New thinking on wood. Purchasing and manufacturing products that incorporate wooden components can greatly reduce the overall embedded carbon footprint of those goods and the buildings into which they are employed.

# Wood – another low carbon footprint solution

With the International Panel on Climate Change (IPCC) warning that at least 60 per cent reductions in greenhouse gas emissions will be needed to stabilise emissions at double pre-industrial levels, organisations across a range of industry sectors are now considering where such deep cuts can be achieved at a profit. There are some surprisingly simple and practical options already being successfully employed. How many consumers in Australia, for example, realise that using more sustainable plantation timber products significantly reduces your carbon footprint?

Life Cycle Analysis (LCA) studies show that plantation timber products have a far less harmful 'footprint' than many other materials in terms of greenhouse gas emissions and embodied energy. If sourced from sustainably managed plantations, timber products can significantly reduce the greenhouse gas emissions impact from activities such as building, and products such as furniture, entertainment units, flooring materials, window frames and playground and park seats, to name a few. In fact, LCA studies show that of all the materials considered, plantation timber has the lowest environmental impact compared to other options. Why is that?

Let's consider how plantation timber performs in terms of greenhouse gas emissions when compared to other materials in a few key consumer markets. Within the building sector, a comparison of three houses established by researchers[1] calculated that a predominantly steel house contains 553 GJ of embodied energy, whilst a predominantly concrete house contains 396 GJ. A predominantly timber house contains just 232 GJ.

Similarly, recent research[2] made a comparative assessment of steel, concrete and wood building material and found that wood had the lowest embodied energy. Also, the higher the embodied energy of the building, the more air toxins (such as carbon dioxide, sulphur dioxide, particulates, nitrogen oxides and hydrocarbons) were released into the atmosphere. Steel and concrete buildings are therefore much worse in this respect.

Flooring is a significant market globally, and LCA studies of three different types of material for flooring (solid wood, linoleum and vinyl/PVC) have been assessed.[3] The functional unit was defined as 1 $m^2$ of flooring and the considered lifetimes of each of the products were based on real world data of average lifetimes: 25 years for linoleum, 20 years for PVC and 40 years for wood. The wood flooring was found to consume the lowest amount of energy in manufacturing (electricity and fossil fuel), followed by linoleum and PVC.

By comparing global warming potentials of these flooring materials, this study showed that PVC had the highest global warming potential (GWP) of 4.2 kg/$m^2$. This was 2.5 times greater than linoleum (1.6 kg/m2), while the GWP of wood was negligible (0.42 kg/$m^2$). In other measures – such as acidification potential and photochemical ozone creation potential – wood was found again to be the best performer.

LCA studies of window frames again showed the same trend for wood, compared with aluminium and PVC, in terms of global warming potential, acidification potential, eutrophication potential and photochemical ozone creation potential.[4]

But does this footprint benefit extend to the use of wood components in particular products? Absolutely. LCA studies looking at the effect of including more wood in entertainment units for TVs and DVD players, for example, found that wood reduces the overall environmental load of the product.[5]

LCA studies of office furniture suggest there is great potential for timber furniture, or at least office furniture with higher timber content, to make a significant difference to greenhouse gas emissions. Furniture (particularly in the office environment) can contribute a surprising amount to the overall environmental impact of a building. A number of analyses of office and residential buildings show

1 Buchanan AH and Honey BG (1994) Energy and carbon dioxide implications of building construction. *Energy and Building* **20**, 205–217.

2 Glover J (2001) Which is better? Steel, concrete or wood. A comparison of assessments on three building materials in the housing sector. Fourth year thesis, Department of Chemical Engineering, University of Sydney. (In this work, the comparison of embodied energy was derived from data obtained by Lawson B (1996) Building Materials Energy and the Environment. Towards Ecologically Sustainable Development. The Royal Australian Institute of Architects, and The Canadian Wood Council (1994–2000) Life cycle analysis for residential buildings. Canadian Wood Council Technical Bulletin No. 5.)

3 Jönsson A, Tillman A and Svensson T (1997) Life cycle assessment of flooring materials – case study. *Building and Environment* **32**(**3**), 245.

4 Findings of Glover J, (2001) and Jönsson A, et al (1997) summarized in this article are based on the research presented in Taylor J, Langenberg, K V, (2003) Review of the Environmental Impact of Wood Compared with Alternative Products Used in the Production of Furniture. Forest and Wood Products Research and Development Corporation (FWPRDC).

5 Nedermark R (1998) *Ecodesign at Bang & Olufsen. Product Innovation and Eco-efficiency*. Twenty-three Industry Efforts to reach the Factor 4. (Eds J Klostermann and A Tukker). Kluwer Academic Publishers.

| Material | Embodied energy (MJ/kg) |
|---|---|
| Air dried sawn hardwood | 0.5 |
| Kiln dried sawn hardwood | 2.0 |
| Kiln dried sawn softwood | 3.4 |
| Particleboard | 8.0 |
| Plywood | 10.4 |
| Glued-laminated timber | 11.0 |
| Laminated veneer timber | 11.0 |
| Medium Density Fibreboard (MDF) | 11.3 |
| Glass | 12.7 |
| Mild steel | 34.0 |
| Galvanised mild steel | 38.0 |
| Zinc | 51.0 |
| Acrylic Paint | 61.5 |
| PVC | 80.0 |
| Plastics (general) | 90.0 |
| Copper | 100.0 |
| Aluminium | 170.0 |

**Process energy requirements (PER) for some common building materials.**

Source: Lawson B (1996) Building materials energy and the environment. Towards ecologically sustainable development. The Royal Australian Institute of Architects.

that the embodied energy in the structure of buildings is significant.[6] But a Forest and Wood Products Research and Development Corporation 2003[7] report highlights that 'When the life span of the building is taken into account, the embodied energy from the office furniture, which is replaced many times over the life span of the building, actually becomes the most important item in the life cycle of the building.[8] In fact, McCoubrie demonstrates that office furniture, compared to other elements in the building, accounts for 31 per cent of the life cycle energy of a medium-rise Melbourne office building over a 40-year period.[9] Frequent replacement of the office furniture was found to be the cause of the high percentage of embodied energy.'

However, the report points out that McCoubrie's model does not account for any reselling of used furniture for second-hand use, therefore re-using furniture in addition to increasing wood content would reduce the energy implications over the life span of the building even further.

But the conclusions of these LCA studies – and thinking on the beneficial effects of plantation forestry – recently appeared to have been dealt a blow by an article in the international science journal *Nature*. Frank Keppler and colleagues reported for the first time that plants can directly emit methane, a significant greenhouse gas that plays a central role in atmospheric oxidation chemistry and affects stratospheric ozone and water vapour levels.[10] An opinion piece by David Lowe in the same issue of *Nature* stated 'we now have the spectre that new forests might increase global warming through methane emissions rather than decrease it by sequestering $CO_2$', which has sparked significant interest from the media.

The authors of the paper itself soon responded[11] to what they saw as misrepresentation and misreporting of their results by *Nature*'s opinion article and other media. In the clarification they said 'these estimates show that methane emissions by plants may slightly diminish the effect of reforestation programs. However, the climatic benefits gained through carbon sequestration by reforestation far exceed the relatively small negative effect, which may reduce the carbon uptake effect by up to four per cent. Thus, the potential for reduction of global warming by planting trees is most definitely positive.'

**Until recently it was assumed that it took about 10 years in landfill for timber and paper products to decompose and release their carbon emissions.**

In Australia, Ensis scientists have tested this assumption, using Keppler's methodology as reported in *Nature*, by comparing estimates of methane emissions for radiata pine forests with the amounts of carbon stored, to determine the overall effect.[12] They found that the average amount of methane emitted would offset about five per cent of the carbon dioxide stored by trees in terms of its effect in contributing to global warming.

In further evidence of the benefits of plantation timber to greenhouse gas reduction, world-first studies by the Australian CRC for Greenhouse Accounting show that

**Wood products after 19 to 46 years in landfill.**

CRC for Greenhouse Accounting

timber and paper products could be significantly better carbon stores than previously thought. Until recently it was assumed that it took about 10 years in landfill for timber and paper products to decompose and release their carbon emissions. But the research by the CRC showed that timber that had been in landfill for 46 years had only lost between 1.4 to 3.5 per cent of its carbon. Paper, likewise, had lost very little of its carbon over 20–50 year periods in landfill, significantly altering the thinking on carbon storage times.

Similarly, in the past, scientists have assumed that the rate of decomposition of leaf litter and the roots of felled trees was rapid, thus quickly releasing stored carbon. But, again the CRC for Greenhouse Accounting's research shows that the actual rate of decomposition is orders of magnitude less than thought previously.

These outcomes underline that further research is now needed on this critical carbon accounting issue by other nations, in order to establish whether the same results occur under different local conditions. They also reinforce how timber products from plantations can help to appreciably reduce greenhouse gas emissions.

This article is an adapted excerpt from the A3P (Australian Plantation Products and Paper Industry) *Sustainability Action Plan*, the development of which is being assisted by **Philip Toyne** (EcoFutures Ltd), with research and contributions from **Michael H Smith** and **Karlson 'Charlie' Hargroves** (The Natural Edge Project).

6 Goverse T, Hekkert M, Groenewegen P, Worrell E and Smits R (2001) Wood innovation in the residential construction sector; opportunities and constraints. *Resources, Conservation and Recycling* **34**, 53. Harris D (1999) A quantitative approach to the assessment of the environmental impact of building materials. *Building and Environment* **34**, 751. Cole R and Kernan P (1996) Life-cycle energy use in office buildings. *Building and Environment* **31**, 307. Chen T, Burnett J and Chau C (2001) Analysis of embodied energy use in the residential building of Hong Kong. *Energy* **26** (**4**), 323. McCoubrie A and Treloar G (1998) Life-cycle embodied energy in office furniture. In *Proceedings of embodied energy – The current state of play*, pp. 113–118, Deakin University, Geelong.

7 Taylor J, Langenberg K V, (2003) Review of the Environmental Impact of Wood Compared with Alternative Products Used in the Production of Furniture. Forest and Wood Products Research and Development Corporation (FWPRDC).

8 Goverse T, Hekkert M, Groenewegen P, Worrell E and Smits R (2001) Wood innovation in the residential construction sector; opportunities and constraints. *Resources, Conservation and Recycling* **34**, 53.

9 McCoubrie A and Treloar G (1998) Life-cycle embodied energy in office furniture. In *Proceedings of embodied energy – The current state of play*, pp. 113–118, Deakin University, Geelong.

10 Keppler F, Hamilton J, Brab M, Röckmann, T (2006) Methane emissions from terrestrial plants under aerobic conditions. Nature 439, 187.

11 www.greenhouse.crc.org.au/crc/research/methane-from-plants/maxplanck.pdf

12 http://www.ensisjv.com/Default.aspx?PageContentID=736&tabid=318