



Co-funded by the Eco-innovation Initiative of the European Union

euro-cell

Layman's Report



Project Partners



working with



Layman's Report

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'.

Source:

European Commission Energy Efficient Buildings: Multi-annual roadmap for the contractual PPP under Horizon 2020.

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

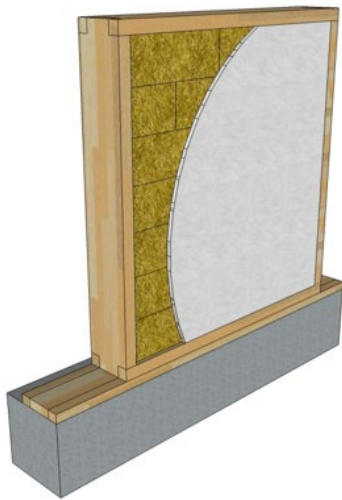


Fig 2 Lime Rendering of a ModCell® Panel

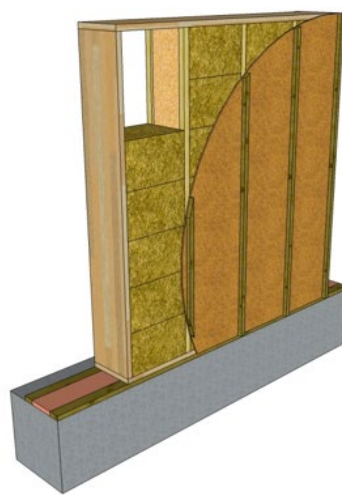
ModCell® Construction Panels

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.

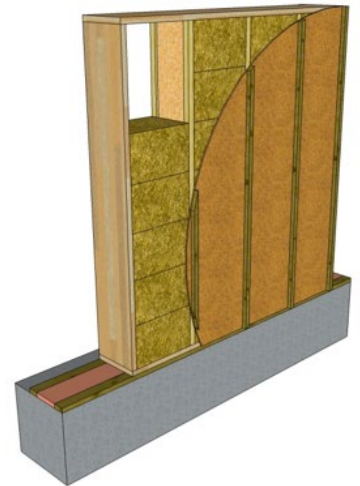
ModCell® Panels are available in three variants:



ModCell® Traditional panels comprise of a glulam perimeter frame with the straw bale infill sufficiently compressed such that the bale, timber and render system act compositely to provide a fully structural panel. The panels are delivered to site with a two layer lime-based render finish inside and out. A finish skim coat is applied on site from a scaffold or mobile elevated working platform (MEWP).



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 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.

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

Panel Performance and Development

Fire Testing of ModCell® Core Panel



Fig 3
A fire resistance test performed on a loadbearing timber framed straw insulated wall system

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.

Loadbearing capacity	52 minutes*
Integrity	
Cotton pad	52 minutes*
Continuous Flaming	52 minutes*
Gap gauges	52 minutes*
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



Fig 4 Water being sprayed onto the face of a ModCell® Traditional Panel



Fig 5 Render core removed from three year old straw bale panel

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 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. Results so far are positive although further testing is required.

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 shows that straw is able to resist high humidity conditions for short periods of time.

Building Performance

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 have now been collected for over 12 months in both instances and the data provides a valuable benchmark for the performance of straw bale buildings.

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.

Timber
Frame
Elements



PassivHaus

PassivHaus refers to a construction standard for any type of building, offering excellent comfort conditions in both winter and summer, with nearly-zero energy consumption.

There are now over 20,000 completed Passivhaus buildings worldwide. As part of the Eurocell project, the ModCell® system is undergoing Passivhaus certification as a Wall and Construction system. 23 standardised construction details have been developed, and are being tested to meet a set of stringent certification criteria. Certification provides a guarantee of quality and proof that the system has extremely good thermal performance in the most challenging climates. As such, any building built with ModCell® using the standardised Passivhaus details will be highly energy efficient and comfortable, built from natural and renewable building materials. In August 2014 the Consortium received a positive technical appraisal from the PassivHaus Institute and expects a positive certification result in the final quarter of 2014. The ModCell® system will be the first pre-fabricated straw-bale timber construction system to achieve Passivhaus certification in the world, bringing together low-embodied energy, carbon-positive materials, with high levels of energy efficiency and thermal comfort.

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.

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 (www.balehauscustomhomes.com). 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.

Impact of the product



“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

BaleHaus

The BaleHaus research focused on a number of key area’s including:

- Thermal performance
- Acoustics
- Air tightness
- Relative Humidity

The BaleHaus is now occupied and successfully in use.

Impact of the product



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

- Green Energy Awards 2013 – 'Best Energy Efficiency' Category
- '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.

Impact of the product



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, Young Peoples Review 2013 for New 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

EuroCell Consortium

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 BRE 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 Nassehi is a Senior Lecturer 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.

EuroCell Consortium

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. As co-founders of ModCell®, Integral will continue to support the development of the business so that low carbon building can become a reality for ordinary people, as well as the passionate early adopters.

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-contracting, 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
Galderseweg 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
f: + 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)117 955 6731
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

Thomson A., Walker P. Durability Characteristics of Straw Bales in Building Envelopes. Journal of Construction and Building Materials 2014

Thomson A., Walker P. Condition Monitoring and Durability Assessment of Straw Bale Construction 2013. Portugal SB13: Contribution of sustainable building to meet EU 20-20-20 targets. pp 791-798

Press

<http://euro-cell.org/ecohabitar-article/>
www.ModCell.com/news/ModCell-win-international-ciob-award/
<http://euro-cell.org/construction21-eu-article/>
<http://euro-cell.org/cordis-building-eco-friendly-straw-homes/>



Co-funded by the Eco-innovation Initiative of the European Union

euro-cell

Project Partners



working with

