Layman’s Report

Project Partners working with
Background

The construction industry is a key European employer and contributor to the built environment affecting the quality of life and work of all EU citizens.

‘Buildings use 40% of total EU energy consumption and generate 36% of greenhouse gases in Europe. The construction sector is on its critical path to decarbonise the European Economy by 2050, reducing its CO₂ emissions by at least 80% and its energy consumption by as much as 50%. As the replacement rate of the existing stock is very small (1-2% per year), acceleration is urgently needed. Simultaneously, this offers a unique opportunity for sustainable business growth, provided that products and related services for both new and refurbished buildings are affordable, non intrusive and of durable quality, in line with European Directives’.


Project Aims

The Eco-Innovation EuroCell project has sought to provide a solution towards decarbonisation through the development of wider sector uptake of straw bale construction using ModCell®, an innovative prefabricated low carbon cellulose-based panel building system designed for use in a wide variety of construction sectors, including housing, schools and retail projects.

Research on materials, product testing and development and monitoring of building performance has proven that buildings built using the ModCell® System reduce CO₂ emissions and the cost of heating and cooling by up to 85%. The inexorable rise in utility costs and the dependency of the EU on imported natural gas, sets a trend that continues to reinforce the market opportunity for ModCell®.

The EuroCell Project has addressed current EU wide market barriers to the mainstream uptake of ModCell® and BaleHaus® products. Barriers include the lack of product certification, warranty approval, scaling the manufacturing approach and limited market presence.

Fig 1 A truth window in a ModCell® Panel
Objectives:

- Complete further product development and refinement in preparation for certification approval and provide a pathway for future EU market adoption
- Complete performance testing for future EU market product certification
- Achieve UK third party product certification
- Develop manufacturing processes to facilitate scaling up and EU franchising of the product
- Develop framework for delivery of through life support for the product to clients and develop ModCell® pathway to warranty scheme
- Produce an exploitation plan, including an EU market survey, business plan and franchising arrangement, for mainstream uptake of the product
- Successfully manage the EuroCell project and promote the product and project through dissemination and marketing activities
- Develop a 3-5% European market share for the proposed product (ModCell® and BaleHaus®) by 2020

Fig 2 Lime Rendering of a ModCell® Panel
ModCell® Construction Panels

Initially developed as low carbon highly insulated external cladding panels in framed buildings, ModCell® panels have been further developed for use in wholly prefabricated low carbon renewable building systems, in which the panels are used to form the structure of the building.

ModCell® Panels are available in three variants:

**ModCell® Core** is a factory finished fully closed straw insulated timber panel system. The panel comprises a glulam perimeter frame with intermediate vertical timber I-joists. Internally a fire resistant board creates a 38mm deep closed services zone with OSB/3 sheathing panels. Externally the panel is closed with a vapour permeable timber based panel that is protected by a rainscreen cladding fixed with 38mm pressure treated battens. Thermal insulation is provided through the use of straw bales installed between the vertical timber studs.

**ModCell® Core +** is as the Core panel above but the external battens are replaced with 40mm of wood fibre breather/render board. The wood fibre board then has a thin coat breathable render system applied. Both the wood fibre board and render is applied onsite. Thermal insulation is provided through the use of straw bales installed between the vertical timber studs.

**ModCell® Traditional panels** are delivered to site with a two layer render finish inside and out. A finish skim coat is applied on site from a scaffold or mobile elevated working platform (MEWP).

ModCell®

Core +

Construction Systems
The ModCell® Core + System delivers on the demanding PassivHaus specification requirements for thermal performance (U-values), air-tightness and thermal bridging. PassivHaus projects combine the excellent performance of ModCell® with improved glazing specification, Mechanical Ventilation Heat Recovery (MVHR) and project and location specific design.

The ModCell® System is already recognised for its innovation and has won the following awards and international recognition:

- UK Offsite Construction Magazine’s Product of the Year 2008
- Sustain Magazine’s Product of the Year 2009
- Runner up in CNBC’s international Good Entrepreneur Competition 2009
- Chartered Institute of Builders, Innovation Award 2010
- Shortlisted for the British Construction Industry Awards 2010
- Technology Strategy Board, UK top twenty Clean Tech Company
- Clean and Cool Mission company 2010
- Carbon Trust Entrepreneurs Fast Track Company 2011
- British American Business Club Innovation Award, America, 2011
- Local Authority Building Control Excellence Innovation Award 2011
- Featured in The Times Budget Review 2012
- Chartered Institute of Building (CIOB) International Innovation & Research Award, 2013
- LILAC wins Construction 21 green building solutions award, 2014

Performance Indicators

PROVIDED BY MODCELL – AWAITING CHART
Panel Performance and Development

Fire Testing of ModCell® Core Panel

Fire Resistance

The ModCell® Core Panel was successfully tested during March 2014. A reduced thickness panel was tested to allow vertical loading to be applied to the panel via a specialist steel restraint frame. The panel provided a fire resistance of 52 minutes. The limitations of the steel restraint frame are such that a full thickness panel cannot currently be tested but it is expected that the performance of the panel would significantly improve.

<table>
<thead>
<tr>
<th>Loadbearing capacity</th>
<th>52 minutes*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Integrity</strong></td>
<td></td>
</tr>
<tr>
<td>Cotton pad</td>
<td>52 minutes*</td>
</tr>
<tr>
<td>Continuous Flaming</td>
<td>52 minutes*</td>
</tr>
<tr>
<td>Gap gauges</td>
<td>52 minutes*</td>
</tr>
</tbody>
</table>

| **Insulation**           |             |
| Average set              | 52 minutes* |
| Standard set (maximum)   | 52 minutes* |

* No failure of the test criteria at termination of the test at 52 minutes

Fire Resistance Classification

RE20, RE30, REI15, REI20, REI30, REI45, REW20, REW30
Panel Performance and Development

Accelerated weather testing of ModCell® Traditional Panel

ModCell® Traditional Panels use a lime based render that is directly applied to the straw bale insulation. Certification of this panel system requires that accelerated weather testing of the panel is completed to demonstrate that the render will protect the straw insulation for the design life of the building. In preparation for future European wide (CE) marking of the system, hygrothermal testing was successfully completed in accordance with ETAG 004, the guideline for European Technical Approval of external thermal insulation composite systems with rendering. The test subjects the panel to 80 cycles of heating and spraying with cold ‘rain’ prior to five final cycles of heating to 50°C and cooling to -20°C. The current focus of this testing is on demonstrating the long term freeze thaw performance of the panel.

Straw bale durability research

The EuroCell project has supported original research into the measurement, monitoring and assessment of straw bales used in buildings. Laboratory studies are using carbon dioxide monitoring to help assess the long term durability of straw when it is subjected to elevated levels of humidity. Condition monitoring of existing and new buildings allows benchmark data to be collected whilst opening up surveys have allowed the direct inspection of straw to be completed (see Fig 5). The initial findings of this study have been published in the Elsevier Journal of Construction and Building Materials. This paper brings together monitoring data from an exposure test facility and findings from the laboratory study that provides encouraging insight into the medium term resilience of straw to short periods of exposure to high levels of humidity.
Product innovation: fixings

In addition to the development of new panel types, the EuroCell project has also explored the use of prototype screws for fixing cladding elements to straw bale insulation. ModCell® developed a novel 3D printed prototype bale screw design that was tested in the University of Bath structures laboratory. The screws were found to have a pull-out capacity in the range of 0.4 – 0.45 kN. This would be equivalent to hanging approximately 40kg from a single screw. Future innovation will explore different screw designs and methods of fixing cladding elements.

Fig 6  A 30 mm diameter 3D printed screw being pulled out of a straw bale

Fig 7  A 30 mm diameter 3D printed screw
Post Occupancy Study

Two post occupancy studies have been completed as part of the EuroCell project. The aim of the studies was to help better understand the performance of ModCell® buildings and to inform future research, development and design. The first study focussed on ModCell® buildings completed prior to the start of the EuroCell project and the second on new buildings that were built after the project began. In both instances the emphasis was on understanding the performance of the straw bale infrastructure within the buildings and how this was viewed by building occupants. Building users and managers from a total of seven buildings have provided feedback on their experiences and opinions of working or living in a ModCell® building. The majority considered their building to have positively influenced the behaviour of users in terms of environmental attitudes and transport and building usage.

The construction of two buildings at the start of the EuroCell project allowed condition monitoring equipment to be installed in the panels of the building to allow their performance to be remotely monitored. Data has now been collected for over 12 months in both instances and provides a useful indication of the seasonal variation in the moisture content of the straw insulation.

Certification

The ModCell® System is already in use across a number of construction sectors and meets or exceeds all aspects of the UK Building Regulation requirements. In the housing sector, house buyers have to secure mortgages to finance their purchase. In order to do this, lenders require housing systems to be certified by an accredited body so that they can be warranted and insured. In the UK, the NHBC (National House-Building Council) is the leading warranty and insurance provider for UK house-building for new and newly-converted homes. The ModCell® Core Panel has been certified under the Q Mark certification scheme run by BM TRADA (www.bmtrada.co/qmark.php) which qualifies the system for NHBC approval. In the future full CE Marking of the ModCell® Panel will be sought.
Future Developments

As a result of the EuroCell research work ModCell® has been able to innovate in a number of areas.

Custom Homes

The UK Government has put in place a number of policies to support the development of housing by individuals. The initiative is known as the Right to Build. The target is to grow the annual delivery of self build houses from 15,000 a year to 50,000 by 2020. However, it is difficult for individuals to meet this target and the Right to Build agenda is supported by a number of initiatives. Rather than self builders acting individually the Government is supporting the idea of Custom Build. Custom Build is a facilitated way of allowing developments to be built where individuals can select their own house types with customisable options. The intention is for local authorities to identify sites in their ownership where Custom Build projects can be delivered.

There are three Custom Build pathfinder projects in the UK, and ModCell® has been successful in being selected as one of the providers of customisable housing for these projects. Working with Igloo Regeneration (www.iglooregeneration.co.uk/do) and Cornwall County Council a site for 54 houses has been identified. A master planner has laid out the house plots. Home buyers can visit a website called Plot Shop, where they can select the plot they are interested in building on. They then choose a Home Manufacturer from a list of five providers of which one is BaleHaus Custom Homes (www.balehauscustomhomes.com) the branded housing offer from ModCell. They can then select from four BaleHaus types each of which have eight variations of finish and specification. The house types developed for the Igloo Custom Build are also being applied to a 50 BaleHaus Development that will be ready for Bristol European Green Capital 2015.

Government Funding Initiatives that support the Right to Build Agenda in the UK:

- Affordable Housing Programme 2015:18 – the 2015:18 funding allocations are expected to be announced shortly and we expect these to show a significant increase in the numbers of housing being built through offsite construction.
- From September the Homes and Community Agency (HCA) will be taking further bids for funding and will be further encouraging bids which use Modern Methods of Construction (MMC).
- Custom Build Fund - This £150m fund will help to address the challenges that custom builders face and provide finance for the development of serviced plots to support people who want to build their own home: www.gov.uk/government/publications/custom-build-serviced-plots-loan-fund
- Right to Build - DCLG has launched invitations for Vanguard local authorities to allow prospective self and custom builders to register their interest. The local authorities will then need to identify and supply suitable sites for development. The industry will want to explore with local authorities how they can support these developments.
- Housing Zones and Brownfield development - £400 million funding from Government and the Greater London Authority to create 20 new housing zones on this brownfield land in London as well as £200 million of additional government funding available for 10 zones outside London. This fund aims to support delivery of high quality homes quickly. www.gov.uk/government/news/government-initiatives-to-help-build-more-new-homes-on-brownfield-landLocal Growth Fund
• The housing revenue account borrowing programme has made an additional £300 million of borrowing available for 10,000 new affordable homes over 2015 to 2016 and 2016 to 2017. This was announced in the 2013 Autumn Statement as part of the Local Growth Fund and is available to local authorities who have a proposal agreed by their Local Enterprise Partnership.

• Local Growth Deals - Provides funds to local enterprise partnerships or LEPs (partnerships between local authorities and businesses) for projects that benefit the local area and economy. The first wave of Growth Deals was announced on 7 July 2014: www.gov.uk/government/collections/local-growth-deals

• Over the lifetime of growth deals (six years), the investment is estimated to unlock the land or finance for more than 150,000 homes, from the projects that will start in 2015/16.

• RGF round 6 - Round 6 of the Regional Growth Fund is now open with at least £200m of RGF support being made available in this round and bidders have until 30 September to submit applications. BIS is holding roadshows and expression of interest workshops during July and August and is happy to discuss with organisations who are interested in bidding. Further information can be found here: www.gov.uk/understanding-the-regional-growth-fund#rgf-round-6

Stramit and ModCell®

ModCell® has been approached by the owner of Stramit Technologies, manufacturer of Compressed Straw Board (CSB) with a view to acquiring the business. ModCell® and Stramit are currently agreeing the process for doing this with the intention of manufacturing CSB in the UK. CSB has a British Standard BS4046 which is unique for the use of straw anywhere in the world. The method compresses and heats the straw fibres until the lignin present in the cellulose structure of the straw is liquified and bonds the individual strands into a monolithic whole. The resulting board has exceptional structural properties allowing it to form part of a load bearing building system. The boards have already been integrated into the ModCell® system and has been used to enable PassiveHaus certification as part of the Eurocell research project.

Stramit facts:

• Manufactured in 15 countries worldwide
• Ceased manufacture in the UK in early 1990s
• Can be used as both load & non load-bearing partitions
• Can be used as flooring on upper floors
• Complementary with ModCell® BaleHaus and Renewable Schools
• Can be combined into ModCell® Core, Core+ and ModCell® Roof Cassettes
• Cost effective at £10 per m² of product
• 30,000,000 m² sold worldwide in varying climates and conditions to date
BaleHaus

The BaleHaus research focused on a number of key areas including:

- Thermal performance
- Acoustics
- Air tightness
- Relative Humidity

The building has been fitted with the latest testing technologies which continue to monitor the building's performance.

“...We won’t get to an ultra-low-carbon built environment simply by improving on the performance of the same old construction techniques. We need a lot more genuinely disruptive innovation. The BaleHaus (incorporating specially designed straw or hemp bales) certainly hits that button, and could play an important part in enabling house builders (both big and small) to meet their carbon targets, stay profitable and provide people with the quality, style and comfort they’re looking for European Directives.”

Jonathon Porritt
Founder Director, Forum for the Future
Nucleus Building  Hayesfield Girls’ School, Bath

Hayesfield Girls’ School is a Technology College with an emphasis on innovation in science, technology, engineering and mathematics. The Nucleus building at Hayesfield School used the ModCell® panel system as the main building elements for the external walls as well as the roof.

Awards

- ‘Gold’ Green Apple Award 2013- The Built Environment and Architectural Heritage’ category
- BANES Design Quality Award 2012
- LABC (Local Authority Building Control) Design Quality Awards 2012: Winner for the Public/Commercial category

Image shows a visualisation of the carbon dioxide gas that has been sequestered in the Hayesfield Nucleus building. A total of 376 metric tonnes has been sequestered.
LILAC (Low Impact Living Affordable Community) (LILAC) Low Impact Living Affordable Community. Is a member-led, not-for-profit Cooperative Society registered with the Financial Services Authority. Using ModCell® Traditional panels they have built a community of twenty beautiful homes in Bramley, West Leeds on an old school site. Their community includes a mix of one and two bed flats and three and four bed houses. Most have private gardens, whilst upper flats have balconies. The homes are self-contained with kitchens, bathrooms and living space, and finished to a very high standard. A common house forms the heart of the community, offering shared facilities.

Awards
- 2degrees Champions Award 2014, Shortlisted building or property
- Construction 21 Award Green Building Solutions, (1) Materials and Building Systems
- Construction 21 Award Green Building Solutions, (2) Efficient Building
- Leeds Architecture Awards 2013, Commendation, Landscape
- Place Making Awards 2013 Finalist, Sustainability
- Build It Awards 2013, Winner, Best Community or Group Self Build Initiative
- LABC Building Excellence Awards 2013, Finalist, Sustainability
- Constructing Excellence Awards 2013, Legacy Award Winner, LILAC and White Design
The University of Bath

The BRE Centre for Innovative Construction Materials at the University of Bath is an internationally leading centre of excellence for research on renewable construction materials. The centre has access to excellent testing and analysis facilities for materials, building and structural engineering research and has supported delivery of the EuroCell Project.

Prof. Pete Walker is Head of the Architecture and Civil Engineering Department at The University of Bath and the Director of the Centre for Innovative Construction Materials. He has gained extensive research experience in the field of sustainable building materials and technologies over the past 20 years.

Dr Andrew Thomson is a Research Associate at the University of Bath. His research is in the area of low environmental impact construction materials. His research interests include timber engineering systems, rammed earth materials and contemporary straw bale construction.

Dr Aydin Nasseh is a Research Fellow at the University of Bath with expertise in manufacturing.

Dr Fabio Santomauro is a Research Associate at the University of Bath. His research relates to the study of microbial biodiversity for the optimisation of industrial processes.

Shuna Griffin is the Research Project Coordinator. She studied the History of Art at UCL, specialising in the history of architecture and has travelled and worked in France and Greece on a number of sustainable building and farming projects. She has extensive project management experience in the public and private sectors.

Sarah Lewis is the Project Research Accounting Assistant providing expertise in the financial accounting and reporting of the project.

White Design Associate Architects

White Design Associates (WDA) is a sustainable design practice collective comprising architects, landscape architects, designers and researchers. WDA bring skills in architecture, design project management, product design and sustainable construction. WDA designers have informed the consortium on product development and develop budgets, the supply chain, market sector, business planning, and application of the product and the knowledge transfer of design skills to the architects, specifiers, clients and market as a whole. WDA have lead delivery of architectural design product knowledge transfer aspects of the project.

WDA Directors, Craig White and Linda Farrow have provided design leadership and have used their considerable experience of managing multi-disciplinary policy and research projects to quality assure the project definition, detailed methodology and delivery of outputs to meet client specifications. As co-founders of ModCell®, WDA will continue to bring straw bale construction into modern building practice through the development of modular prefabricated building systems.
EuroCell Consortium

Integral Engineering Design

Integral have brought structural engineering expertise to the EuroCell consortium. Their expertise includes consideration of the properties of individual panels (for example specifying the testing required to increase the size of panels for supermarket warehousing). Integral’s day to day involvement with commercial clients and building sites has given them a unique understanding of the engineering issues of bringing such a product to market. Integral has close links with the University of Bath both on the education of students and the research required for the various projects within the office. In collaboration with WDA Integral pioneered the use of prefabricated straw bale cladding for the new School of Architecture at the University of the West of England.

ModCell® Limited

ModCell® Ltd is the primary product manufacturer and supplier. As the lead industrial partner for product implementation and delivery to date, ModCell® brings considerable expertise and have made a significant contribution to all aspects of EuroCell. Their experience includes in-depth knowledge of product development and manufacturer implementation of decentralised (flying factory) panel manufacture, specialist sub-contraction, and product support. ModCell® have provided the physical panel system that have been used as the main element of construction and testing. ModCell® will bring market experience and intricate technical know-how to offer a good platform to work from.

EuroCell Consortium

BB-A Architecten

BB-A’s team of Architects and Engineers have specialist knowledge on sustainable building and practicing Corporate Social Responsibility (CSR). As a ‘full service’ practice BB-A bring extensive knowledge on design, building costs, Dutch and EU legislation and building physics (PassivHaus: energy performance). BB-A have used their business network to develop new opportunities in the Netherlands and other EU member states for ModCell®.
Working with:

Progetic
Barcelona Office
C/Ciutat de Granada, 69b
08005 Barcelona, Spain.
t: + 34 600 092 809
t: + 34 93 624 1667
www.progetic.com

Stroom
STROOM architecten
Galdersweg 8A
4855 AH Galder
t: 076 - 532 23 23
t: 06 - 373 393 97
info@stroomarchitecten.nl
www.stroomarchitecten.nl

Funded by:
Executive Agency for Small and Medium-sized Enterprises (EASME)

EuroCell Project Contacts:

The University of Bath
Principal Investigator: Professor Pete Walker
(The University of Bath)
Department of Architecture and Civil Engineering
University of Bath
BA2 7AY
t: 01225 386646
e: P.Walker@bath.ac.uk

Project Website
http://euro-cell.org/

White Design Associates Ltd
The Proving House
21 Sevier Street
Bristol BS2 9LB
t: + 44 (0)117 954 7333
t: + 44 (0)117 954 7338
e: mail@white-design.co.uk
www.white-design.com

EuroCell Project Contacts:

Integral Engineering Design
Tollbridge Studios Toll Bridge Road
Bath BA1 7DE
t: 01225 859657
e: mail@integral-engineering.co.uk

ModCell® Ltd
The Proving House
21 Sevier Street
Bristol BS2 9LB
t: 44 (0)117 954 7333
f: 44 (0)117 304 1738
e: enquiries@ModCell.com
www.ModCell.com

BB Architecten
4844CK
Bredaseweg 69
Terheijden
T: 0765934451
E: info@bb-architecten.nl
www.bb-architecten.nl

BaleHaus
www.bath.ac.uk/features/balehaus/

Publications

Press
http://euro-cell.org/ecoabitur-article/
http://euro-cell.org/construction21-eu-article/