BRE Trust Review 2014
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Having decided to step down as Chair of the BRE Trust at the end of 2014 I’d like to take this opportunity to reflect on the achievements during my 6 years in this role, as well as specifically highlighting the outputs in 2014.

The Trust was created in 2001 with the overarching remit to provide research and education for the public good in the built environment and due to the ongoing success of its operating companies it continues to be the UK’s largest charity focused on the built environment. Industry has faced unprecedented challenges since the downturn in its home market in 2008, so the work of the Trust is vital in ensuring firms can embrace new knowledge to enhance skills. This is needed to improve quality and efficiency of their products and services to maintain competitiveness in a rapidly growing global marketplace.

In 2014 we launched a targeted research strategy which clearly defines the following 3 key objectives to

– Drive change in the built environment
– Develop state-of-the-art skills and knowledge in industry
– Create world class research capabilities

This will provide further focus for the activities of the programme to ensure the impact of the Trust is maintained in the future.

The level of underpinning fundamental research completed continues to grow, with over 90 PhDs being funded by the Trust since 2001. This adds to the overall total of more than 200 PhDs now completed or active across the BRE Trust 5 University Centres of Excellence. This critical mass of activity has attracted the best staff and students, resulting in exceptional results from the 2014 Research Excellence Framework. Funding for 9 new studentships was provided in 2014 and ongoing support for the 5 Chairs of the Centres approved for the next 5 years.

The main research programme has supported over 350 individual projects since 2001, focused on delivering outputs which address key challenges facing our industry. In 2014 funding was provided for 26 new projects, joining the existing 46 active projects already underway. Many of these programmes involve collaborative working with other researchers in both academic and industrial organisations, enhancing collective capabilities and the contextual relevance of the work.

This has also brought with it increasing levels of additional funding, with 2014 attracting an all time high of £3.2m additional funding in year, leveraged against the £950k provided by the BRE Trust. This has not only enhanced the amount of research that can be completed but also the potential impact that the outputs from the work will create.

The current Thematic Programme focused on cities was launched in 2012, with the 3 specific themes of energy, infrastructure and wellbeing. The majority of project work for this 3 year programme has now been completed and additional funding so far has been exceptional. Over £6m additional funding has been leveraged to BRE and its University Centres, with a collective research portfolio of over £30m being delivered in collaboration with more than 70 partners. Although the main programme is nearly complete further associated research and product development will continue to support our sector build and operate effective cities in the future.

The next Thematic Programme, which will begin in 2015, will focus on resilience, with an initial emphasis on the impact of climate change. This has already attracted interest from over 100 organisations from across the supply chain and the £1m initial funding provided by the Trust over the next 2 years will act as a catalyst for the development of new data and knowledge to support the enhancement of new innovative products used in buildings, communities and infrastructure.

The translation of data and information generated by the research programme to advance the skills of professionals in our industry is a critical priority for the Publications Programme, which has funded over 300 new and updated titles since its launch in 2009. This has added to the significant wealth of knowledge generated by BRE in its 90 years and the 1300 titles available through the BRE Bookshop. 2014 saw 42 new publications released, a mix of traditional and new digital formats to enhance the value of the content for the reader. This will also enable extended outreach on a global scale, delivered by active learning platforms in an affordable and effective way.

This review allows The Trust to share summaries of some of the work it has funded that has been completed in the last year. I would like to thank the Trustees for the tremendous ongoing support they provide as members of The Council and the various programme committees. I would also like to thank the staff and students at BRE and our University Centres for their continued hard work in delivering our programmes and for their contributions to this review. I would finally like to take this opportunity to wish James Wates every success as the new Chair of The BRE Trust.
Introduction

The BRE Trust is the largest UK charity dedicated specifically to research and education in the built environment. The Trust uses all profits made by the BRE Group to fund new research and education programmes that help to meet its goal of ‘building a better world together’.

The Trust funds research to drive improvements, change and delivery in the built environment. We share knowledge and deliver active learning on our findings which provide authoritative guidance to the construction industry.

Through its funded programmes, the Trust aims to:
– Drive change in the built environment
– Develop state-of-the-art skills and knowledge in industry
– Create world class research capabilities

Programme overview 2014

The Trust’s objectives of providing research and education for the public good in the built environment are supported by targeted funding for the development of a world class research organisation with wide outreach and collaboration.

This is achieved by working in partnership with other organisations to support enhanced capabilities through focused and collaborative research. The education programmes with the BRE University Centres of Excellence continue to provide funding for PhD students and those studying for Masters degrees.

Funding provision is also provided for effective dissemination of research outputs via the publications programme, providing relevant data and knowledge needed by the wider industry and those who implement change in the built environment.

The overall expenditure by the Trust on all its programmes was £2.7m, with progress in the individual programmes summarised as follows:

University Centres of Excellence

Excellent progress continued with the 5 University Centres of Excellence, where there have been a total 170 PhD studentships, 100 staff and a portfolio of more than £60m research completed or underway since the launch in 2006. 6 studentships were completed and 9 new studentships were started in 2014, with a total funding of £630k from the Trust.

Research programme

The delivery of the Managed Research Programme was commissioned principally, but not exclusively, through the Trust’s trading subsidiaries. At the beginning of 2014 there were 46 active research projects within the established Managed Programme and the Research Committee also approved 26 new projects to begin in the 2014, leveraging an additional funding of £840k from industry and a further £2.36m from public sector sources. Of these 36 were completed in the year, with a total spend of £950k.

Thematic Future Cities programme

The Future Cities Programme has grown considerably since its launch in 2012, with an additional £5.8m of cash and £1.6m in-kind leveraged against the £1.5m funding provided by the Trust for BRE and its UCEs. The programme now has over 70 partners, from the public and private sector, working with BRE to develop new products to support the efficient operation of cities. At the beginning of 2014 there were 13 active projects, of which 3 were completed, with a total spend of £440k in year.

Publications programme

At the beginning of 2014 there were 65 publications in preparation, with 37 new projects approved in year, 23 of which were new digital formats. Of these, 42 were completed in year, with the total spend for the year at £630k. The approved projects will deliver both new titles in emerging subjects as well as providing timely updates to existing titles which are still considered valuable and popular to practitioners in the field. This maintains BRE’s reputation as a trusted provider of independent and validated data and information.

BRE’s launch of its new digital platform BRE Buzz will support the continued development of new publication formats. It will also deliver enhanced integration of a range of data and information sources to provide multiple access points for people using different devices anywhere in the world.
Jan 2014 BRE Group Research Director Awarded MBE

Dr Deborah Pullen, the BRE Group Research Director, is responsible for the current research and learning programmes delivered by BRE and its strategic research partnerships and University Centres of Excellence.

Deborah has spent the last 20 years leading business teams in government and private sector organisations across many sectors. Over the last 10 years Deborah has also set up and led a number of knowledge transfer networks. She was awarded an MBE in 2014 in recognition of her work in innovation and knowledge transfer in the Built Environment.

Feb 2014 BRE Trust Research Conference

The Ninth BRE Trust Research Conference was held on 25 February 2014 at The Crystal, chaired by Dr Liz Goodwin. The theme of the conference was Future Cities and it included presentations from BRE staff, PhD students and representatives from a number of organisations that are partners in the Future Cities programme. It was attended by over 150 guests and the proceedings of the event together with filmed extracts have been posted on the website.

March 2014 New BRE Academy launched

The BRE Academy was launched at Ecobuild14 with the mission to deliver world-class training and education programmes to provide all those involved in the built environment with the skills and learning they need for working and delivering globally.

Developed in partnership with more than 20 of the sector’s best knowledge providers, the Academy provides a complete spectrum of programmes to support the entire supply chain in an extensive range of subject areas. This will be delivered through qualifications, accreditations and CPD programmes at levels ranging from City & Guilds and BTEC to post graduate diplomas and Masters degrees. In its first year the Academy has already trained over 2000 individuals via its programmes and will play an active part in disseminating the outputs from the BRE Trust programmes.

June 2014 BRE launches new online community platform

BRE launched its new community platform, BRE Buzz, which is aimed at all those working in the built environment and related sectors who wish to drive positive change. BRE Buzz enables users to share knowledge, ideas and opportunities, publish their own news stories and blogs, join in the global conversation and ultimately build networks that will help them deliver better projects and develop more business. This platform will become an integral part of the dissemination of outputs from BRE Trust programmes to increase outreach and seek feedback and opinion to shape future research programmes. To find out more about the new platform go to BRE Buzz, email us at buzz@bre.co.uk, follow us on Twitter or on Facebook.
October 2014 New BRE Chief Scientist and Engineer

Jeremy Watson joined BRE as Chief Scientist and Engineer. Jeremy is concurrently Vice-Dean and Professor of Engineering Systems in the Engineering Sciences, working in the Department of Science Technology, Engineering and Public Policy at the University College of London (UCL).

Jeremy’s role will provide high level technical and business leadership to deliver the Research Strategy, enhancing and extending current capabilities and the excellence of future outputs to support BRE’s future business requirements and the wider objectives of the BRE Trust.

October 2014 BRE Trust and Tsinghua University confirm their Research Partnership

BRE and Tsinghua University, Beijing announced a programme of joint research on that is designed to support the Chinese government’s priorities for Green and Low Carbon Urbanisation.

Three key projects will be conducted as part of the collaboration. The first will focus on the monitoring of the combined effect of air quality, noise, temperature, humidity and lighting and the related impact on productivity and wellbeing of occupiers. Secondly, the partners will also work jointly to validate a Healthy City Index which assesses the status of a city’s built assets in relation to their support for the health and wellbeing of their citizens.

Finally, the partners will conduct a mapping study between China’s 3 Star Green Building Standard (currently used on 3% of developments in the country) and international standard BREEAM. The collaboration has come about following the visit by Premier Li Keqiang to BRE in 2011, when he made a commitment to encourage partnership on sustainable development between China and UK.

October 2014 – Royal Charter International Research Award

The BRE Trust and the Worshipful Company of Constructors launched a competition for applicants who are employed – or undertaking a PhD – in the built environment sector, to undertake innovative research on the theme of built environment resilience. Their study could focus on any aspect of building resilience to climate change or natural disaster, resilient communities, digital infrastructures or one of the many associated topics, but should have an international dimension.

In addition to a £7,000 award towards the cost of the study, the winning applicant’s work will be published by the BRE Trust and a summary of the final report will feature in Constructors Journal, the journal of the Worshipful Company of Constructors.

The shortlisted applicants were interviewed in December 2014 and the award will be presented at the Worshipful Company of Constructors Awards Dinner in February 2015.
November 2014 - Resilience 14

Resilience14 was attended by over 350 people, and explored the challenges of adapting the built environment to the more severe and unpredictable weather patterns than are a consequence of climate change.

The event featured two conferences: Britain Under Water and Britain Overheating, and the BRE’s Centre for Resilience launched its flood resilience policy paper ‘A Future Flood Resilient Built Environment’, which calls for Government to adopt a new approach for tackling flooding which is a risk to over 5 million homes* in the UK alone. Outputs from the event can be found at www.resilience14.com.

December 2014 New Chairman of the BRE Trust

James Wates took over as Chairman of the BRE Trust from Sir Neville Simms, alongside his day job at Wates Group, James Wates is also chairman of Construction Industry Training Board (CITB) and of the UK Contractors Group (UKCG) trade association.

James is also a member of the Confederation of British Industry’s construction council, and a commissioner for the UK Commission for Employment & Skills (UKCES). He is chairman of the Prince’s Trust built environment leadership group, a governor of the University of Westminster and of Emanuel School, vice chairman of Queen Elizabeth’s Foundation for the Disabled and a patron of the Wates Family Enterprise Trust.

Of his latest appointment, Mr Wates said: “This role with the BRE Trust is a great opportunity to connect the research and science outputs of the charity with the skills agenda of CITB and the construction delivery and supply chain through UKCG. Our industry is growing but we have fewer resources to work with, we have a significant skills gap and we continue to be challenged by carbon-reduction and climate adaption – innovation underpinned by science is the key and this is what the Trust does so effectively.”
During 2014 BRE Trust continued to provide grants to support the following five BRE University Centres of Excellence:

- University of Strathclyde: BRE Trust University Centre of Excellence in Energy Utilisation
- Bath University: BRE Centre for Innovative Construction Materials
- Cardiff University: BRE Centre in Sustainable Engineering
- Edinburgh University: BRE Centre for Fire Safety Engineering
- University of Brasilia: BRE Centre for Integrated and Sustainable Communities

Excellent progress continued, with a collective portfolio of over 170 PhD studentships, 100 staff and more than £60m research completed or underway since the first Centres were launched in 2006.

The hard work of our chairs was demonstrated by the excellent performance of the Centres in the Research Excellence Framework (REF) rankings, which are based on three elements that are combined to produce an overall profile (quality of research outputs, the research environment and the social, economic and cultural impact of research).

The ranking reveals that:

**Cardiff University’s** Civil & Construction Engineering faculty, where the BRE Centre is located, ranked number one in the UK. 97% of its research is of world-leading or internationally excellent quality. Its research received a 100% score in terms of impact (social, economic, cultural).

**The University of Bath’s** Department of Architecture & Civil Engineering department, where the BRE Centre for Innovative Construction Materials is based, also achieved first place in the ranking for Architecture, Built Environment and Planning with its impact cited as a key factor.

94% of the overall research activity in **Edinburgh University’s** Research Partnership in Engineering (ERPE) where the BRE Centre is located is world-leading or internationally excellent.

**Strathclyde University’s** joint research which includes Mechanical and Aerospace Engineering (where the BRE Trust Centre is based) has been rated fourth in the UK.
University of Strathclyde: BRE Trust Centre of Excellence in Energy Utilisation

The Centre undertakes fundamental and applied research into sustainable energy utilisation within the built environment in partnership with BRE. The focus is on responsive demand as a means to assist the accelerated deployment of new and renewable energy solutions at both the local and national scale. The intention is to create and disseminate new approaches to well-grounded energy solutions in the context of future cities and rural communities. Such activities require knowledge of technology dynamics alongside an understanding of end user behaviour. This need, to link the social and behavioural aspects of energy end use with research into energy efficiency and network innovation (as emphasised by the UK Research Councils), will be a unique strength of the Centre through its multi-disciplinary capability.

The present association of the Centre with the cognate staff of the Energy Systems Research Unit (ESRU) will be evolved to include energy demand-oriented staff within the Institute for Energy and Environment (InstEE) and Architecture at Strathclyde. Three distinct but interdependent research themes will be pursued by the Centre, these are: monitoring and energy services, whole systems modelling and simulation and integrated investigation of energy utilisation technologies.

New studentships in 2014

Graeme Frett - Developing a Bottom-up Approach to the Modelling and Simulation of Low Carbon Community Energy Performance

The PhD project will develop a high resolution toolkit for the detailed analysis of community energy schemes and then apply it to the important issue of optimised heating feasibility in a more energy efficient built environment. The work will employ a novel and computationally intensive approach involving assessing the performance of communities from the bottom-up: simulating the performance of many individual buildings in parallel along the communal energy networks, yielding the communities’ overall energy performance.

Maria del Carmen Bocanegra-Yanez – Simulation-aided building design

The traditional way of applying simulation in the design of buildings has been for a base case design to be suggested by the design team, together with a set of parametric changes to explore alternative designs. Selecting appropriate design options is made difficult by the large increase in available technologies – both passive and active systems. The project will explore how simulation can be used in the early stage of design to suggest a subset of design solutions. It will require automatic generation of large numbers of building model variants and a method of evaluating relative and absolute performance from the simulated results database. The research will also consider how the approach can be applied to other simpler software tools such as SBEM.
Bath University: BRE Trust Centre for Innovative Construction Materials

The BRE Centre for Innovative Construction Materials (BRE CICM) was founded in July 2006. Its primary aim is to conduct internationally leading and interdisciplinary research in the development of innovative and sustainable construction materials and technologies. Since its establishment BRE CICM has developed particular expertise in the following areas: Advanced composites in construction, Concrete materials and structures, Low carbon building materials, Structural masonry, Timber engineering.

2014 saw the launch of The Hive, a unique test rig in the UK for the analysis of the environmental impact of low carbon construction materials— including energy efficiency, flood resilience, structural capability and internal air quality performance. The £1m HIVE is funded by the Engineering and Physical Sciences Research Council (EPSRC) and will provide extended capabilities for the University and BRE.

New studentships in 2014

Andrea Giampiccola, Development and evaluation of photocatalytic coatings for improving the indoor air environment

The PhD will develop novel titanium dioxide photo catalytic coatings for the removal of volatile organic compounds (VOCs) and pollutants from the indoor air environment. In support of the FP7 ECO SEE project these coatings will be vapour permeable and compatible with environmentally friendly and natural materials. The development of methodologies for low temperature coating application will be an important objective and lime based binders will form a starting point. Furthermore evaluation of the photocatalytic activity, durability and performance will be achieved through laboratory testing using a range of microstructural characterisation and analytical techniques such as SEM, TEM, Raman Spectroscopy, TGA/DTA and X-ray diffraction. The work will encompass proof of concept testing in the laboratory, large-scale tests and pilot studies.

Carla DaSilva Hygro-thermal behaviour and capture of volatile organic compounds by natural building materials

The PhD project will develop scientific understanding of the interaction of VOC’s and formaldehyde with various types of organic and inorganic insulation materials, coatings and panels. A range of electron optical and analytical techniques, such as FTIR, XRD, Raman spectroscopy, TGA/DSC will be used for initial characterisation. Absorption and re-emission of VOC’s will be studied using GCMS, HPLC and emission cells and chambers. As part of the FP7 ECO SEE project the work will combine the development of new experimental characterisation methodologies and performance testing.

(Courtesy of University of Bath)
Cardiff University: BRE Trust Centre in Sustainable Engineering

BRE Centre in Sustainable Engineering will support a new generation of digital buildings that have lifelong resilience and adaptability to their environment, usage and occupancy, enabled by (a) smart materials and products, (b) integrated design and manufacturing systems, and (c) total lifecycle approaches.

Research focuses on dynamic and self-updatable digital conceptualization of a building / district / city, that fully exploits latest advances in ICT, including pervasive sensing technologies, is central to the centre’s vision. These digital technologies will provide real-time performance (including energy) measurement, while promoting lifelong adaptability.

The Centre is currently carrying out a variety of projects including:

- Knowledge based energy management for public buildings though holistic information modelling and 3D visualisation (KNOWHOEIM), sponsored by the European Commission under FP7
- CloudBIM: Exploring the feasibility and potential for cloud research in the architecture, engineering and construction sector, sponsored by the Engineering and Physical Sciences Research Council
- SCriPT: Sustainable Construction Service Platform, sponsored by the Welsh Assembly Government
- Cost-effective, large-scale, adaptable and deployable innovative domestic renewable energy product and process solutions, sponsored by BRE Ltd, MOMENTA

New studentships for 2014

Sean Howells – Ontological Representations for Integrated Smart Cities Modelling and Data Analytics

The project will involve the development of a language for modelling of city systems. A number of technologies and data format/sharing standards have been used to date to conceptualise and share built and infrastructure artefacts, including BIM and GIS. Integrating these standards and their underpinning concepts around a common analytical reference and associated mathematical and numerical models is a prerequisite for addressing the complexity of our city systems. The project will help develop an integrated semantic representation of built and infrastructure facilities (including energy, transport, water, IT and health) that will enable cross-sectoral evaluation of changes to city networks (including design, configuration, pricing, management and governance).
University of Edinburgh - BRE Trust Centre for Fire Safety Engineering

The BRE Centre for Fire Safety Engineering conduct research into the areas of impact of climate change / natural disasters, smart visualisation/ user interface functionality, resilience of buildings, districts and cities to fire and semantic BIM-based Fire Prevention and Mitigation. The centre has 40 research members from more than 18 different nationalities and is deeply involved in setting the direction for Fire Safety Engineering practice.

In addition to an extensive portfolio of research the Centre supports three Structural and Fire Safety Engineering degree courses; International Master of Science in Fire Safety Engineering; Masters Degree in Structural and Fire Safety Engineering; and Undergraduate Degree in Structural and Fire Safety Engineering.

New studentships in 2014
Ben Ralph – Multi-scale Modelling of Fibres in Modern High-Rise Buildings, University of Edinburgh

The PhD project will focus on advancing current multi-scale modelling methods for modern high rise buildings, building on work already developed for tunnel structures with high and complex ventilation systems. The work will use 3D CFD simulations to accurately predict part of representative systems where air flow is likely to be complex combined with simpler 1D models for the remainder of standard features. The combined multi-scale model will then require significantly less computational time with negligible reduction in accuracy.
University of Brasilia: BRE Trust Centre for Integrated and Sustainable Communities

The Centre conducts research and development of tools and services that enable the creation, delivery and maintenance of a more sustainable built environment. Specific research topics include:

- **Productive construction supply chain.** This research deals with aspects of innovation and sustainability of the materials, processes and products of the construction industry supply chain, covering buildings, urban spaces and urban infrastructure.

- **Urban waste management.** This research aims for the integrated management of solid waste, includes the optimization of environmental sanitation, the integration of social agents and construction waste recycling.

- **Social and urban regeneration systems.** This line of research deals with the urban environmental management; sustainable, healthy and eco-efficient cities; low cost housing; sustainable mobility; green infrastructure; water cycle ecologic management; education for sustainability; and models for inclusion.

The work of the Centre underpins BRE’s business growth in Brazil via the Innovation Park being built at the University.
BRE Trust Research Programme
Completed Projects
Why the research was needed

The project sought to develop a training course for a new role, Site Sustainability Manager (SSM), created to address a series of construction site related problems, namely:

- Buildings falling short of their performance targets through failures in the construction process (e.g. a lack of skills/knowledge on the part of contractors delivering construction details)
- A lack of expertise in other site-specific areas, e.g. site waste management plans, how to minimise energy used during construction and reduce site impacts.
- A lack of communication of design principles to operatives both in terms of potential failures and which parts of the design already delivered work well and which cause problems.

It was recognised that these types of failures are less likely to occur if specific environmental knowledge is available on construction sites. The project proposed that contractors’ site teams could include someone who had also been trained and assessed as a competent SSM and whose job would include ensuring that sustainable construction requirements are met (a sustainability role analogous to that of a Health and Safety Manager).

Provided a role could be suitably defined, communication would be encouraged both upstream to design teams and downstream to the site operatives. Contractors embedding an analysis of these site dependent factors in a construction project would learn over time about how sites operate and how procedures can be improved cost effectively.

Objectives

The project aimed to create a role that supports BREEAM, providing increased assurance that what has been designed will be delivered in practice. Through the establishment of a Site Sustainability Manager (SSM) scheme, to promote communication, linking design decisions to effects on site and then feed learning back to active sites to allow more informed decision-making. The data gained from the scheme will be used to underpin new guidance and standards.

Outcomes

The BRE Academy Site Sustainability Manager course was launched in 2014 with successful participants gaining a City and Guilds Level 3 Diploma. The role is formally recognised within BREEAM 2014 New Construction.

The qualification is gaining significant traction in the industry, with 200 managers being trained in the first six months and all Balfour Beatty Site Managers undertaking the training.

Next steps

BRE is now considering how this qualification can be expanded to Level 4 diploma status by incorporating additional BRE tools such as CALIBRE and SmartWaste, as well as a variant specific to refurbishment. The project also has international potential, with several European countries looking at how the course can be used to drive standards in their countries.
Quantifying Sustainability in the Aftermath of Natural Disasters (QSAND), Yetunde Abdul

Why the research was needed
UNEP, OECD and others have called for sustainability to be appropriately considered and integrated into disaster recovery operations, managing trade-offs between quick delivery and longer-term sustainability. The International Federation of Red Cross and Red Crescent Societies (IFRC) and BRE Global have been working together to develop a tool to promote, support and guide sustainable approaches to recovery and reconstruction operations in the aftermath of natural disasters.

Objectives
The aim was to develop a tool to inform and measure the sustainability impacts and performance of various stages of the disaster timeline (e.g. relief, recovery, reconstruction) within the context of shelter and settlement. Where practical, early decisions should go on to positively influence the sustainability of the long-term reconstruction of the disaster hit area. Members of the Project consultation Group include UN-HABITAT, Habitat for Humanity, WWF US, Norwegian Refugee Council, OXFAM, and Swiss Development Agency.

Outcomes
The key output of the QSAND project is a tool called the Shelter and Settlement Sustainability Assessment Tool, which draws on aspects of BREEAM. The tool can be used in the field by individuals on the ground, regularly reviewing the assessment criteria and ensuring the relief programme meets its requirements. It can also be used by programme managers at regional level and international donors at a global level to take a broader look at how the recovery effort has performed.

Next steps
The tool is currently being peer reviewed by a range of organisations and an online version is being developed. BRE and IFRC are considering further materials and shelter solutions research, technical support (both remote and in-country deployment) academic partnerships and networking, training and regulatory mechanisms, particularly in addressing sustainability and resilience issues.
Pre-demolition and pre-refurbishment audits, Katherine Adams

Why the research was needed

Pre-demolition and pre-refurbishment audits are typically undertaken to provide a client with independent advice about the products and materials that can be reused or recycled prior to demolition or major refurbishment. The client can then use this report to set targets and objectives within the demolition or refurbishment tender documents to ensure best practice in resource efficiency is adopted by the appointed contractor. To date there has been little guidance available about how to conduct audits and as a consequence there are implications for the quality of audit work and potential for commercial interests to influence audit outcomes. Most audits are carried out by demolition contractors themselves in the form of a method statement. A key driver for audits is BREEAM; an audit has to be undertaken to obtain credits relating to demolition waste management. There is an opportunity to make this part of the assessment more rigorous with clear guidance on the requirements of an audit and the procedures to follow.

Objectives

This piece of work aimed to build upon BRE’s existing knowledge to set out a process for completing independent pre-demolition audits and implementing the results. A further objective was to consider the scope for incorporating the resulting technical guidance within further revisions of BREEAM. This included the potential for an independent audit and a mechanism for recording what is actually achieved in comparison to the recommendations of the audit.

Outcomes

Technical guidance was produced and trialled on two projects: the demolition of two Bradford college buildings for principal contractor BAM and the demolition of a former retail/industrial unit for principal contractor RG Group. The actual waste arisings and waste management routes were compared with those forecast by the audit. Overall, the comparison showed that the forecast from the audit was more detailed and more accurate than that provided by the demolition contractor. Recording of materials for reuse was poor and could have been improved if considered earlier in the project – ideally before the demolition contract was put out to tender.

Next steps

BRE is working with the UK Contractors Group (UKCC) to publish the guidance which will inform their membership which accounts for over £33 billion of construction turnover. An online module for recording pre-demolition/pre-refurbishment audits has been developed as an add-on to the SMARTWaste tool. The data entered via this module will be used to improve understanding of resource efficiency on demolition projects and to provide best practice guidance to the industry.

1. When to carry out the pre-demolition audit
2. Who should carry out pre-demolition/prefurbishment audits
3. Pre-demolition/prefurbishment procedure
4. Comparison of actual performance against targets
5. Communication and reporting
Developing the Green Growth Generation programme, Gillian Hobbs

Why the research was needed

Work has been undertaken on behalf of the BRE Trust to develop a high impact and ambitious programme of work called “Green Growth Generation” (G3) that is dedicated to improving awareness of and access to fulfilling roles in the green economy for young people.

Unfortunately, getting information out to all young people is not simple, and the current mechanisms for providing insight and inspiration are not working very well. This is partly down to the ad hoc approach to sustainability in the current education system. A further barrier is the availability of, and access to, effective advice, mentoring, skills and work experience in relevant sectors linked to green growth. Improving on this situation is a key objective of the Green Growth Generation Programme.

Objectives

The project aims were to attract young people to the green agenda through a range of community-based places, projects and volunteering activities; engage them via education, activities, careers guidance and mentoring programmes; and improve access to green growth opportunities, such as new business start-ups, work experience, apprenticeships and training.

Outcomes and next steps

Working with programme partners Groundwork, Eden Project, MyScience, Generation4Change, and Reuseful UK, BRE has prepared a detailed programme and is seeking funds to allow it to be implemented. The targets for the G3 programme are to create a network of 1000 inspiring places, provide access to 10,000 employment opportunities and to actively engage with 100,000 young people.

A dedicated resource is now active on BRE Buzz http://www.brebuzz.net/tag/green-growth-generation

Sustainable refurbishment: exploring identifying and overcoming potential barriers in listed buildings and within conservation areas, Gavin Summerson

Why the research was needed

There is currently a market shift in non-domestic buildings from new build to major refurbishment in order to reduce running costs, increase rental returns and offer improved occupant satisfaction. However a large proportion of existing buildings have inherent restrictions which limit the potential improvements that can be delivered to the building. This is particularly true in buildings of historic value many of which are formally listed or in a conservation area.

The BREEAM Refurbishment scheme aims to drive the sustainable refurbishment of existing buildings. However, for the scheme to be a success, it is vital to understand current practice, demonstrate what can be achieved in buildings of a historic nature and explore potential innovations that can be applied.

Objectives

– Identify new approaches to the sustainable refurbishment of listed buildings and buildings in conservation zones
– Test BREEAM Refurbishment against a selection of historic projects in order to feed into the development of the scheme
– Gain a better understanding of refurbishment projects and sustainable refurbishment across a range of projects
– Identify key barriers and opportunities for refurbishment projects
– Identify potential improvements with regard to: approaches to design; technologies; and innovation

Outcomes

This research indicates that refurbishment projects for heritage buildings perform much better than refurbishment projects in other types of building.

This research has provided an insight into sustainable refurbishment across a range of projects. The findings can be read in full in the Briefing Paper Sustainable Refurbishment of Heritage Buildings – How BREEAM Helps Deliver, available from the BREEAM website.

The key learning outcomes from this project have been incorporated into the BREEAM Refurbishment 2014 criteria, to ensure the research outcomes are used to drive performance improvement in refurbished buildings.
Researching standards and tools to support sustainable infrastructure, Chris Broadbent

Perhaps even more than buildings, civil engineering and infrastructure projects need third party certification to verify and demonstrate their attributes and there is considerable scope to apply rigorous standards and tools such as BREEAM to them.

The National Infrastructure Plan update published in 2012 identified a pipeline of 550 projects valued at £310bn. There is a strong UK infrastructure programme, with new national rail links such as HS2 and Crossrail, major water and sewerage projects such as the Thames Tideway Tunnels, the construction of nuclear power stations again being considered as well as other projects delivering low carbon solutions.

The BRE Trust has supported a range of research projects that support the development of BREEAM Infrastructure, a science based measurement approach to driving sustainability in infrastructure projects to achieve better outcomes and to encourage innovation and continuous improvement.

Development of core standards for BREEAM Infrastructure

Why the research was needed

This BRE Trust project was to develop a draft core technical standard providing the set of sustainability requirements for which subsequently developed certification schemes would set criteria to assess infrastructure projects.

Objectives

Before a scheme could be defined for infrastructure, the Core Standards and science base had to be established. The Standard defines the technical and process requirements that must be covered by the certification scheme. The objectives included scoping the requirement for metrics to be developed and science to be researched and evolving and confirming the final structure of the scheme.

Outcomes

BRE has completed a draft Core Technical Standard developed collaboratively with industry. A consultation group of over 70 people representing over 41 key organisations was formed. The final report defined the scope of 13 research work packages, which will form the basis for the next stage of developing a BREEAM Infrastructure certification scheme for the assessment of projects seeking to be compliant with the standard.

Next steps

The next stage of development for the scheme will include piloting the standard on real projects.
How to measure and reward material choices in infrastructure projects

Why the research was needed
Sustainability and specifically reducing carbon and cost are seen as essential key elements of the recent Infrastructure Carbon Review, Construction 2025 and National Infrastructure Plan reports. Having defined the Core Technical Standards the next step is to develop a compliant certification scheme.

Objectives
The project had three core objectives:
- Determine whether a screening Life Cycle Assessment (LCA) can be carried out at the strategy stage to positively influence the project.
- Investigate construction and design options for a project, re-use and recovery of existing infrastructure, off-site construction, materials optimisation/lean design, waste efficient procurement, deconstruction and flexibility, service life planning requirements.
- Establish to what extent responsible sourcing is carried out for infrastructure elements and what would be considered best practice for the sector. Investigate local sourcing of materials policies and any restrictions.

Outcomes
It was determined that factors informing the content of a screening LCA should be identified at the strategic stage to enable them to feed into an Integrated Design BREEAM category. A screening LCA can then be applied, taking into account issues arising across the different BREEAM categories. If the screening LCA results suggest the impact from the use of materials is substantial, a full LCA can be conducted. Infrastructure projects are usually unique which makes the provision of benchmarks against which to measure the performance of infrastructure assets through design and operation difficult to set. With some issues, such as responsible sourcing, best practice recommendations are able to be made. Structuring a scheme in order to gather data over a number of projects will be important in setting benchmarks to drive improvement.

Next steps
It is important that the proposed scheme works well with real projects across the full range of civil engineering works. The methodology is being piloted with as wide a range of projects as possible, capturing relevant learning from early adopter infrastructure projects.

Waste reduction and management in infrastructure projects

Why the research was needed
Large amounts of excavation waste can be produced due to the nature of infrastructure works e.g. tunnelling. There is also a myriad of requirements related to how this waste is managed, including its reuse and storage. It is important to establish current practice for waste management on infrastructure projects, how this can be improved to encourage greater resource efficiency and translated into a standard.

Objectives
The work will provide underpinning data for waste that includes:
- Best practice in the management of waste for infrastructure assets through design, construction and operation
- Appropriate use of benchmarks and target setting to measure performance, including utilising waste management plans
- Detailed requirements and metrics for waste reduction, reuse (and use of surplus materials), recycling and energy recovery (following the waste hierarchy)
- Application of relevant waste management legislation to different types and scales of project
- Consideration of the whole system within which the project sits

Outcomes
Infrastructure projects are inherently unique and therefore there is limited data available regarding the environmental impact of infrastructure assets. This makes the provision of benchmarks, against which to measure the performance of infrastructure assets through design and operation impossible at this stage. With some issues, such as responsible sourcing, best practice recommendations are able to be made. Designing an infrastructure scheme to encourage industry to meet, and exceed, best practice will drive behaviour in a positive direction, promoting the concept of whole life thinking, reducing the embodied and operational impact of projects. Structuring a scheme in order to gather data over a number of projects is key in allowing future developments of a BREEAM Infrastructure scheme to develop industry benchmarks, allowing measurement and improvement within the infrastructure sector.

Next steps
Specific activities and tools are being scoped that will enable data to be gathered. Over time this data may enable suitable standards and targets to be set.
**Assessment of early stage options for infrastructure projects**

**Why the research was needed**

During the early stages of the development of core technical standards, the matter of how sustainability is addressed in the early stage option selection of projects was raised. It was considered that evaluation and appraisal of sustainability issues at this early stage can contribute more to the final environmental performance and sustainability of a project than an assessment process to optimise the sustainability and environmental attributes of its design, construction and operation.

The BRE Trust commissioned an initial investigation to explore whether there are opportunities to add value to the current processes.

**Objectives**

The research had three core objectives:

- To determine the opportunities, constraints and challenges in developing a robust and consistent approach to early option evaluation in Infrastructure projects.
- To develop, discuss and evaluate proposals on how an approach to this could be delivered.
- To understand how any proposed approach to early option evaluation in Infrastructure would support and link to the Environmental Impact Assessment (EIA) and the certification of the construction that would follow later.

**Outcomes**

The stakeholder consultation process concluded that there was a need for a new and consistent approach to optioneering.

The project found there were methods, drivers and processes within the existing landscape that both support and restrict choosing the most (or a more) sustainable option at the early option appraisal stage. Moreover, existing supportive systems were often not mandated, approaches were not transparent or unbiased and tended towards ‘silo’ thinking as opposed to ‘systems’ thinking.

**Next steps**

The next stage is to review existing options appraisal legislation, tools and methods to see how they can be used in any potential new approach. The team will also engage a wider stakeholder group to help define a mechanism for improving early stage option appraisal.

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**How to measure and reward enhanced resilience in Infrastructure projects**

**Why the research was needed**

Resilience is a key criterion in the assessment of the sustainability of infrastructure projects in a BREEAM methodology, which seeks to address the following industry challenges:

- The need to reduce cost, get more for less; the importance of whole life cost.
- The importance of reducing carbon as well as energy and other resources.
- Seeking improved health, safety and wellbeing for our people and all those engaged projects, while meeting their needs.
- Improved project certainty and delivery of outcomes on time.
- Adaptation to climate change, addressing extreme weather impacts and the need for resilient construction and durable materials.
- Consistency in delivery and best practice demonstrated by evidence and certification.
- Delivering world-class projects with excellent and reliable operational performance.

**Objectives**

The specific objective of this research is to provide the local science research needed for the development of resilience aspects including resilience, security, food risk and surface water run-off, the effects of climate change and designing for future needs. These aspects need to be considered in terms of what can be influenced at the design and construction stage for both construction and operational phases of the life of the asset.

**Outcomes**

Given the long operational lives of the infrastructure assets we construct today, the research recommends that new infrastructure should be located (planned), designed, built and operated with both the current and future climate in mind. In addition, it presents proposals to enhance resilience in existing infrastructure, such as maintenance regimes and programmes of enhancements that can be delivered over the whole life of assets to improve their resilience to the gradual change in climate. It also presents the need to consider issues such as information security, business continuity, expertise, engagement and communication, risk assessment, risk mitigation, contingency planning, security specific requirements and flood specific requirements.

**Next steps**

The research and feedback is currently informing the development of BREEAM assessment criteria. This will be issued to pilot projects for their further comment and then amended to take this all into account. The whole set of criteria will be reviewed as a whole to ensure it works as a whole before finalising as a draft for the pilot projects to assess with. A beta scheme based on this will be launched in 2015.
DG 498, Selecting Lighting controls, P Littlefair

Lighting controls can give energy savings of up to 30-40% or more of total lighting if used appropriately. However it is vital that the correct type of lighting controls are selected to match the lighting system installed to ensure adequate provision to occupants and optimised energy utilised. This BRE Digest provides relevant information to ensure compliance with the lighting controls requirements in non-domestic buildings of the new Building Regulations Part L, coming into force in April 2014.

FB 66 Environmental impact of windows, O Abbe

This report reviews how window units and frames have been assessed within The Green Guide to Specification, including the application of the Environmental Profiles methodology, which underlies data. The way in which windows are addressed within building-level environmental assessment schemes such as BREEAM and the Code for Sustainable Homes is also explained. The report will give manufacturers and specifiers a general understanding of the significant benefits and impacts of window units and frames over their whole life cycle. It is part of a series that provides comparable information on cladding, floor finishes, insulation, masonry and concrete, metals and timber to assess the environmental impact of specific construction.

IP6/14 Delivering water efficiency in commercial buildings: A guide for facilities managers, T Taylor

Often seen as secondary to energy efficiency, the importance of improving water efficiency should not be underestimated, particularly with increasing shortages due to the growing demand for fresh water supplies and the increasing variability of weather patterns. This Information Paper provides guidance on delivering water efficiency savings through improved facilities management. It provides an overview of how to determine water consumption and establish a building’s water efficiency performance, providing guidance on how to ensure that all water systems are operating as intended.
FB 67 Environmental impact of biomaterials and biomass, N Jones and J Mundy

The report gives manufacturers and specifiers a general understanding of the significant benefits and impacts of biomaterials and biomass over their whole life cycle and helps to identify opportunities for improvements to their environmental performance. It reviews how biomaterials and biomass have been assessed within The Green Guide to Specification, including the application of the Environmental Profiles methodology, which underlies the data. It also explains how biomaterials and biomass are addressed within BREEAM and other environmental assessment schemes.

IP 3/14 British-grown Douglas fir: Growth rate and density relating to visual grading and strength class attribution, E Suttie

This Information Paper describes research carried out on visual methods to assess the strength of Douglas fir. Current standards for visual grading use the growth rate to draw conclusions for wood density, but testing the wood density of samples grown in various parts of the UK found that these standards underestimate the mean density. This often results in capable structural timber being downgraded and used for lower value applications. The ratio of earlywood to latewood in the growth rings can be used successfully to assess the wood density, which would lead to less wastage of serviceable structural timber.

IP5/14 Penrhiwceiber Eco Terrace: Achieving housing for the 21st century and the UK’s 2050 carbon reduction target, C King

Focusing on a refurbishment project in Wales, this Information Paper examines the arguments against demolishing existing housing stock and describes the level of refurbishment that may be required when looking to improve solid wall dwellings built before 1920. This publication is aimed at housing providers, architects and homeowners who are evaluating approaches for individual house improvements or area-based regeneration. It sets out the cost of measures making comparisons with new build costs in the social housing sector to demonstrate that the UK’s older housing stock can be made fit for the twenty-first century.
FB 63 Delivering sustainable buildings: Savings and payback, Y Abdul and R Quartermaine

The publication included findings from research carried out by Sweett Group and BRE to investigate the validity of the perception that sustainable buildings are more costly to build. It includes three case study buildings – an office, secondary school and community healthcare centre where detailed capital and operational cost information was obtained. The research also examined the life-cycle costs of operating buildings, focusing on energy and water consumption. It was found that specifying sustainability measures during the building’s design and procurement stage can result in cost savings over the operational life of the building for little or no additional upfront cost. It has also been shown that achieving lower BREEAM ratings can incur little or no additional costs. Targeting the higher BREEAM ratings typically incurs less than 2% additional costs, which can be paid back within 2–5 years through utility cost savings. There is demonstrated a downward trend in sustainability costs and a sustainable approach can enhance the quality and values of a development.

IP 12/14 Delivering waste efficiency in commercial buildings: A guide for facilities managers, S Blofeld

Waste management is becoming an important part of a FM’s role, with key drivers including: compliance with existing waste legislation, pressure to reduce building management costs and implementation of company environmental management systems that require better reporting of waste management. The provision of waste management services in commercial buildings can be varied, with many different operating models dependent on the contractual arrangements in place between the building owner, facilities management companies, tenants and waste management contractors. This publication provides guidance on the implementation of an integrated waste management strategy through improved facilities management. It is relevant to facilities managers, maintenance contractors, and building owners relating to the operation and management of commercial buildings.

Sustainable Refurbishment of Heritage Buildings - How BREEAM Helps Deliver Kiruthiga Balson, Gavin Summerson and Andrew Thorne, November 2014

This briefing paper will help readers to understand the levels of environmental performance that can be achieved in heritage buildings – i.e. listed buildings and buildings in conservation areas. For these types of building there can be several inherent restrictions, which limit the potential improvements that can be delivered. This paper provides an overview to planners, owners and aspirational designers on ways to achieve challenging BREEAM targets for such projects. In addition, BREEAM assessors and BREEAM APs can use this information in providing appropriate advice to their clients when seeking BREEAM ratings in heritage buildings.
Digest of BREEAM Statistics, August 2014

This new publication provides an authoritative and in-depth guide to the trends in the application and uptake of BREEAM, measured in terms of projects assessed and certified by type, life cycle stage and country. The information it contains will be particularly useful to BREEAM Assessors and APs, and anyone wanting the hard facts on BREEAM's growth and development. The Digest presents detailed statistics covering the period from BREEAM's launch in 1990, up to and including 2012, along with similar data for dwellings certified by BRE Global under the Code for Sustainable Homes (CfSH) in England and Wales.

BREEAM In-Use: Driving Sustainability Through Existing Buildings, S. Summerson, J.Atkins & A.Harries, March 2014

This Briefing Paper provides an overview of the BREEAM In-Use standard, why it was developed, the benefits it provides to buildings and stakeholders, and how the scheme operates. BREEAM In-Use provides building owners, facility managers, investment managers and building occupiers with a consistent and credible means of determining the impact and performance of their buildings, and determining areas for improvement.

Sustainable Refurbishment of Domestic Buildings using BREEAM, T.Wiseman & G.Summerson, June 2014

The purpose of this guide is to advise professionals on how to sustainably refurbish a domestic property. The guide covers the key aspects of the refurbishment process and outlines how sustainability issues can be considered through every step of the way. This includes issues to consider when planning the project, issues that may be specific to the site such as flood risk, as well as opportunities that should be considered for individual project types ranging from the extension of a property to re-roofing, installing new windows or electrical and water fittings.

Low Carbon Domestic Refurbishment, K Balson, G Summerson & S Stenlund, June 2014

The research outlined in this paper was funded by the BRE Trust with the objective of understanding what improvements can be carried out in common dwelling types to improve the Energy Efficiency Rating (EER) and as a result achieve higher performance within environmental assessment schemes such as BREEAM Domestic Refurbishment (BDR).
Cost-effective healthcare fire safety, David Charters

Why the research was needed
The NHS has one of the largest and most varied estates in the world. The enforcement of the Fire Safety Order by Fire and Rescue Services coupled with budgetary reductions are a challenging context for the provision of fire safety in healthcare premises. This project focused on establishing a new knowledge base and risk methodology to assist the healthcare sector to optimise their spending on fire safety provisions.

Objectives
To provide leading edge information on the most cost-effective fire strategy(s) for healthcare premises by analysing healthcare fire statistics, fire risks and fire protection costs. The purpose of this project was to develop a methodology to identify which fire precautions and combinations of fire precautions are most cost-risk effective.

Outcomes
From a life safety perspective, the global risk methodology that has been developed predicts a clear reduction in casualties from fire, but the investment per casualty saved would be relatively high. There is a clear reduction in financial losses from fire predicted, with an indicative payback period of twenty years. There is, however, in this case, an environmental cost paid for sprinkler protection, though this would be the equivalent of less than one person’s CO₂ per system per year.

Whilst this study clearly indicates that it is not practicable to retrofit sprinklers in all hospitals at once, there is some evidence that sprinklers should be considered as part of an alternative FIRECODE fire strategy for new hospitals. Although the evidence from the global risk model indicates that there might be some marginal risk cost-benefits from incorporating sprinklers, there may be situations where there are clear benefits and other situations where there are none. The evidence indicates that sprinklers should be considered on a case by case basis for all large new hospital developments and extensions.

Equally, the relatively high cost per casualty saved, the moderate payback period and additional carbon footprint from the inclusion of sprinklers (in addition to FIRECODE) indicates that the current fire standards in FIRECODE generally provide a good, practicable level of fire safety, in a cost-effective and environmentally prudent way.

Next steps
Although the work focussed on the NHS Estate, the researchers are currently exploring how the methodology developed is applicable to other occupancy types, although some statistically relevant data will be required to support the risk-based/probabilistic approach.

The full project results will be made available in an Information Paper set for publication in 2015.
Characterisation of smoke from modern commercial buildings for evaluation of smoke detectors, Raman Chagger

Why the research was needed
The test fires that appear in the EN 54-7 commercial and EN 14604 domestic smoke detector standards were developed in the 1980s and subsequent ISO and EN standards (for multisensors, optical beams and aspirators) have adopted the same four test fires.

These fires are intended to produce a broad range of smoke types however other materials such as plastics and flame retardant foams generate smoke with different properties when flaming and depend on the type of smouldering mode (e.g. near a radiant heat source or sustained contact with hot surface). Therefore it was important to identify how the smoke profiles generated from these new materials, in these various modes, differ from those currently prescribed. The project also provided an opportunity to assess the performance of approved smoke detectors to the smoke generated from these alternative materials.

Objectives
The objectives were to investigate the reliability of approved smoke detectors to the smoke generated from modern materials and identify if there were shortfalls in detector performance for certain smoke types; then to influence and drive changes to the existing product test standards for smoke detectors.

Outcomes
The research concluded that commercial and domestic approved ionisation and optical detectors respond to a broad range of fires with my ratios outside and inside the fire test limits of EN 54-7. The fire tests specified in EN 54-7 were considered to be appropriate and were sufficiently wide in terms of distribution of smoke characteristics. Therefore no significant changes to product standards or codes of practice were recommended.

The research confirmed that both ion and optical smoke detectors are attuned to detecting certain types of fires and in order to ensure that the most appropriate type of device is installed guidance on the appropriate use of ion and optical smoke detectors should be sought from BS 5839-1:2013.

Next steps
Further research is being carried out with manufacturers to compare smoke levels generated on walls with those on the ceilings during EN 14604 fire tests. The team are exploring how alternative test fires could be used by manufacturers to analyse how detectors respond.
Fire and Security Publications

BR 187 2nd Ed. External fire spread: building separation and boundary distances, R Chitty

While the risk of fire spread between buildings cannot be completely eliminated, calculating separation distances can help to delay adjacent buildings from catching fire enough to allow the arrival of fire services. In this new edition, flame projection from windows and several other sections have been expanded. It gives more methods of calculation and illustrative examples; updates the theoretical background, including conversions to SI unit; and presents detailed analysis to the methods so that users can create their own fire engineering software. It also uses more recent experimental data to ensure the assumptions used in the methods are valid for modern buildings.

DG 533 Fire risk in high-rise and super high-rise buildings: Prevention and mitigation, D Charters, R Cullinan and E Warren

Ensuring high-rise buildings are safe from fire is fraught with challenges, not least from the fact that there is no universally agreed definition of what a high-rise building is. This Digest seeks to redress some of these uncertainties, providing as it does practical information and guidance on the nature of fire risk and how it can be adequately assessed and mitigated against. The publication reviews several major fire incidents in high-rise buildings, including New York’s World Trade Center and Windsor Tower in Madrid. It also provides an overview of current fire safety regulations, fire statistics as well as theoretical and quantitative analysis of fire risks in high-rise buildings.

DG 534 Watermist systems for fire protection in domestic and residential buildings: an introduction, C Williams

Watermist fire protection systems are now being considered as fire protection measures in both domestic and residential buildings. They are seen as a novel technology but are sensitive to small design changes. Therefore, for successful implementation, watermist suppliers and approving bodies require in-depth knowledge of the system and its intended application. This Digest is aimed at designers, specifiers, building control practitioners, fire safety officers as well as clients, developers and non-specialists. It explains how watermist systems work, provides information on current UK standards and highlights particular issues around specification, design, installation and on-going maintenance.
IP 11/14 Managing fire risk in commercial buildings: A guide for facilities managers, J Fraser-Mitchell and T Taylor

This Information Paper provides guidance on how to deliver fire resilience in commercial buildings through improved facilities management. In England and Wales, employers and building managers are required by legislation to carry out an assessment of the fire risks to occupants to ensure that they are safe from fire and its effects. The publication explains the basic methodology behind carrying out a fire risk assessment before considering how best to deal with residual risks. It also provides an overview of the operation and maintenance requirements for fire detection systems, fire suppression systems, fire fighting equipment and emergency lighting.

Causes of false fire alarms in buildings (BRE Trust briefing paper)

The purpose of this project was to collate information about the causes of false alarms observed in buildings and to identify approaches that could be developed and used to reduce their occurrence.

Identifying contributors and obtaining false alarm data proved to be a difficult exercise, however, two different contributors were identified- Kings College London and Buckinghamshire & Milton Keynes Fire Authority.
Energy Research

Cornwall test case for Green Deal assessment methodology, Caroline Weeks

Why the research was needed
The Green Deal scheme allows householders to have improvement works carried out on their home that will bring about energy savings that will in turn result in reduced running costs. Viability is dependent on the cost of the works (plus any interest) being paid back from the savings achieved. It was anticipated that before householders and investors would consider becoming involved in Green Deal loan schemes, they would want to know that they add up financially. This two-year research programme investigated the effectiveness and financial viability of a range of refurbishment measures when applied to typical dwelling construction types found across Cornwall.

Objectives
The project aimed to establish which retrofit measures were suitable for typical property construction types in Cornwall, whether these measures were likely to be viable and what factors would be most influential. Also, to what extent occupancy and behavioural factors influence the savings made. It also considered whether any particular modelling tools were more accurate for the forecasting of potential energy savings taking into account potential occupancy characteristics.

Outcomes
The research team provided analysis and recommendations that saw 78 privately owned dwellings fitted with a mix of energy refurbishment measures. The pilot confirmed that mainstream measures such as loft insulation and boiler upgrades were effective and viable. However, the measures that offered the biggest potential savings were more expensive and less mainstream, namely EWI (External Wall Insulation) and ASHPs (Air Source Heat Pumps). PV did not bring significant benefits to everyone, despite overall generation being higher on average than forecast. This is due to individual household energy usage patterns not aligning with generation periods and occupants not optimising their offset-usage of grid electricity. It was also found that tools capable of modelling occupancy in more detail than SAP did not necessarily produce realistic results.

Next steps
The key learning outcomes from this project are underpinning BRE’s work in this area, including using the detailed survey templates on the DECC project ‘Understanding heat loss from solid walls.’ The findings of the project, particularly relating to External Wall Insulation, have given a ‘reality check’ on the performance that may be expected from refurbishment measures.
Carbon reduction projects for higher education buildings, Andrew Thorne

**Why the research was needed**

The Revolving Green Fund is a partnership between the Higher Education Funding Council for England (HEFCE) and Salix Finance Ltd. that provides loans to Higher Education institutions to fund energy and carbon savings. £30M of funding was made available in 2010 for large-scale ‘transformational’ projects and smaller initiatives, but little information had been shared about outcomes.

**Objectives**

The project sought to produce case studies of ‘transformational’ scale projects and mini case studies of the smaller scale ‘institutional’ projects funded under the first round of the scheme.

**Outcomes**

The case studies revealed some impressive results. For example, the University of Bradford’s JB Priestley Library refurbishment had delivered a dramatic improvement in energy performance. The refurbishment included building fabric improvements, a new mixed mode ventilation system, passive cooling, improved daylighting and renewable heat with the installation of a biomass boiler. From 2011/12 to 2012/13 results show a decrease in gas consumption of 73%, a reduction in water consumption of 55% and an 18% reduction in electricity consumption. As a consequence, the University reduced spend on gas by £48,000 and electricity by nearly £52,000. Though not all organisations were as successful or as ready to publically share information,

**Next steps**

The findings from this project are being used to inform future development of the BREEAM Education Scheme.

Chimney flues – their distribution and use, Peter Iles

**Why the research was needed**

Unused and unsealed chimney flues in occupied dwellings may be a significant cause of heat loss. For a typical centrally heated semi with one open chimney flue, compared to one with no chimney, SAP indicates significantly greater space heating energy, cost and CO₂ emissions; however there will be situations where it is larger than this. Blocking the chimney, e.g. with a commercially available chimney balloon or similar device (while leaving some ventilation to prevent damp) would save a significant proportion of such heat loss.

**Objectives**

The project sought to quantify the number of dwellings with chimneys potentially causing heat losses (i.e. not used for the primary heating system) against a range of variables:

- The number of chimneys in the dwelling
- The dwelling location e.g. rural or urban
- The tenure; owner occupied, private rented or rented social landlord
- Number of storeys (research may show that the stack effect causes this to give significantly different losses)
- Age and type of dwelling
- Primary heating system

**Outcomes**

The project has provided the underpinning data to enable more accurate assessments of the potential savings from intervention at a national level. With 6.75 million dwellings with one or more open fireplaces there are significant savings to be made.

**Next steps**

The findings are now being incorporated into a DECC-funded project to monitor actual air flow and hence heat loss through a representative sample of individual chimneys.
IP 1/14 Understanding the choices for building controls, A Lewry

The control of energy in smaller buildings is generally poor, despite the availability of a range of tried and tested systems incorporating both mature and innovative technologies. The installation of heating, ventilation and air conditioning (HVAC) zone controls, optimising controllers for wet heating systems, and lighting controls are encouraged by the government. Financial support through the enhanced capital allowances (ECA) scheme and good practice guidance from the Carbon Trust is provided. This paper provides a summary of current status and also highlights emerging understanding of potential improvement methods and approaches, aimed at building and estates owners and facility managers.

IP 2/14 Operating BEMS: A practical approach to building energy management systems, A Lewry

Building energy management systems (BEMS) are often an integral part of a wider building management system (BMS), their purpose being to optimise the building’s energy use. These systems are commonplace in larger buildings and are rapidly becoming standard. This has also been recognised by the industry, culminating in the publication of the European Standard BS EN 15232:2012 (Energy performance of buildings – Impact of building automation, controls and building management). This is aimed at the design of the system which will support improved operation and maintenance. This paper is aimed at building and estate owners, designers and specifiers.

IP 7/14 Findings from the Penwithick Green Deal pilot project in Cornwall, C Weeks

Improving the energy efficiency of the existing building stock is one of the biggest challenges facing the UK. The government’s Green Deal programme offers a financial mechanism aiming to facilitate cost-effective energy efficiency improvements to dwellings. This Information Paper presents the key findings from research carried out over two years, investigating the effectiveness and financial viability of a range of refurbishment measures. It includes worked comparisons of air source heat pumps (ASHPs), external wall insulation (EWI), top-up loft insulation, new energy efficient oil boilers.

DG 531 Making the most of renewable energy systems, J Holden

This publication describes the most popular renewable energy technologies included in the Microgeneration Certification Scheme. It provides an overview of the safety, performance and reliability for each technology together with eligibility criteria for applicable financial incentives. It is aimed at anyone considering or who is responsible for small-scale renewable energy systems serving domestic or non-domestic buildings, including architects, specifiers, landlords, home and business owners. A number of references are also provided to facilitate a more detailed review of specific technologies where required.
DG 532 Pts 1-4 Renewable energy sources: How they work and what they deliver, J Holden and P Robinson

This series of 4 Digests provide a basic understanding of a number of different renewable energy sources used in domestic buildings for people who have little or no prior knowledge of the subject. Each describes different types of systems, including their operation, safe and efficient installation, annual energy performance and standards and certification.

Part 1: Solar Photovoltaics (PV)
Part 2: Wood fuels
Part 3: Electrically driven heat pumps,
Part 4: Solar Thermal Systems

FB 68 DC isolators for photovoltaic systems, S Pester

PV power systems are now commonplace. In most cases the PV systems are safe and reliable, but incorrectly specified or installed isolators can cause fires, damage the reputation of the solar power industry, or worse, cause loss of life.

This guide provides key information needed when specifying DC isolators, including standards and certifications. This includes the purpose, functions and features of isolators on PV systems and also some of the current available products. It also highlights real issues occurring in the field (with a rogues’ gallery of examples), reviews the relevant standards and guidance that are currently available and summarises the key recommendations.

IP 13/14 Energy efficient refurbishment of community centres: Findings from the ‘U Choose 2 Retrofit’ scheme in Cornwall, C Weeks and A Sutton

One of the biggest challenges currently facing the UK is improving the energy efficiency of existing buildings. For many community groups who run their own centres, minimising the operating costs (including fuel bills) is one of the most significant and on-going issues they encounter. This publication provides guidance and lessons learned from the refurbishment of several community centres in Cornwall, providing information on potential energy-saving adjustments they can be implemented. It will support groups who are embarking on refurbishment as well as to designers and consultants that may be called upon to assist with management and delivery.

FB 72 A technical guide to district heating, R Wiltshire, J Williams and P Woods

This guide is aimed at all involved in the technical aspects of district heating networks. It provides a source of information for people developing new schemes or refurbishing existing schemes, focusing particularly on technical rather than financial issues. The importance of other low-carbon sources of heat including thermal renewable energy is emphasised. Comprehensive technical information is presented, outlining system and component design, and operation and maintenance.
Health Research

Air quality adaptability, Andy Dengel

Why the research was needed

We spend on average 80% of our time indoors. Some groups, such as infants, the elderly and infirm, spend up to 100% of time indoors. Poor indoor environments have the potential to affect physical and mental health and wellbeing, productivity, learning and recuperation.

Through an extensive programme of monitoring and investigation, this project considered key air quality drivers & issues in cities including external air pollution and Indoor Air Quality (IAQ). It considered the development of protocols for site visits and monitoring and assessment in the field. The research included physical monitoring (IAQ, ventilation, lighting, noise); materials, finishes, layout, view-out, haptic factors; building user feedback.

Collaborators included: Great Ormond Street Hospital, Barnet General Hospital, Barchester Homes, Royal National Orthopaedic Hospital, Walterton & Elgin Community Housing Trust and Northamptonshire County Council.

Outcomes

Monitoring produced a rich and complex data set relating to indoor environments. The outputs are being incorporated into the air quality, noise and thermal comfort measures of the BRE Healthy Cities Index. The research has been taken up by the World Green Building Council as part of their report on “Health, Wellbeing and Productivity in Offices” and been featured in the RICS Property Journal.

Next steps

The protocols developed and refined for monitoring of indoor environments in this project and eliciting the important factors affecting the health and wellbeing are being incorporated into BREEAM and the New Homes Standard. The research team are now collaborating on further research in this area with the Joseph Rowntree Foundation and Tsinghua University.
Lighting and Health: A review, Paul Littlefair

Why the research was needed
Lighting can impact the health of people in buildings. This goes beyond the safety aspects of providing enough illumination to see by; lighting affects mood and human circadian rhythms, while poor lighting can in principle cause glare, headaches, eyestrain, skin conditions and various types of sight loss.

The impact of lighting on health has been investigated before, for example a short chapter in the 2001 BRE report ‘Building Regulation, health and safety’. However since then there have been considerable advances, for example the discovery of a new sensor in the eye that mediates melatonin secretion, studies on fluorescent lighting and cancer in shift workers, and new European regulations classifying hazards from light sources. There are also new LED light sources with small size and unusual spectra.

While some of the more topical areas in lighting have been subjects of stories in the popular media, much of the current research is published as health sector journal articles, which are relatively inaccessible to building professionals.

Objectives
The project aimed to provide a detailed review of the existing literature on how lighting affects human health, making it accessible and relevant to building professionals and providing guidance on how current knowledge of the effect of lighting on health might be applied to building design.

Outcomes
One of the key areas of the review, human circadian rhythms, is very topical at the moment, with substantial recent developments in scientific knowledge. This information has been primarily available in paywalled scientific journals and through popular media coverage. The review provides relevant and understandable guidance and information for building professionals on a subject, which has not been particularly well understood and addressed by that sector in the past. A publication is being produced explains the ways in which lighting can affect health and gives guidance in simple and straightforward language, suitable for use by professionals working in the built environment.

Next steps
The knowledge gained will be used to critically evaluate lighting designs or to create new ones. One of the project partners, the Pocklington Trust, will be taking the review findings forward with its research programme on lighting for people with sight issues. Relevant findings from the review have informed LED guidance from another partner, the Institution of Engineering and Technology.
GR 38 Radon remedial measures for older buildings, C Scivyer

This publication provides guidance to builders and homeowners carrying out installation works to reduce indoor radon levels in older homes. It describes various construction features found and explains how commonly used radon remedial measures can be tailored to suit older buildings, including those that are listed or located within conservation areas. This Good Repair Guide supplements the guidance given in Good Repair Guides 37/1, 37/2 and 37/3.

FB 64 Quantifying the health benefits of the Decent Homes programme, H Garrett et al

This report quantifies the improvements imparted in social housing by the Decent Homes programme (2001–2010) have reduced costs to the NHS in treating housing-related injuries and illnesses. It uses the same basic methodology developed to calculate the costs of poor housing in England described in BRE’s 2010 report The real cost of poor housing.

The report also discusses the additional societal costs of homes that do not achieve basic decent homes standards, the impact of less serious, but still significant levels of Housing Health and Safety Rating System (HHSRS) hazards. It also covers the work that still remains in upgrading homes to achieve decent homes standards and the consequential benefits that this will achieve.

FB 65 The cost of poor housing in London, H Garrett et al

This report summarises the results of a BRE Trust research project to apply a methodology previously developed to calculate the cost of poor housing in England to the housing specifically in London. The results of this research show that there is proportionately less poor housing in London than in the rest of England. This is largely due to the fact that London has a much higher proportion of homes that are purpose-built flats than the rest of England and such dwellings tend to be newer, more energy efficient and in better repair than other types of home.
GovernBIM, Nick Tune

Why the research was needed

Through the publication of the BIM Working Party Strategy, the UK Government confirmed its call for collaborative BIM to be adopted on all UK Government construction projects over £5m by 2016. Since this mandate was issued a plethora of documentation relating to BIM, some even erroneously purporting to be ‘UK standards’ have become available to the industry. As a result, rapid action on BIM information management for the construction sector was needed in order to develop the protocols and interaction models that are required for UK industry to be ‘BIM compliant’. The GovernBIM project was designed to research and develop governance processes that address these issues.

Objectives

The project sought to use current standards and accepted practice the project sought to:

– Create a generic and scalable “BIM governance” model, which can outline the actors’ “jobs” in a logical process.

– Produce the software components that will provide a “supply-chain friendly” BIM solution for the UK and beyond.

Outcomes

The output of this work was a prototype proof-of-concept platform (gBIM) that takes a number of data sets from project participants across the construction and supply chain and collates these into a manageable, editable online resource of BIM data.

These datasets then have the potential to be managed throughout the project, taking inputs from the architect, the supply-chain and the contractor to allow every “actor” in process to contribute the data required of them. This can be organised to happen at the specific time requested and for the specific work package and work stage that this information is needed in order to conform to the UK BIM Level 2 standards. This tool also allows a project manager to monitor this data and see where requirements have not been met, and if participants have provided enough data for the required work stage.

The proof-of-concept work has now been undertaken and has been developed into a fully operational application that aids with the implementation of Construction Operations Building information exchange or COBie (BS1192-4:2014) to meet the requirements of the UK Government’s BIM Level 2.

Next steps

The project has developed a working beta version of a tool - the first of its kind for the UK BIM Construction sector. The proof-of-concept tool is being reviewed in line with other tools to either bring it to market as a stand-alone product or to become incorporated into a suite of products to support the BIM Level 2 Strategy. BRE have incorporated the use of the tool into training courses for BIM to aid in understanding the BIM Level 2 process requirements.
This Good Building Guide series will provide practical guidance for designers, construction managers, operatives and property developers on the requirements of national building regulations concerning the provision of sound insulation in dwellings. Part 1 explains the importance of providing good sound insulation between and within homes which, if considered at an early stage of any development is likely to reduce of costly remediation measures and delays at completion.

Parts 2 and 3 will provide advice on obtaining the correct level of sound insulation when constructing new dwellings and multi-dwelling building conversions.

Lighting controls offer substantial energy savings, and new techniques, such as touchscreens, scene setting and colour changing LEDs, allow flexible and sophisticated control. However, clear and accessible controls system interfaces are vital if users are to control the lighting properly. This Information Paper explains how to design easy to use lighting control interfaces that understand and give appropriate feedback to users. It will be of interest to controls manufacturers, lighting designers, building services consultants, ergonomists, facilities managers and building owners.

Roof-mounted solar thermal (ST) and photovoltaic (PV) systems, which have seen a surge in popularity, must be designed and installed to withstand the maximum wind loads expected during their lifetime. However, there are no British or European Standards that give specific guidance. This digest updates the first edition (2004) with wind loading guidance for a wider range of roof-mounted solar installation configurations and is now applicable to both ST and PV. Guidance is for the design of roof-mounted systems in the UK based on the Eurocode for wind actions (BS EN 1991-1-4:2005) and the UK National Annex.
DG 416 revised Specifying structural timber, E Suttie and C Holland

Structural timber used to sustain loads in buildings, includes joists that support ceilings, floors and flat roofs, rafters and purlins or traditionally built pitched roofs. This Digest discusses aspects that should be considered in a specification for structural timber and provides a guide to the fuller information contained in relevant British Standards, European Standards, Eurocode 5 and other documents. It is aimed at saw millers and timber merchants in the wood processing industry and will also be of interest to engineers, designers and architects that need to understand the range and qualities of strength-graded timber. This Digest replaces the guidance published in 1996.

DG 361 Why do buildings crack?, R Sadgrove

This Digest examines the causes of cracking in buildings, showing, with the help of illustrations, the visible results of a wide range of problems, and solutions to every cracking problem. It aims to broaden the understanding of the factors responsible for cracking and increase the likelihood of correct diagnosis and repair. Avoidance of some of the pitfalls will minimise future trouble in new buildings and lead to better design and workmanship. This Digest was first published in May 1991. The factual content remains valid and this revised issue is primarily concerned with updating references.

GG 84 Applying flood resilience technologies, S Garvin and K Hunter

This Good Building Guide outlines steps that can be taken to protect buildings or communities against flooding by means of flood resilience (FRe) technologies, which provide resistance or resilience to flooding impacts. It aims to help developers, planners, designers and construction companies to select FRe technologies as part of a flood risk management strategy. It explains different types of flood risk and provides a glossary of terms used by flooding experts. It focuses on perimeter barriers and aperture barriers for buildings, with advice on design and testing standards, installation and maintenance. It has a comprehensive illustrated installing guide.
IP 8/14 Installation of photovoltaic panels on existing flat roofs - some lessons learned, R Sadgrove and S Pester

This Information Paper, based on a BRE photovoltaic (PV), considers some of the issues involved in the installation of PV systems on traditional flat asphalt roofs, from assessing roof robustness and calculating load, to monitoring system performance and maintenance. It highlights installation issues, such as access limitations, working at height procedures and inadvertent shadowing, plus gives guidance on government policy. It is aimed at clients and their consultants.

FB 69 Computational fluid dynamics in building design: An introduction, R Chitty and C Cao

Computational fluid dynamics (CFD) modelling is a powerful tool that is routinely used in fire engineering analysis and the design of buildings. It can be used to simulate different aspects of a building’s performance or its impact on the local environment. This guide gives some of the background to the CFD methodology for non-experts. It discusses the current capabilities and limitations of CFD for building design and gives guidance on best practice, focusing on fire safety, ventilation, thermal comfort and wind movement around buildings.

IP 10/14 ThermoWood® cladding: A technical summary, E Suttie

This Information Paper reviews the modified wood product, ThermoWood®, focusing on its use as exterior cladding and giving the results of long-term field trials. It examines the properties of this aesthetically pleasing material and its environmental impacts, coating performance, service life prediction and specification for exterior cladding. The Information Paper will help building owners, architects and designers to decide on the suitability of ThermoWood® for new domestic and commercial construction and refurbishment projects. It will also be of interest to all those involved in specifying ThermoWood® materials.
FB70 Design of durable concrete structures, S Matthews

This book aims to provide an understanding of the complex set of phenomena governing durability and long-term performance of concrete structures and how these form a basis for service life design. While consideration is given to concrete as a material, the focus is on the behaviour of the concrete structure and its interaction with its environment.

This will not only assist the designer to improve the future durability performance and reliability of concrete structures, but will also assist engineers involved with the assessment, maintenance and extension of life of existing concrete structures.

The content is also incorporated into a separate publication from FIB (the International Federation for Structural Concrete) and is published in this separate volume to make it more widely available to concrete specialists and engineers worldwide.

FB 71 The age and construction of English homes: A guide to ageing the English housing stock, S Nicol, C Beer and C Scott

There are some 22.4 million homes in England, housing 52 million people. They range from the smallest studio flat to the largest palace, and vary in age from medieval castles built of local stone to new homes designed to the most exacting sustainability standards. Numerous books have been written on English housing – particularly those buildings of architectural interest.

This guide is unique and provides detailed information on typical designs and features of houses built at different periods, using statistics from the 2010 English Housing Survey. Experienced surveyors and housing professionals will have developed an intuitive feel for when a house was constructed and the date of any modifications which have been undertaken – particularly in their own local area, where they are familiar with local materials and designs. As such, this book is intended for less experienced professionals, students of housing, or individuals with a personal interest, to be taken onto the streets and used as a reference book.

IP 14/14 Natural fibre reinforced polymers (NFRPs) in the construction, Julie Bregulla

The construction industry is one of the largest users of fibre-reinforced polymers (FRPs), second only to the automotive industry and their use is growing.

This Information Paper reviews the potential for natural products in construction materials, specifically fibre-reinforced composites including various natural fibres, such as hemp and flax. It discusses their specific benefits and the factors that are influential to their wider utilisation.
Future Cities
Thematic Programme
Executive summary

The BRE Trust Future Cities research programme was launched in April 2012 with over 70 public and private partners. The collective value of these projects is over £30m. The research involves 16 universities and 14 cities in the UK, European Union and Brazil. The thematic areas include health and wellbeing, infrastructure and energy; with projects often touching on more than one theme. The impact of this research has changed the way we operate in relation to cities. A new cross-business approach to exploitation and further research has been developed in recognition of the need for multidisciplinary input to the complex challenges facing urban areas in the 21st century. We have embedded several key outcomes from this research into the company’s strategy on cities:

- **Clients in the ‘cities market’ will go beyond city government. Our products and services are frequently used by local government.** However, a significant portion of our work on city challenges benefits other private and public sector organisations that are supplying ‘solutions’ to cities. This is the model for products like BREEAM where accredited assessors operate in the supply chain to improve sustainability in buildings, communities and infrastructure.

- **Strategic partnerships are essential to meet clients’ needs in relation to emerging technologies and city decision making processes.** We have a great deal of expertise in relation to the built environment and how people use buildings. Partnering with other companies, universities and potential clients can build on this knowledge to provide multidisciplinary approaches and holistic solutions. This model was used in the research programme to leverage Innovate UK and EU funding which has resulted in new jointly-owned patents and products for BRE.

- **New technologies and analytical tools using data are an essential aspect of research and product innovation for cities.** The expectations from clients will be for products and services to be informed by data; increasingly gathered in real-time through sensors. The BRE digital products team manages a range of growing data sets generated through the current business. These can be augmented through partnerships and new methods of analysing the data, providing value for clients and future research.

The next steps for BRE following on from the Future Cities research programme will involve product development and continued research activities in a number of key areas, including:

- **Healthy cities (including ageing population and air quality)**
- **Interactive and connected components in buildings and infrastructure**
- **Sustainable energy generation and demand optimisation.**
Homes, schools, offices, shops, streets and parks – the built environment represents the core components of our cities. As our cities grow our expectations and requirements of urban environments are changing. People are turning to urban centres in unprecedented numbers for the vibrancy and opportunity they provide. Rapid urbanisation means city governments must expand and regenerate the built environment to compete on a global scale.

The BRE Trust Future Cities research programme applied BRE’s extensive knowledge of the built environment to better understand its role in meeting the challenges facing urban government, businesses and people now and in the future. The programme focused on the needs of people and the planet to understand how the built environment will support sustainable rapid urbanisation.

The predicted growth of cities around the world provides opportunities to build places that will promote equality, reduce our impact on the environment and ensure economic success. Preparing for the challenges of cites in the future and managing the risks of today’s cities goes beyond smart urban-scale infrastructure. Technologies and solutions range from the scale of sensors in homes to resilient transport infrastructure, all of which combine to ensure urban areas bring about the best outcomes for people and are built to withstand the uncertainties of the future.

The Future Cities research programme has produced a wealth of knowledge which at the very least underpins existing commercial activities, and in many cases completely changes the way we think about the role of the built environment in meeting future city challenges. We will build upon the success of this programme through continued collaborative research and new products and services based on the outputs of the programme.

**Introduction**

Urban areas are growing by **1.3 million people every week**\(^3\)

Between 2014 and 2015 urban populations may grow to **66%** of the global population\(^1\)

Cities consume **75%** of natural resources\(^4\)

Urban areas now account for around **80%** of global economic output\(^2\)

70% **global energy consumption and energy-related carbon emissions come from urban areas**\(^5\)

US$50 **trillion** is required for investment in global infrastructure\(^1\)

Capital requirements for buildings are up to **US$7 billion** to 2030\(^6\)
BRE’s role in Future Cities

The impact of BRE’s work on the built environment touches everything from testing individual building components to certifying regional-scale infrastructure projects. This work helps clients such as city governments, real estate portfolio holders, product manufacturers, contractors and developers to ensure the long-term resilience of physical assets, manage risks, create value and ultimately, to improve people’s lives.

The BRE Trust Future Cities research programme complements BRE’s existing commercial activities in relation to cities. In this document four categories are used to demonstrate the reach of our work on urban challenges that can be addressed through the built environment. These categories are: smart cities, liveable cities, resilient cities, and healthy cities.

The research projects in the Future Cities programme fit into each of these categories and will be explained in more detail. Likewise, our current products and services can be mapped across these four themes.

A summary of the BRE Trust Future Cities research projects is shown in the following pages.

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Smart Cities

Context

With the rise of connected and smart technology in homes, buildings and infrastructure comes the opportunity to improve quality; reduce costs and environmental impact; and manage resources. The use of Building Information Modelling (BIM) and sensors (deployed in the environment and in assets) will give people greater control over their environment and offer the potential to improve city services. This will have many benefits including improved health and wellbeing, greater citizen involvement and reduced service delivery costs for cities. Smart systems allow for the management of city systems and physical assets in an environment where circumstances may change by the minute or over the lifetime of the asset. The data created from these systems can improve our understanding of how to build and operate the most efficient buildings and infrastructure in the future. To maximise the opportunities, a significant amount of work is required to ensure the interoperability of data. The work of organisations such as BuildingSMART, the Open Geospatial Consortium (OGC) and the World Wide Web Consortium (W3C) are assisting with this.

Where BRE is leading the way

BRE now operates BuildingSMART UK to improve the way BIM can be used to manage assets. Our research is allowing facilities managers to model and manage the energy consumption of buildings in real time. This work is being expanded to the city-scale in cooperation with other international organisations. Many of the projects in this section represent research into emerging technologies and have significantly moved our commercial offering in these areas.

Research summary and outcomes

Structure life knowledge from interactive components

Facilities managers are becoming increasingly interested in the potential savings available through sensors in building materials and management systems.

Sensors can be used to monitor a wide range of data that will enable condition-based maintenance of building management systems. This moves maintenance away from a dependence on the estimated durability of materials or components toward managing systems based on real performance data. The project identified opportunities and priorities for condition-based maintenance in the built environment. Alongside another research project, the team used the latest ICT data capture solutions to set out the possible method and route map to this smarter maintenance strategy. This project will continue into product development with strategic partners.

Cyber security, digital systems and interoperability

‘Cyber security challenges are evolving quickly. Billions of additional connected devices in new locations and application will create new challenges. Examples of connected devices being hacked are increasingly commonplace.’

The cyber security and digital systems project researched the security of connected devices in homes and the potential for standards to overcome these risks. Ongoing research is being carried out to determine BRE’s role in this growing challenge.

‘There are not yet any clear ‘winners’ [standards] for interpreting the data from devices or for connecting them to one another.’

The digital interoperability project was part of wider Innovate UK-funded work exploring the issue of interoperability standards and accreditation of specific technologies. The research defined a methodology for testing for interoperability and completed test evaluations.

Two events were run with Innovate UK, including a public workshop and a hackathon. BRE will continue to be involved in standard development relevant to future city challenges with other UK and international organisations.
Future city modelling

Using open standards such as those developed for BIM by BuildingSMART allows the management of data sets that can be used to make informed real-time decisions on the optimisation of city services.

This research focused on developing a new approach for digitally modelling new and existing buildings at the city-scale. The research was filling several gaps in current knowledge. It developed a semi-automated approach to ‘semantic model creation’ based on individual data points. It also developed an approach to integrate multiple data sources into the model and created an integrated software platform. The project findings will be integrated into BRE’s work on BIM.

Clouds4Coordination

Building Information Modelling (BIM) presents the possibility of shared information throughout the construction and property management sectors enabling efficiencies and benefits for future cities. It has also emphasised the challenges of data ownership and trust.

The Clouds4Coordination (C4C) project aims to address some of the core challenges arising for the construction industry from the increasingly widespread adoption of computerised BIM. C4C adopts the approach that each party involved in using BIM creates and stores their own information.

The project outcome will allow a complete BIM dataset to be visualised without changing how or where the original source material is kept, or who is responsible for that data. This research will be completed in 2016.

Smart cities are ‘places where information technology is combined with infrastructure, architecture, everyday objects and even our bodies to address social economic and environmental problems.’
**Context**

The rate of growth of urban areas is estimated at 1.3 million people every week. With growth comes the opportunity to ensure that new communities are housed in high quality homes with access to schools, jobs and leisure activities. Sustainable urban growth takes careful planning and early community engagement to ensure long-term benefits will be achieved for new and existing residents. This requires the coordination of multiple stakeholders and there are usually competing demands and cost constraints that must be balanced by city leaders.

**Where BRE is leading the way**

Cities have started using standards to ensure community-scale developments are sustainable from social, economic and environmental outcomes. BREEAM Communities is a sustainability assessment method for new masterplanned neighbourhoods and is being used in the UK, Europe and the Middle East. Initiated at the earliest stages of planning, it involves the community and other stakeholders in setting the vision and ambition for a new community. This leads on to BREEAM standards for homes and other buildings ensuring the vision becomes reality through detailed design, procurement and construction. BRE provides consultancy services to cities seeking to incorporate sustainability in planning policy and procurement. Where the market may not be ready for BREEAM standards, bespoke benchmarking tools can be created for use by public and private developers. The BRE Trust Future Cities research programme began to take BRE’s community-scale work up to the level of cities. The focus was on understanding how to expand current tools and standards to have a city-wide impact.

**Research summary and outcomes**

**City-Scale Resource Productivity**

Currently, around 1.3 billion tonnes of waste are produced globally, with an estimated impact of 1.4 billion tonnes CO₂ (eq.) and solid waste management costs of $205 billion. This volume is expected to increase to 2.2 billion tonnes by 2025, especially in lower income countries, with global costs set to rise to about $375 billion.

Running counter to rising levels of waste production is increased resource consumption, with the amount of materials extracted worldwide doubling since 1980. This project involved comparing data from a city in two different countries (Watford, UK and Brasilia, Brazil) to map out waste resources, current resource management practices and the potential gains through reuse, recycling and recovery. The main output was a methodology and tool that provides high level modelling of economic, environmental and social benefits that could be achieved through improvements in resource efficiency and productivity in urban areas. This research underpins a number of BRE’s research and development activities particularly in relation to the circular economy.
Enabling sustainable urban development in Brazil

Brazil has a housing shortfall of 6.7 million homes, requiring 4,932 homes to be built every day until 2022.

Ensuring that this level of growth will meet the needs of Brazil’s population is a significant challenge and one that requires a holistic approach to sustainability encompassing economic, environmental and social issues. BRE’s researchers held meetings with key stakeholders in the social housing sector including: local and central government, academics, developers and financial institutions to scope out the key challenges and requirements for new housing and communities. These informed the development of a balanced scorecard for evaluating proposed social housing projects. The scorecard was presented at a two-day stakeholder workshop hosted by MCidades (Brazil’s Ministry for Cities) and plans are in place to develop and pilot key sustainability performance indicators for the procurement of new housing developments in Brazil.
Resilient Cities

Context

Resilience has become a buzz word akin to sustainability, taking on multiple meanings to a range of stakeholders. The Rockefeller Foundation’s 100 Resilient Cities programme refers to resilience as being about ‘making cities better, for both the short and long-term, for everyone.’ They emphasise the importance of resilience to chronic stresses and acute shocks. This means planning for and seeking to prevent long-term challenges like climate change and short-term unexpected risks like disease outbreaks. This requires city leaders to prepare for both known and unknown risks, using systems approaches to complex problems across local, national and international levels of government, business and society.

Where BRE is leading the way

A significant portion of BRE’s current work is about creating resilience in the built environment to risks as diverse as climate change, flooding, security and fire. In 2014, BRE launched its Centre for Resilience as a global resource being developed through partnership with the public and private sector to improve the resilience of the built environment. The Centre will be a knowledge hub with information and tools to build resilience capability and capacity in the UK and internationally. The next BRE Trust Thematic Programme will be on resilience. Starting in April 2015, the research programme will focus on resilience to the effects of climate change. This specific aspect of resilience was chosen following market research and stakeholder engagement workshops about the market needs and research gaps. There are three priority climate driven impacts or needs that the programme will address: flooding, overheating and wind.

Approaches to refurbishing existing housingstock

In England, of the total 22.2 million existing homes, 39% were built before 1944 and 42% were built between 1945 and 1980. The need to refurbish existing properties is clear; 80% of the homes in use in 2050 are already inhabited today.

This research includes two projects both examining different methods of housing stock refurbishment. The projects helped to identify the key enablers of success for refurbishment of high rise properties and the Green Deal programme.

The team did extensive community engagement to provide strategic recommendations to registered social landlords and project planning and delivery teams. Their work on the Birmingham Energy Savers programme resulted in over 300 social housing tenants requesting a Green Deal assessment.

The team is now working with Letchworth Heritage Foundation on refurbishing hard to treat properties in heritage locations.

Research summary and outcomes

Imaging tool for future heat networks

Heating the UK costs £32 billion pounds a year and accounts for a third of the country’s greenhouse gas emissions.

There are strong drivers to find more sustainable and cost effective heating solutions in the UK. In Europe, district heating networks are more widespread and produce many benefits for those connected. The Department of Energy and Climate Change has a strategy to dramatically increase the supply of district heating in the UK but there are barriers in terms of financial models and technical skills at the feasibility and planning stage. BRE collaborated with University College London’s Centre for Virtual Environments, Interaction and Visualisation (VEIV) to create an imaging tool that supports local authority planners to visualise and assess options for district heating networks.

The tool provides evidence and information for local authorities to increase confidence and the deployment of district heating networks. The research has led to multiple consultancy engagements with UK cities and the team are now looking for cities interested in applying the tool.
Energy optimisation demonstrator

Cities account for 70% of global energy consumption and energy-related carbon emissions.

BRE and partners are working with support from the European FP7 fund to develop solutions to control the generation, storage and use of renewable energy at the city scale. The research allows for the optimisation of renewable energy generation so that its output can be put into the grid, stored or used in buildings based on set parameters such as reducing CO₂ emissions or minimising energy costs.

This technology is also being applied to the building scale in the energy optimisation demonstrator project. The team have built an electricity monitoring and control device that minimises energy costs associated with background electrical loads through a combination of maximising renewable generation benefits and accounting for potential variable electricity tariffs. The prototype control device is being trialled in an occupied property to gather performance data and occupant feedback. The research will be complete in late 2015.

‘If there is a single lesson to be drawn from the first decade of the 21st century, it is that surprise, instability and extraordinary change will continue to be regular features of our lives.’
**Healthy Cities**

**Context**

The importance of the built environment in determining our health and wellbeing has been highlighted through the work of the World Health Organisation Healthy Cities Network and the Marmot Review in the UK. The epidemic of non-communicable diseases such as cancer and heart disease are linked to the built environment through the shape of our urban fabric and the quality of buildings and public spaces. The urban environment can impact mental health, road accidents, respiratory illness, diet, community participation, and much more. This does not mean that cities are bad for health. On the contrary, research has suggested that people living in cities benefit from an ‘urban health advantage’, although health inequalities within cities are a significant challenge. The complexity of the impact of urban life on health requires cross-government approaches which involve non-health professionals as well as the community in finding and implementing solutions.

**Where BRE is leading the way**

BRE’s work on housing and health has shown that there is a real cost to the National Health Service from health conditions created or exacerbated by poor housing, such as respiratory illness and heart disease. The most recent estimate is that leaving vulnerable people living in the poorest 15% of England’s housing has an approximate cost to the NHS of £1.4 billion per annum. Through data modelling, BRE is able to provide information to local authorities about the condition of local housing, highlighting risks and opportunities to be managed through local improvement programmes.

The impact of the indoor environment on occupant health and wellbeing is an area of growing interest as links have been made with outcomes such as office productivity and recovery times in hospitals. The output from these research programmes will be fed into our existing products. We will be partnering with other organisations to continue research and development in the area of health and wellbeing.

**Research summary and outcomes**

**Air quality, indoor environments and adaptability**

Research suggests that productivity improvements in offices of 8-11% are not uncommon as a result of better air quality.

Building on BRE’s specialist knowledge of air quality, ventilation, noise, and lighting, the research team explored the complexity of the indoor environment to uncover key issues in hospitals, schools, care homes and individual dwellings. The researchers also analysed the impact of external pollutants on the indoor environment and occupants. The project integrated measurements of multiple factors in the indoor environment (each complex in its own right) and assessed the combined effect on occupants. Physical monitoring of the indoor spaces was complemented by information gathered from building occupants, via informal discussions, questionnaires and focus groups. The lead researcher provided technical input to the World Green Building Council report on Health, Wellbeing & Productivity in Offices. A series of eight articles was commissioned by the Royal Institute of Chartered Surveyors Property Journal. BRE will continue to do research in this theme which underpins BRE’s indoor environment monitoring business.

**Crime in urban areas**

The condition of the built environment can have an effect on health: ‘a European cross sectional survey of 12 cities found that, compared to respondents from areas with low levels of litter and graffiti, those from areas with higher levels, were 50% less likely to be physically active and 50% more likely to be overweight’.

Dilapidated buildings and poorly maintained public spaces influence our perceptions of crime in an area. This can have significant impacts on the health and wellbeing of individuals as well as community cohesion. For example, fear of crime can deter people from using parks and green spaces which provide multiple health benefits. This project used four case study cities in England to explore the relationship between recorded crime and the characteristics of the built environment that may increase the fear of crime or decrease the perception of safety in particular neighbourhoods. The research findings inform BRE’s products and services linked to sustainable communities as well as the Healthy Cities Index project.
Healthy Cities Index

Despite the epidemic of non-communicable diseases, ‘the focus of the health sector remained on care and cure rather than on health promotion and disease prevention’.

This project is about using data to better understand how a city’s physical assets and urban fabric are contributing to health and wellbeing. Cities will be able to use this tool to benchmark themselves with similar cities and to understand the impact of the built environment on health in different neighbourhoods across the city. This can help inform the prioritisation of scarce resources and regeneration efforts. The research involves working with partners across the health and built environment professions to explore the relevant indicators and data sources that can be used to inform local decision-making. BRE has applied its own expertise to focus on measures such as housing, crime, noise and air quality. This phase of the project will be complete in mid-2015 with plans to join with strategic partners for further development.

Conclusion

The outcome has demonstrated that the combined programme has had more impact and value than the sum of its parts. BRE will continue research and development activities related to cities and would like to collaborate with cities and other organisations to pilot emerging solutions and develop new products and services.

Please contact us for further information at futurecities@bre.co.uk.
Resilience of the Built Environment Thematic Programme

Commencing April 2015
The challenge

‘Resilience is the ability of assets, networks and systems to anticipate, absorb, adapt and / or rapidly recover from a disruptive event.’ Cabinet Office

Resilience of the built environment has been identified as one of the main priorities of governments around the world, in response to increasing risks presented by: extreme weather, natural and manmade disasters, terrorism and cyber-crime, a burgeoning global population and increased urbanisation. Policies, practice and technologies to improve resilience will only come about as a result of research and innovation. The concept of resilience has two dimensions, as follows:

- The inherent strength of the built environment to better resist stress and shock
- Its capacity to bounce back rapidly from impact and adapt to change

Increasingly those affected by disasters and hazards are looking for solutions that allow a ‘bounce forward’ as opposed to a bounce back. The bounce forward represents a status of improvement and a change of the norm.

Programme budget, programme and additional funding opportunities

The programme plan covers two years, with £1,000,000 total funding provided by the BRE Trust and will support the completion of priority research which will underpin an effective partnership linking BRE, Government, academia, and industry. Attraction of other significant additional money will create one of the largest single initiatives required that requires a long term view of risk. The project will involve a scoping study of the causes of failures that are under design limits (using examples from BRE data on past failures), the impact of climate change on future risk and how to close the gap. The project will result in a more detailed proposal based on testing and standards from DCLG and / or Innovate UK.

1. Standard for flood resilience of property

Flooding continues to cause substantial damage to property throughout the UK, with high repair and reinstatement costs being experienced. There are a number of good practice guides for new build and repair situations that have been produced by a variety of organisations, but there are no recognised standards that industry can follow.

This research will develop the template standards for new build and resilient repair in flood risk areas. The standard will include good design practice, materials performance, flood ‘details’ and construction advice. The standard will be the basis of future certification through LPCB. The research project will also receive Defra funding for a small-scale demonstration of low cost resilience measures for properties at risk of flooding.

2. High risk buildings and people in heat stressed times

Heatwaves and long periods of warm weather will become more frequent throughout the 21st Century. The impact of such heat stressed periods will be on the most vulnerable people. Research is therefore needed to find better solutions that meet the needs of care homes, elderly / disabled housing and hospitals to overheating. Such solutions can include design measures, improving understanding of building performance and new technologies to improve indoor temperature and environment. The research will address MMC and traditional building and use the BRE Innovation Parks as test grounds for new technology.

3. Buildings and climate resilience

Many standards and regulations already address climate resilience aspects of buildings, including wind loading, overheating fire engineering and weathertightness. However, failures often occur well below the design limits intended in standards. This research will address how the performance gap can be closed. Future proofing the performance of buildings is an essential requirement that requires a long term view of risk. The project will involve a scoping study of the causes of failures that are under the design limits (using examples from BRE data on past failures), the impact of climate change on future risk and how to close the gap. The project will result in a more detailed proposal based on testing and standards from DCLG and / or Innovate UK.

4. Community resilience: enabling people to better cope with disasters

Major events such as floods, droughts, heat-waves, extreme cold, terrorism and wars all challenge the resilience of communities. Different communities have developed response mechanisms for events that they experience regularly, but increasingly there are a multitude of risks to communities around the world and traditional ways of coping with risk has been eroded by urbanisation. Enabling communities to better cope requires an up-skilling of disaster management and recovery specialists. The training, qualification and accreditation of professionals needs will be addressed against the resilience requirements of people and communities. This project will use a case study approach in the UK and in Asia to provide a scope for resilience tools and how they address disaster recovery. Such tools would need to work for communities and for the professionals involved in disaster recovery. The intention of such tools is to provide direction towards a more resilient future.
About BRE Trust

Background

BRE Trust is a charitable company whose objectives are, through research and education, to advance knowledge, innovation and communication in all matters concerning the built environment for public benefit.

Building Research Establishment Limited, along with BRE Global Limited and FBE Management Limited, are wholly owned subsidiary companies of the Trust. This ownership structure enables BRE to be held as a national asset on behalf of the construction industry and its clients, independent of specific commercial interests and protects BRE’s impartiality and objectivity in research and advice.

Profits made by the subsidiary companies are gift-aided to the Trust and used by it to promote its charitable objectives.

The Trustees meet in Council four times a year to provide strategic direction and to oversee and guide developments of the charity and its subsidiary companies. The Trustees ensure that the charity pursues its objectives of ‘for public benefit’ research and education and that the assets owned by the Trust, namely its subsidiary companies, are used in a way that will contribute to the Trust achieving its objectives.

The Trust is the largest UK charity dedicated specifically to research and education in the built environment.

Constitution

BRE Trust is a company limited by guarantee Company number 3282856 and is registered as a charity in England and Wales (no 1092193) and in Scotland (no SCO39320). It is governed by its memorandum and articles of association. Its registered office is Bucknalls Lane, Garston, Watford, Herts, WD25 9XX.

Trustees and officers serving in 2014

The Trustees have delegated the day to day management of the Charity to the Chief Executive of the BRE Group Limited, Peter Bonfield and the Company Director, Russell Heusch and management of its subsidiary activities to the Board of BRE Group Limited.

Chairman – Sir Neville I Simms FREng
Michael Ankers OBE
Mark Clare
John Carter
Michael Dickson CBE, FREng FIstructE FICE FRSA
Hugh Ferguson
Dr Liz Goodwin
Richard B Haryott FREng (Stepped down October 14)
Sir Ken Knight CBE, QSFM
Quentin Leiper CBE FREng, FICE
Peter Lobban OBE
Ian Tyler (Stepped down June 2014)
James Wates CBE, FCIOB, FRSA
Martin Wyatt FRSA
Secretary – Russell Heusch

BRE Trust Research Committee

Dr Liz Goodwin, Chief executive WRAP (Chair)
Michael Dickson CBE FREng FIstructE FICE, Founding Partner of Buro Happold
Quentin Leiper CBE FREng, Formally Chief Engineer Carillion plc
Richard Haryott (stood down Oct 2014)
Dr Jeremy Watson CBE FREng FIET FICE, Chief Scientist and Engineer

Publications Committee

Hugh Ferguson (Chair)
Michael Ankers
John Carter
Martin Wyatt
Richard Haryott (stood down Oct 2014)
Governance

Trustees are invited to become a Trustee because of the merit of their skills, and because their general expertise would be of benefit to the Trust and represent wider interests of the built environment. During 2014, the Council had three committees reporting to it:

– BRE Group Trust Audit Committee
– Research Committee
– Publications Committee

Management

The role of the Trustees is to manage the activities of the Trust, its assets and investments. These are explicitly defined as:

– To manage and administer the activities of the BRE Trust, its assets and investments in accordance with the relevant Acts and guidance issued by the Charities Commission
– To give strategic direction to the work of the BRE Trust and group companies
– To make input into the strategic business plans of the group companies
– To extend the scope of BRE Trust’s charitable activities for the public good and seek funding
– To develop research and education objectives for the charity and to prioritise expenditure against such objectives
– To act as ambassadors for the work and objectives of the Trust and its group companies
– To periodically benchmark the activities and achievements of the BRE Trust and its group companies
– To ensure the excellence of scientific standards within the BRE group of companies.

All day-to-day decisions have been delegated to the boards of directors of the subsidiary companies.

Subsidiary companies

The Council of Trustees meets quarterly. The directors of subsidiary companies and senior staff are invited to the meetings to report on operational and business performance.

The activities of the trading subsidiaries are:

– Building Research Establishment Limited provides independent advice and information on building performance, construction and sustainability in the United Kingdom
– BRE Global Limited carries out research, testing and certification of materials and products, and certification of personnel, buildings, processes, systems and supply chains
– FBE Management Limited manages research work and carries out consultancy and research for the European Commission and provides technical support for the Construction Product Directive.
The BRE Trust uses profits made by BRE Group to fund new research and education programmes, that will help it meet its goal of ‘building a better world together’.

The BRE Trust is a registered charity in England & Wales: No. 1092193, and Scotland: No. SC039320.