

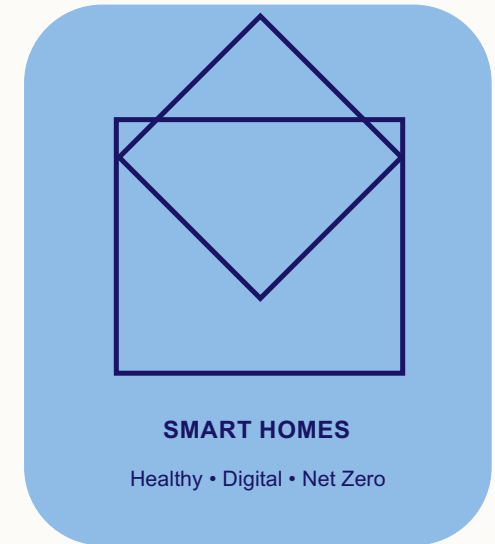
CIB 2026

European Affordable Housing Symposium

Delivering Housing at Scale through Industrialisation

Next-Generation Smart Homes:

Digital Twins, Healthy Building Retrofits
and AI-Driven Health Intelligence



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University of Huddersfield

10–11 September 2026

Nottingham Trent University London Campus

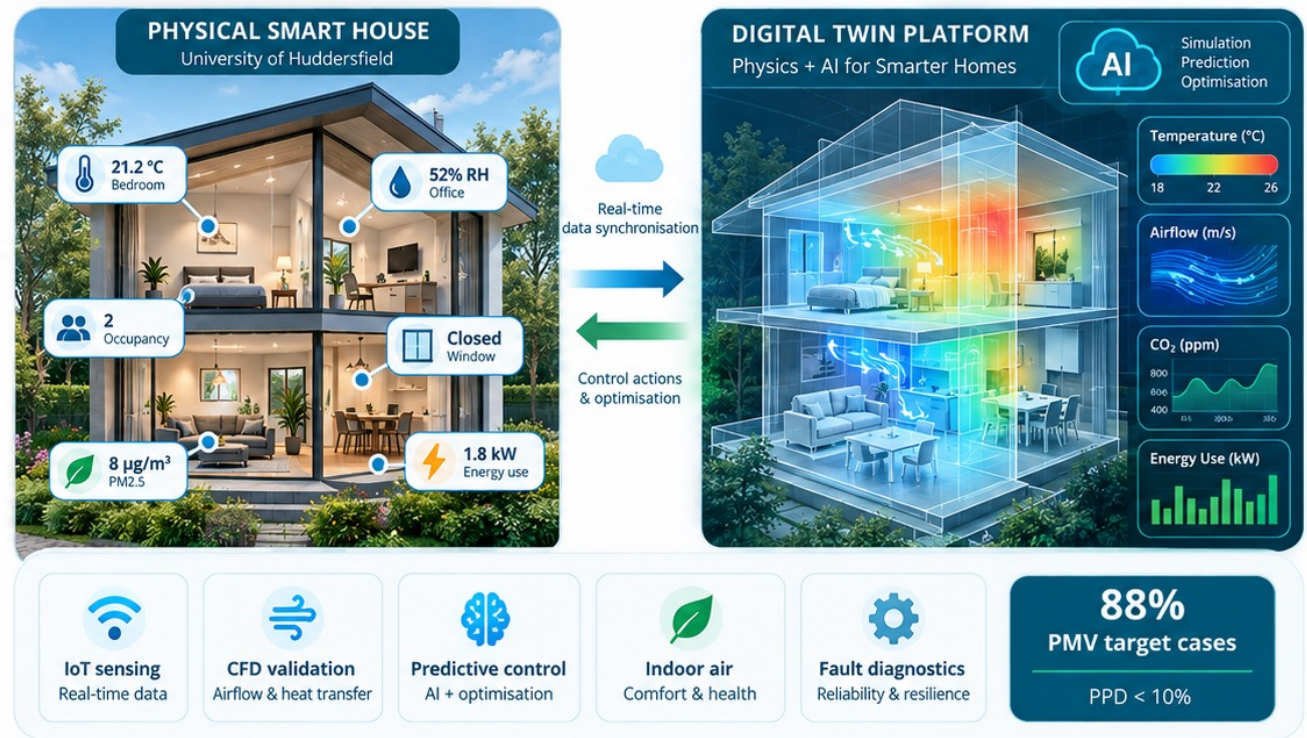
Healthy Retrofit Intelligence: Beyond Energy Savings

- Retrofits must balance energy efficiency with IAQ, overheating, moisture, and infection resilience.
- CFD reveals local airflow, thermal stratification, ventilation effectiveness, and contaminant hotspots.
- Digital twins combine sensors, simulation, and adaptive control for continuous optimisation.
- Occupant behaviour—window opening, door use, movement, and schedules—strongly shapes exposure and comfort.
- Novel contribution: a Retrofit Suitability Index (RSI) integrating energy, health, comfort, affordability, and user acceptance.



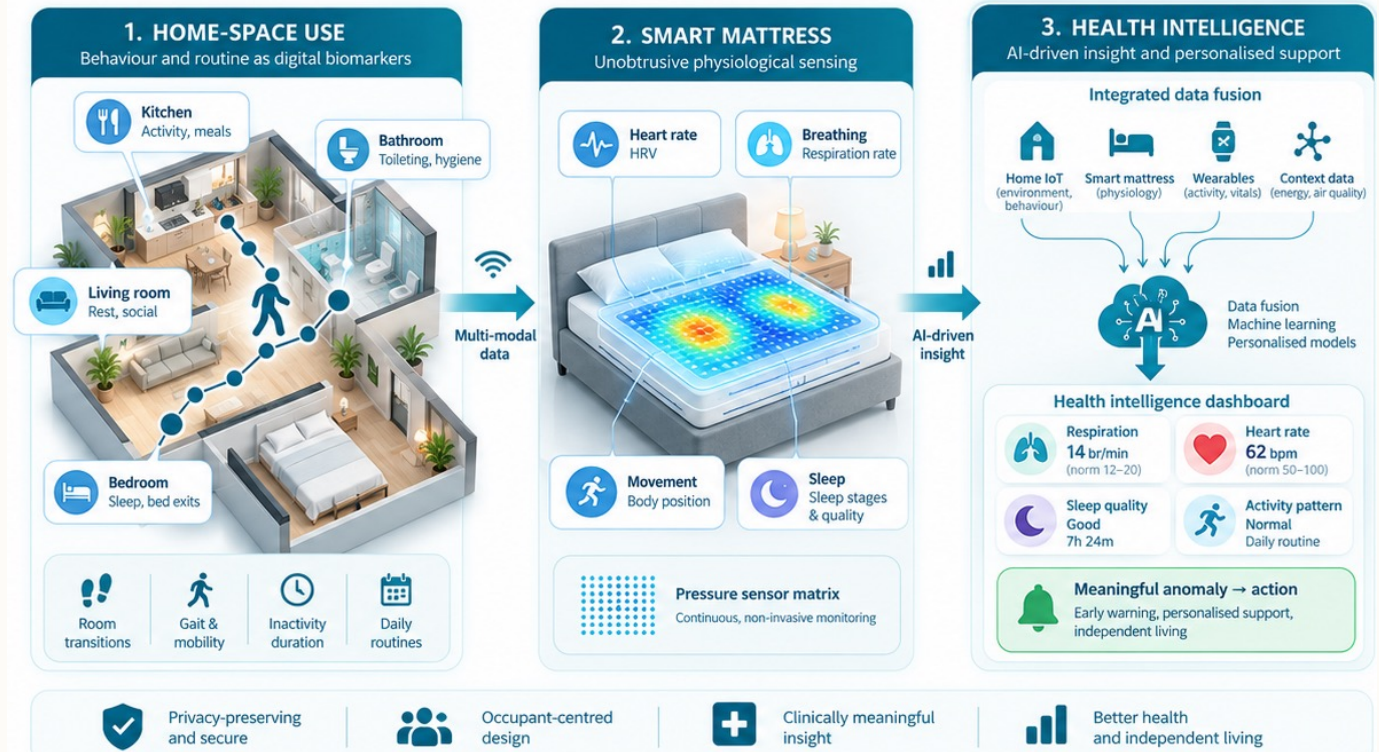
Living-Lab Digital Twin: University of Huddersfield Smart House

- Two-storey instrumented Smart House serves as a living laboratory for next-generation housing research.
- Dense sensing captures temperature, humidity, occupancy, window state, and energy use in real time.
- Sensor data validate CFD predictions of airflow, heat transfer, and contaminant transport.
- A physics + AI digital twin enables scenario testing, predictive control, and continuous commissioning.
- Applications include thermal comfort, pollutant dispersion, HVAC optimisation, solar/EV integration, and fault diagnostics.



Home as a Health Diagnostic Space: AI, Behaviour & Smart Mattresses

- The home can act as a passive diagnostic environment where daily routines become digital biomarkers.
- Space-use signatures—room transitions, bed exits, gait changes, kitchen/bath activity, and inactivity—can reveal early decline.
- Smart mattresses unobtrusively monitor pressure distribution, movement, respiration, heart rate, and sleep quality.
- AI can fuse home, mattress, wearable, and IoT data for early warning, personalised support, and independent living.
- Key challenge: privacy-preserving, clinically meaningful, occupant-centred decision support.



Thank you

Questions & Discussion

Next-Generation Smart Homes

Digital Twins • Healthy Building Retrofits • AI-Driven Health Intelligence

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