3

How wood products help slow Global Warming

- Tools are available to measure CO_2 impacts
- Wood and wood products save CO_2
- Wood buildings use less CO_2
- Governments are using legislation to curb CO_2
- Wood is going to become more important

Assessing the CO_2 impact of different materials

"Wood plays a major role in combating climate change… Trees reduce carbon dioxide in the atmosphere, as one cubic metre of wood absorbs one tonne of CO_2… Greater use of wood products will stimulate the expansion of Europe's forests and reduce greenhouse gas emissions by substituting for fossil fuel intensive products. The Commission is examining ways to encourage these trends."

European Commission's DG Enterprise, 2003

Forestry and wood products can help EU countries achieve their Kyoto targets, not only by increasing the carbon sink of wood-based products and growing forests, but also by decreasing carbon sources through substituting wood-based products for energy-intensive products and fossil fuels.

There are three broad areas to consider when assessing the relative CO_2 impact of different building materials: the energy used in the production of the material or product, the ability of the product to save energy during the use of the building, and the recycling and final disposal of the materials or products.

This is a complex process, in which governments across Europe are taking an increasing interest, and specific assessment tools are now available to designers, clients, specifiers and developers to help achieve sustainable strategies for housing and commercial buildings.

These tools enable designers to assess the initial CO_2 footprint of a building, as well as its environmental impact during use and disposal, and balance them against building and running costs.

Building Materials Carbon Indicator

The Nordic Timber Council and its partners are currently developing a tool to calculate the CO_2 footprint of elements of a particular building or structure that will be invaluable in choosing the best combination of materials and products.

Opposite above

The environmental impact of the wooden structure of Finland's METLA building is significantly smaller than that of an equivalent concrete structure, saving 620 t CO_2

Tarja Häkkinen and Leif Wirtanen, VTT Technical Research Centre of Finland, 2005

Opposite below

The timber framed Gallions Ecopark in the UK achieved an EcoHomes 'excellent' rating

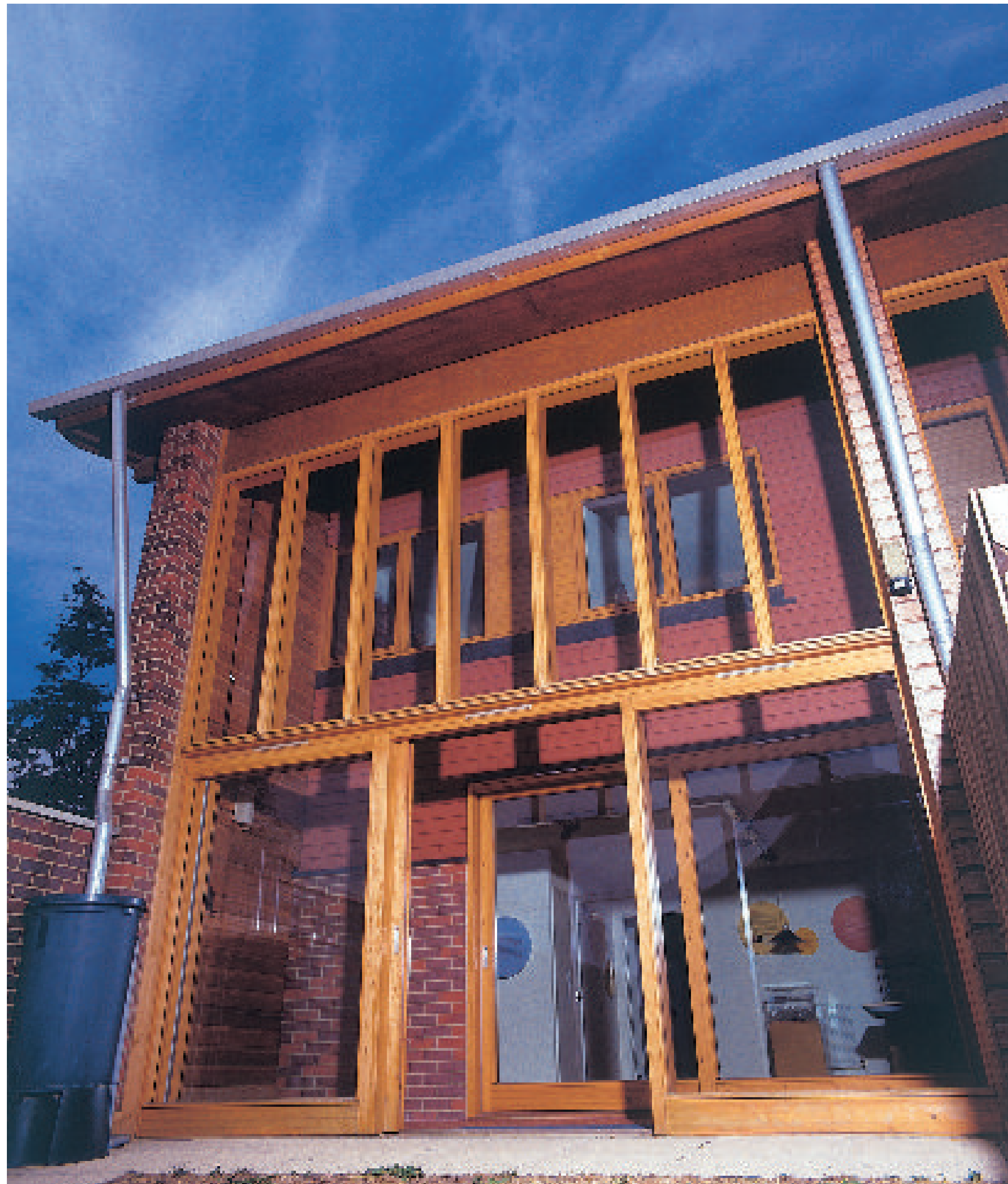
Life Cycle Assessment

LCA is a technique which assesses the environmental impacts of a building component right the way through its life. It is becoming increasingly important as more and more specifiers are required to consider the environmental impacts of the products and materials they select, taking into account where the material comes from, how it is used or converted into a product and its use in a building, right through to its disposal or re-use/recycling[17].

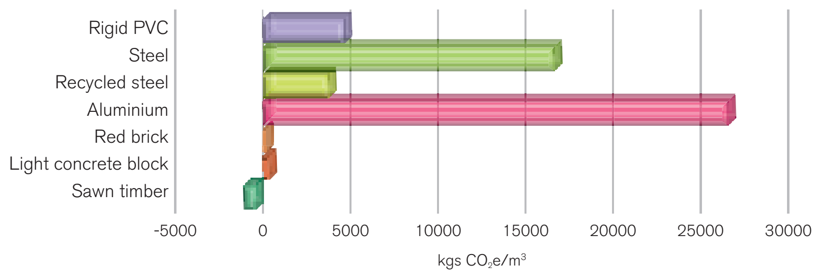
It considers the impact of a material or product's use during 3 specific phases:

Production phase	In-use phase	End-of-life phase
extraction production transport to site	energy use thermal properties maintenance	recycling recovery disposal

n.b. This approach cannot always be used to compare materials or products from different countries, many of which have different climates, energy generation sources, design customs, building codes, infrastructure, political influences and building methods, some of which will have a bearing on LCA and Whole Life Cost information.



Net emissions of CO_2 including carbon sink effect



Above

A comparison of the CO_2 production of different materials (net CO_2 emissions including carbon sink effect)

RTS, Environmental Reporting for Building Materials, 1998-2001

Right

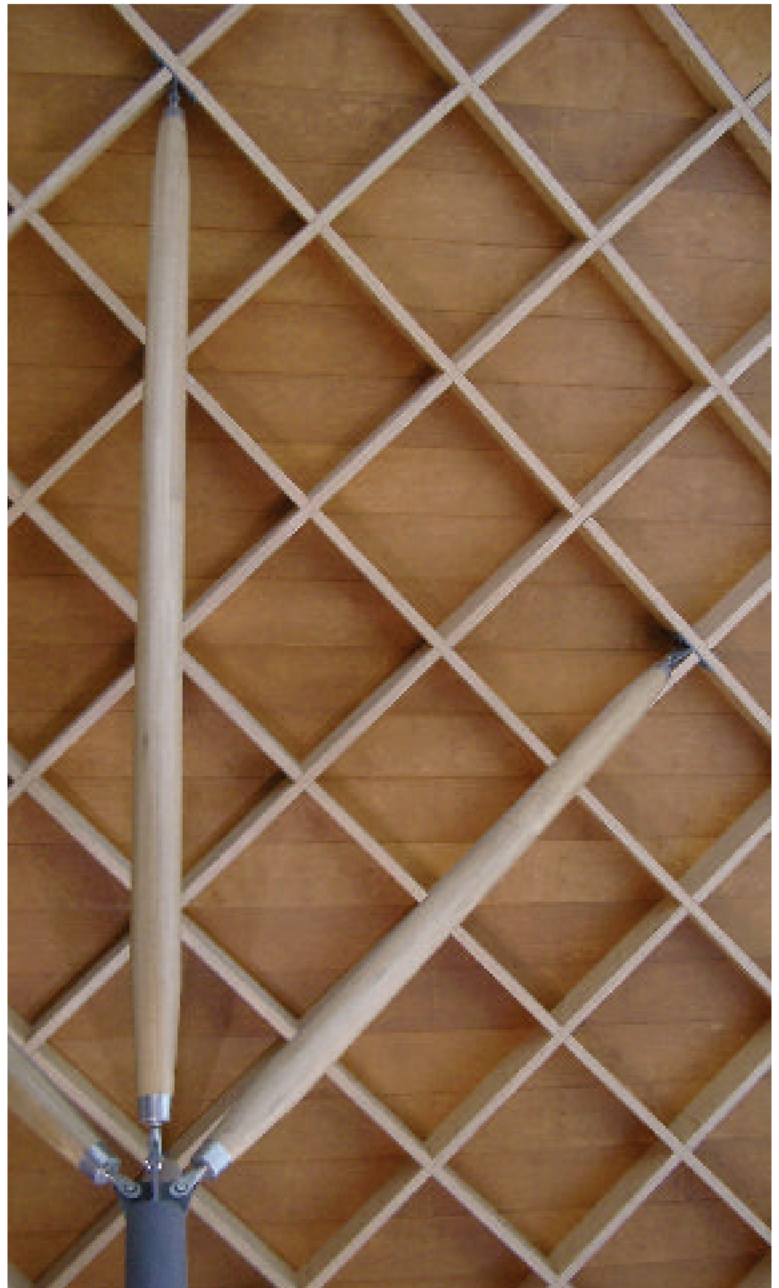
LVL struts and lamella roof, Hounslow East Station, UK

Production phase - energy use in extraction, production and transport to site

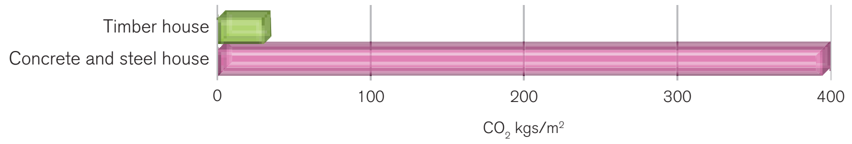
The energy used in the extraction and production of a material or product is called 'embodied energy'. Generally speaking, the higher the embodied energy, the higher the CO_2 emissions. Compared with the high emissions and embodied energy of alternative materials like steel, concrete, aluminium and plastic, wood has low embodied energy and, thanks to the carbon sink effect of the forest, negative CO_2 emissions[18].

Even when materials like steel or aluminium are recycled, the process often requires huge amounts of energy. By comparison, where the wood industry does require energy, it is one of the highest users of biomass power generation, often making a net contribution to national grid networks.

The impact of materials transport is taken account of within the LCA calculation.



CO_2 emissions from different house constructions



Above

The difference in CO_2 emissions from the materials and construction content of two houses is 370 kg/m²

Tratek/SCA, Materials Production and Construction

Below

Energy use across the life-cycle of a house

Pohlmann, 2002

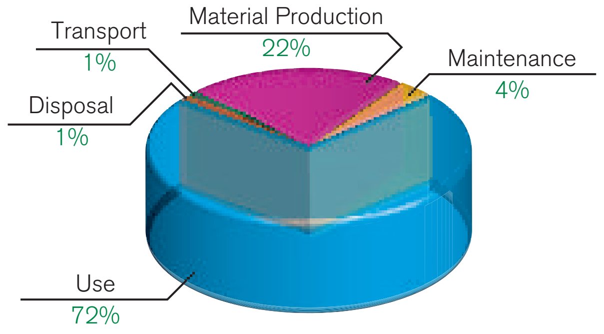
In-use phase

European governments are increasingly using legislation to improve the thermal efficiency and reduce the energy consumption of new buildings. This has an impact mainly on the building's overall envelope performance and is equal for all materials[19].

However, wood's natural thermal efficiency means timber systems can be more cost-effective in constructing energy-efficient buildings than cement block, brick or alternative materials. In addition, triple-glazed windows can be more easily produced in wood than in other materials and wood floors will provide better thermal insulation than concrete floors.

It is especially favoured in cold climates, where, with careful design and considered use of insulating materials, low-energy consumption reduces heating costs whilst providing comfortable living conditions, often in sub-zero external temperatures.

Energy use across the lifecycle of a house



A Swedish study undertaken in 2001 compared the embodied energy and CO_2 emissions from the construction of two similar houses, one made from timber, the other from steel and concrete. The difference of 2 300 MJ/m² energy used in the materials and construction of the houses is enough to heat one of the houses for 6 years, while the 370 kg/m² difference in CO_2 emissions is equivalent to the emissions from 27 years' heating – or driving 130 000 km in a Volvo S80.

"Two thirds of energy used in European buildings is accounted for by households; their consumption is growing every year, as rising living standards are reflected in greater use of air conditioning and heating systems."

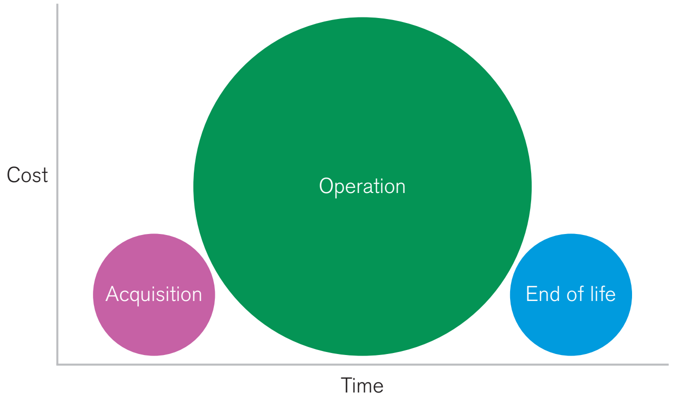
EU Commission: Better Buildings: New European Legislation to Save Energy, 2003

School in the UK, case study
Kingsmead Primary School in Cheshire, UK, has become an exemplar project, short-listed for the Prime Minister's Award for Better Public Buildings.

Natural ventilation and daylighting, timber construction with high levels of insulation, the use of photovoltaic cells and a wood burning Combined Heat and Power boiler, all contribute to reduced energy and running costs.

The money saved on running costs each year pays for an extra teacher.

End-of-life phase
Wood and wood-based products have unique end-of-life properties. In addition to recycling by-products like sawdust, chips and off-cuts into particleboard, many other panel products are manufactured from recycled wood. However, beyond this, wood is increasingly used as a substitute for fossil fuels, providing a renewable energy source which simply returns to the atmosphere the CO_2 it originally removed.



Opposite left

Kingsmead Primary School, Cheshire, UK. Designers: White Design

Opposite right

Recycled wood can be made into many panel products

Above

Operating costs are significantly larger than acquisition and end of life costs

Right

Laminated wooden brise-soleils reduce solar gain and air conditioning costs

Whole Life Costing

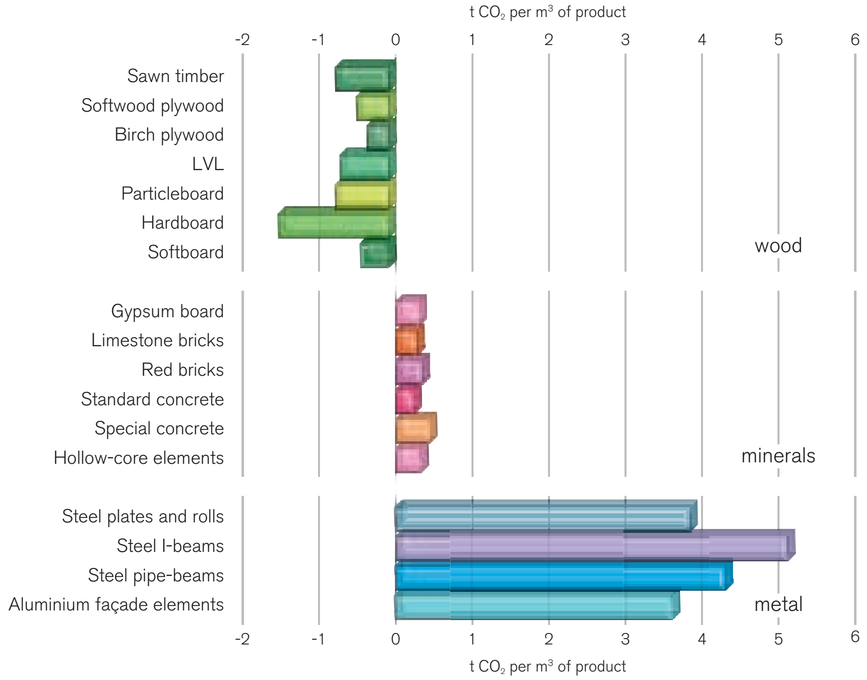
Developments will increasingly need to ensure a balance between environmental impact and long-term value for money. WLC is a commonly used technique which enables comparative cost assessments for a product or project to be made over a specified period of time, taking into account all relevant economic factors of initial capital costs and future operational costs - the total cost of a building or its parts throughout its life, including the cost of planning, design, acquisition, operations, maintenance and disposal, less any residual value. Together with LCA, it can provide a thorough economic and environmental assessment to support decision-making and an effective procurement strategy.

What may appear to be a low-cost choice initially may prove more expensive during its service life or when it comes to disposal. For example, in 2003, a consultancy working with the London Borough of Camden in the UK conducted research on window costs, which found that more expensive high-performance timber windows had a 14% lower Whole Life Cost than PVC windows when comparing identical specifications[20].

How much CO_2 can be saved using wood?

The energy used in construction, including manufacturing, transporting and erecting buildings, is significantly lower for wood-based products and systems than for other building materials.

Net CO_2 lifecycle emissions



"Specifying wood in public procurement can help fulfil national and local climate change programmes. Encouraging the use of wood products can act as a greener alternative to more fossil-fuel intensive materials. Substituting a cubic metre of wood for other construction materials (concrete, blocks or bricks) results in the significant average of 0,75 to 1 t CO_2 savings."

International Institute for Environment and Development, Using Wood Products to Mitigate Climate Change, 2004

"The combined effect of carbon storage and substitution means that 1m³ of wood stores 0,9 t CO_2 and substitutes 1,1 t CO_2 - a total of 2,0 t CO_2."

Dr A Frühwald

Left

Net CO_2 emissions of selected building materials during the whole lifecycle

Building Information Foundation, RTS

Opposite

The timber construction of London's Fairmule House saved around 1 000 t CO_2

"The decision to include forest sinks at the 2001 Conference of the Parties to the UN framework Convention on Climate Change, opens the way for the possible inclusion of wood products as of 2013-2017 (second commitment period of the Kyoto Protocol).
Since wood products store the carbon initially trapped in trees, carbon is removed from the atmosphere as long as the wood product remains in use and beyond, when the product is re-used, or recycled for secondary material or energy recovery. Besides, the more wood products replace other materials, the more the so-called 'substitution effect' further reduces CO_2 in the atmosphere. CO_2 reductions achieved by wood products are eligible under Art. 3.4 of the Kyoto Protocol and the woodworking industries may be granted carbon credits in the framework of the emissions trading scheme, at EU and international level, if and when decisions and procedures are put in place."

DG Enterprise - Unit 4, COMPREHENSIVE REPORT 2002 – 2003 regarding the role of forest products for climate change mitigation[6]

Case study
London's Fairmule House is the UK's biggest solid timber construction. 5 storeys high, it was fabricated offsite using laminated panels up to 12,5m long, 2,9m wide and 170mm thick, which were produced from sawmill offcuts.

The glue content of the panels is 2% and the building uses 360m³ of timber, which in turn sequestered 300 t CO_2 from the atmosphere.

If concrete or steel had been used instead of wood, there would have been around 720 t CO_2 emissions.

The main opportunities for substituting wood products

Carbon storage in domestic products

Unit	Carbon Content
House	10-25 t C/house
Wooden window	25 kg C/window
Wooden flooring	5 kg C/m^2
Furniture	1 t C/household
House and contents	12-30 t C

The main opportunities to capitalize on these CO_2 savings include using a greater proportion of wood products, using wood products with a longer life, and substituting wood and wood-based products for energy-intensive materials.

An idea of the scale of the opportunity is provided by a research study conducted by Dr A Frühwald, of Hamburg University, which estimated that between 12 and 30 tonnes of carbon can be stored in the fabric and content of an average timber house.

Left

Carbon storage in domestic wood products

Frühwald, 2002

Below

12 - 30 t C can be stored in the fabric and content of an average timber house

Opposite above

Wooden beams save CO_2

Opposite middle

The environmental impact of window frames and (right) of flooring made from different materials

(Global Warming Potential, Acidification Potential, Eutrophication Potential, Photochemical Ozone Production Potential)

FAO, 2003

Opposite below right

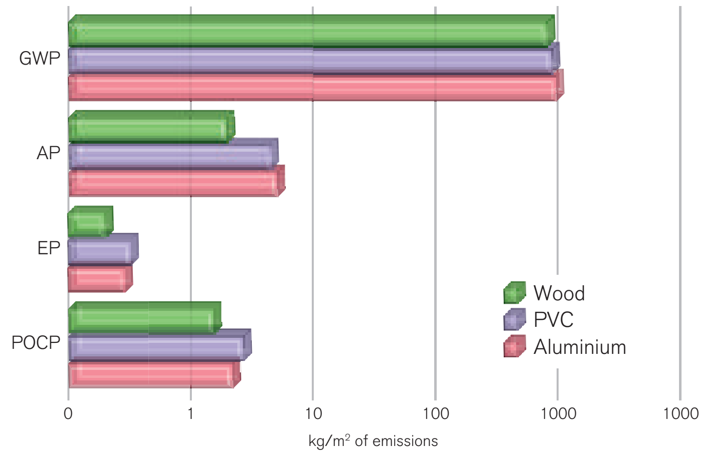
Comparison of CO_2 emissions of beams made of different materials

Indufor, CEI-Bois Roadmap 2010, 2004

Wood windows

In the production phase, wood windows have lower environmental impacts than PVC-U and aluminium. But, not only do they use less energy to produce, they also use less energy throughout their life, thanks to wood's excellent insulation and cold-bridging properties.

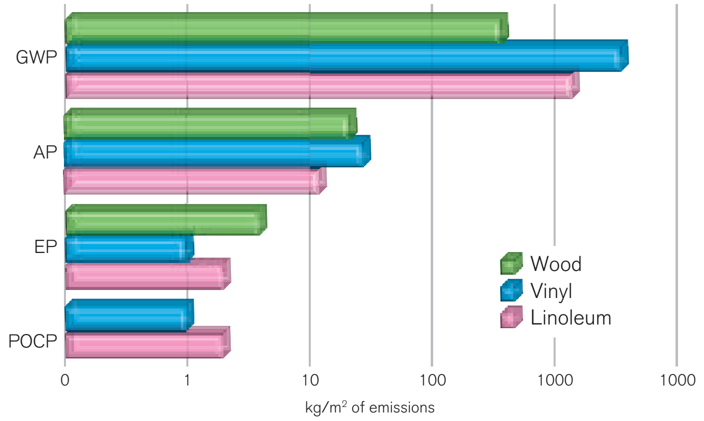
Window frames: the environmental impact



Wood floors

Low-energy and thermally efficient, wood floors are healthy, durable, and have low environmental impacts.

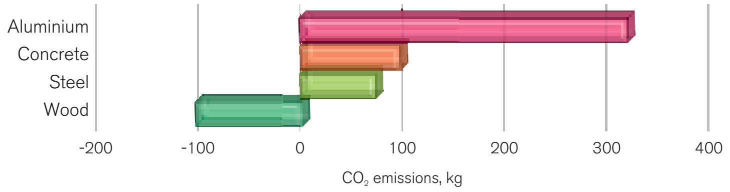
Flooring: the environmental impact



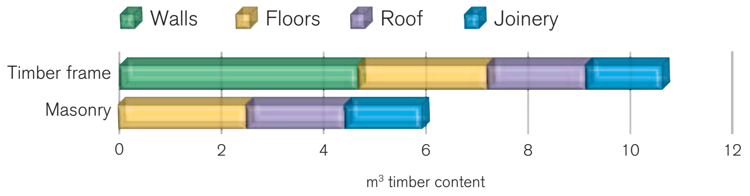
Wood beams

A French study comparing wooden building beams against concrete, steel and aluminium, clearly illustrates the gap between CO_2 neutral (absorbing) wood and its CO_2 producing alternatives.

Beams: CO_2 production



The timber content of wood vs masonry houses



Timber frame share

North America	90%
Scotland	70%
Scandinavia	45%
Japan	45%
Europe	8-10%

Timber frame

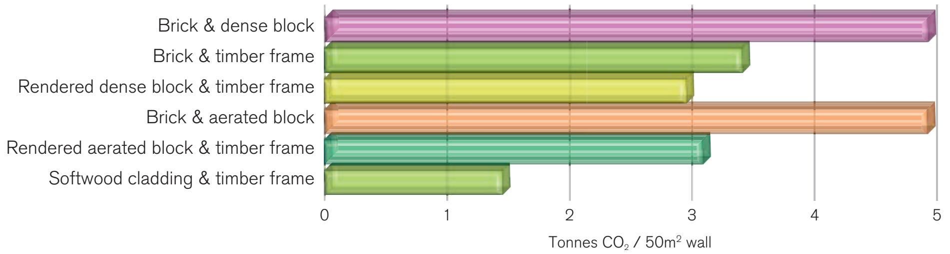
There are significant CO_2 savings to be made by using timber in the construction of housing and other buildings, both in terms of embodied energy and in-use energy efficiency. There are also many different timber frame and solid timber construction systems commonly used across Europe. Generally, the higher the timber content, the lower the embodied energy of the building.

For example, in the UK a brick-faced timber frame house will save 1,55 t CO_2 per $50m^2$ wall, compared with brick and block, while facing the timber frame with softwood weather-boarding will result in savings of up to 3,45 t CO_2[21].

This means that a typical UK timber frame house could save around 5 t CO_2 (about the amount used driving 23 000 km in a 1,4l car) even before its lower running costs are considered.

Wood's naturally good thermal insulation makes it the material of choice in cold climates. But wood framed buildings are just as efficient in hot climates, making use of wood's natural ability to dissipate at night the heat built up during the day. Often, a combination of a thermally-efficient lightweight wood frame with a high thermal mass concrete or stone core is used to achieve the most effective insulation along with minimal daytime/night-time temperature fluctuation.

CO_2 emissions for different wall constructions



Above left

Timber frame is the most popular house construction method in the developed world

Frühwald, 2002

Above

A comparison between the timber content of a $100m^2$ two-storey detached house using 140mm studs timber frame and masonry

TRADA and Lloyd's Timber Frame, UK

Below

A comparison of CO_2 emissions over the lifecycle of different wall constructions, based on a 60 year life

BRE Environmental Profiles database

Right

A typical timber frame housing development in the UK

Middle

Preliminary environmental results for a typical residential dwelling in Minneapolis

Below

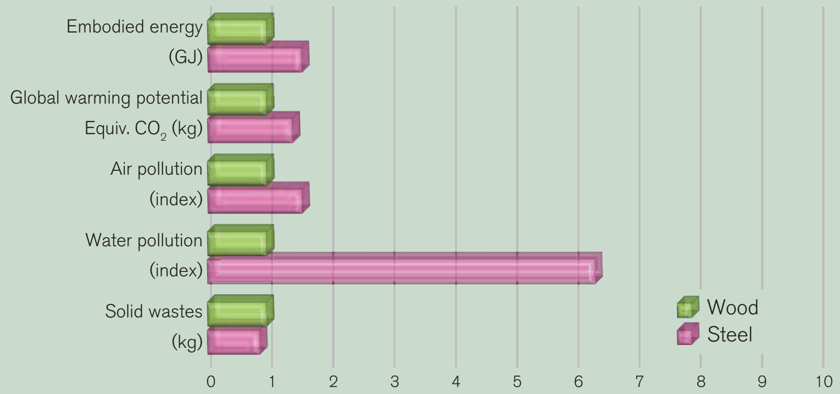
Preliminary environmental results for a typical residential dwelling in Atlanta

Roofing

A typical German roof contains between 4,6 and 10,5 m^3 seasoned timber, keeping between 3,7 and 8,4 t CO_2 from the atmosphere[22].

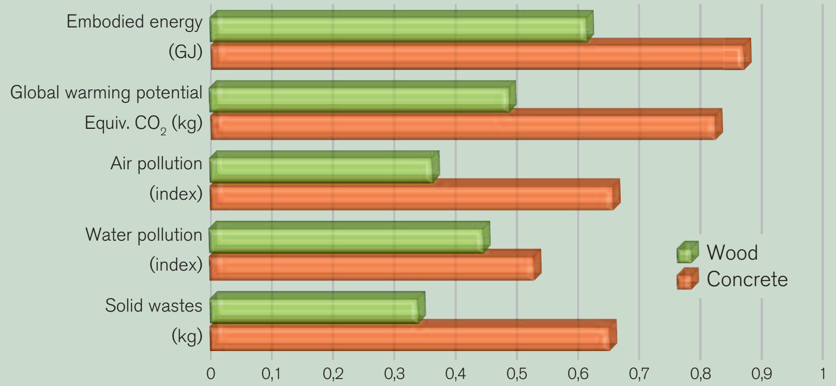
Environmental impacts of a steel house relative to a wood house

Steel house results shown indexed to wood house at 1,0



Environmental impacts of a concrete house relative to a wood house

Both concrete and wood house results shown indexed to Minneapolis wood house at 1,0



Case study

LCA methods were used to investigate the impact of different building materials on whole buildings, testing different materials in different climate conditions in similar single storey family homes in Minnesota and Atlanta USA; timber versus steel in Minnesota, and timber versus concrete in Atlanta. Results show considerable savings for wood construction in place of steel or concrete in embodied energy, Global Warming Potential, CO_2 and other environmental impacts.

European legislation

"Forestry practices can make a significant contribution by reducing greenhouse gas emissions through increasing the amount of carbon removed from the atmosphere by the national forest estate, by burning wood for fuel, and by using wood as a substitute for energy-intensive materials such as concrete and steel."

Securing the Future – delivering UK sustainable development strategy

Opposite

The 2002 European Performance of Building Directive (EPBD) will apply to almost all buildings, residential and non-residential, both new and existing, while Eurocodes play a major role in creating a single market for wood building, forming a basis for specifying contracts in construction works and related engineering services, as well as a framework for drawing up harmonised technical specifications for construction products.

Many countries across Europe have set targets to reduce CO_2 emissions within the Kyoto Protocol and, encouraged by EU policies, are adopting legislative methods to ensure buildings and materials help achieve individual country targets.

In many cases, this legislation has led to an increased use of wood, or at the very least, consideration of wood as an alternative to conventional construction material, such as steel and concrete. France, for example, is preparing a specific decree to 'define the conditions for using a minimum rate of wood material in public buildings', in the framework of its law on air and rational energy use.

Building regulations

Changes in national building regulations are encouraging multi-storey wood buildings. Denmark and Finland now allow up to four storeys and Switzerland six. Sweden has no set limit on the number of floors and six storey wood buildings are common, while the largest timber frame building in the UK is now seven storeys high.

In the UK, for example, where 50% of the country's CO_2 emissions are attributable to the energy consumed by and in buildings, new building regulations were introduced in 2001 to require all new buildings to achieve target U-values so as to reduce the amount of heat energy loss through the fabric of the building and its components, such as windows, doors and roof. Targets will be made 20% tougher in revised regulations to be introduced in 2006[23].

The challenge

The evidence is clear, but current policies still have some way to go to recognize the full benefits to the climate of using more wood.

"In spite of the overwhelming evidence to the contrary, the use of wood substitutes, and the belief that these substitutes are better for the environment than wood, are both increasing.
Greenhouse Gas emissions reporting under the United Nations Framework Convention on Climate Change unjustifiably favours non-wood alternatives by classifying harvested forest products as emissions as soon as they leave the forest site.
Building and packaging standards also place barriers in the way of wood use, often despite technological advances which might overcome structural or hygiene concerns.
Recycling and recovery programmes for wood are often dismissed in favour of incineration and landfill, due to prevailing attitudes and lack of political will.
Each of these policies has the perverse effect of favouring more carbon intensive wood substitutes.
The development of a workable carbon intensity labelling system, pro-wood building and packaging standards and invigorated recycling programmes would help to maximise the climatic advantages of wood use."

IIED, Could wood combat climate change? 2004