

Environment Audit Committee Carbon Inquiry

Green Building Encyclopaedia

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<https://GreenBuildingEncyclopaedia.uk> <https://GBELearning.com> <https://GreenBuildingCalculator.uk>

To what extent have the Climate Change Committee's recommendations on decarbonising the structural fabric of new homes been met?

- To answer the question, can CCC be more specific about which recommendations and which publications or website pages, they are asking about?
- Having spent the last 22 years presenting to hundreds of mixed discipline audiences on environmental construction, it has become clear that very few official publications on the subject are in the industry's awareness.
- I will ask audiences "and who has read any of the publications presented by the previous speaker?"
- 1 in 100 hands are raised, it's the librarian or the knowledge manager, rarely directors nor executive staff.
- The only publications that are read are those forced by legislation, funding or development control.
- The mainstream industry is driven by fiduciary rules, meeting legislative minimum, filling checkboxes, and business as usual with their well-established supply chains and avoiding bankruptcy by delaying their payments.
- Changing specifications to reduce carbon is not on their agenda.
- Exceptionally real value engineering rather than cost cutting finds a suitable solution:
 - To reduce time on site and reduce site establishment overheads, replacing slow strengthening high-carbon concrete with rapid assembly carbon-negative mass timber structures, knocks weeks off the programme.

How can materials be employed to reduce the carbon impact of new buildings, including efficient heating and cooling, and which materials are most effective at reducing embodied carbon?

Single Property Top Trumps:

- WRAP Waste Resource Action Programme when it had a construction program, focussed on a single issue: recycled content and some of their guidance publications promoted substitutions of specified materials with others having a high recycled content, whilst ignoring their other fundamental properties.
- Example:
- This leads to materials with two properties say: k value and decrement factor for thermal insulation with another material with the same k value but high recycled content, leading to incompetent insulation in light weight construction (Light Timber frame or Light Metal frame) leading to summer overheating by solar radiation through opaque building fabric, overheating loft space or attics in turn overheating upper floors and bedrooms.
- Dense wood fibre thermal insulation with hygroscopic properties, moisture permeability that is compatible with historic fabric walls; being replaced by plastic insulation which is hydrophobic and moisture impermeable is incompatible with historic walls
- This 'single-property Top-Trumps approach' focussing on one property at a time leads to incompetent interventions and should be avoided at all costs.
- Insulation manufacturers have realised they can play the Top-Trumps game in their advertising and inexperienced designers or specifiers can be fooled into focusing on Insulation-Thinness alone.
- Focussing on Carbon alone tempts the inexperienced into a false sense of purpose and risks making incompetent new buildings or making good existing building interventions incompetent.

Materials Choice for Low carbon Building

- It is generally understood that mainstream methods of building and mainstream building materials have varying amounts of Embodied Energy, Carbon, Chemistry and Water; GBE calls these Violet materials
- Simple examples:

- Bricks: High embodied energy material and variable embodied carbon due to the fuel used to make them, mid embodied water
- Aggregates: Low embodied energy and low embodied carbon material, heavy so high transport emissions
- Cement: 8-10% of man made CO₂; major ingredient of Concrete: High embodied energy material, high embodied carbon due to chemical process and variable embodied carbon due to the fuel used to make it, high embodied water
- Concrete: After water the 2nd most used material in construction. High embodied energy material, high embodied carbon due to cement chemical process and variable embodied carbon due to the fuel used to make it, high embodied water, high natural aggregate content, high chemistry additives
- Plastics e.g. PVC: High embodied energy material, high embodied carbon due to non-renewable fossil carbon, high chemical process and variable embodied carbon due to the fuel used to make it, high impact toxic manufacturing waste products; flammable and highly toxic in files
- Metals: High Embodied Energy material and Embodied carbon in the fuel used to make it
- Steel: 7% of man made CO₂: Bi-product: Ground Granulated Blast furnace Steel (GGBS) Low carbon Cement replacement
- By contrast it is less well known that low carbon materials are readily available in the UK market but remain 'Innovative, Modern, Green' and under used by mainstream construction; what most understand as Green materials
- Simple examples:
 - Timber: High Sequestered Biogenic Carbon, Low embodied energy materials
 - Bio-based Plant-based materials: High Sequestered Biogenic Carbon, variable embodied energy materials variable embodied water, sometimes low embodied chemistry as binders or mineral for durability or loft
 - Unfired clay: low embodied energy materials, low to zero carbon, low embodied water, high moisture mass
 - Lime: lower embodied energy and lower embodied carbon than cement and variable embodied carbon from fuel choice
 - Reclaimed and Reused material: zero or low additional embodied energy and carbon
 - Recycled materials: lower embodied energy and lower carbon than virgin/primary materials, sometimes embodied chemistry as binders or embodied mineral for durability or loft
 - Manufactured stone aggregate: low impact chemistry, high carbon sequestration

Low carbon materials for low energy heating and cooling of buildings

- Whilst wood-based, cork, cellulose-based, plant-based, grass, cotton, recycled denim, straw insulation materials offer conductivity thermal insulation they are middle of the road performance and need 250-400 mm for future facing U values for winter heating season.
- However they do have exceptional performance in solar radiant thermal insulation function protecting interiors from solar heat gains through opaque external envelop in summer, reducing risk of overheating for extended periods and eliminating the need for high energy air conditioning.
- Mainstream materials like expanded or extruded plastics, glass or stone wool at conductivity thermal insulation densities do not have this radiation thermal insulation characteristic.
- This issue will be potentially cause problems in Modern Methods of Construction (MMC) where conventionally pursued wall thicknesses of c300 mm or less and lightweight construction will require very thin high performance conductivity insulation with little or no solar radiation protection of opaque external envelop, risking overheating, risking use of air conditioning, in the 25% MMC target for future homes
- Other materials include:
 - Cellular glass: low conductivity thermal insulation, high radiation thermal insulation,
 - Vacuum Insulation panels: Exceptional conductivity thermal insulation, no radiation insulation performance
 - Aerogels: Very good conductivity thermal insulation, good radiation thermal insulation
 - Hemp-lime: low conductivity thermal insulation, high radiation thermal insulation

Moisture Mass & Thermal Mass for low energy heating and cooling of buildings

- Moisture mass:
 - Humans occupying spaces breath and sweat out moisture vapour, raising the humidity levels; adding discomfort for the occupants, using ventilation or air conditioning are the conventional solutions
 - Natural materials with Hygroscopicity can absorb moisture vapour from the air into the materials and into their fibres reducing the room humidity and delaying or eliminating the need for ventilation or air conditioning
 - When people vacate the space and humidity levels reduce these materials will release the absorbed moisture and return to normal, ready to absorb moisture again
 - Wood-based, cork, cellulose-based, plant-based, grass, cotton, recycled denim, straw, sheep's wool insulation materials offer moisture mass
 - Plastics are hydrophobic and do not absorb moisture vapour from the air into their fibres

- Glass and stone mineral fibre insulation are hydrophobic and do not absorb moisture vapour from the air into their fibres
- Clay and lime plasters and finishes offer high Hygroscopicity and high moisture mass
- Cement, mortar render and concrete do not readily absorb moisture vapour.
- Gypsum plasterboard and plaster offer resistance to moisture permeability and low moisture mass
- Short term thermal mass:
 - Can absorb direct solar radiation that has entered a dwelling via glazing and convection heat rising from one surface towards another.
 - Requires large surface area, high density materials at internal surfaces (floors walls and ceilings)
 - Can be beneficial in short term hot spells
 - Conventional materials like stone, ceramic tile, brick, screed, concrete all perform well in this respect
 - Lightweight suspended ceilings or plasterboard of medium density are not and they isolate the thermal mass from the heat source
 - Heavyweight cement particleboard and dense timber particle gypsum boards offer thermal mass at surfaces
 - Cement render used internally: Good thermal mass
 - Clay plaster: Good thermal mass and moisture mass
- Long term thermal mass:
 - Can absorb summer solar gains and winter heating gains and stabilise internal temperatures to a relative steady state compared to the larger external inter seasonal temperature fluctuations
 - Heavy weight construction is the conventional method of exploiting long term thermal mass
 - Modern method of construction seek out lightweight materials
 - MMC are more likely to suffer overheating and require energy intensive solutions
- Phase Change Materials (PCM):
 - Materials that respond to changes in temperature and readily shift from solid to liquid and visa versa
 - Heat energy is either absorbed or released in order to enable this phase change
 - This can be used as a substitute for thermal mass in materials
 - This can be exploited by adding the equivalent of thermal mass to lightweight construction
 - PCM must be at the internal surfaces in order to absorb and release heat readily from and to a space
 - PCMs that are constantly hot or constantly cold offer no advantages
 - Burying PCM inside construction reduced its ability to gain or release heat and perform this function
 - PCMs include mineral, salts, waxes; waxes could be petrochemical or natural

What role can nature-based materials play in achieving the Government's net zero (carbon) ambition?

- Since Building Control does not address in-use performance then the 'performance gap' identified by Zero Carbon Hub remains a major barrier to meeting any ambitions.
- Energy Design Standards including Passivhaus, Carbon Lite, EnerpHit, Carbon Lite retrofit do ensure tested performance.
- These design standards do not dictate or limit the material choices.
- RIBA 2030 Carbon Challenge and LETI Embodied carbon targets could drive embodied carbon downwards if adopted widely
- Embodied Carbon standards in combination with in use Energy performance standards if adopted widely will help to drive down both embodied and in use energy and carbon.
- Mainstream materials including concrete, steel, aluminium, bricks, blocks, consume energy and generate carbon to varying degrees and do not help in the drive towards net zero carbon nor energy.
- Mainstream adoption of natural materials with the properties and performances referred to in previous answers to EAC questions will play a major role in achieving net zero energy and carbon
- Bio-based, plant-based, rapidly renewable carbon-sequestering materials grown in one agricultural growing season are fast to replenish and fast at making a difference to net zero carbon ambitions
- Carbon sequestration in manufactured aggregates and high density high thermal mass materials can play its part in striving for Net Zero Energy and Carbon.

What role can the planning system, permitted development and building regulations play in delivering a sustainable built environment?

- Permitted development:
 - Developer, Contractor or Constructor's fiduciary rules require short term profits and little interest in the consequential in-use energy, carbon and running costs for occupiers
 - GBE can see little opportunity to deliver sustainable built environment here
 - Adding additional storeys to existing buildings probably requires lightweight construction to avoid overloading existing structures and foundations
 - Lightweight construction opaque external envelop is prone to permitting radiant heat in and preventing conductivity heat out and not having density and thermal mass to absorb the heat, causing overheating to the interior of the new top floor or floors

- Joined up Development Control Planning permission with reserved matters or obligations on the applicant is a route to delivering sustainable built environment
- But if the Planners are not policing the actual work on site then those obligations may well be avoided
- Handover of those Planning Permission obligations to Building Control could be a means to police them
- However with local authority funding cut-backs Building Control is failing to police its own functions on site so could not reliably be asked to address planning obligations too.

How can these policies incentivise developers to use low carbon materials and sustainable design?

- Belgium Government's ambition to use LCA and Environmental Product Declaration (EPD) datasets (Includes Embodied Energy and Embodied Carbon datasets) to incentives developers was explained in 2012
- Their proposal was to tax development according to the size of the developments environmental impact based on LCA and EPD
- This needs a value assigning to CO₂equivalents or Climate Change Potential
- Fundamentally this must address as-built not just as-designed impacts.
- Substitution and surreptitious substitution of materials must be policed and embodied impacts and loss of in use performance must all be accounted for.
- UK could adopt a similar approach but focus on Energy or Carbon alone

What methods account for embodied carbon in buildings and how can this be consistently monitored and applied across the sector?

- Government and Authoritative bodies, Institutions and private enterprise publications and tools are fast entering the market

Targets

- NZC 2050, Construction 2025, CCC 2019, The Construction Playbook 2020,
- National Infrastructure Strategy 2020,
- RIBA 2030 Carbon Challenge, LETI and other targets

Consistency

- RICS Carbon calculator 2017 a common reference for many
- ICE Inventory carbon and Energy V3 2019 a common source for many
- Many LCA EPD databases provide a common source of product data

Monitoring

- Embodied:
 - Post Grenfell's Golden-Thread of information, Information Warehouse and project monitoring looking for anomalies?
 - Post GreenDeal and ECO's PAS 2035 and Information Warehouse and project monitoring looking for anomalies?

Should the embodied carbon impact of alternative building materials take into account the carbon cost of manufacture and delivery to site, enabling customers to assess the relative impact of imported versus domestically sourced materials?

- Absolutely yes, I cannot imagine any reason why not
- Post-Brexit Government might wish to encourage us to buy British
- Specify local where it is available, within 30-50 miles of a site, UK or EU if not available in the UK, International if nobody else makes it or reconsider the choice.
- Most of the environmental best practice natural materials come from mainland Europe.
- Fiduciary Rules driven Contractors will source internationally if it can be found cheaper, usually at the expense of social sustainability.
- Carbon impacts of energy production in the source countries must be taken into account following LCA rules and in EE EC SC data outputs

How well is green and blue infrastructure being incorporated into building design and developments to achieve climate resilience and other benefits?

How should we take into account the use of materials to minimise carbon footprint, such as use of water harvesting from the roof, grey water circulation, separate foul and surface water drainage systems, porous surfaces for hard-standing, energy generation systems such as solar panels?

- Water has a materials, carbon, energy, chemistry and even water load (embodied carbon, energy chemistry and even water) at all stages of the supply and disposal path
- Hot water has the additional carbon and energy load of heating directly or indirectly
- Solar panel heating of hot water has a low to zero energy and low to zero carbon load and a Renewable Heat Incentive (RHI) a Government financial incentive.
- Photovoltaic panel heating of hot water is an option offered with Feed In Tariff (FIT) rather than RHI and consists of one technology not two.
- Foul water (Grey and Black waste water) and combined sewer water, needs cleaning within the public sewerage system before entering the public water mains or discharging to water courses, water bodies or oceans.
- Rainwater and surface water flows need mitigation measures and may need treatment before entering drains and sewers.
- Living Roofs, Green, Brown and Blue roofs, Rain gardens along with Sustainable Urban Drainage Systems (SUDS) need to be made more use of.
- SUDS can be simple no-fines recycled or virgin aggregates with microbe water cleaning and mineral filter beds, plastic crates, pipes, tanks; with UV light cleaning, with or without membranes.
- Cold, hot, harvested rain water consumption and waste grey, black, combined water and must there for all be taken into account in any government drive or targets.
- All of these systems need carbon reduction incentives applied.
- Competent autonomous low energy, carbon and chemistry drainage and water treatment systems should be promoted and encouraged with ECA for all users.

How should re-use and refurbishment of buildings be balanced with new developments?

- Make their carbon targets equal
- Make refurbishment a preferred choice financially
- Make EPC target equivalent results as Building Regulations (once they have been improved significantly)
- Make EPC a competent process by competent people using competent methods

What can the Government do to incentivise more repair, maintenance and retrofit of existing buildings?

Domestic

- Drive all property EPC targets to meet the same ambitions as new build carbon targets sooner than currently planned
- Adopt equivalent of Welsh Technical Advice Note TAN 6 policy for Zero carbon Self-build and Self-Refurbishment across the UK
- Widespread adoption and enforcement of PAS 2035 and PAS 2030 on all domestic refurbishments including Public and Private Landlords, RSL, ALMOs, etc.
- Prevent the wide spread offloading of inadequate property from public ownership to private ownership to avoid the problems of upgrading them under PAS
- Encourage and incentivise domestic users to engage with ECA and ETL WTL CTL (as proposed below) and expand scheme to domestic appropriate technologies
- Energy Savings Trust EST product endorsement schemes to be embraced into ECA
- Broaden EST scheme to engage with overheating not just winter heating
- Reduce VAT on repair and refurbishment to match new build
- Lower or remove VAT from ETL, WTL, CTL and EST products.
- Allow VAT reclaim, permitted to self-builder also to builders and constructors
- Improve BRE Green Guide to Specification to include low carbon natural materials

Non-domestic

- Make equivalent of GreenDeal/ECO (improved to PAS 2038) to apply to all buildings
- Widespread adoption of PAS 2038 once published on all non-domestic refurbishments
- Bring back Carbon Reduction Commitment equivalent (CRCe) as an incentive not as a fine tax
- Bring back Enhanced Capital Allowance (ECA) to help with CRCe
- Simplify ECA form filling so that it is adopted and not rejected.
- Promote Energy Technology List ETL and Water Technology List WTL and ECA
- Develop comprehensive Carbon Technology List (CTL) for low carbon materials and link to ECA

- Zero rate Value Added Tax (VAT) from CTL products.
- Make it obligatory for designers, developers and constructors to engage with ETL WTL CTL and ECA in the specification of energy and water saving technologies not just WRAS accredited taps and valves; and pass those on to the Owner/Occupier as part of the Government Soft Landings (GSL) process.
- Roll out TOTEX used to incentivise the water sector with great results, and apply to all Government Department Procurement programmes, driving it into all design specifications
- Police and train BRE to be better than they are on the MicroGeneration Certification Scheme (MCS), Appendix Q and any other approval processes
- Ensure the Innovative Technologies, IOT, energy saving solutions are considered robustly and included even if BRE do not understand them themselves yet.
- Improve BRE Green Guide to Specification to include low carbon natural materials

3184 – 267 = 2917 words

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27th April 2021 – 28th April 2021