EMBODIED AND LIFETIME ENERGIES IN THE BUILT ENVIRONMENT

The following is an extract from the CSIRO on line brochure at http://www.dbce.csiro.au/ind-serv/brochures/embodied/embodied.htm

Buildings are high consumers of energy and therefore have a significant impact on our environment. The study of embodied energy gives us an understanding of how much and where energy is used in the construction of buildings, and the cost benefits of recycling.

What is Embodied Energy?

Embodied energy is the energy consumed by all of the processes associated with the production of a building, from the acquisition of natural resources to product delivery, including mining, manufacturing of materials and equipment, transport and administrative functions.

How is Embodied Energy Related to Carbon Dioxide Emissions?

CO2 emissions are highly correlated with the energy consumed in manufacturing building materials. Furthermore, cement and aluminium are higher than average and glass is lower. On average, 0.098 tonnes of CO2 are produced per gigajoule of embodied energy.

Why is Embodied Energy Important?

The energy embodied in existing building stock in Australia is equivalent to ten years of the total energy consumption for the entire nation. Choice of material and design principles have a significant, but previously unrecognised, impact on energy required to construct a building. Embodied energy is one measure of the environmental impact of construction and the effectiveness of any recycling, particularly CO2 emissions.

How much does Embodied Energy vary between Building Materials?

The embodied energy per unit mass of materials used in building varies enormously from about two gigajoules per tonne for concrete to hundreds of gigajoules per tonne for aluminium. Using these values alone to determine preferred materials is inappropriate because of the differing lifetimes of materials, differing quantities required to perform the same task and different design requirements.

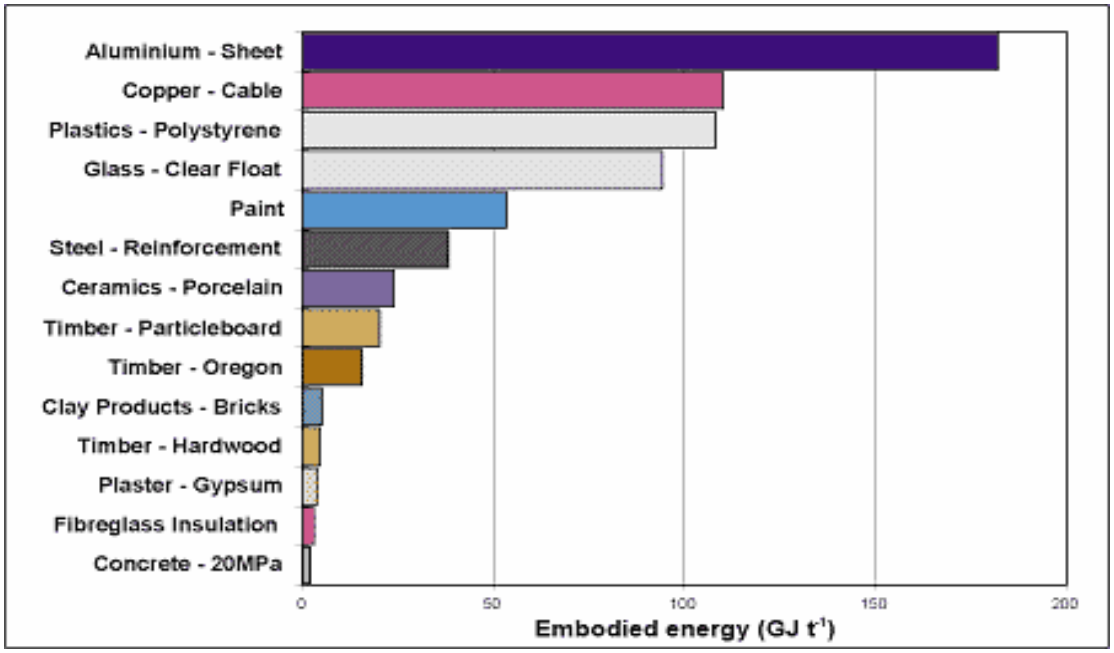

Figure 1 Embodied Energy of Selected Materials

How do we Compare the Embodied Energy Impact of Materials?

In choosing between alternative building materials or products on the basis of embodied energy, not only the initial materials should be considered but also the materials consumed over the life of the building during maintenance, repair and replacement. As buildings are becoming more energy efficient in their operation, the embodied energy is approaching half the lifetime energy consumption.

Does Reuse and Recycling of Materials Reduce Embodied Energy?

The reuse of building materials commonly saves about 95% of embodied energy which would otherwise be wasted. Some materials such as bricks and tiles suffer damage losses up to 30% in reuse. The savings by recycling of materials for reprocessing varies considerably with savings up to 95% for aluminium but only 20% for glass. Some reprocessing may use more energy, particularly if long transport distances are involved.

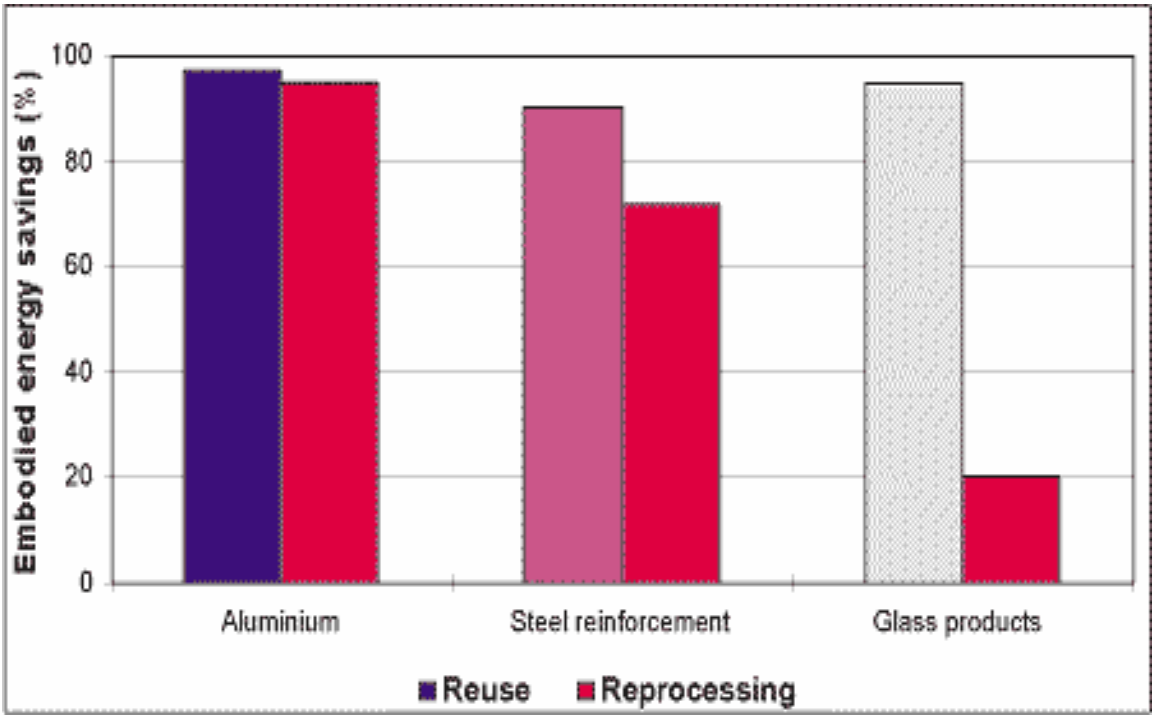

Figure 2- Potential Energy Savings

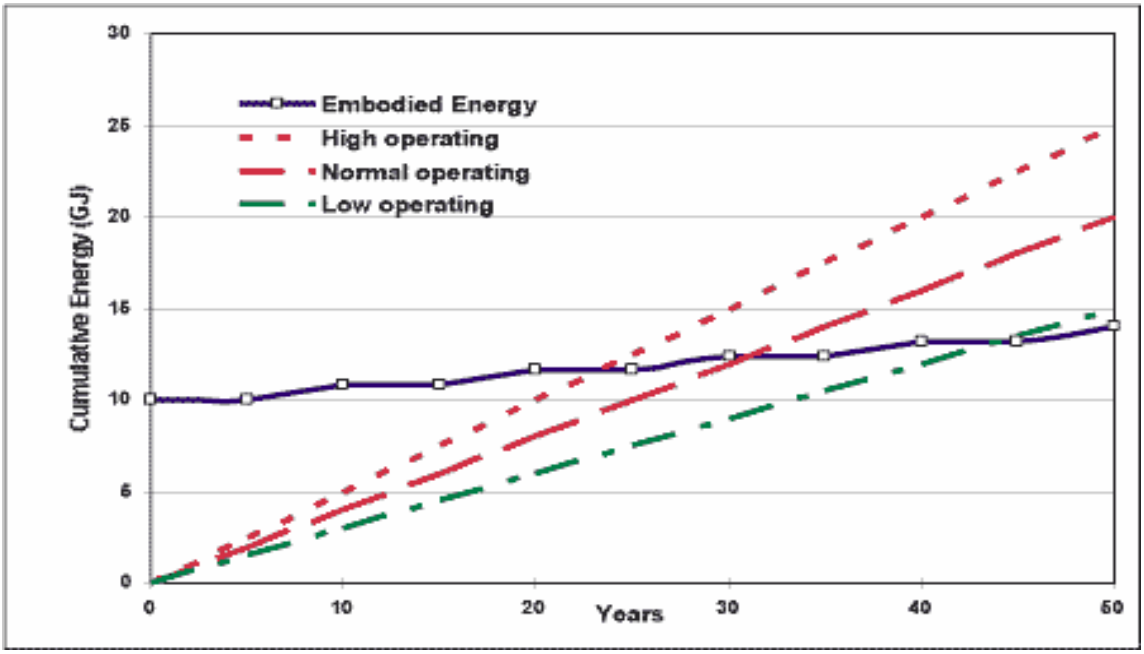

Figure 3 - Cumulative life cycle energy of an office building

How does Embodied Energy compare with Annual Operating Energy?

The embodied energy of a building is a significant multiple of the annual operating energy consumed, ranging from around 10 for typical dwellings to over 30 for office buildings. Making buildings such as dwellings more energy efficient usually requires more embodied energy thus increasing the ratio even further.

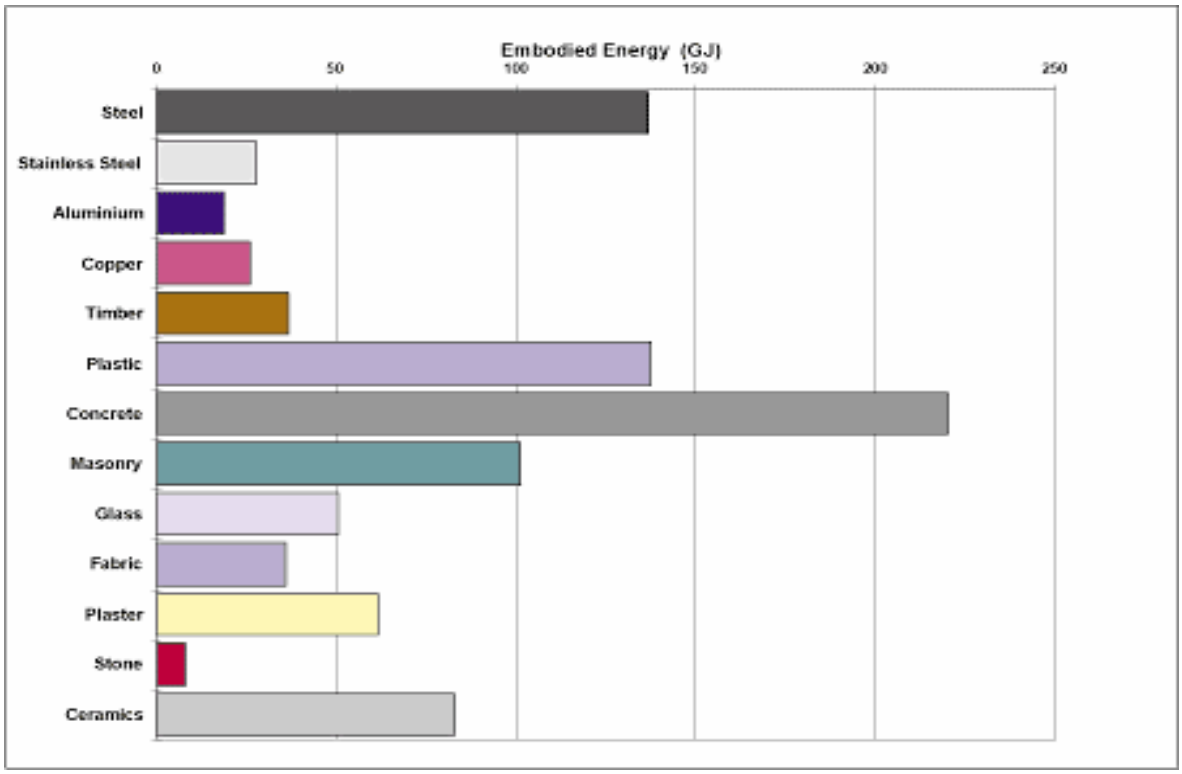

Figure 4 - Embodied Energy in a House by Material Group

How much Embodied Energy is there in a House?

Materials such as concrete and timber have the lowest embodied energy intensities but are consumed in very large quantities; whereas the materials with high energy content such as stainless steel are used in much lesser amounts. Thus the greatest amount of embodied energy in a building is often in concrete and steel.

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