Opportunities for bio-based building materials to create net zero new and retrofitted buildings

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M&S

Arguments for greater use of bio-based construction materials

- Reduced GHG emissions and environmental impact
  - Lower embodied carbon
  - Lower building energy use
- Resource efficiency
  - Renewable
  - Reduced waste – circular construction
- Building environmental performance
  - Hygrothermal performance
  - Vapour permeability
- Healthier buildings
- New markets

Need to “*develop policies to drive more resource-efficient construction and use of existing low-carbon materials, including a substantial increase in the use of wood in construction*”. Climate Change Committee report (2021)

In UK the use of bio-based materials remains under-utilised: 0.2 - 0.3% market share Natural Fibre Insulation (NFI) products

The UK still largely relies on imports for its NFI products.

Natural Fibre Insulation

Cellulose
Cork
Hemp-lime
Hemp flex
Mycelium board
Sisal flex
Sheep’s wool
Straw baled
Straw chopped
Wood fibre flex
Wood fibre board

Natural Fibre Insulation…

- Reputation for higher thermal conductivity (0.035 – 0.068 W/mK) than competing products: PIR* (0.022 W/mK); EPS** (0.032 W/mK); Mineral Wool (0.035 W/mK). Requiring thicker layers of insulation.
- Hygroscopic and vapour permeable: climate change resilience; building infrastructure resilience.
- Thermal diffusivity: decrement delay.
- Cost: higher initial cost; competitive whole-life costs.
- Durability: more durable than expected.
- Embodied carbon: net store rather than emitter of CO_2.
- Fire performance: Burns; Fire Rating B; Building Height Restrictions.

* Polyisocyanurate

** Expanded polystyrene

Bio-based construction materials research and development

Building with straw bales

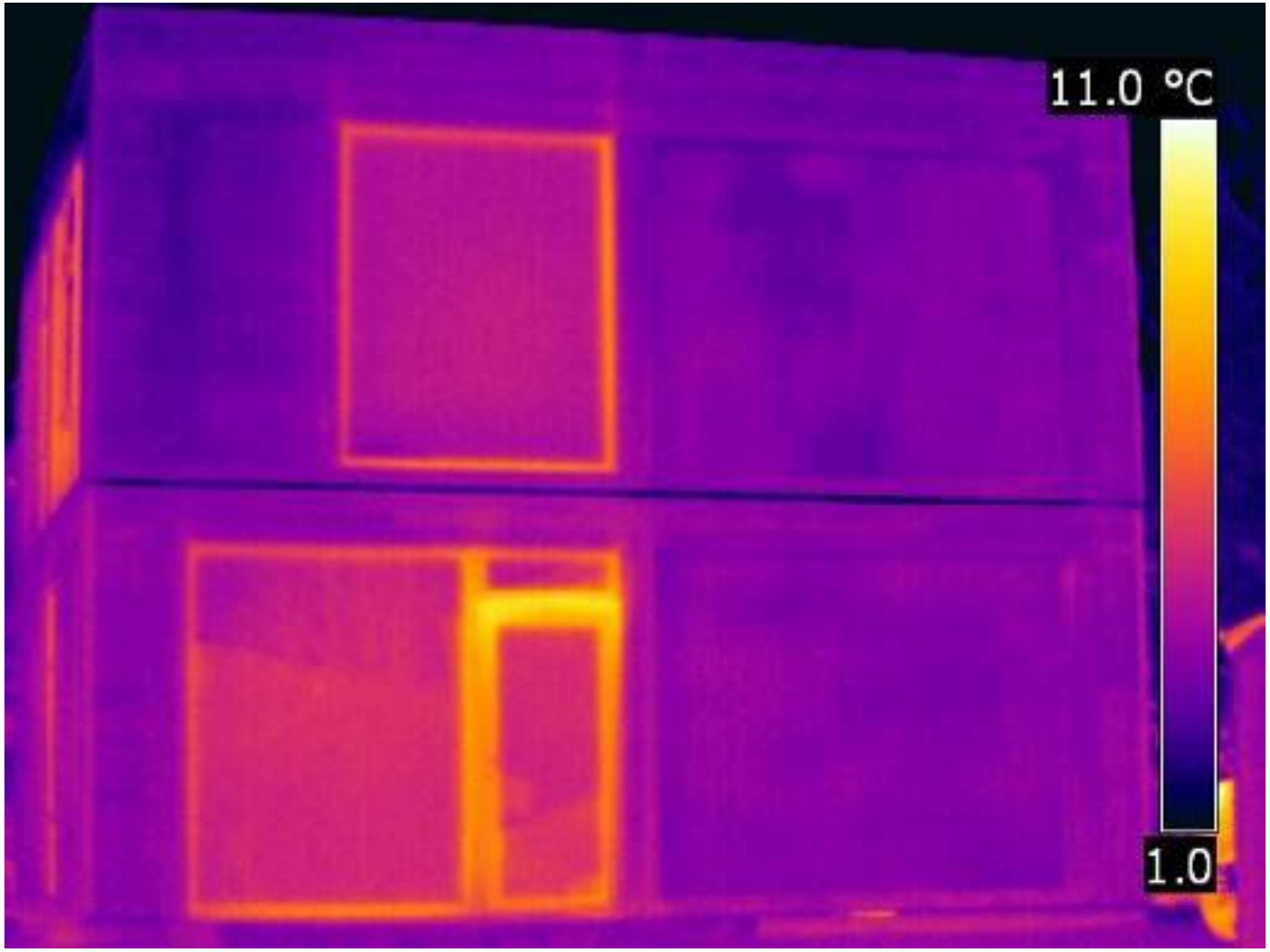
Prefabricated Straw Bale:

Fire resistance

Fire test in accordance with BS EN 1364-1:1999

- >1000° C
- 2 ¼ hours

Thermal performance



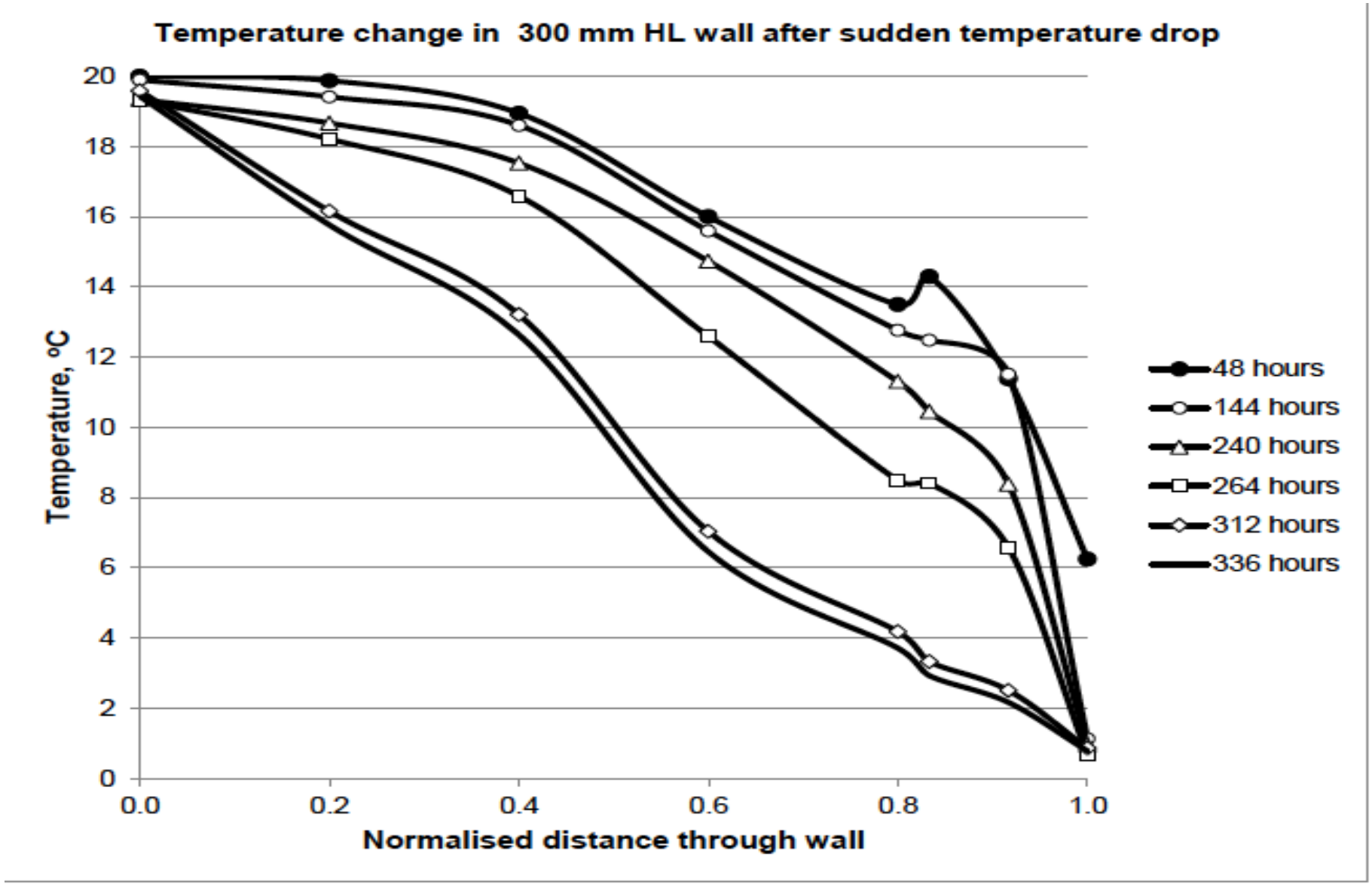
Straw orientation

Hemp-lime: insitu

Hemp-lime: prefabricated

Hemp-lime: structural enhancement

Hemp-lime: decrement delay


Temperature change in 300 mm HL wall after sudden temperature drop
Temperature, °C
20
18
16
14
12
10
8
6
4
2
0
0.0
0.2
0.4
0.6
0.8
1.0
Normalised distance through wall
48 hours
144 hours
240 hours
264 hours
312 hours
336 hours

Cork

- Very lightweight natural insulation
- Thermal conductivity 0.06 W/mK
- Density 65-200 kg/m^3
- External insulation systems

Mycelium insulation

- Networks of filamentous hyphae
- Convert low-cost organic wastes into bio insulation products
- Technical feasibility achieved, but competitive thermal conductivities, combined with scalable and commercially viable manufacturing processing, have not yet.
- On-going research into substrates, fungal species, growing conditions etc.

AHRC Green Transition Ecosystems

Transforming Housing and Homes for Future Generations

Need to improve our existing homes

- Housing sector is responsible for around 20% of the UK's total carbon emissions
- 80% of the homes that will be occupied in 2050 already built
- Retrofitting existing houses an infrastructure priority for the UK Government.
- Improvements required to:
  - Reduce operational carbon emissions
  - Improve energy efficiency (and reduce running costs)
- Fabric First approach to:
  - Increase levels of insulation
  - Improve air tightness
  - Minimise thermal bridging
  - Improve resilience of building fabric
  - Reduce VOCs (risk of increase from improved air tightness)
  - Reduce impact of climate change

TRANSFORMING HOMES

1920-1940s low-rise houses account for approximately 3 million of homes still in use today.

TRANSFORMING HOMES

Our vision for the Transforming Homes GTE is to transform existing housing by working with, and for, communities.

Create a co-design innovation ecosystem of industry, practitioners, social housing landlords, community groups, and researchers.

Co-create low energy resilient homes using bio-based and non-extractive materials, together with renewable energy supply and storage.

We aim take on the challenge of bringing together diverse stakeholders to work together to design remodelling solutions to create low energy homes.

Our GTE partners…

UNIVERSITY OF BATH

Mewn partneriaeth â
In partnership with
Cyngor Abertawe
Swansea Council

MIKHAIL RICHES

CARDIFF UNIVERSITY
PRIFYSGOL CAERDYDD

MODULAR

ASBP The Alliance for Sustainable Building Products

University of BRISTOL

University of Exeter

WE CAN MAKE

woodknowledge WALES

- Architectural Design
- Building Environmental Design
- Circular Design
- Climate System Dynamics
- Community Empowerment
- Construction Materials
- Environmental Sciences
- Environmental Psychology
- Forestry Industry
- Housing Policy & Strategy
- Human Geography
- Life Cycle Assessment
- Modular Construction
- Operations & Supply Management
- Performance and New Media
- Retrofit & Remodelling
- Structural Engineering Design

Co-Design

- Work with communities based in Bristol and Swansea to implement and demonstrate transferrable solutions.

- Examine the technical, environmental, and economic feasibility of using bio-based and non-extractive materials for retrofitting homes, employing circularity and zero waste combined with renewable supply and storage.

- Understand that greater use of locally sourced bio-based and non-extractive materials will only happen with the resolution of numerous governance concerns.

Intended outputs

- A new multi-partner, transdisciplinary, AHRC co-design ecosystem to further transform housing for future generations
- Increased national capacity to deliver bio-based and non-extractive solutions for housing transformation
- Validated prototypes for retrofit
- Increased engagement between academics and key stakeholders
- New policies and processes in housing transformation
- Raising public awareness of the housing challenge and solutions
- Support training, upskilling and job creation

TRANSFORMING HOMES

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Thank you

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