PROFESSIONAL GREEN BUILDING COUNCIL (PGBC)

LAUNCH OF THE PGBC ZERO CARBON CHARTER 2007 & SYMPOSIUM
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The Development Sector and Carbon Emission

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As a member of the Hong Kong Institution of Engineers, I am delighted to note that the PGBC Green Charters are its new initiatives to engage all persons involved in the development sector to commit to creating a greener built environment in Hong Kong. The launch of the Zero Carbon Charter 2007 aims at promoting energy efficiency for better air quality. On behalf of the Council for Sustainable Development, I therefore would like to thank and congratulate PGBC to make use of the Green Charters as a response to the Council's stakeholder engagement activities on Promoting Better Air Quality in 2007.

Since 1800, the world's population had gone up from one billion to over 6 billion. Until recently, Hong Kong's population had increased by one million every decade since after the Second War.

Also since time immemorial, the human species has strived to improve their standard of living and the growth of economies has been driven mainly with consumption of resources and energy – notably fossil fuels. A major oil company recently advertised the fact that the first trillion barrel of oil was used in the past 150 years, the next trillion barrels will be burnt in the coming 30.

Exponential growth of population compounded with exponential increase in consumption of fossil fuels has resulted in vast quantities of green house gas being discharged to the atmosphere. It has been proven beyond reasonable doubt that the emission of green house gases, particularly carbon dioxide, is causing global warming and climate change which is the single most serious and compelling threat to the well being of animal and plant species on earth.

Apart from a small percentage from renewable sources, the bulk of world's energy supply is from fossil fuels. No matter it is coal, oil, or gas, burning of fossil fuels will generate a host of pollutants and most significantly carbon dioxide; not only because its huge quantity but also because there is not yet any commercially viable method for its capture and sequestration. Therefore for the purpose of this discussion, it is fair to say consumption of energy is the primary source of carbon in the atmosphere.

According to Sir Crispin Tickell, a distinguished British diplomat, scientist and philosopher, who said during the International Conference on Climate Change in Hong Kong in May this year that unless some urgent and effective actions for carbon reduction are taken, our civilization will be at great risk by the middle of this century.

Closer at home and in spite of the fact that all our energy intensive industries had moved out of Hong Kong, Figure 1 shows that the per capita consumption of primary energy consumption has been creeping up since 1996.

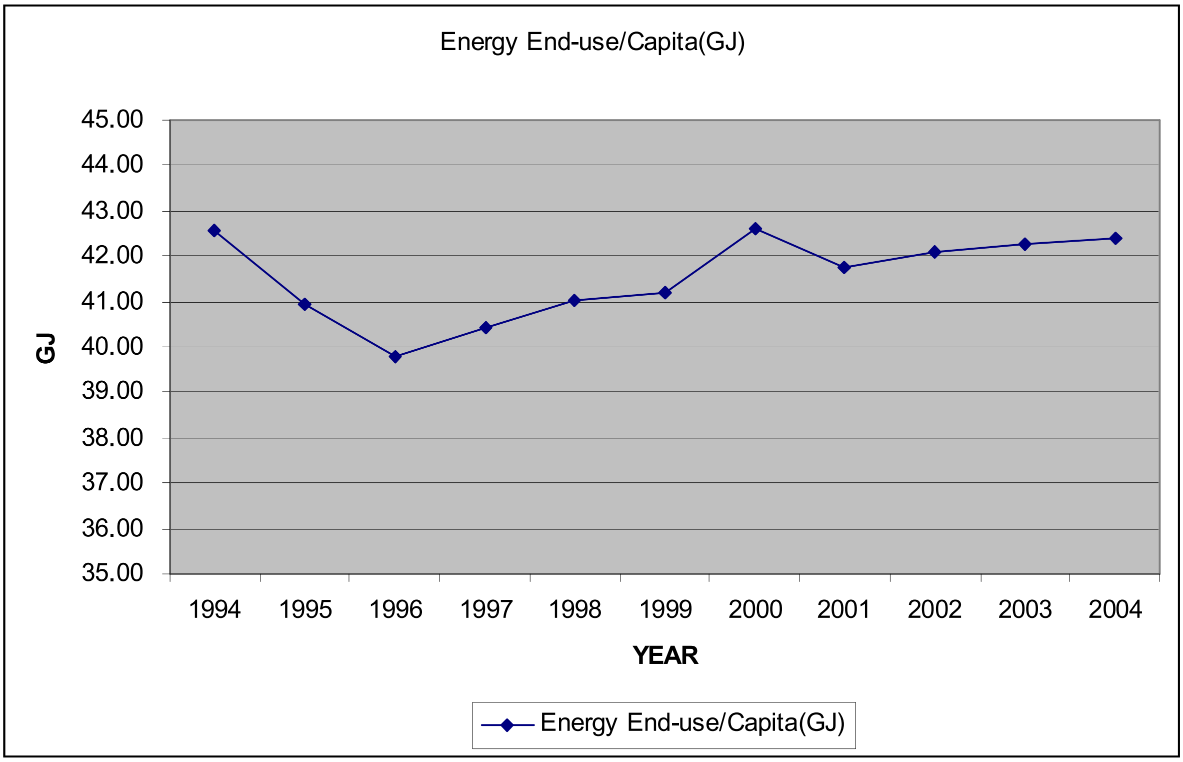

Figure 1

Typical of service economies and referring to Figures 2 and 3, the energy used in the industrial sector is on the decline while energy used for residential, commercial and transport sectors are on the increase. Although the transport sector appears to be the dominant energy consumer, the total energy consumption in buildings far exceeds that for transportation. As the energy consumption of the commercial, residential and industrial sectors are used predominantly in buildings, and if Hong Kong wishes to achieve lower carbon foot print, efforts should be focused on ways and means to improve their energy intensity.

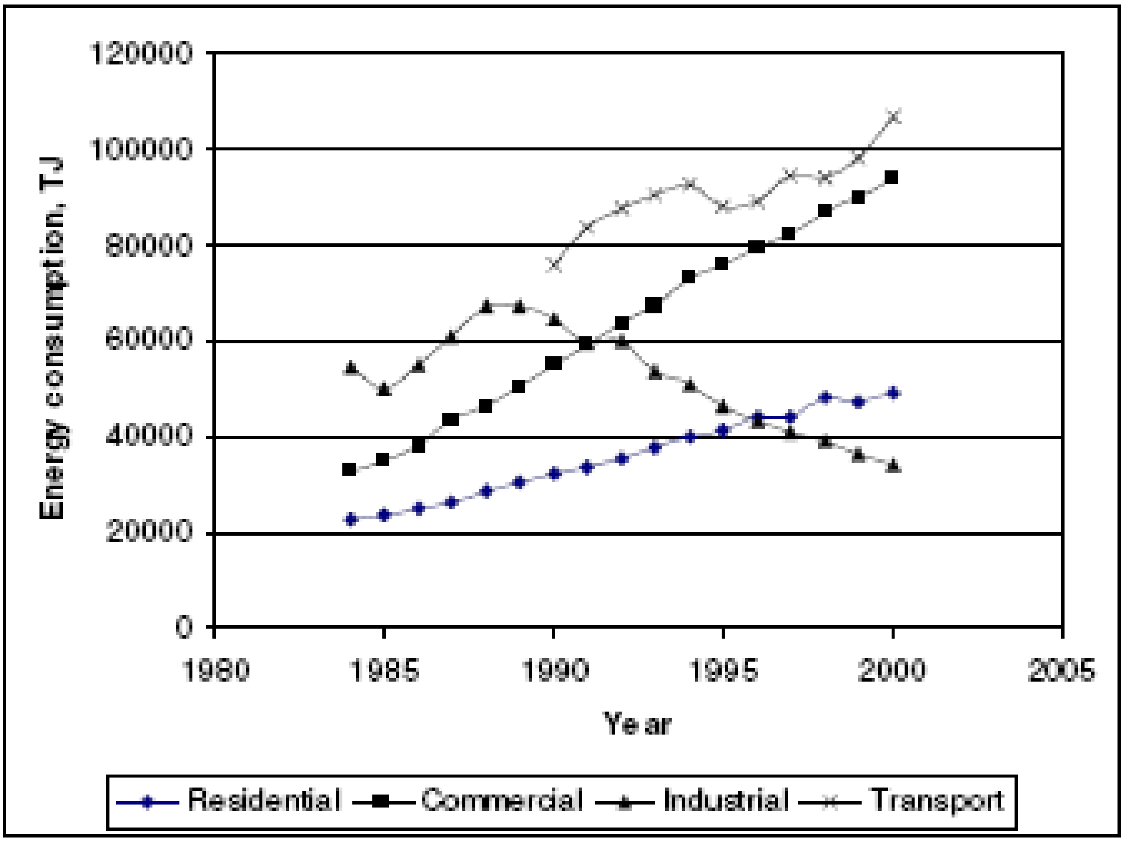

Figure 2 – Energy consumption of the residential, commercial, industrial and transport sectors of Hong Kong in 1984 to 2000

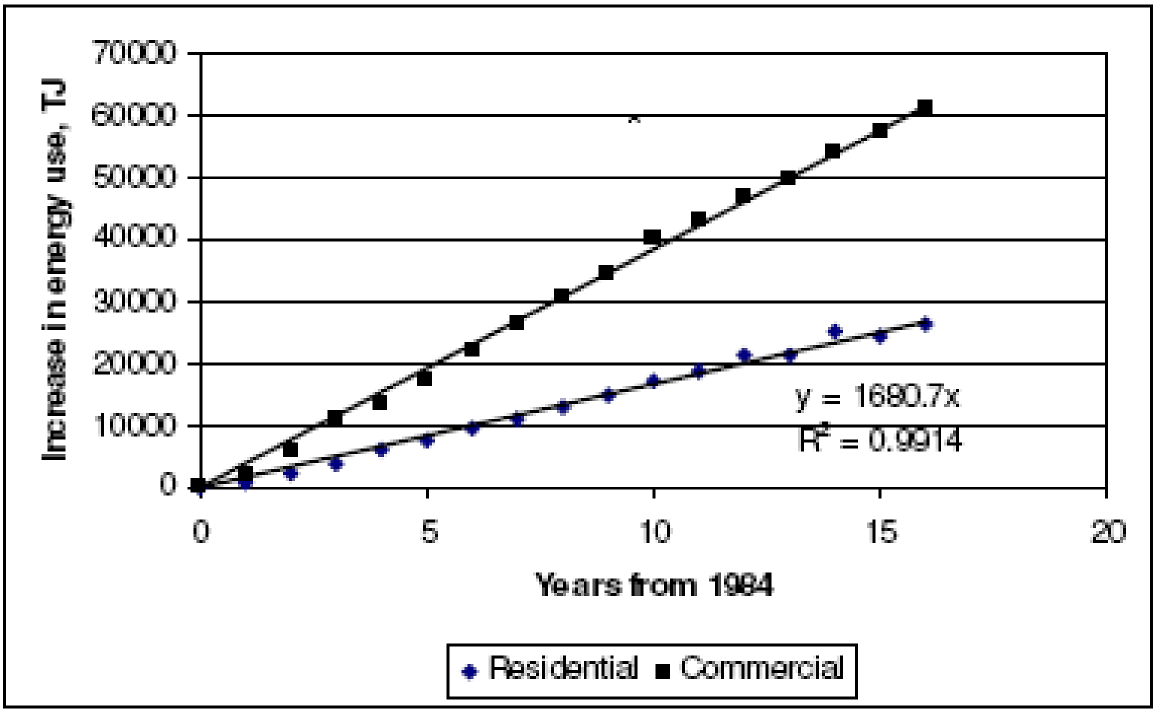

Figure 3 – Increase in energy use of the commercial and residential sectors of Hong Kong from the respective 1984 levels

Figures 4 and 5 show the energy end-uses in commercial and residential sectors of Hong Kong from 1984 to 2000 which clearly shows space conditioning is the dominant and fastest growing end-use in both types of buildings. This indicates air conditioning, heating and ventilation systems would offer the biggest potential for energy saving and carbon foot print reduction.

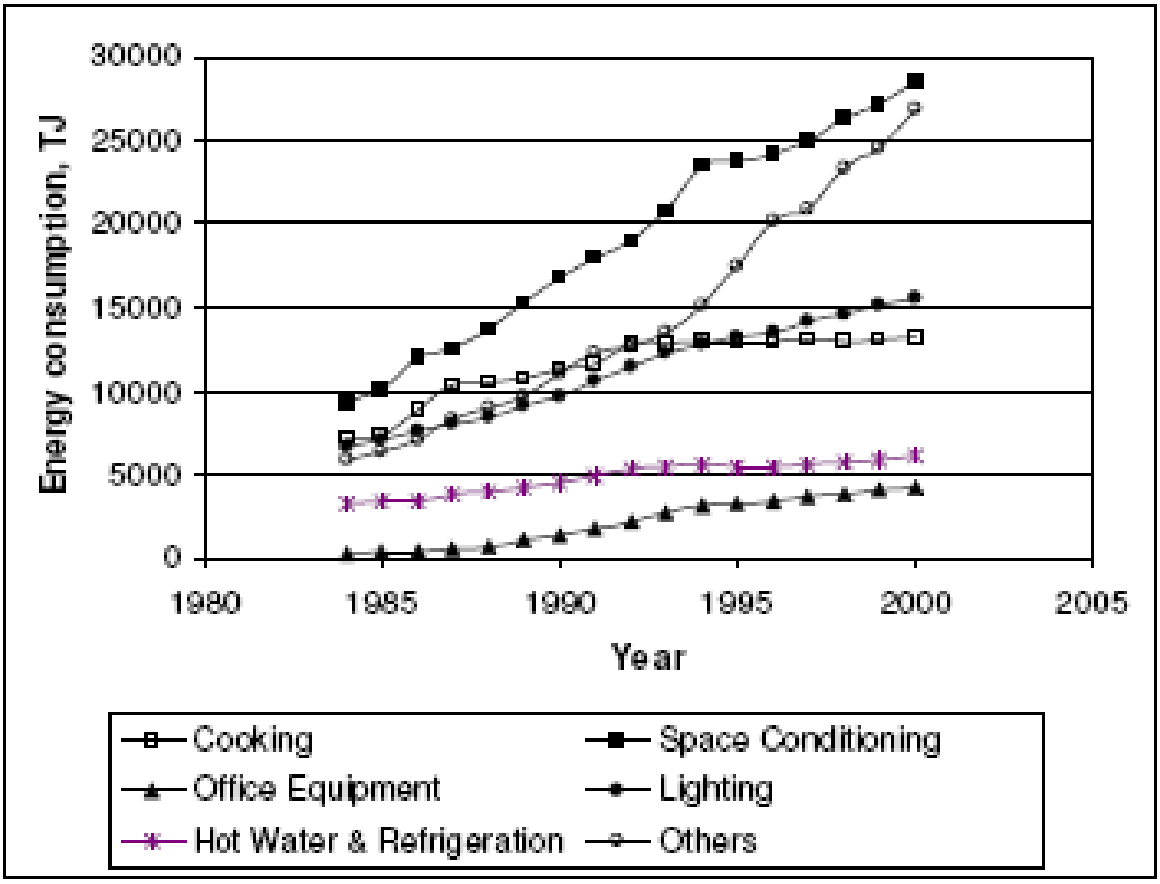

Figure 4 – Energy end-uses of the commercial sector of Hong Kong in 1984 to 2000

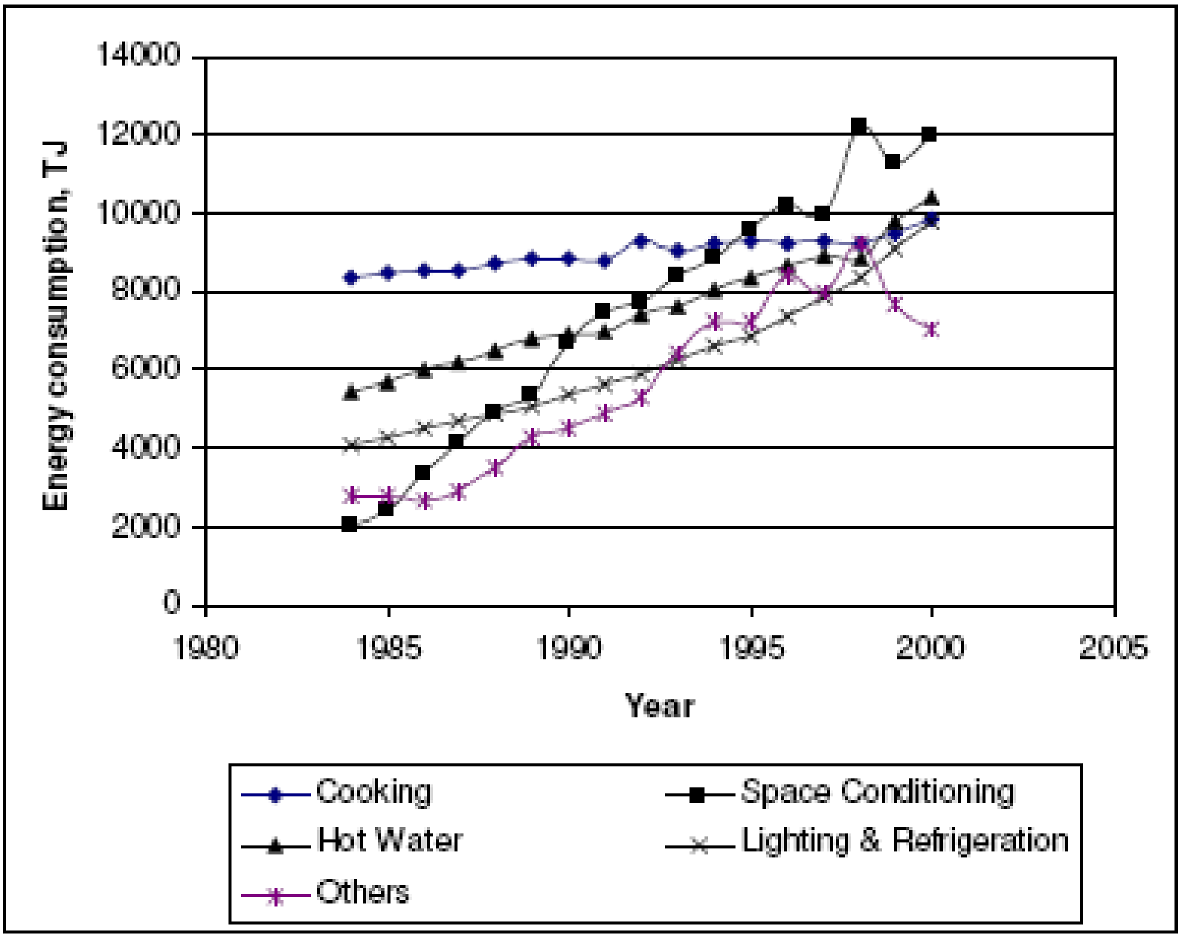

Figure 5 – Energy end-uses of the residential sector of Hong Kong in 1984 to 2000

All the above figures cover only the energy consumption in operation of plants and equipment in residential, commercial, industrial and transport sectors. However, to complete the story, we also need to account for the energy embedded in the materials to construct the buildings and equipment; the physical construction of the structures; retrofit, operation and maintenance; and demolition of buildings and disposal of wastes. Figure 6 shows a "cradle to grave" approach to determine the life cycle total energy consumption of building and infrastructure developments. ISO14040 series of ISO Standards provides an internationally accepted framework to track the embedded energy, energy consumption, environmental impacts and costs incurred by a building throughout its life cycle.

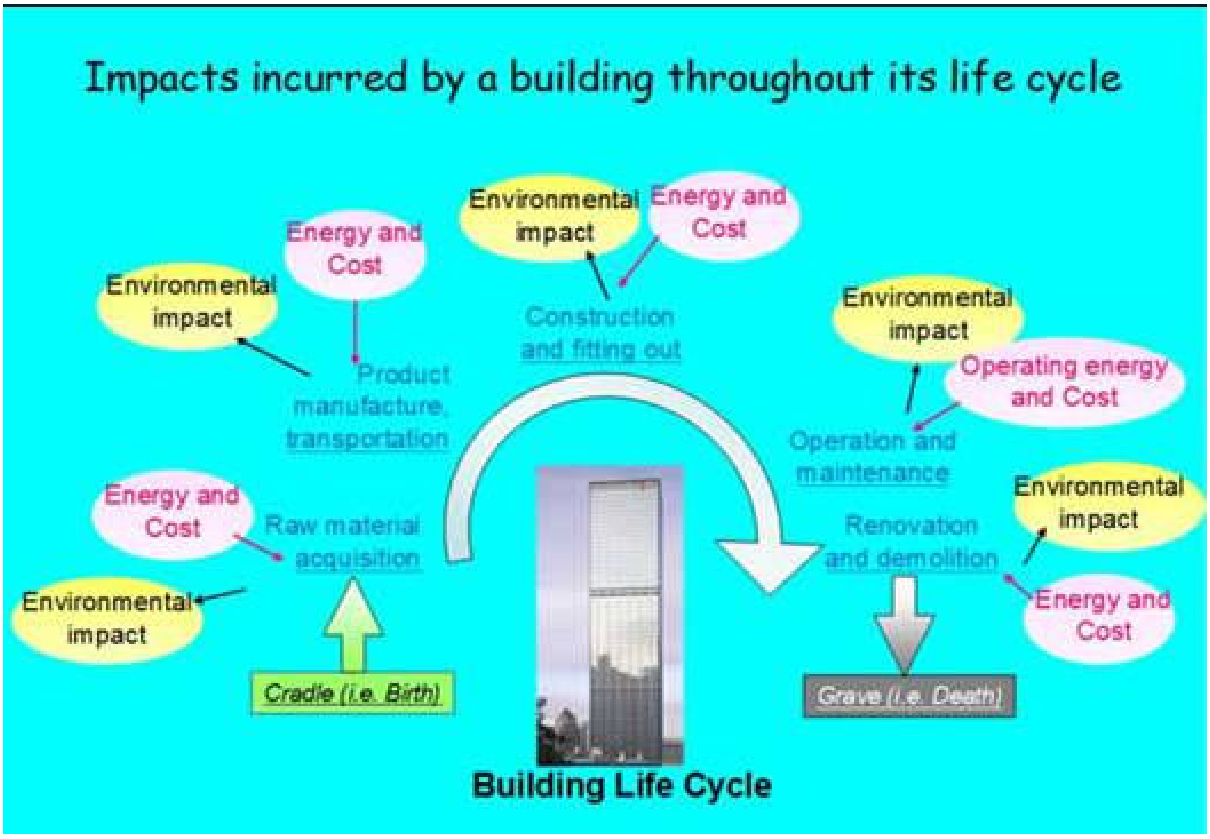

Figure 6

Embedded energy can be defined as the total energy to extract, process, produce, pack, and transport the materials from the supplier to the building sites. Figures 7 and Table 1 give the embedded energy of some commonly used building materials. It is more difficult to determine the embedded energy of electrical and mechanical equipment. Fortunately it is possible to obtain these data from the equipment manufacturers.

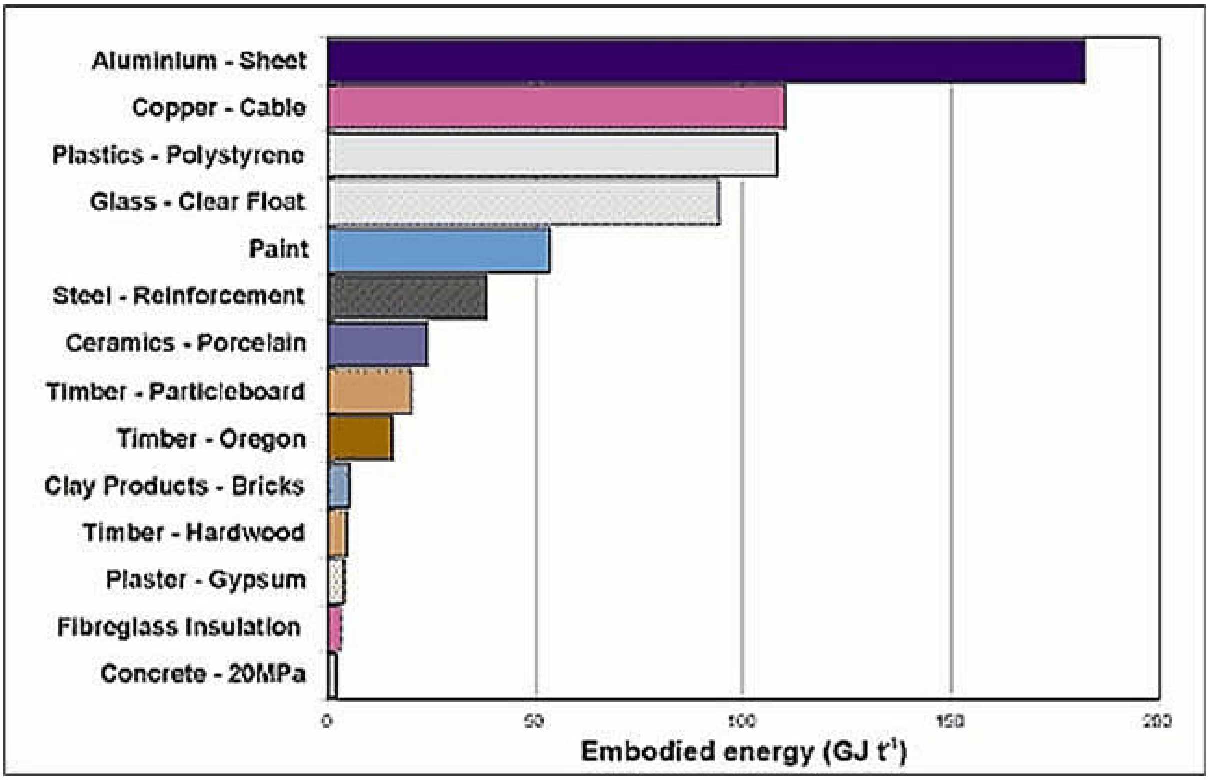

Figure 7 – Embodied energy of building materials
Source : www.tececo.com

MATERIAL	PER EMBODIED ENERGY MJ/KG
Kiln dried sawn softwood	3.4
Kiln dried sawn hardwood	2.0
Air dried sawn hardwood	0.5
Hardboard	24.2
Particleboard	8.0
MDF	11.3
Plywood	10.4
Glue-laminated timber	11.0
Laminated veneer lumber	11.0
Plastics - general	90
PVC	80.0
Synthetic rubber	110.0
Acrylic paint	61.5
Stabilised earth	0.7
Imported dimension granite	13.9
Local dimension granite	5.9
Gypsum plaster	2.9
Plasterboard	4.4
Fibre cement	4.8*
Cement	5.6
Insitu Concrete	1.9
Precast steam-cured concrete	2.0
Precast tilt-up concrete	1.9
Clay bricks	2.5
Concrete blocks	1.5
AAC	3.6
Glass	12.7
Aluminium	170
Copper	100
Galvanised steel	38

Table 1
Source : Lawson 1996;
***fibre cement figure updated from earlier version and endorsed by Dr. Lawson**

Energy to operate and to maintain electrical and mechanical equipment depends on their performance characteristics and the operating environments. Energy used in lighting systems could be adjusted and dependent on the ambient light conditions. Energy consumption of air conditioning plants would vary depending on ambient temperature, sunlight, overall thermal transfer value of building envelopes, quantity of fresh air, and temperature setting in the conditioned space. Photo 1 is a CO2 meter at the Headquarter of the Institution of Mechanical Engineers, London which is an innovative instrument that translates the energy and resources used in the building as the total carbon emission.

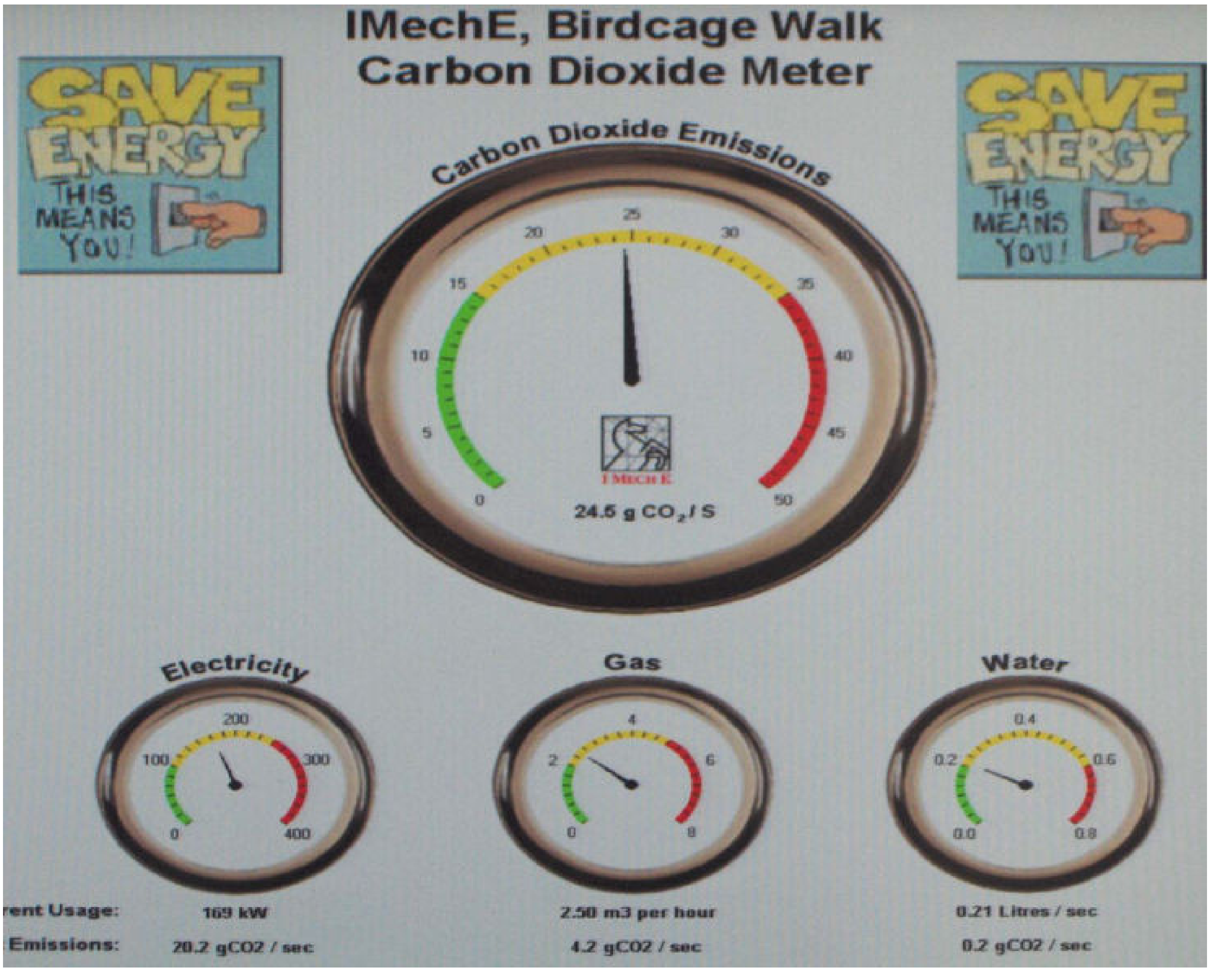

Photo 1 – CO2 meter at the Headquarter of the Institution of Mechanical Engineers, London

Energy used to construct the building depends on the work process. A detailed method statement could be used to estimate the total energy used.

Many buildings are designed with a fifty year life expectancy. Demolition of structures and disposal of wastes also require energy. Again detailed method statements for demolition and transport and disposal of wastes would give a rough estimation of the energy used.

Choices of materials and construction methods can significantly change the energy embedded in the structure of a building. True low energy building design will consider this important aspect and take a broader life cycle approach to energy assessment. Merely looking at the energy used to operate the building is not really acceptable.

Operational energy consumption is dependent on the occupants. Embedded energy is not occupant dependant – the energy is built into the materials. Embedded energy content is incurred once (apart from maintenance and renovation) whereas operational energy accumulates over time and can be influenced throughout the life of the building.

Research by CSIRA of Australia has found that the average household contains about 1,000Gj of energy embedded in the material used in its construction. This is equivalent

to about 15 years of operational energy use. Figure 8 illustrates a building that last for 100 years, this is over 10 percent of the energy used in its life.

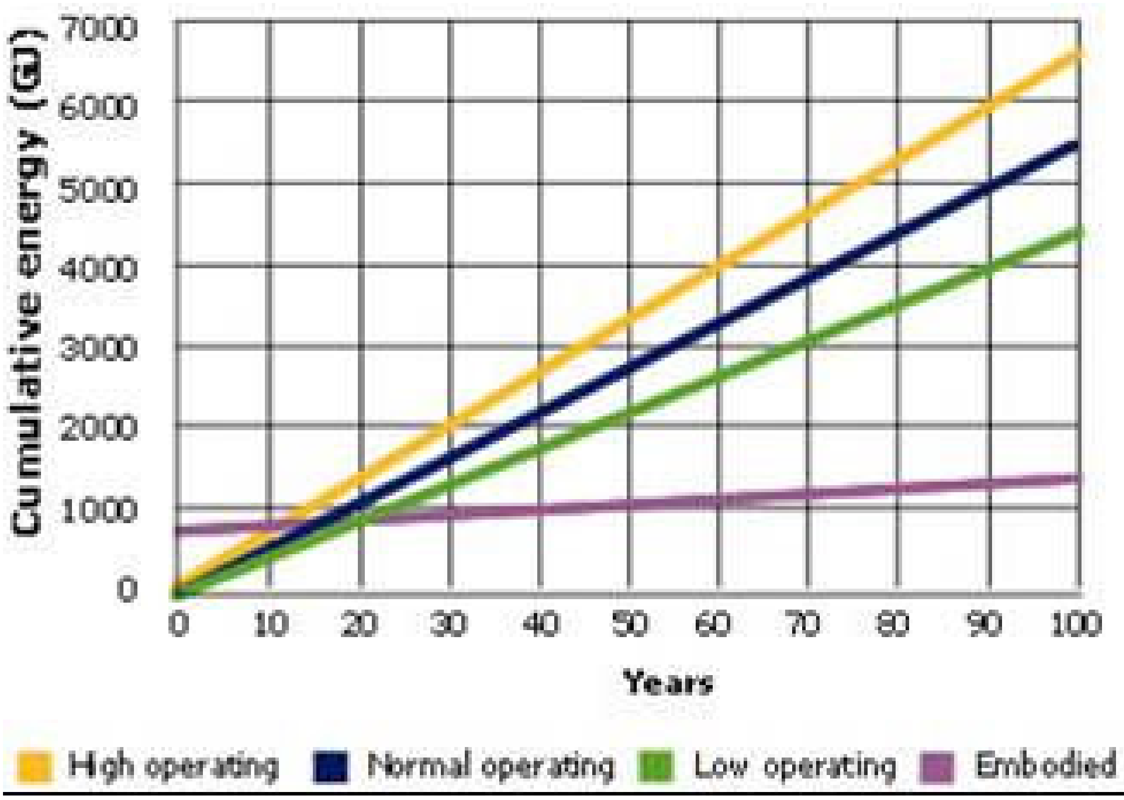

Figure 8

Embedded energy content varies greatly with different construction types. In many cases a higher embodied energy level can be justified if it contributes to lower operating energy. For example, large amounts of thermal mass, high in embedded energy, can significantly reduce heating and cooling need in well designed and insulated passive solar house.

By summing up the embedded energy in materials, energy to operate and maintain, the energy used to construct and demolish a building, and the energy to dispose of the waste materials, the total life cycle energy can be estimated. Energy is used as a common denominator and depending whether the source of energy is from coal, oil, gas, nuclear or renewable, the total life cycle energy of a building could be roughly translated into total carbon emission which is also an indication of how "green" is the building.

However, this calculation must be and can only be considered as the first order of estimation because the embedded energy can be different from different manufacturers; the energy needed for the transport of the materials from the factory to building sites can also vary significantly; and the energy required to provide water, treatment of waste water and disposal of daily generation of wastes have not been taken into consideration.

From the life cycle approach, there is no such thing as a zero carbon building. What can be done is to reduce the total life cycle carbon foot print through use of materials with least embedded energy, high efficiency electrical and mechanical equipment and

systems, effective house keeping measures to ensure all plants are operating at their peak efficiency and are properly maintained, and efficient construction and demolition methods. Most importantly, the architects, designers and engineers have to exercise sensible judgement to optimize all these factors.

There is no magic and there is only so much that could be achieved in reducing the carbon emission with available materials and existing technology. However, if population continues to grow, more buildings will be needed and there will be more carbon emission. By the same token, if people want greater comfort and more convenience, more energy will be used with its associated carbon emission.

As the carbon in the atmosphere has already reached a critical value, can people continue expect to maintain their life style? Referring to Figures 4 and 5, the total energy used in Hong Kong for space conditioning had increased by three times in the commercial sector and six times in the residential sector from 1984 to 2000. Even allowing for the population growth of say 20% in this period, the per capita use of energy for space conditioning still showed a substantial increase.

If one accepts climate change due to increase in carbon dioxide in the atmosphere is a real threat of global dimension, conventional sustainable development wisdom is not going to resolve this earthly problem. We need to develop and implement a four tier energy hierarchy to :

- **conserve energy which means to use less,**
- **improve energy efficiency which means doing more with less,**
- **use of renewable or low carbon energy sources, and**
- **develop new technology to provide carbon free energy sources.**

China mandated in its Eleventh Five Year Plan to reduce its energy intensity by 20% and all new buildings to be so designed and constructed to reduce their energy consumption by 50% from 2006 to 2010. The result so far indicated that China will probably miss the target, but at least they have a target and are working very hard on it.

The Energy Office of Electrical and Mechanical Services Department has developed a number of energy codes, energy labeling systems, and energy intensity indicators for different types of buildings all of which could help to reduce energy consumption. Unfortunately they are for voluntary application and the result is far from satisfactory; resulting in the per capita energy consumption keeps on increasing as shown in Figure 1.

To mitigate the climate change problem, I believe that all governments should set mandatory target for reduction in carbon emission enforceable by institutional and legal frameworks. Then the life cycle energy assessment method could be a tool for their effective implementation.

By organizing this Symposium, the PGBC is taking a leadership role in reducing carbon emission in the construction industry, I hope that this is only one of the many initiatives to educate the professionals and the public, to encourage best practice, and to influence the government in taking proactive actions. Let us hope with our joint efforts, our children and grand children will have a better environment that we have today.

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