

Jargon Buster: Carbon Dioxide



Definitions & Meanings

Definitions: Carbon

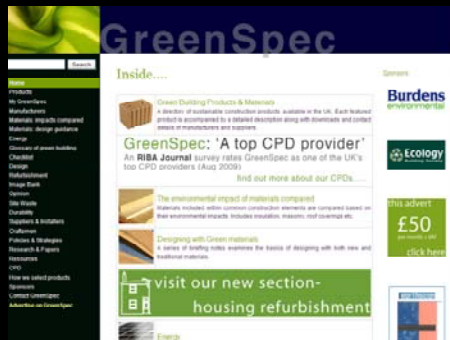
- **Carbon**
- **Carbon Dioxide CO₂**
- **Photosynthesis**
- **Non-renewable Carbon**
- **Global Warming Potential**
- **Greenhouse Effect**
- **Non-renewable Carbon Materials**
- **Renewable Carbon**
- **Renewable Carbon Materials**
- **Rapidly Renewable Carbon Materials**
- **Renewable Carbon Materials v non-renewable Carbon Materials**
- **Renewable Energy**
- **Renewable Building**
- **Carbon Sequestration**
- **Oceanic Carbon Sequestration**
- **Land Carbon Sequestration**
- **Carbon Capture**
- **Carbon Sequestration in Construction**
- **Carbon Sink**
- **Not a carbon sink**
- **Carbon Store**
- **Carbon Reduction Commitment**

Carbon Dioxide CO₂

- ‘Carbon’ an unhelpful shortening of Carbon Dioxide
- A gas
 - 1 part Carbon and 2 parts Oxygen
- An important part of the Earth’s Atmosphere
 - Not enough and its too cold,
 - too much and its too hot

Carbon Dioxide or CO₂

- Main Greenhouse Gas (GHG) produced from the burning of fossil fuels
- such as coal, oil and gas.



Photosynthesis

- plants and trees convert:
 - Sun's solar energy
 - (renewable energy as far as humans are concerned),
 - water H_2O from the ground
 - carbon dioxide CO_2 from the atmosphere
- create cellulose fibrous material C in plants and trees
- emits oxygen O_2 as a waste product

Non-renewable carbon

- Prehistoric plants and trees died and rotted down under pressure and heat over millennia to create fossil materials
- Because of its long gestation period it cannot be repeated over human lifetimes
- Called non-renewable
- We discovered it and found it has calorific value and used it as fuel
- Comes as coal, oil, gas and in combinations
- In burning the fuel CO_2 is released to the atmosphere

Global Warming Potential GWP

- CO_2 is ever present in atmosphere
- CO_2 is an essential part of the mix
- Adding excess CO_2 can modify atmospheric performance
- Excess CO_2 in the atmosphere can raise the temperature of the atmosphere and much more
- CO_2 is not the only gas that has GWP

Greenhouse Effect

- Solar rays enter the earth's atmosphere
- But once entered, its rays are modified and parts cannot escape the atmosphere
- The atmospheric temperature rises
- This is the same principle as in a Greenhouse

Green House Gases (GHG)

Non-renewable carbon materials

- A by product of oil is plastics
- Plastics are an example of non-renewable material
- They often use a lot of chemicals to convert oil to plastics
- They often generate a lot of chemicals as waste
- Chemicals are often hazardous waste

Renewable Carbon

- Carbon in the form of cellulose fibre as grown by plants and trees is renewable over a much shorter period
- Some is naturally fast growing
- Some slower and artificially fast grown in plantations
 - Trees: 40-100 years
 - Plantation thinnings: much sooner
 - Plants: 1 growing season
 - Bamboo: 1 growing season
- Uses include: Food, Oils, Biomass fuel, Bio-fuels, material for cloths, utensils, boats, construction materials

Renewable Carbon Materials

- **Materials using plant and tree based cellulose**
- **Trees: 40-100 years >**
 - Wood many applications
- **Plantation thinnings: much sooner >**
 - small section and composite timber products
- **Wood fibre:**
 - Thermal insulation and boards

Rapidly Renewable Carbon Materials

- **Plants: 1 growing season:**
 - E.g. cellulose fibre
 - E.g. Hemp shiv
- **Bamboo: 1 growing season >**
 - Flooring, boards, etc.
- **Oils and resins:**
 - 1 growing season > Linseed oil,

Renewable carbon materials v Non-renewable carbon materials

- **Plant based materials with properties of plastics**
- **Potato starch made into equivalent of expanded polystyrene**
 - At end of use + water > reverts to starch
- **Bio-plastics are being developed using plant based material and plant extract resins**
 - With the properties of plastics
- **Foamed plastics in particular**
- **Plant based resins in place of synthetic resins**
 - used to make carpet
- **Resin and cellulose**
 - furniture

Renewable Energy

- We are familiar with this
- Energy: Electrical and/or Heat
- Made by nature: Wind, gravity, etc.
- Powered: ultimately by the sun
- Renewable: as long as the sun keeps working

Renewable Energy

- The energy generated from natural resources
- Such as: daylight, sunlight, wind, rain, tides, and geothermal heat
- Renewable (naturally replenished)
- Avoids the use of carbon based fuels which add to carbon in the atmosphere when burned.

Renewable Building

- **Buildings that use a predominance of renewable carbon materials and rapidly renewable carbon materials**
- **Including: structure, building fabric, insulation, finishes, coatings, etc.**
- **Also the name of a group of advocates of Renewable Carbon Building Materials**
- **That meet with NNFCC National Non-Food Crops Centre**
- **Research & Test, then promote the well understood superior characteristics of these materials**
- **See us at EcoBuild 2010**

Carbon Sequestration

- The naturally occurring or deliberate removal of carbon from the atmosphere
- The storage of carbon in materials or a store or a sink where it will remain.
- Types of sequestration include:
 - 'geological' where CO₂ is captured and buried underground or under ocean e.g. in porous stone
 - 'biological' where CO₂ is absorbed during the growth of plants and trees.
 - 'Oceanic' where CO₂ is absorbed by the surface of the oceans
 - 'Soil' where CO₂ is absorbed by top soil

Oceanic Carbon Sequestration

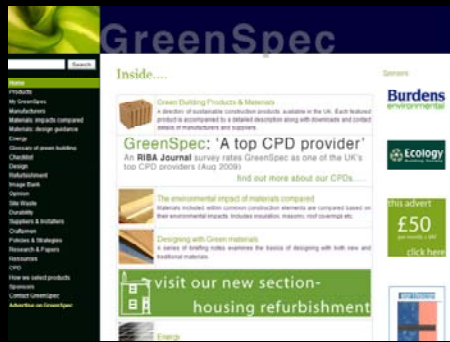
- Absorption of Carbon Dioxide into the water of the oceans
- Vast amount but still finite
- But it can only take so much:
 - Acidification of the seas
 - Algal blooms
 - Coral death
 - Ecosystem disrupted
 - Raised temperature
 - Increased evaporation & precipitation
 - More severe storms

Land Carbon Sequestration

- Carbon sequestration in fenland peat bogs is a intermediate renewable carbon sequestration
- Not fossil (but some might be that old)
- But not renewable in millennia
- 100 years not uncommon
- Not rapidly renewable but renewable

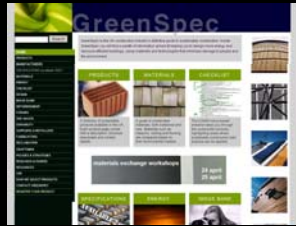
Land Carbon Sequestration

- Soil absorbs carbon
- Taken into account in LCAs (later)



Carbon Capture

- Is the deliberate removal of carbon from the atmosphere and capture or storage
- Exploring: pumped down to replace the combustible gas we extracted

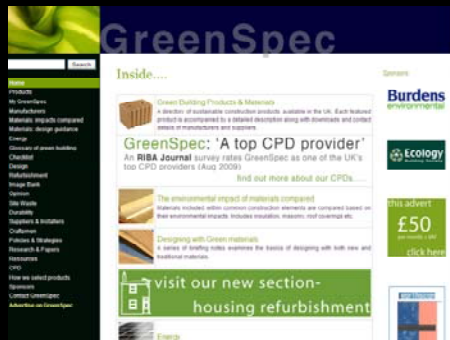


Carbon Capture Sequestration Trading

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Carbon Sequestration in Construction

- usually refers to building products derived from plant materials
- such as wood and hemp,
- where CO₂ is absorbed as part of the growing process.
- The carbon remains 'locked' in the material for the lifetime of the building.

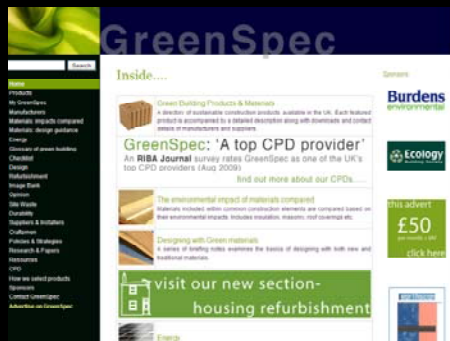


Carbon Sink

- E.g. Trees in a plantation
- Trees grow and are cut down
- Carbon comes and goes
- but is managed as a long term business
- A resource and source of renewable materials

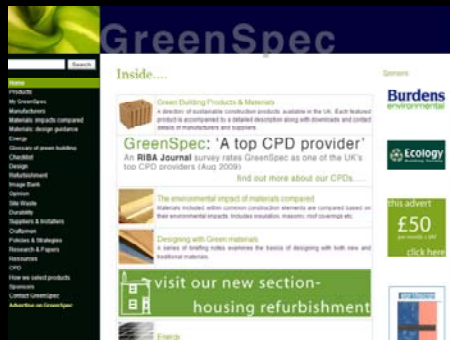
Not a Carbon Sink

- **Trees in a forest (ancient forest in particular) should not be considered a Carbon Sink because they have a much bigger role to play**
 - Home for some species including humans
 - Support Fauna and Flora
 - Support Biodiversity
 - Medical apothecary
 - Includes endangered species



Carbon Store

- E.g. Timber in a building
- A Local Authority T&CP Office required 10% renewable energy on-site supplies as part of the development
- Building could not accommodate 10%
- Argued carbon sequestration during growth of trees for Cross laminated timber panels superstructure would remove over 10% of the CO2 that would otherwise be saved by Renewable energy over 60 years of life
- T&CP accepted this.
- Need to check the energy efficiency of production ³¹



Carbon Store

- A protected ancient forest
- Unlikely to be cut down
- Carbon is safely held for the foreseeable future

Definitions: Carbon

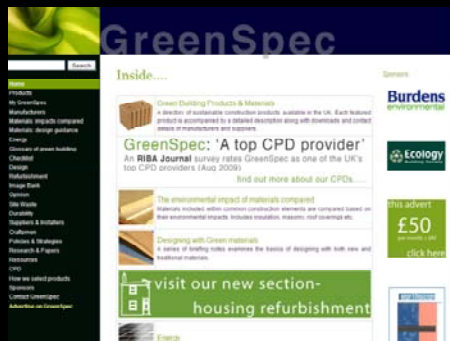
- **Embodied Carbon**
- **Embodied Energy**
- **Carbon Load**
- **CH&P Combined Heat & Power**
- **CCH&P Combined Cooling Heat & Power**
- **Carbon as a by-product of manufacture**
- **Low Carbon Alternatives**
- **Carbon Negative**
- **Carbon Positive**
- **Carbon Neutral**

Embodied Carbon

- Conceptually, Carbon 'embodied' in the material
- Usually the totalling up of the carbon used to create a material or product
- Includes the carbon from fossil based fuels used in the manufacturing and transporting processes

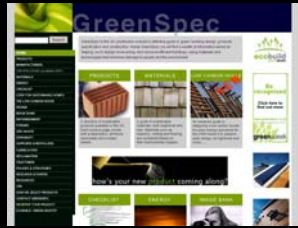
Embodied Energy

- All the energy required and used to grow, harvest, extract, manufacture, refine, process, package, transport, install of a particular product or building material.
- What about:
 - maintaining and disposing of it?
 - embodied energy of the labour force
 - that made it, stock it & travel to site to install it?



Carbon Load

- **Associated with water supply:**
 - Water is cleaned with chemicals and energy
 - Water is pumped with energy
- **A major supplier to the water sector is the energy sector**
- **Power stations use steam turbines**
- **Turbines are fed with steam**
- **The steam is cooled in cooling towers**
- **Some steam escapes and some water is recycled**
- **The energy sector is a major**
 - user of water
 - waster of energy and heat
- **Its time this was sorted out, where is CH&P,**
 - whichever fuel they choose



ZCD: Water Use Reduction

Brian Murphy (GreenSpec)

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CH&P Combined Heat & Power

- **Electrical generation using steam powered generators is normal**
 - Heat in the steam is usually wasted
- **CH&P uses the steam for heating in winter**
 - Energy efficient
- **CH&P wastes heat energy in summer**
 - Energy inefficient
- **Biomass CH&P uses carbon neutral fuel**
 - Carbon efficient, energy inefficient

CCH&P Combined Cooling Heat & Power

- CCH&P could avoid wasting energy
- By converting excess summer heat to summer coolth
- Or inter-seasonal storing of the heat

Carbon as a by-product of manufacture

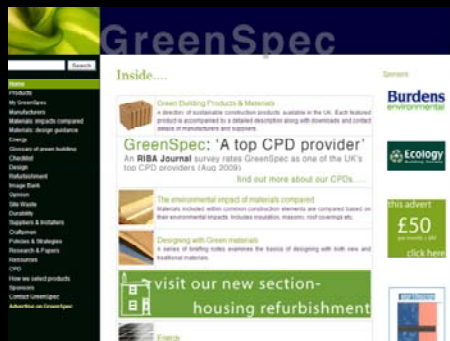
- In addition to carbon released from fuel
 - This can be improved by use of renewable energy or non-carbon based fuel
- There can be carbon dioxide as a by-products of chemical reactions
 - Cement produced from Calcium Carbonate
 - Generates CO₂ this cannot be reduced
 - But Calcium Carbonate can be replaced
 - UK manufacturers vested interest resists change
 - Or cement can be replaced
 - UK manufacturers vested interest resists change

Low Carbon alternatives

- **OPC Ordinary Portland Cement**
- **Replace with OPC substitutes**
 - **GGBS Ground Granulated Blast Furnace Slag Cement (from steel production)**
 - **PFA Pulverised Fuel (High Carbon Coal) Ash Cement**
- **OPC replaced partially or completely**
 - **with Lime**
 - **Lower cooking temperature**
 - **Carbon sequestered during construction and during building life**

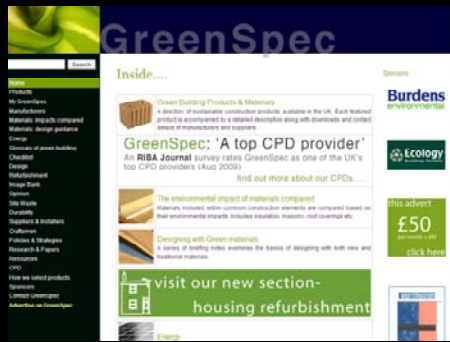
Carbon negative, positive & neutral

- **Grow Trees**
 - Carbon sequestration from atmosphere
 - Carbon negative C-ve
- **Convert to wood or paper**
- **Burn wood or paper**
 - Release carbon to atmosphere
 - Carbon positive C+ve
- **Net result: Carbon neutral C+=-**
- **But there is a little energy and possible carbon in converting the tree to wood or paper**
 - not quite Carbon neutral a bit Carbon positive C+ve



Carbon Negative

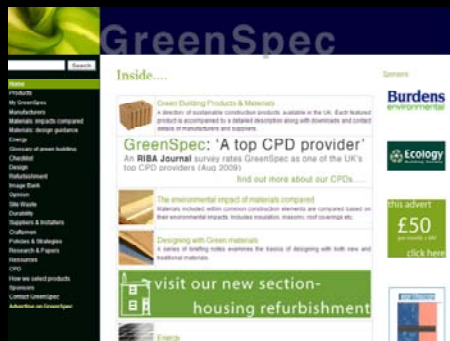
- Hemp-lime construction
- Uses hemp shiv as an aggregate C-ve
- Uses lime as a binder C+ve
- To make a material like concrete C-ve
- But many other positive properties
- But add cement for fast set C+ve
- Add aluminium oxide to react with cement to foam like aerated concrete E+ve
- But still C-ve



Carbon Positive



- Often used confusingly
- meaning carbon negative with a 'positive' swing



Carbon Neutral

- Conceptually, a state whereby the CO₂ generated by a process is exactly balanced by the amount of CO₂ either offset or sequestered by the process.
- A carbon neutral building is one that either uses no fuel that generates CO₂ or where its consumption of CO₂-generating fuel is equally balanced by exported renewable energy.
- The definition continues to be debated as to the extent of direct / indirect CO₂ that is included in the equation
- E.g. CO₂ generated in the construction of the building.



Jargon Buster: Carbon Dioxide



Reducing Carbon Dependency

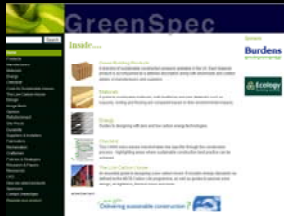
Definitions: Carbon Reduction

- Low Carbon Agenda
- Carbon Reduction
Commitment CRC
- Carbon Trading
- Carbon Offsetting
- Carbon Credits
- Carbon neutral
company

Low Carbon Agenda

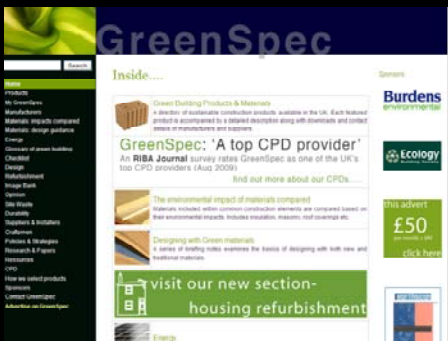
- **Government Carbon focus**
- **Conflicts with Energy Efficiency**
- **Biomass fuel is low carbon to carbon neutral (and potentially polluting)**
- **Biomass CHP:**
 - is energy efficient in winter
 - Is energy inefficient in summer

Carbon Reduction Commitment



Carbon Reduction Commitment CRC

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Carbon Trading

- Kyoto Summit's Protocol called for Carbon reductions by all nations
- USA and a few others refused to sign up if it meant this might affect their business communities profitability (and profligacy)
- A last minute suggestion to try to get the USA to sign up was to invent a way for the developed countries to do nothing and pay another country for its share of unused 'carbon credits'



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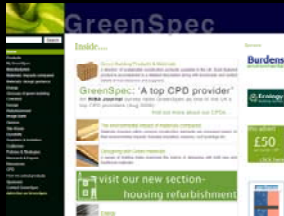
Carbon Offsetting



Carbon Offsetting

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Carbon Credits



Personal Carbon & Carbon Credits

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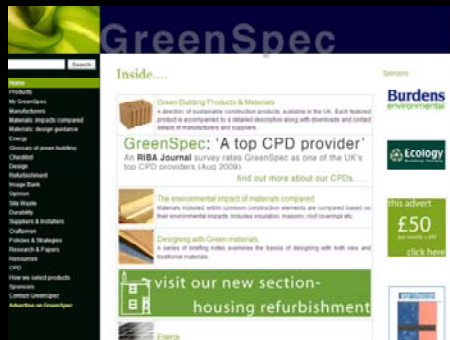
Carbon Neutral Company: Kier Sheffield

Carbon neutral enterprise

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Definitions: Low Carbon Building

- Carbon Hierarchy
- Zero Carbon
- Zero Carbon Building
- Low Carbon building:
in use
- Low Carbon building:
in construction
- Carbon *lite*
Programme
- Carbon neutral toolkit



Carbon Footprint

- A building's carbon footprint is the measure of the carbon emissions resulting from the use of that building, measured in units of carbon dioxide (CO₂)
- (BCT & GreenSpec '08)

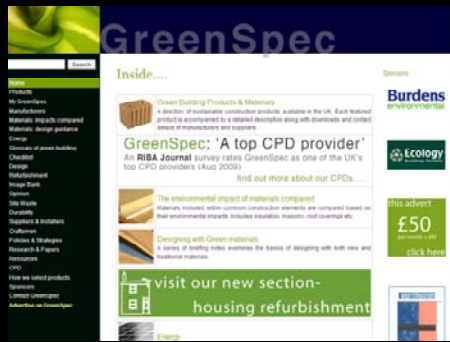


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Carbon Footprint

CPD topic

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Carbon Hierarchy

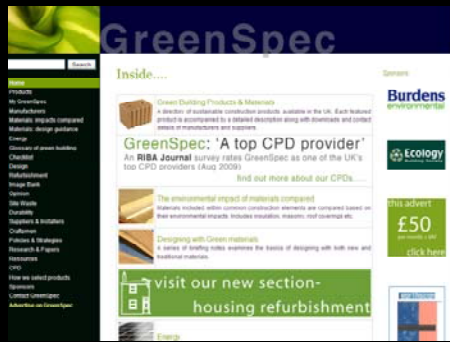
- Carbon Efficiency
 - Energy Efficiency & Fuel Choice
- Priority order



Carbon Hierarchy

Fuel Energy Heat
Low Carbon Lifestyle

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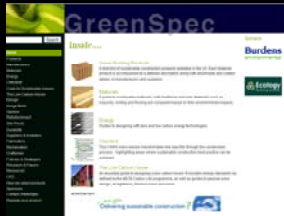
Zero Carbon



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- Government yet to Define?



Zero Carbon Definition

Zero Carbon Hub

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Zero Carbon Buildings

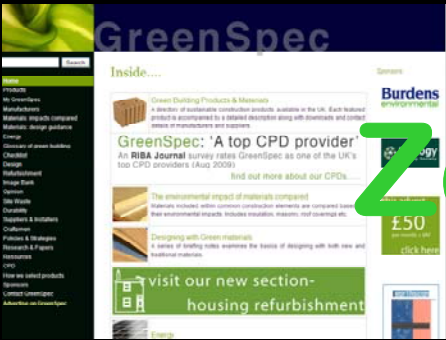
- Since the publication of the Government's plans to achieve zero carbon in all new homes from 2016, and all new non-domestic buildings from 2019 there have been calls from the industry for a clear definition of 'zero carbon'
- The basic definition is that a zero carbon home is one whose net carbon dioxide emissions, taking account of emissions associated with all energy use in the home, is equal to zero or negative across the year, as outlined by The Minister of State John Healey MP in August 2009.
- BCT Biodiversity in Low- to Zero- carbon buildings 2010

UK Zero Carbon Buildings

- All new schools by 2016
- All new public buildings by 2018
- All new non-domestic by 2019
- England only
- New only
- (Budget '08)

'Zero Carbon' building (in use)

- One where, annually, there are no net carbon emissions resulting from the operation of the building.
- In practice, different views are taken as to the degree of autonomy the definition of 'Zero Carbon' refers to.
- For example, the Code for Sustainable Homes requires much of the energy consumed to be generated from on-site renewable technologies, whereas other definitions would include off-site generation to various degrees and remoteness of source.
- No official definitions currently include the Carbon generated in the construction of a building.
- (GreenSpec '09)



Zero Carbon Building (in construction)

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CAPEM
 Cycle Assessment Procedure for Eco-Materials



www.greenspec.co.uk

ZED Zero Energy Development



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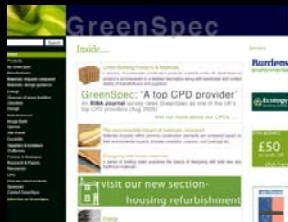
Carbon Neutral Toolkits

ZED products

ZED factory

BedZED

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Low Carbon Technologies

Carbon-free Group

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Low Carbon Building (LCB): (In use)

- LCBs are buildings which are specifically engineered with Carbon Dioxide reduction in mind (a major Greenhouse Gas (GHG) with Climate change potential).
- So by definition, a LCB is a building which emits significantly less Carbon Dioxide than regular buildings.
- There is at the moment no emissions threshold under which a building would qualify as a LCB.
- But to be genuinely Carbon or CO_2 neutral, a LCB would have to achieve at least 80% Carbon or CO_2 reduction compared to traditional buildings.

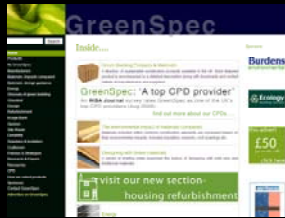
Low Carbon Building: In Construction



Low Carbon Homes

HHP workshop

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LCGB: Low Carbon Green Buildings

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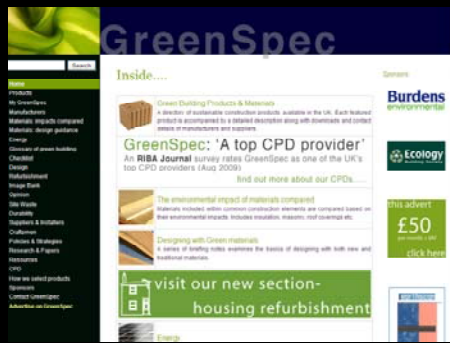
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Low Carbon Green Building

Ogle Oct 8th 2008

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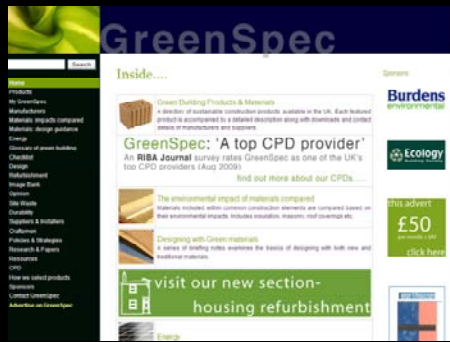
Carbon Literacy



Carbon *Lite* Programme

- AECB's Carbon *Lite*
- AECB
- The sustainable building association
www.aecb.net/
- Carbon Literate Design & Construction Programme
- <http://www.carbonlite.org.uk/carbonlite/>

Carbon *Lite* Programme

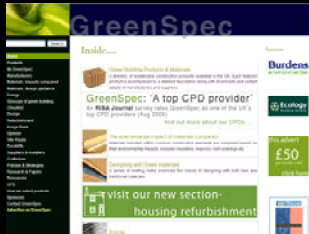


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Low Carbon Lifestyles

Low Carbon Lifestyles



Low v High Carbon Lifestyles

Implied criticism

Green v Violet

Good v Bad

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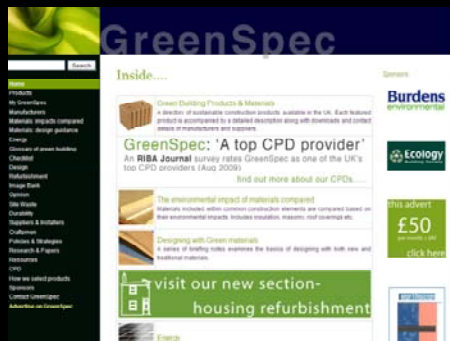
Community low carbon lifestyles

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Community Support low carbon lifestyles

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Definitions: Life Cycle Assessments

Definitions:

Life Cycle Assessment

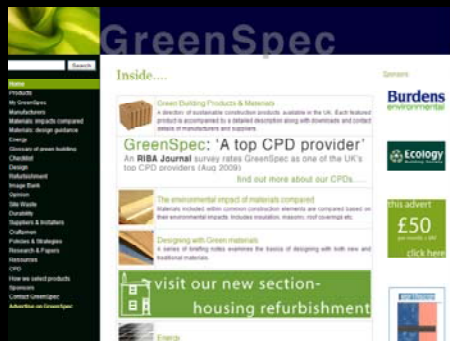
- LCCA
- LCA
- Cradle-to-*
- LCA for transport
- Carbon Sequestration in LCAs
- BRE Green Guide
- Environmental Profile
- CAP'EM Project
 - simple LCA
- Carbon Footprinting

LCCA Life cycle cost analysis

- A method for assessing the total cost of facility ownership
- It takes into account all costs of acquiring, owning, occupying, maintaining and disposing of a building or building system.

LCA Life Cycle Assessment

- Looking at Life cycle of materials



Cradle-to-*

- **Life Cycle Analysis (LCA)** is often broken down into phases of lesser ambition.
- **Cradle-to-cradle**
 - Where recyclable / reusable products are the subject
- **Cradle-to-grave**
 - For non-recyclable materials that are destined to be disposed of
- **Cradle-to-gate**
 - production from extraction of raw material and factory production
- **Cradle-to-site**
 - extraction, factory production and delivery to site
 - though these LCAs are useful and more common
 - they tend not to tell the whole story

LCA for Transport

- We need transport LCA calculators too
- For all parts of the journey
 - From source by Land to coast
 - port to port by sea
 - Coast to site by land
- not just by sea

Carbon sequestration in LCAs

- BRE Green Guide argue that the carbon sequestered by plant or tree
- stored in construction materials for life of building
- Will be released when the materials are landfilled or burned
- However Landfill is no longer seen as end of life option
- Designers have a long way to go to design for deconstruction
- But MMC is easy to assemble, dismantle and reassemble
 - So lets make things well, durable & robust so they can be reused

Carbon sequestration in LCAs

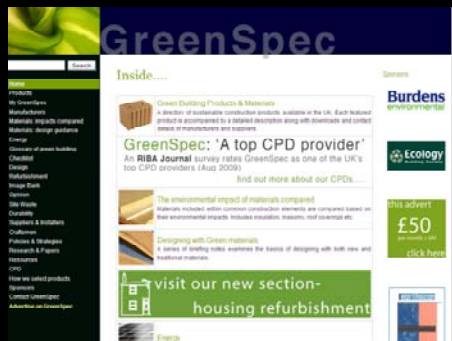
- BRE argue that materials will be lost to landfill
- but we argue they may also be suitable for composting so they still retain Carbon
- Some plant based thermal insulation materials are robust
- Can be used and reused

Environmental profile

- The output of an environmental profiling process
- Profiling can be of a generic nature using general industry data or it can be of a proprietary nature using product-specific data
- for example as part of the BRE's 'Environmental Profiles Certification Scheme'.
- Generic profiles (based on whole sector data) form the basis of the BRE's 'Green Guide to Specification'.
- Product Profiles (based on one manufacturer's product) form the basis for BRE's 'Green Book Live'
- Occasionally Product profiles are used by BRE in Green Guide creating false impressions of green materials

Environmental profiling

- The ‘identifying and assessing the environmental effects associated with building materials’ (BRE)
- usually using a standardised methodology
- The UK profiling market is dominated by the BRE, but other methodologies are currently being developed
- for example CAP’EM project.



CAP'EM project



- An EU Interreg funded project, currently underway,
- to develop a harmonized assessment procedure for building materials based using a simplified LCA-based methodology.



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CAP'EM

Cycle Assessment Procedure for Eco-Materials



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- **Architect by Training**
- **Specification Writer by Choice**
- **Greening up my act since 1999**
- **Founder of www.greenspec.co.uk**
- **E BrianSpecMan@aol.com**
- **Twitter: <http://twitter.com/brianspecman>**
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