



Sustainable Building and Future Proofing

Dr Michael Crilly **CABE @ Tees Valley**

Eur Ing Peter Loftus C.Eng M.I.Mech.E **Renew Tees Valley Limited**

Energy and Environment Fair

Friday 22nd September 2006

Commission for Architecture
and the Built Environment

The government's advisor
on architecture, urban design
and public space

Sustainable Building



EU Directive [2002/91/EC – 16 Dec 2002] on the Energy Performance of Buildings.
EU Directive [2004/8/EC – 11 Feb 2004] on the Promotion of Cogeneration based on Useful Heat Demand in the Internal Energy Market.
EU Directive [Proposal for a Directive - 10/12/2003] on Energy End Use Efficiency and Energy Services [COM[2003] 739 Final 2003/0300 [COD]]

All these items pass into British Law in 2006.

PPS22 Planning Policy Statement on Renewable Energy
Regional Spatial Strategy for the North East / Local Development Frameworks
'The Merton Rule'

Building Regulations
Sustainable Construction Standards

Appropriate technologies
Lifestyle / behavioural change



Statutory Standards



The UK **2006 Building Regulations [Parts L and M]** control the quality and performance of new buildings including standards for conservation of fuel / power [part L] and access to buildings [part M]. The recent revisions [coming into effect from 6th April 2006] based upon the EU Energy Performance of Building Directive require 20% improvements to energy efficiency on the previous standards. These deal with;

- CO₂ emissions [Kg of CO₂ per m² floor area per annum based on SAP - heating installation / hot water supply, active solar systems and other heating / cooling and electricity systems based on renewable energy sources, electricity produced by CHP];
- Performance of the building fabric [thermal characteristics of the building shell and internal partitions];
- Consideration of solar shading and summer overheating [building orientation, natural lighting, passive solar systems and solar protection];
- Insulation and air-tightness;
- Information for building users.

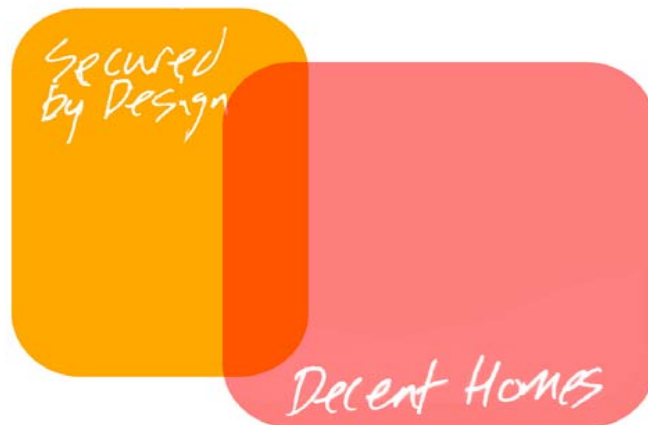




Decent Homes

A central government defined standard [initially established 2000] for social housing as integral to all public sector regeneration funding and applicable to all Registered Social Landlords. This 'decency' is defined as; meets current minimum **statutory standards**; reasonable state of **repair**; reasonable **facilities** and services; reasonable degree of **thermal comfort** [including effective insulation and efficient heating system].





Secured by Design

The UK police force's 'flagship' promotion of an integrated design approach around; **environmental quality** / ownership [including landscape planning / site management with detailed consideration of specific security measures and specifications for property / building typologies]; promoting natural **surveillance**; **access** routes [footways, cycleways and roads]; public **open space** [linked to management]; **lighting**.

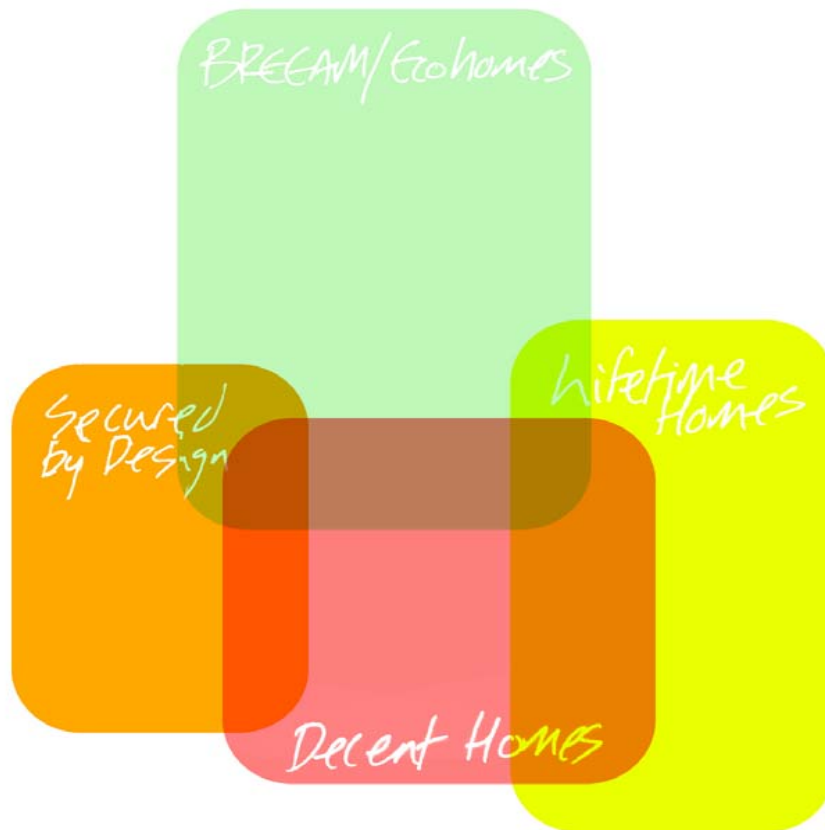




Lifetime Homes

Voluntary standard defined by the Joseph Rowntree Foundation for accessible homes meets basic **access** requirements [compliant with the Part M Building Regulations] and promotes **flexibility** for future adaptation. It does impact on some aspects of **external space** design [particularly car parking and levels] as well as ground floor **uses** and areas of **communal** access.

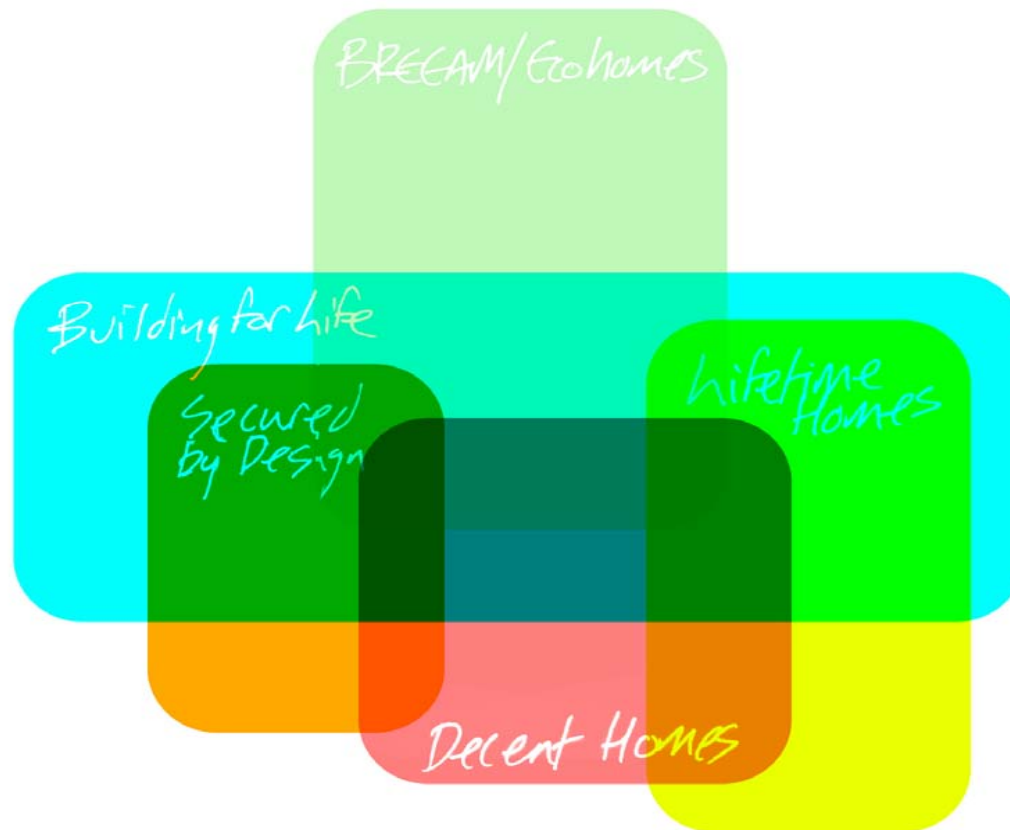




BREEAM

[Building Research Establishment Environmental Assessment Method] is a widely accepted and respected scheme that sets a benchmark for **environmental performance** and provides measurable benefits. It is independent, authoritative and is based on many years of construction and environmental research carried out at BRE, together with the input and experience of the construction and property industries, government and building regulators.

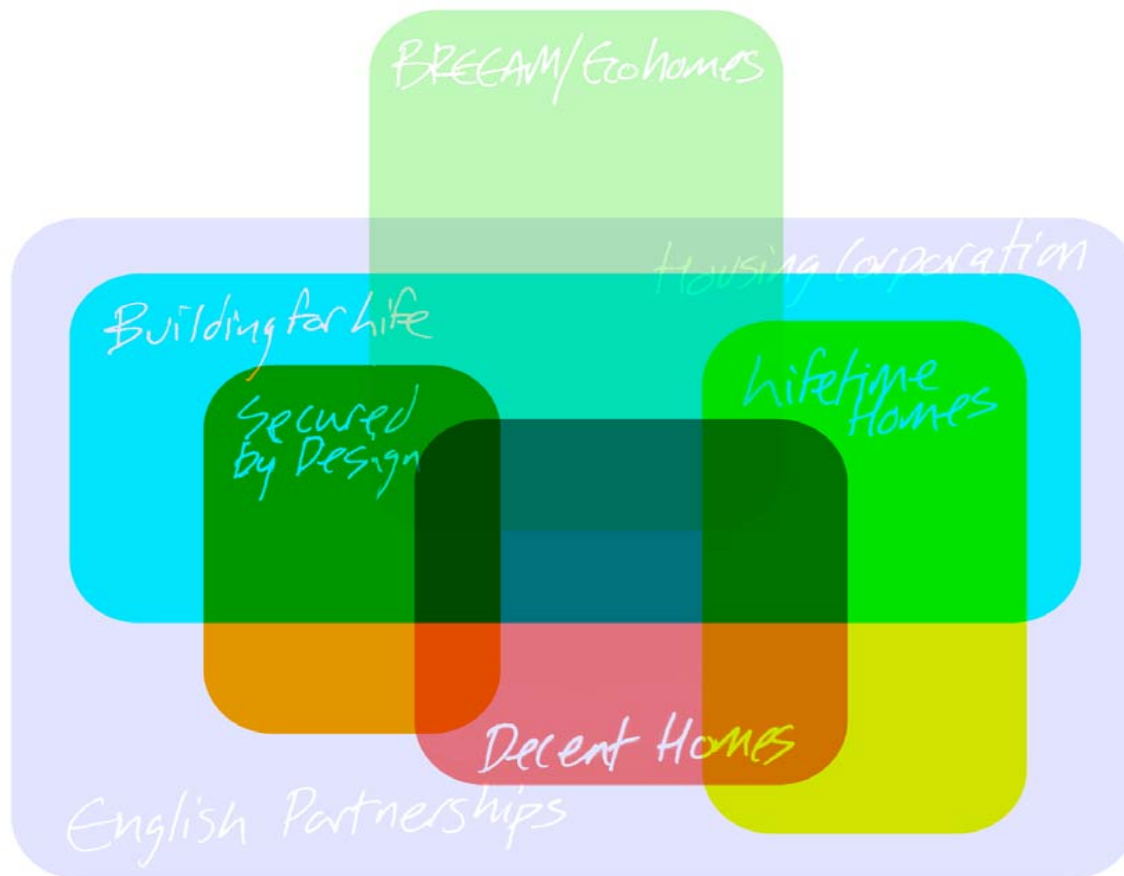




Building for Life

Collaborative award system developed by the Home Builders Federation and the Commission for Architecture and the Built Environment to assess and validate design quality for residential developments. This is a largely qualitative assessment based upon peer review against a set of four broad criteria addressing; **character**, **road, parking** and **pedestrianisation**; **design** and **construction**; **environment / community**.

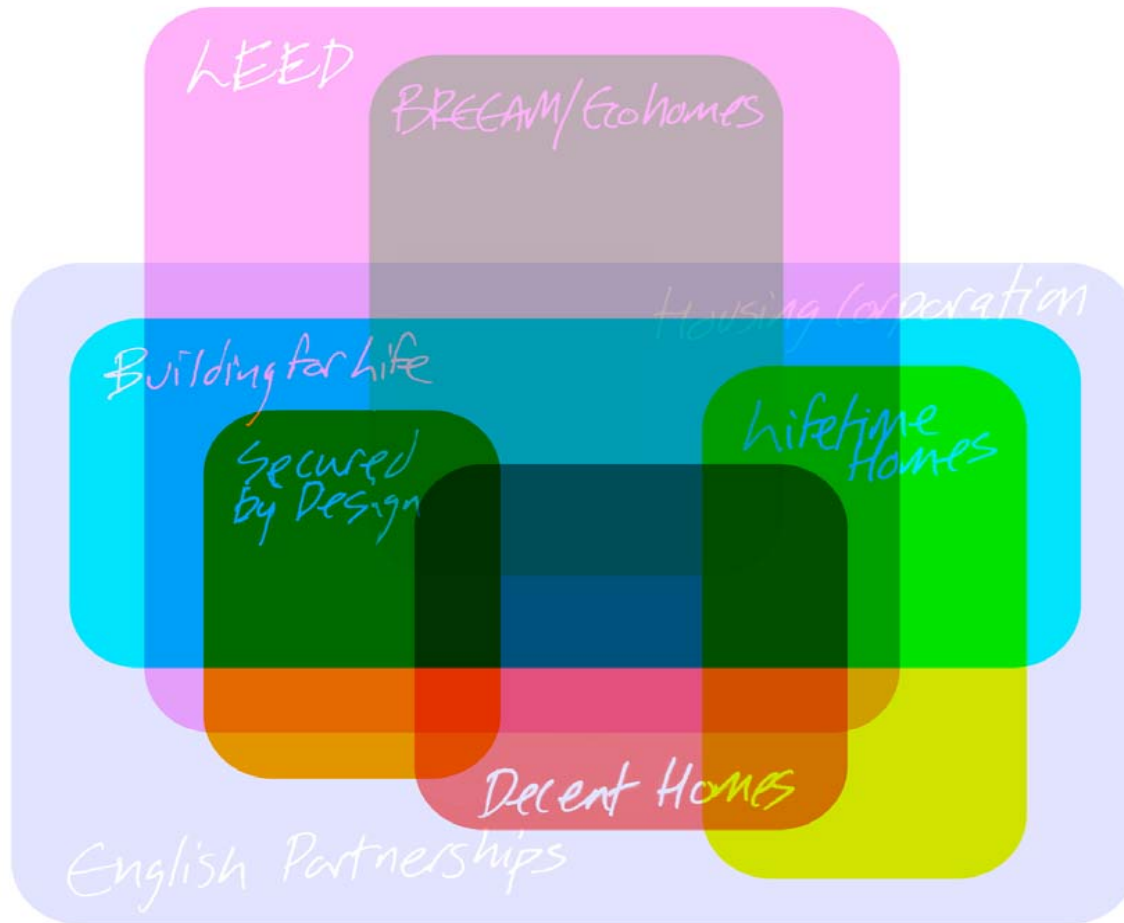




Housing Corporation / English Partnerships

Scheme Development / National Quality and Price Standards address design and quality in RSL housing schemes. It deliberately incorporates and refers to other familiar 'thematic' guides and standards, with reference to urban design guidance and external reference to *CABE Design Review* service and sets minimum measurable and qualitative 'standards' as a requirement for financial support.

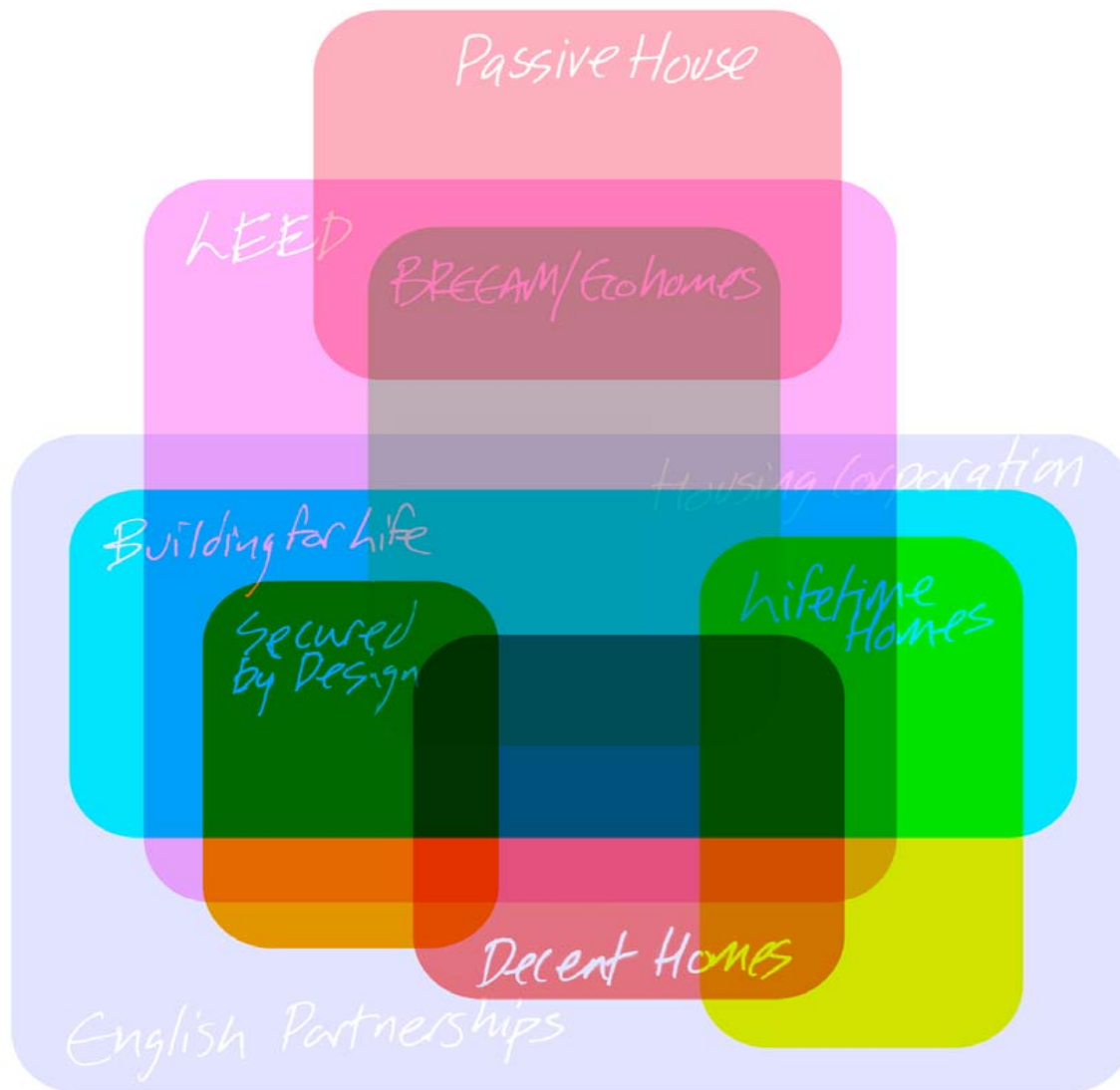




LEED

[Leadership in Energy and Environmental Design] is a green building rating system 'franchise' provided by support and assessment by the U.S Green Building Council. It is gained by consideration of the key design issues of; **site planning**; **water** use and efficiency; **energy** efficiency and renewable energy; conservation of **materials / resources**; and **indoor environmental quality**.

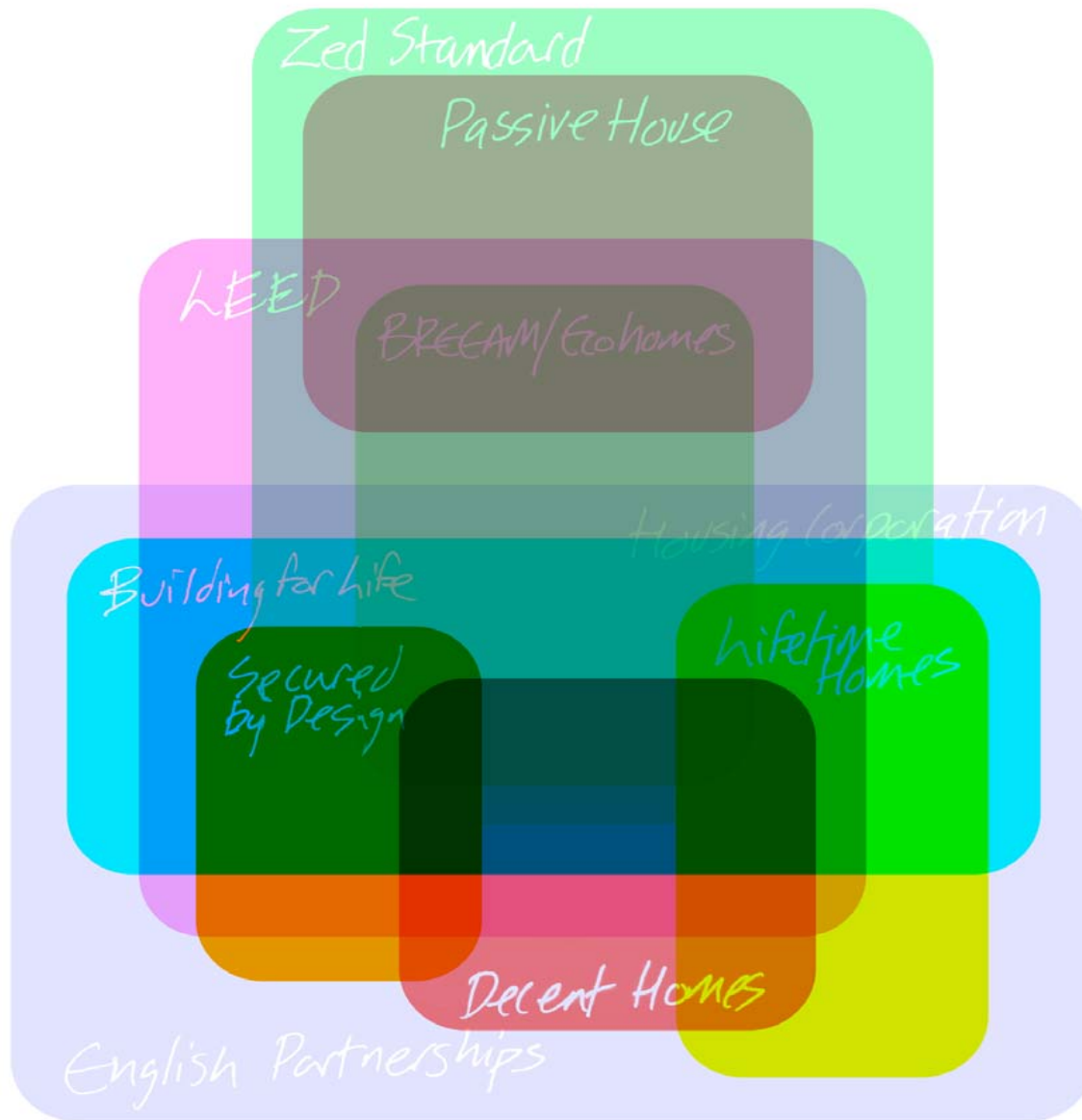




Passiv Haus

Energy requirement for heating [space and water] is typically lower than 10 to 20 kWh/[m²a] by consideration of principles of; orientation to maximise **passive solar gain**, make it well **insulated** and **air tight**; design of the **energy system**; extension of energy **efficiency** appliances throughout the dwelling; meeting remaining energy demand from **renewable** sources.

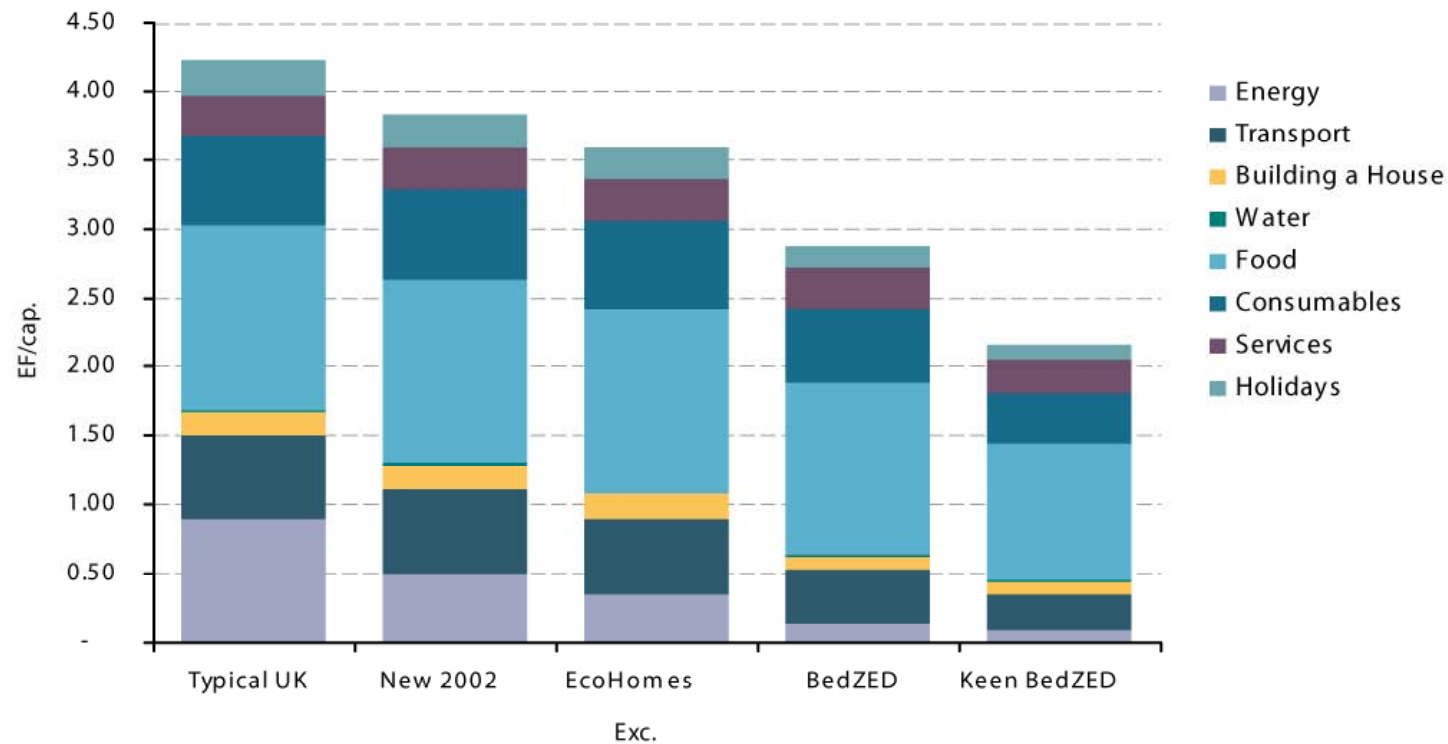
It can be applied to new build or retro-fitting to existing buildings and the methodology can be applied to non-residential uses.



Zed Standard

Published as a discussion draft by Bill Dunster Architects, based upon the lessons learnt from the development of BedZed. It is distinctive in the extent to which it facilitates the sustainable use of the development with regard to **food** production, **recycling**, **water** use and the impact of **transport** – based on the principle of diminishing returns, where CO₂ emissions, and environmental impact can be more easily reduced through lifestyle changes rather than physical design measures.

Relative Standards



[An analysis of four different UK housing types and the associated Ecological Footprint of the residents, combining the indirect impacts of consumption, including the impact of construction – ARUP / SEI 2006]



Energy Grading



Electricity is high grade energy and should not be used for space heating which is a low grade energy use.

- **Natural** forms of **ventilation** are preferable to electric fans.
- **Domestic Heat Pumps** use high grade electrical energy to produce space heating which is a low grade energy use.
- Use **natural light** rather than electric.
- **Solar gain** and **passive solar heating** is preferable to fossil fuel CHP.

Renewable energy is itself a limited resource and should not be used unwisely even though it is 'Renewable'. There is often a time factor or **intermittency** factor with renewables [wind, solar]. Renewables cause more difficulty affecting such items as the building orientation and the building has to be designed to store heat and stimulate natural airflow.

The heat gain from the buildings occupants and their activities now becomes a significant resource. We can design 'zero heating' buildings. Energy generated on site is preferable to centrally generated electricity [or heat].



Super-Insulation



By increasing the thermal insulation to 300mm or using an 'Earth Sheltered' design it is possible to derive all of the heating from building occupancy plus passive solar.

Windows doors and rooflights would need to be triple glazed and achieve 1 W/m² 0C.

There is a capital gain from doing away with radiators, piping, air ducts, and boilers



[external insulation / triple glazing, 'Lummerland' Passiv Haus development, Hannover-Kronsberg]



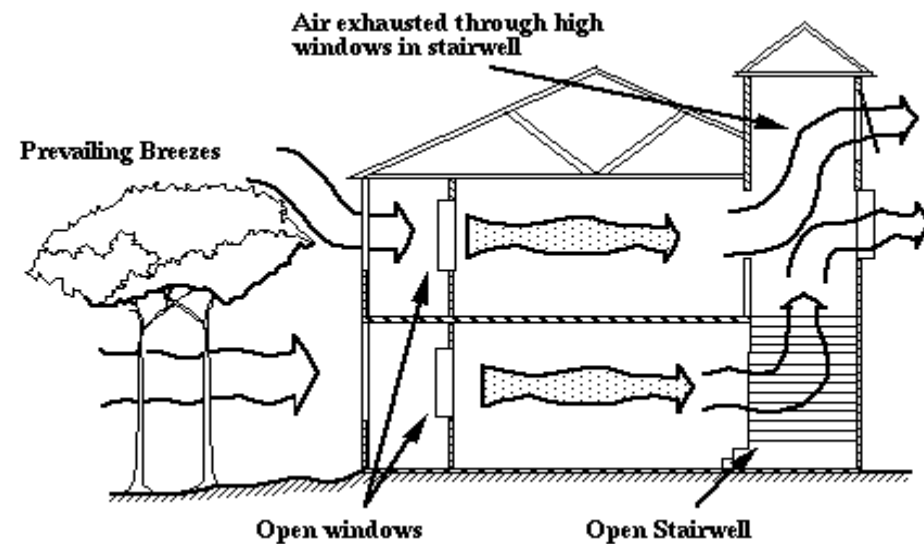
Airtightness



Airtightness can be increased to better than 1 m³/hr/m² or 2½ air changes per hour at 50 Pa.

Reduces direct losses through the building fabric.

Facilitates natural ventilation systems.

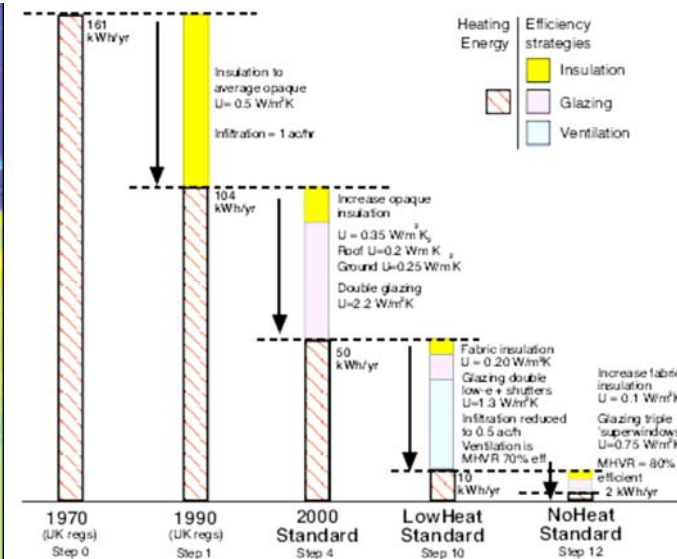
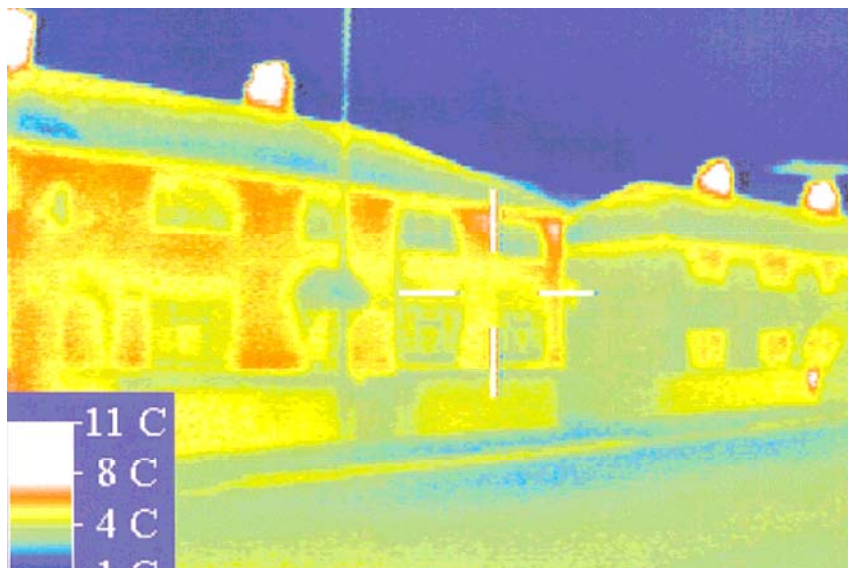


Super-Insulation



The above improvements to the building envelope reduce space heating per unit of floor area to 16.2kWh/m²/year or 27% of the year 2000 building regulations.

This is a possible overall reduction to 20% of current housing average.

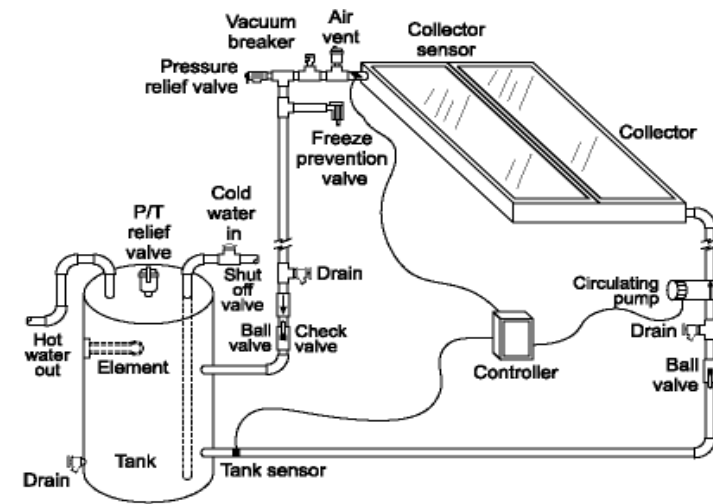


[standards and specifications to reduce heating energy use through insulation, including retrofitting into existing properties from; XCO2 conisbee Ltd [February 2002] *Insulation for Sustainability – A Guide*. Study for BING.

Hot Water Usage



By harvesting solar energy using a solar hot water collector and using water flow restrictors and 'A rated' white goods we can reduce hot water consumption to 6KWh/household/day or 56% of year 2000 building regulations.



[examples of solar water heating at western harbour, Malmö and Kronsberg-Hannover]



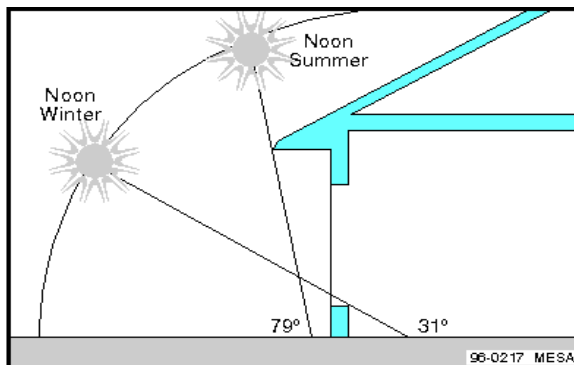
Passive Solar Heating



Passive solar heating is achieved by locating windows within 30° of due south. South facing windows should be sized to provide a winter sun exposed area of $0.08\text{m}^2/\text{m}^2$ floor area.

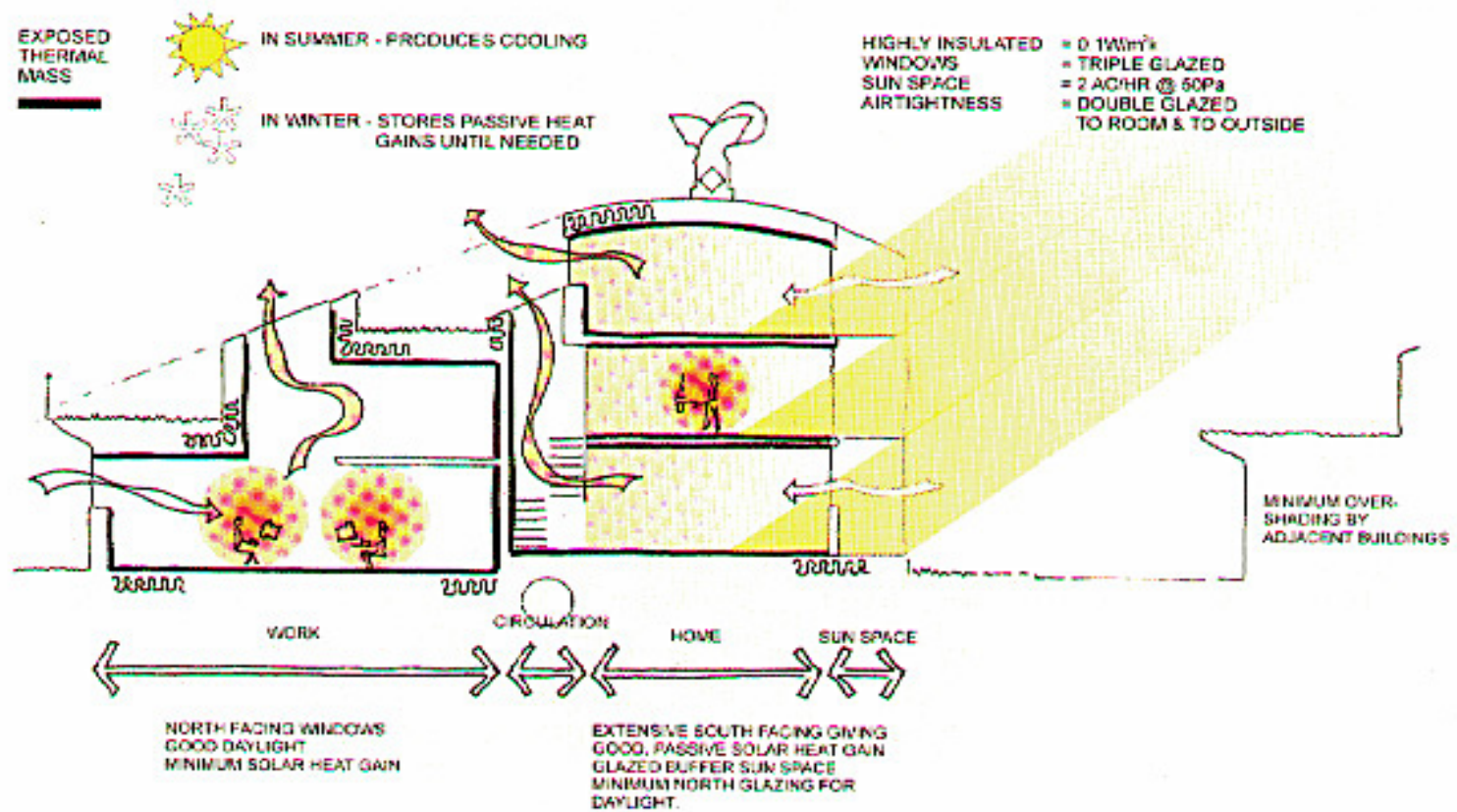
- Unheated sunspace buffer zones harvest the solar energy and provide a light and airy conservatory like environment.
- Solar shading would normally be provided against summer overheating.
- Small windows on the other sides or 'Sunpipes' would provide natural light to $0.16\text{m}^2/\text{m}^2$ of floor area.

Passive solar heat can provide 40% of the buildings requirement even at British Latitudes.



[Thamesmead 'Ecopark', North Greenwich, Splinter Archtchen]

Thermal Inertia



Competing with Cheap Energy



Electricity Costs p/kwh

Nuclear 1.5 – 3

Coal 2 - 5

Oil 3 - 5

Nat Gas 2 - 5

Onshore wind 3 – 8

Solar 20 – 40

Tidal & Current 7 – 10

Wave 3 – 12

Geothermal 7 – 9

Biomass 2.9 – 8

Small Hydro 5 – 10

Large Hydro 0.5 – 2



Attention to detail



As an example it is necessary to design out *'Thermal Bridges'*. In a building constructional details such as the junctions between wall and floor slab may have gaps between the insulation systems in the walls and floors. In a super insulated building this is more significant than in a traditionally heated building.



Embedded Energy



Concrete. Cement production is a high energy process. Concrete can be formulated using Ground Granulated Blast furnace Slag [GGBS] as a cement substitute.

Brick. Bricks are fired in kilns. Using recycled bricks recovers the embedded energy. Consider hardwood cladding from a renewable source.

Steel. Production uses coke, gas and electricity in vast quantities. Steel structural members and lintels can be formed from recovered steel sections dressed and repainted.

Insulation. Substitute natural materials for artificial oil based products. Consider earth sheltered design, straw bales or blown recycled paper.

Embodied CO ₂ in construction for domestic dwellings	300 – 1,000 kg/m ² ³
Embodied CO ₂ for volume house builders	600 – 800 kg/m ² ¹
Average 3-bedroom semi-detached house:	
Floor area	100m ²
Occupants	3.5!
Life-span	60 years
Embodied CO ₂ / person/year	286 – 381 kg
UK Total CO ₂ equivalent emissions/person/year	12,300 kg ¹
Embodied CO ₂ of volume domestic dwellings as % of total CO ₂ emissions	2.3 – 3.1%



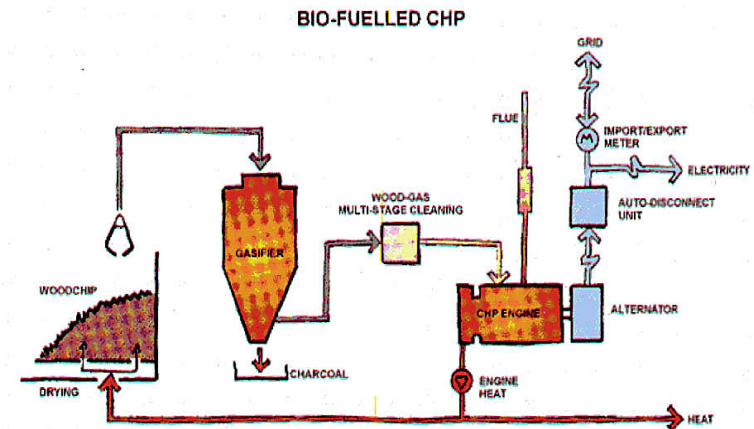
Biomass CHP Plant



Conventional CHP [Combined Heat and Power] plant running on natural gas will provide economic electricity and heat with considerable savings on carbon emissions.

Firing the CHP with renewable woodchip from a sustainable source the power generation becomes carbon free.

Mass burn steam raising solutions are available but high efficiency gasification units are becoming available on the market.



Wind Turbine



Electricity can be generated from a renewable source for powering computers, television, control systems and domestic appliances.

Wind turbines are often associated with batteries because of the intermittency of wind.



[wind micro-generation BowZed, London]



Photo-Voltaic Arrays



Currently three times the effective cost per KW of Wind.

Incorporated in windows or in cladding such as roof tiles where the unit they are part of would already be a high cost item.

Use Photovoltaic electricity to charge electric vehicle batteries. Cost is compared with road fuel payback reduced from 50 years to 15 years.



[Badenova stadium FC Freiburg / Solar Fabrik]



Woodchip Heating Boilers



Woodchip boilers are nearly carbon neutral utilising the short carbon cycle of growing biofuel crops for combustion.

They are fully automatic but require electricity for their operation.

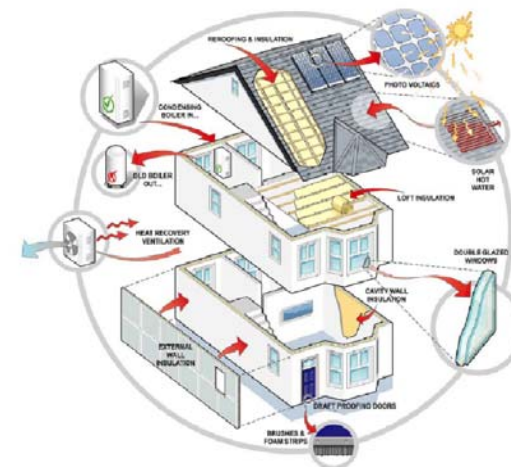
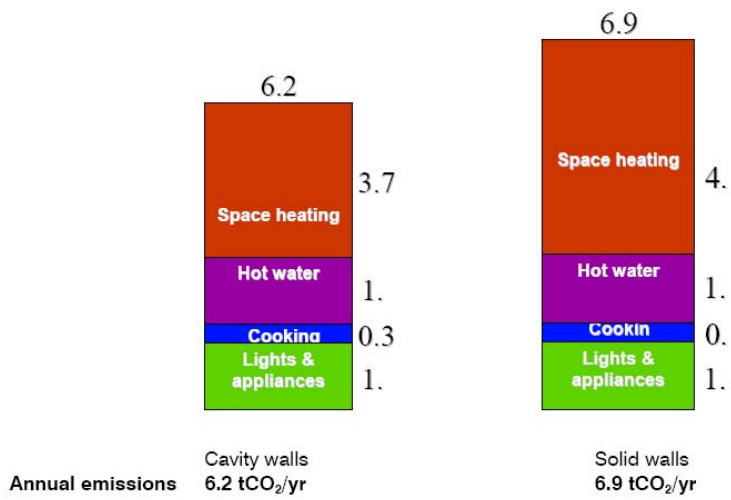
Some non renewable energy consumed in the pelletisation process.



Domestic Building Programme



Traditional building methods are failing to deliver affordable or decent housing. Neither are they delivering the necessary energy efficiency targets or dealing with fuel poverty. In 2001 we had the lowest building levels since the war. In 2002 only 37% of new households in England could afford to buy as compared with 46% in the late 1980s. 1 in 12 children are more likely to develop diseases such as bronchitis because of bad housing and overcrowding. [Recent Shelter report 'Toying with their Future']



[technical options for retro-fitting energy saving devices into a typical semi detached property from; Energy for Sustainable Development [June 2004] *Low Carbon Homes: Towards zero carbon refurbishment feasibility study*. Report for the Energy Saving Trust Innovation Programme.]

Domestic Building Programme



'The government should inject £1.6bn a year and build between 70,000 and 120,000 new homes a year' [Baker Review]. It is possible to design our way out of this impasse by using novel construction methods and while we are at it deal with the energy efficiency and embedded energy issues.

- The use of **offsite construction** techniques particularly for bathrooms and kitchens. Transfer site work to a controlled factory environment.
- **Wood frame** or **steel space lattice construction**. Save embedded energy and increase build rate.
- Use of **Fibreboard** for walls and roofs.
- **Fast track construction** techniques minimising time on site.
- **District heating and CHP**. Help deal with fuel poverty and reduce carbon emissions



Commuting and Car Clubs



A car covering 12,000 miles per year produces as much carbon emissions as a 4 person home.

- **Integrate** design for living, work and Public Transport to minimise car miles and make car use non essential.
- **Mix** work units and living units to make working and living in the same location a real option.



The need to own a car is generally an insurance policy against immobility. Having acquired the asset it is then economically sensible to use it for most travel.

The object of the car club is to free the member to make more reasoned decisions in planning journeys. The use of public transport is then compared fairly with the car. The member can have the option of an MPV, 4x4, sports car, electric or hybrid vehicle. The car club can also provide vans and minibuses.



Transport and Foodmiles



One shopping basket of 26 imported organic products could have travelled 241,000 kilometres and released as much CO2 into the atmosphere as an average four bedroom household does through cooking meals over eight months [Sustain 'Eating Oil' report Dec 2001].

- **Foodmiles** - the energy used to grow, process and transport produce to table.
- **'Slow food'** grow food locally in a sustainable way with a minimum of artificial chemical fertiliser and packaging.
- **Seasonality**, the drive to have fruit and vegetables 'out of season' leads to international air miles for transporting non essential foods around the planet.
- Locally communities can use internet **ordering** and **delivery** with low energy vehicles [electric, Hybrid, CNG] or local farmers markets.





Thank you

www.ignite-ne.com

www.renewteesvalley.co.uk

www.cabe.org.uk

Commission for Architecture
and the Built Environment

The government's advisor
on architecture, urban design
and public space