

A Combined Operational and Embodied CO2 Approach:

The Limits of Conventional al Insulation Materials and Case for High Performance Vacuum Technology

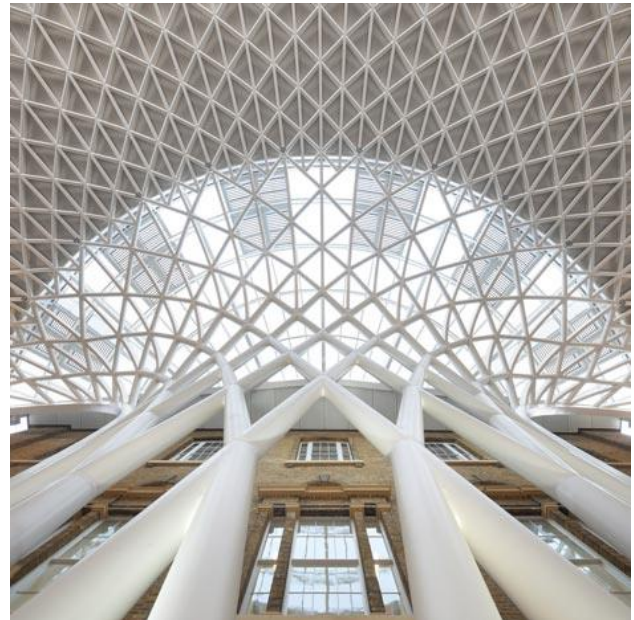
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Context: Drivers of Change in Construction Markets

- *Low carbon and sustainable design*
- *Efficiency*
- *Performance*
- *Cost*
- *Architectural intent*



Current Situation: Highly Developed Metal Building Envelope Market



Market Sectors: Manufacturing



Market Sectors: Logistics



Market Sectors: Industrial



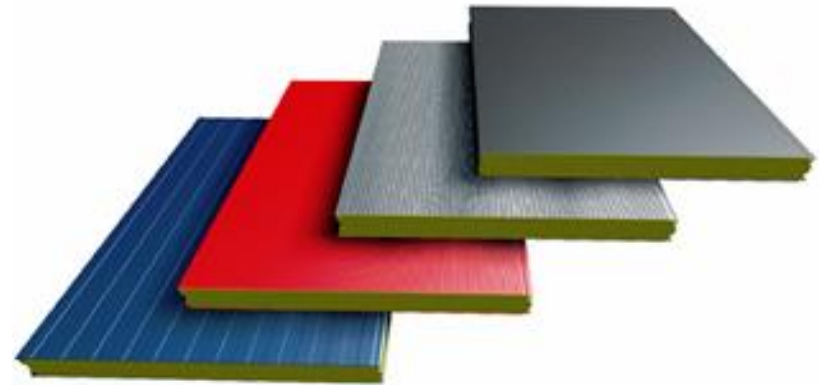
Market Sectors: Offices and Commercial



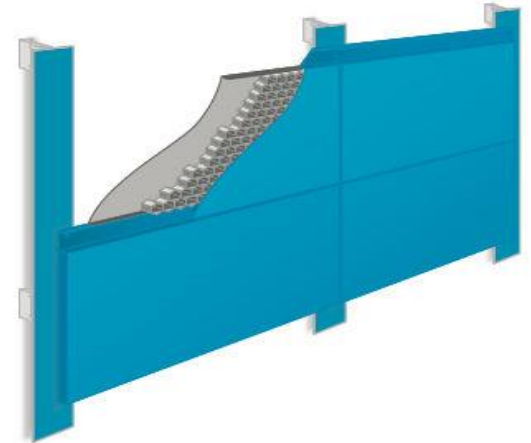
Market Sectors: Residential



Products: Composite and Built-Up Systems



Products: Rainscreen

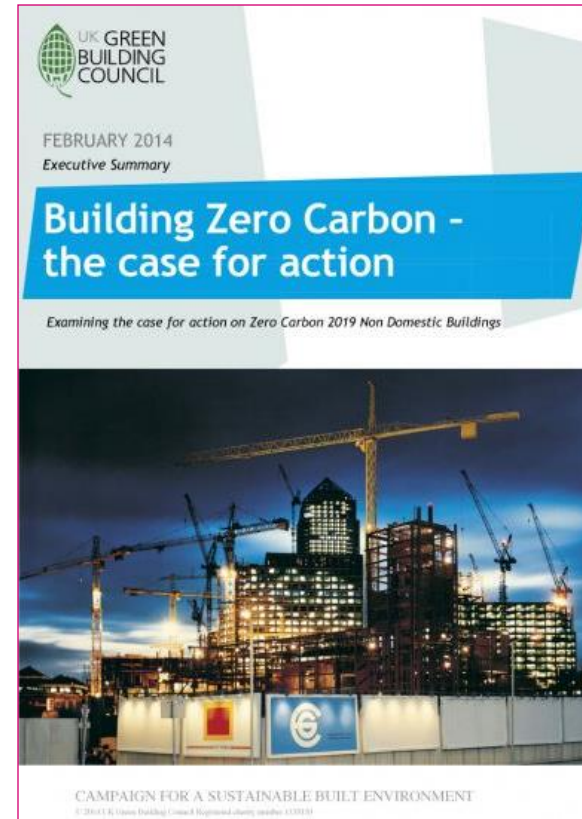


National and European Energy Targets

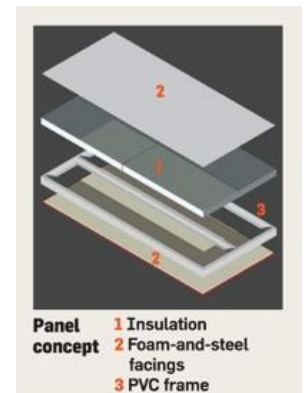
The building sector is responsible for 40% of Carbon Emissions in the UK

EU Energy Performance of Buildings Directive (EPBD) requires amongst other things that:

- a. All new buildings must be nearly zero carbon by 2020
- b. Fabric first approaches favoured



Advanced Insulation Concepts



Panel concept

- 1 Insulation
- 2 Foam-and-steel facings
- 3 PVC frame

True Low Carbon Solutions: Operational and Embodied Energy

- Historically embodied energy accounted for only 10% of total building energy use, operational energy accounting for the remaining 90%.
- As operational energy use has reduced however, and embodied energy and operational energy use is becoming similar, each accounting for approximately 50% of total energy burdens.
- Focus therefore has to shift to combine operational and embodied energy appraisal.

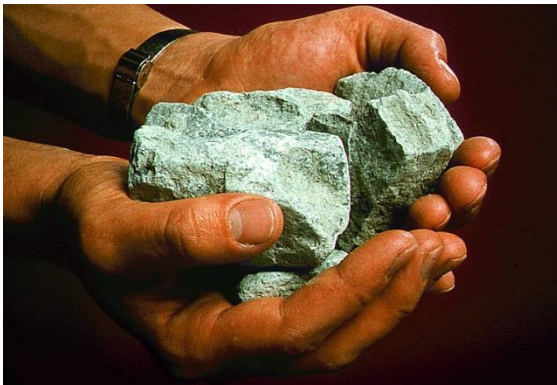


True Low Carbon Solutions: Insulation Materials

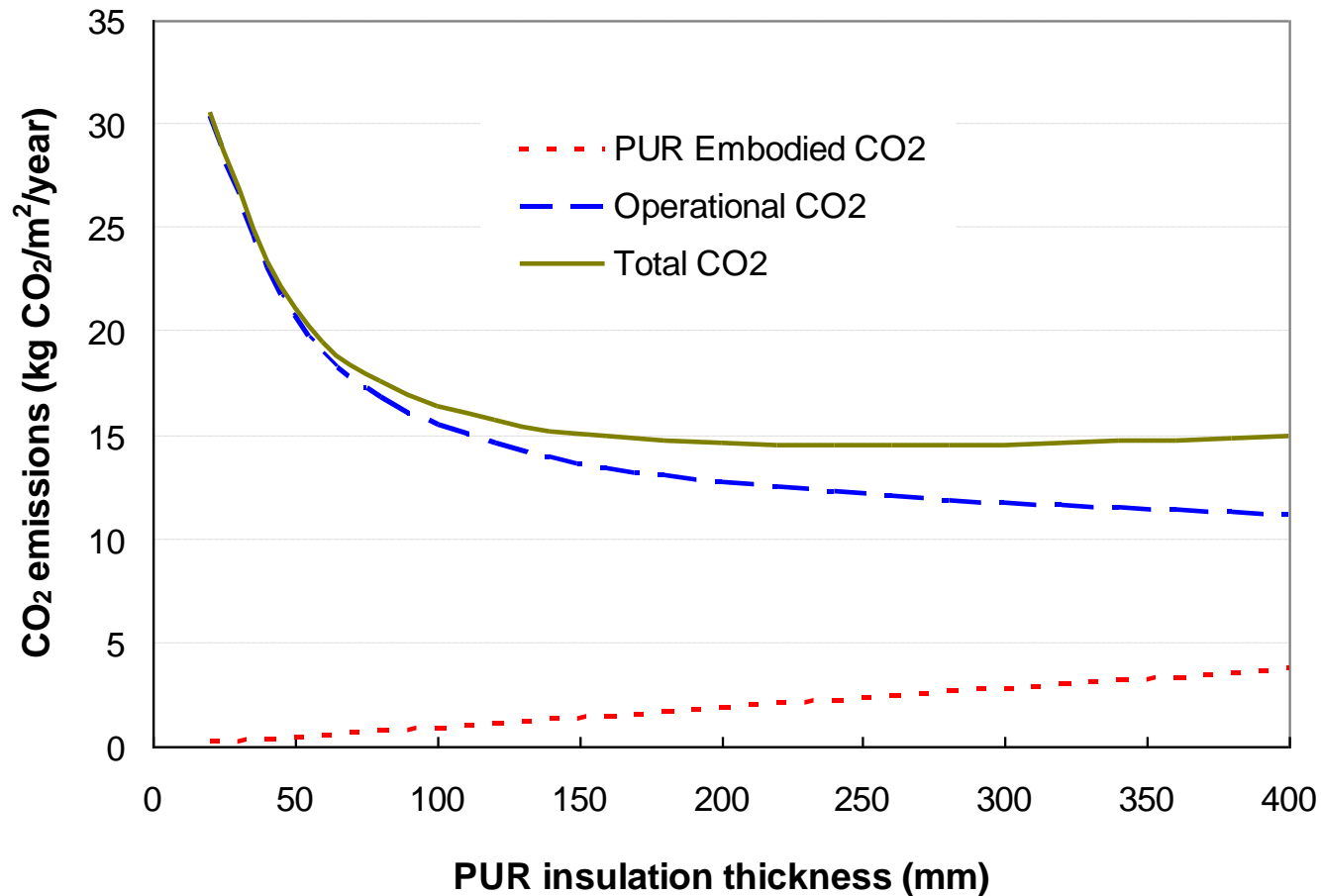
Most insulation materials have high embodied carbon:

- PUR/PIR is requires oil derived polymers
- Mineral wool requires high temperature processing of source materials

Future materials should combine high levels of thermal insulation with low embodied energy.



Non-linear Relationship Between Embodied and Operational CO₂ and Combined Amounts: Typical Case



Optimal Insulation Levels Based on Operational and Embodied Energy Calculations: Warehouses

Building type	Insulation type	Minimum CO ₂	Roof U-value	Wall U-value
		(kgCO ₂ /m ² /year)	W/m ² K	W/m ² K
Large warehouse	Mineral wool	13.5	0.08	0.111
Medium warehouse		10.74	0.08	0.116
Retail shed		2.19	0.13	0.18
Large warehouse	PUR	14.48	0.09	0.13
Medium warehouse		12.08	0.09	0.13
Retail shed		3.97	0.15	0.21
Large warehouse	VIP	*	*	*
Medium warehouse		*	*	*
Retail shed		0.8	0.05	0.06

True Low Carbon Solutions: Conclusions

- Improved thermal efficiency of new and existing buildings is essential if the UK and Europe are to meet energy reduction targets, and parallel issues will apply internationally.
- Current conventional insulation materials cannot achieve low U-values without substantially increasing thickness, and embodied energy burdens are then likely to negate operational energy savings.
- VIP systems can achieve low or extremely low U values without incurring net embodied energy dis-benefits.
- Few, or no, viable rival approaches to VIPs have thus far been identified.

