INNOVATION REVIEW

ISSUE 5, December 2010

SUSTAINABLE BUILDING DESIGN AND REFURBISHMENT IN SCOTLAND

SUSTAINABILITY LABELLING IN SCOTLAND

SUSTAINABLE COMMUNITIES

TWO PROJECTS FROM SCOTLAND’S HOUSING EXPO 2010
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### Sustainability labelling in Scottish building regulations

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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](http://www.cicstart.org) to access the registration page at the project website

**PROJECT PARTNERS**

- Glasgow Caledonian University
- Edinburgh Napier University
- Mackintosh School of Architecture, The Glasgow School of Art
- Heriot-Watt University
- Robert Gordon University
- University of Strathclyde

**FUNDED BY**

- The Scottish Government
- The Scottish Government European Regional Development Fund
Welcome to the fifth issue of Innovation Review!

We are happy to announce that CIC Start Online has obtained additional funding for feasibility studies from European Regional Development Fund and Scottish Government’s SEEKIT programme. Joint applications from academics and Scottish small to medium sized enterprises should be submitted by 14th January 2011. Information on how to apply is provided on web pages Feasibility Studies and Academic Consultancy on our website. Interdisciplinary collaboration between academics and practitioners (e.g. architects, services engineers, manufacturers of building and services products and components, and building surveyors) is especially welcome in developing innovations for sustainable building design and refurbishment.

CIC Start Online project was shortlisted in two categories for the European Structural Funds 2007-13 Mid-Programme Best Practice Awards for contributing to “greener” Scotland and partnership working. Although we did not win any of the awards, we were very happy that our work has been noticed among many very successful projects funded by European Structural Funds.

The outcomes of the feasibility study Improving Energy and Carbon Performance of Housing - A Glasgow Case Study completed by Energy Systems Research Unit at the University of Strathclyde Glasgow and Collective Architecture in collaboration with Garrioch Residents Association were presented at the seminar and interactive online webinar on 23rd November 2010. Information on the contents and how to access the video recording can be found on page 8.

The next seminar and webinar will take place on 25th January 2011. The outcomes of the feasibility study on Embedding Simplified Post Occupancy Evaluation within the Design Process, undertaken by Energy Systems Research Unit at the University of Strathclyde Glasgow and Page&Park Architects will be presented. Please see how to book a place on page 9.

As Glasgow Caledonian University, Heriot Watt University and Edinburgh Napier University collaborate with European Energy Centre in the delivery of a training courses for renewable energy technologies and in the organization of the UNEP conference Getting Ready for Renewable Energy – Green New Deal, we provide information on these activities in this issue on pages 10 and 11.

Since our September issue, Scottish Government has published the Energy Efficiency Action Plan and Consultation on Sustainability Labelling Within Building Standards. We bring an article on the second document in this issue on pages 12 and 13.

Malcolm Fraser Architects won the Scottish Government run ideas competition for the Scottish Sustainable Communities Initiative, which looked at one housing plot within a larger Cadell² masterplan for the proposed development of Whitecross Village near Linlithgow. Their project is presented in this issue.

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 the September issue, the article on The WholeLife House designed by Brennan and Wilson Architects, that is also exhibited in Inverness, was published. In this issue, two more demonstration projects from Scotland’s Housing Expo 2010 are presented by a+j burridge and Oliver Chapman 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
ADDITIONAL FUNDING FOR INNOVATIONS

Following the funding of 11 feasibility studies and 7 academic consultancies during the first year of the project, CIC Start Online has obtained additional funding for feasibility studies from European Regional Development Fund and Scottish Government SEEKIT programme. This provides funding for additional 39 feasibility studies.

The next submission deadline for applications is 14\textsuperscript{th} January 2011.

Interdisciplinary collaboration between academics and practitioners (e.g. architects, services engineers, manufacturers of building and services products and components, and building surveyors) is especially welcome in developing innovations for sustainable building design and refurbishment.

Innovations that tackle some of the following themes are encouraged in light of Scottish climatic, social, economic and policy conditions:

- Cost-effective solutions for adaptation to future climatic conditions
- Reliability, cost effectiveness and comparison of domestic and/or non–domestic microgeneration of energy
- Cost-effective solutions for reducing fuel poverty
- Feasibility of district heating systems in tenemental areas
- Conditions that optimise technical and financial effectiveness of low carbon technologies
- Feed-in tariffs vs. cost effectiveness and take-up of microgeneration
- The impact of humidity on air source heat pumps
- Reducing noise from an air source heat pump
- Insulating cavities against driving rain
- How to insulate a hard to fill cavity or other potential solutions
- Effectiveness of curtains and carpets vs. shutters and floor insulation
- A cost-effective investment strategy for a national, regional or local Registered Social Landlord to develop district heating systems
- A cost-effective investment strategy for reducing emissions from a specified public building (e.g. school or hospital)
- The social and economic costs and benefits of an investment strategy for a large Registered Social Landlord to provide tenants with free electricity, space and water heating (i.e. cost included in rents) up to a specified maximum usage
- An economic analysis of the impact of existing, potential or innovative energy efficiency programmes on employment

The above list of research themes has been derived from a wider list recently sent by Scottish Government to academics at Scottish universities. Guidance for applying and application forms for feasibility studies and academic consultancy are available at www.cicstart.org. For any additional information, please contact Dr Branka Dimitrijevic at 0141 273 1408 or branka@cicstart.org.
DISSEMINATION OF INNOVATIONS

The outcomes of feasibility studies and academic consultancies completed through the CIC Start Online competition are disseminated at seminars and interactive online webinars. After the events, video recordings are published at our website.

Our first seminar and online webinar took place on 29th September 2010. Its title is “A Hybrid Solar Thermal Mass System Development for the Application to Tenants First Housing Co-operative’s Zero-Carbon Affordable Homes”.

The speakers were:

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

**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 University

Along with the audience in the seminar room, 24 online viewers watched the webinar and 25 members watched the video recording to date. The viewers were from across Scotland.

The event recording is published at our website and available following registration with CIC Start Online. Registration is free and can be done through the Membership page of our website.

There are over 440 members of CIC Start Online who can access the webinars and video recordings of dissemination events. They save time and money by watching free online events, and reduce carbon emissions by not travelling to the events from distant locations.

If you are not already a member of the CIC Start Online project, we would like to invite you to register – it is free for everyone!
Date: 23rd November 2010  
Time: 12:30 - 14:00 (GMT)  
Venue: Seminar Room K505, Buchanan House, Glasgow Caledonian University, 58 Port Dundas Road, Glasgow. G4 0HG

Speakers:

Mr Michael Dougall, Collective Architecture  
Dr Paul Touhy, University of Strathclyde Glasgow  
Dr Jeremy Cockroft, University of Strathclyde Glasgow

Summary:

The Energy Systems Research Unit (ESRU) at the University of Strathclyde Glasgow and Collective Architecture have defined and demonstrated a process for assessing and communicating the energy upgrade options to a residents association, landlord or housing association. The first process step is a meeting with the client to explain the project and get their inputs on the current issues with the building and the range of upgrades of most interest. Following this consultation process the current building performance is established through a physical survey, air-tightness testing, thermography and smoke analysis in representative dwellings. The appropriate upgrade options and best practice examples for the building type are then researched and a reference database created.

The carbon and energy performance of a representative sample of the existing dwellings is then modelled; and the carbon, cost and energy impact of a range of upgrade options quantified. Based on best practice and modelling results some recommendations are provided. A customised version of the modelling tools is made available to the residents association and training offered to allow them to assess further upgrade options on an ongoing basis. The customised tools are similarly available as the starting point for future similar projects. A report of the outcomes of the work is prepared and presented to the clients allowing them to gain understanding.

In this case the process was applied to the quadrangle of traditional red sandstone tenement flats in the west end of Glasgow represented by Garrioch Residents Association. There are many similar properties in Scotland requiring similar upgrades therefore work undertaken in this study can be utilised elsewhere. However, the process is not restricted to these similar properties; it can also be applied to other dwelling types.
EMBEDDING SIMPLIFIED POST OCCUPANCY EVALUATION WITHIN THE DESIGN PROCESS

Date: 25 January 2011
Time: 12:30 - 14:00 (GMT) - Lunch from 12:00
Venue: Seminar Room K505, Buchanan House, Glasgow Caledonian University, 58 Port Dundas Road, Glasgow. G4 0HG

Speakers:
Prof. Joe Clarke, University of Strathclyde Glasgow
Ms Fiona Bradley, University of Strathclyde Glasgow
Ms Karen Nugent, Page & Park Architects

Summary:
This research project involved the team looking at Post Occupancy Evaluation (POE) analysis from a number of perspectives. The team studied information relating to existing POE methods, current energy best practice benchmarks and compared appropriate figures against Page & Park attainments. They also developed a simple questionnaire that clients would regard as quick to fill in and user-friendly.

It was decided that the most effective way to deliver a simplified POE process, to complement the existing work practices of Page & Park, was to design and trial a software tool, named POET (Post Occupancy Evaluation Tool). This tool was developed over the period of the project and underwent a number of revisions to deal with issues relating to compatibility with Page & Park hardware, work practices and application expectations.

A key deliverable of the project was to use POE as a method of gauging any difference between design intent and use in practice, so that information could be fed back into future Page & Park projects. It was also crucial that the architects would be able to compare designs with best practice guidelines. The benchmark figures chosen for this project were extracted from CIBSE Benchmarks TM46 (2008).
ENERGY TRAINING COURSES

in association with

HEAT PUMPS AND A/C SYSTEMS
3-4 December 2010
Edinburgh
http://www.euenergycentre.org/training/68-heat-pumps-a-ac-systems-

SOLAR PHOTOVOLTAICS
10-11 December 2010
Edinburgh
http://www.euenergycentre.org/training/66-solar-photovoltaic-training

RENEWABLE ENERGY MANAGEMENT
17-18 December 2010
Edinburgh
http://www.euenergycentre.org/training/71-financing-renewable-energy
The conference ‘Getting Ready for Renewable Energy – Green New Deal’ run by the United Nations Environment Programme (UNEP) and the European Energy Centre (EEC) will take place at Heriot-Watt University in Edinburgh on the 21 January 2011 with a number of high profile delegates and speakers from around the world expected to attend.

The objectives of the conference, which seeks to explore the opportunities for partnership between Europe in renewable energies include:

- Opportunities for individuals entering the renewable energy sector
- Options and opportunities for companies expanding in the renewable energy market
- Company requirements to meet CO₂ emission targets
- Comparison and choosing between Renewable Energies
- Investment potential for both the economy and the environment

The conference is organized by the EEC in cooperation with Centro Studi Galileo, the Indian association TERRE, the Associazione Tecnici Italiani del Freddo, and the Intergovernmental International Institute of Refrigeration. Building upon the outcomes of the 13th European conference, this event will directly address the Governments’ desire to collaborate with international institutions to push on Renewable Energy Applications.
Sustainability labelling in Scottish building regulations

Stuart Watson
Senior Architect; Directorate for the Built Environment, Scottish Government

Building standards and sustainability

The standards introduced by the Scottish Government in October 2010 set a demanding level for new building work. Scotland now has building regulations that are amongst the best in Europe, reducing CO₂ emissions from new buildings by 70% compared to buildings built to the standards in force in 1990.

But sustainability is a broader term encompassing many aspects of design other than energy and CO₂ emissions. Wider matters related to buildings such as protection against excessive noise, access to good daylighting levels and improving water conservation all play their part in creating buildings that are more sustainable for us all. Buildings designed more sustainably can positively impact on the potential for sustaining human wellbeing, whilst reducing the use of finite resources. The process of sustainable development and the quality of ‘sustainability’ to aspire to within the built environment should account for:

- social, economic and environmental factors;
- the potential for long-term maintenance of human wellbeing, which in turn depends on the wellbeing of the natural world and the responsible use of natural resources;
- the exploitation of natural resources without destroying the ecological balance of the area where these resources originate or are processed, and;
- the ability to be maintained.

In Scotland, the response to ‘furthering the achievement of sustainable development’ has been to progressively embed more sustainability into building regulations. For example, the principles of Lifetime Homes, to allow greater accessibility, were added in 2007. Further features have recently been introduced, such as a new standard that addresses security against house-breaking.

A proposed next step

To enhance the sustainability of new buildings and in response to market sectors that aspire to higher levels of sustainable design, the Scottish Government propose a system of labelling that recognizes the achievement of meeting the current minimum standards, and also defines optional higher levels. Benchmarks are being created, to which those who decide to demonstrate their ‘green’ credentials can refer, thus encouraging:

- lower carbon buildings;
- the efficient use of resources such as energy and water; and,
- progress in sustainable new designs that link with more sustainable communities.

For a building to earn a sustainability label, it must demonstrate that a balanced range of factors have been considered in design and then achieved in construction.

How would it work?

Because Scottish building standards have already travelled significantly along the road towards lower environmental impacts, the base level of sustainability labelling (the ‘bronze’ level) would mean compliance with the minimum standards. Therefore sustainability labelling would not trigger extra capital costs other than for those who opt to achieve the higher levels.

The proposed upper sustainability levels for the design and construction of domestic buildings have been developed in conjunction with industry. Two levels known as ‘silver’ and ‘gold’ have been defined, containing aspects that aim to be pertinent at the building warrant stage of development process when applicants are looking at the detailed design. As they address issues to be fairly controlled within the building standards system they tend to be directed towards technical environmental performance issues of design. The proposed eight aspects are:

1. Carbon dioxide emissions
2. Energy for space heating
3. Energy for water heating
4. Water use efficiency
5. Optimising performance
6. Flexibility and adaptability
7. Wellbeing and security
8. Material use and waste

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¹Brundtland Commission, United Nations, 1983. “sustainable development meets the needs of the present without compromising the ability of future generations to meet their own needs”
²The Building (Scotland) Act 2003
In practical terms, a new section would be added to the Technical Handbooks containing a single mandatory standard and guidance for all warrant applicants when proposing a new building in Scotland. To comply there would need to be a label of a specified level of sustainability fixed to the building (see examples in figure 1) in a similar way that an EPC\(^1\) should be fixed; for example in meter cupboard or utility space.

**Benefits**

It is hoped that the system will offer several benefits to new buildings in Scotland:

- Because the system works within the existing warrant system there is no separate assessment cost.
- It should encourage consistency between planning authorities that use supplementary guidance to promote higher measures of sustainable construction in their geographical areas. By making reference to this standard, local aspirations can be met by selection of clear national benchmarks.
- It supports reducing CO\(_2\) emissions to mitigate the effects of climate change.
- It mainstreams sustainability, placing sustainable design within reach of all new buildings and not just belonging to a niche market.

**Your views**

The guidance text aims to be transparent and simple to follow for applicants, as well as straightforward to verify. It defines in detail what to aim for during the design process so that any new home could show it has achieved an optional higher level of sustainability. A similar set of higher level aspects is expected to be developed for non-domestic buildings in due course.

The proposed standard and guidance to meet the upper levels in each aspect for domestic buildings is detailed in the consultation documents that can be accessed at [http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/publications/pubconsult](http://www.scotland.gov.uk/Topics/Built-Environment/Building/Building-standards/publications/pubconsult). In the example of CO\(_2\) emissions, the upper levels refer to the staged recommendations of the Sullivan Report\(^4\) but also recognize that sustainability needs to be looked at in-the-round without overly emphasizing one particular aspect.

The consultation will remain open until December 24\(^{th}\) 2010 and any views on the proposals are welcome.

\(^1\)Energy Performance Certificate

CIC Start Online joins up with the Enterprise Europe Network in Scotland

CIC Start Online is working closely with the Enterprise Europe Network in Scotland to give our members free access to opportunities, partnerships and tenders, and EU funding.

We are working with the Enterprise Europe Network in Scotland for two key reasons - working with the Network helps us promote our activities and reach a wider audience but, even more importantly, the Enterprise Europe Network in Scotland works in areas of particular interest to our members and those involved with the CIC Start Online project.

CIC Start Online involves many university departments and academics who, by subscribing to the Enterprise Europe Network e-alerts, will now have access to advice and information from the Europe-wide Network to help them find partnerships, create collaborations and explore technology offerings.

We’ve recently extended the range of departments and SMEs involved in CIC Start Online to include those working in the energy sector because we realised that there are tangible opportunities not just for contracts but also for technology transfer and information exchanges across the 47 countries in the Network. What we do is all about collaboration so the services they provide are a perfect fit. We encourage all members to sign up and take advantage of what the Enterprise Europe Network has to offer.

The Network’s Lorna MacLean explains: “The team at Enterprise Europe Network understands that, for many small businesses, getting a foothold in new markets can be a challenge. We help Scottish businesses and organizations by providing a local gateway to a wealth of information on doing business, accessing funding, driving innovation and increasing their competitiveness in new markets across Europe. With a presence in 47 countries, Enterprise Europe Network is the world’s largest business support network.”

More information on Enterprise Europe Network in Scotland is available at http://www.enterprise-europe-scotland.com/sct/
Green training opportunities in Scotland

A total of 650 new training places, to be delivered through Skills Development Scotland, are being funded with the support of the European Social Fund to enable employers to train employees in low carbon technologies as part of the Scottish Government’s drive to maximise the economic benefits of greener business.

Damien Yeates, Chief Executive, Skills Development Scotland said:

"The low carbon skills fund will provide businesses with access to sector specific training to help improve their performance, efficiency and improvement processes around low carbon. By developing a highly skilled, more confident workforce Scotland will be able to maximise the benefits of its natural resources in these vital emerging sectors."

The Scottish Government, with the support of European Social Fund money, has invested £585,000 to fund these training places this year.

The fund will be open to all private sector, voluntary and community-not-for-profit organisations, employing less than 250 staff, whose current or intended business activity is in energy efficiency, carbon reduction and/or renewable energy. The initial focus will be on the skills needs in the built environment.

To qualify for the funded training places, businesses must demonstrate their work fits with the following:

- Increasing energy efficiency of products and/or the built environment
- Increasing energy efficiency relating to process improvements
- Installing lower carbon products or renewable energy resources

Skills Development Scotland is working with a number of Sector Skills Councils covering the built environment including Asset Skills, Construction Skills, Energy and Utility Skills, ProSkills and Summit Skills. The Low Carbon Skills Fund will be available for companies operating within these sectors.

Specifically Asset Skills is working with employers and training providers in its housing, property and facilities management sectors to address current training needs. Opportunities exist to learn more about the potentially huge contribution employers in these sectors can make towards an energy efficient built environment, whether through building more energy efficient houses, installing, using and maintaining energy efficient and/or micro-renewable technologies or influencing the energy behaviours of building users.

For more information about opportunities for Asset Skills' employers, contact Tim Pogson on 0131 667 2448 or scotland@assetskills.org.
Innovation for Competitive Enterprises (ICE)

About ICE

Innovation for Competitive Enterprises (ICE) is a one year programme that offers selected small to medium sized companies; in-depth, hands-on, in-house support to develop their potential for innovation, and thus increase their competitiveness and profitability (at no financial cost to participating companies). The programme is focused on improving competitiveness through the commercialisation of new ideas, improved products or processes or the introduction of a new business model.

ICE is a tri-regional (West of Scotland, Northern Ireland and the Six Border Counties of Ireland) collaboration led by Dundalk Institute of Technology in partnership with Glasgow Caledonian University, University of Glasgow, and the University of Ulster. Funded by the European Union’s INTERREG IVA programme, Scottish Enterprise, and the accountable departments of Ireland and Northern Ireland.

The ICE Approach

ICE offers a results-focused approach, which aims to improve a business’s bottom line. Throughout the programme the project team will work with selected companies to enable them to (without financial cost to the company) -

- Access tailored in-house support, from innovation experts for a period of up to 12 days free of charge.
- Identify and generate ideas for new products, processes or new business models which commercially can best drive profitability.
- Develop a tailor made innovation plan to support implementation whilst still running core company activities.
- Access additional specialist expertise and knowledge, for example from universities.
- Access technology transfer & licensing opportunities, where appropriate.
- Access experts with a proven track record in successfully bringing new ideas to market.
- Network with other participating companies from across the three regions.
- Attend training opportunities designed by the programme team to support innovation implementation.

Eligible Companies

- Must be SMEs employees between 10 and 250 employees (F/T equivalent).
- Have moved past early stage development and planning to move into the growth phase of their lifecycle.
- Be located in the West of Scotland INTERREG IVA/Scottish Enterprise designated areas only. These are normally only companies with a base in Ayrshire and Dumfries and Galloway, although a small number of companies based in adjacent areas e.g. Inverclyde may also be eligible. Interested companies should check with the Project Manager.

Is there any financial cost?

The programme is free to participating companies, although they must be prepared to give their time and commitment to programme activity.

The Application and Selection Process

Companies who wish to be considered should contact the ICE Programme Manager, Janet Hamilton. Janet will be available to assist interested participants with programme application, and provide free of charge access to an innovation evaluation. Places are limited and a selection panel from each region will assess company readiness to participate during year one.

For further information contact
Janet.Hamilton@gcal.ac.uk
07702 729490
E: ice@gcal.ac.uk

The Special EU Programmes Body is the Managing Authority for the European Union’s INTERREG IVA Cross Border Programme
Build with CaRe films on sustainable renovation of built heritage

Build with CaRe (Carbon Reduction) is a European project which focuses on mainstreaming sustainable buildings and construction, in which the Robert Gordon University and Aberdeen City Council are partners.

As part of the project the partners in Southend on Sea Borough Council, Essex will produce a series of films charting the progress on the sustainable renovation of Prittlewell Chapel (a dilapidated, locally listed building) on North Road, Southend.

The first of the series of films is available to watch, via You Tube: http://www.youtube.com/watch?v=zZJa2eB4IRk

This first film introduces the project and the following three films will then focus more specifically on the technologies being used and the BWC partnership itself. They will also be producing a more technical film, aimed at professionals, later in the year.

The four short films are intended to increase awareness of energy saving and carbon reduction in the built environment amongst local residents and others, as well as drawing attention to the work and objectives of the Build with CaRe partnership.

By allowing viewers to see first-hand what is happening on site, the film series will introduce the renewable and energy saving technologies being employed at Prittlewell Chapel, explaining how they work and their benefits.
Whitecross Village near Linlithgow

Clive Albert (Malcolm Fraser Architects) and Stewart Dalgarno (Stewart Milne Homes)

Malcolm Fraser Architects (MFA) and Stewart Milne Homes (SMH) recently won the Scottish Government run ideas competition for the Scottish Sustainable Communities Initiative, which looked at one housing plot within a larger Cadell masterplan for the proposed development of Whitecross Village near Linlithgow. The critical question posed by the competition brief was not just to design a sustainable housing scheme, but also to examine how the principles of low carbon development might fit with ideas about good ‘place making’. In this short article MFA set out the basic principles that influenced the design of the site layout and SMH elaborate on the energy strategy and features of the individual houses.

The skills required to create environments where people feel happy, secure and content are less tangible concepts than photovoltaic’s and wind turbines. They don’t form part of any BREEAM checklist. They are often not integrated as part of the teaching of sustainable design in schools of architecture. In short, they are too subjective. Yet if we are going to invest resources and energy into making any built environment, good design and place-making must be at the core of what we do. It should not be enough to simply fulfil the requirements of the end users and environmental checklists, we have also to make something beautiful, and for an environment to be truly sustainable it should still be functioning as an attractive place to live or work in hundreds of years from now. This question, which is at the heart of the competition brief is what attracted us to enter, and this article is not just about technical solutions to low energy home making, it is about the interface between these two ideas and how we addressed them in this particular location.

Three core ideas influenced the discussions and development of a site strategy. These were to:

- Minimise the intrusion of cars on the site to create secure, family focused places at the heart of the site
- Maximise the efficiency of passive solar design strategy for each house type (and minimise the use of gadgetry) and give every house a south facing garden
- Create a landscaped pedestrian between Stein’s Park and Haining Wood running north–south through the heart of the site (the green-spine)

The site is arranged to give every home a south facing garden, which the main living areas overlook and exploit a passive solar design strategy. At its most basic this involves a highly thermally efficient wall and roof construction, with external shading to minimise heat gain in summer, combined with a simple efficient natural stack ventilation system to evacuate and distribute rising warm air. This environmental strategy for the homes also underpins and informs the logic of the site layout. The two are integral to one another, and while key structural decisions in the masterplan about roads and infrastructure have been respected, the competition entry proposed an alternative vision of how the site could be developed. One in which the environmental ideas that inform the making of a low carbon home also establish the layout of these homes, and reinforce ideas of place-making that are focused around people and not cars.
Our design varies the pattern of streets in the masterplan by keeping all new access roads to the perimeter of the site and clearly defines these as pedestrian priority areas.

Car-parking is kept adjacent to these roads in a series of compact hard landscaped courts which front onto people’s gardens, providing most homes with adjacent parking or on driveways beside them, so that there is not far to walk from the car to door if residents are carrying children and shopping.

This simple amendment to the masterplan allows the creation of green spaces at the centre of the competition site, which are intended to bring activity into the heart of the development, to anchor social areas within the site, and also create communal areas for playing, eating and socialising amongst a mixture of soft and hard landscaped spaces.

This sequence of car-free recreation spaces is intended to create a sense of ownership for the family homes adjoining them, encouraging families to look beyond the boundaries of their own garden to take control of how these spaces are used and maintained and in doing so to start to foster and encourage a sense of community.

Keeping the heart of the site free of cars, allowed us also to propose the creation of a ‘green-spine’ which would connect the proposed new park at the north of the site (Steins Park) to the footpath along the edge of Manuel Burn and Haining Wood to the south.

Smaller east-west running pedestrian ‘closes’ connect this primary pedestrian route through the site to individual houses and to the perimeter roads and car-parking courts.

The ultimate ambition would be to try and establish a linear communal orchard where fruiting trees and shrubs form the main structural element of this ‘green spine’, enhancing and connecting biodiversity through the site (and adjoining sites) as well as providing seasonal food for
A restrained palette of robust, hard surfacing materials is proposed for these pedestrian routes and these would be softened with raised wild flower beds with adjoining seats made from recycled railway sleepers. The intention is to have clearly defined boundaries between public and private areas of the site (defensible space). Some of these would be walls, built from the same recycled brick of the houses, and others would be hornbeam and beech hedges that would help reduce the hard landscape elements on the site and also encourage biodiversity across the site.
Housing Design Approach

The team decided on a strategy of simple passive solar homes that would be straightforward for families to understand and use. Time was spent ensuring that the site layout maximised sunlight for each house type and in making compact homes that were familiar to the public (i.e. marketable and appropriate) that would reinforce and establish a sense of community in the new village.

The team have focused on simplifying the active systems incorporated into the homes. Research into the ‘performance in-use’ of low-carbon housing has suggested that people can find it difficult to understand and use gadgetry and this can result in the homes not performing as efficiently as designers often envisaged. We wanted to focus our efforts to improve on simple, well tested, passive solutions that were more user-friendly and that are intended last the lifetime of the home with minimal or no maintenance. We believe that this strategy will have the best opportunity to stand the test of time and also have the best overall ‘fit’ with the ambitions for the development of Whitecross Village.

All the houses exploit solar orientation specific to the longitude and latitude of Linlithgow. The team predict that this strategy will be so successful, that when combined with a highly thermally efficient building envelope, the homes will require minimal heat input.

All the different house types (listed in the table below) organise kitchens, utility rooms, bathrooms and staircases in a north facing ‘service zone’, which has smaller window openings to minimise heat loss, while the living areas always open onto south facing gardens.

The houses use a simple palette of materials - recycled brick at ground level, with Scottish Larch stained cladding above and zinc sheet roofing. This material strategy makes for a highly efficient ‘scaffold-free’ on site build. Seventy one houses are proposed within the competition boundary. These range from starter terraced homes to large family houses. The variety of housing aims to cater for all sizes and tenures. All the house types have an area that can incorporate a workspace, the Type 3 homes have a dedicated study, and seven of the Type 1A homes have an integrated ‘work/live’ component.

All house types incorporate the following features:

- Wood Burning Stoves
- Internal and external recycling facilities
- Desk space as a minimum in all houses
- Built-in storage to all bedrooms
- Dedicated composting facilities and vegetable plots in all gardens
- Rainwater harvesting for use in the gardens

<table>
<thead>
<tr>
<th>House Type</th>
<th>Number</th>
<th>Total number of homes</th>
<th>Gross internal floor area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1A</td>
<td>3 bed terrace</td>
<td>18 (7 work/live)</td>
<td>104 sq metres</td>
</tr>
<tr>
<td>Type 1B</td>
<td>2 bed terrace</td>
<td>22</td>
<td>90 sq metres</td>
</tr>
<tr>
<td>Type 2A</td>
<td>4 bed detached</td>
<td>7</td>
<td>140 sq metres</td>
</tr>
<tr>
<td>Type 2B</td>
<td>3 bed detached</td>
<td>18</td>
<td>120 sq metres</td>
</tr>
<tr>
<td>Type 3</td>
<td>4/5 bed detached</td>
<td>6</td>
<td>158 sq metres</td>
</tr>
</tbody>
</table>
House Type 1A

House Type 1A is a three bedroom terrace house. The ground floor is faced with recycled brick, the first floor is stained Scottish grown larch. As mentioned in the Housing Design Approach the bathrooms and kitchen are located to the north side of the house and the dining, living and majority of the bedrooms are located to the south to maximise solar gain. The dining and living spaces have large openings to the south facing garden. Seven of the Type 1A houses have a work unit at the end of the garden. This in turn opens to the street providing a separate access if the workspace is used for a business.
Environment Cross Section House Type 1A

Ground Floor Plan of Terrace House Type 1A
House Type 3

House Type 3 is a four bedroom family house with a double garage. The majority of the house cladding is stained Scottish grown larch with a recycled brick base courses. The bathrooms, kitchen and utility room are located to the north side of the house and the dining living and all of the bedrooms face south to maximise solar gain and views over the garden to Haining Wood and Manuel Burn.
Environmental Approach

The project’s approach to delivering a 60% reduction on carbon emissions, over 2007 Section 6 Scottish Building Regulations, was informed by Stewart Milne’s research into the ‘as-built’ performance and occupancy evaluation of their ‘Sigma’ prototype home, built at the BRE innovation park in Watford. This was the UK’s first level 5,100% CO2 reduction, near Zero Carbon home built to comply with the English Code for Sustainable Homes back in 2007.

In addition the competition submission also adopted the Scottish Government’s, ‘Sustainable Energy Best Practice for Planners Guidance’, published in July 2010, relating to the preferred energy hierarchy approach when considering a carbon reduction strategy. This relies on maximising energy reduction from passive and operational measures before considering renewable energy technologies.

Energy and Carbon Saving Features

The energy and carbon saving feature’s that have been designed into the homes include world leading fabric design with super insulation levels for walls, floors and roofs, using Stewart Milne’s ‘Sigma II Build System’. This significantly reduces space heating demand to minimal levels. Superior construction detailing, focusing on high levels of air tightness and exemplar thermal bridging to prevent heat loss, through factory fitted air seal, well designed details and the innovative use of space stud technology, which provides a thermal break within the timber frame wall panel assembly.

The ‘Sigma II Build System’ envelope solution, adopts high levels of off-site prefabrication to ensure that quality and energy performance is built into the construction process.
The system adopts home grown timber space stud components which provides a unique thermal break in the construction build up. The system also adopts factory fitted windows, air seals, service cavities, membranes and gaskets, which ensure air tightness integrity is maintained. Conventional external cavity, dry lining and exterior brick or timber cladding systems, simplify the build up. The system offers U-Value of 0.12, air tightness of 2 and a thermal bridging Y-Value of 0.03. Several sites have been completed and as-built test reports, demonstrate compliance after the construction process.

The team also addressed heat loss through party wall thermal bypasses in the terraced and semi detached units. In this instance fully insulated and sealed timber frame acoustic walls, provide up to 8% reduction in carbon emissions from party walls alone, whilst providing high levels of acoustic performance.

The homes have triple glazing throughout, with factory fitted air sealing detail around their edges to prevent draughts. The windows also optimise their G and U-Value parameters, which reduces night time losses, whilst maximise solar gain during the day.

When adopting superior fabric performance, natural and passive ventilation and shading become extremely important to properly consider within the design. The homes have improved thermal comfort and mitigate overheating through fast response systems, such as purge and stack ventilation within stairwells and natural “green shading” in the form of planted trellis canopies over south facing glazed openings.

The design of the glazed openings maximise south facing heat gains in commonly used habitable areas in the morning and during the daytime, with smaller rectangular windows at upper levels, to reduce external heat gains and rising heat accumulation, effecting night time occupancy comfort, during the homes daily heating and cooling cycle.
Operational Energy Efficiency

The project seeks to inform users of their energy consumption and to assist change behaviours towards conserving energy. Within each home, energy consumption displays, such as ‘smart meters’ and EWEGO units would be fitted. These raise user awareness and encourage behavioural change, through switching off appliances or using appliances outwith peak demand times. In addition each home adopts simple smart energy saving controls. The heating system uses weather compensators, is zoned for more effective control, thus avoiding the need for complex TRV controls, often left on unwittingly.

The designs propose that each home would have a whole house heat recovery system. This is established technology commonly used in developed European countries. It captures incidental and solar heat gains, retained through the use of superior fabric insulation. The system extracts the heat and recycles it back into the home, whilst also providing fresh clean air back into the home.

Building services also play a key part in the proposals. The use of flue gas heat recovery, which maximise boiler efficiency through ‘turbo’ charged technology, to reuse the exhaust combustion heat and recycle this back into the boiler. This is easily integrated with high efficiency ‘best in breed’ Gas Boilers, which are easy to run and maintain, reliable, and act as ‘back up’ to the solar thermal, when required.

Super insulated storage vessels and pipework would also help to reduce heat losses through poor storage and distribution systems, often seen in many poorly designed homes.

Renewable Energy

Stewart Milne have undertaken a lot of research on renewable technologies, through their Sigma Home. This provided valuable hard data and learning which has been put to good use in the design of this project. Solar Thermal technology is one of the more mature renewable technologies, which produces hot water during the day and stores this to match usage patterns. This is generally beneficial, although cannot be fully relied upon throughout the calendar year. Hence the need for a back up in the form improved gas boiler systems. This means each home is never without hot water or space heating when demand requires it.

To maximise the performance of the solar hot water heating the roof pitches on the houses are engineered to optimise plot design with 35 degree south facing slopes and gardens. This allows simple and unobtrusive positioning which maximises positioning of sunlight and blends well with the simple roof designs and building shapes.

Summary

Our strategy avoids the use of photovoltaic, heat pumps and communal heating and power systems, in favour of a reliable, long lasting, plot specific and generally passive solution. We are seeking to push the boundaries of fabric design and adopt reliable building services and renewable technologies, which are simple to install, easy to maintain and proven over their lifetime. This keeps things simple and cost effective, for the home user and developer, over the whole life of the home.

The housing footprints, form and roof shapes are simple and in keeping with a traditional Scottish vernacular. They are extremely well suited to super energy efficient envelopes and simple integrated technology solutions, without the need for complex ‘bolt-on’ devices, to offset less efficient building design or user behaviours.

The project has reduced and simplified the amount of renewable technology required to offset the balance of CO₂ emissions needed to achieve the 60% carbon reduction target. The project only uses ‘solar thermal’ technology which can be reliably integrated into the home and building form and avoids the need for a complex, multi-system approaches, which from Stewart Milne’s Sigma experience and research, has proven to be ineffective.

The predicted fuel costs for the various homes range from £250-£330 per annum, assuming good occupant usage. A conventional three bedroom new build home to 2007 regulations is approximately £1200 per annum and a comparable second hand home is approximately £2100. This makes financial and environmental sense and will make the homes highly attractive in the current market.
THE FLOWER HOUSE
AT SCOTLAND’S HOUSING EXPO 2010

a+j burridge

Introduction

Based on the Finish model Scotland’s Housing Expo is a showcase of innovative sustainable housing design. Located on the outskirts of Inverness, 54 new homes have been built creating an exemplar community for future house design and development in Scotland.

Architects for the project were selected through an RIAS competition in 2007. The winning proposal which a+j burridge developed was for a detached house on a prominent site facing the village green. The design was vibrant and innovative with a distinctive identity and was a clear and simple response to a challenging brief.
Competition Brief

As a first of its kind in Scotland, the Highland Housing Fair (later rebranded Scotland’s Housing Expo) aspired to be a catalyst for change in housing design within the Highlands and throughout Scotland. The competition sought house designs which were:

• innovative, creative architectural solutions with a quality of design that would raise the bar for housing design and heighten public expectations
• sustainable: ecohomes was to be used as a benchmark, and the use of emerging technologies, sustainable materials and innovative construction methods was encouraged
• capable of being integrated with other quality designs into an exemplar community.

Following the European model, the Fair was planned to run as a month long event open to the public in August 2009 (which ultimately became 2010), after which the houses would be sold or rented at market value.

The proposed location was an elevated green field site on the outskirts of Inverness in the Milton of Leys area - a well established suburban district southeast of the city centre with views to the North over the Beauly Firth and Black Isle.
Ground floor plan

First floor plan
Masterplan design requirements

The brief for the competition was the Urban Design Framework (UDF) document which included plot codes and sustainability design criteria. The UDF stated the key objectives of the Fair Architecture were to achieve the following:

- Showcase creative design solutions to encourage an improvement in design standards in public and private sector housing
- Create a sustainable living environment with a focus on the use of local materials and low energy houses
- Encourage technological and construction innovation
- Encourage a step change within sectors of the building industry including component suppliers and self builders
- Capture public imagination and raise expectations in house design
- Promote a distinctive local vernacular
- Promote the creativity and quality of lifestyle in the Highlands to residents and visitors
- Exploit regional development opportunities including trade links and local manufacturing potential
- Encourage innovation in interior and product design
- Enable future Fairs to act as a catalyst in assisting in the regeneration of smaller communities.

At the competition stage the master plan was in draft form and subject to community consultation. Its design was conceived as a response to the local landscape and topography. It prioritised a sense of place, community, resource efficiency and local materials. Plot 25 was located on the principle street, ‘the avenue’, and overlooked the village green. As a corner site, it also faced onto a side street and the southeast court at its rear. Dedicated parking for the house was accessed from the southeast court with visitor spaces on ‘the avenue’. Recycling and refuse points were located in the shared semi-public southeast court.

Plot design codes set out in the UDF indicated general requirements on building form – a set depth of plan (6m), roof height, elevation height and frontage line dictated shallow buildings and long elevations. Plot 25 required the provision for a separate home work unit in the garden.

The relevant ‘zone energy efficiency theme’ for plot 25 was ‘recycling and adaptability’ – architects were required to take account of this in the proposed means of construction and material choice.

The relevant ‘material and colour theme’ for external materials was ‘lightweight and rural’; the minority wall cladding was masonry (including render) and the majority wall cladding was lightweight with an emphasis on the use of timber cladding. The general emphasis on colour was ‘within the landscape – greens, heather, bracken etc.’
Sustainability

The environmental brief (of 2007) included the following summary and requirements:

- The UK target for CO₂ emission reductions from domestic properties is a reduction of 20% of 1990 levels by 2010
- The Scottish Renewable targets are 18% by 2010 and 40% by 2020
- The Stern Report recommends a reduction of 60% by 2050

The technical component of the competition submission required:
1. a statement of sustainable design (SSD) and
2. a BRE ecohomes statement.

A community heating system throughout the site (no need therefore for gas supply) was to be provided but was omitted later.

The SSD needed to cover the following topics:
1. demonstrating zone based theme
2. contribution to highland economy and communities
3. making best use of site
4. enhance biodiversity
5. low carbon design
6. design to conserve water
7. design in sustainable waste and sewage treatment
8. use of sustainable materials
9. minimise waste in construction and lifetime.

Also the SSD needed to:
1. clarify steps that have been taken to design for sustainability during construction and in long term occupation, maintenance and adaption,
2. encourage innovative or imaginative strategies for limiting energy consumption or wastage.

A BRE Ecohomes excellent rating had to be achieved (this requirement was later dropped).

The following U values were to be complied with (generally a value 20% better than shown by the technical handbooks clause 6.1.2):

<table>
<thead>
<tr>
<th>Element</th>
<th>U Value W/m2K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls</td>
<td>less than 0.20</td>
</tr>
<tr>
<td>Floors</td>
<td>less than 0.18</td>
</tr>
<tr>
<td>Roofs</td>
<td>less than 0.13</td>
</tr>
<tr>
<td>Openings</td>
<td>less than 1.5</td>
</tr>
</tbody>
</table>

SAP 2006 Dwelling Emissions Rate (DER) 30kg CO2/yr.m² or 50% improvement over Target Emissions Rate (TER), whichever was the lower.

Air–tightness

As the U values of a building improve, air infiltration rate becomes the key component of heat loss. To address this issue the following air permeability was to be achieved: 2m³/hr.m²@50pa pressure.
Detail of the cladding design model
Competition Design

Plot 25 was a 3 bedroom detached house with separate granny flat / home work unit at the bottom of the garden. The two storey building was organised with living accommodation at first floor level which, in addition to the environmental benefits, offered panoramic views to the north over Inverness and the Moray Firth and provided a large, flexible living space consistent with the needs of contemporary living. Bedrooms and bathrooms were located on the ground floor.

The house was entered through a two storey conservatory space located at the southwest end. As well as an attractive entrance this space provided a draught lobby and a sun space both for enjoying the sun and taking advantage of solar energy on less clement days.

A canopy covered the bike store and parking spaces and provided a raised deck (sheltered from the prevailing wind, enjoying the morning and evening sun) and a covered drying area. Additional secondary entrances to the house were provided at ground floor level directly adjacent to the car parking and at the upper level from the deck direct to the kitchen area.

The latter provided a connection between living spaces and garden. (Ultimately, the home work unit, upper deck, external stair and secondary entrances were omitted as cost savings).
The highly insulated building used a ground source heat pump to supply the modest heat requirements via domestic radiators. Solar panels on the southeast facing roof provided the energy for hot water requirements. Triple-glazed windows and prefabricated timber construction provided good air tightness. Energy efficient light fittings and whole house ventilation system with heat recovery minimise energy loses.

The dwelling was constructed in proprietary solid timber panel system clad in untreated larch boarding and timber shingles to the roof became timber boarding at the detail stage for technical reasons. Flooring and stair treads are made from recycled timber. Reclaimed masonry was to be used for the hardcore, as aggregate for the footings and in the gabions forming the boundary wall with cellulose insulation made from recycled newspaper or locally sourced lambswool insulation.

The design of the Flower House tackled the issues of sustainability head on but remained delightful and user friendly. The key components of the environmental design were as follows:

**Passive environmental design strategy**

1. First floor living spaces optimise available natural light.
   - More light comes in from roof lights than from windows of the same area, creating a bright pleasant space which saves energy by reducing the number of hours that artificial light is required.
   - First floor living spaces enjoy longer days of natural light, seeing the sun earlier in the morning and it is later in the evening before it is overshadowed.
2. Ground floor bedrooms more comfortable

For best sleep conditions rooms should be cool; the recommended temperature for bedrooms is 18°C whereas it is 21°C for living rooms. As heat rises the most fuel efficient arrangement is to have bedrooms below living spaces.

3. Plan optimises orientation

• Small windows to the north reduce heat losses and large windows to south optimise heat gains.
• The ground floor corridor located to the north acts as a thermal buffer to the bedroom on the south side of the building.
• Ground and first floor storage on the cold north elevation also helps to insulate the building.

Heat Loss

• Lobbied external doors prevent heat escaping every time doors are opened.
• Prefabricated construction means that joints are very accurate giving good air tightness, reducing heat loss through drafts and air leaks.
• Triple glazing
• Highly insulated
• Flexible space – sliding doors close down living space and reduce heat loss in winter and open up in summer, extending living area into sun space.
Active systems

Whole house ventilation system controls the air quality and reclaims energy from the exhaust air.

Solar thermal panels on southeast facing roof provide the energy to heat all the hot water for the kitchen and three shower rooms, topped up by the boiler in the colder months.

Ground source heat pump supplies the modest heat requirements via domestic radiators. An alternative strategy was developed with Buro Happold at the detail design stage.

Sustainable materials

Timber - structure, insulation, cladding

• Timber is a regenerating resource.
• Timber has low embodied energy, confined mainly to transporting it to site.
• Carbon sequestration as trees take carbon from the atmosphere and lock it in, unlike most materials which cause carbon to be released when they are produced.
Prefabrication

- Accurate factory fabrication reduces gaps in construction, leading to better quality of build, fewer gaps and better air tightness.
- Reduces site time.
- Reduces site wastage.
- Reduces cost and embodied energy of transporting excess materials to site.

Water conservation

The house has 3 showers and no baths, consuming less heat and conserving water.

The house is designed with a rainwater harvesting which helps to conserve water and consequently reduce the amount of chemicals used to purify tap water. The system is not presently installed.

Detail Design

Materials

The criteria influencing the choice of materials are wide. The Green Guide to Housing Specification (BRE) identifies these in order of importance:

- Climate change
- Fossil fuel depletion
- Ozone depletion
- Freight transport
- Human toxicity
- Waste disposal
- Water extraction
- Acid deposition
- Ecotoxicity
- Eutrophication
- Summer smog
- Minerals extraction.
Timber performs well against green criteria having a neutral effect against most measures (ozone depletion, toxicity, acid deposition, eutrophication, summer smog and mineral extraction). The BRE rank climate change as the most important environmental issue, giving it a weighting of 36%, more than three times that which it gives to the issue it rates second, fossil depletion. Uniquely, timber has a positive affect in relation to climate change – it acts as a carbon sink storing the equivalent of 0.9 tonnes of CO₂ in every cubic metre in contrast to the average building product which adds 1.1 tonnes of CO₂ to the atmosphere. Consequently, it was an early decision to use timber extensively, the final building benefiting from timber cladding, wood fibre insulation and solid engineered timber panel external walls, roof an first floor.

Prefabrication

30% of energy in the UK is consumed in the home. With improved building insulation levels, heat loss through ventilation has become the significant challenge. Prefabrication offered considerably higher degree of precision than site construction, resulting in higher quality building and a consequential improvement in air-tightness. The fabrication of panels close to the source materials reduces the embedded energy of the product by omitting the transportation of surplus materials to site and the subsequent removal and disposal of the waste. Further, there is more intensive use of the source timber at the factory – there is never the issue of surplus and off-cuts, and timber particles can be used in other engineered products, further reducing the embedded energy.
Cross-laminated timber

Cross-laminated timber (CLT) panels are formed in a similar way to ‘glulam’ by stacking a number of lamellas at right angles to one another and subsequently glued to each other to create panels of up to 18m in length. The finished product is substantially timber - 99.4% timber 0.6% glue – but with a significantly improved structural characteristics.

Currently, CLT panels are not fabricated in Scotland - the panels used in the Flower House were transported from Austria. As a consequence roughly 2.5 tonnes CO₂ were emitted in transport. However, since the house comprises of 43 m³ of CLT this represents net stored CO₂ of more than 40 tonnes, and by comparison with similar volume of alternative building materials a saving of 83.5 tonnes CO₂.

Although Scotland grows an abundance of timber, only a small percentage is high-grade timber used in construction. By forming it into engineered CLT panels, the performance and value of the timber is increased and we were interested in exploring a technology that is particularly appropriate to be produced in Scotland.

As with other prefabricated systems, using CLT panels substantially reduces the site time. Within 36 hours of the panels arriving on site, the shell of the building - external walls, roof and first floor - was erected, as can be seen at www.youtube.com/watch?v=tNLV4MMfpdo.

The speed at which a weather-tight enclosure can be produced using such a system is of particular benefit in the local context where a significant amount of time is lost on site due to inclement weather. The CLT panels were also fair-faced to the interiors, removing the need to apply a board finish and saving additional time.

Insulation

180 mm Pavatherm wood fibre insulation to the outside of the CLT walls gives a U value of 0.18 W/m² and 300 mm thick to the roof achieves 0.13 W/m². The outer layer of insulation is PavathermPlus, which is impregnated with latex and a tongued and grooved edge detail, forming a breathable waterproofing layer.

Timber Cladding

The house was designed to be clad with horizontal timber boarding on both the walls and roof. An extensive selection process was carried out with close consultation from Edinburgh Napier University Centre for Timber Engineering and timber suppliers to specify the timber which satisfied the various and conflicting demands of durability, sustainability and price.
At the competition stage sweet chestnut was specified as it was domestically grown and durable without the need for biocide preservatives. However, this was eliminated by the client on cost grounds. The timber used as roof cladding is subject to a much higher moisture load than when used on a vertical wall. Fungal decay risk increases as a function of moisture load and so the timber needs to be relatively resistant to decay. In addition, the roof timber cladding is subject to extremes of wetting and drying, increasing the risk of splitting and warp. The selected timber species had to have a low susceptibility to both. As a consequence, British and European standards require that timber used as roof cladding needs to be at least durability class 2 or be preservative treated to a use class 4 specification. The timber also had to have a low movement class and be of a species that is not prone to splitting. In addition to this, we wanted a domestically grown timber from a sustainable source. These imperatives dictated and significantly restricted our subsequent choices of timber cladding.

Although we were not keen to use a treated timber, since the option of using either sweet chestnut or oak were prevented on cost grounds, our only domestic option was preservative treated Scots pine sapwood. However, this too was ultimately ruled out as the timber readily available had a greater number of knots and holes than was suitable for cladding.

An additional problem was that to achieve the required fire resistance the roof timbers were to be treated with a fire retardant, and this conflicted with the biocide treatment.

The eventual decision was to use different timber boards for the roof and walls - an untreated domestic timber, Scots larch, for the walls and a durable modified timber, Platowood, for the roof. Although Platowood did not require preservative treating and would readily accept the fire retardant, it had not been tested to show compliance with the relevant standards and as a consequence, a fire engineering report had to be prepared before it was approved by Building Standards.

The Scots larch cladding has open joints permitting some moisture to pass through the timber rainscreen, but also air to circulate freely and allow the construction to dry more readily.

The timber boarding was designed to be turned at 72° to form the large daisy motifs on both the walls and roof – the boards being cut to maintain the chamfered top and bottom edges of the rainscreen profile. Although there was initial resistance to this proposal, once we had produced full details and models of the design it was approved using a half-width board with staggered joints to express the motif. Unfortunately, on site, for reasons of expediency, the flowers were routed into the surface of the boards leaving them with horizontal surfaces and potential water traps.
Design Development

Buro Happold Services engineers carried out various computer based simulations to help understand and tune the building performance. This analysis included the following:

- Glazed area optimisation
- Fabric performance study
- Use of thermal mass
- Daylight studies
- Optimisation of the solar shading
- Thermal comfort studies.

One of the key design decisions at the competition stage was to take full advantage of natural light and solar energy. As in urbanized societies most people spend more than 90% of their time indoors, a good provision of daylight is now considered to be highly desirable in terms of building occupants’ well-being and productivity\(^1\) and poor levels are linked to SAD (Seasonal Affective Disorder) and sick building syndrome (SBS).

In addition, sunlight is a free natural energy source providing both light and heat. This affected our decisions to include the sunspace and locate the living spaces on the first floor, enabling the utilisation of roof lights which have been shown to give around 33% additional useful daylight illuminance (UDI)\(^2\).

Although this decision would prevent the building achieving Passivhaus levels of thermal efficiency, we felt that a reduction in light would be to the detriment of the building users and their experience of living there.

The Buro Happold study helped achieve an optimal balance between good levels of daylight and reduction in the need for artificial light, solar gain without overheating and limiting heat loss, resulting in a net benefit of useful energy to the building.
Overview of Shading Analysis

Three different shading system configurations have been analysed:

Scenario 1: No Shading
Scenario 2: d=150mm; h=150mm; h/d=1
Scenario 3: d=150mm; h=350mm; h/d=2.3
Scenario 4: d=150mm; h=400mm; h/d=2.7

The key aim of the study is to provide summertime shade whilst maximising the potential for passive solar heating during the winter i.e. minimising the increase in heating demand.

N.B. Assuming the ratio of fin-spacing-to-fin-depth (i.e. h/d) remains similar then different configurations of fin depth and spacing will produce similar performance.

Fuel

The house is designed to have a wood-burning boiler sited on the ground floor with adjacent thermal store and fuel storage. This is linked to underfloor heating on both floors, which is both more comfortable and efficient than radiators, effectively providing heat at low level where it is required rather than at high level. Burning wood from managed sources does not add to carbon in the atmosphere, it does not deplete limited natural resources and reduces our reliance on imported energy. The house currently has a gas boiler.

1 “Working in day lit environments results in higher productivity” Vischer 1989
2 “Learning in day lit environments results in more effective learning” Heschong et al. 1999
3 “A good provision of daylight is now considered to be highly desirable in terms of building occupants' well-being and productivity”
4 “...research shows people feel happier, more energetic and have lower sickness rates in the longer, brighter days of summer, whereas moods and health decline during duller days of winter.” Mayer Hillman, Senior Fellow Emeritus, Policy Studies Institute, University of Westminster, London BMJ 2010; 341:c5964 doi: 10.1136/bmj.c5964 (Published 27 October 2010)


Climate-Based Daylight Analysis for Residential Buildings Impact of various window configurations, external obstructions, orientations and location on useful daylight illuminance, Dr. John Mardaljevic, Institute of Energy and Sustainable Development, De Montfort University
THE SKEWED HOUSE

Oliver Chapman, Oliver Chapman Architects

This article outlines the ideas informing a new rural housing cluster which was, however, only partially realized. It will describe how the characteristics of the plot, in relation to the whole site, led to a new model for a rural (rather than a suburban) house type and how the ambition of the initial brief evolved during the design stages. It concerns the design process as well as the final design.

The original competition entry was for six courtyard houses arranged as a ‘rural cluster’ around a parking court.
The project came about through an open architectural competition organized by the RIAS but rather than accepting the plot boundaries as set out in the masterplan, we took the view that the Expo might be better served by a proposal for a larger cluster of houses which might be a more sustainable model for small remote settlement in the highlands. Our competition entry, therefore, stretched over three neighbouring plot boundaries, promoting our idea of a larger neighbourhood comprising six interconnecting courtyard houses. The intention was not to appropriate a larger commission, instead, we sought to address a concern that the Housing Expo’s legacy should embrace more than a litany of individual house types.

One cannot use the word ‘suburban’ without triggering a slight prejudice amongst architects, but this idea for a rural housing cluster was not a reaction to the maligned reputation of the suburban house. We wanted to interrogate its constituent parts and address potential failings. For example, the suburban house is predisposed to have its car parked in front of it, whereas our rural clusters could remove cars away from the front and conceal them via an access track into a courtyard in the centre of the cluster.

The cost efficiency of building a shared parking court could be balanced with the expense of an extended access track.

Another benefit of clustering houses together is that they can then start to form interesting, protected spaces between buildings. There could be a variety of courtyard types along with private gardens which could look outwards toward the landscape, and entrance courtyards with a glimpse into the house in one direction and a view into the central landscaped parking courtyard in the other.

Placing all the rooms on the ground level meant that as well as making the houses very accessible, their volume could be more easily stretched and modelled around courtyard spaces. Two storey houses have smaller footprints and suit straighter terraces rather than the interconnecting linear forms we wanted to explore.

Our design looked back to the work of Peter Aldington’s houses at Turn End and Jørn Utzon’s Kingo Houses in Helsingør, Denmark.
Switching Site

Although we were winners in the competition, our initial scheme relied on us being able to extend across adjacent Expo plots. The assessors, however, restricted our commission to a single plot (Plot 23) with room for only two smaller versions of the six proposed large houses. The new site on the masterplan indicated two houses set back from the street within a deeper and wider plot than its neighbours. The proportions of the plot meant that in order to accommodate two houses, they would have to be unlocked from the line of the street and instead be loosely tethered forms located in the centre of the site. We kept the idea that the houses could interlock and concluded that two houses would work standing alone as a fragment of a larger cluster. That larger vision saw four or six houses arranged in a pinwheel around a car courtyard with the same idea of entrance courtyards and private gardens. Two principal changes were made to the design of the houses; one concerned the houses’ form and the other was a change to their materiality.

The rotational composition of the buildings on the site inspired us to make an expressive alteration to the form of each house. We manipulated the original duo pitched design by skewing the ridges slightly so that they were no longer parallel with the eaves. This had the consequence of disrupting the balanced nature of the interior spaces and generated some unexpected shifts in geometry. The short cross-sections reveal this variety. Being an expressive gesture, we felt that the rationale should be tested by making a number of balsa models, so that we could make a collective judgment on the most suitable option.

This change to the form of the houses required a counterpart change to the materials as we did not want the houses to be viewed as an assembly of planar walls supporting pitched roofs. We now felt that the walls and roofs had to be covered with the same material so that the walls and roofs visually merged together. Timber shingles suited that purpose best and by adopting a timber frame and recycled insulation, we realized that, with the exception of the plasterboard, we could build using entirely timber-based building products.
Switching Client

Our initial proposals were for large private houses, but the competition assessors assigned us to a Housing Association client instead. We were then asked to re-design them as affordable homes requiring us to reduce floor areas and budgets to prescribed benchmarks. This was achieved with remarkably little input from our client, an Inverness based RSL. Our appointment was later switched to a different RSL and eventually novated to the contractor (as a Design + Build contract). None of these switches were anticipated at the start and required us to be nimble, negotiating the design and our appointment all the way through the process. From our office’s experience with other affordable housing projects, we had come to expect a routine of regular client progress meetings where the client would wrestle with our proposals and a thoroughly scrutinized product would emerge after a great deal of sweat. For us, the dialogue is a vital part of making the architecture relevant to its purpose and it was regrettable that it was missing in this process.

Switching Targets

We also regretted the fact that the Highland Housing Fair (which was later rebranded as Scotland’s Housing Expo) quickly dropped its ambition to measure all the houses by one sustainable assessment methodology. This appeared to be linked to the failure to get adequate commitment to the idea for a bio mass fuelled district heating system. If they had adopted say the Code for Sustainable Homes (CSH) then every house could be compared with each other and proposals measured against a variety of targets. However, there appeared to be inadequate resources to fund CSH assessors for all houses and so the opportunity was lost.
Construction and Technology

The focus for us on Plot 23 was to provide an insulated and breathable building envelope to considerably more stringent U-value targets than the Building Standards. Working closely with John Rennie of Natural Building Technologies, we adopted their approach to wall and roof construction using the NBT Pavatex products. Rather than importing a technology such as cross laminated timber, we thought it would have greater benefit to the struggling Scottish house builders if we demonstrated how a well understood method like timber frame could be adapted to be more breathable without the need for vapour control layers, and use entirely wood and waste wood products.

There is no plastic vapour barrier or breather membrane and the insulation is all waste wood products. The principal difference to conventional timber frame construction is that the structural sheathing, in this case oriented strand board (OSB), usually fitted to the outside of the timber frame in this case is fitted to the inside of the studs. Wood fibre insulation board is then fitted on the outside of the timber frame and is impermeable enough not to need protecting with a membrane whilst exposed to the elements as the rainscreen cladding and roof coverings are fitted. A 38mm deep service zone with batens and plasterboard on the inside of the external walls allows electrical and plumbing services to be routed without the need to penetrate the instated timber frame panels.

The walls and roof construction are A+ rated according to the Building Research Establishment’s Green Guide to Specification. High energy efficiency benchmarks were set by us at the outset to ensure these elements achieve considerably improved heat loss values compared to the Building Standards at the time of the warrant application, namely: roof + 42%, walls + 25%, and windows + 22%.

The heating is a water-based under floor system and is supplied, along with hot water, from a NIBE air source heat pump with electric back up. We were advised by the Energy Saving Trust and we selected a model with a remarkably low sound level and located the external heat exchanger unit just beyond the external wall of the house. Ground source heat pumps would have given greater carbon savings but were not affordable on this occasion, but the air source heat pump gives the houses a 24% improvement on the carbon emission rate for the same house heated by a traditional gas combi-boiler.

Switching Cladding

We developed specifications and viewed samples of both Larch and Scots Pine shingles with a major timber sawmill in the Cairgorms with the intention that this would be an opportunity to launch locally grown shingles as a new timber cladding product. Sadly, this was another missed opportunity partially due to concerns over longevity but primarily due to the switch to a Design + Build contractor wrestling with a reduced budget.

Certainly Larch has a demonstrable durability as an external timber lining, but the contractor was skeptical about its use in shingle form. Western Red Cedar however, has a track record as a shingle and so the initiative to launch a locally sourced sustainable product was lost.

In Conclusion

Perhaps it was inevitable that Scotland’s first housing expo would be compromised (though lack of central funding) and protracted (the opening was delayed by one year) but it did generate great excitement in the Inverness area and over 30,000 visitors paid to see the 52 houses. We were delighted to be invited to contribute to the Expo and consider ‘The Skewed House’ to be a successful and sustainable model of how to build for the future in rural Scotland.
SCOTLAND’S HOUSING EXPO 2010

Client: Highland Housing Alliance
Architects: Mark Cousins (Associate Director), Fraser Bell (Project Architect),
Engineers: Robertson and Eadie
QS & CDMC: WSD
Contractor: Tulloch Homes Express
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