CICSTART ONLINE

INNOVATION REVIEW

ISSUE 8, September 2011

SUSTAINABLE BUILDING DESIGN AND REFURBISHMENT IN SCOTLAND

ONLINE KNOWLEDGE BASE
EDINBURGH CENTRE ON CLIMATE CHANGE
PHOTOVOLTAIC THERMAL HEAT RECOVERY SYSTEMS

CIC START ONLINE

The Scottish Green List 2010

European Structural Funds

Best Practice Awards 2010

CIC Start Online was shortlisted in two categories:

BEST PARTNERSHIP WORKING

BEST CONTRIBUTION TO A "GREENER" SCOTLAND

EUROPE & SCOTLAND
European Regional Development Fund
Investing in your Future

FUNDING AVAILABLE THROUGH CIC START ONLINE FOR:

- **27 FEASIBILITY STUDIES – up to £5,000 each**
- **8 ACADEMIC CONSULTANCIES – up to £3,000 each**

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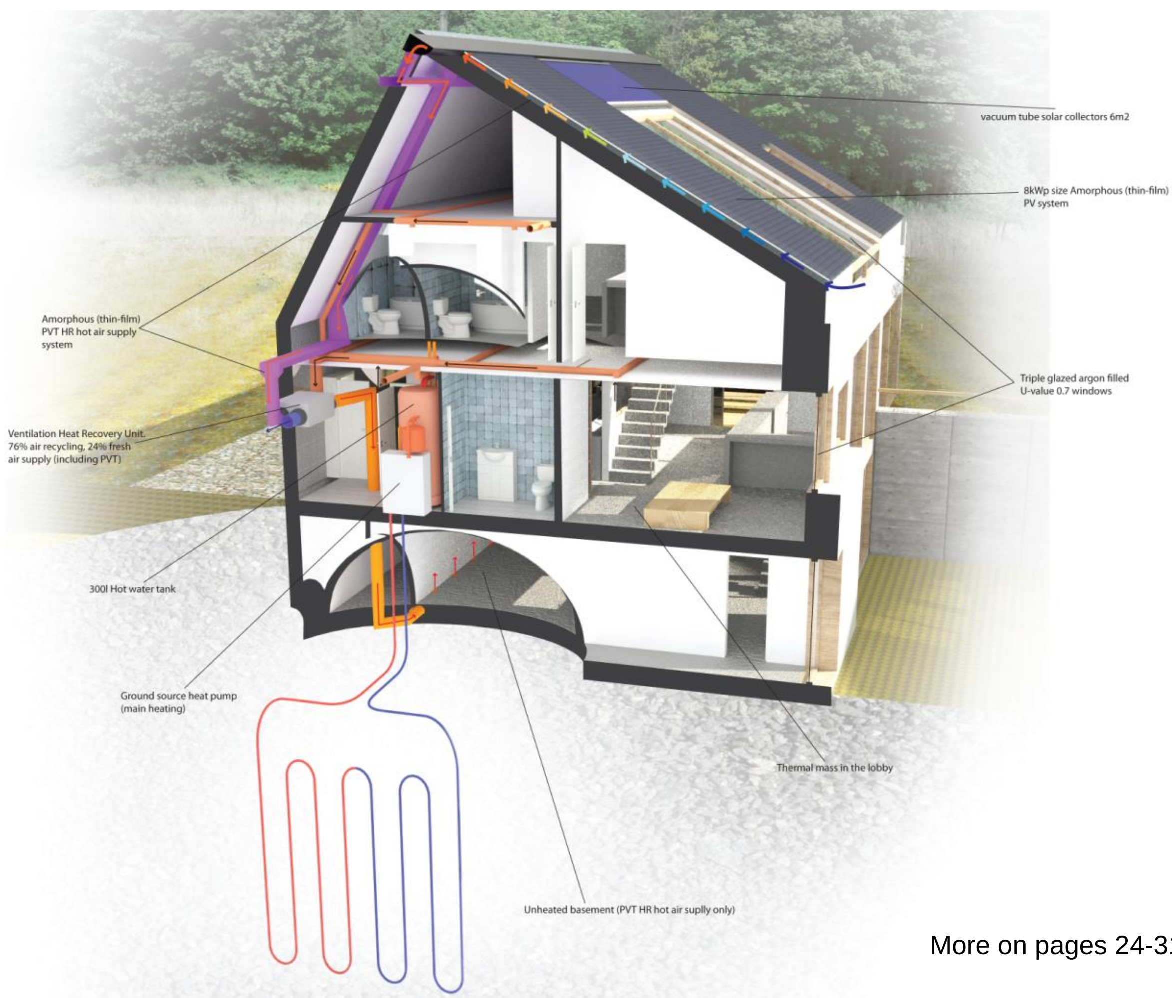
Photovoltaic Thermal Heat Recovery Systems



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CICSTART ONLINE

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 CO_2 emissions and other negative environmental impacts from buildings
  - To reduce fuel poverty and improve indoor climate
  - To create jobs and support competitiveness of Scottish construction industry through innovation
  - To remove the barriers to the application of innovation in practice

- HOW?
  - Through competitions for academic/industry feasibility studies and for 10-days free academic consultancy on sustainable building design and refurbishment
  - By testing innovations at the testing facilities of the project partners' institutions
  - By publishing guidelines for the application of innovations in practice
  - By developing and publishing database of design solutions for sustainable refurbishment
  - By providing assistance and advice on sustainable building design and refurbishment to Scottish small to medium sized enterprises
  - By disseminating the project outcomes through the project website, seminars, interactive webinars, webcasts and three whole-day online events that will include an exhibition, a conference and networking facilities
  - By publishing information on products and services for sustainable building design and refurbishment offered by Scottish small to medium sized businesses registered with CIC Start Online.

BENEFITS OF FREE MEMBERSHIP

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

Please click here to access the registration page at the project website

www.cicstart.org

PROJECT PARTNERS

Glasgow Caledonian University

Edinburgh Napier University

Mackintosh School of Architecture, The Glasgow School of Art

Heriot Watt University

Robert Gordon University • Aberdeen

The University of Edinburgh

University of Strathclyde Glasgow

FUNDED BY

The Scottish Government

EUROPE & SCOTLAND
European Regional Development Fund
Investing in your Future

OUR ONLINE KNOWLEDGE BASE

Welcome to the 8th issue of Innovation Review!

CIC Start Online membership has reached the figure of **800** individual members from **601** organisations of which **400** are small to medium size enterprises based in Scotland.

We have slightly reorganised our website to enable easier search for videos and articles on sustainable building design and refurbishment, including all published issues of our quarterly online magazine Innovation Review. Videos and articles can be found within six themes: Decision making, Planning, Design, Construction, Refurbishment and Performance, representing the main processes in building life from the decision to build until the assessment of performance through post occupancy evaluation. Each group has subthemes that will be further expanded as new themes emerge within our videos and articles. The contents of each group and subgroup are presented on pages 8-19. You can access them through the search wheel on our website's home page.

The next submission deadline for applications for feasibility studies and academic consultancy is 15 September 2011. We would like to invite the members from Scottish small to medium size enterprises to apply for the remaining **27 awards for feasibility studies (up to £5,000 each) and 8 academic consultancies (up to £3,000 each)** to test or improve products or services for sustainable building design and refurbishment. Please see the call for applications on page 6.

Our webinar series will start in October. Information on forthcoming events will be provided in our E-News in September. **Sponsorship of seminars, webinars and our forthcoming online conference are welcome** – please contact Craig.Bishop@gcu.ac.uk, 0141 273 1401, for more information on sponsorship opportunities.

Our conference programme has been further developed. We will organise **six live conferences** at the universities involved in CIC Start Online, starting from February 2012.

We welcome the members' in-depth articles on sustainable building design or refurbishment projects, or the products manufactured or services offered to achieve more sustainable built environment.

The articles for the next issue should be submitted by 15th November 2011. If you would like to discuss the contents of your article, please contact me at Branka@cicstart.org, 0141 273 1408. I look forward to receiving your articles for the future issues of Innovation Review.

Kind regards,

Branka

CALL FOR APPLICATIONS FOR FEASIBILITY STUDIES AND ACADEMIC CONSULTANCIES

Submission deadline: 15 September 2011

- **27 awards for feasibility studies (up to £5,000 each)**
- **8 awards for academic consultancy (up to £3,000 each)**

Please see information on how to apply and download the application forms at our website in the sections Feasibility Studies and Academic Consultancies at www.cicstart.org. You can also watch a video on ‘How to Apply?’ at the same pages.

If you do not know what university could assist you or have any questions regarding the application, please send an email to

branka@cicstart.org.

We look forward to receiving your applications!

INNOVATION REVIEW

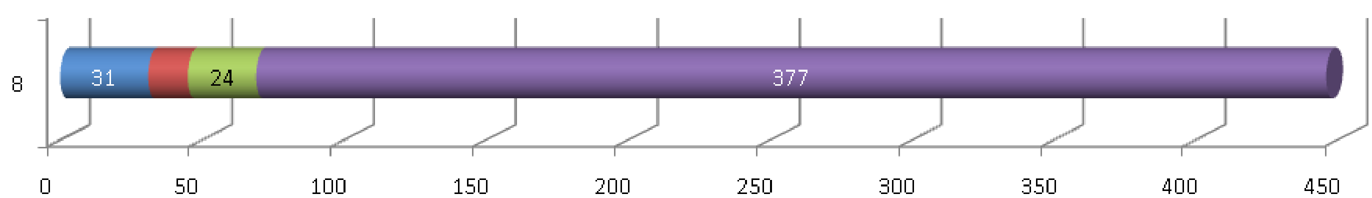
We have a wide readership of over 800 industry professionals and decision makers within Scottish small to medium sized enterprises. Our members cross multiple sectors but all maintain a unifying interest in sustainable building design and refurbishment in Scotland.

We are offering an excellent value proposition of £50 for a half page advert in our quarterly magazine, or £90 for a full page.

Contact Craig Bishop on 0141 273 1401 or cbishop@cicstart.org for more information

CONFERENCE WEBCAST VIEWING FIGURES

Within less than one month, our conference webcast on Energy Communities has been viewed by nearly **450 *on demand* visitors.**



We are also happy to report that **290 attendees** were online ***LIVE*** over the conference week

FEEDBACK

"... a thoroughly interesting presentation.. " "... Thoroughly enjoyed the experience ..." – Ola Uduku

"... the Webinar format was an excellent way for me to obtain both technical information & CPD time efficiently & effectively without the need for travelling... " – Duncan Campbell

CIC Start Online Knowledge Resource Library

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DECISION MAKING

Policies

Title	Format and source
Energy Efficient Buildings Policies – EU perspective, Ecole des Ponts ParisTech, France	Video – Build with Care Conference
A transnational view – planning and policy issues, Robert Gordon University	Video – Build with Care Conference
The energy and sustainability standards in Scottish building regulations, Directorate for the Built Environment, Scottish Government	Video – Build with Care Conference
The local view – Aberdeen City, Aberdeen City Council	Video – Build with Care Conference
Energy Performance Certificates (EPCs) in housing, Immobilière des Chemins de Fer, France	Video – Build with Care Conference
Towards a Sustainable Built Environment, by Dr David Grierson, University of Strathclyde Glasgow	Article - Innovation Review, 1, Dec 2009, pp. 70-77.
Raising the Standard, by Bill Dodds, Scottish Building Standards Division	Article - Innovation Review, 2, March 2010, pp. 16-18.
Build with CaRe project and conference, Mohamed Abdel-Wahab, David Moore and Amy Smith, Robert Gordon University	Article - Innovation Review, 4, September, 2010, pp. 10-12.
Sustainability labelling in Scottish building regulations, by Stuart Watson**,** Directorate for the Built Environment, Scottish Government	Article - Innovation Review, 5, December, 2010, pp. 12-13.
Airtightness and the new Scottish Building Standards, by Gordon Park, BSRIA Airtightness	Article - Innovation Review, 7, June 2011, pp. 20-21.

Practice

An Investigation of the Adoption of Low-Carbon Technologies by Scottish Housing Associations, Robert Gordon University and Anderson, Bell and Christie Architects, Glasgow	Video of a webinar
Development of an Economic Assessment Tool to Calibrate Cost Effectiveness of Energy Efficiency and Waste Reduction Measures for Low Energy Housing Delivery and Operation, Glasgow School of Art and NRGSTYLE LTD, Prestwick	Future webinar video
The benefits and options for the retrofit of an 18th century traditional Scottish house using the Passivhaus standard, Edinburgh Napier University and SA Estates, Cellardyke, Anstruther, Fife	Future webinar video
*The problem of rural SME contractors and sustainable technologies***,** Robert Gordon University	Video – Conference 2010
Tackling Fuel Poverty by Improving the Energy Efficiency of Scotland's Housing Stock, by Norman Kerr, Director, Energy Action Scotland	Article, Innovation Review, 2, March 2010, pp. 19-22.

Building Standards Scotland

Section 7: Sustainability
Non-domestic

Gold
Silver: Partly Achieved
Bronze Star: Heat Pump
Bronze: Section 1-6, 2010 Standards

Building / Development:
64 Greenstreet,
Bigtown
XX9 9XX

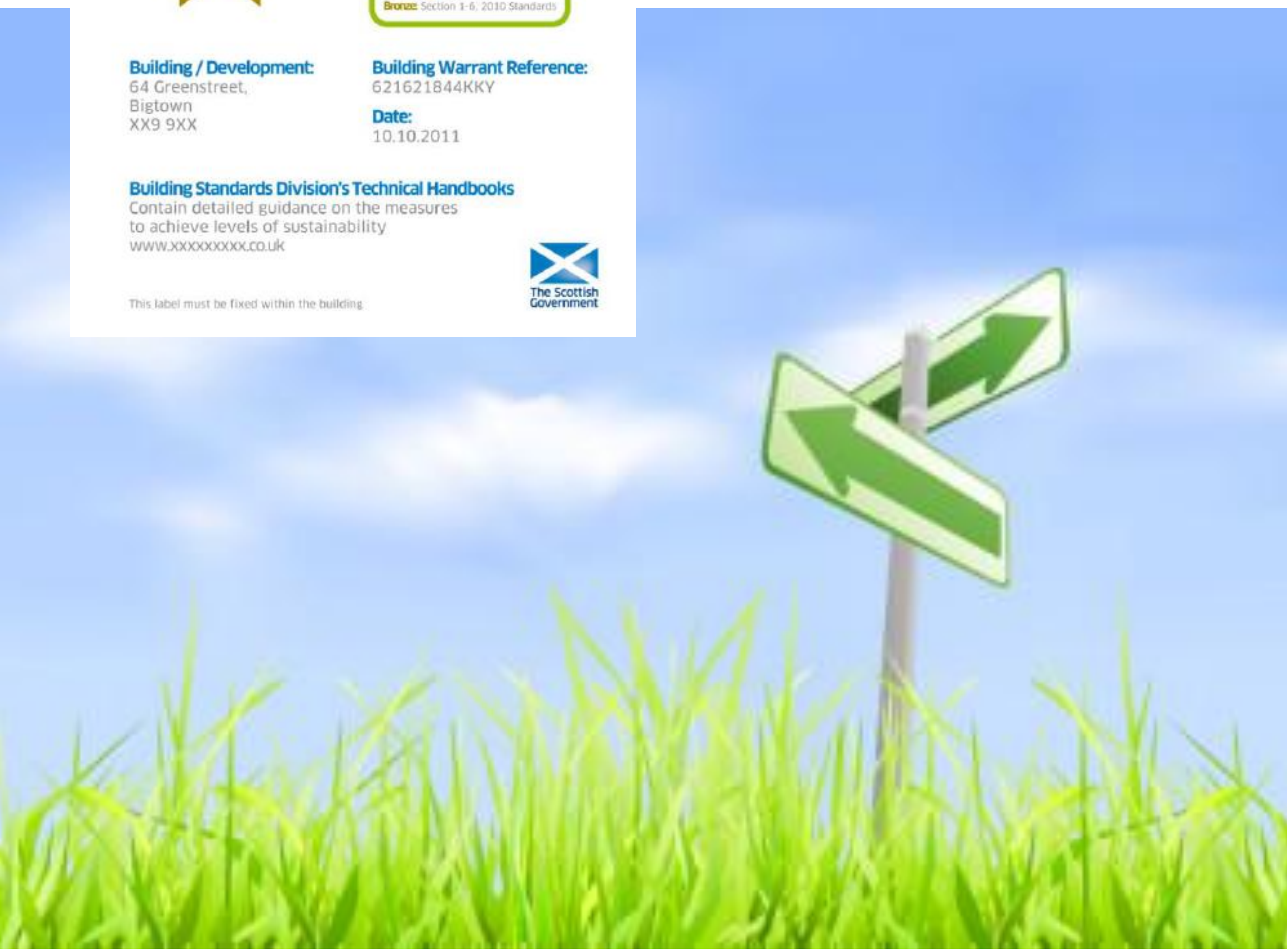
Building Warrant Reference:
621621844KKY

Date:
10.10.2011

Building Standards Division's Technical Handbooks
Contain detailed guidance on the measures
to achieve levels of sustainability
www.xxxxxxxxx.co.uk

This label must be fixed within the building

The Scottish Government



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PLANNING

Climate Change

Title	Format and source
Urban Heat Island: Managing local climate change to enhance resilience of cities, Glasgow Caledonian University	Video – Conference 2011
*Flooding resilience: avoidance, resistance and recovery***,** Heriot Watt University	Video – Conference 2011
*Learning from Scotland's Housing Expo: Making resilient buildings and neighbourhoods***,** University of Edinburgh	Video – Conference 2011
Exploring the link between Lighting, Regeneration and Sustainable Place Making, by C. Houston and G. Hogan of Collective Architecture Ltd, Glasgow	Article, Innovation Review, 3, May 2010, pp. 39-50.
Whitecross Village near Linlithgow, by Clive Albert (Malcolm Fraser Architects) and Stewart Dalgarno (Stewart Milne Homes)	Article, Innovation Review, 5, December, 2010, pp. 18-27.
Graz Insights - Environmental Siedlungs: Lessons from site visits prior to Eurosun 2010, 29th September to 1st October, by Prof. Colin Porteous, Mackintosh Environmental Architecture Research Unit, The Glasgow School of Art	Article, Innovation Review, 6, March 2011, pp. 42-55.
Urban microclimate study in Glasgow, by Rohinton Emmanuel, Glasgow Caledonian University & Eduardo Kruger, Technological University of Parana, Brazil	Article, Innovation Review, 7, June 2011, pp. 24-28.

Accessibility

Title	Format and source
Towards a Visible City for Visually Impaired Users, University of Strathclyde Glasgow	Video – Conference 2011

Image by Cadell^{2} -J. Cadell, AREA

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DESIGN

Principles

Title	Format and source
Principles and Processes Related to Sustainable Building Design, University of Strathclyde Glasgow	Video – Conference 2011
Tarryholme Sustainable Housing Project, University of Strathclyde Glasgow and Assist Design, Glasgow	Future webinar video
Enkelt Simple Living, Glasgow School of Art and Ballyconnelly Construction Ltd, Wemyss Bay	Future webinar video
A case study of passive houses in Aberdeenshire, Robert Gordon University	Video – Build with Care Conference
Inverdee House, Scottish Environment Protection Agency (SEPA)	Video – Build with Care Conference
Carrochan: Loch Lomond and the Trossachs National Park Authority HQ, Balloch: A low Carbon Approach to Building Design, by Karen Pickering, Page/Park Architects	Article, Innovation Review, 1, Dec 2009, pp. 56-62.
Earthship Biotecture: Independent, Off-Grid Architecture, by Charlotte Simmons	Article, Innovation Review, 1, Dec 2009, pp. 63-68.
Passive solar PassivHaus paradigm for Scotland in zero-carbon quest? By Prof. Colin Porteous, The Glasgow School of Art	Article, Innovation Review, 2, March 2010, pp. 32-46.
Affordable Low Allergy Housing, by Prof. Sandy Halliday, Gaia Research	Article, Innovation Review, 2, March 2010, pp. 47-56.
The Glasgow House: A 'low-tech' approach to the problem of fuel poverty, by Stuart Carr, PRP Architects	Article, Innovation Review, 3, May 2010, pp. 24-30.
A Scottish Passive 'Hoose', by Ross Barrett, Associate, HLM Architects	Article, Innovation Review, 3, May 2010, pp. 31-38.
BRE Innovation Park @ Ravenscraig, by Dr David Kelly, BRE Scotland	Article, Innovation Review, 4, September, 2010, pp. 16-20.
The WholeLife House at Scotland's Housing Expo, by John Brennan, Brennan and Wilson Architects	Article, Innovation Review, 4, September, 2010, pp. 21-25.
More support, less obstacles: how we need to encourage innovation in housing, by John Gilbert, John Gilbert Architects	Article, Innovation Review, 4, September, 2010, pp. 26-29.
Acharacle Primary School, Ardnamurchan, by Howard Liddell, GAIA Architects	Article, Innovation Review, 4, September, 2010, pp. 30-34.
Low Energy Dwelling, by Angus Calder, Simpson & Brown Architects	Article, Innovation Review, 4, September, 2010, pp. 35-41.

Title	Format and source
The Flower House at Scotland's Housing Expo 2010, by a+j burridge	Article, Innovation Review, 5, December, 2010, pp. 28-43.
The Skewed House, by Oliver Chapman, Oliver Chapman Architects	Article, Innovation Review, 5, December, 2010, pp. 44-49.
The Hardcore Softhouse: Scotland's Housing Expo, Plot 26, by Christopher Platt, studioKAP architects	Article, Innovation Review, 6, March, 2011, pp. 20-29.
The Modular House – Plot 15 – Scotland's Housing Expo, by David Keith**,** Bracewell Stirling Consulting	Article, Innovation Review, 6, March, 2011, pp. 30-41.

Renewables

Title	Format and source
A Hybrid Solar Thermal Mass (HSTM) System Development for the Application to Tenants First Housing Co-operative's Zero-carbon Affordable Homes, Glasgow School of Art, Edinburgh Napier University and Tenants First Housing Co-operative, Aberdeen.	Video of a webinar
Energy Impact of different strategies of integrating PV/Thermal heat transfer, Glasgow School of Art and Robert Ryan Timber Engineering Limited, Saltcoats	Future webinar video
Novel Solar Thermal Collector Design, Heriot Watt University and AES Ltd, Forres	Video of a webinar
New wood pellet storage facility for biomass heating systems, Edinburgh Napier University and Glendevon Energy, Kinross	Future webinar video
*Use of solar PV and hot water for buildings***,** Edinburgh Napier University	Video – Conference 2010
The Solar Refurbishment of Scotland, Heriot Watt University, AES Solar, Changeworks, Lister Housing Co-op	Video – Conference 2011
Solar-Wall systems for domestic heating: an affordable solution for fuel poverty, Heriot Watt University, Changeworks Resources For Life Ltd and Ormandy Ltd, Edinburgh	Video of a webinar
*Energy co-operatives as a means of achieving sustainability within the housing sector***,** Edinburgh Napier University	Future webinar video
Industry Aspirations for Building Integrated Photovoltaic Thermal Heat Recovery Systems, Dr Masa Noguchi, The Glasgow School of Art	Article, Innovation Review, 8, September, 2011, pp. 22-29.
A Hybrid Solar Thermal Mass (HSTM) System Development for the Application to Tenants First Housing Co-operative's Zero-carbon Affordable Homes, Glasgow School of Art, Edinburgh Napier University and Tenants First Housing Co-operative, Aberdeen.	Video of a webinar
Energy Impact of different strategies of integrating PV/Thermal heat transfer, Glasgow School of Art and Robert Ryan Timber Engineering Limited, Saltcoats	Future webinar video
Novel Solar Thermal Collector Design, Heriot Watt University and AES Ltd, Forres	Video of a webinar
New wood pellet storage facility for biomass heating systems, Edinburgh Napier University and Glendevon Energy, Kinross	Future webinar video

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DESIGN

Simulation

Title	Format and source
Simulation-based design tools: real time energy systems performance information, University of Strathclyde Glasgow	Video – Conference 2010
*The theory of self-organising built environments as a response to carbon levels***,** Robert Gordon University	Video – Conference 2011
Independent verification of a climate based worldwide building energy index, Glasgow Caledonian University and IES Ltd, Glasgow	Video of a webinar
Environmental Design Teaching Model, University of Edinburgh and IES Ltd, Glasgow	Future webinar video
Assessment and Application of Zero Carbon Building in Scotland, HWU and IES Ltd, Glasgow	Video of a webinar
Optimization of economic, environmental and energy savings in buildings, Edinburgh Napier University and Eurocapital Group Ltd, Edinburgh	Future webinar video
Taking Analysis Out of the Architects' Back Room, By Dr Craig Wheatley, Integrated Environmental Solution**s**	Article, Innovation Review, 2, March 2010, pp. 26-29.

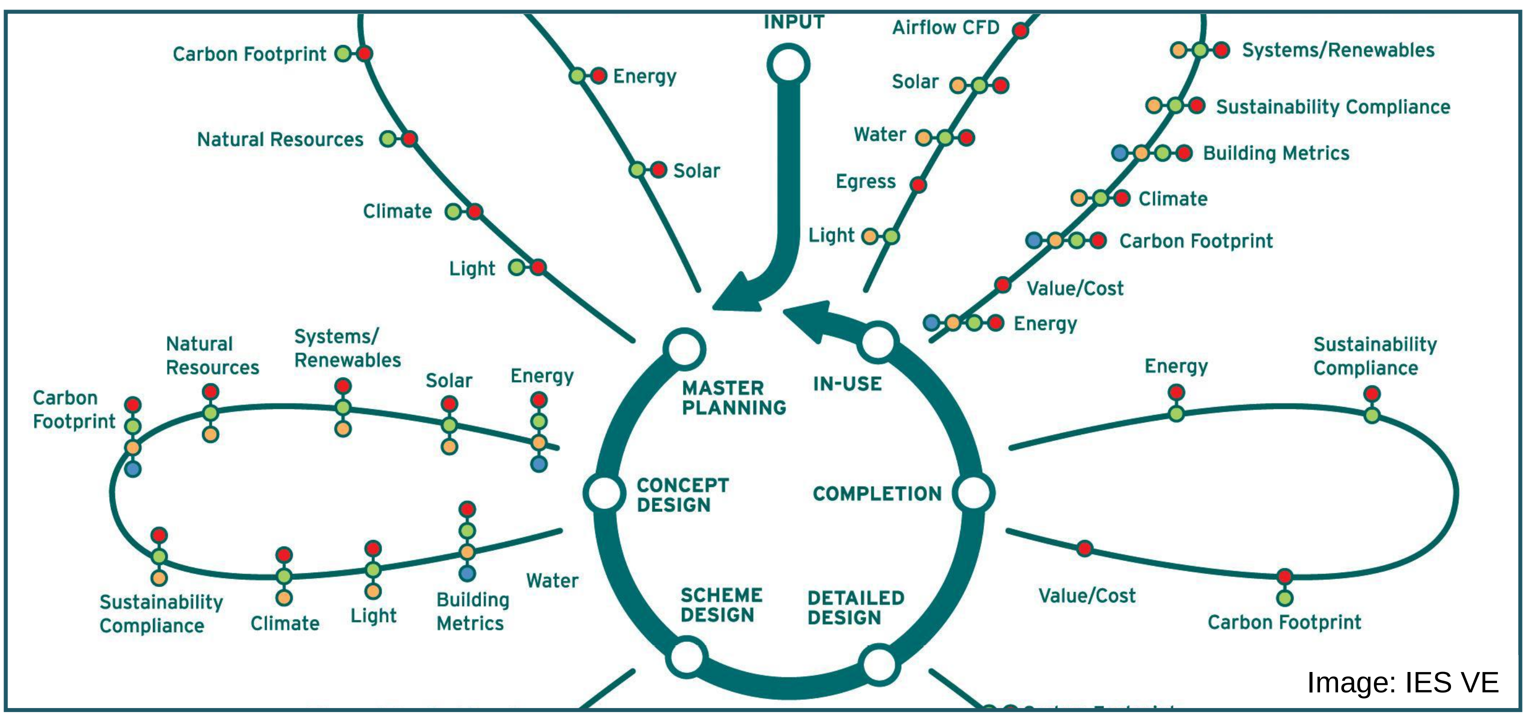

Image: IES VE

CONSTRUCTION

Materials

Title	Format and source
Developing Homegrown Natural Fibre Insulation Products, Glasgow Caledonian University and Kraft Architecture, Glasgow	Future webinar video
Testing of Natural Composite Material based on Earth, Wool and Alginate, University of Strathclyde Glasgow, Glasgow Caledonian University and ARC Architects, Auchtermuchty, Fife	Future webinar video
Testing and Evaluating Recycled Plasterboard Prototypes to assess Thermal and Moisture Performance for Suitability as Insulation Material, Glasgow Caledonian University and First Option Services Ltd, Kelty	Future webinar video
Investigating new Markets for Recycled Plasterboard, Glasgow Caledonian University and First Option Services Ltd, Kelty	Future webinar video


Image: ARUP

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REFURBISHMENT

Domestic

Title	Format and source
Tenement Flat Carbon Reduction Shopping List, University of Strathclyde Glasgow and Holmes Partnership, Glasgow	Video of a webinar
Upgrade Strategy Development for Garrioch Residents Association, University of Strathclyde Glasgow and Collective Architecture, Glasgow	Video of a webinar
Synergy of Fabric and Energy conservation in older historic properties, Edinburgh Napier University and The Morrison Partnership, Edinburgh	Future webinar video
Testing of a method for insulation of masonry and lath walls in existing domestic Scottish construction, Robert Gordon University Aberdeen and Craigie Levie, Aboyne, Aberdeen	Future webinar video
Energy Efficiency Improvements in Tenements, Edinburgh Napier University and Lanarkshire Housing Association, Motherwell	Future webinar video
Retrofitting of Solar Photovoltaic Panels in Existing Housing Stock of a Registered Social Landlord in Edinburgh, Edinburgh Napier University and Malcolm Homes Ltd, Edinburgh	Future webinar video
Solar PV Feasibility Project in Glasgow, Edinburgh Napier University and Easthall Park Housing Co-operative Ltd, Glasgow	Future webinar video
Towards improving energy efficiency in traditional buildings, Glasgow Caledonian University, Historic Scotland, Changeworks and Lister Housing Co-op	Video – Conference 2010
Upgrading Glasgow's Social Housing Stock- reflections on 1990's demonstrations and 21st Century reality, Glasgow School of Art	Video – Conference 2010
*Retrofit and renewables in traditional rural buildings***,** University of Edinburgh	Video – Conference 2010
Gilmour's Close: Edinburgh World Heritage Site Low Carbon refurbishment, by Andy Jack, Assist Architects	Article, Innovation Review, 1, Dec 2009, pp. 48-55
Energy Efficiency and Microgeneration in Traditional and Historic Homes, by Nicholas Heath, Changeworks	Article, Innovation Review, 2, March 2010, pp. 69-77.
Historic Scotland: Innovative solutions to make traditional buildings more energy efficient, by Moses Jenkins, Historic Scotland	Article, Innovation Review, 3, May 2010, pp. 18-22.
First Scottish SuperHome, by Andy Maybury	Article, Innovation Review, 6, March 2011, pp. 15-19.

REFURBISHMENT

Non-domestic

Title	Format and source
1 Alexander Thomson Place (formerly Caledonia Road Church): A Regeneration Proposal, by Architects Gholami Baines	Article, Innovation Review, 2, March 2010, pp. 58-68.


Image: Assist Architects

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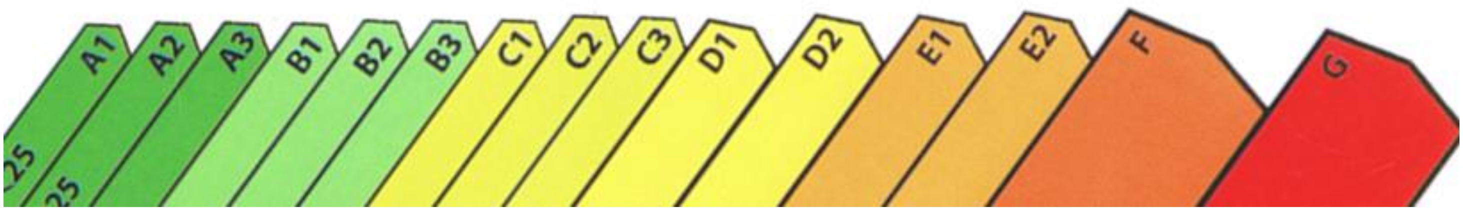
PERFORMANCE

Occupant Behaviour

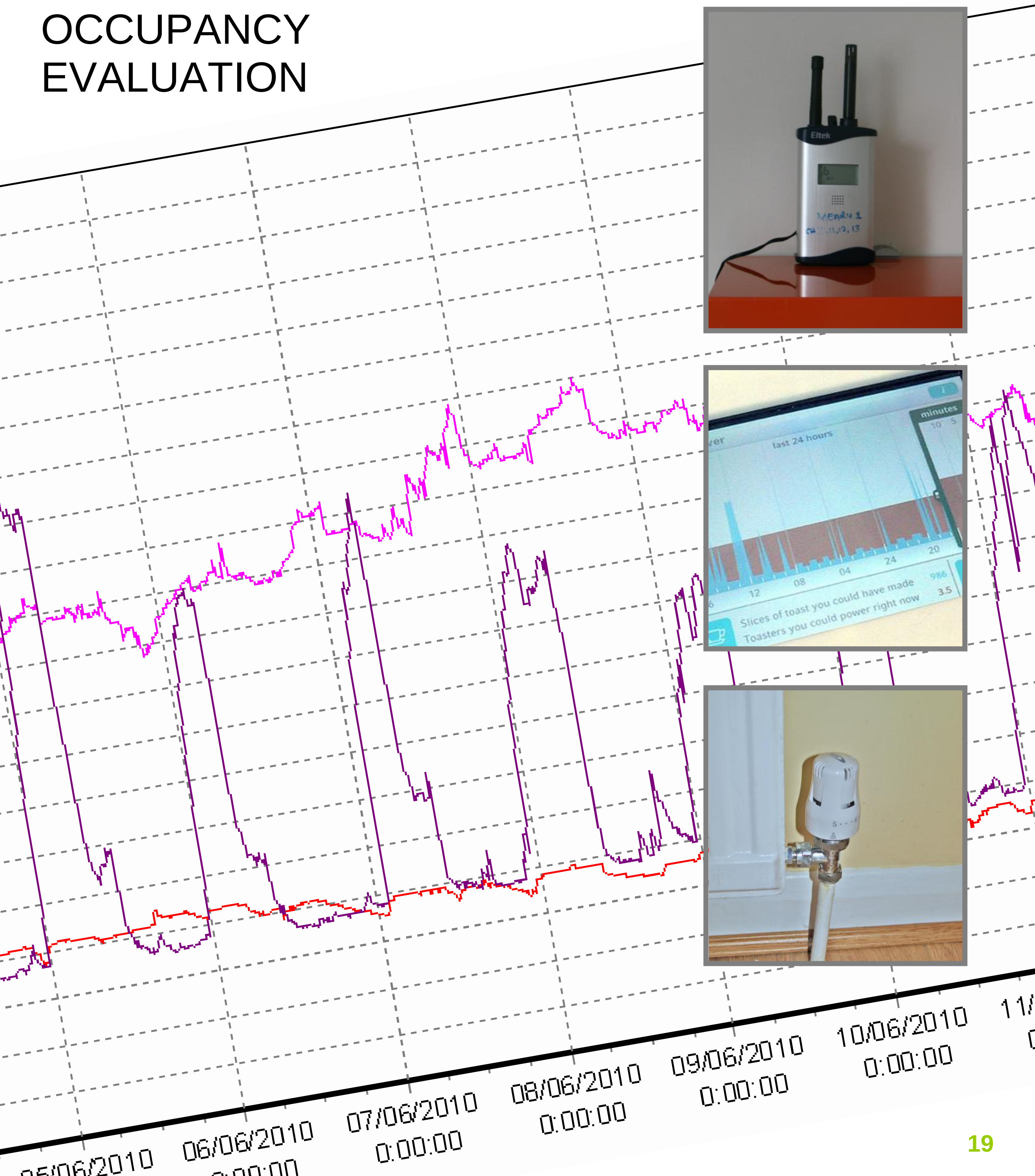
Title	**Format and source**
Resilience to Occupancy: Findings from recent Post Occupancy Evaluation projects, Glasgow School of Art	Video – Conference 2011
Developing a template for quick start user guides for new home owner, Glasgow School of Art and The Property Log Book Company Ltd, Edinburgh	Future webinar video



Post Occupancy Evaluation

Title	**Format and source**
Embedding simplified post occupancy evaluation in design process, University of Strathclyde Glasgow and Page and Park Architects, Glasgow	Video of a webinar
Development of Post Occupancy Evaluation for evaluation of innovative low carbon social housing projects, Glasgow School of Art and John Gilbert Architects Ltd, Glasgow	Video of a webinar
In-service testing of a prototype dwellings in relation to passive versus active ventilation strategies and assessment of air quality and comfort balance with fuel poverty avoidance, University of Strathclyde Glasgow and Assist Design, Glasgow	Future webinar video
9-11 Gilmour's close – comparing the theoretical performance of a suite of sustainable installations in the building against actual performance and user experience Glasgow School of Art and Assist Architects, Edinburgh	Future webinar video
Post Occupancy Evaluation of Municipal Terrace, Dumfries, Glasgow School of Art and Dumfries & Galloway Housing Partnership (DGHP), Dumfries	Future webinar video
Application of a low cost wireless sensor network into a low-carbon built environment: Apple Green House by Glasgow Caledonian University and AppleGreen Homes, Glasgow	Future webinar video
Assessing the environment and energy impact of occupant behaviour and spatial & temporal diversity in PassivHaus homes in Scotland by Glasgow School of Art, Robert Gordon University and Fyne Initiatives, Rhotesay, Isle of Bute	Future webinar video

POST OCCUPANCY EVALUATION



Synergy of Fabric and Energy Conservation in Older Historic Properties

Seminar and interactive webinar on Thursday, 10 November 2011, at 12:30

Speakers:

Julio Bros Williamson, Scottish Energy Centre, Edinburgh Napier University
Dr. Cameron Purdie, The Morrison Partnership

The Morrison Partnership (Architects) are involved with a private client who wishes to convert and extend a 19th century traditional built two storey mansion house in Alyth, Blairgowrie, Perth & Kinross, Scotland. The proposal is to convert the this former hospital to a home and in doing so, the SME require to propose an energy efficient heating system for both space and hot water which is not only sustainable but respects the behaviour and appearance of the existing historic building fabric. The academic consultancy has identified appropriate actions in achieving minimal fabric intervention for maximum energy conservation in traditional buildings with specific reference to solid stone/ lath & plaster wall construction typical of the 19th century in Scotland. Much of the Victorian and Edwardian building stock in Scotland has many features and characteristics of both materials and construction techniques to commend itself. Implementing energy conservation measures into this fabric balance can have a deleterious effect and so the need for synergy between fabric and energy conservation is of growing concern.

The key drivers for this project include rising fuel poverty levels for owners of large domestic difficult to heat properties, the growing threat of global warming and climate change, and the specific national target of reducing carbon emissions by 42% by 2020. This last driver will prove ever more difficult to achieve since new build housing stock will not constitute as great a percentage of the housing stock in 2020 as previously assumed.

This is due, in the main, to the recent downturn in house building and likely low levels of completion over the coming years. The main focus for carbon reduction in the housing sector must therefore switch to seeking affordable and practical ways of achieving energy conservation in existing buildings. Currently, existing homes account for over 25% of the UK's total carbon emissions. Part of that sector, and prevalent across Scotland as a result of the nation's heritage, are medium and large scale rural residences. These properties are often listed or carry a particular style characteristic internally or externally which make it difficult to apply many of the modern range of energy gimmicks or applied solutions in an acceptable manner.

The project aimed to address:
1. Environmental issues by seeking methods of reducing CO_2 emissions and improving energy conservation and management in older difficult to heat stone built properties.
2. Social issues by improving health as a result of improved and balanced indoor air and heating quality.
3. Economic issues by considering whole-life energy costs in large domestic difficult to heat buildings in Scotland.

The study aimed to establish:
1. A detailed energy assessment process for the building study type that could be used in other similar projects.
2. Future research and improvement work in this area to develop and market an energy management process for this building study type.

Sustainable Refurbishment

Exhibition and event on Tuesday, 25 October 2011, at 16:00
Talks in room A426, Govan Mbeki Building, Glasgow Caledonian University
Exhibition and networking in Garden Cafe (ground floor)

16:00 **Welcome,** Tony Kilpatrick, School of Engineering and Built Environment, Glasgow Caledonian University (GCU)

16:10 ***Sustainable refurbishment and restoration***: ***Collaboration between Historic Scotland and GCU***, Roger Curtis, Historic Scotland

16:20 **Case studies**

Natural Energy and Efficiency and Sustainability in Existing Buildings, Dr Rohinton Emmanuel
A proposal for sustainable refurbishment of the Lion Chambers in Glasgow, Dr Branka Dimitrijevic

17:00 **Reinforced Concrete Condition Assessment in Architectural Heritage**, launch of the book by B. Dimitrijevic (GCU), A. Guida and A. Pagliuca (University of Basilicata); Presentation of the copies of the book to the organisations that assisted in the research.

17:10 Networking cocktail

18:00 Close

This is FREE EVENT, but please let us know if you will attend by contacting
David O'Neill at 0141 273 1411 or at David@cicstart.org.

CICSTART ONLINE

Edinburgh Centre on Climate Change

Bridging the gap between good ideas and positive actions to ensure a low carbon economy

ECCC EDINBURGH CENTRE ON CLIMATE CHANGE

Sign up and become part of the ECCC community: http://www.climatechangecentre.org.uk/sign-up.html

Small and medium sized businesses are under increased pressure to survive, both from a fragile commercial climate and greater expectations from policy makers to implement green measures but support is at hand from the Edinburgh Centre on Climate Change. Located in Scotland's capital city and the first of its kind in the UK, ECCC has a bold vision to become one of the world's leading centres for supporting the innovative ideas and solutions that will help create a low carbon economy, in Scotland and beyond.

The Edinburgh Centre on Climate Change is hosted by the University of Edinburgh, Heriot-Watt University and Edinburgh Napier University, creating a unique platform for combining excellence in research, enterprise, investment and innovation.

The Centre **has 3 clear functions:**

Innovation Centre: ECCC brings together policy makers, academics, entrepreneurs and industry leaders to tackle the challenges of delivering a low carbon future.

Executive Training and Postgraduate Education: ECCC co-ordinates expert training and education that will help meet the skills needs of decision makers, business leaders, experts and innovators.

Hub: As a virtual and 'bricks and mortar' **low carbon hub**, ECCC creates a space and place for risk taking and knowledge sharing among vibrant communities, networks and partnerships of 'low carbon' leaders.

Each of these areas is geared towards accelerating businesses towards greater energy efficiency, cost control and sustainability.

Andy Kerr, Executive Director
of Edinburgh Centre on Climate Change

Executive Director Dr Andy Kerr explains:
"The Centre has already started its work with SMEs and we are currently planning our engagement with that community in respect of the educational element - to start in 2012. We have had good feedback that senior executives of mid to large companies recognise the need to ensure their workforce - and those of their supply chains - are supplied with skills to take advantage of the rapidly changing market opportunities of low carbon / clean tech revolution.

Small companies understandably have less focus on these courses and more on survival, so we are also seeking to support the growth of companies that develop low carbon products and services. Our focus is on senior/mid level executives, while others are focusing on apprenticeship level qualifications.

We are planning the first executive education courses here at the Centre early in the new year (2012). And although all the courses are open to international participants, we are for example working to offer similar courses in China and India, we are focusing on meeting Scottish needs as well.

The first Carbon Management Masters has been running under the auspices of University of Edinburgh for a couple of years and the first Carbon Finance Masters course starts in September, and we are working with a couple of very large companies and their global supply chains to develop appropriate courses to meet their professional needs. We are also working with Strathclyde Uni with one such company.

Each university has niche capability, but we believe ECCC provides a better approach to tackling low carbon and resilience problems that crosscut the existing expertise in the three universities and that crosscuts other expertise in other universities. "

Far from being a burden on businesses therefore, the Edinburgh Centre on Climate Change intends to help Scottish businesses turn climate risks and increased pressures from policy makers into opportunities for growth and prosperity and believes that by creating a global centre for excellence right in their back yard, the Scottish business community can become leaders in the march to a low carbon economy.

For more information about the ECCC community and what the Centre's activities can do for your business, visit http://www.climatechangecentre.org.uk.

Become part of the ECCC community by signing up to our mailing list:
http://www.climatechangecentre.org.uk/sign-up.html

An artist's impression of the new Centre building, completion set for 2012.

Industry Aspirations for Building Integrated Photovoltaic Thermal Heat Recovery Systems

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

The International Energy Agency indicates energy use in buildings worldwide accounts for over 40% of primary energy use and 24% of greenhouse gas emissions. Energy use and emissions should include both direct, on-site use of fossil fuels as well as indirect use from electricity, district heating/cooling systems and embodied energy in construction materials. National Housing Federation claims that housing in the United Kingdom (UK) is responsible for 27% of carbon dioxide (CO_2) emissions. In particular, Scottish homes today are conspicuous energy consumers emitting on average 3 ton-CO_2 per house annually which is much higher than the UK average of 2.75 ton-CO_2. The UK's fuel poverty issue is on the rise. In fact, 26.5% of households in Scotland alone live in fuel poverty according to Scottish House Condition Survey 2008. In order to encourage the house-building industry to move towards the mass delivery of eco-friendly houses, the Code for Sustainable Homes was introduced in 2006.

Following the code, the UK government now expect the industry to achieve their bold zero-carbon housing target by 2016. Despite the policy, the homebuilding industry today is barely ready for accomplishment of such sustainable housing agenda. Given the national and international challenges related to climate change and resource shortages, much more is required than incremental increases in houses' energy efficiency.

To take the initiative to meet the societal needs, governmental expectations and industrial obligations, ROBERTRYAN Homes is currently developing design ideas and solutions towards the construction of zero-energy healthy houses. The housing prototype has been called *Z-en house* aiming to achieve the net zero energy housing consumption in view of the UK government's recognised Standard Assessment Procedure (Fig.1).

Figure 1: South-west Façade Image of the Z-en House: ROBERTRYAN Homes
(Source: MEARU, Mackintosh School of Architecture)

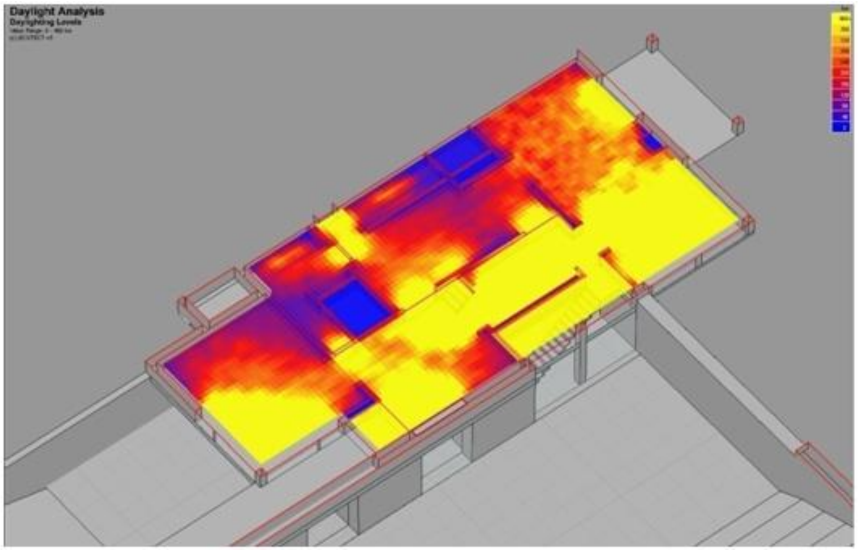


Figure 2: Daylight Analysis of the Zen House Ground Floor (Source: MEARU, Mackintosh School of Architecture)

The construction site has carefully been selected in consideration of the solar access and sun shading potentials. The large south facing windows to be installed in the house also contribute to optimising the use of natural light and solar gains (Fig.2).

The Z-en house is a single detached home to be built in a new rural residential development in West Kilbride, Scotland. The floor area of this house is approx. 346m^2 excluding the basement floor area and the exposed wall area was estimated at 279m^2. The house contains 4 bedrooms and a study and semi-private spaces, such as a kitchen, dining room, lounge, and sunspace family room, are on the ground floor. A basement is also introduced to this project, designed to serve as a multifunctional space in which thermal mass components are installed heavily so as to capture heat from the sun and active hybrid renewable energy technologies including the BIPV/T MVHR system which is relatively new to the homebuilding industry in the UK (Fig.3).

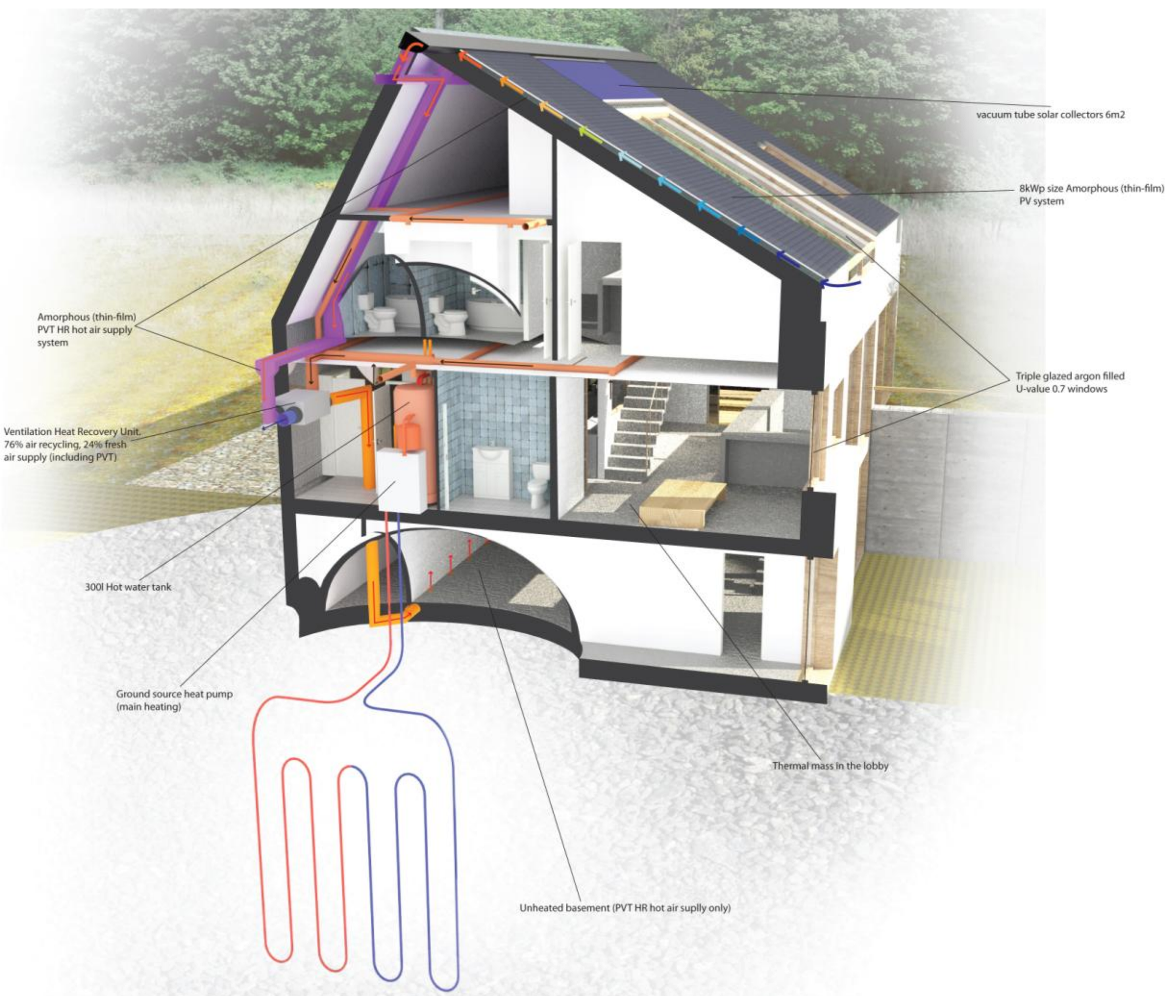


Figure 3: BIPV Thermal Mechanical Ventilation Heat Recovery System's Schematic Diagram (Source: MEARU, Mackintosh School of Architecture)

The Z-en house is aiming to meet the net zero-energy target based on SAP 2009 and encompass passive solar housing design techniques and active hybrid renewable energy technologies. The design features being considered currently can be summarised as follows:

- Elongation of the south-facing façade for optimisation of solar gain and day-lighting opportunities throughout the building.
- Placement of large south-facing windows to achieve 45% glazing to floor ratio (including skylights) for effective balance of desirable heat gains and losses.
- Introduction of a south-side sunken garden that helps enlarge the south façade exposure to the sun and the outdoor recreational green space.
- Placement of an integral south-facing sun space equipped with the generous basement and ground floor thermal mass that is used for heat storage, as well as with the vertical ventilation void that accelerates fresh preheated or cool air circulation to upper floors.
- Placement of a pantry and storage in the north side of the house to provide air buffer for reduction of fabric heat loss from the north walls.
- Minimisation of the north façade opening areas for reduction of heat loss.
- Application of 'Accredited Construction Scheme' for reduction or elimination of thermal bridging conjunctions of the building components.
- Application of 'Insulated Concrete Form' (IFC) walls and well-insulated roofs and floors to achieve U-values of 0.15W/m^{2}K in walls and 0.1W/m^{2}K in roofs and floors.
- Installation of high thermal performance wood frame triple glazing windows accompanied by argon gas filling and low emissivity coating to maintain U-value of 0.7 W/m^{2}K. Of glazed doors, U-value is 1.2 W/m^{2}K.
- Introduction of multi-purpose basement and attic for post-occupancy renovation through DIY for reduction of initial construction cost.
- Effective placement and sizing of widows located in a north-side pantry, bathroom and bedrooms for reduction of artificial light use and heat loss.
- Effective colour coordination by applying light colour to interior surfaces in the rooms desired for natural light reflection and dark colour to thermal mass walls and floors for heat absorption.
- Use of a ground floor projection on the west side of the house, which to some extent shelters cars parked outside the garage from rainwater drips.
- Introduction of air-tight construction techniques to seal the building envelope junctions to maintain the air permeability less than 3m^3/m^{2}h at 50 Pa, where the air change rate will be kept less than 0.5 through the installation of a humidity controlled balanced mechanical ventilation heat recovery system (MVHR) whose air velocity should be higher than 1m/s.
- Provision of a multi-functional roof for weather protection and power and heat generation by the integration with 8kWp photovoltaic (PV) cells and 6m^2 solar thermal collectors.

- Introduction of a BIPV/T MVHR system with high heat exchange efficiency and a summer bypass that heats 10-30% of incoming fresh air extracted from the outside, where the air heated by PV/Thermal is supplied through MVHR outlets placed in the basement.
- Proper location of humidity controlled MVHR internal extracts particularly in the kitchen, utility room and bathrooms for 70-90% recovery of internally preheated air.
- Installation of a ground source heat pump that is used as the main space heating system where the heat is spread through the screed concrete floor heating system which also serves as thermal floor mass to store the heat.
- Alignment of the vertical placement of a kitchen, utility space and bathrooms for reduction of the total length of service and drainage pipes.
- Use of 100% dedicated energy saving lights.
- Installation of low flush plus dual flush toilets to reduce water usage.
- Installation of rain water butts to use rain water for car washing and gardening.
- Introduction of energy label A++ white goods for reduction of stand-by energy use.
- Installation of a high efficient boiler equipped with weather compensator and enhanced load compensator to maximise the performance of heat distribution accompanied by zone control multiple thermostats and programmers for energy saving.
- Installation of interactive energy and water consumption monitors for enhancement of energy-saving user behaviour and for post occupancy evaluation.
- Limited use of carpets and porous materials to mitigate the accumulation of dusts that contribute to deteriorating indoor air quality.

The Z-en house has the great potential for taking the lead to showcase the state-of-the-art passive solar design techniques and hybrid green building technologies—particularly, the BIPV/T MVHR system that is relatively new to the housing industry at national and international levels. In fact, due to the potential zero-energy housing innovations, the project team has already been invited to introduce the Z-en house design features at several industry and academic events around the globe including the Renewable Energy 2010 Conference's Zero-energy Housing Workshop held in Yokohama, Japan, and the EU-Korea Photovoltaic Applications into Buildings Forum held in Seoul, Republic of Korea. After the construction of the first Z-en house prototype, the post occupancy evaluation to analyse the value mismatch between the domestic energy simulation results and the users' actual energy consumption data gathered by ROBERTRYAN Homes will be carried out with the aim to continuously improve design and production quality of the Z-en house prototype where 3 more houses are hopefully built within next 3 years.

Observed PV/T HR System Mock-up Profile

PV/T is a hybrid PV application which produces usable energy in the form of not only electricity but also heat for heating space and/or water. The heat is a by-product of PV modules and traditionally dumped as it contributes to lowering PV power generation. In collaboration with Mr Stefan Larsson, CEO, Finsun Inresol, the Swedish delegate of the 'Zero-energy Mass Custom Mission to Japan' held in June 2010, the PV/T HR system mock-up was built in his testing facility in Alvkarleby, Sweden (60.57N, 17. 45W) (Fig.4). The mock-up was observed at the initial stage of this study with the aim to gain the knowledge of basic features and performance for further discussion on how the system should be integrated with the Z-en house in question.

In general, the higher the temperature of PV cells, the lower the power generation. Thus, the aforementioned systems were designed with the aim to maximise PV power generation by cooling the cells by either air or water.

Figure 4: PV/T HR Roof Integrated System Mock-up Built by Finsun Inresol in Alvkarleby, Sweden

To increase the power output, each row of polycrystalline silicon PV cells installed in the mock-up examined was aligned with an optical parabolic reflector; thus, the amount of sunlight on the PV surface could be enhanced drastically. In the PV/T modules, ventilation air/water ducts are created by placing PV cells vertically and horizontally (Fig.4). In the ventilated PV/T HR mock-up, both ends of the air duct are equipped with NF-P14 FLX Noctua 1.2w direct current (DC) fans which are powered by PV. Thus, the DC fans provide a self adjusting variable air flow rate in proportion to received incoming solar radiation levels—i.e. the higher the insolation the faster the PV ventilation. Each air inlet has a filter that prevents the duct and fans from physical damage associated with air dusts. The conversion efficiency of the observed air cooled PV/T HR mock-up was estimated at 17.6% when the outside temperature reaches 25°C—i.e. summer season. The possible module price was estimated at US$ 420 (£ 267.11) or US$ 1.4 (£ 0.89) per Watt.

The observation of the mock-up's performance was carried out by MEARU staff between 9th and 11th of November, 2011. Equipment to monitor the actual performance of the PV/T HR systems included: a hand held thermal camera, CO_2 and temperature meter, and air flow anemometer. The observation helped identify the performance of PV/T modules in question—particularly, the ventilated PV/T mock-up, which was regarded initially as a relevant application to Z-en house, under snowy winter conditions. This also helped identify the negative impact of snow on PV cells if the system is not integrated with building envelope (i.e. roof) properly. The snow accumulated on the warm surface of a roof (e.g. PV) melts while one on the cold part stays in place forming an ice dam under the cold ambient temperature. This may possibly lead to damaging the PV roof with water leakage.

Monitoring Results of Ventilated PV/T HR Mock-up

The reflectors installed in the PV/T HR mock-up examined could help to increase the level of solar radiation on PV cells; hence, the conversion efficiency of PV cells might be enhanced. However, the concentrated sunlight also contributes significantly to the PV cell temperature rise. It was observed that the high operating temperature of PV cells could lessen power output (Fig.5). The observed PV/T modules consist of polycrystalline silicon PV cells which can be considered as relatively more sensitive to the temperature rise than amorphous PV. Thus, the circulation of air or water under PV cells is a meaningful approach to reducing the temperature rise for sound power generation.

In view of the moderate cost and the simple configuration, the concept of a ventilated PV/T HR system may be considered as attractive and applicable to the Z-en house project. Accordingly, the system was examined further in order to identify the PV air heating potential. The inlet and outlet ventilation air temperatures and flow velocity were measured (Fig.6).

The monitoring results indicate that the air velocity associated with the ventilation fan was recorded between 0.11m/s and 0.75m/s. The temperature of PV/T outlet air was slightly higher than inlet or ambient temperature. However, due to the small size (2,368mm x 1,014mm x 235mm) of the mock-up and the limited PV capacity (300Wp), the rise of the ventilation air outlet was marginal. Between 10:00am and 11:00am, the temperature of the outlet air was recorded lower than one of the inlet.

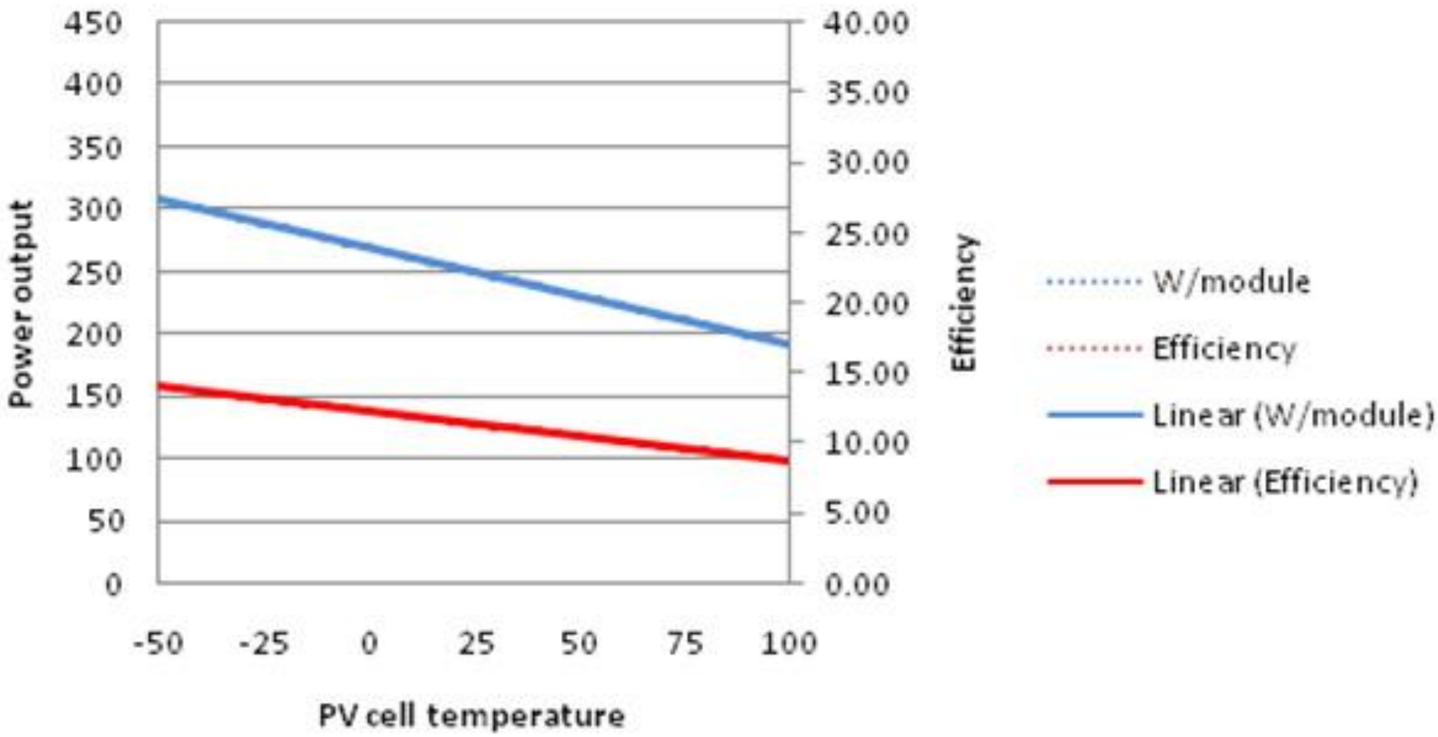
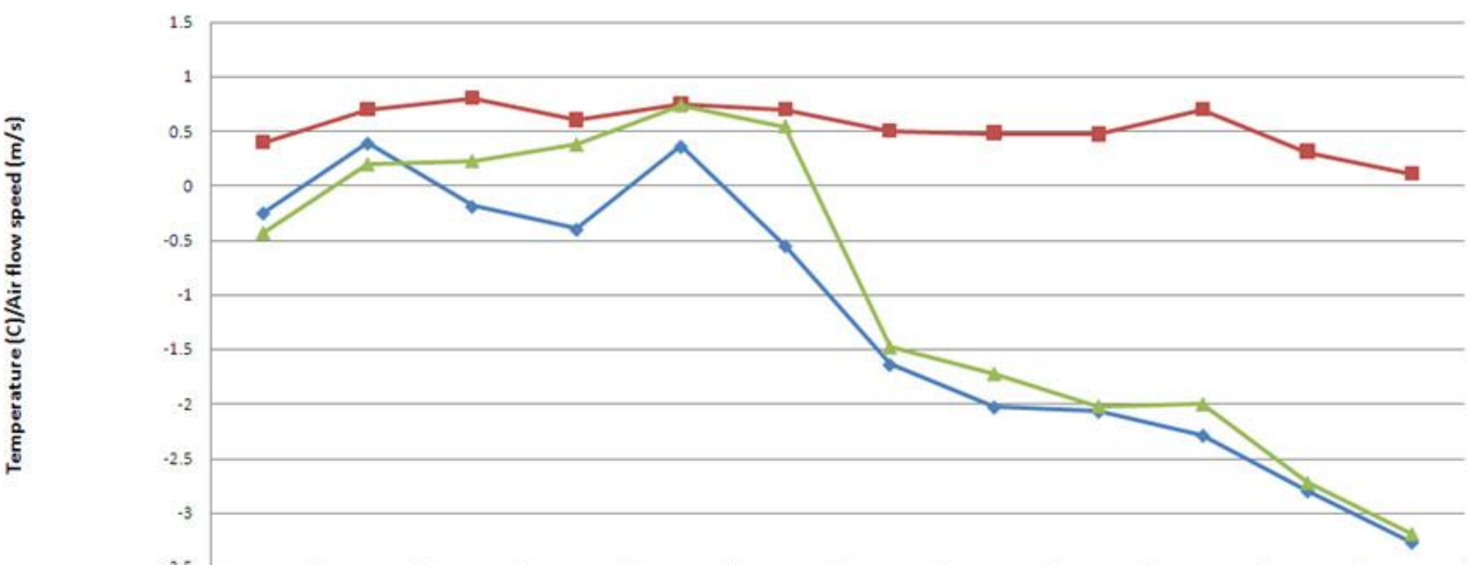


Figure 5: Co-relationship between crystalline-silicon PV efficiency and temperature



	10:00	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	15:30
Outside/inlet temp.	-0.25	0.39	-0.19	-0.4	0.36	-0.55	-1.64	-2.03	-2.07	-2.29	-2.8	-3.27
Air flow (m/s)	0.4	0.7	0.8	0.6	0.75	0.7	0.5	0.48	0.47	0.7	0.31	0.11
Outlet temp.	-0.43	0.2	0.23	0.38	0.74	0.55	-1.48	-1.72	-2.02	-2	-2.72	-3.19

Figure 6: Inlet and Outlet Air Temeparture and Velocity Monitoring Results of Ventilated PV/T HR Mock-up, 11th November 2011

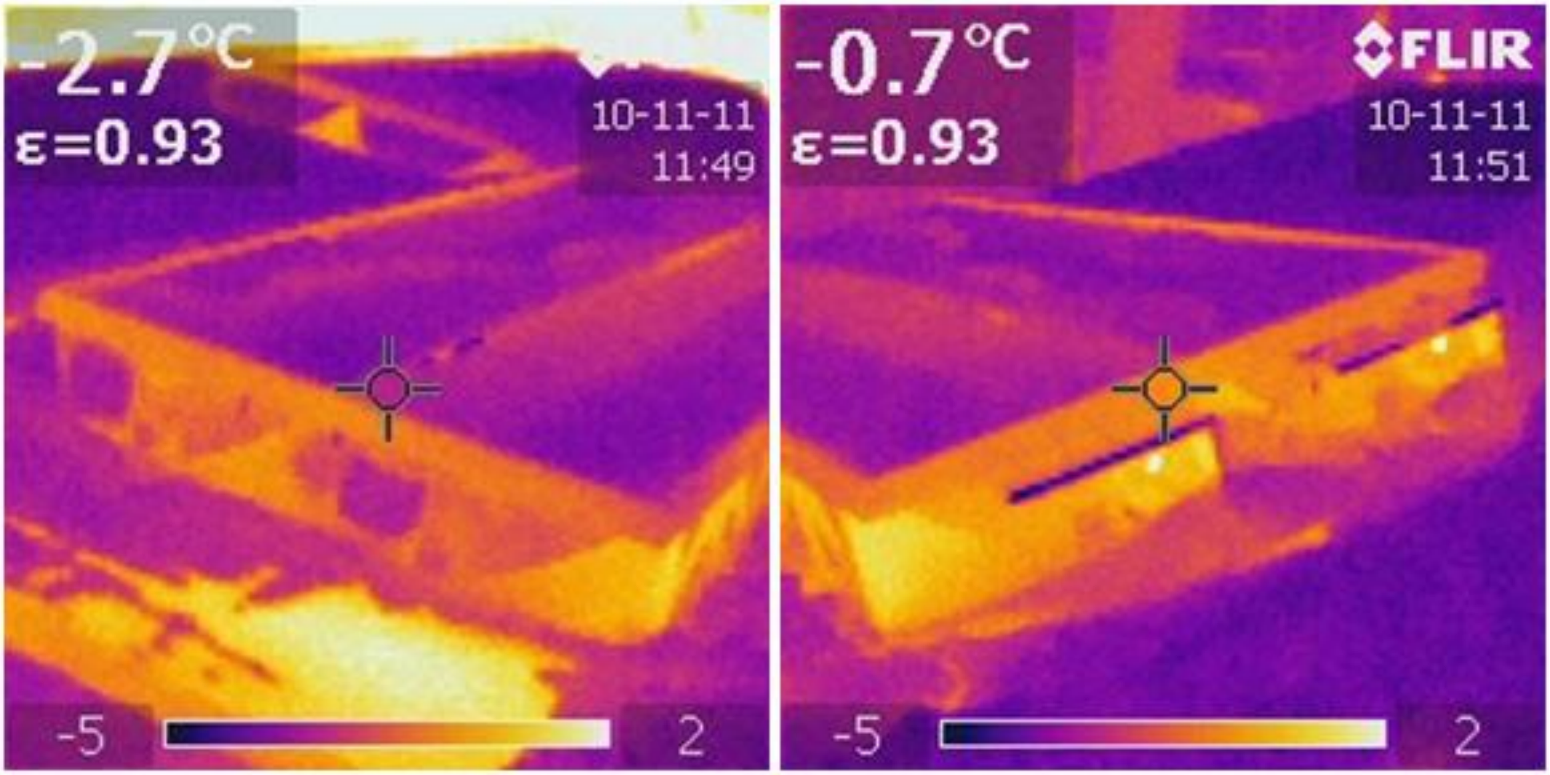


Figure 7: Thermal Image of Ventilated PV/T HR Mock-up: Air Inlet (left) and Outlet (right)

This might be attributed to the module components' cold temperature which stayed for about an hour even after the snow accumulated on the PV surface was removed for the purpose of monitoring. In addition to the inlet and outlet air temperature and velocity measurements, the thermal properties of the module components were also recorded using a thermal imaging camera on the same day (Fig.7).

The thermal image clearly indicates the temperature differences not only between inlet and outlet air ducts but also between the surfaces covered with PV cells and solar reflectors. The extreme surface temperature differences possibly lead to the ice dam formation that may damage the PV roof with water leakage, as described above.

The investigation of the PV/T HR mock-up observed helped corroborate the heat generation that can be applied for heating space and/or water. Particularly, due to the relatively simple configuration that helps reduce installation cost, a ventilated PV/T HR system approach was considered as relevant to the Z-en house development. The mock-up also demonstrated the formation of ice dams on the PV roof which should be averted by proper architectural integration. Moreover, this mock-up study led to suggestions that the PV heat rise correlates with the level of incoming solar radiation, ambient temperature, configuration of PV solar roofs, types of PV cells and the PV/T air velocity. However, the performance may differ when a PV/T HR system is installed in the Z-en house that is expected to be constructed in Scotland.

PV/T HR Performance Simulation

Accordingly, the performance of PV/T HR systems under Scottish climatic conditions were investigated in collaboration with Prof. Mitsuhiro Udagawa and Dr. Yoshiki Higuchi, Kogakuin University, by making use of the state-of-the-art *EESLISM* energy and environment simulation tool which was developed by Prof Udagawa in 1989. The study indicated that PV could generate heat which would make the air running under the PV panels 10-15˚C warmer than the outside temperature even during the Scottish winter (Fig.8). Moreover, low efficient amorphous silicon PV generates more heat than high efficient PV of the same nominal power output due to the necessarily larger area of amorphous PV roof coverage as well as the less sensitivity to temperature rise as opposed to the mono/polycrystalline counterparts.

In addition to PV types, the configuration of a PV/T integrated roof also affects the heat and power generation performance: i.e. PV roof sizes, angles and ventilation rates. For the purpose of this feasibility study that aimed to develop a guideline for PV/T HR applications to Scottish homes, the roof angle was determined to be 30˚, 40˚and 50˚.

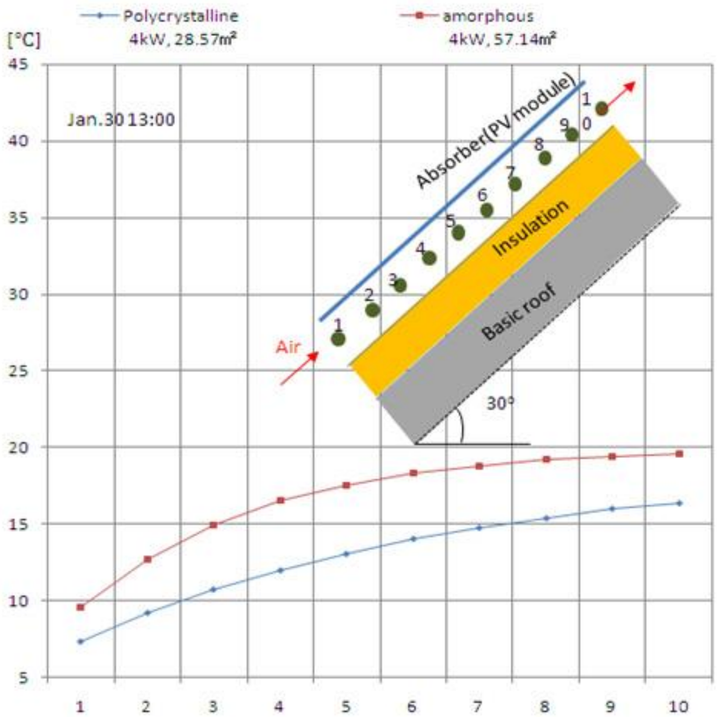


Figure 8: 4kWp Ventilated PV/T Air Temperature Profile at the Air Flow of 300m^3/h, 30th January

Lessons Learned

Amongst these design options, the roof angle of 40˚ provides the best performance in terms of both heat and power generation. Due to the lowest height amongst the options given, the 30˚ roof pitch can be considered to be most efficient in terms of the building material consumption and the associated initial cost. Nonetheless, it also contributes to lessening the amount of PV heat and power generation but the expected outcomes will be better than the PV/T roof with an angle of 50˚. performance and the most expensive approach to the construction.

When the area of the roof coverage becomes double, both low and high efficient PV panels (i.e. the conversion efficiency of 7% and 14%, respectively) tend to serve nearly twice as much to generate electricity. On the other hand, albeit the vertical extension of the PV roof from 7.14m to 14.28m (thus, the increase of the roof area from 57.14m^2 to 114.28m^2), the heat production of the amorphous PV roof with an angle of 30˚ can increase by 6% only when the velocity of ventilation air is limited to 0.5m/s and about 17% when 1.0m/s.

In the case of the polycrystalline PV under the same condition, the heat production can increase by 25% when the air velocity is set to be 0.5m/s and 43% increase with the air flow of 1.0m/s. The ventilation rate of the PV/T roof can be considered as one of the most cost-effective influential factors that help improve the heat collecting performance while contributing to cooling the temperature of PV cells. For instance, in the low efficient 4kWp PV roof with an angle of 30˚, the annual rate of heat collection can be increased by 77% when the velocity is changed from 0.5m/s to 1.0m/s and this approach is about 13 times more efficient than the mere increase of the PV size from 4kWp to 8kWp. In the case of high efficient 4kWp PV roof, 55% performance improvement can be expected and it is about twice higher than the increase achieved by enlarging the PV size itself. However, the simulation did not extend to the study of the effect of the ventilated PV/T air velocity any more than 1m/s; thus, it may be worth examining the extended scope so as to clarify the relationship between the increased air flow and the PV/T heat collecting capacity under the Scottish climate condition in depth.

Acknowledgements

The author would like to express his sincere gratitude to CIC Start Online for the financial support that realised this feasibility study and equally to Dr Branka Dimitrijevic, Director, for her constructive guidance on the grant application. Also, I would like to thank deeply Mr Billy Kirkwood, Managing Director, ROBERTRYAN Homes, for the provision of the construction site documents and the company's aspirations accompanied by his patient, effective collaboration. Also, his thanks extend to Prof. Mitsuhiro Udagawa and Dr. Yoshiki Higuchi of Kogakuin University in Japan for their technical support of the PV/T heat and power generation simulation using their own software tool called '**EESLISM' and Mr** Stefan Larsson, CEO, Finsun Inresol, in Sweden to physically demonstrate the PV/T HR system performance using their own facilities. At last, the author would also like to thank Mr Audrius Ringaila who helped monitor the physical performance of PV/T HR mock-up and visualised the Z-en house's design schemes.

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Seal Tight, Ventilate Right

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Background

As mandatory standards for air tightness in new buildings are brought into the Scottish Building Regulations the implications of these improved construction standards (for that is effectively what they represent) must be properly understood. For designers and specifiers this understanding should go beyond a knowledge of how the standards can be met to a realisation of what the effects are of constructing to mandatory high levels of air tightness.

In Innovation Review, Issue 7 (June 2011) a short piece relating to the introduction of regulated air tightness noted the benefits of air improved air tightness as
lower energy use (and associated cost savings/ reduction in carbon footprint) and increased comfort for building users.

The key driver for this change in legislation appears to be the desire to conserve energy and reduce carbon output and, of the factors noted above, this is the one which is most tangible. For professionals and building users alike it doesn't take much of a leap of imagination to see that reducing the leakage of warm air from a space will ultimately reduce the requirement to heat that space and, therefore, save energy.

With respect to the second stated benefit, however, the relationship to air tightness is less clear-cut. In this instance it would seem that a notion of improved comfort comes simply from a space being less draughty. While thermal characteristic of a space are key to an occupant's perception of comfort there are other considerations which are essential in creation of healthy habitable environs.

Internal Air Quality

Foremost amongst these considerations is the internal air quality (IAQ) - an area of increasing interest for research within MEARU.

A recent publication by Prof. Colin Porteous[1], founding Director of MEARU, sets the scene for the expectations occupants should have from their internal environments.

This piece comprehensively catalogues the historic and contemporary moves which have been made to identify a robust indicator of internal air quality; set as a maximum desirable CO_2 concentration of 1000ppm, a value that has endured form the 1870s until the present despite significant cultural and physical changes to typical indoor chemical cocktails.

In relating this maximum to IAQ it is important to understand that it is not the concentration of CO_2 itself that is problematic to occupants (unless in exceptionally high concentrations) but that this quantifiable value is relative to the rate of air change. It is an indicator for the potential of internal pollutants to concentrate and it is these that can have detrimental effects on those who inhabit affected spaces.

In modern dwellings pollutants can range simply from moisture vapour (concentrated levels of which are linked to fungal growth, and propagation of dust mite populations) to emissions from building products (aldehydes, VOCs, etc.) and other pathogenic bodies; all of which provide a significant identified health risk, particularly for the ever increasing atopic members of our population.

Mechanical Ventilation with Heat Recovery (MVHR)

For new build dwellings the Technical Standards dictate that a minimum air infiltration of 7 $m^3/h/m^2$ @ 50Pa should be achieved. For any dwelling achieving a level of less that 5 $m^3/h/m^2$ @ 50Pa Technical Standards note that, in relation to MVHR, "such a system should be used". While the intent of this standard is useful in its aspiration to maintain good IAQ it puts a great onus on the performance of the MVHR system. We must, therefore, consider whether these systems are capable of achieving appropriate levels of IAQ.

[1] Sensing a Historic Low-CO_2 Future, (chapter of) Chemistry, Emission Control, Radioactive Pollution and Indoor Air Quality, Intech, 2011; http://www.intechopen.com/articles/show/title/sensing-a-historic-low-co2-future

Recent Studies

In a recent project undertaken by MEARU the 'Glasgow House' development was monitored while under occupation (Fig. 1). These prototypical houses were constructed by Glasgow Housing Association (GHA) as they look towards the design and construction of their future housing stock. Each of the 2 dwellings was built to exceed contemporary technical standards and employ a whole house MVHR system in conjunction with their low air infiltration level of 3 $m^3/h/m^2$ @ 50Pa.

Various parameters, including IAQ, were monitored over a two week period and subsequently analysed as illustrated below in Fig 2 which shows values for temperature, vapour pressure and CO_2 concentrations in one of the dwelling kitchens over a 24 hour period.

Figure 1 Glasgow House, Glasgow Housing Association

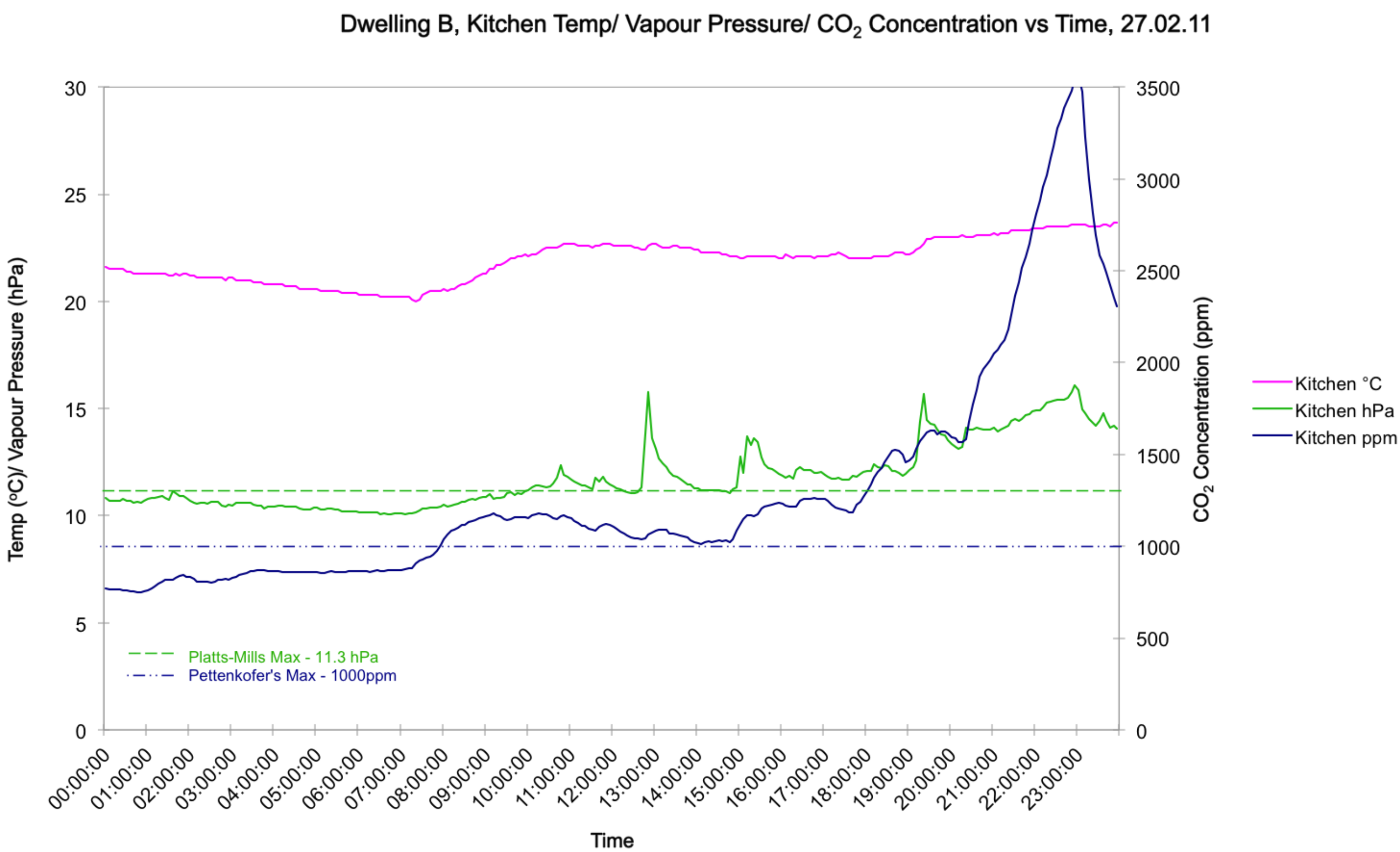


Figure 2 Monitoring results in kitchen of the dwelling B

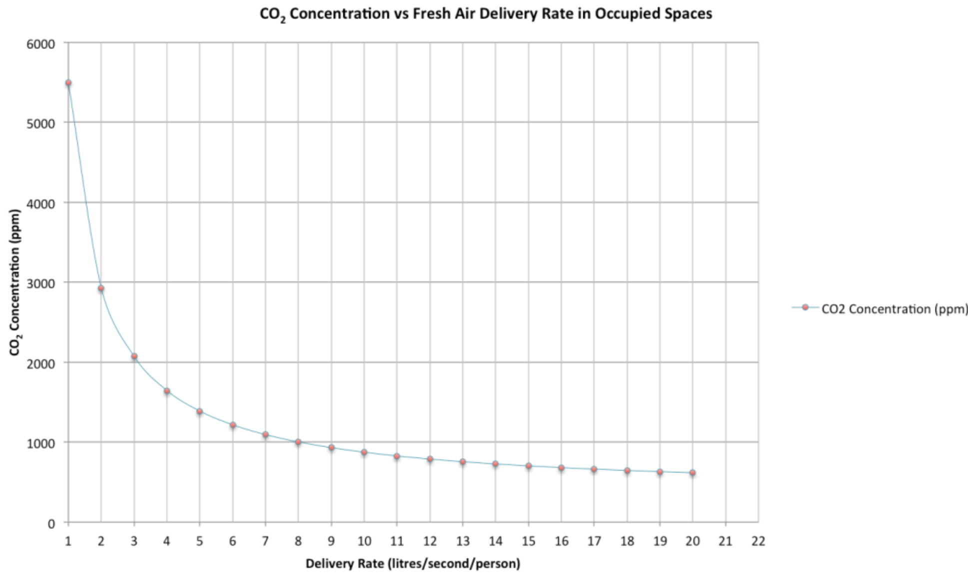


Figure 3. CO_2 concentration vs fresh air delivery rate in occupied spaces

From a review of the CO_2 profile it can be seen that levels were above the desirable maximum for two thirds of the 24 hours and at worst peaked at over 350% of that maximum. While this presents one instance of poor IAQ it depicts a situation repeated all too frequently elsewhere. In six other dwellings, spanning two different developments, MEARU have recently identified similar instances of poor air quality in residences with MVHR. Therefore, this illustration of poor IAQ is not intended to highlight a failing of the Glasgow House in particular but is illustrative of the recurring limitations of all dwellings that MEARU have analysed to date with MVHR systems.

In this particular instance, while CO_2 is the indicator of poor air quality and of occupancy it is also interesting to note that this correlates with the presence of another identified pollutant in the form of airborne moisture. For almost the same time period that CO_2 concentration is above the desirable maximum, vapour pressure is also above the desirable maximum of 11.3haPa - this is the level at which internal vapour pressure can promote dust might colonisation[2].

Understanding the Problem

Early analysis of this apparent problem seems to point to limitations of the systems in terms of its ability to deliver fresh air. In part this may be driven by the fact that these balanced systems are principally designed to deal with the extract of moist air from dwellings with supply of fresh air being a secondary function. This in turn is driven by the regulatory requirements which refer to BRE Digest 398 – a guidance document produced some 17 years ago where contemporary levels of air tightness would have been almost inconceivable for mainstream housing.

The effect of poor air supply in terms of IAQ and CO_2 concentration can be understood by consideration of Fig.3 which illustrates the non-linear relationship between supply air volume (per person) and the effect on air quality. While this ably demonstrates the volume required to maintain levels below the identified maximum of 1000ppm (8 l/s per occupant) it can also be used chart the level of air delivery which was experienced relative to Fig. 2 (approx. 1.5 l/s per occupant).

Failure to provide good internal air quality is problematic in terms of the recognised health risks. If MVHR (driven by guidance on air tightness) cannot meet this demand then we are designing and building dwellings which will ultimately have a detrimental impact on wellbeing.

There is however another implication of this scenario which takes us full circle to the desire to improve air tightness in the first place. The level at which humans perceive poor air quality is only marginally above the 1000ppm benchmark and once perceptible it can quickly trigger stress initiated behavioural responses. This equates, inevitably, to window opening and, particularly during heating season, counteracts the benefits of improved thermal insulation and air tightness; without suitable and controlled internal air quality efforts to reduce regulated energy consumption may be undone.

We therefore have a situation where the efficacy of MVHR systems is brought into question in terms of its ability to provide appropriate IAQ under the new mandatory requirements. This is an area which warrants further study and one which MEARU will continue to work on now and into the future.

[2] Platts-Mills and De Weck (1989) have posited that a maximum vapour pressure of 1.13kPa is required to limit excess dust mite population growth.

RECENTLY PUBLISHED RESEARCH

Colin Porteous (2011). ***Sensing a Historic Low-CO2 Future, Chemistry, Emission Control, Radioactive Pollution and Indoor Air Quality***, Nicolas Mazzeo (Ed.), ISBN: 978-953-307-316-3, InTech, Available from: http://www.intechopen.com/articles/show/title/sensing-a-historic-low-co2-future

"The title of this chapter is intended not only to flag up the longstanding role of carbon dioxide (CO2) as an indicator of air quality inside buildings, but also to imply an altogether different need to curb its presence, this time in our upper atmosphere and with a shorter history of awareness of the global warming phenomenon. The first word also suggests a role for human perception. In relation to air quality, we sense humidity and odour, and often have a fairly accurate idea as to causes.

For example, our washing hanging out in a room can make it feel too humid, and fabric softener can emit an identifiable chemical smell. But CO2 itself is odourless and its concentration above a certain level is normally an indicator of the 'bad company' that it keeps when air is changed too infrequently.

This means that we can wrongly interpret a perception of stuffiness as being due to an inadequate supply of fresh air, when the actual cause might be that the room has become warmer than necessary in the quest for comfort. In this case, the incorrect diagnosis could lead to throwing open a window, rather than adjusting a thermostatic heating control.

When direct or indirect burning of a fossil fuel provides the heating, repeated 'corrective' responses of this kind will add to global CO2 emissions. In short, our sensing, valuable though it is, may lead us to take an expeditious action, but one that adds to both the energy and carbon emissions burden.

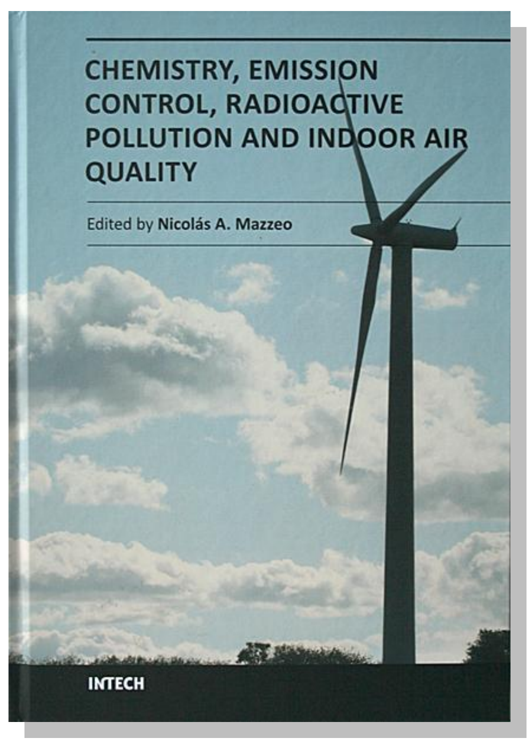
On the other hand, if the temperature of a space is appropriate to a particular activity, we can sense freshness or stuffiness quite correctly. It is also true to say that the early, and valuable, research into control of air quality in buildings predates the means to measure CO2.

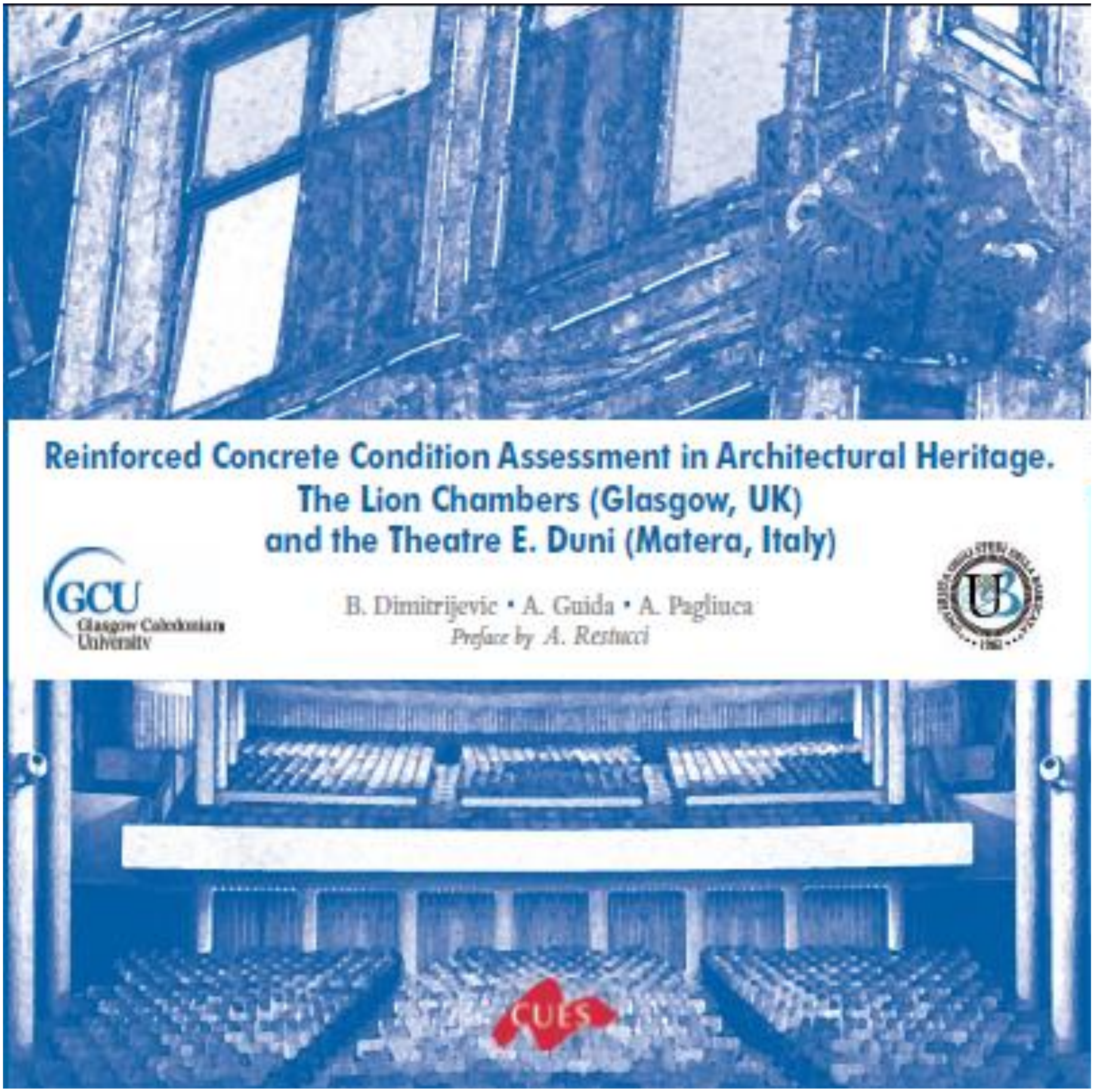
In other words it was largely reliant on perception and observation, and even after the ability to measure CO2 was achieved, the values had to be systematically cross-checked with perceptual responses from volunteer cohorts.

This is where history is relevant to the future, all the more so at this temporal watershed when increasing demands to make buildings more airtight raise the stakes relative to the risk of poor air quality. Although we have approximately 175 years of developmental experience of mechanical control of ventilation, and the same length of scientific awareness regarding natural thermo-circulation, we have yet to fully resolve the ideal interface between electronic automation and manual intervention.

The focus on air quality has a new urgency, embraced by the broader area of inquiry into 'sick building syndrome', in parallel with, and meshing with, wider research in the field of public health, particularly in the area of microbiology."

From the Introduction to the above chapter





The Lion Chambers (1907) in Glasgow and Duni Theatre (1948) in Matera (Italy) were the focus of the case studies that include research on their architectural design, structure, history of use, maintenance, interventions and current condition of their internal reinforced concrete structure. The research was initiated following the agreement between Glasgow Caledonian University and University of Basilicata (Italy) to establish research collaboration. The aim of the collaboration is to use the expertise available at both institutions on a range of research projects in the field of sustainable refurbishment of buildings to assist in decision making for preservation and revitalisation of architectural heritage.

This publication contains the results of the start-up phase of the research undertaken by the Faculty of Engineering - Department of Architecture, Planning and Transport Infrastructures of the University of Basilicata and the School of Built and Natural Environment of Glasgow Caledonian University. The research was funded within the scope of the International Collaboration Project "Call for Ideas" – Internationalisation Programmes provided from the first Triennial Programme for the Region of Basilicata/University 2007/2009.

B. Dimitrijevic, A. Guida and A. Pagliuca (2011), ***Reinforced Concrete Condition Assessment in Heritage Buildings: Lion Chambers in Glasgow (UK) and the Theatre E. Duni in Matera (Italy)***, Cooperativa Universitaria Editrice Studi, Fisciano. ISBN: 978-88-95028-80-4

Talk at Doors Open Day

Within the lecture programme of Doors Open Day in Glasgow, organised by Glasgow Building Preservation Trust, Dr Branka Dimitrijevic will give a talk entitled "**The Lion Chambers: Its condition and a potential sustainable restoration"** at the Mackintosh Lecture Theatre, The Glasgow School of Art on Friday, 16 September 2011, at 4.00 pm.

NO BOOKING REQUIRED.

The Lion Chambers in Glasgow

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Articles

Submission deadline for the articles for the fifth issue of Innovation Review is 15th November 2011. To discuss the article that you would like to submit, please contact us by email or telephone on the contact details provided below.

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