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Introduction

Construction has been a major consumer of natural reserves and fossil fuels for the past 250 years. This activity has generated a substantial proportion of the greenhouse gasses which have been discharged into the atmosphere. The greenhouse emissions have upset the natural balance of inflows and exits leading to circumstances that have affected the global climate, the result of which is that temperature increases are now inevitable. It is therefore essential that the Real Estate sector takes steps to reduce (if not eradicate) the discharge of greenhouse gasses through changes in design and the creation of sustainable sources of energy in both existing and new buildings.

1. The challenge

Future energy policy will be determined by, Firstly, fossil fuels being a finite resource, secondly, concern over continuity of energy supply, and thirdly, it's very probable that using fossil fuels changes the climate. Sustainable consumption of energy together with maintaining or creating sustainable communities is the aim of sustainable development. (DEFRA 2010)

Survival

If we are to leave a planet which will sustain future generations we have to minimise, if not eliminate, the destructive effects of the activities of manufacture, use and disposal of all aspects of modern living. Such actions must go to the use of energy (and its creation), the reuse of nearly all existing and future components, the avoidance of the disposal of waste materials and the operation in a sustainable manner of the resources of water and soils. Whilst steps are being taken to reduce carbon emissions from future buildings (through regulation and taxation) existing buildings form the dominant proportion of the real estate complement. The challenge for the future lies more in the management of the change in the existing built environment than in the changes required for all new construction.

Global warming

There is strong evidence that the warming of the Earth over the last half-century has been caused largely by human activity, such as the burning of fossil fuels and changes in land use, including agriculture and deforestation. The size of future temperature increases and other aspects of climate change, especially at the regional scale, are still subject to uncertainty. Decision makers must have access to climate science of the highest quality and take account of its findings in formulating appropriate responses (Royal Society 2010). The uncertainty in the predicted warming as a result of human activity over the next two decades is in the range between 0.2^{o}C and 0.4^{o}C per decade. (Royal Society 2010). Sea level rises are only one of the inevitable consequences.

Buildings are a major cause of greenhouse gas emissions

Carbon dioxide emissions from UK buildings accounted for approximately 45% of total UK CO_2 emissions in 2006. (Mackenzie F. 2010). (The figures for Australia are 23%; China 42%; and Brazil 42%).

Annual pollution per person

The annual pollution per person in the world is about 5.5 tons of $CO_{2.}$ Europe and the USA contribute substantially more per person than the average. To achieve responsible reductions in global emissions would require countries such as the UK to reduce emissions to 10% of their existing levels (In the UK that would be from 11 tonnes to 1 tonne per person) (MacKay 2009).

Consumption of finite reserves

Expressed per head of population per year, the UK construction industry uses about 6 tonnes of material. Over 50% is for repair and maintenance of the existing stock of buildings (if DIY and other unrecorded works are included) and about 20% is for infrastructure (civil engineering).

Quarrying

The quarrying of around 300 million tonnes of material in the UK each year for aggregates, cement and bricks is at significant environmental cost.

Recycling

There is very little recycling within the construction industry. For example, around 12% of the aggregate used in construction is from recycled and alternative sources (but mainly in low grade applications such as hardcore and landscaping fill). Efficient use of this material can save money, reduce waste for disposal, and reduce energy consumption and pollution from the supply processes. (1995 White Paper). In 1995 the target set for reducing waste was from around 30 to 55 million tonnes per year by 2006. Recycling remained static at 30 out of 335 million tonnes (DEFRA 2006). (32% of that came from the construction industry.).

The implications of the condition of the existing stock of buildings

In the UK the replacement rate for existing stock is less than 0.1 percent per annum and the proportion of new build compared to existing buildings is less than one percent (Sidall 2010). This means that the UK building stock is growing and that to replace all of the existing premises in the UK would take over 1,000 years.

Over 4 million houses in the UK date from before 1919 and it is expected that around 70% of the existing built environment will still be in use in 2050 (Raman 2009). These buildings are going to be less efficient than new buildings and this will result in the older stock of buildings consuming greater amounts of energy per square metre to enable them to be used.

Policy and action

We cannot do without buildings. The challenge is to provide a viable future whilst maintaining (if possible) an economic present.

The development of policy in relation to the selection of materials for construction must consider the ***cradle to crad***le approach; the impact of the first use of the material, the deconstruction of the building at the end of its life and then the subsequent reuse of the salvaged materials.

Zero energy

The zero fossil energy consumption principle is gaining considerable interest. In the European Union and US traditional building use consumes 40% of the total fossil energy.

In developing countries many people have to live in zero-energy buildings out of necessity. These conditions would be considered uncomfortable in the developed countries, but acceptance may represent one further challenge for those in the US and European Union.

End of fossil fuels

It seems possible that cheap oil (which powers transport) and cheap gas (with which we heat most of our buildings) will run out in our lifetime. We need alternative energy sources which are environmentally friendly and reduction in energy demand.

(Given that fossil fuels are a valuable resource in manufacturing we should save them for better uses than burning) (MacKay 2009).

For the construction industry the challenges, (other than economic, environmental and social), are

- Climate change (Global warming, Carbon emissions, Energy use and Global dimming),
- Water resources (availability, over-use, flooding, salinisation and security),
- pollution (water and marine pollution, air pollution, acid rain, and soil pollution; soil erosion,
- biodiversity, damage to ecosystems, resource depletion, ozone depletion, and habitat destruction). (BRE 2009)

Sustainable development seeks to maintain a delicate balance between the human need to improve lifestyles (and feeling of well-being) on one hand, and preserving natural resources and ecosystems, on which we and future generations depend, on the other. (Bruntland 1987).

There must be a question as to whether the aim to improve lifestyles is achievable .

David King, UK Chief Scientist, 2007*, said "Avoiding dangerous climate change" is impossible – dangerous climate change is already here. The question is, can we avoid* **catastrophic** *climate change?*

2. The stakeholders

Construction and the management of the built environment involve many stakeholders. The methods of assessment and the creation of drivers for change will meet resistance from vested interests and those who are affected directly or incidentally by policy initiatives that seek to reduce the affect of construction.

Sustainable Construction aims to apply the principle of 'meeting the needs of today without compromising the ability of future generations' to the construction industry by providing ways of building that use

- **less** virgin material and
- **less** energy,
- cause **less** pollution and
- **less** waste

but still provide the benefits that construction projects have brought us throughout history. The use of fossil fuels is not sustainable. (MacKay 2009)

Economic status for construction

Construction is a major financial force. Construction and its products contribute £95 billion (~10%) to the UK's gross domestic product (Department of Business, Enterprise & Regulatory reform 2010; Office of National Statistics, 2010) as well as underpinning all of the UK's economic activity. The construction industry has annual export earnings of £10 billion. All of this comes at a high environmental cost with buildings contributing around 45% of total UK greenhouse gas emissions (Prout and MacKenzie 2005) and the production of materials accounting for a further 10% (Office of National Statistics, 2008).

Increased Cost of change

Passive solar building design and PassivHaus buildings have demonstrated heating energy consumption reductions of 70% to 90% in many locations, without using any active energy harvesting systems. With careful design this can be accomplished at a cost that is about 10% over that of a conventional building (although some Estate Agents are of the opinion the additional cost is over 20% (Andrew Lowe Director DTZ 2010)

Cost benefit

Need to encourage adoption

To achieve sustainable construction on a voluntary basis clients and funders need to see clear business benefits from commissioning more sustainable buildings. If that fails, legislation may be the only solution. Those who legislate must hope that public opinion will support their actions if they are to represent a permanent change.

The power of vested interests seeking to prevent change (which may result in lower profits) will make policy makers reticent to take the steps that logic requires (and one day public opinion may demand).

Estate Agents/Brokers reactions

Agents report that the biggest barrier to greater implementation of sustainable solutions among clients tends to be the perception that the benefits do not necessarily outweigh the costs. (RICS 2010) This was the leading barrier to implementation identified in most markets and ranked above lack of budgets across all global regions. The level of awareness is increasing and the promotional benefits of a green agenda may result in no one wanting to be seen to be out of step.

Public pressure not sufficient to drive change

The increasing of the public profile of the green agenda for attractive, healthy, flexible and productive space is seen as having some influence on the agents' traditional criteria of cost and location, but at a very slow rate. (RICS 2010)

Possible economic benefit beyond the building

When one considers the evaluation of a building design there are several assessment techniques that can be applied which do reflect the economic benefits of buildings. The triple bottom line (abbreviated as "TBL" or "3BL", and also known as "people, planet, profit" or "the three pillars" (*Goethe-Institut* 2008.) captures an expanded spectrum of values and criteria for measuring organisational (and societal) success:

Certified standard not reflected in value

The European and UK valuation methodologies (TEGOVA and RICS) do not include energy efficiency in a building valuation. Energy Performance Certificates (EPCs) and Display Energy Certificates (DECs) will take sometime to influence the market and there are fears that they do not sufficiently differentiate as most buildings will fall into roughly the same category. The potential external benefits that tall buildings bring to the neighbourhood or the wider city/country are not included within valuations (save for the market reflection in the market price).

Economic benefit

But the requirements of the market would appear to be overriding the sustainable development aims. For example, the City of London, as one of the world's leading international financial centres, is a key asset to the UK's national economy and to London itself. In order to assure the City's business occupiers and investors of their continued dynamism, they believe that the Corporation needs to ensure that demand for office space can be met within the Square Mile. In this context they maintain that tall office buildings are necessary because of the efficient use that they make of the limited land available. (Corporation of London 2002)

Action to enhance chance of change

Drivers towards sustainability are based on taxation and Legislation rather than encouragement. In the UK there is the Landfill Tax, Climate Change Levy, Aggregates Tax, and similarly motivated government directives and regulation such as the Energy Performance of Buildings Directive (EPBD), implemented in the UK as building regulations. Each of these legislative measures is set to apply increasingly demanding targets and higher penalties for non-compliance. These pressures are not achieving all possible improvement in commercial buildings, rather the effort seems to be in avoiding the requirement.

The Greater London Authority's Renewables Target is that 10% of a building's energy is to be derived from renewable sources, but this is not achieved on new commercial buildings. It has recently been announced that the standard is to be raised to 20%. Those in favour of tall building will maintain that these targets are unrealistic.

Developers are in business to make profit in the short term. The economic issues of tall buildings are wider than just the initial capital cost. Whilst in the short term account needs to be taken of the influence the building has both on whole life costs and on economic, social and environmental whole life values, it will be difficult to square the long term energy consumption of the building with the required targets for reduction in energy consumption (greenhouse gas emissions)

The sustainability claims from those constructing new tall buildings in London at the moment include:

- the glass facades reducing the need for internal artificial light (Heron 2010) ,
- the proximity to a transport hub (only sustainable element in a 300 metre tall glass clad tower (Shard 2010).)
- The development relies on combined heat and power (Kings Cross redevelopment London 2010)

The promotion of these as the only green credentials highlights the minimal contribution to sustainability of most new development.

3. Zero energy construction

Zero energy building (ZEB) is a general term applied to zero net energy consumption and emissions. Zero energy buildings can be used autonomously from the energy grid supply and surplus energy can be harvested.

The reduction in a building's energy consumption starts during the design process. Successful zero energy building design combines tried and tested passive solar or natural conditioning principles that work with the on-site assets.

Stable indoor temperatures and internal lighting can be achieved with minimum mechanical means by.

- Sunlight and solar heat,
- The use of prevailing breezes, and
- the temperature of the earth below

Zero-Energy Buildings are built with significant energy-saving features. The heating and cooling loads are lowered by using:

- high-efficiency equipment,
- added insulation (both in terms of the materials used as well as the thicknesses applied),
- triple glazed high-efficiency windows, and
- natural ventilation.

These features vary depending on climate zones in which the construction occurs.

If this can be achieved for some buildings, can we expect this to be the standard for all new buildings?

4. On site renewable energy

UK Developers are now required to generate 10 and 15% of the required energy close to new buildings being developed. In part this goes someway to offset the large amount of energy wasted in transmitting electricity over large distances, and in part it offers an inducement to the developer to trade some of the imperfections in the new building with the off set of energy production.

The sustainable options for energy generation close to a new building include wind, solar, and some shallow depth thermal, whilst renewable techniques include the use of alternative fuels and recycled waste heat. Some of the lessons from early experiments have included:

1. **Zero emission energy generation**

A Wind:

- In part the problems over the use of wind generation in an urban environment is the turbulence in wind flow caused by neighbouring buildings (and may be caused by future development close by)

- To maximise the potential, on a pitched roof, the turbine needs to be installed as high as possible above the ridge. (Preferably at a height of 3 – 4.5 metres). (Blackmore 2008).

- Wind generation of energy on buildings has been patchy.

B Photovoltaics

- There are different outputs and cost for each of the three main systems available. (Single-crystal cells 25% efficiency and make up 29% of market, polycrystalline cells 15% and make up 62% of market, Amorphous silicon 5% cheapest to make and have about 8% of the market.). The systems are durable and reliable and require little maintenance.

- There is a 10% variation in performance between those panels angled towards the sun and those laid flat.

2. Renewable Energy with low emissions or environmental damage

Heat recovery and ground heat recovery

Deep geothermal energy uses the natural heat found deep underground. However, because the process reduces the ambient temperature over time and becomes less efficient, there are environmental issues.

Low depth energy relies on solar gain. The system uses heat pumps to recover the heat from minor variations in the earth's temperature due to solar gain in the top three metres.

These systems are noisy and require energy to drive the compressor and pumps and may produce little benefit if there are long pipe runs between the equipment and the building.

3 Renewable Energy with emissions

A **Biomass**

- Biological material from living, or recently living organisms are burnt (such as wood, waste, (hydrogen) gas, and alcohol fuels).

- Biomass still involves the burning of a fuel which discharges CO_2, even if it is from sustainable sources. (AECB 2010)

- There is not enough wood to supply building energy demand (UK).

B. **Combined Heat and Power**

- Use of the heat created in the generation of energy is used in local buildings
- Delivering useful heat to a customer always reduces the electricity produced to some degree
- The true net gains from combined heat and power are often much smaller than the hype would lead you to believe (MacKay 2009).

5 Assessment

There are those who believe that you cannot manage what you do not measure or if you don't measure it you cannot manage it (Kelvin 1892). Whilst benchmarking may have a role it should not have the dominant role in achieving change.

For commercial buildings, the two most commonly-used third party assessment tools at the design stage are BREEAM (Building Research Establishment Environmental Assessment Method) and LEED (Leadership in Energy and Environmental Design).. These two groupings include a range of schemes for assessing environmental impact, with specific variations applying either to different building types or to different stages in the construction and occupation of a building. These measurement tools will be updated as the focus moves from the source of space heating to a wider application to sustainability. There is currently no single agreed definition of a green building that encompasses all aspects of design, development and use.

These weighted evaluations of new construction offer assessment that can be comparative.

BREEAM is the Building Research Establishment Environmental Assessment Method, and was invented by BRE, a building research organisation - funded mainly by the UK Government and is **assessor based**. It gives a dominant role to energy and material usage, and health and safety. Site management may have too large a weighting. Greater consideration should be given to the responsible sourcing of materials and acknowledgement that thermal mass should be delivered through the optimisation of both operational and embodied carbon to provide lower energy-in-use buildings. There are also calls for further consideration to be given to the efficiency of primary structures which can be over-designed by as much as 50 per cent – which is profligate with scarce resources.

LEED stands for Leadership in Energy and Environmental Design, and is a United States measure run by the USGBC and uses **self certification**. About 2000 buildings have been accredited by LEED up to 2010 as opposed to over 120,000 by BREEAM.

It was created to Define "green building" by establishing a common standard of measurement, promoting integrated, whole-building design practices, recognising environmental leadership in the building industry and stimulating green competition.

LEED assessment uses a total of 100 points with a further 10 bonus credit points available. Energy usage is a dominant factor in the weighting of the assessment (37%), with indoor climate quality, water efficiency and material resourcing. Bonus points are available for design innovation and regional priority.

6 The future

6.1 Change by Design

The design of new buildings can reduce the energy consumption of the finished building, when compared with those that have been built in the past. These considerations affect the heat gain and dispersal, water usage, and internal health. The appearance of future buildings will be different with the focus on highly insulated walls as opposed to glass and with sealed buildings constructed to higher standards than has been achieved to date. These changes will come at a price, and new construction will cost more, perhaps by between 10 and 15%. Key benefits have been identified by better insulation, airtight construction (a ten fold improvement), reduced glazing, better windows (triple glazing), the orientation, controlled ventilation and heat recovery.

6.2 Change by encouragement

Can Population-Power achieve a better future? The three interrelated drivers to sustainable development are Policy, Technology and Personal choice (Reynolds 2009). If policy continues to be overridden by vested interest, and technology is too far in the future, personal choice must be encouraged.

The contribution of the individual may have a better chance if they were reliably informed of the cost of consumption, the consequence and the alternatives. :

Reduce Consumption

- Awareness of consumption can halve demand (MacKay 2009). All energy bills should show annual consumption for this and the previous year with a guide as to the target for future usage in kWs /currency

- Energy usage metres should be in conspicuous locations within all buildings

- All equipment sold must show the rate of consumption in kWs.

Action to cut energy demand

- Products must be developed and available at sensible prices (to cut energy usage in existing buildings) or be subsidised:

    - To enable the **external** walls of buildings to be overclad to improve insulation standards.

    - To enable **internal** floor and wall surfaces to be overclad to improve insulation standards.

- To enable additional glazing to windows to upgrade to triple glazing by retrofit panels placed on the inside of existing window frames

Incentives

These are being offered on a country by country basis. An example is the UK's FIT (feed-in-tariff) which offers incentives and tax breaks to those introducing energy generators up to 5MW. Consideration must be given to international incentives.

6.3 Change by force

Raised international standards for new buildings

Stabilizing concentrations of greenhouse gasses at "safe" levels may require reductions in emissions of more than 50% below current levels in 2100 (IPCC 2001). In terms of construction alone, China, Australia, Brazil, and most European countries now impose standards for new construction which will reduce emissions of greenhouse gasses by between 50% and 80%.

Construction (using the UK as an example) contributes around half of total emissions. To make changes that affect the level of emissions will require 'encouragement'.

6.4 Future prospects

Balance

Our way of life has caused an environmental burden for the planet through consequential climate change, consumption of finite resources and placing stress on our environmental systems from the way we produce, consume and waste resources, thus increasing the loss of biodiversity from the rainforest to fish stocks.

We are living in a world where over a billion people live on less than a dollar a day, more than 800 million are malnourished, and over two and a half billion lack access to adequate sanitation. A world disfigured by poverty and inequality is also unsustainable. (DEFRA 2010) Unless we reconcile these contradictions, we face an uncertain and insecure future.

To achieve a balanced future we have to achieve lower energy demands and an increased in energy supply without consuming fossil fuels or creating carbon dioxide. The real estate industry, as a major consumer of energy and distributor of greenhouses gasses should be showing the way to a sustainable future.

To reduce demand for energy we have to build better and improve the existing stock of buildings. To increase energy supply we have to generate using the wind, water and the sun, and minimise all energy created through burning.

Our future depends upon renewable energy and materials and the recycling of energy and materials.

We have, using the analogy of the balance sheet for World plc, been living beyond our means. We have been spending more than we have earned and our overdraft is due to be called in. If our business is to survive we must settle our debts over a reasonable period of time. There is no interplanetary bank to buy out our ailing business.

> 'Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.
>
> (WCED, Brundtland Commission, 1987)