INNOVATION REVIEW

ISSUE 1, December 2009

SUSTAINABLE BUILDING DESIGN AND REFURBISHMENT IN SCOTLAND

EXPERTISE AND TESTING FACILITIES AT SCOTTISH UNIVERSITIES
SUPPORT FOR SUSTAINABLE BUILDING DESIGN AND REFURBISHMENT
SHARING KNOWLEDGE AND BEST PRACTICE
Front Page: Concrete formed in textile at the University of Edinburgh - more on pages 18-19

Environmental Testing Chamber at Glasgow Caledonian University – more on pages 11-13

Acoustic laboratory at Heriot Watt University – more on pages 22-23

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SUSTAINABLE NEW BUILDING: Carrochan by Page\Park Architects – more on pages 56-62

INSIGHT: Earthship Biotecture – more on pages 63-69
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.

**PROJECT PARTNERS**

**FUNDED BY**

**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](www.cicstart.org) to access the registration page at the project website

Please click [here](www.cicstart.org) to access the registration page at the project website
Welcome to the first issue of Innovation Review, a quarterly online publication that will consist of articles on sustainable building design and refurbishment in Scotland such as:

- A feature article on the context and need for innovation
- Articles and interviews regarding expertise available and research undertaken/planned at Scottish universities
- Case studies on testing of innovations at Scottish universities
- Articles on academic/industry collaboration in research, development and testing of innovations
- Articles on feasibility studies undertaken and academic consultancy provided to Scottish small to medium sized businesses through CIC Start Online
- Information on support, incentives and funding
- Articles by practitioners involved in sustainable building design, construction and refurbishment
- Information on products and processes developed in Scotland for sustainable built environment

The first issue provides information on academic expertise and testing facilities at the participating institutions. As CIC Start Online will collaborate with organisations that provide support and/or coordinate funding and incentives for sustainable building design and refurbishment, Innovation Review includes articles on remit and services of some of them.

Innovation in practice is presented in the article on Gilmour’s close refurbishment project by Assist Architects and a new headquarters of Loch Lomond National Park in Balloch by Page\Park Architects. An insight into contemporary off-grid living is given in an article on Earthships in the USA, written by a recent graduate of the Mackintosh School of Architecture who has helped build one. In each issue, we will publish one academic paper on research undertaken on sustainable building design and refurbishment. The first one provides information on the international and national context for creating a sustainable built environment.

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. Along with the text and images, you can also send short videos.

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.

To receive the quarterly CIC Start Online Innovation Review and monthly E-News, please register by accessing the following link Registration.

Kind regards,

Branka
COMPETITION FOR FEASIBILITY STUDIES

Access to information and the application form at the CIC Start Online website.

CALL FOR APPLICATIONS

CIC Start Online is running a competition for joint ACADEMIC/INDUSTRY FEASIBILITY STUDIES. The first round of applications should be submitted by 15th January 2010. The applications can also be submitted every three months following the first submission date until 15th January 2012.

WHAT ARE THE AWARDS?

The awards are aimed at building relationships between small to medium sized enterprises (SMEs) and higher education institutions (HEIs) and at stimulating collaborative work that will lead to new products and processes for more sustainable building design and refurbishment.

The awards are aimed specifically at funding feasibility studies that will allow the participants (of whom there must be 2 or more, at least one SME and one HEI) to assess both the potential and feasibility of a new product or process. The feasibility studies must focus on opportunities that can either attract follow-on funding from existing sources, demonstrate a clear route to market or indicate a step change in current processes within a company.

The output of the feasibility studies should, preferably, reflect the interdisciplinary nature of the work, the value to be obtained from any partnerships on an ongoing basis and the potential to develop a product or process that can give benefit to the participants and to the Scottish economy.

Applications are requested from any Scottish SME requiring technology transfer from the HEIs.

HOW MUCH IS THE AWARD?

The grants, which are of a value up to £5000, are to be awarded to the HEI(s) to evaluate the feasibility of an interdisciplinary approach to a market led problem. This should be of relevance to a Scottish SME who should be a contributing partner to the study. No restrictions apply to the number of awards that an SME can apply for. There is flexibility in the way in which the funding may be committed. All expenditure, however, must be clearly accounted for in a final report.

HOW MANY AWARDS ARE AVAILABLE?

There are 19 awards available for allocation until January 2012.

RULES AND CONDITIONS APPLICABLE FOR BOTH COMPETITIONS

HOW ARE THE APPLICATIONS ASSESSED?

Applications will be assessed by an independent committee assembled especially for the task, all of whom will have signed appropriate confidentiality statements. Applications should indicate relevance of the proposed innovative product or process to sustainable building design, construction or refurbishment by addressing one or more of the following:

- environmental issues (e.g. reducing CO2 emissions, improving energy conservation and efficiency, using renewable energy sources and building materials, reducing waste, saving water, recycling energy and materials etc.)
- social issues (e.g. reducing fuel poverty, improving indoor health and accessibility, improving the quality of the built environment, improving work conditions, health and safety etc.)

Proposals will be assessed according to the following criteria:

- A strong opportunity to show the feasibility to research and develop a novel market led product or process
- Opportunity to attract follow-on funding from other sources to research and develop market led products or processes
- HEI track record
- Quality of the work proposed
- Relevance and benefit to SMEs
- Relevance and benefit to the HEIs
- New partnerships that have not jointly received funding from any source
- Relevance to sustainable economic growth
10-DAYS FREE ACADEMIC CONSULTANCY

Access to information and the application form at the CIC Start Online website

CALL FOR APPLICATIONS

CIC Start Online is running a competition for 10-DAYS FREE ACADEMIC CONSULTANCY. The first round of applications should be submitted by 15th January 2010. The applications can also be submitted every three months following the first submission date until 15th January 2012.

WHAT ARE THE AWARDS?

The awards are aimed specifically at funding 10-days of academic consultancy that will assist SMEs to develop, test or improve products and processes for more sustainable building design and refurbishment. The application for academic consultancy must demonstrate a clear route to market or indicate a step change in current processes within a company.

The output of the academic consultancy should be a report that demonstrates the value to be obtained from the advice given through the consultancy and the potential to develop a product or process that can give benefit to the SME and to the Scottish economy. Applications are requested from any Scottish SME requiring technology transfer from the HEIs.

HOW MUCH IS THE AWARD?

The grants, which are of a value up to £3000, represent 75% of the total value of the work undertaken. The in-kind contribution from the companies receiving consultancy should amount to 25% of the total value of the work undertaken. There are no restrictions on the number of times an SME may apply for an award, However, SMEs may only receive one award per year.

HOW MANY AWARDS ARE AVAILABLE?

There are 19 awards available for allocation until January 2012.

DE MINIMIS RULES

Under EC regulation 69/2001 ("the de minimis aid regulation"), this is a de minimis aid to an SME. There is a ceiling of 100,000 euro for all de minimis aid provided to any one firm over a 3-year period. Any de minimis aid awarded to you under this grant will be relevant if you wish to apply, or have applied, for any other de minimis aid.

PROMOTION OF ACADEMIC/INDUSTRY COLLABORATION

After a consultancy has been completed, the SME and HEI will contribute to a seminar/webinar and a webcast that will showcase different aspects of their collaboration, while taking care of non-disclosure of any IPRs developed through the feasibility study. Where appropriate, academics will write guidelines for application of the product or process in practice. The guidelines will be published on the CIC Start Online website.

For general advice and help send an email to Branka@cicstart.org

FINAL REPORT

The Final Report submitted with the Grant Invoice shall be in two parts. The First Part must detail the work done during the study and outline the outcome of the feasibility study. A summary of the First Part of the Final Report will be available for publication on the CIC Start Online website and by the Scottish Government. The Second Part of the Final Report is NOT for publication. It must include detailed accounting of all expenditure by the HEI and the SME and full details of the SME contribution. If the Final Report includes any confidential material then this should be included in Part 2 which will be available to the Partners and to the CIC Start Online (under appropriate confidentiality agreements if required).

CONFIDENTIALITY AND INTELLECTUAL PROPERTY

The Universities and SMEs applying for the award must consider both confidentiality and intellectual property prior to submitting their application. The university’s Research and Innovation Office will be required to approve any application of grant. It is strongly recommended that the applicants make early contact with the university’s RIS or equivalent office. The CIC Start Online will, if required, enter into a Non Disclosure Agreement with the applicants. Given the value of the award it is considered unlikely that significant levels of IP will be generated during the study. However the applicants should evaluate the potential for generating intellectual property and consider entering into an appropriate agreement, if necessary.

It will be a condition of award that the SME is able to exploit any foreground Intellectual Property within their business sector.
SUSTAINABLE REFURBISHMENT

EXHIBITION – CONFERENCE – NETWORKING

for eliminating or reducing negative impacts of existing buildings on the environment, society and economy
by providing building refurbishment products and/or services

Whole-day online event
Friday, 4th June 2010, 9.30 – 17.00

This whole-day online event will consist of three parallel sessions that will enable marketing, disseminating research and best practice, and networking. The access to the event is **FREE** following the registration to attend the event. To receive a set of **FREE** headphones that will enable you to listen to the conference webinars, please register at [www.cicstart.org](http://www.cicstart.org) to become a member. The membership is **FREE** and entitles the members to provide brief information on services and products for sustainable building design and refurbishment offered by their business.

EXHIBITION

The online exhibition of products and services for sustainable building design, construction and refurbishment will offer virtual booths to businesses wishing to promote their capabilities. Each booth will contain a welcome desk with information on the business contacts who will be available on the day online and images, videos and brochures on the products and services offered by the company.

Expressions of interest are invited from the businesses interested to exhibit at the online exhibition. In collaboration with the exhibitors, we will be designing the booths and inserting marketing contents from beginning of January by mid-May 2010. We would encourage you to contact us early by sending an email to Branka@cicstart.org or on 0141 273 1408 to enable a successful preparation of your exhibition booth. Please see below information on the exhibition fees.

CONFERENCE

The conference will consist of seven webinars delivered by academics of the higher education institutions who are partners in CIC Start Online, i.e. Glasgow Caledonian University, Edinburgh Napier University, Glasgow School of Art, Heriot Watt University, the Robert Gordon University, University of Edinburgh and University of Strathclyde Glasgow. All webinars will focus on research and innovations for sustainable building design, construction and refurbishment. The conference programme will be advertised well in advance.

NETWORKING

All delegates registered to attend the whole-day event will be able to provide information on their expertise or/and interest in the event topic and to contact people attending the event. A virtual discussion room will be provided to ask questions and/or exchange views with the academics and delegates. The complete event programme will be advertised at the start of May 2010. Expressions of interest for hiring an exhibition booth are welcome now to Branka@cicstart.org or on 0141 273 1408.
EXHIBITION FEES

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<th>Company size</th>
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<td>❖ Welcome message</td>
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<td>❖ PDF brochures</td>
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<td>1-5 employees</td>
<td>£100</td>
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<td>Between 5-250 employees</td>
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<td>Over 250 employees</td>
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SPONSORSHIP

Sponsorships are invited for the following exhibition halls and rooms that will enable a sponsor to provide their name to an exhibition hall or a room of their choice listed below. The sponsors will be entitled to the following:

❖ A hall/room bearing the name of their company/organisation
❖ A central and highlighted position in the exhibition hall
❖ Welcome message
❖ Products/services info
❖ Key people
❖ Contact details
❖ Website address
❖ PDF brochures
❖ Video or a Power Point presentation with voice over

Sponsorship fees

HALLS (Environment, Society or Economy) – £1500 per hall name

ROOMS (please see the list below) - £1000 per room name

The exhibition booths and conference contents will remain available on the CIC Start Online website after the event as long as the exhibitors wish. The exhibitors will be able to access their booths and update the contents without charge. This online source will be accessible to interested parties following their registration with CIC Start Online.
ENVIRONMENT HALL

Exhibition rooms:
- Architectural design services for sustainable re-use, refurbishment and restoration of buildings
- Engineering services for sustainable re-use, refurbishment and restoration of buildings
- Procurement services for sustainable refurbishment of buildings
- Construction services for sustainable refurbishment of buildings
- Assessing environmental impact of existing buildings
- Modelling environmental services in existing buildings
- Manufacturing or/and supplying renewable building materials
- Recycling or/and supplying recycled building materials and components
- Manufacturing or/and supplying/installing wind powered technologies
- Manufacturing or/and supplying/installing solar powered technologies
- Manufacturing or/and supplying/installing hydrogen and fuel cells technologies
- Manufacturing or/and supplying/installing combined heat and power technologies
- Manufacturing or/and supplying/installing ground source heat pumps
- Manufacturing or/and supplying/installing biomass products and technology for heating
- Manufacturing or/and supplying/installing underfloor heating
- Manufacturing or/and supplying/installing district heating systems
- Manufacturing or/and supplying/installing smart metering and energy monitoring
- Manufacturing or/and supplying/installing mechanical ventilation
- Manufacturing or/and supplying/installing water saving and recycling technologies
- Manufacturing or/and supplying/installing heat recovery systems
- Restoration and conservation of building fabric and components
- Improving air-tightness and U-values of existing windows
- Sustainable waste management
- Manufacturing or/and supplying/installing green roofs
- Retrofitting thermal insulation
- Sustainable drainage

SOCIETY HALL

Exhibition rooms:
- Support, advice, services and/or technologies for reducing fuel poverty in existing buildings
- Support, advice, services and/or technologies for eliminating dumpness in buildings
- Advice, manufacturing and/or supplying non-toxic finishes
- Support, advice, services and/or technologies for improving accessibility of existing buildings
- Support, advice, services and/or technologies for security and safety of existing buildings and their environment
- Support, advice, services and/or technologies for health and safety of refurbishment works
- Support, advice, services and/or technologies for fire safety in existing buildings
- Support and education for developing skills for sustainable refurbishment and maintenance of buildings
- Support for raising awareness of building clients, owners and occupants on sustainable use of buildings
- Incentives and support for refurbishment of buildings

ECONOMY HALL

Exhibition rooms:
- Support, advice and consultancy on expanding refurbishment business for sustainable growth of construction industry
- Support, advice and consultancy on improving efficiency and quality of construction processes for refurbishment of buildings
- Support, advice and consultancy on improving management and productivity in building refurbishment businesses
- Support, advice and consultancy on employment opportunities in refurbishment of buildings
- Support, advice and consultancy whole-life cycle costing for refurbishment of buildings
- Financial services for innovations and start-ups for sustainable refurbishment of buildings
CIC Start Online was launched at Glasgow Caledonian University (GCU) on 23rd October 2009. **Dr Branka Dimitrijevic**, the project director, announced the call for applications for joint academic/industry feasibility studies and 10-days free academic consultancy that will be assessed by an independent panel. Submission deadline is 15th January 2010. Guidelines on how to apply and application forms are available at the CIC Start Online web pages [Feasibility Studies](#) and [Academic Consultancy](#).

**Dr Paul Baker** of the Centre for Research in Indoor Climate and Health at GCU provided information on expertise on sustainable building design and refurbishment at GCU and testing facilities such as the environmental chamber that is designed to test the performance of building materials & components under the range of climate conditions experienced in the UK.

**Archie Ferguson**, Chairman of Scottish Construction Forum, commented after the event: "CIC Start Online provides an excellent opportunity for sharing innovative ideas amongst our leading academics, researchers and industry leaders in tackling the various aspects and implications of climate change. The initiative has the potential, through collaboration, to place construction in Scotland at the leading edge of both development and delivery within this critical topic and its ongoing worldwide impact."

**John Sheridan**, Chair of Planet group of Scottish Construction Centre, said: “This collaborative project is an excellent way to bring greater cohesion and establish a first class data set of practical knowledge and expertise in this field. Our Planet group looks forward to working closely with Branka and her colleagues.”

**Graeme Ogilvy**, ConstructionSkills Director for Scotland, said: “ConstructionSkills is incredibly supportive of the CIC Start Online project and considers it to be a very positive development for sustainable building innovation in Scotland. Seeing such excellent education institutions coming together to work on such a worthwhile project is a step in the right direction and, over time, it will help ensure we have the construction skills necessary to help deliver to the needs of Scotland's green economy.”

**Billy Kirkwood**, Managing Director of Ayrshire based RobertRyan Timber and RDK Construction, said: "The importance of this type of collective academic and industry collaboration cannot and should not be underestimated. I do not believe my industry at ground level fully appreciates the seriousness of changes that will be required to achieve the Scottish Governments Zero Carbon Objectives."
EXPERTISE

School of the Built and Natural Environment

The School of the Built and Natural Environment is the largest school of its type in Scotland, and one of the leading schools for programmes in building and surveying in the UK. The school also carries out extensive research in partnership with industry, commerce and other academic institutions in the UK and overseas. Our research is rated by The UK Research Assessment Exercise (RAE 2008) as ‘world leading’ and ‘internationally excellent’.

Sustainability and sustainable development form the main themes of our five broad areas of research activities:

- Building Performance
- Construction Management and Information Technology
- Construction Procurement and Economics
- Environmental Technology and Management
- Waste Management

The School has two research centres whose main role is to carry out research and consultancy:

The Centre for Research on Indoor Climate and Health (RICH Centre)

The RICH Centre focuses attention on the factors that determine the indoor environment (primarily in buildings but also including transportation) and the consequent affect on the health of the occupants.

Centre staff has expertise in the following areas:

- The indoor environment of buildings and its affect on human health – heat, air and moisture transfer through building structures
- Energy efficiency
- Climate impacts on buildings and the effects of climate change, especially driving rain and flooding
- Performance of heritage buildings
- Sustainable construction
- Testing and/or monitoring and analysis of the thermal and moisture performance of buildings, both in situ and under laboratory conditions
- Monitoring of allergens in buildings and identification of fungi, bacteria and mites
- Prevention of biodeterioration of buildings and building materials - distribution and significance of building pests.

Caledonian Environment Centre (CEC)

CEC has a wide range of skills and expertise in relation to the environmental and sustainability agendas and community engagement.

CEC is recognised as a leading research and consultancy organisation in its sector, employing around 25 professional staff. Engaging directly with both public sector and private sector organisations has enabled CEC to develop an enviable capacity to communicate and transfer knowledge in a variety of complex and challenging fields.

Centre staff has a wide range of skills and expertise, including:

- Resource and waste management
- Carbon management and greenhouse gas emissions
- Energy efficiency
- Environmental management

TESTING FACILITIES

Environmental Chamber

The Environmental Chamber is a unique facility in the UK purchased with an award from the Science Research Investment Fund (SRIF3). The SRIF 3 scheme in Scotland is a joint initiative involving resources from the Scottish Higher Education Funding Council (SHEFC) and the Office of Science and Technology (OST).

The chamber is designed to test the performance of building materials & components under the range of climate conditions experienced in the UK. The chamber consists of two walk-in rooms, an “Exterior” room which can be used to simulate outdoor weather and an “Interior” room to simulate typical indoor environmental conditions. The aperture formed between the rooms can accommodate a wall up to 3m wide by 2.4m high. By moving the interior room different wall thicknesses can be constructed.

In the exterior room temperature ranges in exterior room between -20°C to +30°C and relative humidity between 20% to 90%. In the interior room temperature ranges between +10°C to +40°C and relative humidity between 20% to 90%.

The exterior room also has the facilities to simulate driving rain and solar radiation (using infra-red lamps) on a wall surface. Both rooms can be pressurised.
The temperature and humidity in both rooms and the driving rainfall and infra-red lamps are fully controllable from either built-in controllers or a PC. For example, a typical daily cycle of winter climate can be programmed to run in the exterior room including rainfall to investigate moisture penetration in historic wall constructions, whilst the interior room is set to follow a typical heating pattern using the results from the monitoring of real buildings. Other techniques such as Thermography can also be applied in the chamber to gain additional information.

The working space in the chamber (790 mm along the horizontal-axis, 419 mm along the vertical-axis and 368 mm between the X-ray source and detector) allows for a large sample size or a number samples to be tested in the same sequence. The location of the sample within the chamber may be determined precisely relative to the detector gantry. The movement of the gantry may then be programmed to enable the scanning of the sample at precise locations.

Recent projects including research funded by Historic Scotland and English Heritage to evaluate methods of improving the thermal efficiency of traditional timber windows.

**Environmental chamber**

**Thermal Conductivity**

We have the facilities to measure the thermal conductivity of insulation products and materials such as stone and ceramics with higher thermal conductivities. The Lasercomp Fox314 is suitable for insulating materials with a maximum thickness of 102mm. The Lasercomp Fox50 is for designed for testing the thermal conductivity of materials in the conductivity range of 0.1W/mK to 10W/mK. The maximum sample thickness is 25mm.

**Vapour Permeability Testing**

The water vapour transmission rates of building products such as vapour permeable membranes can be measured precisely using a Gintronic GraviTest Model 6300. The GraviTest conforms to the following international standards: ASTM E96, ISO 2528, EN ISO 12572, EN 1931, BS 3177, DIN 53122 (Part1) and others.

**Moisture Content by X-ray Absorption**

The response of building envelopes to imposed moisture loadings is an area of increasing concern to building professionals. Porous building materials can be extremely vulnerable to water-related damage. This vulnerability impacts not only on the durability and acceptability of new materials, but also on the viability and maintenance of traditional ones, as is evidenced by the marked degradation in the external fabric of many historic buildings of national importance.

The absorption and transport of moisture in porous materials is complex. The X-ray absorption apparatus at GCU enables high resolution moisture content measurements under transient conditions, e.g. the wetting and drying behaviour of sandstone. The moisture transport properties derived from these investigations can be used in simulation models for predicting moisture movement at material interfaces and other important macroscopic features. This is particularly important for the building sector from the viewpoint of regulations, design and material manufacture, where performance and durability of new materials and systems are of significant concern.
CIC Start Online Launch event at University of Strathclyde Glasgow on 2 November 2009

Dr Mike Grant, Head of the Architecture Department, welcomed over forty delegates. Dr David Grierson, Director of Research at the Department of Architecture, provided information on expertise and testing facilities for sustainable building design and refurbishment at the University of Strathclyde Glasgow.

Dr Grierson said that the University of Strathclyde Glasgow was ranked as the top university regarding the sustainability orientation of the universities’ programmes as assessed by Engineering Education for Sustainable Development (EESD) Observatory, an initiative of three of the leading EESD research universities in Europe – including the Technical University of Catalonia, Barcelona (Spain), Delft University of Technology (the Netherlands) and Chalmers University of Technology (Sweden) – in association with the Alliance for Global Sustainability (AGS).

Dr Grierson said: “By providing graduates with the knowledge and skills needed to lead the process, and increasingly supporting research in this area, Universities are responding to major challenges within the sustainability agenda. We are therefore delighted to be participants in the CIC Start project which offers a real opportunity for industry and academia to work together to achieve significant improvements in the built environment.”
EXPERTISE

Sustainability at Strathclyde

University of Strathclyde Glasgow has been ranked first in the sustainability rankings by the Engineering Education for Sustainable Development (EESD) Observatory 2008. This report measured the extent to which sustainability is embedded in research & teaching in engineering & architecture within Europe’s top 56 technological universities.

ABACUS (Advancing Buildings and Concepts Underpinning Sustainability)

Since 1970 the ABACUS research group within the Department of Architecture has undertaken research work aligning emerging technologies with education and practice in the area of the built environment. The group was flagged in the 1996 and 2001 RAE (Research Assessment Exercise) (equivalent of 5*) and has an international reputation demonstrated by its interdisciplinary research projects. The group focuses on the development and application of new design and management processes, lean construction methods, and communication & information technologies to help support a more sustainable built environment.

ABACUS staff has expertise in:

- Sustainable building design & construction management system: application of principles and guidelines tackling social and environmental impact, pollution prevention, and energy & resource efficiency at a community level or within individual building designs.
- Development of a searchable digital repository of postgraduate research in the area of sustainable design and development – (MALAMA)
- Accessible design
- Healthier homes - the development and testing of solar/organic/low allergen prototype dwellings that can optimise low carbon design strategies with excellent indoor air quality to provide improved respiratory health. The design also incorporates off-site prefab techniques to achieve faster build times – (SOLA)
- Advice on BREEAM assessment and the Considerate Constructors Scheme

ESRU (Energy Systems Research Unit)

The Energy Systems Research Unit (ESRU) within the Department of Mechanical Engineering was established in 1987 as a cross-discipline team concerned with new approaches to built environment energy demand reduction and the introduction of sustainable means of energy supply. Services include the performance appraisal of proposed new designs or retrofits options, the laboratory testing of new products, and the field monitoring of energy systems in use. The group focuses on the development of low carbon and renewable energy solutions and demand reduction measures to satisfy the energy demands of the built environment.

This involves the development of simulation tools for the appraisal, benchmarking, and certification of the energy performance of buildings. ESRU operates the Scottish Energy Systems Group (SESG) which comprises a range of energy sector organisations: architectural and engineering design practices, local authorities, component and system manufacturers, utilities, renewable industries, software vendors and research bodies.

ESRU operate an Open Source policy on all of its software and its staff has expertise in:

- Dynamic building simulation program (ESP-r) - a leading research tool for investigating whole building energy and environmental performance, including building-integrated renewable energy systems.
- Clean and renewable energy supply options matched to building energy demands either singularly or combinatorial (MERIT) and the identification of demand management options to increase renewable energy utilisation.
- Domestic energy modelling (EDEM) designed to support carbon and energy policy formulation, carbon footprinting and roadmap formulation, strategic or concept low carbon design, carbon and energy performance rating, and cost effective improvement identification. The tool can be applied at National housing stock level, community or Local Authority level or to individual dwellings.
- Training in building energy performance appraisal methods e.g. Passive House techniques, SAP, SBEM, etc.

UDSU (Urban Design Studies Unit)

UDSU established in 1989 within the Department of Architecture focuses on all aspects of urban and social sustainability. Initially the Unit focussed on research on the city and its origin, its development, form and structure and its impact on people and the environment. Today UDSU is expanding its areas of expertise to urban morphology, simulation and environmental impact assessment of performance, and is also developing its consultancy portfolio. UDSU has a young international membership adding to an in-depth knowledge of local circumstances, an invaluable network of experiences that make research, teaching and consultancy vibrant and international.

UDSU staff has expertise in:

- community engagement in urban design and regeneration;
- environmental impact assessment at urban scale (i.e. exposure to natural elements, legibility, visual preference, energy potential of spaces and buildings)
- centrality assessment (retail)
- investigation of community potential
- strategic planning and detailed design of the public realm
- urban morphology (history, theory, practice)
DEPARTMENT OF ARCHITECTURE

Woodworking Machine Shop and Model Making Facility

New up-to-date machine shop tools and a series of work stations equipped with pillar drill, belt and disk sander and scroll saw these combined with 110v and portable battery appliances (jigsaws, power drills and power-drivers) provides the medium range toolset for the cutting and forming of wood and plastics.

For the smallest scale modelling the workstations have access to Dremmel battery-powered, model machining tools with a range of accessories for shaping wood and plastics.

The workshop is staffed by a dedicated member of staff with a background in engineering, tool-making and scale model design and construction.

Virtual Environment Lab (VEL)

This a fully immersive VR Research Laboratory based on a Silicon graphics Onyx O2 and 3 projector 160 degree screen, mainly for research and post-graduate use.

DEPARTMENT OF MECHANICAL ENGINEERING

Testing Laboratories

Laboratory facilities cover all aspects of energy and the environment - from the fundamental properties of solids, liquids and gasses, to the production of power and heat from fossil fuels and renewable energy sources. The intention is to support teaching and research in relation to:

- fundamentals, e.g. material hygrothermal behaviour;
- climatology, e.g. solar irradiance and sky luminance;
- modes of heat transfer, e.g. conduction, convection and radiation;
- human comfort, e.g. air psychrometry;
- conventional energy systems, e.g. for heating and cooling provision;
- power production systems, e.g. fuel cells and engines;
- solar and low temperature applications, e.g. photovoltaic cells;
- mixed mode supply approaches, e.g. combined heat and power.
CIC Start Online Launch event at University of Edinburgh on 4 November 2009

Prof. Richard Coyne welcomed around 30 delegates at the Edinburgh School of Architecture and Landscape Design. Prof. Remo Pedreschi advised the delegates on the School’s expertise and testing facilities for more sustainable building design and refurbishment, including some recent research projects and collaboration with the industry.

Delegates then visited the workshop and testing facilities available within the Department of Architecture where Prof. Pedreschi explained how some innovative construction techniques have been developed, including concrete beams and panels formed by using different types of textile material that achieve required performance while saving material and producing aesthetically attractive forms and surfaces.

The talks were followed by networking sessions for businesses and researchers to identify opportunities for collaboration.

Gloria Lo of Gray Marshall commented after the event: “I think it is a worthwhile project and would very much like to join and see what comes of the website that hopefully will give a lot more practical guidance and hard information with facts, numbers and test results published for general use for practical applications in buildings we design.”
EXPERTISE AND TESTING FACILITIES

Sustainable Technology

We have research expertise in the field of Building Technology from the design of individual components to entire buildings. In recent years we have conducted as series of successful Knowledge Transfer Partnerships with the construction sector. Our base at Chambers Street in Edinburgh includes an exceptionally well equipped suite of teaching and research workshops that include, include metalworking, woodworking, casting, CAD laser cutting, 3D rapid prototyping and structural testing.

Research in the workshop is concerned generally with the industrialisation of the construction process particularly with lightweight steel structures, the building envelope masonry and concrete. In particular, we have worked with efficient and sustainable construction processes, including the development of lightweight, demountable steel-plywood systems and fabric-formed concrete. The work has led to numerous papers and reports and has also received awards and patents. These include a most creative design award for innovative use of fabric-formed concrete at the RHS, Chelsea Flower Show and an RIBA President’s Award for research. Part of the research involves design and construction of prototypes at full-scale.

Architecture and Sustainability

We have specific practical expertise in strategic sustainable design methodologies and have provided consultancy to a wide range of companies and organisations including specialist advice to architectural practices.

We have strong links to the School of Geosciences and have researched the use of GIS systems and sustainable landscape strategies. We conduct research in gearing sustainable design strategies to social and economic contexts. We carry extensive computing facilities that include a wide range of environmental simulation packages. We offer courses and degrees to masters level including a postgraduate degree in advanced sustainable design and are able to deliver CPD and consultancy that meshes specialist knowledge with wider design and construction processes.

http://www.architecture.ed.ac.uk/research/techandenvironment/

Research at the School of Engineering

We have links in the University to the School of Engineering. Located in Kings Buildings, research is conducted in two relevant areas. The Institute for Energy Systems undertakes research in renewable energy generation for wind, marine and tidal power systems. The Institute for Infrastructure and the Environment has specialist expertise in researching urban water systems that includes SUDS, wetlands and bio-filtration processes. Located in Kings Buildings to the south of Edinburgh, The School of Engineering has extensive testing facilities and laboratories.

http://www.see.ed.ac.uk/research/IES/
http://www.see.ed.ac.uk/IIE/research/environ/
Dr Bassam Bjeirmi, Associate Head of Scott Sutherland School of Architecture, welcomed over 30 delegates from the industry, local authorities and professional associations.

Prof. Richard Laing gave a presentation on expertise and facilities for sustainable building design and refurbishment available at the School, the recent research in this area and the collaboration with the industry.

The delegates’ comments on the event were very positive, one of them saying that the collaboration that will be established between academia and the industry “should have been initiated twenty years ago”.

Ewan Smith of Intelligent Home Systems said: “I found the meeting very informative and great opportunity to meet with like minded individuals. What I feel we now need is some positive collaborative strategies to move forward.”
Research in architecture and the built environment at the Robert Gordon University relates to national policy and social agendas and usually involves the solution of practical problems. There is a high degree of collaboration between disciplines, with industry and with professional and public bodies.

‘Environments for People’ Centre

Most research is based around the ‘Environments for People’ Centre, with a focus on social, economic and physical resource sustainability and evaluation of the design of built environments in terms of their ability to meet the needs of people.

The RGU approach to research is problem-focused, involving the search for solutions to real design, social and economic problems defined by industry and Government agencies, as well as by academics. Solving these problems involves a network of inter-linked activities and skills.

The diverse issues we have dealt with include the design of assistive technology systems, the modelling, planning and design of urban open space, social issues arising from new ways of building houses, the sustainability of new housing, mapping social research on architecture across Europe, the design of new university buildings, a directory of green materials, life-cycle issues in the design of hospital environments and understanding of experience in virtual environments. These projects have been funded by a wide range of academic, research and policy bodies.

The research remains relevant to industry and grounded in real buildings and projects however, e.g. design and assessment of the use of a number of housing projects, several of which have been associated with recent design awards.

Masonry Conservation Research Group

The need for a physical and material science research base is also recognised at RGU, primarily based in the Masonry Conservation Research Group, which covers a diverse range of research projects and consultancy in the material science field.
CIC Start Online Launch event at the Heriot Watt University on 9 November 2009

Prof. Sue Roaf welcomed the delegates from the industry, local authorities and professional associations, and gave a presentation on expertise and facilities for sustainable building design and refurbishment available at the School of Built Environment, the recent research in this area and the collaboration with the industry. Campbell McLennan of AES talked about the collaboration with Heriot Watt University on application of solar water heating panels on buildings. Dr Branka Dimitrijevic, director of CIC Start Online, explained how to apply for joint academic/industry feasibility studies and 10-days free academic consultancy through CIC Start Online.

The talks were followed by networking between businesses and researchers to identify opportunities for collaboration and a visit to laboratories for testing the performance of building materials and components. Dr Laurent Galburn explained how different types of testing can be undertaken in the acoustics laboratory.
EXPERTISE AND TESTING FACILITIES

As a technology-focused university, Heriot-Watt has built up an impressive range of laboratories, workshops and specialised equipment which can be accessed by companies for their own use. This might be for experimental work, testing prototypes, computer analysis, machine component or for training purposes.

We can work with you to provide access to the most appropriate facilities to meet your needs. These facilities are supported by well-trained technicians and specialist members of staff who can assist you with the equipment or facilities and help interpret the results.

**BUILT ENVIRONMENT ANALYSIS**

- Acoustics Lab
- Concrete Lab
- Drainage Lab
- Pipe Testing Centre
- Rotating House
- Wave Basin
- Wind Tunnel

The range of laboratories, facilities and equipment also include:

- BIOLOGICAL ANALYSIS
- BREWING AND DISTILLERY
- CUSTOM SYNTHESIS OF FINE CHEMICALS
- HIGH VOLTAGE TESTING
- MATERIALS ANALYSIS
- OPTICAL FACILITIES
- TEXTILE PRODUCTION
- WORKSHOP FACILITIES
CIC Start Online Launch event at Glasgow School of Art on 11 November 2009

Prof. David Porter, Head of the School, welcomed the delegates. Dr Tim Sharpe, Director of Research, provided information on expertise and testing facilities for sustainable building design and refurbishment at the Mackintosh School of Architecture.

The talks were followed by networking sessions for businesses and researchers to identify opportunities for collaboration.
**EXPERTISE**

Mackintosh Environmental Architecture Research Unit

The Mackintosh Environmental Architecture Research Unit (MEARU) has been in operation for over 14 years and has an established track record of high quality research into environmental architecture. It operates at a unique interface between architectural design, science based research and human factors. The unit is built on an established track record in passive solar energy design and participatory design. It was founded by Colin Porteous and Tim Sharpe, who previously worked in architectural practice at the Technical Services Agency, a tenant managed Community Technical Aid Centre, where they worked closely with tenants groups on a variety of housing and other design and rehabilitation project.

This work provided crucial insights into the interaction between people and their environment. It led to a successful European funded solar demonstration project for a tenants group in Easterhouse, Glasgow, and the subsequent work of the Unit has been focussed on the relationship between people and their environment.

MEARU has a strong track record of working with user groups in relation to housing, but its remit now includes all aspects of construction, low energy design and sustainability. The unit also has detailed knowledge of building construction and typologies, particularly in relation to UK housing.

The unit undertakes both research and consultancy, with corporate and commercial clients well as commercial and public organisations such as local authorities, housing associations and architects. Recent research has involved the exploration of emerging low carbon technologies in housing, such as building integrated renewables, (PV and wind turbines), as well as low carbon approaches such biofuels and CHP. Current developments into the concept of user engagement with low energy design includes research into mass-customisation for new housing. The unit is also well networked with similar European partners and publishes regularly at the Eurosun, Northsun, PLEA and WREC conference circuits.

Its situation within the Mackintosh School of Architecture, at the Glasgow School of Art enables its work to contribute to the international research community and architectural practice, whilst also directly informing teaching and learning within the school.

The Unit has undertaken a wide range of research, published extensively and is represented on several national and international committees. This activity contributes greatly to the learning and teaching culture of The Glasgow School of Art and has also established MEARU as a significant global research player in scientific and architectural circles.

**FACILITIES**

MEARU currently operates from offices in The Mackintosh School of Architecture’ s Bourdon Building. Facilities include offices and studios, computer suites for CAD, Energy, Lighting and CFD modelling. There are also technical workshops for computer and physical modelling.

MEARU have the following facilities and expertise which have been applied in recent and ongoing projects:

**Post Occupation Evaluation**

MEARU can undertake durational monitoring of CO2, humidity and temperature together with appliance energy consumption monitoring via an electrical pulse monitor. Simultaneous monitoring of up to eight locations can be undertaken with the use of MEARU’s radio controlled data loggers. Instantaneous environmental CO2, humidity and temperature readings can also be taken using MEARU’s handheld monitoring devices.

In addition to quantitative environmental monitoring, MEARU has extensive experience of qualitative assessment through questionnaires, surveys and interviews with end users resulting in a systematic evaluation buildings in use from the perspective of the people who use them. MEARU can work with clients to assess how well buildings match users’ needs, and identify ways to improve building design, performance and fitness for purpose.

**Building Thermography Assessment**

Through the use of state of the art thermographic imaging, problems in existing buildings can be identified (including energy loss caused by missing or defective insulation, air leaks, moisture penetration and thermal bridging). Once these building defects have been identified, MEARU can provide advice on upgrading strategies to improve thermal performance.

**EcoHomes/ Code for Sustainable Homes accredited assessment**

MEARU is fully qualified to assess buildings registered under the residential Code for Sustainable Homes and Ecohomes. Pre planning, we are able to guide clients through the Code and Ecohomes, offering practical advice on how to meet the various sustainability goals, as well as how to meet any sustainability conditions at the different code levels. Post planning, during the design and construction phase, we advise on how projects can meet both design stage and post construction certification. Finally, we certify the buildings through the Building Research Establishment (BRE).

**NHER - Domestic Energy Assessment**

MEARU can assist in the production of SAP calculations and NHER rating certification in addition to providing energy efficiency advice both on the upgrading of existing housing stock and on proposed new build construction.
CIC Start Online Launch event at Edinburgh Napier University on 16 November 2009

John Currie, Director of Scottish Energy Centre at the Edinburgh Napier University, welcomed the delegates. In his talk on academic expertise, Tariq Muneer, Professor of Energy Engineering at Edinburgh Napier University presented the experience of his research group's work that encompasses a span of over 30 years of R&D work related to sustainable energy technologies and their incorporation within the building sector. Prof. Muneer said that Edinburgh Napier University was at the forefront of R&D work related to energy efficiency and the use of sustainable energy for buildings. The University’s Energy Group has maintained a strong presence within the RAE framework and has also attracted significant amounts of R&D grants from UK Research Councils, Local and UK Governments, industry and charities.

Please click on the following link to download the presentation on expertise available at Edinburgh Napier University.
EXPERTISE AND TESTING FACILITIES

Sustainable Energy Research Group
Centre for Infrastructure Research
Building performance evaluation & modelling
Community CHP design
Sustainable design in construction

Fuel cell technologies
Solar cell materials
Wind turbine materials

Solar heating system design and evaluation
Energy auditing, monitoring and reporting
Solar air heating systems design and implementation

Electronic sensor technologies
Safety, reliability and environmental issues
Fuel cells for transport applications

Solar water heating systems
Small and micro scale hydroelectric generation
Optimisation of PV driven solar pre-heated ventilation systems

Energy audit and conservation
Sustainable and renewable energy systems
Small Scale Wind Power

Solar energy
Energy in buildings
Life cycle assessment

Research on and development of sustainable energy technologies
- Solar PV
- Solar water heaters
- Solar air heaters
- Solar light pipes
- Micro wind turbines
- Micro Stirling engines
- Bio-mass
- Solid-Oxide Fuel-Cells
- Hydrogen use in railways
- Heat pumps
- Super-insulated windows
- Building fabric insulation
- Building infiltration
- Energy conservation
- Energy management
- Micro hydro control systems

Links to construction focussed innovation centres
www.napier.ac.uk/bpc
www.napier.ac.uk/sec
www.cte.napier.ac.uk
www.recyclingandreuseofbuildings.com

- Start date: 6 April 2005
- Annual electrical generation: 10.7MWh
- Peak output on 16 Jan 2007: 12.8 kW
- CO₂ saved to date: 11.4 tonnes
- Average daily energy output: 29.4 kWh
- Project backed with a 60% grant from the Energy Saving Trust
- The energy payback-to-investment ratio for the current PV technology = 9.
Thinking of professional development?

If you would like to expand your knowledge and, please see below brief information on MSc courses and links to more information on each one.

MSc in Sustainable Energy Technology

Energy is crucial to all economic activity. It is an essential requirement for development and industrialisation, but its production and use has been associated, directly or indirectly, with many of the world’s environmental problems.

Today, there is uncertainty about how much fossil fuels there are left in the ground, and fluctuating prices on the world market make it difficult to plan ahead. The spectre of global climate change due to burning fossil fuels strengthens the case for renewable energy resources and energy efficiency. These twin threats make it more important that we understand how energy is used and how it could be exploited more effectively.

This programme is intended for engineers and technologists who want to develop a career in energy-related fields. The focus is on understanding the technologies of energy production and consumption. To find out more on this one-year MSc course, please click here.

MSc in Energy and Environmental Engineering

Energy and the environment are increasingly taking their place as a major issue in today’s world. With this qualification, you’ll build on your current credentials in the field, or take the first step into this vital industry.

The course emphasises management techniques and theory, while also addressing the scientific background associated with sustainable construction and renewable and alternative energies.

As part of the pilot scheme run by the Scottish Government to support the economic priority sectors, five part-time study funded places are available for this course. If you are interested in applying for this funding please contact us via the ‘enquire about this course’ form.

Successful applications will then be given further instructions for funding application and this is subjected to eligibility (Home / EU students only). More information on the above course is available through the following links: Part-time course and Full-time course.
CONTINUOUS EDUCATION

Part-time or full-time MSc courses could be the answer.

Join the growing number of experts who contribute to the development of more sustainable built environment of Scotland.

**MSc in Advanced Sustainable Design**

There are profound changes taking place in the way we design buildings and neighbourhoods. Sustainable development is becoming a universal driver in the built environment, but how can we meaningfully engage with it?

This programme seeks to equip you with the knowledge and the means to make your own value judgements in this field and navigate a path through a fast evolving and sometimes contradictory body of knowledge.

You can study for this MSc either full or part time in a way that best suits your personal circumstances. You can study for a year on campus or alternatively over a longer period through our on-line distance learning facilities.

Both streams include an intensive spring semester working together in Edinburgh on a studio based architectural design project that explores key sustainable issues. To find out more on this MSc course, please click [here](#).

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**MSc in Environmental Sustainability**

Extremely relevant in today’s climate-aware world, this course is aimed at graduates from a wide range of disciplines.

Whether you’re an engineer, architect, lawyer or accountant, it will give you the qualifications you need for a career in either the renewable and traditional energy industries.

With an emphasis on sustainable development principles and practice, the course takes an industry-focused approach, with particular application to the water sector, property development and building design.

You’ll also study national and international environmental legal principles, opening the door to a possible career in sustainability-based projects worldwide.

More information on the above course is available through the following links: [Part-time course](#) and [Full-time course](#).
Today’s engineers are helping to solve some of the major problems facing society - from effective flood management to more efficient renewable energies and greener transport.

Our pioneering Sustainable Engineering PG training package combines study in specialist, advanced engineering technologies underpinned with training in sustainability. In practical terms, this includes effective use of materials and energy to mitigate associated environmental impacts, and the application of concepts such as life-cycle analysis, disassembly and re-use within the design process.

The MSc in Environmental Engineering is available full-time (1 year) and part-time (2 or 3 years), and is offered to students from engineering, earth sciences, environmental management or other relevant disciplines.

More information
Apply online
CONTINUOUS EDUCATION

... for the sustainable future

Please access the links below for more information on the website of each university.

MSc/PgDip/PgCert in Sustainable Engineering

Courses with a sustainability theme to further your career in:

- Chemical Processing
- Computer Aided Engineering Design
- Engineering Design
- Integrated Product Development
- Management of Competitive Manufacturing
- Marine Technology
- Offshore Renewable Energy
- Renewable Energy Systems & the Environment
- Technology Management

This flexible, multidisciplinary programme combines study in specialist, advanced engineering technologies underpinned with training in sustainability. The programme has been developed with direct industrial involvement to provide you with a solid understanding of modern, sustainable engineering.

More information
Apply online

MSc in Renewable Energy Systems and the Environment

This course provides advanced training in the design and operation of energy systems in which people live and work. Graduates gain employment as environmental, safety and consultant engineers in industries ranging from biofuel manufacture to wind energy and housing.

You will learn about different energy resources - renewable, fossil and nuclear - and the systems that can be employed to harness these resources, such as combined heat and power schemes, heat pumps, solar capture devices, high efficiency condensing boilers, advanced materials and adaptive control systems.

You will also learn about the impact energy has on the environment and how this impact can be reduced, particularly the technical relationship between energy systems and the environment, and gain confidence in using computer-based methods to address the complexities that underlie this relationship.

Leaflet
To apply and for further information contact christina.rossi@strath.ac.uk
Innovation Review will publish articles and information on support provided for innovations for sustainable building design, construction and refurbishment in Scotland. In this first issue, articles on some of the support available are provided in the pages that follow. Articles on the support available through organisations and associations, including advice, funding, knowledge sources and other services, are welcome.

To discuss the article that you would like to submit, please send an email to Branka@cicstart.org or call on 0141 273 1408.
In today’s intensively competitive economy, businesses that continually create, evaluate and exploit their new ideas are the most likely to survive and prosper in the global economy. This is particularly important right now. In an economic downturn, change through innovation is precisely what benefits a business – making it more efficient, more profitable and more successful.

Despite recent economic difficulties, our region continues to demonstrate strengths in key sectors, including financial services, life sciences, creative industries and tourism.

Scottish Enterprise works with our most ambitious companies to help them grow and although times are challenging, there are real opportunities for Scotland to grow a more vibrant, internationally competitive economy by harnessing the advantages of vigorous, profitable business innovation.

Our goal is to help increase Scotland’s long-term sustainable economic growth. And the key to this is a private sector alive with ambitious businesses that use innovative flair to sharpen their competitive advantage. Research shows that Scotland is already comparatively highly rated in our business appetite for innovation. As a nation, we are alert to the opportunities. The critical ingredient is innovation – how we transform the things we do, how we make more from the services we offer and how we improve the things we make.

Businesses that do this have the potential to accelerate growth and achieve a major positive impact on our economy. Scottish Enterprise offers a free innovation advisory service, including regional events and workshops, for local businesses. We can help businesses by assessing potential, developing creative ideas, looking at new markets, and generally challenging the way businesses think.

We face challenging times, however the longer term outlook is more favourable. In output terms, the region is expected to begin to recover from the downturn in 2010, with growth averaging 3.1 % per annum over the period 2011–18. This is above the average expected for Scotland. However, employment is expected to continue to fall with jobs growth not expected until 2012.

This economic climate means that now, more than ever, companies want to take advantage of new opportunities as the economy recovers.

We are home to world-class universities which are key drivers of innovation through the research they undertake and share with the wider economy. Scottish Enterprise is working with academic and industry partners to commercialise Scotland’s outstanding science to help support existing and create new high growth technology companies.

Ideas are the currency of the future and successfully exploiting them will make local business even more competitive. This year, Scottish Enterprise is investing some £74 million to boost innovation.

Wherever you are and whatever industry you’re in, with our support we can help make your ideas a reality and boost your business. Contact us on 0845 607 8787 or read more http://www.strengthenyourbusiness.com
Academic Partnerships Build Business Sustainability

In an age that is increasingly environmentally aware, and with a growing trend towards the construction and development of environmentally friendly “green” buildings, the companies that are able to deliver sustainable and innovative solutions in this field will stay ahead of the game.

In the current economic climate, the ability to compete in a competitive marketplace has never been more important, and a strong R&D (research and development) strategy can help to ensure that companies stay in the lead.

Dr Siobhán Jordan
Director, Interface

Tapping into world-leading expertise

Home to renowned universities and research institutes, Scotland has a long-standing reputation for innovation across the world. Businesses can tap into a wealth of knowledge and experience through academic partnerships that will help them to compete on a global stage through access to ground-breaking research and innovations.

Interface – The knowledge connection for business – is a Scottish Funding Council-backed initiative that offers a central point of access for industry to Scotland’s research base through its unique matchmaking service. Its aim is to maximise the potential of businesses by matching them with the relevant expertise at universities which can help develop solutions to R&D requirements.

Interface is helping a number of companies operating in the building and construction sector across Scotland to develop more innovative and sustainable products and services.

Case Studies

APMW Limited

Dumfries and Galloway based company APMW Limited, which specialises in land remediation and developments, was interested in exploring the feasibility of a system that installs a new form of insulation into the wall cavities of established buildings. The development of a new method of installing natural fibres in almost all buildings, old and new, could add great value to an environmentally aware market and prove a more popular choice of material. However, developing such a system and using new materials from eco-friendly, renewable sources required further investigation to prove that there was a market for the product and if the concept was feasible.

APMW Limited approached Interface, which undertook a search for relevant academic expertise, and a partnership was subsequently formed with the Department of Design Manufacture and Engineering Management at the University of Strathclyde. The project was divided into two parts – firstly there was a need to identify a process by which a completely natural form of insulation could be installed in an existing building. Secondly a marketable product that could actually fulfil this function was required. The research focused on the idea of adding value to the natural fibres as an insulation material, particularly as it is not only a highly effective insulator but also energy efficient and carbon-neutral.

Alongside Strathclyde’s strengths in design, it was decided that the Mackintosh School of Architecture at Glasgow School of Art could contribute key skills in construction. As a result, the study is being run as a collaboration between the two Higher Education Institutions and the company with the funding being offset from a grant awarded by Scottish Government’s SEEKIT programme. The feasibility study is now complete and APMW Limited continues to work with Glasgow School of Art and the University of Strathclyde to bring the concept to market.
Sidey

Sidey is a PVCu window and door manufacturer in Scotland. The company was interested in improving its current manufacturing processes for the beading that holds the glass in position within the PVCu frame. It wanted to collaborate with an academic group to devise a method of automatically measuring (via electronic methodology) the dimensions of the beading required for each frame. This may be via laser detection, and then via radio frequency or wireless technology the data could be sent to the saw to generate the correct lengths. The devised method of detection must be accurate and be capable of linking to the existing software that controls the saw.

The company approached Interface to help source the relevant expertise in this field and Interface introduced the company to Glasgow Caledonian University. They have subsequently been awarded Scottish Government SCORE funding to look at the development of new equipment as part of the manufacturing process and the project is underway.

Emtelle

Emtelle is the global leader in inducted network solutions and airblown fibre solutions. It produces small, lightweight and robust underground cabling systems, pioneering the next generation of broadband network solutions for FttH (Fibre-To-The-Home).

A particular problem of underground cable management is the presence of water and moisture in the tubing which houses the fibre optic cables. Emtelle’s R&D team in Hawick has been looking to develop the next generation of polyethylene tubing to overcome this problem and reduce the water permeability rate. To do this, Emtelle required a recognised specialist working in the area of semi-permeable membrane technology and it approached Interface for help. Interface identified that this area of expertise was available within The Glasgow Caledonian University’s Centre for Research on Indoor Climate and Health.

A short-term consultancy project was agreed, enabling Emtelle to begin developing a superior product with ultra low water permeation rates, helping Emtelle to take its product to the next stage in the development cycle.

A win-win partnership

There are many ways in which an academic partner can help companies to tackle their real life business issues and collaborations can offer a range of benefits for both industry and academics.

Academia benefits through development of relationships with key industry contacts and real-world expertise. Businesses gain through accessing the specific expertise they need to overcome their business challenge. This can save both time and budget - particularly important for smaller companies that are often stretched to capacity at the best of times. This type of partnership can ultimately deliver impressive business benefits, including a better product or service and economic advantages through improving sales.

The partnerships that have a green element are not only tackling a business challenge, they also serve to deliver sustainable solutions, which will ultimately provide long term rewards both in industry and on a wider scale into the future.

To find out more about how the Interface service can help to benefit your company log onto www.interface-online.org.uk.
The Energy Saving Trust: Improving the energy performance of homes

Making our homes environmentally sustainable is a challenge and in response the Energy Saving Trust provides a number of services to housing professionals.

Technical solutions and advice on how to integrate low-energy design into a project are available through our free guides, dedicated helpline and website. In addition the Energy Saving Trust runs the Energy Efficiency Design Awards (EEDA), which is a Scottish Government initiative worth £1 million annually, which is aimed at improving the energy performance of Scotland’s homes.

Website, technical guides and online tools

Visit our website – www.energysavingtrust.org.uk/housing – for access to a library of free downloadable technical guides that cover all areas of new build and refurbishment. The site also contains details of upcoming events and a range of interactive tools to help you implement energy saving solutions. Gain access to energy calculators, an innovative ‘interactive’ house and much more....

The Energy Efficiency Design Awards

The awards are intended to improve Scottish homes and are primarily aimed at communities, local authorities and housing associations, although businesses are encouraged to participate as part of a consortium.

The maximum award any one project can receive is £250,000. Projects should be located in Scotland, be primarily residential and achieve cuts in carbon dioxide emissions of at least 40%. They should use designs, materials, methods, technologies, approaches or intervention packages which are in some way novel.

Up to £5,000 of development funding is available for each project to assist with heat loss calculations and the design process. This Development funding should be applied for separately.

The call for applications for the 2010-11 financial year has opened and will remain open until 19th April 2010. The judging process is competitive, and an expert panel will meet after the closing date to decide which applicants are to receive an award.

Application forms and further details including information on the 2009-10 winners are available from the web site www.energysavingtrust.org.uk/energyefficiencydesignawards.

If you would like to discuss a possible project please contact Gill Davies at gill.davies@est.org.uk or 0131 555 7904.

Helpline

Our Technical Helpline offers access to some of the UK’s leading experts in energy efficiency and renewable technology in housing. If you are looking for advice on a technical issue, call 0845 120 7799. Details of your query will then be taken by one of our agents, before being passed on to an expert consultant who will contact you directly with information and advice.

Domestic solar thermal installation

Scottish Renewable Heating Pilot – roof insulation
The Carbon Trust in Scotland is here to help Scottish businesses achieve the move to a low carbon economy, inspiring organisations to get involved in taking action on climate change with the business benefits it brings. The Carbon Trust continues to make significant inroads by working with businesses of all sizes, from SMEs to large industrial sites, to help them reduce carbon emissions and costs and to develop the low carbon technologies that will support Scotland’s future. This is especially important as Scotland takes the lead in action on climate change.

A key focus for the Carbon Trust in Scotland is reducing the amount of CO₂ emitted from buildings, which are currently responsible for producing 50 per cent of total carbon emissions[^1]. Going forward, it is therefore essential that all new and refurbished buildings work towards low carbon principles.

There are already some exemplars of low carbon construction in Scotland, and these are acknowledged through the Carbon Trust Low Carbon Building Award. Now in its fourth year, the award has been specifically designed to recognise and applaud the success of organisations in Scotland that design and construct low carbon buildings. The 2010 Award will also see the introduction of a new category, with the aim to acknowledge those companies and organisations which have successfully included low carbon design principles within a refurbishment project.

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[^1]: [2003 data from Scottish Energy Study (2006)]
The research undertaken involved interviews with a series of managers at each building, including the facilities, building and business managers. Focus groups were also held with the occupiers of each building, all with the aim to find out from the occupants what effect, if any, their respective buildings have had on their work.

The research discovered that all of the organisations felt their buildings represented good value for money. It was difficult for them to estimate how much additional capital cost was represented by the low carbon elements as these were to a large extent integral to the building itself rather than ‘add-ons’. The additional cost estimates ranged from 3% to 8%.

However, there are early indications that the running costs of the buildings are low compared with a standard benchmark for buildings of a comparable size. This is attributed to high levels of insulation, natural ventilation and technologies such as solar thermal water heating. One of the organisations has estimated a saving of £3.1 million at net present value over the lifetime of the building.

In the future, buildings with low carbon credentials will have higher asset values than those of a standard build quality.

It appears the new buildings have brought many intangible benefits in terms of positive impacts on staff. These are much more difficult to measure, but it was felt safe to say that they even outweigh the running cost benefits.

All the occupants reported that they enjoyed working in their new buildings, especially in comparison with their old buildings: “It’s the nicest building I have ever worked in – a really nice working environment in general.” The buildings have instigated a positive cultural change with a new office plan layout aiming to improve communication and team working, with staff reporting that communication, collaboration and information sharing has improved. The buildings have also had a positive impact on staff health and wellbeing, with reports that staff felt better working in a naturally ventilated building and health improvements were apparent due to better air quality.

The results of the research found that all the buildings have been well received by their occupants and the general feeling was that their respective organisations had gained from their move in business terms. Most staff felt they were more productive in their new premises and were positive about the impact on their motivation, health and wellbeing. Taking into account issues such as the ‘honeymoon’ effect of a move to a new building, the three buildings were felt to be exemplars of the positive aspects of low carbon design, with direct and indirect benefits to the occupying organisation. The research uncovered a number of business benefits, namely:

- Reduced operational costs – utility costs and other running costs such as facilities’ staff time.
- Expected increase in asset value over a standard speculative building.
- The high levels of daylight, good air quality and the natural ventilation that are associated with low carbon buildings have a positive impact on occupant health and well being compared with their previous air conditioned buildings.
- Open plan, transparent offices, encourage communication and break down silos. This can be extremely motivating for staff – colleagues and managers are more accessible.
- Award winning low carbon buildings provide excellent profile raising and marketing opportunities. Visitors (clients and local community) enjoy visiting the building and are encouraged to attend meetings and events.
- Raised awareness of sustainability amongst occupants, encouraging pro-environmental behaviour at work which spills over to the home environment.
- Improved image amongst staff who feel it is really important to work in a sustainable building and enhanced amenities for staff which contribute to making staff feel valued at work.
- Some indication that a sustainable building can have a positive impact on recruitment.

The three organisations involved in the research were also asked for their advice for organisations and/or companies who may be thinking of specifying a low carbon building/embarking on a similar project.
They gave the following key points:

- Be very clear from the start what you want the building to deliver, in terms of sustainability and organisational benefits. Be firm and confident in what you want.
- Recognise that a sustainable building also brings business benefits such as resource savings, flexibility, transparency and improved image. Therefore, if you are struggling to get something accepted as a sustainability benefit, highlight the attendant business benefits.
- Be careful about going down the cost/payback justification route – there are lots of other advantages to a sustainable building, including creating something that will have a higher asset value in the longer term, notwithstanding the impact on staff.
- Sustainability is not ‘something you tack on afterwards but is included within the design from the start’. Time spent at the front end, including planning the integration of sustainability will reap substantial benefits later on.
- Use the experience of others who have gone through the process.

“It is my hope that this research will have a significant impact on people’s perceptions and despite the constraints of the current economic climate, will give a clear picture of the many financial and cultural benefits to be had for businesses specifying a low carbon building. At the Carbon Trust we work tirelessly to help companies and organisations realise the benefits of specifying low carbon.”

The Carbon Trust provides low carbon design advice which helps developers and property owners in Scotland realise the benefits of carbon efficient methods, which if incorporated into a new build or refurbishment from an early stage can make a huge difference.

The Carbon Trust provides case studies on its website (www.carbontrust.co.uk) of companies which have gone through the process of specifying a low carbon building. These can be downloaded. The Carbon Trust also regularly runs low carbon building master classes, aimed at engaging senior decision makers and stakeholders who are in a position to influence the specification of buildings.

Full copies of the low carbon building research reports are available to download on www.carbontrust.co.uk/buildings.

For more information on the Carbon Trust visit www.carbontrust.co.uk or call the Carbon Trust Advice Line on 0800 085 2005.

John Stocks, manager of the Carbon Trust in Scotland concluded: “The business benefits of specifying low carbon buildings are numerous and significant and this research has reaffirmed our strong belief that a low carbon building can only be a good thing for employers, managers and for the business as a whole, both in the short term and the longer term. However, the research has also helped to identify the many barriers that stand in the way of decision makers specifying a low carbon building – the misunderstanding of total life costs, the perception that only heavily serviced buildings ensure comfort, the lack of information, knowledge and training about what to do and how to go about it and the lack of a real understanding of the business case for a low carbon building.”

Scottish Natural Heritage building in Inverness by Keppie Design
Solais House is NG Bailey’s new regional Scottish HQ building at Strathclyde Business Park in Bellshill, Central Scotland. The 22,000 sq ft building was completed in summer 2008, at a total cost of £5.5 million and was awarded a BREEAM Excellent rating, as well as an EPC A-rating.

The new office has given the company a chance to showcase their sustainability credentials and use state of the art technologies to demonstrate that a low carbon building can have business benefits in terms of increased asset value and reduced operating costs. This was achieved through reducing energy and water consumption, high levels of insulation and air tightness, generating power through renewable technologies, managing rainfall and reducing the environmental impact of the building. Technologies employed by NG Bailey include solar thermal collectors for domestic hot water heating; photovoltaic glass installed on the south facing frontage; energy efficiency lighting with combined daylight and occupancy sensors; a ground source heat pump; natural ventilation with motorised opening windows; rainwater harvesting integrated with a sustainable urban drainage system for WC flushing and intelligent BMS.

The building is a clear demonstration that sustainability is not “something you tack on afterwards but is designed in from the start.” NG Bailey staff also think it is important for them to be working in a low carbon building, both for their own part but also to demonstrate their credentials to clients: “in our industry it is really important that we are leading the way and at the forefront of technologies we are going to be installing and offering.”

It is difficult for the company to say exactly what has been the additional cost of the building over a conventional one of the same size, as so many of the features such as PV glazing are integrated into the building. It has been estimated at 8-10%, approximately £850,000, however it is expected that this will be recouped in savings in running costs which have been estimated at about £50,000 a year - £3.1 million at net present value over the lifetime of a building.
Loch Lomond & the Trossachs National Park Authority received the Carbon Trust Low Carbon Building Award 2009 for the new Loch Lomond and The Trossachs National Park Authority headquarters, or ‘Carrochan’ as it’s known.

Michael Russell, the then Minister for Environment, presented the award to Chief Executive of the National Park Authority, Fiona Logan, at the Scottish Energy & Environment Conference (SEEC), held in Glasgow.

John Stocks commented: “The judging panel were particularly impressed with Page and Park Architects’ design and felt the building reflected the National Park Authority’s objective to own an affordable, sustainable building that sets new standards for office accommodation and in so doing demonstrates that low carbon buildings are within the reach of all smaller businesses and public sector organisations.”

Some of contributing factors towards the winning award entry were the maximum use of timber within the building, natural material finishes throughout, the primary biomass heating system and passive design strategies for heating, cooling, ventilation and lighting. In addition, operational demand for energy is minimised within the building through the incorporation of roof lights with automatic opening sections to provide natural ventilation. Carrochan received an ‘excellent’ BREEAM rating, the industry benchmark for sustainable build.

Entries are currently being sought for the 2010 Carbon Trust Low Carbon Building Award. To register an interest and request an application form, please email emma.davies@smarts.co.uk. The deadline for entries is 11 January 2010.
Research Pooling

Scotland has many areas of research expertise that are world-class, but these can often be distributed across a number of universities where developing and maintaining critical mass is a challenge. We must therefore be creative in our approach to maintaining and developing our higher education research base and continuing to compete on the international stage.

The Scottish Funding Council (SFC) has invested over £350m in the Scottish research base over the past 5 years, much of this in the areas of engineering and basic sciences. This funding has been matched to the level of a further ~£500m by the Universities themselves. Alongside this considerable financial investment the SFC has also been leading on organisational and behavioural changes through ‘research pooling’ in order to promote increased levels of collaboration between academics and researchers at different Scottish universities. Research pools are now in place in areas such as physics, chemistry, geosciences and life sciences and have been shown to be delivering real benefits in the effectiveness of these research communities. The pooling concept on this scale is unique within the UK and provides a model that is attracting great interest nationally and internationally.

Research pooling involves universities coming together to share staff and facilities in certain disciplines or cross-disciplinary subject areas and has been developed as a basis for academic discipline growth and strengthening. The resulting enhancement of the research base has been significant as seen in measures such as citation indices and investment in research and knowledge transfer.

These pooling investments have “raised the game” in the Scottish research scene to a position consistent with leading international research performance levels and have attracted partners from around the world, indicating the growing recognition of our conjoined capabilities.

The Energy Technology Partnership (ETP) is one of the most recent examples of research pooling and an alliance of Scottish Universities engaged in world class energy related RD&D, encompassing the cross-cutting energy theme within the Scottish Research Partnership in Engineering.

With around 250 academics and 600 researchers, it is the largest, most broad-based power and energy research partnership in Europe. Partners currently lead or participate in energy research programmes and investments valued in excess of £300m funded through the public sector and industry. This portfolio has increased significantly over the past five years, enhanced by the research pooling strategy.
Organisation

The ten core members of are University of Aberdeen, University of Dundee, the Robert Gordon University, University of Edinburgh, Heriot-Watt University, University of St Andrews, University of Glasgow, University of Strathclyde Glasgow, Glasgow Caledonian University and University of West of Scotland.

These members are active across all aspects of the RD&D pipeline, from conceptual and feasibility studies through to research, testing, development, demonstration and commercial deployment.

The ETP Directorate provides leadership and comprises: Profs. Jim McDonald, Chairman (University of Strathclyde); Patrick Corbett (Heriot-Watt University); John Irvine (University of St Andrews); Paul Mitchell (University of Aberdeen) and Robin Wallace (University of Edinburgh).

An Advisory Group, co-chaired by Ian Marchant (CEO Scottish and Southern Energy) and Prof. Anne Glover (Scotland’s Chief Scientific Advisor) and including other senior industry and public sector representatives, provides strategic advice and support in relation to industry and policy matters.

A Research Advisory Forum (chaired by Professor Paul Mitchell) brings together ETP members with representatives from other research pools to identify opportunities at the interface between energy and other disciplines (e.g. physics, life sciences, computing etc.)

Technology Areas

ETP has an unparalleled energy R&D capability and core research strengths offering a spectrum of energy technologies. Coupled with research pooling, this provides an integrated energy technologies community that is providing strong leadership in the UK/EU/global energy agenda. Key focus areas include:

- Built Environment and Demand side management (e.g. Sustainable architecture, Low carbon buildings, Energy Utilisation, Demand reduction);
- Wind energy;
- Marine energy;
- Power systems and networks;
- Bio-energy;
- Energy conversion and storage;
- Oil and gas;
- Carbon capture and storage.

In the area of the Built Environment/Demand Side Management, there are already a number of very successful initiatives in place (involving ETP members and others) such as the Centre of the Built Environment, BRE Trust Centre of Excellence in Energy Utilisation and the recently established CIC Start Online project.

In June 2009, a workshop co-hosted by the Scottish Construction Centre, Scottish Enterprise and ETP identified opportunities for further academic collaboration both with colleagues in academia and with industry.
Relationship Building - "Promoting the expertise and capabilities within the ETP, to develop new strategic relationships with industry, academia and others."

ETP has a strong track record of successful engagement with industry and enjoys an unrivalled portfolio of active industrial partnerships based on academic excellence and long-term, strategic energy RD&D programmes such as:

- Rolls-Royce University Technology Centre
- SSE Research Fellowship and Distributed Generation programme
- DECC Distributed Generation Centre (including EdF Energy and EON)
- National Grid Research Framework
- ScottishPower Advanced Research Centre
- BRE Trust Centre of Excellence
- British Energy / EdF Diagnostics Centre
- GSE Power Plant Simulation Centre
- EdF Group R&D Framework Agreement
- Advanced Forming Research Centre (AFRC)
- Power Network Demonstrator
- Converteam Advanced Technology Group

These strong linkages all enable the academic base to interact with multi-national "corporates" to help align research outcomes with global market opportunities. ETP is also serving as an effective ‘front door’ to new SMEs or international players that may have less knowledge of the energy R&D community within Scotland.

Strategic Objectives

ETP was established for two main reasons; to promote greater levels of collaboration between its members and then to use the quality of the “ETP Brand” to raise the profile of energy R&D in Scotland in order to develop new working relationships. Consistent with this, four main objectives help guide and communicate its activities:

- Capacity Building
- Relationship Building
- Internationalisation
- Economic Impact

Capacity Building - "Deepening and broadening existing relationships and partnerships (within ETP) to promote increased collaboration."

Increased collaboration here can take many forms. For example, a single collaborative submission to a large UK or EU call might have a much greater chance of success than a number of separate and un-coordinated bids. During the past year, several bids for funding have been submitted, and a number of them have been successful, which have included more than one ETP university or have been led by a single institution with cross-reference in the proposal to ETP’s broader capabilities.

A current example of collaboration is the recent bid submission into the SFC for establishing a new Energy Industry Doctorate Programme as part of an overall Scottish Energy Research Academy. The programme aims to produce 50 students that will be augmented by a further 50 in a second phase to deliver a total of over 100 Energy Industry Doctorates in Renewable Energy Technologies over five years. These will quickly contribute to industry, increase the research capacity of ETP and significantly enhance energy sector knowledge exchange and innovation.
Economic Impact - "Connecting the work of the ETP with Scottish Policy and economic development opportunities for Scotland."

The Scottish energy sector is a priority industry for the Scottish Government and its Development Agencies and comprises around 2500 companies (oil/gas, >2000; power generation/utilities, 200-250; renewables, 150-200). Gross Value Added to the Scottish economy is some £18 billion, one of the highest of all industry sectors. Scotland has therefore both a world-class/world-scale RD&D alliance and a large, world-renowned energy industry.

ETP has a strong track record in the transfer of its R&D capability into industrial development and exploitation in partnership with large scale and SME sized industrial partners.

We are working with Scottish Enterprise to maximise the impact of knowledge transfer into the Scottish economy and with Scottish Development International to support inward investment opportunities and outward trade opportunities.

In relation to the policy agenda, ETP is well represented on the new Scottish Advisory Board and its Ministerial led theme groups with Prof. Jim McDonald Co-Chair (with the First Minister) of the Advisory Board, Prof. Paul Mitchell on the Renewables group, Prof. Stuart Hazeldine and Simon Puttock on the Thermal Generation/CCS group and Simon Puttock on the Oil & Gas group.

Summary

In summary ETP is a world scale and world class alliance of academics and researchers working on leading edge, energy related R&D activities.

ETP is pleased to be associated with the CIC Start Online Project and will continue to provide support through its member universities to help deliver a successful outcome.

Find out more: www.etp-scotland.ac.uk

Dr Simon Puttock
Executive Director
Energy Technology Partnership
SEDA - Who We Are and What We Do

The Scottish Ecological Design Association (SEDA) was established in 1991 by people from different design disciplines, with a shared aim of promoting "the design of communities, environments, projects, systems, services, materials and products which enhance the quality of life and are not harmful to living species and planetary ecology".

Since then SEDA has become a well-established and well-regarded network – undertaking and disseminating research; providing a discussion forum for members; reviewing and auditing building and technical standards; producing publications; establishing links and partnerships; informing, lobbying and working with legislative and other authorities to develop and formulate policy and improve Building Standards and performance.

We aim to bring together people from across the different design disciplines – and elsewhere in the construction sector - to promote, develop, test and share best practice in environmentally-friendly building and sustainable design in Scotland.

In partnership with others SEDA organises events and activities to discuss, develop and deliver better performance and consistent standards in sustainable building design, detailing and construction in Scotland.

During 2009 we have organized and run successful events on Brettstapel Massive Timber Construction, Use of Biomass Fuel and Post Occupancy Evaluation – the latter in partnership with SUST.

In April SEDA members contributed to an RIAS CPD event Sustainability and Energy.

This year our AGM was held over 3 days in the Borders with talks from the Director of the Sustainable Development Commission on their report "Prosperity without Growth", a local sculptor on Landworks and Malcolm Fraser on the Berwick Workspace. This was a project we visited as well as Dawyck Gardens Visitors Centre by Simpson and Brown, Tantah House by Locate Architects and Graham Bell’s Permaculture Garden.

We have also displayed an exhibition and hosted events at the Big Tent Festival of Stewardship at Falkland in June.

SEDA works actively with policy makers and other built environment organisations and agencies as well as with individuals and housing and community based organisations.

For the Scottish Executive we have researched and produced three Design and Detailing Guides - Deconstruction Airtightness and Toxic Reduction in Buildings which are downloadable from our web site http://www.seda.uk.net/

In partnership with SUST our members are involved in the compilation of a Green Directory of Sustainable Building Designers, Products, Materials, Services and Suppliers and recently SEDA has embarked upon a project to collect and collate examples of projects demonstrating the best practice in sustainable design in Scotland as case studies for a Green Buildings database of projects.

SEDA seeks to promote:

- The design of materials and products, projects and systems, environments and communities which are benign to living species and planetary ecology
- Professional and consumer awareness of ecological design and choices
- Interdisciplinary contacts between those who wish to incorporate ecological concerns into their creative and productive work
- SEDA encourages people to share knowledge, skills and experience
- Education and the involvement of young people to facilitate the spread of eco-design in the training of designers and innovators
- Research, evaluation and the setting of standards for ecological projects, services, materials and products.
THE UNIQUE ROLE OF SEDA

The uniqueness of SEDA comes from what we do and where we do it. Since devolution in 1997 virtually all matters which relate to environmental protection, development and climate change have been devolved to the Scottish Government.

SEDA is delighted that 7 leading Universities in Scotland have come together to form CIC Start Online as this will prove to be an invaluable resource in the future. There are many organisations whose work touches upon aspects of sustainable design in Scotland and many of our members work for or with those organisation, but there are none for whom it is their sole subject and purpose.

Clients, NGOs and others in Scotland seeking support and guidance to often very localised problems. SEDA is financed by the membership and it is therefore able to retain complete independence. This makes SEDA uniquely free to express opinions which are not always at one with the prevailing political and socio-economic models. This freedom is increasingly valuable now sustainability is on every agenda.

SEDA has always been able to steer a careful path between the radical and the mainstream and has been successful in generating respect from all sides as a source of valuable but also applicable information on sustainable design issues. Importantly, SEDA has been able to introduce to Scotland a myriad of ‘radical’ ideas and techniques which have subsequently found acceptance within the mainstream. SEDA is focussed on Scottish solutions to Scottish issues. This does not mean that these issues or solutions are not applicable elsewhere, but by attempting a more bioregional approach, by trying to focus on more localised issues, we have been able to be more useful to the many Designers, Clients, NGOs and others in Scotland seeking support and guidance to often very localised problems.

More or less all of the Designers who have been interested and involved in ecological design in Scotland during the last 15 years have been, or are involved in one way or another with SEDA. This gives SEDA an unparalleled resource base of deep and broad ecological design understanding and know-how and generates the potency and widespread value of so many SEDA events and guidance. With the appointment of our Development Officer this has allowed SEDA to capitalise on the knowledge bank of the members and this is reflected in our activities over the last 3 years.

SEDA is unusual in explicitly aspiring to engage ecological design issues across the design spectrum and across sectors. Thus SEDA has tackled sustainable development in areas such as planning and policy, architecture and construction, product design and manufacture, landscape and place identity, community and society, spiritual inspiration and personal development, energy generation and conservation, health issues in design, supply chain management and economics, aesthetics and philosophy, forestry and land use, furniture and furnishings, and many others. This breadth is as enlivening as it is informative, lessons can be learned from other practices and this ‘joined up’ approach to problem solving is part of what makes SEDA a uniquely valuable force in sustainable development in Scotland.

Membership Rates

Individual: £22, Student: £10, Unwaged: £10, Family: £30, Corporate Small: £50 (charities, voluntary organisations, practices with 5 people or less), Corporate Large: £100 (businesses, local authorities, practices with more than 5 people), Sponsors: £250 minimum (subject to agreement)
Gilmour’s Close: Edinburgh World Heritage Site
Low Carbon refurbishment

By Andy Jack, Assist Architects

Hillcrest Housing Association and Assist Architects beat off stiff competition to win Inside Housing’s most sustainable social housing refurbishment project of the year. The greenest social housing organisations in the UK were honoured at a glittering awards ceremony in London in November 2009, hosted by Jon Snow, Channel 4 news anchor and organised by Inside Housing magazine and its sister-publication Footprint.

John Mulloy, Hillcrest Group Chief Executive commented that “We have a strong focus on sustainability so we are delighted to be recognised in this way. This is the second award Gilmour’s Close has won this year specifically focusing on the energy efficiency aspects of the development.

“With Gilmour’s Close being a listed building in a world heritage site, the refit and the rehabilitation of the development faced particular difficulties. This project specifically tackled the difficult task of refurbishing an existing building to minimise CO2 emissions and dependency on non-renewable energy. We are very proud of the end result and are pleased to be able to offer affordable housing in one of Edinburgh’s most picturesque and vibrant areas.”

The tenants in the 17 affordable homes benefit from various innovative energy efficiency features through reduced energy costs and a reduction in their carbon footprint.

Amongst the most notable of these sustainable design features is the installation of a ground source heat pump which delivers heating and pre-heated water to all of the apartments. The only energy used by Ground Source Heat Pump systems is electricity to power the pumps. Sunspaces are featured within twelve of the flats which utilise passive solar gain, re-circulating warmed air within each flat.

Andy Jack of Assist Architects commented that “With Gilmour’s Close, we set out to meet the challenge of addressing emission reductions in existing housing stock. The process was only made possible through key partnership working – Hillcrest HA, Energy Savings Trust, Historic Scotland, Communities Scotland, specialist suppliers and the design team. We were delighted to be applauded at the official opening by the Leader of City of Edinburgh Council, Councillor Jenny Dawe, as an exemplar in partnership working.

“Gilmour’s Close signals the way forward in achieving sustainable social housing and how it is possible to meet the challenging targets set for the reduction of green house gas emissions.”

The judges included some very distinguished experts including Robert Napier the Chairman of the Homes and Communities Agency; Neil May, Managing Director of Good Homes Alliance; Jon Lovell, Head of Sustainability at Drivers Jonas; Simon McWhirter, the Head of Campaigns at WWF Homes and Alan Yates, Director of Regeneration at Accord Housing Association.
Client: Hillcrest Housing Association  
Design Team: David Adamson and Partners (QS), Clark Contracts (contractor), Waterman Group (structural engineers), Faber Maunsell (service engineers)

Project description

The project entailed refurbishment of two 19th century tenement closes to provide 17 energy efficient new flats for social housing with 10 of these providing specialist accommodation for vulnerable young people. It was the final phase of redevelopment of the Caste Trades Hostel in the centre of the city’s World Heritage site.

The project specifically tackles the difficult task of refurbishing an existing building to minimise CO2 emissions and dependency on non-renewable energy. To achieve this, Assist specified a ground source heat pump (GSHP), with 70m vertical bores drilled into the bedrock to provide onsite renewable energy for hot water and space heating. We also designed south facing sunspaces for passive solar gain, combined with a positive input heat recovery system to minimise the requirements for a non-renewable energy source. Finally, enhanced insulation was wrapped inside the existing stone fabric and secondary glazing added to the existing sash & case windows to minimise heat loss.

Alongside this was a programme of extensive stone conservation and façade protection funded and monitored by the Edinburgh World Heritage Trust. The project was completed during 2008.

Project management

The project management arrangements employed to deliver the challenging brief set by Hillcrest Housing Association was one of collaboration with key suppliers and stakeholders. This vital collaboration took place from the onset at RIBA stages A and B, Inception and Feasibility. It was at these stages that key decisions were made to ensure the smooth integration of architecture and services. This collaboration included:

- Early meetings with Scottish Community and Householder Renewables Initiative (SCHRI) – where advice was given on options for renewable technologies, funding available, list of accredited suppliers and designers.
- Establishing agreed levels of thermal insulation of the building fabric to allow details of other strategies to be developed such as the ground source heat pumps, underfloor heating, and heat recovery strategies.
- Appointment of a Service Engineer with specialist knowledge of renewable technologies to advise on early design ideas and options.
- Environmental modelling carried out on proposed sunspaces to identify the optimum area of glazing to maximise solar energy saving but avoid excessive overheating.
- Meetings with mechanical ventilation and heat recovery (MVHR) suppliers and designers to discuss system installations ensuring distribution routes, service zones, outlets and terminals were integrated into plan layouts and architectural forms.
- Meetings with Clear Sky accredited installers to discuss the installation of GSHP, including the viability of the project for this technology; desk top studies carried out to check viability of using GSHP for a community heating system – the extent of bore holes required to meet designed heat losses, checking access for drilling rigs, and suitability of available land to install the heat pump.
- Co-ordination meetings between the appointed Clear Sky installer and design team service engineer to develop informed performance specifications to be used in the contract.
- Strategic overview meetings between the appointed Clear Sky installers and the client to clarify the visual impact of the GSHP, how it will be installed and work, key issues regarding backup strategies and health & safety issues such as how to deal with the risk of Legionnaires disease.
**Procurement**

The procurement process selected to deliver the low carbon designs on the project involved a series of contractor-designed packages included in a standard JCT Contract (with Quantities) and based upon performance specifications developed by the project Service Engineer Faber Maunsell. The process involved developing a pre-contract, detailed understanding of the key installations with the suppliers involved. Most critically in this project was the ground source heat pumps supplied by Eco Heat Pumps. By the time work began on site, the following documents had been prepared and procedures followed:

- The selection of a Clear Skies accredited supplier, Eco Heat Pumps.
- Assessment of the viability of the heat pump for this type of project.
- Sizing of the heat pump based on supplied heat losses for the 17 flats, using national geological data to calculate the number and depth of bore holes required (10Nr at 100 metres deep to give 51KW load). Then, checking available space to confirm this can be achieved.
- Induction meetings with clients to discuss system operation, metering, and distribution to the 17 dwellings.
- Meetings with drilling rig companies to confirm that there were suitable rigs available to negotiate the restricted access.
- Detailed site investigation undertaken to confirm the findings of the desktop study.
- Meetings with the Service Engineer and Eco Heat Pumps to develop detailed performance specifications for the ground source heat pump.
A similar process was followed to develop detailed performance specifications for:

- The positive input ventilation and heat recovery
- The hot & cold water installation/distribution
- All electrical Installations
- The underfloor space heating

The detailed performance specifications in turn became key contract documents, embedding system and client requirements into the contract. The tendering process itself was a conventional single stage selecting tender, followed by a tender report from the project QS recommending Clark Contracts as the main contractor. Clark Contracts in turn subcontracted all M&E works to James Frew, who in turn entered into subcontractor agreements for the individual specialist works for the:

- Ground source heat pump
- Underfloor heating
- Hot and cold water
- Positive input ventilation and heat recovery.

The performance specifications for each of these sections of work had clear outcomes required by the contractor in terms of:

- Production of detailed drawings
- Calculations in support of designs
- Commissioning of system
- Induction of client of system operation
- Provision of detailed health and safety file documenting as built drawings, products and manufactures, warranties and maintenance requirements.

The process of approval of each installation involved preliminary proposals, drawings, products and specifications being prepared by James Frew, which in turn were reviewed and commented on by the project service engineer, measured against the required outcomes of the performance specification: this process concluded when the project service engineer had no further comments and the detailed drawings and specifications were then adopted as contract documents.

Prior to work starting on site, a high level services meeting was held, involving specialist installers, M&E subcontractor, main contractor, and design team members, to discuss programming, co-ordination with other trades, and any outstanding issues.

During key times of the installation, in addition to the general works Clerk of Works, Faber Maunsell provided specialist M&E Clerk of Works to monitor work in progress. This included:

- Checks on first fix installations
- Checks on second fix & component installation
- Checks at commissioning and before practical completion
- Client technical staff induction of operational features of installations.

The culmination of these actions has contributed to producing the following good internal environments:

**Comfort**

A warm comfortable environment is key to occupants’ sense of quality in their home environment: underfloor heating provides evenly distributed heat at low level where it is wanted. This type of heating is ideally suited to being served by a ground source heat pump as it supplies low pressure water at low temperatures (35-45°C) to the underfloor heating circuits unlike conventional radiators where the water circulates at up to twice this temperature.

**Air Quality**

Good air quality is fundamental to high quality occupant experience of their internal environment, which to a large extent relies on an efficient ventilation system. With high levels of insulation and air tightness (provided by new secondary glazing) a mechanical ventilation system is essential to ensure air quality and avoid problems of condensation. The specified positive input ventilation system with heat recovery provides both incoming conditioned fresh air and recovered heat through a flat plate heat exchanger, gathered from expelled stale air from kitchen and bathroom. In addition, warm air from the sunspaces is also collected and passed through the heat exchanger, providing valuable free solar heating to each flat.

**Noise intrusion**

Within busy urban locations such as Gilmour’s Close in the Grassmarket, noise pollution is a major problem. Coupled with conservation requirements to retain the existing sash and case windows, the solution was to install high quality secondary glazing, providing both a significant reduction on traffic noise and reduction of heat loss through the glazing and ventilation losses.

**External space and warmth**

Within an urban environment where garden space is limited, the sunspaces provide not only passive solar gains but also much needed amenity space associated with each flat.

As well as these environmental factors, the building also meets the following standards:

- **Housing for Varying Needs (HFVN)**
  The quality of the internal environment relies heavily on the design plans being able to carry out fully the normal activities of eating, sleeping and relaxing. By design to current design standards defined by HFVN, we have ensured a functional and pleasing internal layout for each flat.

- **Secure by Design**
  The development has been awarded Secure by Design status confirming that the principles of community safety are embedded in the development, ensuring that each tenant feels safe in their home.
To minimise non-renewable energy consumption and reduce the building's carbon footprint, we specified a ground source heat pump to provide onsite renewable energy for hot water and space heating. The GSHP was a Thermia Robust 38 model supplied by Eco Heat Pumps who also supplied all the hardware required for this system. Fourteen 70m vertical bores were drilled into the bedrock at the rear of the building and this in itself proved a logistical challenge as the only way of accessing the rear of the building is through one of two close pends, 2m wide and 2.5m high. A specialist drilling rig was commissioned to crawl through the pend and over a period of several days drilled the deep holes for the pipe loop (because of the site location and its restricted footprint, the conventional coil loop system of GSHP laid out over a large area at shallow depth was not possible and a deeper, more intensive system was specified which took up less ground area).

The GSHP was connected to a communal heating and hot water system that supplies both closes with hot water, heating the flats via a low temperature under-floor heating system from Velta. Each flat has three thermostats, one of which is located in the sunspace, to control the room temperatures.

Heat meters have also been fitted to measure the efficiency of the heat pump installation. Initial calculations predict an efficiency rating of 4:1, but we intend to monitor this and also collect data from each flat to assess the true impact of this renewable system on the tenants' fuel bills.

Building form and fabric, façade, orientation

This project re-uses an existing historic tenement building which has a nominal footprint, with shop units on the ground floor and four storeys of refurbished flats above. The existing building fabric is a solid masonry construction with plasterboard lining which had an exceptionally high heat loss and U-value.

Our objective was to significantly improve the U-value and reduce the heat loss from the new homes above the basic requirements of the Scottish Building Standards. To achieve this, 100mm of mineral wool was fitted to the inside of the masonry and a 50mm air gap created within which was hung Alreflex 2L-2 dry lining wall insulation which consists of two layers of polythene bubble sheet faced on both sides with an aluminium foil lining. This make-up was then sheeted with plasterboard and the combined effect was an improvement from approx 3.0 W/m²K to 0.22 W/m²K.

300mm of mineral wool quilt was added within the roof space to achieve a U-value of 0.14 W/m²K. Between each flat a sacrificial ceiling contained 100mm of insulation, primarily for acoustic compliance, but the Velta underfloor heating system was laid within 50mm rigid polystyrene to minimise any heat loss beneath.
Avoiding overheating

The positive input heat recovery system minimises the need for mechanical cooling due to summertime overheating by monitoring the internal temperature and drawing fresh air into the building. All sash and case windows are openable for natural ventilation and the sunspaces also have openable windows to give tenants control over the internal temperature.

Renewables

As mentioned above, a ground source heat pump from Eco Heat Pumps was specified to minimise non-renewable energy consumption and reduce the building’s carbon footprint. This was partially funded by the SCHRI with the remainder of the cost being funded from Hillcrest Housing Association’s own funds.

The windows also posed a significant problem, being original sash and case single glazed units. Due to the building’s location within the Edinburgh World Heritage site, it was not possible to replace the windows with double or triple glazing, so we opted for secondary glazing, which had to meet EWHT’s conservation requirements, to help reduce the heat loss from the flats.

The orientation of the building is east-west along the southern edge of the Grassmarket and as such, the rear elevation was not susceptible to as strict conservation controls as the front street elevation to the north. To maximise passive solar gain, we designed south-facing sunspaces which are cantilevered off the main structural core of the building. These provide passive solar gain which, combined with a positive input heat recovery system, minimise the requirements for a non-renewable energy source, and provide attractive semi outdoor spaces within the high-density fabric of the Old Town.

Building services

A positive input whole home heat recovery system from Expelair was specified to work in tandem with the sunspaces and the GSHP to minimise the use of non-renewable energy.

The MVHR system provides whole home ventilation using a combination of the positive input ventilation principle, continuous low level extract ventilation and heat exchange heat recovery.

Simultaneously, air is extracted from ‘wet’ areas such as the kitchen, bathroom and sunspace. Supply and extract pass through a heat exchanger which transfers heat to the supply air and discharges the extract air outside.
Sustainable construction

It is well known that reusing and refurbishing old buildings can save more CO₂ emissions than building environmentally friendly new ones. In this instance we have taken a redundant city centre building and through grant aided conservation and the implementation of a sustainable design strategy we have extended the lifespan of the building and provided new accommodation without the emissions, waste and use of embodied energy associated with constructing a new building.

The conservation work included repairing the stone façade with natural stone and lime mortar, the re-use of the existing slates and the addition of second-hand Scottish slates where required, and the overhauling of the existing sash and case windows.

Because we were reusing an existing building, apart from the strip-out (where waste from the old building was sorted by skip), there was significantly less waste produced in the refurbishment than in the construction of equivalent new building.

A minimal amount of concrete was used throughout the building (primarily for the new GSHP plant room), and as noted, all stonework repairs and re-pointing was undertaken with lime mortar.

Steel was used to cantilever the sunspaces from the original structure of the building but this can be recycled at the end of its lifespan.

Structural and finishing timber was from a sustainable source whilst all insulation materials used have a low GWP and ODP of zero.

The aluminium cladding to the sunspaces is 100% recyclable.

The location of the site on the main busy thoroughfare of the Grassmarket combined with the fact that the rear of the building can only be accessed by vehicles through a 3m high pend meant that the removal of waste (as well as the delivery of materials) had to be carefully coordinated and limited.

A bus stop and pedestrian crossing in front of the site restricted the number of skips which could be loaded at any one time so waste was generally sorted on-site prior to being taken to the front of the building and removed.

And the omission of wet trades from the construction process meant that significantly less water was used in this refurbishment than compared to a new build, and this minimised the amount of potential discharge of contaminated liquids into the existing drainage system.
INNOVATIVE PRACTICE

Costs

This low carbon design strategy has resulted in an overall higher capital cost for this project. These additional capital costs can be attributed to:

- Additional thermal insulation to achieve lower U-values: £1,000
- GSHP installation and pipework: £5,500
- MVHR unit: £1,000
- Underfloor heating coils and manifold: £500
- Sunspace construction: £4,000
- Secondary glazing: £1,000
- Total cost per flat: £13,000
- Total project cost: £221,000

The £100,000 cost of the GSHP was partially funded by the SCHRI with a grant of £40,000. Of the remaining £60,000, Hillcrest were able to allocate equivalent HAG funding for the cost of 17 conventional condensing gas boilers, the remainder of the cost (£22,000) being funded from Hillcrest Housing Association’s own funds. Hillcrest were then able to re-coup this cost by charging the tenant’s a higher rental rate to reflect part of the fuel bill saving.

The initial capital costs of a ground source heat pump system is more than a conventional oil or gas fired boiler, but the initial one-off expense is offset by the lower running costs, lower maintenance and low servicing requirement. Clients also have the security of knowledge that the majority of their heating and cooling energy comes out of your ground, is under their control and will not increase in price. Gas prices are continuing to rise and supplies will eventually run out. The GSHP relies only on electricity, which can be sourced from hydro, wind or wave, and will provide more certain cost security in the long term. And with an estimated pay-back period of 4-5 years based upon 2007 gas prices, tenants can expect to save in the region of between £300-400 per year in fuel costs.

The whole life cost implications of the GSHP over a lifespan of 30 years are significantly lower than a gas or oil fired boiler and can be addressed as follows:

- Lifespan of heat pump: 30 years
- Lifespan of conventional boiler: 15 years
- Cost of boiler renewal: £1,500 per unit
- Safety check: £100 per visit
- Maintenance check: £100 per visit
- Cost of replacing conventional gas boiler for all 17 units: £34,000 at £1,500
- Cost of gas safety check: £51,000
- Cost of maintenance check: £51,000
- Total cost: £136,000
- Cost of twice yearly safety and maintenance checks for the GSHP: £1,000 per year
- Total cost: £30,000
- Whole life saving cost: £106,000

Occupants’ experience

Since the building’s occupation in June 2008 general feedback on the quality of occupancy has been limited although a tenants’ satisfaction survey will be carried out at the end of the defects period. From the beginning of the winter we have been closely monitoring the performance of the GSHP and underfloor heating to ensure it meets the tenants’ requirements.

The heat pump has been monitored to ensure it is delivering the required heat input but we have become aware of some flat-specific heating issues: four of the seventeen flats have had occurrences of imbalanced heat output to separate rooms.

Through a combination of site visits to monitor ambient temperatures and advice from Eco Heat Pumps, it would appear that whilst the heat pump is delivering appropriate heat to the flats there may be a simple issue with the balancing of the system at the flat manifold. In some instances, design temperatures are being exceeded in one room and not met in another and to resolve this requires the manifold distribution for each flat to be re-balanced.

Once this has been undertaken we will continue to monitor the temperatures to ensure maximised tenant comfort during the winter months. Conversely, we are aware that during the summer months, we will need to closely monitor the Expelair MVHR system to ensure overheating does not occur, either due to hardware and technical issues of user control understanding. Currently, the sunspaces are providing valuable drying space and semi-outdoor space for this city centre building, without which tenants would be struggling to dry clothes without the aid of tumble driers or using clothes horses in internal rooms. This can lead to potential condensation problems within the flats and subsequent potential health issues such as asthma.

Generally, whilst it has been demonstrated that the various technologies are performing both as designed and to meet user requirements, particular challenges experienced have included the induction of the system to the tenants who require supported accommodation and ensuring their understanding of how the systems work.
CARROCHAN: LOCH LOMOND AND THE TROSSACHS NATIONAL PARK AUTHORITY HQ, BALLOCH

A low Carbon Approach to Building Design

By Karen Pickering, Director, Page\Park Architects

The new building, "Carrochan", serves as a central headquarters for the first National Park in Scotland that covers a region of over 700 square miles north and west of Balloch. The new building provides flexible workspace for over 120 staff, associated community groups, staff from Scottish Natural Heritage and SEPA.

The design team has striven to meet the client demands for an affordable, sustainable building that not only sets new standards for office design but also affects ways of working, allowing staff to undertake a planned process of change. It is anticipated that the building will help the National Park to adopt new ways of working; the space will primarily function as an administrative centre that becomes an information point and meeting focus for staff and the community at a central hub in the Park.
A Low Carbon Brief

The project was advertised in the OJEU and, out of 36 responses, 5 architects were chosen to submit a project proposal and attend an interview to present it. Page\Park won the commission with our design.

A main feature of the client’s brief was that the building should be sustainable and achieve an excellent BREEAM rating. Although some aspects of sustainable design can be added later, our design incorporated sustainable features right from the initial concept. This included the optimal building orientation on the site, using as much timber as possible within the building, natural material finishes, using low energy technologies and incorporating a bio-mass boiler for heating and hot water.

Design team meetings were held throughout the design phase, enabling the architect and services engineer to reduce the carbon footprint of LLHQ in the most cost effective way for the client. Influencing the building form and layout allowed the design team to provide the desired internal environment in a passive manner, removing the need for energy consuming systems. This was a goal shared throughout the design team from the beginning.

The next stage in the design process was to ensure that the required services installation was provided in the most efficient way. Essential to this process was input from the client, indicating how the building would be operated and different areas occupied. This was achieved through regular client meetings with the design team.

We looked at supplying the energy demand of the efficient services systems through renewable or alternative measures. This required further coordination with the client as they were the planning authority and so this building set the standards for renewable / alternative technology integration throughout the national park area.

As the design developed, advice was taken from the Forestry Commission Scotland and Edinburgh Napier University on the best timber to be used for the structural frame. Expert construction advice was provided by Carpenter Oak and Woodland, who then became sub-contractors for the manufacture of the timber frame.

We undertook a BREEAM assessment for the project and scored 78.1% at the design stages. Within the employer’s requirement documents strict conditions were included regarding the sustainable design elements, and especially maintaining the BREEAM excellent rating achieved at the design stage.

Specifications and schedules were used to describe the design intent. Within these documents the requirements for the systems were set and the approach developed to achieve them. This included the requirements defined to achieve BREEAM excellent rating. For each procured item a list of three suppliers / manufacturers whose products achieved the design intent was provided.
**Table 1. Energy consumption and CO₂ emissions**

<table>
<thead>
<tr>
<th>Basic Building Loads</th>
<th>kWh/m²/yr</th>
<th>kg CO₂/m²/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas – heating and hot water</td>
<td>33</td>
<td>7</td>
</tr>
<tr>
<td>Electrical – lighting</td>
<td>12</td>
<td>8</td>
</tr>
<tr>
<td>Electrical building services – fans, pumps and general cooling (not comms)</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>51</strong></td>
<td><strong>19</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specialist Building Loads</th>
<th>kWh/m²/yr</th>
<th>kg CO₂/m²/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comms Room electricity and cooling load</td>
<td>3.2</td>
<td>2.1</td>
</tr>
<tr>
<td>Electrical – office equipment and small power</td>
<td>15</td>
<td>10</td>
</tr>
<tr>
<td>Gas – kitchen and catering</td>
<td>n/a</td>
<td>n/a</td>
</tr>
<tr>
<td>Electrical – kitchen and catering</td>
<td>0.1</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>18.3</strong></td>
<td><strong>12.2</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>On-site Renewable Energy Generation</th>
<th>Saving kg CO₂/m²/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>n/a</td>
</tr>
<tr>
<td>Thermal – alternative technology – The biomass boiler provides the majority of heat and hot water demand to the building, only being ‘topped up’ by the gas boiler in peak conditions. With the biomass cycle being carbon neutral (carbon absorbed during tree growth equals carbon released when burnt) a saving in carbon is achieved.</td>
<td>18</td>
</tr>
<tr>
<td><strong>Sub-total</strong></td>
<td><strong>0</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Totals</th>
<th>kg CO₂/m²/yr</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-total basic building loads</td>
<td>19</td>
</tr>
<tr>
<td>Sub-total specialist building loads</td>
<td>12.2</td>
</tr>
<tr>
<td>Sub-total renewable energy</td>
<td>0</td>
</tr>
<tr>
<td><strong>OVERALL TOTAL</strong></td>
<td><strong>31.2</strong></td>
</tr>
</tbody>
</table>

**Estimated Running Costs £ per year**

- Based on 3.45p/kWh: Total gas = 2,503
- Based on 7.2p/kWh: Total elec = 5,739
- **TOTAL** = 8,242

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**Low Carbon Building Form and Fabric Design**

When PagePark started to design Carrochan we looked closely at the brief and at the site. We placed the clients space diagram on the site and curved it to suit the geometry of the location. This was the inspiration for our design, both answering the complexities of the client brief and positioning the building naturally on the site.

The building is close to the railway station, which brings trains directly from Glasgow every 30 minutes. It is also next to the bus station where buses from all the local areas pick up and drop off commuters. There are bike racks for 12 cycles. The client has a green travel plan, which has been widely adopted by the National Park employees.

The orientation of the site allowed the workspaces to be placed on the north east facing side of the building to minimise glare and noise intrusion. The staff and social spaces face south and west, and the public/community spaces face north towards the village and the car park.

The form of the building was conceived early in the design phase with the aim to design out the need for mechanical ventilation in 80% of areas. This was achieved by locating offices around the perimeter of the building and enabling cross flow ventilation via a central atrium.

The building form also provided enough natural light to implement a successful background and task lighting strategy with minimal artificial lighting throughout the offices (only 200-250 lux) whilst complying with the uniformity requirements of Lighting Guide 7.

Office areas on the south façade have small windows to minimise solar gains, while office areas on the north façade have large windows to maximise natural daylight.

The office areas are arranged around a central street, which serves as the main circulation area and is lit by a continuous roof light. This rooflight, and roof lights over the southern offices, have automatically opening sections, which expel hot air as it rises through the building by stack effect. These rooflights are linked to the Building Management System (BMS).
Low Embodied Energy Materials and Local Sourcing

Natural materials are used widely in Carrochan. The main structural frame is constructed from green douglas fir. This timber was sourced in Scotland and the north of England. It was the main design idea that the building should be made of timber, with the minimal use of steel. The first floor plate is made of structural LVL beams with a plywood top layer. There are also timber load bearing external walls and timber stability walls within the design.

The natural slate roof finish, natural stone walling and natural slate paving is supplied from a single quarry in the Lake District. The timber cladding is Scottish larch. The building is well insulated and constructed to have a high degree of air tightness. The insulation in the external walls, roof and sound insulation internally is made from sheeps’ fleece. All the services are designed to be energy efficient. The air tightness was monitored throughout the construction process to ensure that all gaps in the building fabric were minimized. The Clerk of Works employed by the client was particularly vigilant on this aspect.

The timber used for the construction of the building and also for temporary works had to be from sustainable sources. The contractor had to supply Page\Park with certificates proving this, i.e. FSC, PEFC certificates. The internal finishes specified were “A” rated as per the BRE’s Green Guide to Specification.

The client wanted to keep their carbon footprint to a minimum, both with the building material and the energy use within the building. This aim has been achieved. Natural materials are used extensively through the building. There is a green timber structural frame with external facades of British natural stone, Scottish larch cladding and timber windows produced with timber from managed forests. The walls and roof are insulated with sheeps’ fleece insulation from Penrith. The roof is finished in British slate. There is also extensive use of slate flooring internally and externally.
Energy Efficient Building Services

Heating
The building has been designed to have U-values 20% better than regulations. Air tightness testing ensured that the heat required was minimised.

Heat emitters are placed in front of windows to avoid downdraughts that may influence occupants to locally increase heat emitter output. Local control of heat emitters was provided throughout to give occupants control of their local environment.

The biomass boiler system was designed with buffer vessels that act as a heat store, allowing the boiler to run at its most efficient and to reduce cycling on/off – this also minimises maintenance.

Mechanically opening windows only open once the heating system is turned off and are linked to the BMS system.

Lighting
Daylight, presence and absence controls are provided throughout the building. Artificial background lighting in office spaces is only called for if the natural light drops below 250lux in an occupied area. Individual LED task lights are provided for each occupant to increase light levels up to 500lux or whatever the task requires.

Toilets and stores are on presence detection (presence on, absence off) where no natural light exists, and absence detection (switch on, absence off) where natural light is available.

All lighting is provided via high efficient fittings ranging from LEDs to fluorescent tubes or metal halide where appropriate.

Ventilation
The building has been designed to be mainly naturally ventilated. However, when mechanical ventilation is required fans were selected based on their low specific fan power. Local fans were used due to the few scattered areas requiring mechanical ventilation.

Operation and maintenance manuals were provided along with client training on each of the systems employed. User understanding is essential to the efficient operation of the building.

Water Usage
Fittings were specified to have low water usage. WC’s have dual flushes, taps have aerated outlets and showers are low water flow.

Drainage
There is also a Sustainable Urban Drainage System for the rainwater disposal. This is in the form of a SUDS pond at the rear of the building. The pond attenuates all rainwater from the roof, easing the strain on the mains drainage system and enhancing the ecology of the site. The car park has porous paving and a swale, which channels water into the SUDS pond.

Thermal modeling
A Computational Fluid Dynamic (CFD) model was created to ensure natural ventilation sufficiently removed heat gains and avoid the need for cooling in 80% of areas. Highly efficient office equipment and lighting were specified to minimise heat gains. Night cooling is employed via the mechanically operated windows to take advantage of free cooling at night. The only two rooms with cooling are the IT server room and the AV equipment room.

Renewable Technologies
A biomass boiler is used to provide carbon neutral heating and hot water, fuelled by wood chips. The wood chips are supplied by a local firm, Our Power, that is owned by a community charity and the chips are sourced from a 30-mile radius of the building.
Sustainable Construction

Considerate Constructors Scheme
The main contractor signed up to the Considerate Constructors scheme, where guidelines on site management have to be adhered to. This entailed minimising noise and air pollution and protecting water courses from pollution. Neighbours were to be informed and consulted regarding any disruption the construction works could cause. The main contractors carried out all this with great diligence.

Recycling
During construction waste was kept to a minimum and all waste was segregated for recycling. The contractor provided us with waste management sheets, which recorded the amount of waste that was recycled. In the finished building, the client has a strict recycling policy for office waste with large recycling bins distributed around the building.

Occupier Experience

Carrochan’s attributes from an occupier’s perspective are exceptional. The overall space per person ratio has been very effectively distributed within multifunctional open plan spaces. The office area contains a variety of work environments including touch down, layout, project areas and individual workstations, all strategically located throughout the main work area.

Our staff each have very different ways of working and Carrochan effectively provides a plethora of work environments to meet their changing needs throughout their working day. Staff surveys and robust space budget and adjacency modelling at the outset secured this.

The staff amenities have been every effectively integrated within the main building through the use of the village street concept and much interaction takes place throughout the building. Six months since moving in we have completely rearranged the team layouts and the building has offered very real and exciting opportunities for different ways of working. Shortly we will be welcoming up to 20 staff from a separate public body to share our open plan office.

Carron Tobin
Executive Director the National Park Authority
November 2008

The client is very pleased with the Carrochan. They had book published about the building and even had a piece of music especially written and performed at the opening event. Carrachon feels just right for the Park Authority. It is made of natural materials and relies on natural technologies for its servicing.

The quality of the workspace is like no other office. The building is light and airy. The soft curve of the form means that even though the building is open plan you get a feeling of enclosure. The central street creates a feeling of openness and allows views across from department to department.

This building is such a contrast from the old headquarters and the employees find they are much more productive in this space because they fell happier and healthier.

The Scottish Government, as the funders, are also very happy as the Carrochan was delivered on budget and on programme.

The design team and contractor also realise that this project is very much unique.
Running and Life Cycle costs

As all the external material finishes are natural, they will weather well with age and require little maintenance. The larch cladding has an organic preservative treatment but is not coated. This timber will weather naturally and will not need to be recoated. There is a slate skirting to the base of the larch cladding, which allows bottom of the cladding to be raised above the ground and therefore protects it from water splash back.

Oak columns are used externally at the entrance canopy. Oak is much more durable than Douglas fir when used externally. Again, this is left with no finish to weather naturally.

As the building is naturally ventilated and relies on high levels of natural light, the running costs are relatively low compared to a conventional office building.

Heating costs are also low due to the fuel being locally sourced wood chips which are cheaper as they are not transported from far away. Maintenance of these systems is also low, as they are low-tech.

As the above has demonstrated, the project design has created an excellent working environment using low carbon systems, with only 31.2kg CO₂/m²/year being produced and with a cost for energy estimated at £8,242 per year.

The main challenge was to produce a building that was on time and on budget, as this was the first building after the Scottish Parliament to be directly funded by the Scottish Government. Therefore, we had to report regularly to a review body on the project progress and costs. The client also had a strong view on keeping all aspects of the sustainable design and the use of British materials.

We worked very hard to achieve this sustainable vision, and with the client, design team and contractors working closely together, the project was delivered on time, on budget and on programme.

The client sees Carrochan as an exemplar building for development in the National Park. The Authority is promoting and encouraging sustainable design within the National Park and what better way to do this than with their own Headquarters.
Earthship Biotecture: Independent, Off-Grid Architecture

By Charlotte Simmons B.Arch

I spent the past three years studying architecture at the Glasgow School of Art. As I progressed through the course I developed a personal direction that focused solely on environmental design, as well as a desire to educate people about lifestyles which care for the earth.

The brief for our final project was to design an off-grid, completely self-sustainable retreat for musicians in Scotland, which I found to be a very rewarding assignment. During the course of my research I came across Earthships and was impressed by the philosophies behind them and their integration with the earth’s cycles.

Initially I was mainly interested in the systems used within Earthships, such as draining greywater from showers and sinks into planters to grow food; but after further research and a visit to the Earthship in Fife I became convinced by the integrity of the buildings as a whole.

For my degree show I took this conviction further and designed a double storey Earthship which I worked on with an engineer for an Interact project. I was subsequently accepted onto an internship course with Earthship Biotecture in Taos, New Mexico where I helped the crew to build for a month. At weekends we also helped friends with their own Earthship projects, such as an indoor planter and a chicken coop.

Since coming back from Taos, I have been thinking of ways to incorporate Earthships concepts into my life in Glasgow.

As a first step, my flatmates and I have bought a propagator and some plant pots and are growing herbs, lettuces and beans on our window sills. We also have a more long term project to convert our shed into a greenhouse so we can grow all year round. Last week we went to the Glasgow Wood Recycling Center to see their greenhouse made from plastic bottles. Our aim is to finish the build before the spring, so we can begin to grow as soon as possible.

I realise that it is only by example that we can make a difference; by taking a step and doing it yourself. Then, hopefully, others will follow.

Earthships are passive solar homes that set a standard for sustainable architecture. They minimize reliance on public utilities and fossil fuels as they require no heating or cooling, they produce all their own power, they have a plumbing system which allows them to re-use rainwater four times and they are built from forty-five percent recycled materials.

Earthships are in use in countries worldwide. Currently there are two completed Earthships in the UK, one in Fife (Figure 1), and the other in Brighton, however there are many more in stages of planning and construction. Some of these plans include Earthship communities.

Figure 1: Fife Earthship, Scotland
Mike Reynolds, the architect and founder of Earthship Biotecture, is profoundly concerned by how many buildings depend on centralised systems for heat, light, water and sewage. He warns that as our population grows the stress on these systems is dramatically increased. Reynolds recognises the need to respond to energy, food and water shortages with a new approach to architecture. He designs (and builds) buildings that integrate themselves with the earth instead of continually taking from it:

“The Earthship has been designed to reduce our impact on the planet and increase our connection to it.”

In September of this year I spent a month in Taos on an internship with Earthship Biotecture. I stayed in a community called REACH, which was built to push the limits of Earthship design (Figure 2). Nine homes here are built at an altitude of 9,500 feet on the side of a steep mountain and have existed for twenty years without power lines, wells or sewers.

An Earthship is defined by six principles which are based on thirty five years of experimental building techniques:

- Thermal/solar heating and cooling
- Building with natural and recycled materials
- Water harvesting
- Contained sewage treatment
- Solar and wind electricity
- Food production

Earthships were first developed in Taos, New Mexico. At an altitude of 7,000 feet, and with temperatures ranging between 37°C and -30°C, these buildings maintain a constant indoor temperature between 18°C and 24°C with no back-up heating or cooling. This is achieved by using large amounts of thermal mass to naturally regulate indoor temperatures. Earthships are composed of a series of U-shaped modules which have high thermal mass and admit the sun on the south face as required.

The angle of the glazing on the south face is perpendicular to the angle of the winter solstice sun so that maximum solar gain and minimum heat reflection can occur during the coldest months. When the low sun enters the building it warms the massive walls. The walls store this heat until the surrounding air temperature drops, then slowly release it. Overheating in summer is prevented as the sun is higher in the sky and is reflected off the angled glass. It also cannot penetrate as far into the building (Figure 3).
Due to the Scottish climate, the Fife Earthship has a rigid thermal wrap and a water barrier which encase earth behind its thick walls (Figure 4). Because this earth is dry, insulated, and massive it has the same properties as the wall, and creates a large heat store for the building. This means that each wall has more than a meter of thermal mass. This method is also used in the Earthship in Wishaw, Scotland.

In addition to high thermal mass, many Earthships are earth-bermed on three sides (Figure 5). This increases the thermal mass and, if the building is buried deep enough, allows the structure to be in contact with the earth’s stable temperature (about 12°C). Earth tubes can also be buried in the berm to provide fresh air at a comfortable temperature.

### Building with Natural and Recycled Materials

Earthships are built from earth-rammed tyres which are offset like bricks to form walls (Figure 6). Earthships have been built from tyres for over twenty five years for the following reasons:

- They are found in abundance all over the planet (The UK burns approximately 40 million tires each year).
- They do not need to be manufactured into new forms before use.
- They have a high thermal mass as each tyre holds between three and four wheelbarrows of earth.
- They are durable as, once buried and plastered, their air supply is cut off so they do not rot or burn.
- They do not require a skilled labour force as they are easy to fill with earth.
- They are slightly flexible, so they move with the earth instead of resisting it.

Tyre walls are nearly three feet thick, which is wider than the requirement for conventional footings, so they can be built straight onto the ground. This means that thermal mass, structural bearing and foundations are achieved in one monolithic wall (Figure 6). The roof of an Earthship is heavily insulated for added energy efficiency.

Tom Gripeentrog, P.E.), the engineer for Dennis Weaver’s Earthship in Colorado, USA said “in my opinion . . . the construction method is equivalent to or better than the general quality, strength, effectiveness, fire resistance, durability and safety that is required by the [American] Uniform Building Code.”

Cans and bottles are also used as building bricks as they often require large amounts of energy to recycle. They can be made into walls using cement to bond them, or to create decorative details.

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2) Reynolds, Michael; Comfort in any Climate; (New Mexico, 2000); pg 50
Water Harvesting

“Why pipe water long distances . . . [using] significant electrical power . . . when water falls from the sky?” 3

Earthships are designed to catch and use water from the sky without pumping it from centralised sources. The roof of an Earthship is often corrugated metal with a propanel finish, so clean water can be collected from its surface. The water is channeled through a silt-catch and into a cistern. The cisterns are located so they can gravity-feed a Water Organization Module (W.O.M.), that filters the water to different grades, including drinking water. Water is then pumped into a conventional pressure tank to create regular water pressure. Solar hot water heaters provide hot water, or are used as a backup to an on-demand gas boiler.

Contained Sewage Treatment

Earthships have an ecological, self-contained water-recycling system which divides black and grey water and deals with them separately.

Greywater from the shower and bathroom sink is filtered through a grease trap, and then drained into an interior rubber-lined botanical cell, called a greywater planter. In this planter the water is cleaned naturally by the plant roots and a peatmoss filter and then collected in a rock bed at the end of the cell. When the toilet is flushed, a pump sucks water from the end of the planter straight back into the toilet (Figures 8-10). Edible plants can also be grown in the greywater planters.

Black water from the toilet and water from the kitchen sink (which contains food debris) run directly into a conventional septic tank where solids sink. This tank has an overflow into a rubber-lined black water treatment cell which is filled with gravel, sand, soil and robust plants. In Taos’ desert climate the black water cells create such fertile soil that vegetation is growing outside peoples’ homes, in an otherwise very arid environment devoid of much plant life. This is an example of going beyond sustainable, to restorative, design.

Worldwide, aquifers are emptying at an alarming rate and it rains all the time in the UK, yet it is not common practice to collect water from roofs. In the Taos desert, however, Reynolds has managed to design a rainwater catchment system that provides enough water for everyday use as well as for a whole jungle of plants (see ‘Food Production’). There is a lot to be learned from solutions.

3) www.earthship.net
Solar and Wind Electricity

Earthships produce all their own power using Photovoltaic panels and wind turbines. Earthships generate DC energy which is stored in batteries. The Power Organizing Module (P.O.M.) inverts DC energy stored in the batteries so AC appliances can be used. Most of the key electrical items in the home (such as the water pumps and fridge) are DC, so if the inverter has a malfunction, the running of the building will not be affected.

Earthships must provide their own power so they are independent of centralised power systems as “the ever increasing webs of wires and pipes, both above and below ground, are dangerous, unhealthy, ugly and expensive.”

4) Reynolds, Michael; *Comfort in any Climate*; (New Mexico, 2000); pg 5

![Diagram of rainwater harvesting](image)
Food Production

A space for growing food is an integral part of the design of an Earthship. This is to reduce the need for the vast amounts of oil and packaging used to deliver and protect supermarket food. The plants are watered by the greywater treatment system (as they are grown in the greywater planters), so can grow all year round.

When soaps are diluted and added to the plant water, they make the plants stronger and more resistant to pests. Bananas, grapes and avocados are good foods to start off in the planters as they are strong plants. Once these robust plants are happy in the planter, more fragile plants can be introduced, such as lettuces.

The Phoenix Earthship, Taos, has a greenhouse with birds and tree frogs living in it and is split into different temperature zones so that a variety of fruits and vegetables can be grown within it. It grows all its own food including mangoes, artichokes and bananas and has a pond with edible fish in it (Figure 11, below - The living room in the Phoenix Earthship, Taos, New Mexico).

Figure 12: Earthship in Wishaw, Scotland

The Earthship in Wishaw went under construction earlier this year (2009).

Figure 13: Section through the Earthship in Wishaw, Scotland
Earthships are beautiful, natural and rewarding homes to live in. They have been designed to integrate with the earth’s cycles, increase our connection to the planet and provide self-sufficient living. Earthships stand as examples of unique architecture.

Sources of images:
- Figure 1: Photographed by Charlotte Simmons, 2009
- Figure 2: Photographed by Magnus Popp, 2009
- Figure 3: Drawn by Charlotte Simmons
- Figure 4: Fife Earthship visitors’ leaflet
- Figure 5: Photographed by Magnus Popp, 2009
- Figure 6: Photograph provided by Greenhead Moss Community Trust
- Figure 7: Drawn by Charlotte Simmons
- Figure 8: Drawn by Charlotte Simmons
- Figure 9: www.earthship.net
- Figure 10: Photographed by Niel Jolliffe, 2009
- Figure 11: Photographed by Magnus Popp, 2009
- Figure 12: Photographed by Greenhead Moss Community Trust
- Figure 13: Provided by Greenhead Moss Community Trust
- Figure 14: Photographed by Magnus Popp
Towards a Sustainable Built Environment

By Dr David Grierson, University of Strathclyde Glasgow

Sustainable development aims towards improvement and increased quality of life for all on a planet that is finite in its physical resource and its capacity to absorb waste. As defined by the Brundtland Commission report (WCED, 1987) the term implies that a balance can be achieved between human socio-economic activities and the natural environment’s capacity to provide resources and absorb waste on a global scale. Recent research indicates, however, that globally our demand began to outstrip the Earth's carrying capacity in the 1980s (Wackernagel et al, 2002). Today the ecological footprint of the world population/economy exceeds the total productive area (or ecological space) available on a planet (Rees et al, 1996).

Essentially we have gone beyond that which the environment can afford. Excessive levels of production and consumption, resulting from economic growth models that equate success with material throughput, are causing excessive levels of environmental impact. Although we cannot say with certainty at what rate or to what extent, evidence suggests that we are now damaging the biosphere, perhaps beyond repair. The application of the precautionary principle (EU, 2003) has been proposed as one way of addressing uncertainty and offering a practical way to pursue environmental sustainability (Tickner et al., 2001).
The scale of resource use and environmental alteration currently attributable to the construction industry dwarfs most other industrial sectors. Globally environmental sustainability will depend on the successful implementation of measures to reduce the negative impacts of the built environment on the natural environment.

A response to the precautionary principle within architecture lies in the design of buildings that satisfy needs while demonstrating increasing material and energy efficiencies. Buildings consume energy and resources and generate waste on a huge scale. Current construction methods tie us into future patterns of resource and energy use, waste emissions and environmental damage. When poorly designed our buildings leave a lasting legacy for the next generation that extends adverse social, economic and environmental impacts throughout their life cycle.

The Scottish Executive’s A Policy for Architecture in Scotland acknowledges that the complex and challenging sustainability agenda requires fundamental change in our understanding of the nature and purpose of buildings and the role of building design (Scottish Executive, 2006).

Governments cannot achieve sustainable development on their own. Making decisions, and developing policies, that address issues of global environmental sustainability, including the better management of natural, community and economic resources, must be made at all levels of our activity (local, national and international).
For many organisations, the international standard for environmental management systems, ISO 14001 (International Organisation for Standardisation, 1996), forms an appropriate template for the management of their environmental performance. Since it was introduced in 1996, and with its subsequent adoption as a key component in the revised Eco-management and Audit Scheme (EMAS Regulation), there has been widespread and growing use in many sectors.

Research into the implementation of environmental management systems within the wider context of sustainable development has raised issues of fundamental importance to the understanding of the concept if appropriate action is to be taken. In particular, consideration has been given as to how a practical realisation of such a system might be applied to the lifecycle of a building, including the design phase.

We need visions of a more sustainable future that can provide the current generation of designers and planners with sufficient motivation without impairing their capacity to learn what might be the best direction for change.

At the same time we urgently need to improve the energy and environmental performance of the global built environment.

An improved building design process aided by appropriate management tools and regulatory frameworks that address sustainable development issues is suggested here as a way forward.
International Agreements

Viewing sustainability as an integral part of all development has been embedded in international declarations, conventions and other plans for action in recent years. The Earth Summit in June 1992 in Rio de Janeiro was a defining event in the sustainable development movement and resulted in several important international agreements including *Agenda 21* (UNCED, 1992) and the *UN Framework Convention on Climate Change* (UNFCCC 1997). Under Article 12 of the framework many countries attribute greenhouse gas (GHG) emissions from buildings to be in the range 20-30% of their total national emissions. Studies have shown that GHG emissions are increasing at a rapid rate. Even the most optimistic reports expect GHG emissions in the housing sector to have increased by 15% above 1990 levels by 2010. The *European Union Energy Performance of Buildings Directive* was published on the 4th January 2003 (EU, 2003). The overall objective of the Directive is to promote the improvement of energy performance of buildings within the Community taking into account outdoor climatic and local conditions, as well as indoor climate requirements and cost-effectiveness. Each EU member state was required to transpose the Directive into law by the beginning of 2006 with a further three years being allowed for full implementation of specific articles.

Towards Sustainable Design

The European Commission’s policy document *Towards a Thematic Strategy on the Urban Environment (2004)* outlines problems and challenges facing Europe’s urban areas focusing on 4 priority themes. These themes, selected in conjunction with stakeholders, are urban environmental management, urban transport, sustainable construction and urban design. The themes are cross-cutting in nature and have strong links with many environmental issues offering scope to make progress in improving the quality of the urban environment. For each theme, the Communication sets out the nature of the challenges, what action has been taken so far at the European level and ideas for what further action should be undertaken to address better the challenges identified. The Commission starts with the premise that the knowledge and techniques needed to bring about significant improvements in environmental performance in urban areas are already known. Whilst there are some gaps in knowledge, the focus of the Strategy should then be on achieving clear changes in urban areas rather than calling for further consideration of the issues. The Commission recognizes that towns and cities themselves are best placed to develop the solutions to the problems they face and proposes that a framework be established to support them in this task. It proposes that targets should be established at the local level through the adoption of environmental management plans and sustainable urban transport plans for urban areas. Appropriate strategic design at the planning scale of any new proposal, particularly where a large volume of housing is involved, is an important aspect of achieving sustainable development goals and in creating the foundations of a sustainable community.
Ecohomes is a version of BREEAM for homes. Balancing environmental performance with quality of life issues it was developed by the Building Research Establishment (BRE) and offers an authoritative rating for new, converted or renovated homes, and covers houses and flats.

In February 2008 the UK Government confirmed that a mandatory rating against the Code for Sustainable Homes would be implemented from 1 May 2008. The Code measures the sustainability of a new home against categories of sustainable design, rating the ‘whole home’ as a complete package. It uses a 1 to 6 star rating system to communicate the overall sustainability performance of a new home and sets minimum standards for energy and water use at each level and, within England, has replaced the Ecohomes scheme.

The Code provides information to home buyers, and offer builders a tool with which to differentiate themselves in sustainability terms.

There are mandatory minimum levels of performance across 7 key issues:

- Energy efficiency /CO₂
- Water efficiency
- Surface water management
- Site waste management
- Household waste management
- Use of materials
- Lifetime homes (applies to Code Level 6 only)

While not exhaustive the list above indicates the diverse range of issues to be considered at the planning stage of a proposal. Many of the same issues are relevant at the design and construction stages of individual buildings and structures.

Building for sustainable development involves using design and construction methods and practices, which strive for integral quality (including economic, social and environmental performance) in a very broad (or holistic) way. Sustainable building design will consider the entire life cycle of buildings, taking environmental quality, functional quality and future values into account. A respect for all people, demonstrated through the provision of a healthy, functional, accessible and attractive built environment, is vital in promoting social sustainability. Similarly the efficient use of construction budgets, building material and labour within an organized management system will promote economic sustainability. Environmental sustainability will require the rational use of natural resources and the appropriate management of the building stock. This will in turn help to save scarce resources, promote energy conservation and improve environmental quality. Environmentally sustainable buildings aim to lessen their impact on our environment through energy and resource efficiency.

There are a number of assessment methods and tool designed to help UK construction professionals understand and mitigate the environmental impacts of the developments they design and build. BREEAM buildings can be used to assess the environmental performance of any type of building (new and existing).
Alarmed at the level of carbon emissions in the building design and construction industry, the UK Government has produced energy efficiency targets to be met through the Building Regulations and the Energy Performance of Buildings Directive. Housing consumes around 30% of the UK's total energy and generates 27% of it CO2 emissions (DCLG, 2007). If the UK is to continue to meet its commitment towards reducing CO2 emissions it must not only upgrade existing housing stock but must ensure that new homes are built in a way that works towards this goal.

The UK Government's ambition is for all new domestic dwellings constructed by 2016 to meet requirements for a “zero carbon” home. Zero carbon is defined by the UK Government as a home “that, over a year, the net carbon emissions from energy use in the home would be zero” (DCLG, 2007). A series of incremental requirements are applied. These steps as initially proposed in the Building a Greener Future: Towards Zero Carbon Development document require an initial 25% reduction in energy/carbon performance, then 44% by 2013, followed finally by zero carbon in 2016.

These dates and performance requirements are currently subject to a consultation process directed by the Department for Communities and Local Government. The greatest difficulty will be in the transition from the 44% to the 100%. This difficulty is compounded by the Code Level 6 requirement of 100% on-site renewable power generation. Micro-generation is difficult at this scale with perhaps the only currently available source of reliable power being biomass CHP. Employing this technology on a national scale is not yet viable.

There are economic challenges to the zero carbon approach. Improving environmental performance will increase capital costs ad inevitably these will have to be absorbed by the home owner. Additional regulation will increase costs for planning and building control. And there will also be increased material costs and assembly costs on site. The UK Government expects that the additional cost of constructing a Code level 3 home to be around 2-3% (around £2000) per dwelling, increasing to 4-7% (around £4000) for a Code level 4 home. It is difficult to estimate the future cost of a Code level 6 zero carbon home in 2016 however some estimates suggest up to 30% cost increase (DCLG, 2007).
Level 1 and Level 2 Strategies

However, implementing many sustainable building design features during the design and construction phases can be justified on cost grounds because they carry little or no additional cost. They can simply be regarded as good design practice and essentially become embedded within the general design decisions of the scheme. In particular, decisions taken early in the design stage of a project, with respect to social issues, passive solar and low energy principles relating to site and orientation, the form and fabric of a building, and the selection of appropriate building services, can have a major impact on energy savings throughout the building's life cycle and can address issues of fuel poverty. These broad design aspects have an important role in the energy performance of a building should be considered at the outset when establishing sustainable strategies for the building design. These are described as Level 1 strategies.

Level 2 strategies refer to innovative and technology-based sustainable building design features, and energy saving systems and equipment where there is significant additional capital cost associated and where difficulties can be encountered in the process of implementation (this may include, for example, the application of renewable energy systems such as photovoltaic (PV) panels or biomass heating).

The decision on whether or not to adopt level 2 features, systems and equipment in a building will often be made on an economic basis, generally by assessing a rate of return on an investment. A typical way to calculate this has been to use the simple payback period calculated from the following formula:

\[
\text{Payback} = \frac{\text{Capital cost of energy saving feature (£)}}{\text{Value of energy savings per year (£/y)}}
\]

To be deemed worthwhile, industry usually requires a payback period of less than 3 years.

Towards a Sustainable Design Management System

Work undertaken in Scotland at the University of Strathclyde, Department of Architecture, in recent years has explored the articulation of a generic system for sustainable design on two specific and interrelated scales; dealing with both planning issues and building design strategies. The sustainable design management system (SDMS) is aligned with the international standard ISO 14001 and involves the development of a template for managing an organisation’s performance set against pre-determined policy and priority.

The basis for the system has been recently piloted in a number of housing development projects around Glasgow. It is important to acknowledge that the system is not a replacement for the creative design process but offers a supporting framework for the implementation of agreed actions by the design and construction team, and various stakeholders.

ISO 14001 (Environmental Management) was first published in 1996 and specifies the actual requirements for an environmental management system. It applies to those environmental aspects which an organization has control and over which it can be expected to have an influence. Similar in intent with regard to wider issues of sustainability, the SDMS is applicable to any organization that wishes to:

- implement, maintain and improve a sustainable design management system
- assure itself of its conformance with its own stated SD policy (those policy commitments of course must be made)
- demonstrate conformance
- ensure compliance with appropriate laws and regulations
- seek certification of its SDMS by an external third party organization
- make a self-determination of conformance.

The system involves general requirements, policy, planning, implementation and operation, checking and taking corrective action, and management review. A design & construction organisation would identify elements that impact on issues of sustainability and access relevant legislation.

Objectives for improvement and a management program to achieve them would be produced with regular reviews for continual improvement. An auditing authority can periodically assess the system and, if appropriate, register the organisation as SDMS compliant.

The system, as it is currently defined, addresses a number of key urban planning issues and building design strategies while considering six key related themes as follows:
1. Human Impact (including quality of life issues, consultation and social inclusion, development factors, comfort levels, health factors, accessibility, public transportation, facilities for cyclists, etc.)

2. Environmental Impact (including protection of local ecological features/biodiversity, environmental assessment, etc.)

3. Pollution Prevention (including indoor air quality (emissions from equipment, out gassing of toxins/radiations), elimination of toxins, control of pollutants during constructions, etc.)

4. Sustainability Management (including integrated and systemic approaches e.g. sustainability/environmental performance targets, management systems and procedures, construction management, commissioning, dissemination workshops, post-occupancy feedback visits, etc.)

5. Resource Efficiency (including, lean design, material use and recycling, embodied energy, water consumption and conservation, etc.)

6. Energy Efficiency (including, targets, benchmarks and best practice energy use, passive solar, renewable energy, thermal modelling, insulation, ventilation, heating, CHP, heat recovery, etc.)

The above themes are aligned with aspects of the international standard ISO 14001 and offer a basis for the development of a sustainable buildings management system. This allows for the identification a number of tasks that need to be undertaken relating to the design, construction and the operation of sustainable environments.

In line with the UK Government Department of Environment, Food and Rural Affairs (DEFRA) description of sustainable building sustainable design strategies for urban development should:

- fit well with the needs of the local community
- leave as small an environmental footprint as possible
- be economic to run over its whole life cycle
- be designed and constructed to enable occupants to use less water, through, for example, the involve the installation of more efficient fittings and appliances
- provide good access to public transport in mind
- minimise waste in construction
- maximise re-use of on-site materials such as waste soil
- be energy and carbon efficient, designed to minimise energy consumption, with effective insulation and the most efficient heating or cooling systems and appliances
- make recycling easy for the occupants.

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Scottish Executive (SE) *Scottish Planning Policy SPP 6 Renewable Energy* (Commissioned by the Scottish Executive, March 2007)


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