Breakthrough eco-materials and components for healthier and more energy efficient buildings

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What are eco-materials?

Low carbon/low energy/renewable traditional materials

- Bio-based materials
  - Crop residues (straw, hemp)
  - Bamboo
  - Wood
  - Wool
- Mineral based materials
  - Clay/earth based (plasters, blocks, monolithic)
  - Natural stone

Lower energy/carbon developments of industrial materials

- Lower carbon cements and concretes
  - Cement replacements
  - Geopolymers
- Recycled products
  - Recycled metals and reuse of waste materials
Goal of the ECO-SEE project

Development of novel eco-materials for wall panels which will enhance the indoor environment and the energy efficient of buildings.
Introduction to project

- EC FP7 research project
- Led by the University of Bath, UK
- Project Lead: Professor Pete Walker
- Four years: Sep 2013 - Aug 2017
- 11 Work Packages (9 technical)
- EU contribution = 6.5 million Euro
- 18 partners (from 8 EU countries and India)
ECO-SEE is co-financed by the European Commission under the 7th Framework Programme for Research and Technological Innovation.
Project stages

- Identified ‘start of the art’ eco-materials
- Developed novel eco-materials
- Developed suite of testing for material characterisation
- Designed and developed ECO-SEE panels
- Selected short list of prototype ECO-SEE panels for scale-up
- Developed Holistic IEQ model
- Pilot level demonstration of ECO-SEE panels
- Life cycle analysis and life cycle costing
- Training, dissemination and exploitation

Applied research

Upscale, demo & validation

Future market uptake

ECO-SEE is co-financed by the European Commission under the 7th Framework Programme for Research and Technological Innovation.
ECO-SEE innovative products

- Bio-based insulation with enhanced capability (sheep’s wool, cellulose, hemp-fibres)
- Novel clay plasters with improved hygrothermal regulation
- Novel photocatalytic coatings, suitable for interior spaces and applied to lime and wood based substrates, with aim of improving air quality
- Low VOC wood panels
- Design tools for holistic indoor environmental quality
- ECO-SEE wall panels
ECO-SEE Materials: Insulation

- Mineral wool
- Hemp
- Thermal flax
- Hemp-lime (275 kg/m³)
- Cellulose flakes
- Sheep’s wool
- Wood fibre
- Hemp-lime (300 kg/m³)
**ECO-SEE panel designs**

1. **ECO-SEE wall liner**
   There are three liner finishes; Photocatalytic Lime, Clay, Photocatalytic Timber Boards.

2. **ECO-SEE internal panel timber frame**
   The panel is made up of a softwood timber frame. In new buildings internal panels may be prefabricated as either open or closed elements. For installations in both new and retrofit projects the final finish will be installed in-situ once the building is weather tight and risk of surface damage is low.

3. **ECO-SEE insulation**
   The internal panels use enhanced Sheep's Wool insulation for acoustic separation. This inner blanket helps to buffer humidity and to degrade VOCs, which permeate through the vapour permeable liners.

**EXTERNAL**

1. **ECO-SEE wall liner**
   There are three liner finishes; Photocatalytic Lime, Clay, Photocatalytic Timber Boards.

2. **ECO-SEE external panel timber frame**
   The timber frame is made up of two sections; an outer chamber formed with timber I-Joists and an inner chamber. The two are separated with an OSB diaphragm which controls water vapour movement into the colder outer chamber while still allowing the moisture buffering properties of the inner insulation to be coupled with the internal environment.

3. **Outer layer of ECO-SEE insulation**
   Uses either factory installed hemp fibre or Nesocell cellulose, which is blown in on-site.

4. **Inner layer of ECO-SEE insulation**
   Uses enhanced Sheep's Wool insulation. This inner blanket helps to buffer humidity and to degrade VOCs, which permeate through the vapour permeable internal liner.

5. **External cladding**
   Provides weather protection to the external ECO-SEE panels. Cedar cladding is shown but a wide range of materials and finishes can be used.
ECO-SEE panels installation

Comparable to conventional timber frame construction:

• Include installation of lifting straps
• Panels may then be fixed to the existing structure:
  - Screw through the timber;
  - Use external propriety connections.

A typical installation may include:

• Use of concrete foundations;
• Installation of a timber sole plate, damp proof course and timber floor;
• Installation of external ECO-SEE wall panels and roof
Lining out

Cells may be lined either off-site or on-site

Design of an ECO-SEE cell includes a layer of insulation within the air tight barrier.

- Timber studs at regular intervals.
- In-filled with insulation and lined with a plasterboard.  
  - treated sheep’s wool insulation  
  - magnesium oxide board as lining.
Finishing

The internal ECO-SEE finish is achieved through one of:

- Clay plaster
- Photocatalytic Lime plaster
- Photocatalytic timer boards
Demonstration

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Validation of ECO-SEE panels

Building performance tests included:

- Microbial air quality (air spore measurements)
- Acoustic testing
- Indoor Air Quality
- Thermographic imaging surveys
- Airtightness
- Hygrothermal performance
- Environmental performance (energy use and co-heating)
- Thermal comfort
Achievements (I/II)

- Developed breakthrough eco-materials and innovative ECO-SEE products:
  - Bio-based insulation
  - Novel clay plasters
  - Novel photocatalytic coatings, suitable for interior spaces
  - ECO-SEE wall panels

- ECO-SEE prototype products have been taken to proof of concept through field and implementation testing trials. Product development has been supported by LCA and LCC to ensure delivery of lower environmental impact and improved performance.

- Successfully created a novel holistic IEQ tool using Computational Fluid Dynamics (CFD) computer-based tool that combines air quality, hygrothermal performance and acoustic quality.
Achievements (II/II)

- The key novel outcomes from the ECO-SEE project include:
  - 60% improvement in thermal resistance of clay plasters
  - 80% improvement in moisture buffering performance of clay plasters
  - Over 100% improvement in VOC capture potential of sheep’s wool insulation
  - Up to 30% reduction in energy consumption for heating and 10% reduction for cooling,
  - Comparable acoustic performance of ECO-SEE external wall panel with the conventional construction.
  - Reduction of GWP (kg CO₂ eq.) above 100%.
  - Reduction of the Primary Energy Demand around 27-28%.
REuse and REcycling of CDW materials and structures in energy efficient pREFabricated elements for building REfurbishment and construction
Main objectives and project details

• The overall goal of the RE4-Project is to develop a fully prefabricated energy-efficient building made of components containing up to 65% by weight of CDW-derived materials and structures.

• Funded under the European Union’s Horizon 2020 research and innovation programme.

• Led by CETMA

• 42 months: Sept 2016- Feb 2020

• EU contribution: 4,98M€

• www.re4.eu
**RE⁴ consortium and main tasks**

**Applied Research**
- Recycling & Reuse of CDW-derived materials and structures (CDE, STAM, ROS)
- Assessment of CDW-derived materials and structures and development of prefabricated elements (QUB, CBI, CETMA, ROS, VORTEX, CREAGH, CDE, STAM, STRESS, NTUST)
- Innovative concept for modular/easy installation and disassembly of eco-friendly prefabricated elements (ROS, STRESS, CREAGH)

**Industrial Production**
- Prefabricated casted/moulded element
  - Process up-scaling (CDE, STAM, CETMA, QUB, CBI, ROS, VORTEX, CREAGH)
  - Prototypes production (CDE, STAM, CETMA, ROS, VORTEX, CREAGH)

**Application**
- End-use (ACCIONA, CREAGH, VORTEX, STRESS, ROS)

**Market**
- (FENIX, ACR+)

**Strong industrial character** (4 SME and 3 LE), complemented by the specific competences of 5 top level research and innovation organizations.
Thanks for your attention

http://www.eco-see.eu/

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