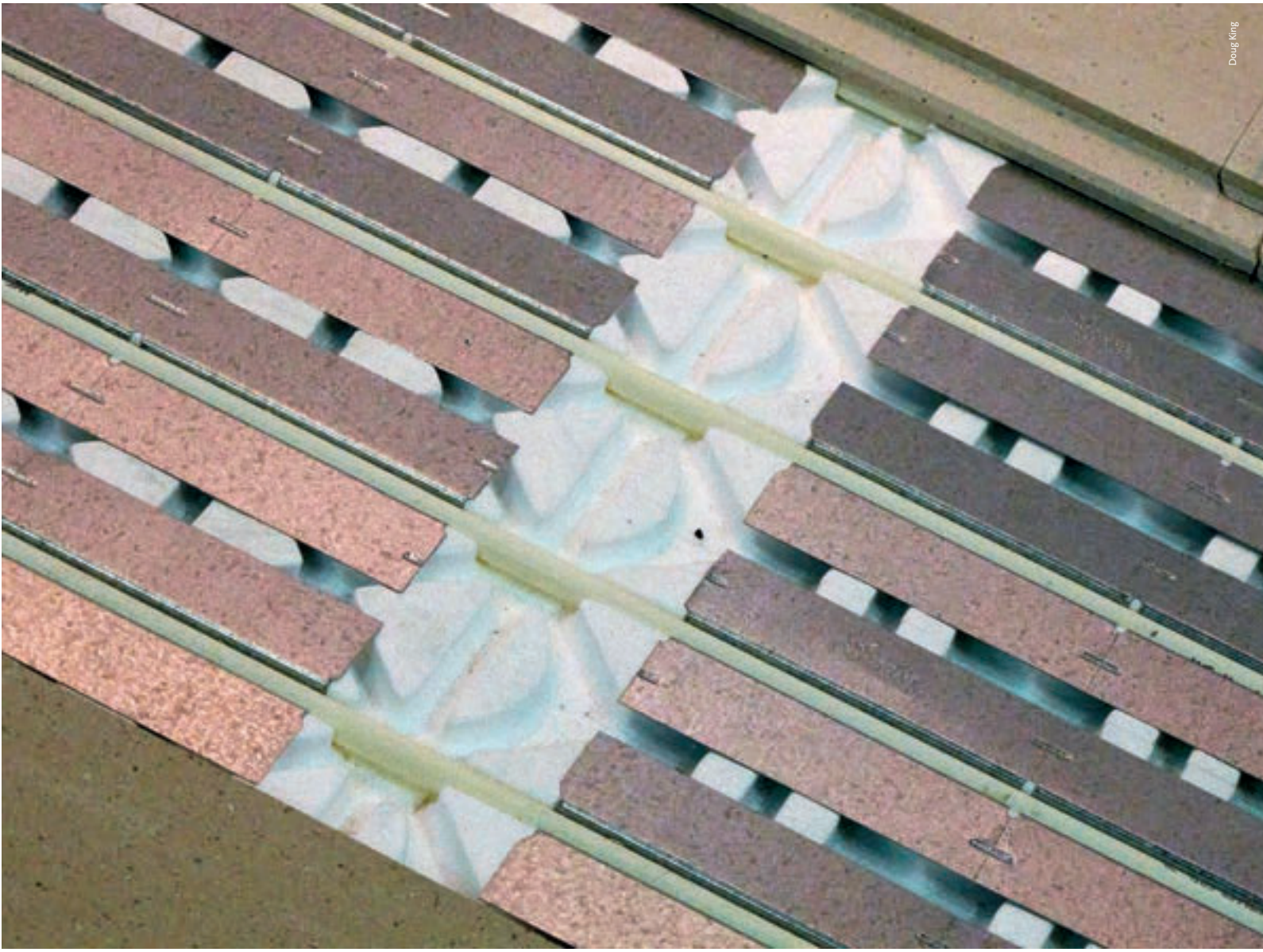
The human metabolism converts calories from food to energy in order for the body to function. Those calories that we do not use to do work, such as moving an object or moving ourselves, are converted into heat. We can lose heat to the environment through convection or conduction to the surrounding air, through radiant exchange with surrounding surfaces, and through evaporation of moisture from our skin and respiratory tract. The body has a number of mechanisms that automatically regulate our rate of heat-loss by these various means to maintain the correct core temperature.

If we get too cool we can increase our rate of heat generation or increase our level of insulation. Shivering is involuntary muscular activity designed to increase heat production. Vasoconstriction restricts blood flow near the skin to reduce heat-loss, and goose bumps appear when hair follicles contract in order to make the hairs stand up, trapping an insulating layer of air against the skin. We can also increase our clothing insulation, which is a cultural, rather than a biological, adaptation to the cold.

If we become too warm, vasodilatation increases the flow of warm blood to the body surface for cooling. Panting and sweating are both means of increasing heat-loss through evaporation of moisture, either from our respiratory tract or from sweat glands beneath the skin. The presence of liquid sweat on the surface of the skin is actually an indicator that this cooling mechanism is already overloaded.

Thus, in order to do full justice to our thermal adaptability, it is necessary to have an index for comfort that takes into account the rate of metabolic heat generation, clothing insulation, air movement over the body and the processes of heat transfer by radiation, conduction, convection and evaporation. The standard method for assessing thermal comfort with all of these parameters is the predicted mean vote (PMV).

One purpose of this Masterclass series is to look for simpler methods of analysis that can lead to insights about the design of building services. Thus, as most heating or cooling systems affect the sensible temperature rather than the humidity or air



Doug King

velocity, it is useful to have a temperature-only index for thermal comfort. CIBSE now uses 'operative temperature' as the index for comfort to align with the ASHRAE and ISO standards, which is directly equivalent to dry resultant temperature, as follows:

$$t_c = \frac{t_r + \sqrt{10v}\, t_{ai}}{1 + \sqrt{10v}}$$

where t_c is the operative temperature, t_{ai} is the internal air temperature, t_r is the mean radiant temperature, and v is the air velocity. In this expression, $\sqrt{10v}$ represents the ratio of the convective to radiative heat transfer coefficients at the surface of the body. Thus, at higher air velocities heat transfer by convection dominates, but at very low velocities the primary means of heat transfer would be radiation.

In a room with no forced air movement – either mechanical or natural – it is assumed that the air velocity due to natural convection is 0.1m/s and so the expression for operative temperature simplifies to the following:

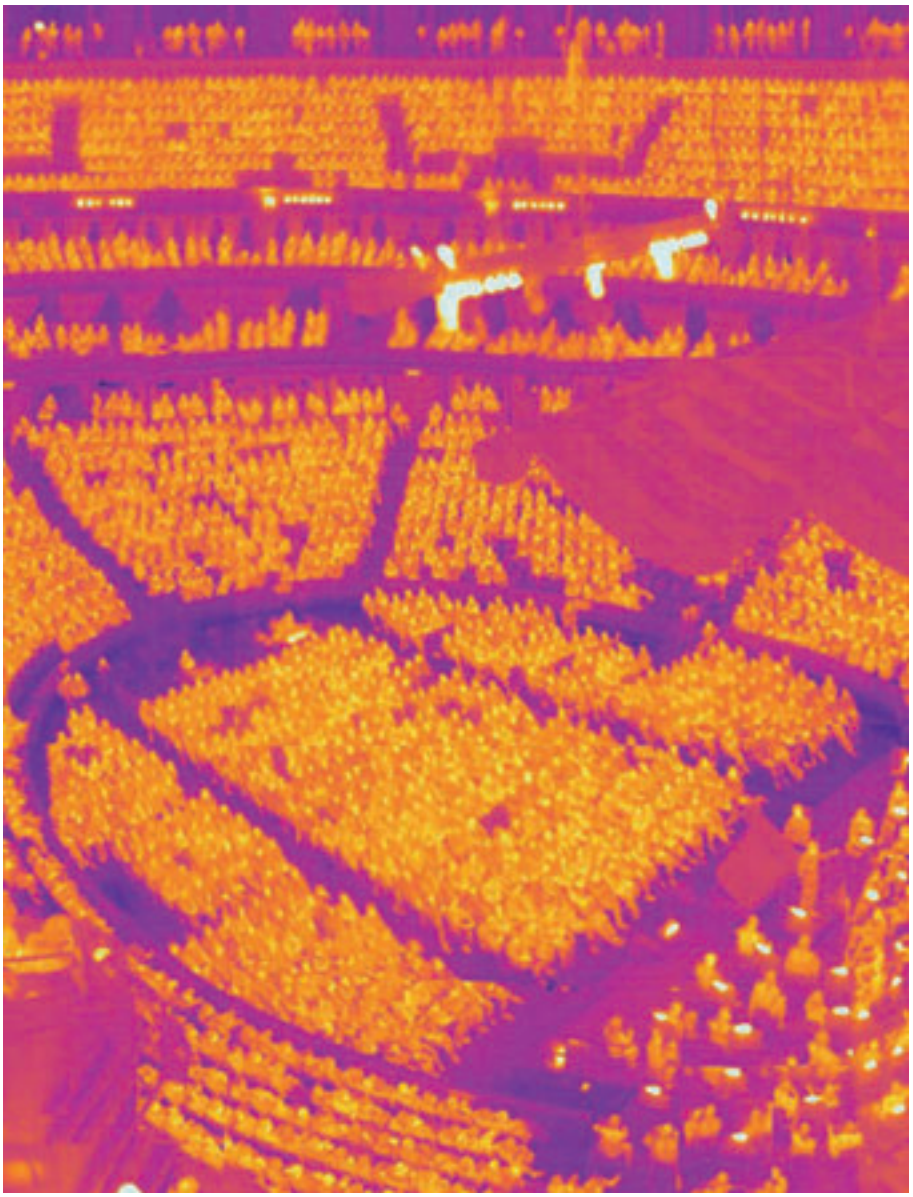
$$t_c = \frac{t_{ai} + t_r}{2}$$

This tells us that, for normal indoor design conditions, the air and mean radiant temperatures are equally important.

For buildings with lightweight finishes, which are heated or cooled with conventional systems that act on the room air, the air temperature, mean radiant temperature and therefore operative temperature are all likely to be similar due to the heating of surfaces by the air. This is probably why so many of us only consider air temperature for the majority of heating and cooling installations.

If we introduce thermal mass, or any form of surface heating or cooling system,

Embedded heating and cooling systems work by changing the surface temperature of building elements. The energy is transferred to the room environment by convection, conduction and radiation. Since occupants sense the radiant temperature of the surfaces, as well as the air temperature, this component of heat transfer can play a significant role in comfort, reducing the need to control tightly the air temperature



The importance of mean radiant temperature is well illustrated by the case of the Royal Albert Hall. This thermograph shows that, due to the unusual arrangement of the space, the internal surfaces are almost entirely lined with audience, with the same radiant temperature as each other. Thus, despite the hall having a chilled air supply, a feeling of thermal discomfort can arise due to the high radiant temperatures. The hall differs significantly from a conventional proscenium theatre, where the audience sits facing the cooler walls of the stage house and can therefore lose heat by radiant exchange

such as underfloor heating, it becomes essential that we consider the operative temperature. A large part of the heating or cooling output of surface systems, whether active or merely passive using thermal mass, is radiant, and therefore we cannot make any judgements about the comfort of the space by considering the air temperature alone.

In thermally massive buildings with passive night cooling it is not unusual to find the surface temperatures at the start of the day reduced to just above the diurnal average, around 20oC in summer. If sufficient fresh air is introduced at the outdoor condition during the day, the internal air temperature rise due to the sensible heat gains could be limited to a few degrees above ambient. However, the operative temperature under such a scenario would be the average of the air temperature and mean radiant temperature, significantly lower than the air temperature alone.

If the building's cooling system were operated under air temperature control, then the refrigeration plant would be started early in the day. However, recognising the contribution of radiant temperature in thermal comfort would delay the point at which refrigeration was necessary for several hours, or even allow passive cooling to meet the demand entirely.

Similarly, using large surface areas of floor or ceiling for radiant heating and cooling can influence the operative temperature in the room, even with air temperatures that are outside the traditionally accepted range. Since large surface area systems can be effective at much lower temperature differentials, these systems can be used to great effect with low temperature heating and high temperature cooling sources, such as heat pumps or even when using ambient sources, such as groundwater.

> If we introduce thermal mass or any form of surface heating or cooling system, it becomes essential that we consider the operative temperature

Humans sense operative temperature, and most thermal modelling software outputs operative temperature results, but we don't yet control buildings on operative temperature. This is partly due to the difficulty in measuring mean radiant temperature, which varies with position in a room, but plenty of research work has been done on instruments that can measure operative temperature. It is about time that our controls industry started producing combined air and mean radiant temperature sensors. Even an approximation of operative temperature at a single point would be a substantial improvement over convective air temperature sensors, when it comes to controlling buildings with mixed heating and cooling sources. This small step would unlock a giant leap forward in the promised energy efficiency of surface heating and cooling systems and of passive thermal mass. **CJ**

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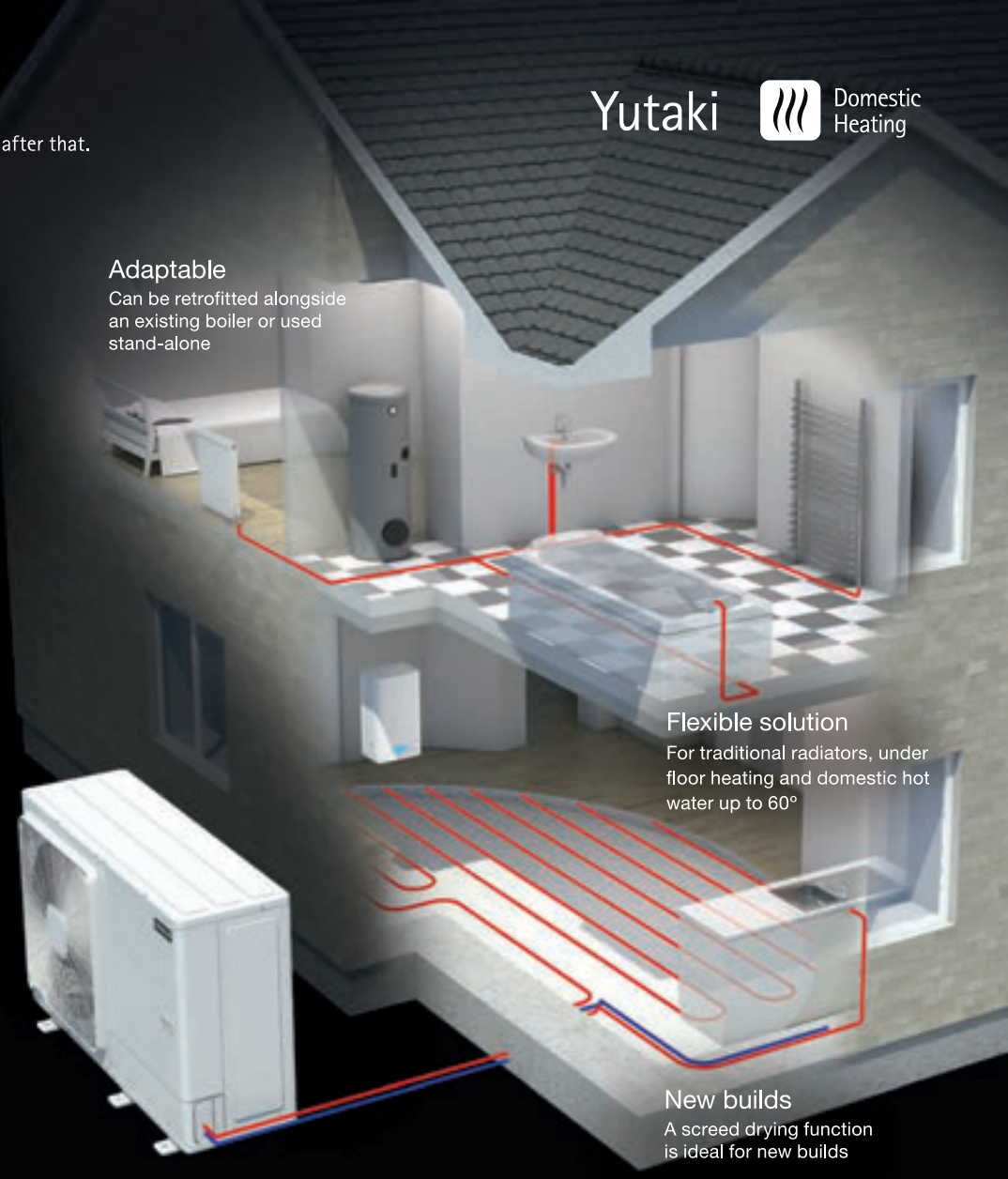

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Determining U values for real building elements

In the May edition of *CIBSE Journal*, the CPD article 'Variations in Thermal Transmittance' considered some of the variables that can affect what might otherwise be thought to be 'standard' values of thermal resistance that are used when establishing the thermal transmittance (or 'U value') of an element in a building structure. This article will introduce some of the considerations that are frequently required when determining the U values of real building components. This includes those that are 'non homogenous' (made of individual layers that themselves are made of more than one material) as well as considering the effects of connections between different surfaces on their U value.

The U Value Calculation

As any student of building services or architectural engineering will know, to determine the U value the individual thermal resistances, R (m^2K/W) of the layers that make up the structure must first be determined from $R = d/\lambda$, where d = thickness or depth of the material (m) and λ = thermal conductivity of the material (W/mK). Example values of thermal conductivities (at standard moisture content and temperature) are given in Figure 1 and extensive tables of these are to be found in CIBSE Guide A 2006 – Section 3.

The 'n' individual resistances that make up a structure are combined with the inside and outside surface resistances, R_{si} and R_{se}, (m^2K/W) to give a total resistance, $\sum R$, for the element $\sum R = R_{si} + R_1 + R_2 + ... + R_n + R_{se}$ m^2K/W

The U value is simply the reciprocal of the total resistance, ie $1/\sum R$, and then the basic building fabric heat transfer coefficient is $\sum(A\ U)$ where the area, A (m^2) is the area of each individual element that has a respective thermal transmittance of U (W/m^2K).

And so it looks quite straightforward. However when considering the individual layers that make up the structure, very few of them are actually consistent across the whole area of the structure. Take, for example, the simplified four layer wall in Figure 2. The outer brickwork is made up both of bricks and mortar and the blockwork is also a mix – this time of lightweight concrete blocks and mortar. Of course the bricks and blocks themselves are not totally

Material	Density (kg/m^3)	Thermal conductivity (W/m K)
Walls (external and internal)		
Brick (exposed)	1750	0.77
Brick (protected)	1700	0.56
Dense concrete block (exposed)	2300	1.87
Light concrete block	600	0.20
Mortar (exposed)	1900	0.94
Mortar (protected)	1900	0.88
Surface finishes		
Plaster (dense)	1300	0.57
Plaster (light-weight)	600	0.18
Insulation		
Expanded polystyrene (EPS) slab	15	0.040

Figure 1: Example of standard thermal conductivities

homogenous as they will contain small air spaces and materials that differ across each piece of masonry. However, in terms of thermal calculations, such 'minor' internal irregularities are normally ignored, and only considered for air pockets in insulating materials that may be large enough to allow air convection currents within the material, reducing the thermal resistance. (BS 10456[1] explains the method to undertake this analysis).

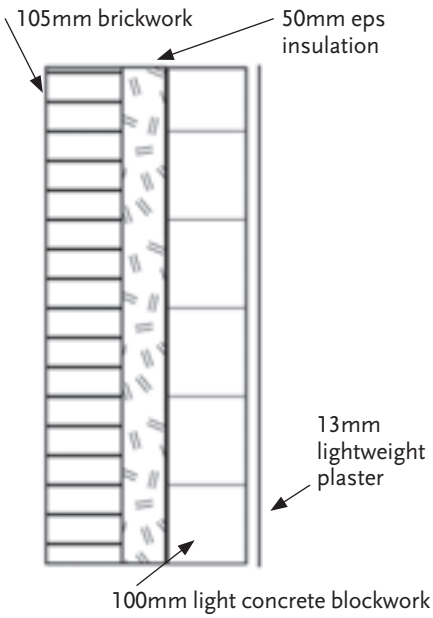


Figure 2: Simple wall structure

So considering the brickwork layer, and referring to the data in Figure 1, the exposed bricks have an R of 0.105/0.77 = 0.136 m^2K/W and the exposed mortar 0.105/0.94 = 0.112 m^2K/W. CIBSE Guide A recommends that if the R values differ by no more than 0.1 m^2K/W then the R value for the major element may be used (and in this case the difference is 0.136 - 0.112 = 0.024 m^2K/W), so the R for this layer is taken as 0.136 m^2K/W.

If the difference exceeded 0.1 m^2K/W, then the layer is said to be thermally 'bridged' and a more complex procedure must be used (that will be described later). A general rule is that mortar joints can be treated as having insignificant influence[2] when the thermal conductivity of the masonry units is greater than 0.5 W/mK.

If the concrete blockwork layer is examined the light concrete block R = 0.100/0.20 = 0.500 m^2K/W and the protected mortar R = 0.100/0.88 = 0.114 m^2K/W. Clearly the difference between the R values exceeds 0.1 m^2K/W and so the blocks are said to being thermally bridged by the mortar.

The effect of a thermally bridged structure is that the flow of heat may not be assumed as going directly from one side to the other (unidirectional) but will also pass sideways between the different materials. Since the simple U value calculation is based on unidirectional flow, this more complex heat flow pattern needs to be solved by computer methods (numerical analysis) or by applying the 'Combined Method'[3]. This method uses the mean of two extreme values of thermal resistance (known as the upper, R_U, and the lower, R_L) of the heat flow paths through the structure to provide the bridged thermal resistance, R_b. The upper limit, R_U, is the resistance that allows for simple unidirectional heat flow and is determined by proportioning the resistances of the different heat flow paths with respect to their area. (And this calculation alone was the method used historically when calculating non-homogenous U values). The lower limit of thermal resistance, R_L, is a value that allows for sideways flow of heat through the structure. The actual resistance will fall somewhere between the two extremes and a mean of the two values is taken as a reasonable estimate of the overall bridged resistance, R_b.

The actual calculations appear complicated (especially where there are multiple bridged layers) but are actually quite straightforward (if sometimes lengthy). An example calculation for the wall in Figure 2 is given in panel 1. Elements in real constructions can be rather more complicated, having several non-homogenous layers. CIBSE Guide A3 2006 Section 3.11.2 has more extensive examples and several are available in "Examples of U-value calculations using BS EN ISO 6946:1997"[4] freely available from the UK government DCLG website.

However it is not always easy to judge how to approach the calculation and to know where simplifying assumptions can be applied. The excellent document 'Conventions for U-value calculations' BRE Report BR 443:2006 can be freely downloaded from the web and has clear and extensive guidance on the practical approach required when examining U value calculations for a whole range of real building elements. This information is particularly useful at the early stages of design when generic materials and construction techniques are envisaged. This not only includes guidance as to the elemental considerations (eg how to determine appropriate resistances for foam faced blocks, or plasterboard on dabs) but also how to establish the U value for constructions complicated by such things as recessed light fittings and loft hatches. BR 443 includes extremely helpful advice on factors to be considered when determining U values for walls, roofs, floors, glazing and doors.

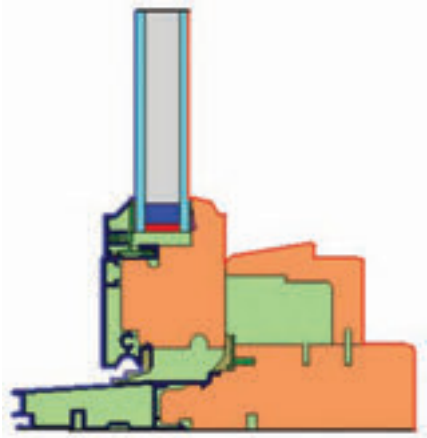


Figure 3: Lower section of example double glazed window with a frame manufactured from two principal materials (source http://windows.lbl.gov/software/therm/images/therm2-1.gif)

One of the concepts applied in BR 443 that was introduced to CIBSE Guide A in the 2006 revision (and still unfamiliar to many) is that of the 'linear thermal transmittance', Ψ-value, or the psi-value (W/mK). This is used to establish the variation in heat flow that occurs at the junctions between the various building elements, for example where a wall joins a roof, or a piece of glass connects to a frame. Because of more complicated geometries and materials used at the junctions, the overall U value of the construction will be affected, and the Ψ-value represents the difference in heat flow through the junction compared to that through the separate connecting elements. This is illustrated by the unevenness of the temperatures across the lower section of an example window (Figure 3 and Figure 4) caused by the increase in U value at the junctions. The 'cooler' green area can be seen extending into the area where the inside pane of glass meets the frame. (Apart from the additional heat loss, this may cause problems with condensation and subsequent mould growth.) The practical impact may be investigated through thermal modelling or by applying tabulated values from the CIBSE Guide. A useful tool, 'Therm', may be freely downloaded from **http://windows.lbl.gov/software/therm**, and will allow 2-dimensional analysis of building structures and windows, so that potential high U values may be avoided.

Psi-values are available for specific construction types, eg roof joints, floor to wall sections and glass to frame connections. Accounting for thermal bridging at edges has become increasingly important as the requirements for building thermal performance have become more stringent, and consequently the main elements have higher thermal resistances increasing the relative impact of losses at edges and junctions. The supporting documents to the

Figure 4: Simulated temperature profile through lower section of double glazed window
(source http://windows.lbl.gov/software/therm/images/therm2-3.gif)

various UK Building Regulations recommend using accredited construction details[5] [6] (ACDs) to ensure that the edge losses are minimised.

The term 'y-value' is used to describe the sum of (length × Ψ) for all junctions in a building envelope divided by the total area of external elements, and provides a performance metric for thermal bridging, (not to be confused with the 'Y value' that is the abbreviation for thermal admittance and completely different!)

As an example, the application of linear thermal transmittance as part of the U value calculation of a simple window is given in panel 2.

Each of the heat flow paths in a building requires appropriate analysis to ensure that the integrity of the predicted heat flows, and hence forecast building energy use, is maintained. Aside from the important issues identified in this article, others include the anomalies when considering heat flow through ground floors, air spaces and basements that will need careful consideration. CIBSE Guide A3 and ASHRAE Fundamentals Handbook chapters 17 & 18 are great places to find out more about this essential area of knowledge and application.

Correction

In the May edition of the CIBSE Journal CPD, the following comment in the sixth paragraph was incorrect: '... [in] Building Regulations Approved Document Part L1A for houses, there are maximum acceptable "back stop" values for the U value of 0.2 W/m2K for external walls, 0.3 W/m2K for a roof and 2.0 W/m2K for windows.' The sentence should have read: '...[in] Building Regulations Approved Document Part L1A for houses, there are maximum acceptable "back stop" values for the U value of 0.3 W/m2K for external walls, 0.2 W/m2K for a roof and 2.0 W/m2K for windows.' This change may have affected your answer to question one. We apologise for the error and hope it has not caused our readers too much inconvenience.

PANEL 1

Considering the wall in Figure 2, it has already been determined that the only non-homogenous layer that will be taken into account is the blockwork. The proportions (as viewed from the face of the wall) of the mortar to blockwork is, in this case, 0.067 (ie 6.7% mortar). This can be readily determined – a simple calculation is given in BRE443 (freely downloadable from the web). So the thermal resistances of the layers can be determined. R_{se} and R_{si} are taken from CIBSE Guide A3.

Layer	Description	Proportion, P	Thickness, d (m)	Thermal conductivity, λ (W/mK)	Thermal resistance, R (m^2K/W)
1	Rse	100%	-	-	0.04
2	Brickwork	100%	0.105	0.77	0.136
3	EPS insulation	100%	0.050	0.040	1.250
4a	Block	93.3%	0.100	0.20	0.500
4b	Mortar	6.7%	0.100	0.88	0.114
5	Light Plaster	100%	0.013	0.18	0.072
6	Rsi	100%	-	-	0.13

There are just two resistance paths to consider – through the block:

Path A = $R_{se} + R_{brick} + R_{insulation} + R_{block} + R_{plaster} + R_{si} = 2.128\ m^2K/W$ and through the mortar,

Path B = $R_{se} + R_{brick} + R_{insulation} + R_{mortar} + R_{plaster} + R_{si} = 1.742\ m^2K/W$

And R_u may be determined by
$$\frac{1}{\frac{P_{PathA}}{R_{PathA}} + \frac{P_{PathB}}{R_{PathB}}} = \frac{1}{\frac{0.933}{2.128} + \frac{0.067}{1.742}} = \frac{1}{0.438 + 0.038} = 2.101\ m^2K/W$$

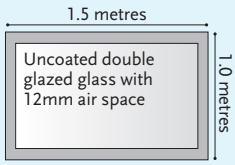
And R_L may be determined by
$$R_{se} + R_{brick} + R_{insulation} + \frac{1}{\frac{P_{PathA}}{R_{Block}} + \frac{P_{PathB}}{R_{Mortar}}} + R_{plaster} + R_{si}$$

$$\text{So } R_L = 0.04 + 0.136 + 1.250 + \frac{1}{\frac{0.933}{0.500} + \frac{0.067}{0.114}} + 0.072 + 0.13$$

$$= 1.628 + \frac{1}{1.866 + 0.588} = 1.628 + 0.408 = 2.036\ m^2K/W$$

Hence $R_b = (2.101 + 2.036)/2 = 2.069\ m^2K/W$ and so $U = 1/2.069 = 0.483 W/m^2K$

PANEL 2



Frame made of 75mm x 75mm softwood

Window in 'normal' exposure

From tables in CIBSE Guide A and from sketch left:

Frame - $U_f = 2.02\ W/m^2K$ (Table 3.25) and calculated area, $A_f = 0.353m^2$

Glass - $U_g = 2.85\ W/m^2K$ (Table 3.23) and calculated area, $A_g = 1.147m^2$

Linear thermal transmittance (in the CIBSE table related to spacer s between the two panes of glass), $\Psi_S = 0.06\ W/mK$ (Table 3.26), perimeter length, p_f=4.4m

And so for the window

$$UW = \frac{\Sigma(A_gU_g) + \Sigma(A_fU_f) + \Sigma(p_f\Psi_s)}{\Sigma A_g + \Sigma A_f}$$

$$= \frac{(1.147\times2.85) + (0.353\times2.02) + (4.4\times0.06)}{1.147 + 0.353} = \frac{3.269 + 0.173 + 0.264}{1.5} = 2.831\ W/m^2K$$

References

1. BS ISO 10456:2007 Building materials and products - Hygrothermal properties - Tabulated design values and procedures for determining declared and design thermal values
2. Conventions for U-value calculations BRE Report BR 443: BRE 2006, **www.bre.co.uk/filelibrary/pdf/rpts/BR_443_(2006_Edition).pdf**
3. CIBSE Guide A 2006, Section 3.3.11
4. Doran SM, and Kosmina L, 'Examples of U-value calculations using BS EN ISO 6946:1997' December 1999 **www.communities.gov.uk/documents/planningandbuilding/pdf/133394.pdf**
5. Accredited Construction Details , DCLG, June 2007 **www.planningportal.gov.uk/uploads/br/accredconbk.pdf**
6. Accredited Construction Details (Scotland) **www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/profinfo/techguide/acdscot**

Module 29

June 2011

1. Using the data in the article what would be the thermal resistance of 15mm of dense plaster?

- ☐ A 0.006 m^2K/W
- ☐ B 0.016 m^2K/W
- ☐ C 0.026 m^2K/W
- ☐ D 0.036 m^2K/W
- ☐ E 0.046 m^2K/W

2. As a general rule, what is the minimum value of conductivity for masonry above which the effect of associated mortar can be reasonably neglected from the U value calculation?

- ☐ A 0.1 W/mK
- ☐ B 0.2 W/mK
- ☐ C 0.3 W/mK
- ☐ D 0.4 W/mK
- ☐ E 0.5 W/mK

3. Which CIBSE Guide would most likely be of use when calculating U values?

- ☐ A A1
- ☐ B A2
- ☐ C A3
- ☐ D A4
- ☐ E A5

4. What is the normal alternative term for the 'linear thermal transmittance'?

- ☐ A pi-value
- ☐ B y-value
- ☐ C Y-value
- ☐ D psi-value
- ☐ E R-value

5. To reduce potential problems of thermal bridging in building elements which of these might best be used when developing designs?

- ☐ A High Y values
- ☐ B Non-homogenous structures
- ☐ C Accredited construction details
- ☐ D High values of R_{si}
- ☐ E Lightweight concrete blocks

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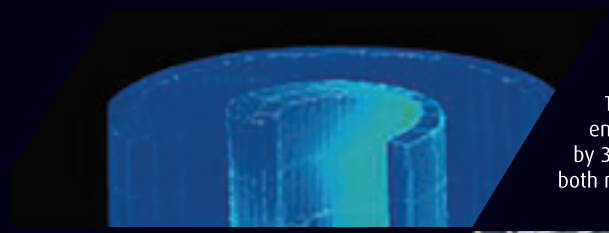

3D Scroll Compressor

This exclusive MHI technology realises greatly enhanced levels of energy efficiency and durability by 3-dimensional compression of the refrigerant, both radially and axially.

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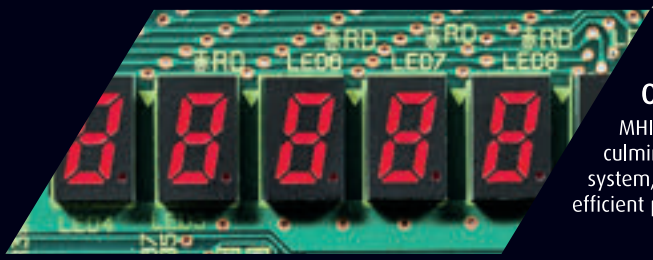
Energy efficiency is enhanced further with MHI's new Vector Inverter control technology that enables optimum comfort control and ultra efficieny at low load.



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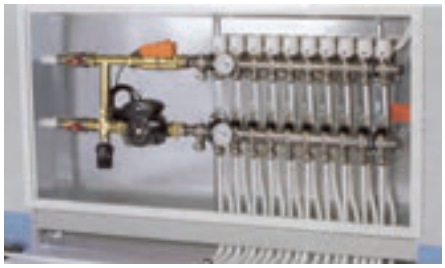


Victorian residence gets update with Oventrop underfloor heating

Oventrop has supplied and installed one of its Cofloor underfloor heating systems in an exclusive three-storey dwelling in west London, as part of an overall refurbishment of the house. Completed at the end of summer 2010, the system provides 140 square metres of additional, comfortable living accommodation in the timber joisted basement area. Using a five-circuit manifold, the system was designed with four zones to provide heating for a hallway, reception room, kitchen and conservatory.

● **For more information call 01256 330441 or email sales@oventrop.co.uk**

Historic hotel chooses MHS Radiators

MHS Radiators has supplied 120 classic cast-iron Clasico, Burlington, Ionic and Liberty radiators for a major refurbishment at Rockliffe Hall in County Durham. The 19th century Grade II-listed hall has been restored and expanded to create a luxury five-star hotel, golf and spa resort. Built in 1863 by Arthur Backhouse – a member of a renowned northern Quaker family whose influence ranged from botany to banking – Rockliffe Hall's design was commissioned from Alfred Waterhouse, who was the architect of the Natural History Museum.

● **For more information call 01268 546700 or visit www.mhsradiators.com**

EcoMESH Adiabatic air inlet cooling

The EcoMESH concept is based on intermittently spraying water onto a mesh placed in front of the heat reduction surface. This reduces power consumption by as much as 30-40% and improves the performance of Air Cooled Chillers, Dry Coolers and Condensers and Refrigeration Plants. EcoMESH is a unique mesh and water spray system that improves performance, reduces energy consumption, eliminates high ambient problems, is virtually maintenance free and can pay for itself in one cooling season.

● **For more information call 01733 244224 or visit www.ecomesh.eu**

New Thermokon catalogue for 2011

Thermokon's new full colour bumper Catalogue for 2011 is packed with 228 pages that include all types of sensors, from room operating panels, pressure, mixed gas-CO_2, light / motion, IO modules, humidity, thyristors and temperature to its innovative wireless system EasySens. Divided into individual sections for ease of use, it has many pages of new products, from wireless valve actuators and CO_2 sensors to the THANOS stylish touch room operating panels. You can download the catalogue from exclusive UK representative Slaney Direct.

● **For more information call 01628 664774 or visit www.slaneydirect.co.uk**

Workspace London development selects DRU Art heaters

Workspace Group owns and manages more than 100 business centres, situated in prime locations throughout London. A typical Workspace development is Riverside Business Park in Wandsworth. Originally an old Airfix building, Riverside offers a mixture of light industrial, office and studio space bringing together creative and manufacturing industries. Workspace has specified DRU Art series balanced flue gas wall heaters for many of the properties at Riverside. The heaters offer an efficient and flexible solution for properties of this kind.

● **For more information call 0161 793 8700 or visit www.drufire.co.uk**

MHI scores a strike at bowling centre

High efficiency climate control from Mitsubishi Heavy Industries (MHI) has scored a strike at The Original Bowling Company, a leading UK ten-pin bowling operator. Outdated heating and cooling plant has been replaced with MHI heat pump systems at four Hollywood Bowl and AMF Bowling Centres so far, with further sites to follow in an ongoing refurbishment programme. The new systems, supplied by AMP Air Conditioning, employ MHI's inverter technology offering variable capacity control for consistent temperatures and energy savings of up to 38%.

● **For more information call 0207 842 8100 or visit www.mitsubishiaircon.co.uk**

Perfect for retrofit – ADI-Nox boilers from MHS

MHS Boilers, part of ELCO Heating Solutions, has solved the problems caused by replacing old atmospheric boilers in compact plant rooms, with the launch of its new range of ADI-Nox ADI new high-efficiency appliances with outputs from 68 to 905kW. Designed to solve difficulties with limited installation space, the boilers have incredibly compact dimensions that belie their powerful outputs. For example, models of up to 110kW output are only 350mm wide – making access and retrofitting much easier.

● **For more information visit www.mhsboilers.com**

Telephone: 020 7880 6206 **Email:** darren.hale@redactive.co.uk

Titon flying high at housing development

The occupants of 150 properties at a development in Mildenhall, Suffolk, are benefiting from clean air and reduced noise, thanks to Sonair acoustic ventilation units from Titon. Havilland Wood is a development of apartments and larger family homes, situated close to the historic military airbase, currently used by the US Air Force. The Sonair units were specified for their ability to deliver filtered fresh air, as well as attenuating the intermittently high noise levels from military jets at the nearby airbase.

● **For more information visit www.titon.co.uk**

Static Systems' fire alarm challenges at Walsall

Formidable site-wide challenges had to be overcome by fire alarm specialist Static Systems Group (SSG) during the construction of the £174m Walsall PFI Hospital. A contract awarded by Skanska involved SSG in the design, supply and installation of fire alarms throughout the new facility. Because the new-build scheme was developed around existing facilities, maintaining full services to patients throughout the project was one of SSG's greatest challenges. Further works are scheduled for completion in Spring 2011.

● **For more information call 01902 895551 or visit www.staticsystems.co.uk**

New Ecoskid heating system from Baxi Commercial division

Baxi Commercial division launches the Ecoskid, a brand new prefabricated condensing heating system that extends the portfolio of high-efficiency, low and zero carbon solutions. Designed to provide the market place with an easy-to-install, fully prefabricated heating solution, it is a development of the early non-condensing prefabricated heating system which it replaces and the MB Series modular condensing option that will continue as a popular specifiers' choice. The new Ecoskid is also available with a standard plate heat exchanger option.

● **For more information call 0845 070 1055 or visit www.andrewswaterheaters.co.uk or www.pottertoncommercial.co.uk**

Baxi Ecogen cuts fuel poverty and carbon emissions

PEARL2 (Pendle Enterprise and Regeneration Ltd) has opted for Baxi Ecogen micro-combined heat and power (micro-CHP) as the low carbon heating and hot water solution for Stanley Street – Nelson, the latest phase of Pendle Council's multi-million pound improvement programme in Whitefield, Nelson, Lancashire. PEARL2 is a regeneration partnership between Pendle Council and Barnfield Construction. It aims to make Pendle a better place to live, learn, work, play and visit. Installing renewable technology was central to reducing energy costs and lowering carbon footprints.

● **For more information visit www.bdrthermaespecification.co.uk**

Durapipe PLX is the order of the day at the NGD data centre in Newport

Durapipe PLX, the specialist pipework system for fuel from Durapipe UK, has been specified to supply the emergency fuel solutions for the NGD data centre in Newport. The centre required a superior fuel system to provide fuel to the back-up power generators in the case of an emergency. Leading electrics company Power Electrics was tasked with supplying and fitting the data centre with a pipework system that would effectively transport fuel to the back-up generators.

● **For more information call 01543 279909 or visit www.plxpipe.com**

Big performance, small footprint – new pump from Dimplex

Dimplex is expanding choice in heat pumps for larger homes with the LA MAS range of air source pumps. A new design gives the range a considerably smaller footprint than previously, allowing greater freedom over location and system design, as well as reduced visual impact. The range offers homeowners the best of both worlds as it can be used as the sole heating source, or in 'bivalent' mode in combination with an existing conventional heating system to reduce bills and cut CO_2 emissions.

● **For more information call 0845 601 5111 or visit www.dimplex.co.uk**

Telephone: 020 7880 6206 **Email:** darren.hale@redactive.co.uk

Crane Valves saves energy for Domino's Pizza

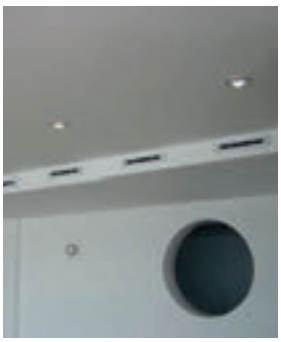
Commissioning valve units, strainers and associated products from Crane Fluid Systems have been installed at the commissary recently built for Domino's Pizza Group, a major pizza delivery company in the UK and Ireland, at West Ashland, Milton Keynes. The state-of- the-art facility will provide for the planned future growth of Domino's global business. More than 500 of its stores will rely on the new commissary for the fresh dough and other ingredients they need to produce consistently high quality pizzas.

● **For more information visit www.cranefs.com**

Birmingham University adopts SE Controls night purge ventilation strategy

The 'night purge' facility is often seen in naturally ventilated buildings. The idea is to cool down the internal fabric of the building during the coolest part of the night. In the Metallurgy and Materials Building at Birmingham University, first and second floor windows can be opened to offer this facility. If the temperature inside the building goes over a set point during the day and the outside temperature is at least 30C below the average internal temperature, the windows will open for one hour.

● **For more information call 01543 443060 or visit www.secontrols.com**



Invisible.AC central to energy-efficient fine dining at the Marine

The versatility of the Invisible.AC small-duct high-velocity heating and air conditioning system (sdHVAC) is highlighted at the restored art-deco beach front Marine Café in Milford-on-sea. The system, supplied by IBD Distribution, is linked to Daikin Altherma heat pumps to provide a fully integrated heating and cooling system for the café bar and the living accommodation. IBD Distribution supplied two compact and low-energy Invisible.AC air handling units and a mini-duct delivery system to provide cooling in the café area.

● **For more information call 01202 825682 or visit www.ibd-distribution.com**

Purmo brings low temperature heating to Launde Abbey

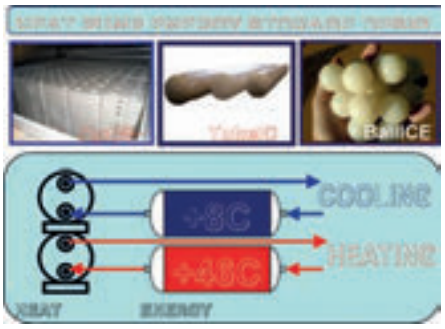
Launde Abbey, the residential Retreat House and conference centre serving the dioceses of Leicester and Peterborough, has had 60 Purmo radiators installed as part of an extensive refurbishment programme. Fourty-four Purmo Compact and 16 Delta Laserline radiators were fitted during the renovation of the 12th-century property. The radiators for the piano room and the library were powder coated brown to match the building's interior panelling. Launde Abbey contains a biomass boiler and 23 bedrooms, each of which had en-suite bathroom facilities installed during the refurbishment.

● **For more information call 0845 070 1090 or visit www.purmo.com**

BPT monitors selected for MediaCityUK

BPT Security Systems (UK), a specialist in door entry, access control and gate automation, is pleased to announce it has received one of its largest single project orders for Nova video door entry monitors. The order is for the MediaCityUK development in Salford Quays, Manchester. Already being referred to as the most significant media development in the UK, MediaCityUK has been designed to provide a purpose-built home for creative and digital businesses.

● **Fore more information call 01442 230800 or visit www.bpt.co.uk**



Heat pump energy storage system

Phase Change Materials (PCM) store and release thermal energy during the process of melting and freezing. The latest range of PCM solutions offer new application opportunities between -100°C and +885 °C. For example, using +8C and +46C PCM materials on both the cold and hot side of the heat pump would spread the loads over 24 hours and reduce the machine size as much as by 50%. By also storing hot and cold air, the overall COP nearly doubles, not only reducing the running cost but also offering a reliable stand-by system.

● **For more information call 01733 245511 or visit www.pcmproducts.net**

First dedicated electrical test kit for solar PV installation

The Seaward Solar Installation PV100 is the first dedicated multi-function electrical tester for those involved in solar panel installation. The tester can carry out all electrical tests required by IEC 62446 on grid-connected PV systems and eliminates the need for multiple test instruments for PV panel electrical installation and connection. With the push of a single button, the new combination tester carries out the required sequence of electrical tests in a safe and controlled manner, avoiding the risk of contact with exposed live DC conductors.

● **For more information call 0191 586 3511 or visit www.seawardsolar.com**

Telephone: 020 7880 6206 **Email:** darren.hale@redactive.co.uk

Douglas-Delabie's new Temposoft 2 range gives 84% water savings

Douglas-Delabie, the specialist supplier of thermostatic control solutions and accessories for the commercial market, has enhanced its successful Temposoft taps and mixers for washbasins with the development of its Temposoft 2 range. Featuring a regulated flow rate at 3 litres/min, the company says these easy-to-operate 'soft touch' timed flow push basin taps and mixers can achieve water savings of approximately 84% compared with a traditional basin tap. Time flow taps are used increasingly in commercial and public buildings for achieving water and energy savings.

● **For more information call 01491 824449 or visit www.douglasdelabie.co.uk**

BACnet natural ventilation control from TITAN Products now available

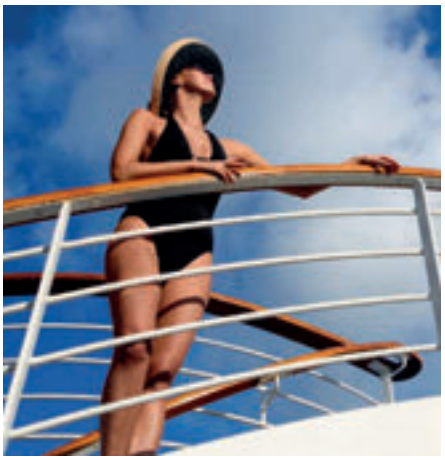
The CCM-204-NV provides energy efficient control in buildings by monitoring the natural ventilation on demand and improving the environmental conditions through the control of temperature and CO_2 levels. The CCM-204-NV can control two separate zones and – when used in conjunction with TITAN Products' temperature sensors, CO_2 sensors, rain detectors and window controllers – the CCM-204-NV can create an extremely flexible multi-zone natural ventilation system. This advanced application-specific controller with automatic seasonal adjustment will increase ventilation as CO_2 and temperature levels increase.

● **For more information call 0161 406 6480 or visit www.titanproducts.com**

Reliable luxury for cruise liners

When a luxury steam room is moving around the world on a cruise liner you can't afford for it to need repairs. The sheer reliability of HygroMatik's equipment was the reason that its steam generators were specified for the steam rooms aboard the Pacific Pearl, a luxury P&O Cruise liner based out of Australia. Specialist design and manufacturer Rigo Spa specified HygroMatik's C10 and C17 Comfort Plus DS Comfort Line Steam Bath Generator equipment for two opulent inbuilt steam rooms.

● **For more information call 02380 443127 or visit www.hygromatik.co.uk**



Grundfos supplies pumps for new five-star flagship hotel in London

London's newest five-star hotel has opened its doors following a reconstruction costing £300m. The building has returned to its roots – it was opened as a hotel in 1886 and operated as The Metropole until it was taken over by the Ministry of Defence in 1936. Working with Ardmore Construction to ensure the pumping solution would meet the most exacting of standards, Grundfos Pumps supplied a complete turnkey solution that included a wide range of energy efficient pumps from the TPE range of centrifugal pumps.

● **For more information call 01525 850000 or email uk-sales@grundfos.com**

Star Refrigeration turns up the heat at Norwegian military base

UK firm Star Refrigeration has designed a groundbreaking renewable energy heat pump system to serve a military base in Norway. The Glasgow-based cooling and heating specialist, with Norwegian refrigeration partner Norsk Kulde, has just installed the Neatpump system at the Ramsund Naval Base. Located in the northern county of Troms, the coastal facility is used for Norwegian Army and Royal Norwegian Navy vessel repairs and is also a Special Forces base. Star's Neatpump is an innovative ammonia heat pump plant that extracts heat from seawater in Ramsund's harbour.

● **For more information call 0141 638 7916 or visit www.star-ref.co.uk**

New World for Vaillant and Sanctuary

Vaillant's acclaimed vacuum tube solar panel systems have been installed by New World Solar, of Birmingham, on 163 properties in an estate in Ashby de la Zouch, Leicestershire, owned by leading UK housing and care provider, the Sanctuary Group. Sanctuary chose Vaillant auroTHERM VTK panels for their high efficiency in preference over a flat plate system, and were also attracted by Vaillant's ability to provide a total system package, including collectors, pipework, fittings, controls and pump station.

● **For more information call 01634 292300 or visit www.vaillant.co.uk**

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● **For more information visit www.aircraftairhandling.com**

Hospital neurology centre in Southampton protected by FP PLUS

Twelve thousand metres of FP PLUS from Prysmian have been installed in the upgraded fire alarm system at the Southampton General Hospital Neurology centre. This New Generation FP PLUS cable with Insudite insulation offers excellent resistance to damage while also being approved for fire detection and fire alarm critical signal paths to BS 5839-1:2002+A2:2008 for enhanced applications. FP Plus is manufactured by Prysmian near Southampton at Eastleigh. Southampton-based electrical contractors Reavey & Son carried out the cable installation work.

● **For more information call 02380 295029 or email cables.marketing.uk@prysmian.com**

Honeywell water balancing and scald protection valves installed on HMS Queen Elizabeth

Honeywell water control valves are being installed on the Royal Navy's new aircraft carrier HMS Queen Elizabeth, to ensure uniform ideal water pressures automatically at all domestic water outlets and to prevent excessively hot water in baths, showers and wash basins. The marine engineering valve specialist Score Marine is installing 50 Honeywell Kombi 4 throttle valves for automatic hot water balancing, which cost less than other auto balancing systems, and 142 Honeywell TM200VP thermostatic mixing valves for scald prevention.

● **For more information call 01344 656172 or visit www.honeywellukwater.com**

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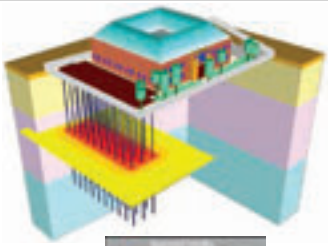

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midlothian.myjobscotland.gov.uk

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BAR623/PA

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NATIONAL EVENTS AND CONFERENCES

Building Services World Cup 2011
11 June 2011, Liverpool
Teams competing for the CIBSE World Cup
www.buildingservicesworldcup.com

Solarplaza – The Solar Future UK
29 June 2011, London
Solarplaza's second UK conference – see box, right
www.thesolarfuture.co.uk

CIBSE Technical Symposium
06-07 September, Leicester
Two-day event showcasing research and technical developments. The symposium will include papers that are relevant for the full range of technical areas of interest to CIBSE members
www.cibse.org/events

SOCIETY OF LIGHT AND LIGHTING

LEDs – a CRI for Help
11 October 2011
Details TBC
www.sll.org.uk

CIBSE REGIONS

Society of Public Health Engineers Technical Evening
07 June, London
AGM and presentation on the future management of sewers and drains. Free, but registration is required
www.cibse.org/sophe

Society of Façade Engineering Factory City Walk
16 June, London
Annual guided walk around London
www.cibse.org/sfe

Intelligent Buildings Group seminar: designing for intelligent underground building
06 July, London
Seminar looking at designing underground buildings for living and working
www.cibse.org/events

Society of Façade Engineering Technical meeting
21 September, London
Details TBC
www.cibse.org/sfe

Future's bright

Solarplaza has announced the line-up of speakers for its second UK solar conference. 'The Solar Future, UK' takes place on 29 June at Central Hall, Westminster in London.

Since the government's recent announcement to review the feed-in tariff (FiTs) scheme, concerns regarding the future of solar deployment in the UK have been widespread. However, the outlook for small- to medium-sized installations remains positive.

'Despite the FiTs review, the UK solar market still has opportunity hotspots and the business case for solar deployment in these areas remains strong,' said Edwin Koot, chief executive at Solarplaza.

Keynote speakers include Huw Irranca-Davies, Shadow Energy Minister, and Rachel Solomon Williams who is leading the FiTs review. Tickets cost £95 including VAT.

www.thesolarfuture.co.uk


Huw Irranca-Davies

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www.cibsetraining.co.uk

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28-29 June 2011, London
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Symposium on lift and escalator technologies
29 September 2011, Northampton
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ELECTRICAL SERVICES

Electrical Services Explained (three days)
21 June 2011, Birmingham

Electricity at Work Regulations Explained
24 June 2011, London

BUILDING REGULATIONS

Gas Safety regulations explained and designing for compliance
28 June 2011, London

ENERGY EFFICIENCY AND SUSTAINABILITY

Low carbon buildings and energy infrastructure for local authorities
16 June, London

Smart Metering
16 June 2011, London

2010 Part L Building Regulations
07 July 2011, Birmingham

Carbon Reduction Commitment
12 July 2011, London

FACILITIES MANAGEMENT

Preparing FM and maintenance contract
09 June 2011, London

Introduction to Facilities Management
30 June 2011, London

FIRE SAFETY

Emergency lighting to comply with fire safety requirements
02 June 2011, London

Fire sprinkler systems – design to BSEN 12845
02 June 2011, London

Fire detection and alarm systems for buildings BS5839 part one 2002
07 June 2011, London

Current Fire Legislation and Guidance
15 June 2011, London

MECHANICAL SERVICES

Air conditioning basics three: air conditioning plant
31 May, London

Air conditioning basics four: automatic controls and refrigeration
01 June, London

Fans in the 21st century, Parts L, F and all that
08 June 2011, London

Mechanical Services Explained (three days)
15 June, Birmingham

PUBLIC HEALTH AND WATER

HSE guidance on control of legionellosis explained
01 June 2011, London

Building Drainage Explained
09 June 2011, London

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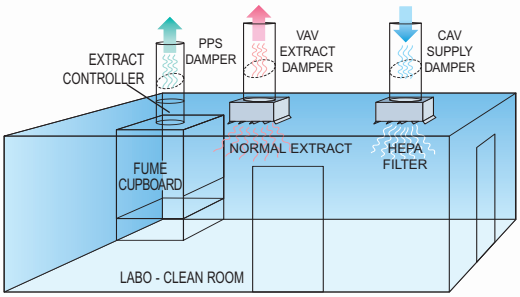

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