INNOVATION REVIEW

ISEUE 4, September 2010

SUSTAINABLE BUILDING DESIGN AND REFURBISHMENT IN SCOTLAND

BUILD WITH CARE VIDEOS
WHOLELIFE HOUSE AND TIMBER HOUSE AT SCOTLAND’S HOUSING EXPO
ACHARACLE PRIMARY SCHOOL
LOW ENERGY DWELLING
A lunch-time date in your diary:

29 September 2010, 12.30-14.00
(GMT+1/BST)

Seminar and live webinar on an innovation for zero-carbon affordable homes

More on pages 6-7

CONTENTS

ABOUT CIC START ONLINE 4
EDITORIAL 5
SEMINARS/WEBINARS 6-7
SUSTAINABLE REFURBISHMENT
Conference videos 8
Exhibition booths 9
BUILD WITH CaRe
Project, conference and videos 10-12
OTHER EVENTS
Workshop: Anti-social behaviour, securing the public realm and partnership approaches 13
PUBLICATIONS
An Introduction to Low Carbon Domestic Refurbishment 14-15
DEMONSTRATION
BRE Innovation Park @ Ravenscraig 16-20
INNOVATIVE PRACTICE
John Brennan 21-25
John Gilbert Architects 26-29
GAIA Architects 31-34
Simpson and Brown 35-41

More on pages 10-12
BRE’S INNOVATION PARK @ RAVENSCRAIG
Dr David Kelly, BRE Scotland
More on pages 16-20

The WholeLife House at Scotland’s Housing Expo
John Brennan, Brennan and Wilson Architects
More on pages 21-25

Acharacle Primary School, Ardnamurchan
Howard Liddell, Gaia Architects
More on pages 30-34

More support, less obstacles: how we need to encourage innovation in housing
John Gilbert, John Gilbert Architects
More on pages 26-29

Low Energy Dwelling
Angus Calder, Simpson & Brown Architects
More on pages 35-41
What is CIC Start Online?

- A three-year project of seven Scottish universities funded by European Regional Development Fund and Scottish Government’s SEEKIT programme
- AIM: To embed sustainable building design and refurbishment into practice
- OBJECTIVE: To support academic/industry collaboration in developing and testing innovations, and to disseminate the outcomes in order to facilitate the application of innovations in practice
- WHY?
  - To reduce CO₂ emissions and other negative environmental impacts from buildings
  - To reduce fuel poverty and improve indoor climate
  - To create jobs and support competitiveness of Scottish construction industry through innovation
  - To remove the barriers to the application of innovation in practice
- HOW?
  - Through competitions for academic/industry feasibility studies and for 10-days free academic consultancy on sustainable building design and refurbishment
  - By testing innovations at the testing facilities of the project partners’ institutions
  - By publishing guidelines for the application of innovations in practice
  - By developing and publishing database of design solutions for sustainable refurbishment
  - By providing assistance and advice on sustainable building design and refurbishment to Scottish small to medium sized enterprises
  - By disseminating the project outcomes through the project website, seminars, interactive webinars, webcasts and three whole-day online events that will include an exhibition, a conference and networking facilities
  - By publishing information on products and services for sustainable building design and refurbishment offered by Scottish small to medium sized businesses registered with CIC Start Online.

BENEFITS OF FREE MEMBERSHIP

- Publish information on your company’s products or services for sustainable building design and refurbishment
- Receive a set of headphones with a microphone, monthly E-News and quarterly Innovation Review
- Ask for advice/assistance

Please click here to access the registration page at the project website www.cicstart.org

PROJECT PARTNERS

[Logos of the partners]

Funded by the Scottish Government and the European Regional Development Fund.

[Logos of the funding bodies]
Welcome to the fourth issue of Innovation Review!

In this issue you will find information on successful applications in the second round of the CIC Start Online competitions, closed on 15th May 2010. Scottish small to medium sized enterprises are invited to submit applications for the third round by 17th September 2010. Information on how to apply is provided on our website www.cicstart.org.

We report on the whole-day online event on Sustainable Refurbishment, held on Friday, 4th June 2010, and provide links to the conference videos that remain available for viewing if you were not able to attend the online conference.

As we have filmed the conference Build with CaRe, organised by the Robert Gordon University, one of the partners in CIC Start Online, an article on the conference and links to the videos of the talks and presentations are published in this issue.

We also inform on the forthcoming workshop on Anti-social behaviour, securing the public realm and partnership approaches, organised by Glasgow Caledonian University.

As the guide “An Introduction to Low Carbon Domestic Refurbishment”, recently published by Construction Products Association, is of interest to the industry, information on this publication is provided in this issue.

Full size demonstration of sustainable housing to potential buyers is crucial for raising awareness of the general public on the advantages of more sustainable buildings. Information on Scotland’s Housing Expo, held in Inverness in August 2010, and an article on BRE’s future Innovation Park at Ravenscraig signal the first steps in that direction in Scotland.

In the June issue of Innovation Review, we published an in-depth article on HML’s Passive House exhibited at Scotland’s Housing Expo 2010. In this issue, you will find an article on the WholeLife House designed by Brennan and Wilson Architects and on Timber House by John Gilbert Architects that were also exhibited in Inverness.

Best practice in sustainable building design in Scotland is also presented in this issue in the articles on the buildings designed by GAIA Architects and Simpson and Brown Architects.

We look forward to receiving articles written by practitioners on innovations for sustainable building design, construction and refurbishment applied in their projects. Please click here to access Guidelines for articles published on the CIC Start Online website. If you have any questions related to the articles that you would like to submit, please contact me by email to Branka@cicstart.org or by telephone on 0141 273 1408.

Kind regards,
Branka
The first seminar and webinar that will present the outcomes of feasibility studies and academic consultancies undertaken through CIC Start Online will take place on Wednesday, 29th September 2010.

In the forthcoming months, our seminar and webinar programme will also present the results of academic/industry collaboration through the following studies:

FEASIBILITY STUDIES

1. "Development of Post Occupancy Evaluation for evaluation of innovative low carbon social housing projects" by Mackintosh School of Architecture at the Glasgow School of Art and John Gilbert Architects
2. "Novel Solar Thermal Collector Design" by Heriot Watt University and AES Ltd
3. "Assessment and Application of Zero Carbon Building in Scotland" by Heriot Watt University and Integrated Environmental Solutions Ltd
4. "A Hybrid Solar Thermal Mass System Development for the Application to Tenants First Housing Co-operative's Zero-carbon Affordable Homes" by Glasgow School of Art, Edinburgh Napier University and Tenants First Housing Co-operative
5. “Embedding simplified post occupancy evaluation within the design process” by Page&Park Architects and the University of Strathclyde Glasgow.
6. "Tenament Flat Carbon Reduction Shopping List" by Holmes Partnership and University of Strathclyde Glasgow
7. "Upgrade Strategy Development for Garrioch Residents Association" by Collective Architecture and University of Strathclyde Glasgow
8. “Tarryholme Sustainable Housing Project, Irvine” by University of Strathclyde and Assist Architects
9. “An Investigation of the Adoption of Low-Carbon Technologies by Scottish Housing Associations” by Robert Gordon University and Anderson Bell and Christie
10. “Energy Impact of different strategies of integrating PV/Thermal heat transfer” by Glasgow School of Art and RobertRyan Timber Engineering Limited
11. “Solar-Wall systems for domestic heating: an affordable solution for fuel poverty” by Heriot Watt University and Changeworks

ACADEMIC CONSULTANCY

1. "Developing ‘Homegrown' Natural Fibre Insulation Products" by Glasgow Caledonian University and Kraft Architecture.
2. "Independent verification of a climate based worldwide building energy index" by Glasgow Caledonian University and IES Ltd
3. "Enkilt Simple Living" by Ballyconnelly Construction Ltd and Mackintosh School of Architecture, The Glasgow School of Art
4. “9-11 Gilmour’s close - comparing theoretical performance of a suite of sustainable installations in the building against their actual performance and user experience” by Mackintosh School of Architecture, The Glasgow School of Art and Assist Architects
5. “In-service testing of a prototype dwellings in relation to passive versus active ventilation strategies” by University of Strathclyde and Assist Design

Information on how to apply for funding for a feasibility study (up to £5,000) and academic consultancy (up to £3,000) is available at our website www.cicstart.org.
A Hybrid Solar Thermal Mass System Development for the Application to Tenants First Housing Co-operative’s Zero-Carbon Affordable Homes

Date: 29 September 2010
Time: 12.30-14.00 (GMT+1/BST)

Seminar Venue: Seminar room 505, Buchanan House, Glasgow Caledonian University, 58 Port Dundas Road, Glasgow G4 0HG

Webinar: Available to the CIC Start Online members or following registration to watch the webinar

Booking: If you are not a member of CIC Start Online, please book at www.cicstart.org, Events page. Members will receive online passwords.

Dr Masa Noguchi
MEARU, Mackintosh School of Architecture, The Glasgow School of Art

Dr Tom Grassie
School of Engineering and the Built Environment, Edinburgh Napier

Euan Barr
Director of Development, Tenants First Housing Co-operative

Summary

Scottish homes today are conspicuous energy consumers emitting on average 3 ton-CO₂ per house annually which is much higher than the UK average of 2.75 ton-CO₂. Moreover, approximately 20% of the households are actually facing fuel poverty. The government has set a market target that all newly built homes would be carbon-neutral by 2016 (or 2017). Having recognised the imminent issues, Tenants First Housing Co-operative (TFHC) is taking the initiative for the actual development of zero-carbon affordable homes in Aberdeen by 2012. TFHC possessing over 1,300 properties in Scotland is the largest Fully Mutual Housing Co-op in Britain. From 2010 to 2013, TFHC intends to deliver almost 300 homes and is now negotiating over its programme. Moreover, the SME partner of this feasibility study is currently taking the initiative for the delivery of zero-carbon affordable homes in Scotland where 10 homes will initially be built in Aberdeen by 2012 and the significance of the Hybrid Solar Thermal Mass (HSTM) system will possibly be demonstrated based on the learning outcomes of this feasibility study.

In this study, the rationale for the design and operational mode of a simple, direct HSTM domestic heating system was examined. The benefits of using the building foundation as the heat store over alternative, more common, wet (or phase change) thermal storage media were discussed. In addition, the scope of this study extended to the investigation of the HSTM system’s architectural integration by demonstrating the possible application by making use of TFHC’s zero-carbon affordable homes project in Aberdeen. The HSTM system performance and the applicability were discussed through a ‘Design Charrette’ held at the premises of Mackintosh School of Architecture, The Glasgow School of Art. The study concluded that using the Ecocirc pump in combination with a 30 Wp PV module, the desired design condition of a relatively constant collector outlet temperature can be achieved in practice. Also, this pump/PV pairing has the potential to deliver appropriate flow rates in larger systems. For the present system, a flow rate of approximately 1 l/min at full sun provides the desired collector temperature rise. This equates to a flow rate of 0.35 l/min m² of collector. For systems comprising greater collector area the flow rate should be scaled accordingly. Measurement of irradiance, and collector temperature and flow, has provided an accurate appraisal of the Solartwin collector thermal performance. It indicates that the HSTM system is able to deliver heat to, and store heat within, the thermal mass of the building foundation. This simple system has the potential to provide a significant contribution to building annual thermal demand.

However, for the optimal performance of HSTM, houses equipped with the system need to be designed properly with due consideration of the orientation of solar panels and the location of thermal mass floors and/or walls. Moreover, shading of the solar panels and thermal mass needs to be avoided or minimised. In consideration of specific system parameters, including the hydraulic resistance afforded by the under-floor pipe, solar thermal collector and ancillary pipe fittings, a number of system materials and equipment were purchased and the system monitoring was carried out by Edinburgh Napier University.
FREE WEBCASTS
AVAILABLE FOLLOWING REGISTRATION

Towards improving energy efficiency in traditional buildings
Dr Paul Baker, RICH Centre, Glasgow Caledonian University
Roger Curtis, Head of Technical Research, Historic Scotland
Nicholas Heath, Changeworks
Alistair Cant, Lister Housing Co-op

Use of solar PV and hot water for buildings
Prof. Tariq Muneer and Hazel Jane Bowmaker, Edinburgh Napier University

The Solar Refurbishment of Scotland
Prof. Susan Roaf, Heriot Watt University
Campbell McLennan and George Goudsmidt, AES Solar
Nicholas Heath, Changeworks
Alistair Cant, Lister Housing Co-op

Upgrading Glasgow’s Social Housing Stock- reflections on 1990’s demonstrations and 21st Century reality
Prof Colin Porteous and Ms Rosalie Menon, Glasgow School of Art

The problem of rural SME contractors and sustainable technologies
Dr David R Moore, The Robert Gordon University

Retrofit and renewables in traditional rural buildings
John Brennan, University of Edinburgh

Tools to Support Sustainable Refurbishment: from initial design to post-occupancy evaluation
Professor Joe Clark, University of Strathclyde Glasgow
SUSTAINABLE REFURBISHMENT

EXHIBITION BOOTHS

ARCHITECTURAL DESIGN SERVICES

ASSESSING ENVIRONMENTAL IMPACT

RENEWABLE BUILDING MATERIALS

SOLAR POWERED TECHNOLOGIES

RESTORATION AND CONSERVATION OF BUILDING FABRIC AND COMPONENTS

CONSTRUCTION SERVICES

IMPROVING AIR-TIGHTNESS AND U-VALUES OF WINDOWS

CONSTRUCTION HEALTH AND SAFETY

RAISING AWARENESS ON SUSTAINABLE USE OF BUILDINGS

IMPROVING MANAGEMENT AND PRODUCTIVITY

WHOLE-LIFE CYCLE COSTING

A Greener Hawick
Build with CaRe project and conference

Mohamed Abdel-Wahab, David Moore and Amy Smith

An overview of the project

Aberdeen City Council (ACC) is a partner in a three-year EU Interreg project, Build with CaRe (BwC), which aims to mainstream energy-efficient building design across Northern Europe. Aberdeen City Council is working with partners from 5 other European North Sea Region countries.

The BwC project comprises of four main Work Packages (WPs), as follows:

- **WP1 (Marketing and Publicity)** promotes the adoption of low energy building design.
- **WP2 (Education and Training)** aims to ensure that craftsmen, technicians, builders, system designers, architects and developers have the knowledge and skills training to produce energy efficient buildings throughout the North Sea Region.
- **WP3 (Planning and Policy)**, which is led by Aberdeen City Council, focuses on ensuring that planners and policy makers facilitate mainstreaming energy efficient buildings by providing appropriate policy, planning and regulatory frameworks.
- **WP4 (Evidence Base)** aims at providing research that supports the mainstreaming of low energy buildings and housing – covering both new and existing buildings.

Aberdeen City Council, as the lead for WP3 (Planning and Policy) has a responsibility for coordinating actions with other project partners in order to:

- Supply input to discussions surrounding EU directive on buildings
- Facilitate drafting of regional energy efficiency strategies
- Ensure local planning policies and building regulations encourage low energy building design.

The expected outputs of the work package are to: influence ongoing debate at EU level for forthcoming Directives; draft regional energy strategies; and share successful policy interventions and good practice.

To date the BwC project has worked closely with Robert Gordon University (RGU) and together developed “A baseline review of standards” describing the current position across Europe regarding energy efficiency in buildings and developments. BwC has also developed a policy paper highlighting the challenge of mainstreaming energy efficient buildings in the North Sea Region and the significance of the existing building stock. This paper has gained support from the North Sea Commission and will be presented to the Conference of Peripheral Maritime Regions (CPMR) later this year.

The project has also recently appointed Jean Lambert, Green MEP for London as a BwC Ambassador who will serve as an overall figure head in Europe acting as a spokesperson for the project and promoting the aims of the partnership. Moreover, the BwC conference was organised as a part of facilitating the outputs of WP3.

Build with CaRe conference

The aim of the conference was to discuss the planning and policy issues related to supporting the implementation of energy efficiency practices in buildings. The conference focused on European policy and how this translates into both UK and local legislation, whilst also looking at the policy issues in other EU countries such as Germany, Sweden and France. Not only was the conference an opportunity for dialogue between policy makers, planners and the construction industry at an EU-level, but also it provided insights into how some of the policy issues may be addressed in practice.

The conference was organised and chaired by Dr. Mohamed Abdel-Wahab and Dr. David Moore, Scott Sutherland School of Architecture and Built Environment, RGU.

---

1. An Interreg project aims at stimulating transnational cooperation in the EU. Further information on Interreg projects, including Build with CaRe, is available at: [www.northsearegion.eu/ivb/home](http://www.northsearegion.eu/ivb/home)

Villa Malmborg (Lidköping, Sweden) is the first private house in Scandinavia to be built according to the Passive House principle. As part of the Build with CaRe project a comprehensive online tool has been developed which tracks the evolution of the building from the initial concept, planning and construction to what it is like to live in. The website provides plans and technical information as well as insights from a range of experts. Further information can be found by following this link: Villa Malmborg, Sweden

The conference programme included an overview of the ‘Build with CaRe’ project and was divided into two broad themes, namely: ‘planning and policy issues’ and ‘policy in practice’ respectively. The former theme was presented from an EU perspective cascading down to transnational, national, and local level. The latter theme relates to case studies across various EU countries. The conference was supported by both the CIOB and RICS. The conference webcast can be accessed by following the link below.

Webcast of the Build with CaRe conference at RGU
An evaluation of the conference

The conference was attended by 50 delegates, who represented a wide range of stakeholders in the construction industry. Stakeholders included Scottish Government, ACC Officers, Consultants, Contractors and Architects. An online post-conference questionnaire was emailed to all delegates, which returned a 28% response rate. Below is a short synopsis of the key findings of the questionnaire. It has to be noted that the questionnaire was not only limited to the evaluation of the conference day, but also it was aimed to elicit the views of stakeholders on key issues pertaining to the implementation of energy efficiency practices in the construction industry.

Overall, the delegates regarded the conference as a positive experience and they found the content relevant. They also regarded the conference as being well-organised. The key highlights for delegates, in relation to specific things they have learnt from the conference, included the following:

- Government carbon reduction targets and its implications to building standards;
- Similarities of issues faced by European countries;
- Deeper understanding of sustainable design especially air tightness and passive house standards;
- Practical examples of energy efficiency building policies in Scotland;
- Monitoring the performance of low carbon buildings; and
- Learning about the Construction Improvement Club (CIC) project.

Delegates unanimously supported an overall European target of decreasing greenhouse gas emissions by 30% by 2020, in addition to more stringent carbon reduction targets for refurbishment of buildings. However, the delegates’ view, in relation to the viability of carbon neutral target for all new buildings in Aberdeenshire by 2016, was divided where 57% thought that the target was achievable whereas 43% thought it was not. An inconsistency in delegates’ views may be attributed to an endorsement of the bigger picture by-virtue but when it comes to the detail of actually implementing the targets at a local level, then challenges crop-up. It was thus reported that the top barriers to the adoption of low/zero energy technologies were cost effectiveness (47%) and lack of know-how (20%) respectively.

Finally, delegates acknowledged unanimously the pivotal role that has to be played by higher education in supporting the implementation of carbon reduction targets. This could be summed-up by the following quote:

“I think that Universities not only have the ability to demonstrate leadership but through both teaching and research and development can demonstrate excellence and influence not only to students but the sector as a whole.”  
Strategist (Sustainable Development)

As such, the expectation on universities is to develop their curriculum to reflect the evolving needs of the industry, in addition to carrying out relevant research that would support the construction industry to become greener. Indeed education and training has an important role to play in making the construction industry greener and more receptive to new practices – as indicated by the following quote from a delegate.

“Introducing technologies to students will mean that future professionals are familiar with technology. This will hopefully reduce the inbuilt resistance to change present within many organisations”.  Technician

Summary and conclusion

An overview of the BwC project was presented in this paper with a specific focus on the conference held in Aberdeen at RGU. The overriding message is that incentives and training are vital parts of implementing the carbon reduction agenda in construction.

A rethink of the approach adopted for policy formulation, which is aimed at carbon reduction, should be considered. A top-down approach appears as the dominant paradigm which has its shortcomings that primarily relate to challenges being met at a local level, such as planning and building regulations. Unless targets are being reviewed within a local context, the chances for meeting high-level and arbitrary targets seem remote. Indeed such targets would become meaningless.

Moreover, 77% of respondents regarded that the current planning system and building standards do not support the aim of mainstreaming low energy buildings. Nonetheless, it was thought that Local Authorities could use incentives (33%) to encourage developers to build/refurbish buildings to meet low/zero energy standards, in addition to providing training support (27%). This finding is interesting because the support required, for buildings to meet low/zero energy standards, is in-tune with the top barriers identified by delegates, namely cost effectiveness and lack of know-how.

3 This was also reflected in the discussions that took place at the conference.
We would like to invite you to this workshop.

The aim of this new workshop is to enable practitioners and others interested in the area to share learning and good practice from work currently going on in Scotland and to explore challenges that agencies have faced in seeking to address this.

The workshop emerges from work we carried out for Glasgow Housing Association, Strathclyde Police, ACPO CPI and Scottish Government on the impact of Secured By Design on housebreaking crime. Subsequent to this we held two events on our findings and it was clear that much partnership work currently exists across Scotland seeking to address 'incivilities' and other anti-social behaviour in the public realm.

We will be having a number of speakers with a range of expertise (community safety, policing, criminology, landscape architecture), but the emphasis of the day will be to enable participants to share experience, expertise and learning.

The School of the Built and Natural Environment which is hosting this event will be producing material from this event as a set of Practice Notes. If you feel other colleagues or organisations might be interested please pass this on to them. This is a free workshop but numbers are limited (on a first come first served basis).

To register, please contact Rossella.Ferraro@gcu.ac.uk.
June 2010

an introduction to low carbon
domestic refurbishment
The UK has made a commitment to reduce its carbon emissions by 80% by 2050 and the built environment is expected to account for about half of this reduction. Programmes are in place to ensure that the new buildings we create in the future meet the highest practical and cost effective standards for energy efficiency, but impressive as we expect this achievement to be, it will barely scratch the surface in terms of meeting the contribution that the built environment has to make to the overall carbon reduction target.

The real challenge is to improve the energy efficiency of the buildings that exist today, the vast majority of which will continue to exist in 2050. This will involve some form of refurbishment to each of the 26 million homes and two million non-domestic buildings – a programme that it is estimated will cost £400bn over the next 40 years. The scale of such a programme is unprecedented in both the challenge and opportunity it provides for the construction industry.

This Introduction to Low Carbon Domestic Refurbishment is a first step in setting out the various ways in which homes can be upgraded. It begins from first principles and highlights what needs to be done before work starts and then focuses on the main elements of the home – the floor, walls, windows, roof, heating and hot water. It concludes with a series of case studies which show the different scale of activity that can be undertaken, ranging from low cost work on walls, lofts and floors, through to radical renovations of the whole structure.

The information is presented in a way that will be of value to a wide audience – the informed householder trying to decide where to start on their property, the builder looking to advise their clients on the most cost effective solution for them, as well as regulators and politicians, who need to understand the challenges ahead.
BRE Innovation Park @ Ravenscraig

Dr David Kelly, BRE Scotland

Introduction

In 2003 the Building Research Establishment (BRE) set out to create a full size demonstration of housing construction technology within the car park of their Garston research facility. The houses built then set out to showcase new ideas in the development of offsite construction technology. In 2005, encouraged by the industry response and the support of the then Deputy Prime Minister John Prescott, the event was repeated and the challenge laid down to designers and manufacturers to come up with affordable solutions for key worker and first time buyers struggling to get onto the property ladder. In 2007, shortly after the launch of the Code for Sustainable Homes, the first Zero Carbon Code Level 6 home was built using Modern Methods of Construction (MMC).

In the same year the landscape around the buildings was designed to provide a more integrated response to sustainability by incorporating features such as biofiltration, attenuation, rainwater harvesting, native planting and recycled and renewable materials. The Innovation Park had come of age.

In 2009 the Park was extended to provide examples of home zones and play in order to create a sense of place.

The BRE Innovation Park @ Ravenscraig has been in development for almost two years and is seen as the next evolution this type of facility. It is an opportunity to create a purpose built facility in the UK which demonstrates housing construction best practice on one of Europe’s largest brownfield sites designated for future homes.

It is an opportunity to showcase innovation in design, construction, materials, heating, lighting and landscaping in the creation of sustainable communities.

The BRE Innovation Park @ Ravenscraig will provide a platform for designers and manufacturers to look ahead at what the communities of tomorrow will look like and provide real time evaluation of new technologies in order to promote and accelerate industry uptake.

The masterplan of the Park has been designed to provide a series of construction plots that enable the demonstration of a variety of building types and energy systems including passive and renewable sources and smart grid technology, with facilities for education and dissemination of knowledge.

The site

The regeneration of the former steelworks site at Ravenscraig, Lanarkshire, presents a significant opportunity to develop a new town that sets a benchmark for sustainable development. This £1.2 billion development will create some 12,000 new jobs and attract 10,000 new residents to the area. The development of the site will also include:

- Housing – 3,500
- Business Park – 100,000 m2
- Industrial – 116,000 m2
- Retail/Leisure – 84,000 m2
- New Motherwell College
- Regional Sports Complex
- 2 Hotels
- 2 Primary Schools
- New Railway Station
- Community Facilities
Stakeholders in the Ravenscraig development have identified the Innovation Park as a key factor in attracting new business and innovation to the area, as well as setting the benchmark for the development for the rest of the site.

The Innovation Park site (0.8 hectare) sits in the northeast of the Ravenscraig site just north of the Calder Water. The site has been identified as a gateway location for the low density residential development within the Ravenscraig Development Framework that received planning consent from North Lanarkshire Council in May 2005. The site sits on a relatively flat plateau to the east of Prospect Hill and adjacent to a spur off the main access route through the site. A surface water collection ditch immediately to the south of the site is connected via pipework to the main attenuation pond which discharges into the Calder Water.
The design of the Park sets out first and foremost to create a sense of place and to provide a cohesive framework in which alternative construction methodologies can be demonstrated side by side. Care has been taken to ensure that each plot has optimum orientation for solar energy and space to demonstrate sustainable water management both on plot and off plot. A hierarchy of roads and pathways ensures that the park can function well when all plots are built out and in the interim with complete separation of pedestrian and vehicular traffic.

The layout has been structured around a central open space that provides collection and attenuation of surface water runoff. Play facilities, seating and gathering spaces help to make the park scheme feel like a real neighbourhood while facilities such as the car park, loop road, circular and lateral pedestrian routes give away the true function of the park. Development plots are arranged around the central spine in an east-west orientation to maximise their potential for solar gain and passive ventilation. To the west of the site we have proposed the creation of a planted bund using material arisings from the pond and swale excavations. The planted mound would form a green frontage to the development, framing the development gateway to the north of the Park.

Masterplan
**Water management strategy**

The implementation of Sustainable Urban Drainage Systems (SUDS) is a key component of any development proposal. The water management strategy for the Innovation Park has been carefully considered to provide the maximum use of water as a renewable resource and promotes the implementation of rain water and grey water harvesting, biofiltration, porous paving and surface water attenuation. Moreover, the plan seeks to integrate surface water management in a very visible way so that swales and ponds become an attractive feature of the landscape and increase the interaction between development and nature. The site topography which falls 1.3m from the north to the south makes it possible to implement an entirely gravity fed system. The site has been organised into three different catchment zones, each with its own individual SUDS train.

**Landscaping**

The planting of the Innovation Park has been designed not only to provide as much biodiversity as possible, but also to represent the diversity of Scottish habitat. The landform of the park, taken as a microcosm of Scotland’s topography, will be used to create natural habitats from woodland to lowland meadow and wetland species.

BRE will strive to ensure that all of the hard materials specified on the Innovation Park will provide permeable surfaces to a greater or lesser degree. The majority of them will contain an element of recycled content and where possible be locally sourced. This however should not lead to a bland and monotonous landscape. We will aim to incorporate products from recycled rubber, glass, ceramics and plastic to build a landscape that inspires confidence in the use of second generation materials.
Community space

There has been much conjecture about the banality of play spaces and the lack of stimulation provided by slick steel and plastic play structures that do not expose children to tactile surfaces and real materials. Apart from being vandal resistant, natural play surfaces provide uneven and unpredictable surfaces for balancing on and challenge young minds to invent games rather than programming their play experience. The play space has been designed to incorporate natural play elements rather than structured and intensive apparatus for play. Flat logs, stones and climbing walls offer alternatives to traditional play structures such as swings and slides.

We believe that play spaces should be real spaces with real materials with just a sprinkle of vibrancy to fire the imagination. Surface materials such as rubber crumb in play areas to create tactile and impact absorbing finishes with bright colours and resin bound glass would be used to create sparkle in walkways. Timber bridges form the entrances to the play space, turning the swale into an imaginary moat and the standing stones into the remnants of an ancient castle.

Demonstration buildings: The Innovation Park will feature a variety of demonstration buildings which will be delivered by a mix of developers, contractors and product manufacturers. The demonstration buildings will have minimum performance requirements that each development partner must demonstrate before the can construct their building on the Park. BRE has set demanding performance targets for these demonstration buildings and these have been informed by the four themes under which the Innovation Park has been developed. The four themes are:

Energy: Scotland has some of the most demanding targets globally with respect to CO₂ reductions and the development of renewable energy sources. The Sullivan Report (2007) illustrated a roadmap for Scotland for the delivery of low and zero carbon buildings. BRE will use the information contained within the Sullivan Report to identify minimum levels of energy performance for the demonstration buildings. BRE will also investigate the use of Smart Grid technology to test the practicalities of using renewable technologies as part of a site-wide energy strategy.

Sustainability: The sustainability of the built environment remains high on the list of priorities within Government and other key industry stakeholders. The sourcing and use of materials and products integrated into the Innovation Park infrastructure and demonstration buildings will be assessed and disseminated to the industry. The demonstration buildings will be assessed against the Code for Sustainable Homes and other emerging assessment criteria.

Affordability: The affordability of the demonstration building demonstrated on the Innovation Park is a key outcome for the development of the facility. BRE has placed a responsibility on development partners to demonstrate the affordability of their solutions. This is a factor of great importance as the industry moves towards the delivery of low and zero carbon buildings on a mass scale.

Community: The key objective of the Innovation Park @ Ravenscraig is to present a vision of sustainability. This will include the energy and sustainability performance that you would expect from such an exemplar project, but will also have a strong focus on social issues and wider community engagement.

At present, five development partners have reserved plots on which to construct demonstration buildings. These building will be a mix of social and private housing solutions which meet zero carbon standards. In addition to the new build solutions, BRE will also develop retrofit demonstrations on the Innovation Park. These buildings will be developed in partnership with Construction Skills and will involve contribution from apprentices and construction students. The outcome of these demonstrations will be used to inform the development of a strategy for retrofit that can be rolled out across the existing building stock. This strategy will take account of issues such as:
- Building type, condition, materials, location, occupancy levels
- Planning restrictions (if any)
- Aspiration performance targets
- Heat and power strategies
- Technologies

The inclusion of retrofit demonstration on the Park will provide an interesting contrast to the new build solutions being presented.

Timescales
Infrastructure works begin on-site – September 2010
Demonstration plots released for development – December 2010
Innovation Park opening – June 2011

For more information please contact Dr David Kelly at BRE: kellyd@bre.co.uk; www.bre.co.uk
The WholeLife House at Scotland’s Housing Expo

John Brennan, Brennan and Wilson Architects

Scotland’s Housing Expo recently showcased a diverse set of innovative and exemplar solutions embodied in 52 building designs. Situated on the southern edge of Inverness, it explores how we can improve the design and sustainable response of new housing. The Expo event has showcased the application, in a Scots context, of emergent technologies. This includes cross laminated timber construction exemplified by John Gilbert Architects’ Timber House, and Passivhaus technologies in the housing cluster by HLM architects that featured in the last edition of Innovation Review.

This article looks at the challenges to make housing more sustainable through designing in adaptability and flexibility from the outset. Such an intention should be viewed as being complementary to fabric and building services innovation to reduce carbon impacts in dwelling design. Each building plot at the Expo was put out to open competition with guidelines as to their sustainable response as well as their physical appearance being contained in the masterplan framework provided by Cadell2.

The Expo is not located in the centre of Inverness but on the city’s edge. This has attracted a degree of criticism but it must be recognised that better solutions to suburban and rural housing is vital in the creation of stable low carbon communities. Sustainable Suburbs by the Joseph Rowntree Trust1 highlight the lack of attention given to how we live outside of the city and the importance of producing appropriate design solutions in both the private and public sectors. The difficulties that Inverness has faced in coping with development pressures make it a very relevant venue for the Expo.

We have been engaged with issues such as live-work and adaptability through both research and practice especially in rural areas. Our concern was to propose a design that would address a number of wider sustainable indicators beyond carbon reduction strategies. The importance of social and economic dimensions of sustainable development are clear but can be hard to quantify and measure in the same way as say, energy conservation techniques. There are criteria emerging, in rating systems such as BREEAM. Many of the indicators that inform the establishment of sustainable neighbourhoods can be found in the goals of Buildings for Life - an agency bringing together organisations such as CABE, the Home Builders Federation and Design for Homes.2


2www.buildingforlife.org

Fig 1. Entrance to Whole Life house shared with both the main house and the flexible annexe

Fig 2. The WholeLife House showing the main building with the attached flexible annex

21
At the heart of Buildings for Life is an evaluation method based around twenty key criteria that engage first with environment and community that address issues such as public transport provision. It then focuses on urban design issues before dealing with the design of individual homes. Its aspirations for housing design include concepts that are quite difficult to define such as ‘architectural quality’ but they do include indicators that measure the ability of the building to allow for ‘adaptation, conversion or extension’.

What drove our design strategy were statistical indications that the majority of suburban housing stock being constructed in Scotland was not fit for purpose in regard to anticipating household change. At starting point for this was that the three to four bedroom family housing directly addresses only 7% of households in Scotland. In Reasons to Move published by the Scottish Government, 43% of the sample moved or considered moving house because their current dwelling did not cater for their needs and aspirations. Such a situation has financial implications for individual households, but also threatens community cohesion, if housing stock suffers from swift turnover.

How therefore can we make housing sustainable through being more flexible and adaptable? Stewart Brand in How Buildings Learn observes that ‘All buildings are predictions and all predictions are wrong’. At the heart of this criticism lies a tendency for housing to be tightly designed, both in terms of construction systems, layouts and space standards that make any future changes difficult to execute.

The book Flexible Housing identifies two approaches to adaptable buildings. ‘Hard’ Flexibility is one where rooms can change function through the use of features such as sliding screens and folding partitions, for example to change a living room to a bedroom. Ironically, these have a limited number of permutations and combinations, and often their complexity means that retrofit and re-ordering is more difficult than that found in traditional housing.

Our Expo design takes a different approach borrowing from ideas of ‘soft flexibility’. To an extent it is an admission of the obvious that architects cannot and should not control how a house is to be occupied, but rather to provide breathing space for change and adaptability. For this to be facilitated, a ‘relaxed attitude’ to planning and technology is called for where adaptability is enabled through the generous provision of space rather than the specifics of a technological solution. The proposal is referred to as the ‘WholeLife House’, although it is certainly not intended that it is expected that it becomes a residence for life. Its purpose is to propose an adaptable model to cope with changing circumstance and complex household patterns. Recent research showed that 22% of 18-34 year olds live with their parents, often out of necessity rather than choice. In these cases, privacy and independence within a home become important. How people come and go, entertain visitors and maintain an identity outside of the traditional family unit becomes important [Fig. 3.]

---

3 Scottish Housing Aspirations survey. Scottish Government Social Research [2006]
The Whole Life House is divided into two. The main wing functions very much as a traditional home with kitchen and living spaces to the ground floor with bedrooms above. An annexe block is attached to this core via a shared entrance and lobby. It allows people to come and go from the annexe without disturbing the remainder of the home. This is not only desirable in households with young adults but also when the building is used to locate a home business. The functions of the annexe are deliberately not clearly defined. It has services provided for kitchen and bathroom facilities. None of the partitions bear load and so it can be opened up or subdivided relatively easily. Some of the uses of the annexe could include extra bedrooms for a large family, a home office able to accommodate employees, an annexe for a young adult or elderly relative. The permutations and combinations of such a building configuration are complex, and are intentionally not predictive as to how a family would choose to live in such a building.

The design is relatively straightforward in terms of its construction and building services. It is of a simple passive solar design with nearly all of the glazing to the south overlooking the garden. The timber frame construction is conventional, relying on 140mm studs. This stud wall is sheathed internally, and fitted with a vapour check. An additional zone is formed with 72mm battens to allow building services to be surface fixed and to minimise perforations to the vapour check. The battens run horizontally to reduce cold bridging and the entire cavity is infilled with insulation to enhance the thermal performance of the wall. For a lightweight construction, a degree of thermal inertia is desirable. The ground floor was therefore specified as a concrete slab on insulation with a tiled finish. This allows the integral underfloor heating system to work optimally in respect of efficient heat transfer. The unheated sunspace provides a degree of passive solar gain and solar hot water heating was specified.

**young family**
The annexe is used as a guest bedroom with a family room attached. If desired, the dividing partition can be removed to make a single space for a larger family room or home office.

**large family**
With three or more children, space can be at a premium. In this case the annexe wing can be utilised for two additional bedrooms, to provide a four bedroom home with a ground floor bathroom close by.

**young adult at home**
With mobility reduced by high rental and house purchase costs, more and more young adults are staying at home. In this case, the annexe wing can be made into a small self contained flat with galley kitchen and separate bedroom.

**elderly relative**
In this configuration, the annexe is converted into a large single room to enhance mobility. The shared entrance and galley kitchen encourage independence and privacy when it’s wanted.

---

Fig 4. Some possible uses of the flexible annexe.
The Whole Life house responds to sustainable agendas in proposing more flexible and adaptable housing. It uses simple but effective passive solar principles, coupled with high levels of insulation and thermal mass to reduce its carbon footprint.

**solar hot water panels to roof**
The Whole Life house features solar hot water panels to preheat how water for use in basins, baths and showers. It is noted that the panels will supply around half of the energy required.

**floor construction**
The building is heated with underfloor heating pipes laid in an insulated concrete slab. To reduce temperature swings and overheating from passive solar gain, the floor is tiled to the concrete to give mass and thermal inertia to the home.

**wall construction**
The building is timber frame construction with locally sourced cladding. Insulation is placed between the timber studs. An additional services cavity is formed to the building interior. This allows the main structure to be sealed effectively to reduce air leakage from the building. The services cavity is also infilled with insulation. By placing the fixing battens horizontally, thermal bridging is reduced.

**the sunspace**
The house is oriented with most windows to the south, with the north face of the building less heavily glazed. The whole life house features a sunspace with roof glazing to admit passive solar gain. At night, it can be closed off from the heated core of the building.

---

Fig 5. WholeLife House: Construction and Services
In its own way the construction and servicing systems allow for a degree of adaptability. The use of the separate services cavity allows easy retrofit without unduly disturbing the vapour control layer or the primary insulation. Underfloor heating negates the need for radiators and thus gives freedom in respect of room layouts. At present, heating is provided by mains gas. However the relatively modest flow temperatures required by underfloor heating allows the incorporation of technologies such as ground source or air source heat pumps if electrical generation becomes less carbon intensive.

The importance of the Expo has been in showcasing a wide spectrum of innovative solutions. The WholeLife House seeks to explore how our housing stock, can be more adaptable and therefore more sustainable.

**Further Reading**


Fig 6. Living room in main house showing exposed tiled floor on the underfloor heating installation.
More support, less obstacles: 
how we need to encourage innovation in housing

John Gilbert, John Gilbert Architects

In comparison to the computer industry, innovation in construction appears very slow and most new materials so often seem to start in Europe rather than Scotland or the UK. We are a very conservative nation with a culture that values lowest cost above nearly all other qualities. It will come as no surprise that the running costs of schools procured under the PFI initiative have rocketed. Trying to specify something that will be longer lasting, have less chemicals, provide carbon savings and require less to heat do not rate as much as cost in comparison to the last cheapest product.

Then again, the UK government uses the construction industry as a convenient tap to turn on and off to control the economy. There is very little long term thinking and this is clearly evident in the housing industry. As an architectural practice dedicated to improving the standard of our housing and environment, trying to bring small innovations can be frustrating as well as sometimes rewarding. The following three examples show what is involved.

Rural Housing Project at Glenmore

Initially we were approached by Perthshire Housing Association to carry out a study for a flexible rural house. They wanted a house that could start off as a one bedroom house and as the family grew, additional rooms could be added in the attic space. This would avoid the need to relocate families as suitable sites were often difficult to find in rural areas.

Of course the problem of building in flexibility to a house is that you have to build in redundancy and that can increase areas and cost. Even adopting a simple attic truss and insulating at roof level rather than in the attic will increase costs and no amount of discussion with the grant aiding departments will make this possible. Despite this, some more enlightened Housing Associations do recognise the need for this flexibility.

The Forestry Commission also participated in the project. This support ensured that we could fully investigate the potential and benefits of using homegrown timber in the construction. We are advised to use the term ‘homegrown’, as ‘Scottish timber’ appears to have negative connections within the timber kit industry. This is because nearly all of the timber used in the industry is imported from Scandinavia or Latvia. Kit manufacturers will give reasons why not to use Scottish timber “it’s sappy”; “it isn’t SC24 grade”; “it’s not regularised”, but in actual fact, for domestic scale housing, it’s quite possible to use SC16 grade timbers and when you get to larger section sizes, such as 195 x 44 quite cost effective.

The project became a reality when Albyn Housing Society agreed with the Forestry Commission, to build two houses on a small site which had belonged to the Forestry Commission. Set within the Cairngorm National Park meant that we had to satisfy stringent planning requirements.

We had to ensure that the surface water from the building did not discharge directly into the adjacent stream otherwise we would have had to pipe the rainwater some distance. The most cost effective approach was to install rainwater containment tanks and to recycle the water for washing and toilet flushing.

The houses are quite simple, made from homegrown timber which arrived as a kit from Alexanders in Troon. The 195 x 44 timber studs were then sheathed with 60mm of tongued and grooved woodfibre board which reduced the effect of cold bridging from the studs and added to the insulation properties. Internally it was sheathed with OSB, another Scottish product, and then filled with cellulose insulation. Externally the whole building was covered in a breather membrane and clad with homegrown European larch.

The roof was made from 400 deep I beams from James Jones and also fully filled with cellulose insulation. U values of this construction were good:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>walls</td>
<td>0.15Wm²K</td>
</tr>
<tr>
<td>roof</td>
<td>0.11Wm²K</td>
</tr>
<tr>
<td>floor</td>
<td>0.19Wm²K</td>
</tr>
</tbody>
</table>
However, as the building was in a rural area, there was no possibility of connecting it to a gas supply. A main heating appliance consisting of a woodfuel stove was sited in the living room with the aim of providing most of the heating for the house. This was supplemented by back up electrical radiators as well as an electric immersion heater for hot water. The effect of using any electrical energy means that the SAP rating is relatively low at 74 even though the insulation standards are very high.

The main problem the contractor had on site was trying to cut wood when the temperature was minus 15ºC. He just had to give up!

Through the CIC Start Online programme we have worked with the MEARU unit at the Mackintosh School of Architecture to carry out a simplified Post Occupancy Evaluation of the house (and 7 other projects), the results of which should be published later this year.

Scotland’s Housing Expo: using cross laminated timber for affordable housing

There have been housing expo’s in Sweden and Finland for a number of years now. In 2001 I attended Bo1 in Malmo which was a major expo and regeneration project on a site previously occupied by shipyards. In addition to the high density housing areas they had a temporary exhibition of individual houses built by different countries. No surprise that the UK plot was never built on. But the Norwegian house struck me as being special. Made entirely from cross laminated timber where the internal walls, floors and ceilings were exposed as timber, even the doors were made from a similar product. The effect was one of simple beauty, one felt at home and relaxed in this house.

In 2007 we were approached by an Ayrshire company (with no manufacturing experience) to prepare proposals for some show houses that would be built using the Thoma system of solid timber. It was agreed that we should go out to visit the Thoma factory in Austria to get better acquainted with the product before we designed anything.

This turned out to be a fascinated visit as the Thoma system is true ‘brettstapel’ construction, where timbers are laid across one another in opposing layers and held together with birch pegs. The avoidance of any glues made the system healthy as well as reducing the primary energy consumption used in constructing the panels.

The Ayrshire company had obtained a franchise from Thoma to make the panels in Scotland but it was soon apparent that the company did not have the commercial standing that was needed. They seemed to want to switch to making SIP panels instead (they were cheap), so we left them to it.

At about this time the competition for the Highland Housing fair, as it was then called, required architects to partner with a developer. The Ayrshire company were keen enough so we entered two projects for two different sites, both using the Thoma system.

After our design won a site for two small affordable houses, the company seemed to disappear and we never did get paid for our initial work. But we had a design and that design had been accepted. The credit crunch saw a number of developers dropping out and thanks to Scottish Government the whole expo was rescued, although hard decisions had to be made over budgets.

Our main drive in the Expo was to showcase a solid timber house that would be affordable, either for social rent or for a first time buyer. Albyn Housing Society, who had been our clients at Glenmore, agreed to take on our houses as well as a number of other plots. The appointment of three main contractors was agreed as the best approach by the organisers, so we then entered a stage where we were to be novated to the contractor and budget costs had to be met. Coinciding with the credit crunch was the higher value of the euro and with it went our hopes of using the Thoma system.

We investigated other ‘brettstapel’ systems such as ‘Optiholz’ but we had to recognise that Brettstapel construction was always going to be more expensive than a glued system. At this time, James Jones had entered into an agreement with Binder Holz to supply the system in the UK. The designs were then advanced to warrant stage on the basis of this system being chosen.

We then came across difficulties of obtaining information in English and certification that would be equivalent to BBA certification for insurers and building control. Then the Jones-Binder partnership broke up and we had to look again at the market, pricing materials supplied by Eurban and KLH which we thought met both the technical and cost requirements.
We then had a number of meetings where certain material decisions were taken out of our hands and ‘value engineered’. Morrisons contracted with Donaldson and McConnell to provide the timber engineering and they opted for a Swedish firm, Martinsons, to supply the cross laminated timber. Although the system was very similar to KLH and Binder-Holz, it did make use of melamine resin adhesives (MUF) which do produce formaldehydes which we had wished to avoid. Polyurethane adhesives (PUR) avoid formaldehydes but do produce isocyanates in the manufacturing process which is one reason why Swedish manufacturers have avoided PURs.

The original insulation batts were from the Gutex company and would have allowed battens to be fixed through the insulant into the solid timber. Selection of the less dense wood fibrous insulation required the installation of metal runners which were fixed to the solid timber but independent of the insulation.

The aluminium corrugated cladding that was used on the roof was also used to clad the building, for two reasons. One to reflect a rural aesthetic which often used such material in form, but also, because of briefing requirements that required the finish material in our zone to be of a harder more robust finish and not timber clad.

Originally we wanted to link into a communal biomass boiler but this never happened. Then we tried to include an air source heat pump linked to a heat recovery unit for ventilation. The solar thermal panels had to be omitted as well even though we had managed to get sponsorship for the panels. The house is now heated with a very efficient gas combi boiler.

The house was tested for air permeability and obtained a figure under 3m³/hour/m² at 50 Pascals which is good, given we were not aiming at passiv haus standards (we have still to obtain the full report on the air test). However we were slightly concerned that our only ventilation was mechanical extraction, although we think that the wood will help to absorb moisture vapour and control humidity levels a lot better than any plasterboard surface.

We calculated that the solid timber, of which there is slightly more than 20 cubic metres in each house, manages to lock in about 4.5 tonnes of carbon, thus reducing the overall embodied energy of the house substantially.

Although we have had to make compromises along the way, we are pleased to at least be able to demonstrate to the public that the system can be used to make affordable housing and we would really wish to see a Scottish manufacturer develop a similar product which could make use of the large amounts of spruce produced in Scotland.

The Housing Expo itself has been a notable success at showcasing different approaches to housing and layouts, helping to raise people’s awareness of housing choices. We hope it can be repeated elsewhere in Scotland, perhaps every four years.
Innovation in a Housing Regeneration Project

We are working with the contractor CCG on a large regeneration project, typical of the many housing developments that Councils completed in the 1960s. We completed a masterplan of the area a few years ago and have completed the first phase of housing. CCG have developed their own off site manufactured product for housing, the iQ system which has four different levels of prefabrication. In the first phase of our project we managed to use their floor cassette systems in a range of different housing types. In phase two, we have developed plans which will use their prefabricated wall panel system. This goes one step further than traditional timber kits, in that the insulation is installed in the factory, along with the windows and wall finishes as far as possible. We also intend to use their brick slip cladding system in a number of house types. The brick slip system is similar to a rainscreen cladding, but uses a terracotta product. The system is not cheap, but the aim is to reduce costs by shortening on site construction time as much as possible. The roofs will also be made as cassettes so the whole construction period on site should be reduced, a benefit in the poor weather from which much of Scotland suffers. CCG have made a substantial investment in developing the system and we have developed our designs to make best use of these innovations.

New housing in Scotland has often been built to minimum space standards. Since the omission of space standards in the building regulations, up until 1998 compliance for publicly funded housing made use of the Metric Space Standards, originally produced in 1968. These space standards were superseded following the requirements set down in ‘Housing for Varying Needs’ as well as further building regulation changes. More recently there have been further changes to improve accessibility.

The requirement for flexible homes that can adjust to the changing needs of a family, really requires that there is a certain amount of redundancy built into our houses. What we design for today will rarely satisfy the needs of tomorrow, unless we try to ensure that the shell of our houses are big enough to cope with alterations.

Unfortunately, when it comes to obtaining cost approvals from Scottish Government, the ‘benchmark’ floor areas which appear to be used to calculate the NIC (New Indicative Cost), do not seem to reflect the need to comply with Housing for Varying Needs Standards nor for recent changes in the Building Regulations for circulation areas and they certainly do not allow for any ‘flexibility’. The areas for the mid range 3-5 person houses are about right however larger 6-7 person houses have a very low floor area (about 17m² less space than in houses we have previously built). The same goes for smaller flats where going by these benchmark’ areas, a living room would be rather small.

House types that are as little as 3% over these ‘benchmark’ areas are seen as being too big, yet the expense and time taken to adjust designs to meet what appears to be an new arbitrary space standard would cost more than the supposed saving. Where then is the value? Smaller houses will indeed be cheaper to build, but they will be less flexible, less popular and thus less desirable over their lifetime. That cannot be sustainable.

Innovation needs support, not obstacles

Our concern is that there is very little really useful research being carried out into the construction of our houses or into how we place a value on space, room size and storage. There are plenty of edicts in the way of sustainable design guides, how we should reduce waste, make our houses flexible, use renewables, cut carbon, but with increasing requirements also comes the expectation that costs have to be reduced.

NIC costs based on spurious ‘benchmark’ area targets are an obstacle to innovation.

Without good practical research and leadership in the field, people who are trying to meet these new standards can become frustrated at the difference between the reality of trying to meet these needs and the government’s expectation that houses need to be smaller to meet budgets.
Acharacle Primary School, Ardnamurchan

Howard Liddell, GAIA Architects

A new primary school at Acharacle - 40 miles west of Fort William – has been delivered as the result of a partnership between 3 main entities:- it is first and foremost the result of over 20 years’ campaigning by the local community, and then five years hard work by the client, The Highland Council, and ultimately pioneering ecological design architects Gaia.
In 2003 Gaia took a group of people from Scotland to look at schools in Norway, and amongst our group was Brian Hemming, who was in charge of schools procurement for The Highland Council. Later that year we were approached to write the brief for the Acharacle Primary School, on the understanding if that we wrote the brief it would be maintain its green credentials, whoever became the eventual architect for the project.

After the completion of the brief writing the project went out to tender and Gaia were the successful bidders. Whilst The Highland Council does have a PPP and PFI programme, Acharacle School was taken out of this process. Gaia were very eager to get this commission, on the basis of traditional procurement, because the council then had more control over what was being delivered – and especially in relation to its green credentials – often not fully understood – and therefore at risk of not being effectively delivered by contractors. One of the things that became very clear when we visited Norway and Germany was that the schools that were procured traditionally were much more likely to deliver a green agenda than those procured thorough PFI.

**Design**

The new Acharacle School was given a very restricted site – in that it was to be built within the playground of the original school. The design and form, therefore, were established pretty well from the outset, due to the tight spatial constraint. The new building has been designed to provide a healthy, state-of-the-art, low-tech. and low carbon environment for pupils, staff and the community for generations to come – a school for many generations of Ardmurchan children and a base for cultural events for the whole local community.

A series of workshops were held with the children, staff and wider community to discuss the design of the school, from the outset – and this resulted in a two-winged layout with a central, communal entrance. The ‘classroom wing’ is oriented east-west to optimise useful solar gain, while the ‘community wing’ is aligned close to a north-south axis. The brief document was written in full consultation with the school community and Gaia presented the evolving scheme designs at these workshops, and identified clearly where the design had met the requirements of their stated community needs (incorporated into the brief).
A very important element of the design is the community wing, which is primarily arranged around a big hall. This hosts the Annual ‘Feis’ event, which is a traditional Gaelic arts and culture festival with music and poetry. The Feis in Ardnamurchan is a very important local flagship event – and reinforces the school itself, which teaches in both the English and the Gaelic medium. The Feis was held in the main hall for the first time in 2009, marking the significance for the wider community, and their close involvement in the school project. For the 2010 event the Bleecher seating had been added – completing a community fund-raising cycle going back many years.

Eco-minimalism

The design of the school was undertaken from the very outset to deliver a model of ‘Eco-minimalism’ – a philosophy which seeks to use careful design to achieve sustainable construction, rather than attempt to achieve it through the addition of superfluous, ‘bolt-on’ technologies and their associated energy, cost and maintenance penalties.¹

Construction

The school is also the first example in the UK of ‘Brettstapel’ construction\(^2\) – a glue-less form of massive timber construction, which in this instance (and pending a production facility to produce it in Scotland) was imported from Austria. This has helped to create a highly insulated and airtight school, which easily achieves the internationally recognized German ‘Passivhaus’ standard, (albeit without adopting the Mechanical Ventilation Heat Recovery system that the Passivhaus Institute regards as mandatory for certification). Other solid timber used in the project, such as decking, battens, bridge glulams, and beads were from homegrown timber. “The bulk of the building – the superstructure - was procured from Austria in prefabricated elements with a core of massive timber. We knew the factory very well, from a European Community research project and they were able to give the client a guarantee that the building fabric would reach Passivhaus standard - which means that, for all but long winter periods, heating is not required, as it is very airtight and with very thick with insulation on the walls. We also chose this route at the time (around 3 years ago) as we had worked on an experimental project using massive timber, and there was the possibility of procuring a package deal from Austria. At that point the UK Pound was strong against the Euro and we were set to make a saving of around half a million pounds. But with the subsequent significant problems with the exchange rate, the promise of savings was never delivered. That came as a big disappointment to us.

Features and Performance

Under regular occupancy conditions there will be no heating requirement; the heat from the occupants and electronic equipment being sufficient to heat the building. The hot water for the kitchen, WCs and changing rooms is supplied from highly insulated hot water cylinders. In turn, the water is heated by electric immersion elements powered by a 9kW wind turbine that is sited on a hill behind the school. Internal air quality is controlled by a combination of natural ventilation and the use of hygroscopic and zero emission materials throughout the school. Natural day-lighting levels have been optimised to ensure an average daylight factor (DF. ave) of 4.5%, and controlled, energy-efficient lighting installed throughout.

\(^2\) www.brettstapel.org
There is an alarming proportion of openly available building materials that are dangerous to health, and we have helped author a report on this for the Scottish Government. There are 55,000 building materials, and only 3% of these have ever been tested for toxicity. This is a major issue that people are either not aware of or not taking sufficient notice of, because they are over-focussed on energy saving and carbon reduction. If there is one over-riding thing that we are proud of about this school it is that we are confident that we have created an indoor environment that is free of any toxic chemicals - which surprisingly could be unique in the UK. We even had the furniture specially designed using non-toxic materials. We discovered at the time that there was no school furniture in the UK that did not have materials that were off-gassing toxins to the environment. After a long search we eventually found a supplier who was willing to go the extra yard and produce non-toxic furniture as a pilot project for the Acharacle School. And this was the only company in the UK willing to go that extra yard! There has been a prevailing culture in the UK, which has not shown interest in such issues.

**Post Occupancy Evaluation**

To help ensure the smooth running of the building once it is completed, and to record successes and failures in the project for the benefit of the design team and client, Gaia and the M+E consultants, Arup, have been employed for 2 years after the building was occupied (in May 2009) - to ensure effective user patterns for the building, and highlight technical issues, which – as well as fine-tuning the running of this particular school can also inform not just future schools but also other future construction projects.

Innovation is core to our practice and we have been involved in this approach to sustainability for the past thirty years. We have worked all over Europe to bring best worldwide practice to Scotland. The practice embodied in the school has been popular in Scandinavia but the wider public and the construction industry have only been interested in sustainability over the past few years - for the first 25 years of our practice it was a big challenge to get most people interested in sustainability. This school can be seen as the result of our experience of working in this area for thirty years, and so far the children love the school, and everyone within the community is very appreciative.

Key features of the school also include: concentration on conservation of resources through use of efficient electrical appliances (i.e. lights) and water fittings (i.e. taps, toilets and showers) before considering the required demand; collection of rainwater for use in toilets; monitoring displays to keep the school children aware of energy consumption, water consumption, temperature, humidity and CO2 levels in the school; procurement of loose school furniture which has been developed to minimise off-gassing of harmful VOCs.

Externally, the form of the building provides sheltered areas for children to use and maintain, and a colour consultant has provided a colour scheme for the inside and outside of the building that is both vibrant and stimulating, and has been designed to enhance the experience of those using the school.

Acharacle School has featured in a number of conferences and debates over the past two years, and was a finalist for the Green Building of the Year award in 2009.

All images courtesy of Gaia Architects.
LOW ENERGY DWELLING

Angus Calder, Simpson & Brown Architects

Project Summary

A snug timber hideaway in the grounds of an existing Victorian villa, built around the twin themes of sustainability and accessibility, which uses dynamic simulation modelling to fine tune the building to its macro and micro-climatic context.

Introduction

This article is not about an emergent technology, or novel product, but documents an approach to the design of an energy efficient dwelling that is innovative in combining simplicity of approach with rigorousness of execution.
Project Background

The background to this project is not an unusual one. An elderly individual is happily settled in the area in which she has spent most of her life, but finds herself living in a house that no longer suits her needs, with no suitable alternative accommodation nearby.

The Existing House

The client’s existing house, a large three storey detached villa, in South West Edinburgh has problems common to almost every unimproved, solid walled house in Scotland; very poor (or non-existent) insulation, draughty doors and windows, single glazing, all of which leads to high space heating costs, and very poor levels of thermal comfort. Space heating is provided by a mixture of gas fired central heating system, and open fires (12 in all!), with an electric Domestic Hot Water system.

However, perhaps even more of a pressing issue for the client than the thermal (dis)comfort, is the increasing accessibility issues that the house is beginning to pose as she anticipates becoming less mobile.

Despite its drawbacks from a thermal comfort point of view, like most buildings built before the modern period, the materials used in its construction (sandstone, timber, lime, slate etc) are largely renewable, unprocessed, and durable. They are therefore almost inherently sustainable, and this sometimes acts as a useful reminder that technological innovation in itself is not the goal.

Search for a Site

A key element of social cohesion in an area is a certain level of continuity of occupation, i.e. stability in a local population, as well as mixed communities. Our client had lived at her present house for forty years, has been deeply involved in local community life, and had made a considerable emotional and physical investment in her garden. Given this background, it was a fairly natural step to look at the possibility of building something more appropriate to her current and future needs, on the grounds of the existing house, which would maintain present stability and social ties.

The Site

The site sits within existing mature gardens, and includes a substantial number of mature trees. It steeply slopes down to the Water of Leith river, and has a significant change of level between the adjacent road and the garden. The site sits within the Currie Conservation Area, and there was a presumption in favour of retention of the existing tree cover.

Although the slope is fortuitously south-west facing, thus offering good solar access, the heavy tree cover was likely to produce significant overshadowing, and limit the potential to use passive solar gain to reduce demand for space heating. The client also requested that we left as much garden as possible untouched.
Key Design Drivers

Our client was well-informed about sustainability, and from the outset was very committed to making the house deeply sustainable. Unusually, this even included an enthusiastic acceptance of ‘green’ behaviour as an occupant (accepting slightly lower than average internal temperatures, proposing to collect firewood herself etc.). She even gently teased the architect for turning up to inspect the site in a car!

Accessibility was the other key design driver. Our client requested that from the outset the house be designed to support the possibility of future limited mobility. Practically, this meant providing a certain amount of core accommodation at street level, while facilitating adaptability, by planning for the evolution of the main bedroom into a stand-alone bed-sit incorporating a modest kitchen. The circulation areas were also generously sized to allow for the future inclusion of a stair lift (in line with the Housing for Varying Needs guidance).

Initial Design Approach

The location of the house on site, and its fundamental massing were significantly constrained by site factors, existing trees to be retained, the proximity of a pedestrian crossing (and the effect on access). Also key was the need to maintain privacy for and from the existing house, and the early decision to build a house that would be raised above the site, minimising the impact on the garden, and involving minimal excavation.

In terms of energy efficiency, our approach was simple:
- First get the building fabric right (thereby reducing energy demand)
- Then, supply any residual demand using low carbon sources

From the outset the design team and client placed the emphasis on optimising the fabric itself, in recognition of now plentiful research that has shown overwhelmingly that improving fabric is the most cost effective, and reliable manner to reduce the energy consumption of buildings, rather than by the addition of expensive, and complex supply-side renewable technologies.

Early proposals incorporated a simple strategy of zoning the building according to the need for daylight, and solar gain. The construction of the main building envelope was also designed to maximise insulation and airtightness, while minimising cold bridging. This was the subject of in-depth comparative evaluation.

Construction System

The restricted site access, a short programme, and considerations of build quality, suggested from the outset that prefabrication would likely be advantageous. The client requested that the design team identify and evaluate a number of different systems from the point of view of both cost and sustainability.

The options looked at initially included:
- I-Beam panels
- Structural Insulated Panels (SIPS)
- ModCell (a prefabricated modular straw bale panel system)
- WeberHaus/Baufritz (German pre-fabricated whole house systems)

The client and design team were keen to identify suppliers who were UK, (and ideally Scottish) based, and ultimately led to designs based on panels prefabricated abroad (such as the WeberHaus or Baufritz) being excluded from consideration. These options were eventually reduced further to two prime contenders: a 300mm prefabricated, pre-insulated I-Joist panel system, and the ModCell system. Both have excellent sustainability credentials, and similar costs. Ultimately, as the house was to be built on posts, the lightweight I-Beam panel system meant that the substructure and foundations could be lighter, and this approach was taken forward.
Combined with a 38mm insulated service void, this I-Beam panel system gave the following:

U-Values: Walls/Floors/Roofs: 0.1W/m²K  
Windows: 1.5W/m²K  
Airtightness: 0.6ac/h

Dynamic Simulation Modelling

One of the more innovative aspects of the design process was the use of Dynamic Simulation Modelling (DSM) to 'fine-tune' the house. DSM software creates a detailed model of a building, including the building fabric, occupancy activities and patterns, and real location-specific weather data, to simulate the building’s performance in depth, and at hourly intervals, throughout an entire year. This can allow detailed evaluation of the performance of the building as a whole, or of any individual element and the contribution it makes.

In this case DSM was carried out in-house to investigate three key issues:
- The extent to which the site was over-shaded
- The annual space heating energy demand and peak loads
- The risk of overheating (controlled using thermal mass and natural ventilation)

Site over-shading

The significant numbers of mature trees on the site led to concern that the solar gain being relied upon to partially heat the house would not be available. DSM made use of the detailed information in the arboricultural report requested by the local authority at planning stage (including crown shape and height and species etc.) to look at the issue in detail. The tree cover was modelled; incorporating both a summer and winter situation, and the impact on the annual space heating demand was then evaluated. The results indicated that during the critical period of the year, the heating season, sufficient solar gain would pass through the leafless canopies of the predominantly deciduous trees.

Overheating risk

Given the design’s target for airtightness, (0.6ac/h), superinsulation (wall/roof/floor U-Values at 0.1W/m²K), and the significant area of glazing on the south and west façades (around 45% and 28% of each façade respectively), the risk of overheating needed to be carefully evaluated. The criteria used to judge the overheating was taken from the ‘Benchmark summer temperatures and overheating criteria’ given in CIBSE Guide A (sec1.4.2.4). These criteria can be summarised as:

Living spaces are overheated if: >1% of occupied hours are above 28°C

Bedrooms are overheated if: >1% of occupied hours are above 26°C
Initially, the intention was for overheating to be controlled purely using occupant controlled natural ventilation, i.e. when the room becomes too hot you open a window! This natural ventilation was modelled accordingly, including simulated occupant control, but the results indicated that, even counting on a high degree of occupant input (i.e. all windows being fully opened when it gets really warm), in both the living areas and the main bedroom (the future stand-alone bed-sit), overheating was likely to be a problem. Following this, the decision was made to incorporate thermal mass in these key areas to capture solar gain while moderating internal temperatures (see following section for details). The model results indicated that the inclusion of this fairly moderate amount of thermal mass had successfully brought the overheating in the two risk areas down below the required 1% of occupied hours.

**Annual space heating energy consumption & peak loads**

The modelling predicted that once solar gain, internal gain, infiltration, etc. had been taken into account, the annual space heating demand would be around 20kWh/m2/year, with peak loads predicted to be 1.5kW

**Key Detail Design Issues**

**Thermal Mass**

In line with the findings of the DSM analysis, thermal mass was incorporated into the house in the most heavily glazed space, the main living space. Thermal mass is only useful if it is exposed, and is particularly effective if it is exposed directly to sunlight entering the building. Accordingly, 100mm unfired clay bricks were proposed to form the rear wall (a load bearing internal partition) in the main one-and-a-half storey living space. This wall will be left exposed to solar gain, and together with the tiled and screeded floor, will provide sufficient thermal mass to smooth out temperature fluctuations in the adjacent spaces.

**Airtightness**

Though superinsulation and a minimal level of thermal bridging were integral to the I-beam panel structure chosen, ensuring a very low level of infiltration required a fairly ruthless focus on the detailed design and specification at openings, junctions, and penetrations. It also involved (an occasionally arduous) coordination with the structural engineer to avoid having the airtightness layer penetrated by elements of the structure.

**Indoor Air Quality**

The very low infiltration rates and carefully controlled ventilation in the design made it especially important that throughout the house, materials and finishes were specified that contributed to good internal air quality. This included natural materials, like untreated timber, and unfired clay bricks, but also the specification of formaldehyde free adhesives, low VOC internal finishes, and limiting areas of carpeting to a minimum.
As noted earlier, reliance was placed on capturing solar and internal gains to avoid the requirement for a conventional space heating system, and to supply residual space heating demand using low carbon sources. As often seems to be the case, it was necessary to have a frank discussion with the client about the debateable economic and sustainability advantages of some of the more high tech, high profile renewable technologies like Ground Source Heat Pumps (GSHP). Ultimately we settled on the use of a Mechanical Ventilation and Heat Recovery (MVHR) system to provide controlled ventilation with heat recovery, and integral back up heating elements, as the most efficient means of providing the minimal amount of heating necessary.

Based on both modelling, and the system specified by the specialist MVHR designers/suppliers (The Scottish Passive House Centre) the estimated annual space heating costs should be around £50 a year (perhaps ¼ of an average 2010 building regulations compliant dwelling).

**Domestic Hot Water (DHW)**
A 2.8m², flat-plate, solar hot water panel has been specified to preheat the DHW, with the water then only being brought up to temperature at the point of use, and only if necessary, by instantaneous water heaters. This avoids the large standing losses associated with large constantly heated DHW tanks in situations in which hot water use is intermittent.

**Water**
The sedum roof will help to reduce and slow flow of surface water off the roof, before it is stored using for garden use in rainwater butts. This attenuation will not only allow a smaller soak-away to be installed on what is a tight site, but ultimately slow its passage into the flood prone Water of Leith (the nearest water course).
Beyond Design Stage

Simpson & Brown recognised that in order to properly follow through on the early sustainability aspirations identified at briefing stage and subsequently embodied in the design, the sustainability criteria would need to be clearly and coherently defined in the production information, and tender documentation. This required going beyond the specification and drawings, to encompass full use of the prelims, performance specifications, and also new approaches to the incorporation of sustainability provisions into the contract documentation.

The Preliminaries

The prelims can play a key role in achieving sustainable design goals through the scope they offer to clearly define the overarching sustainability requirements that concern the project as a whole. For instance:

- The site procedures to be followed (Site Waste Management Plans, Considerate Constructors)
- The information to be provided by the contractor (chain of custody documentation, information to feed into the BREEAM assessment)
- The procedures for testing and any associated remedial work (airtightness, insulation continuity)
- The protection of the wider site’s ecology during construction (restrictions on pollution, protection to existing trees etc)
- The approach to product substitution
- Any procurement restrictions applicable to the project as a whole (e.g. requirement to use FSC certified timber).

Performance Specifications

For airtightness particularly, achieving the targets set at briefing stage in the finished building needs more than good design, and thorough specification, it also depends on good on site workmanship. This situation has been addressed through the incorporation of targets into the contract documentation i.e. making the attainment of the target a contractually binding obligation, through the use of an airtightness performance specification.

The Sustainability Schedule

The JCT’s Sustainability Working Group has recently been investigating new approaches to incorporating sustainability provisions into contract documentation. As an alternative to locating sustainability provisions solely in the specification and drawings, the JCT has drawn attention to the option of using a ‘Sustainability Schedule’, to highlight to contractors the importance attached to sustainability.

JCT recommend that a Sustainability Schedule should:

- Summarise all the key sustainability requirements
- Be appended to the contract conditions
- Be accorded ‘contract document’ status.

This schedule, by its simple presence and status as a contract document, should effectively emphasise the importance attached to sustainability by the client and design team.

The Future and Conclusions

It is the intention that the performance of the house will be evaluated post handover, to test the success of the design strategies, and construction methods, against the design targets. To this end, funding is being sought under the Technology Strategy Board’s ‘Building Performance Evaluation’ scheme, to have the house comprehensively evaluated over its first two years in use. Simpson & Brown are set to further enhance their in-house expertise of low energy design, through the application of this approach to a multi-unit residential project in the Scottish Borders, and which is currently at masterplanning stage. Alongside this, Simpson & Brown intend to broaden the use of dynamic simulation modelling to optimise the performance of designs more routinely within the practice.

As noted at the beginning of this article, in this building the focus is less on innovative technologies and products, and more on developing an approach that is innovative in combining simplicity with rigorousness of execution.
JOBS

Archial Sustainable Futures is looking to add to its small but expanding consultant team with the recruitment of a further suitably skilled and experienced professional to provide low carbon design advice and more general sustainability consultancy. The role will involve providing internal technical support and research and development support for the Archial Group Plc (http://www.archialgroup.com/) companies and their clients, in addition to direct external consultancy. Archial is accredited to provide Carbon Trust Low Carbon Buildings Design Advice, and leads a consortium for the provision of Carbon Trust Strategic Design Advice, in addition to being licensed BREEAM Assessors.

For a full job profile and further details please contact Kelly Menzies at kmenzies@archialgroup.com or call 0141 204 6500.

Subscription

To subscribe to free quarterly Innovation Review and monthly CIC Start Online E-News, please register by accessing the project website at www.cicstart.org or the following link Registration.

Benefits of free registration also include the following:

- Publish information on products and services for sustainable building design and refurbishment offered by your business (free for Scottish small to medium size enterprises).
- Receive a free headset with a microphone to listen to forthcoming CIC Start Online webinars.
- Free information on sustainable building design and refurbishment for Scottish small to medium size enterprises.

Marketing

To advertise products or services for sustainable building design, construction or refurbishment by companies registered in Scotland, please contact admin@cicstart.org for the price list.

Articles

Submission deadline for the articles for the fifth issue of Innovation Review is 15th November 2010. To discuss the article that you would like to submit, please contact us by email or telephone on the contact details provided below.

Innovation Review is published by CIC Start Online project.
Contact: Branka@cicstart.org, +44 (0)141 273 1408