ENVIRONMENTAL LIFE - CYCLE ASSESSMENT

TABLE TURNED

DINING TABLE BY BARNBY & DAY WITH ALEX DE RIJKE

MADE IN AMERICAN TULIPWOOD

THE·WISH·LIST

SUMMARY

Unsurprisingly, the mass of tulipwood used to construct the table dominates the environmental impact, both positively and negatively. On the one hand the energy generated from wood waste during manufacturing and at End of Life offsets most of the carbon emissions. The product is highly durable and therefore has potential to act as a carbon store for decades. The fact that tulipwood is a quick drying hardwood species requiring no more than 7 to 10 days in the kiln, also helps to reduce environmental impact.

On the other hand, the volume of tulipwood used in the table contributes to more significant acidification and eutrophication impacts during transport. It also contributes to relatively high photo-chemical ozone creation potential (POCP). Partially mitigating these impacts is the potential for the table to remain in use for many years, minimising the need for replacement.

WOOD RESOURCE

From a forestry perspective, tulipwood is a good environmental option. Tulipwood is a relatively under-utilised species which accounts for 8% of wood volume in the U.S. forest. U.S. government forest inventory data[1] shows that U.S. tulipwood is growing 32.6 million m^3 per year while the harvest is 13.3 million m^3 per year. After harvesting, an additional 19.3 million m^3 of tulipwood accumulate in U.S. forests every year. It takes less than four seconds for new growth in the U.S. forest to replace the hardwood required to manufacture the table.

CARBON FOOTPRINT

Cradle to grave, the carbon footprint of the table is 135 kilograms of CO2 equivalent. That's roughly equivalent to the carbon footprint of driving 600 miles (970 km) in the average UK car[2].

Carbon emissions during all stages of material extraction and processing, product manufacturing, and transport are 687 kilograms of CO_2 equivalent. Two thirds of carbon emissions - 423 kilograms of CO_2 equivalent – are associated with processing and supply of tulipwood to the UK. However these emissions are offset by 552 kilograms of avoided emissions resulting from substitution of fossil fuels through reuse of wood waste.

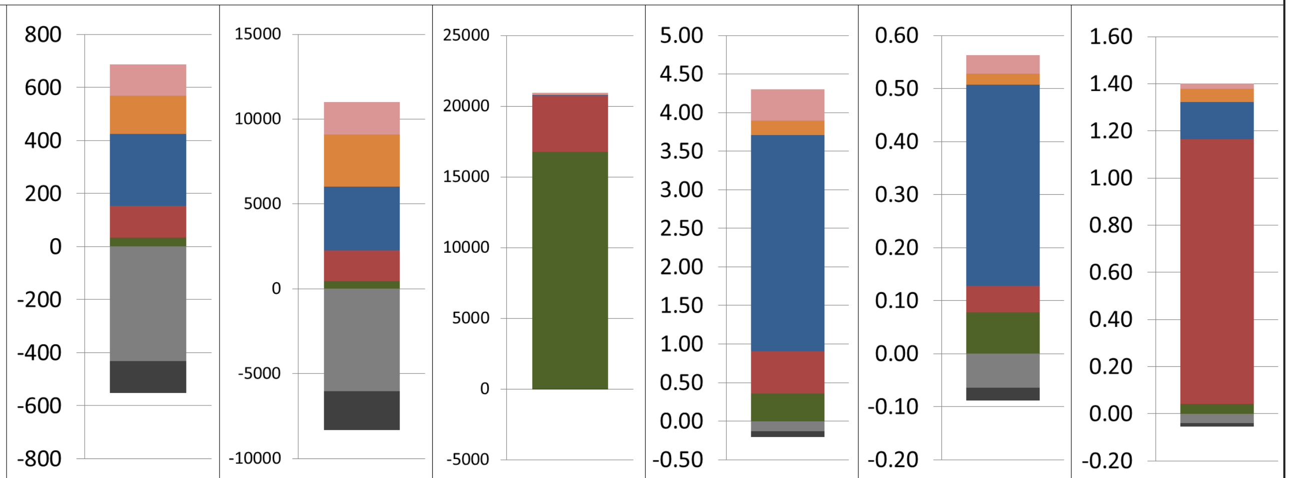
A large proportion of the wood required to manufacture the table did not end up in the finished product. This reduces the long-term carbon storage potential but it also means that there is a significant volume of waste wood diverted to energy production. The overall mass of wood waste arising during manufacture is much more than the final mass of the product, so the carbon credits from processing waste are greater than those at the End of Life.

119 kilograms of CO_2 equivalent is due to the use of grid electricity to power the moulder, sanders and lathe for creating the table at Benchmark. However, the glues were more significant, contributing 144 kilograms of CO_2 equivalent.

CRADLE TO GRAVE ENVIRONMENTAL IMPACT OF THE TABLE

Impact category	Global Warming Potential	Primary energy demand (resources)	Primary energy demand (renewable)	Acidification Potential	Eutrophication Potential	Photochemical Ozone Creation Potential
Unit	kg CO2-Equiv.	MJ	MJ	kg SO2-Equiv.	kg Phosphate-Equiv.	kg Ethene-Equiv.
Total	135	2676	20923	4.10	0.47	1.35

Data by process steps



Key ■ Forestry ■ US processing ■ Transport ■ Other wood ■ Other Materials ■ Glues & Coatings ■ UK processing ■ Process waste ■ End of Life

OTHER IMPACTS

The total eutrophication potential of the table is 0.47 kg of phosphate equivalent, about the same as caused each year by conventional farming of 214 square meters of land for wheat in the UK[3].

Nearly all eutrophication potential of the table is due to nitrate emissions during burning of fuels for transport and processing of materials. Hardly any eutrophication potential is linked to growth of U.S. hardwoods which thrive under natural conditions and very rarely require fertilisers.

The table's acidification potential is 4.1 kg of SO_2 equivalent, mainly due to emissions during shipping of hardwoods from the U.S to the UK and resulting from the relatively high sulphur content of marine fuels. The other significant contributor to acidification potential is the use of grid electricity at Benchmark and during processing of hardwood in the United States, mainly to power the fans in the kilns.

The table's POCP of 1.35 kg of Ethene equivalent is very large for a manufactured product this size and is primarily due to kiln drying of U.S. hardwood. It results from the presence of terpenes, naturally occurring VOCs, in wood resin. Although terpenes are released naturally as trees grow, processes in which wood is heated lead to more significant emissions.

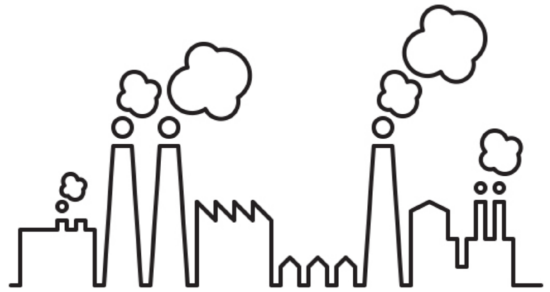
The large input of renewable energy – 20923 megajoules – is due partly to the high proportion of thermal energy derived from burning of wood waste during the hardwood kiln drying process. At least 90% of all thermal energy used for kiln drying in the U.S. hardwood sector is derived from biomass.

The high proportion of renewable energy at the forestry stage is a peculiarity of LCA rules for wood products and has nothing to do with the energy used during forestry operations. It is the solar energy that is absorbed by the tree during growth and converted into chemical energy within the wood itself. In other words it is the energy that would have been released if the wood were burnt immediately after harvest.

MATERIALS USED FOR THE TABLE

Wood materials	Use	Volume (m^3)
American tulipwood sawn 2.5"	Main structure	1.671
Other materials	**Use**	**Weight (g)**
Titebond glue	Bonding the tulipwood	2661g
Osmo oil white	Finishing	700g
Clear coat Osmo oil	Finishing	50ml

ENVIRONMENTAL IMPACT CATEGORIES

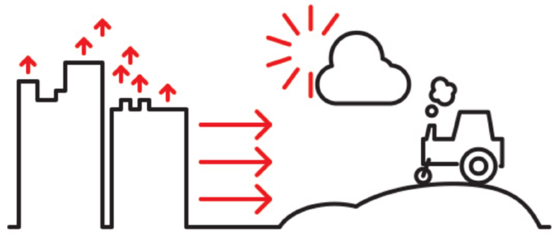


1 PRIMARY ENERGY DEMAND (NON-RENEWABLE RESOURCES)

This is a measure of the total demand of primary energy that comes from non-renewable resources, such as oil and natural gas. Measured in gigajoules (GJ), the primary energy demand takes into account the conversion efficiencies from the primary energy to, for example, electricity. The generation of carbon dioxide from the production of energy is one of the major causes of global warming.

2 PRIMARY ENERGY DEMAND (RENEWABLE RESOURCES)

Like the primary energy demand from non-renewable resources, this is a measure of the total amount of primary energy, but in this case, derived from renewable sources such as hydropower and wind energy. Again, it takes conversion efficiencies into account where appropriate. Total primary energy demand can be measured by adding the figures for energy from non-renewable and renewable resources

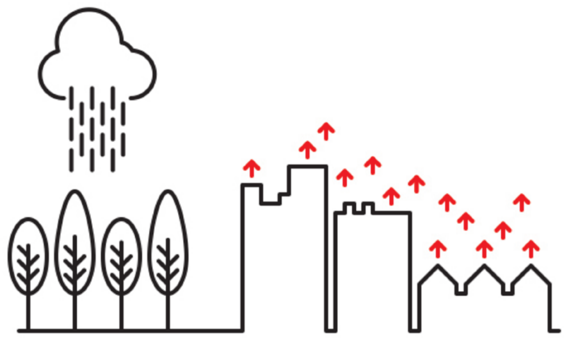


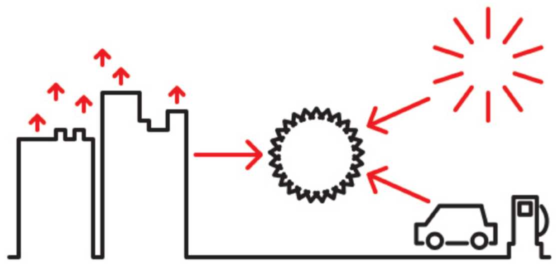
3 GLOBAL WARMING POTENTIAL (GWP)

Global warming is usually regarded as one of the most significant environmental issues. Global Warming Potential, measured in kg CO2 equivalent, is also a good marker for other environmental impacts. It is calculated from the volumes of greenhouse gases, such as carbon dioxide and methane, emitted during a process.

4 ACIDIFICATION POTENTIAL (AP)

This is a measure of the emissions that cause acidifying effects to the environment, which can cause imbalances and the death of species. Emissions of sulphur dioxide and nitrous oxide result in acid rain which can fall some way from the place where the emissions occur. Acidification potential is measured in kg of sulphur dioxide equivalent.





5 EUTROPHICATION POTENTIAL (EP)

Eutrophication is the process by which water receives an excessive amount of nutrients, particularly phosphates and nitrates. These nutrients, which typically come from run-off from fertilisers, lead to algal blooms which, in turn, deprive the water of oxygen and lead to imbalances and deaths in the aquatic populations. Eutrophication is measured in terms of kg of phosphate equivalent, and kg of nitrogen equivalent.

6 PHOTOCHEMICAL OZONE CREATION POTENTIAL (POCP)

This is a measure of emissions or precursors that contribute to low-level smog. It is measured in kg of ethene equivalent. Ozone layer depletion potential (ODP) is also part of the i-report but is not included in the charts because the effect is negligible. There may seem to be a contradiction between these two impacts but, put simply, high-level ozone is good and should be protected, whereas ozone at ground level is a pollutant.

NOTES

1. Figures based on 2011/2012 data from the U.S. Forest Service Forest Inventory and Analysis (FIA) program at http://www.fia.fs.fed.us/
2. Assumes average CO_2 emissions of 139g/km for all the UK's major new cars calculated by Carpages at http://www.carpages.co.uk/co2/
3. Based on Williams *et al* 2010 at Cranfield Natural Resources Management Institute who for 1 tonne of bread wheat from conventional farming in the UK assessed Eutrophication Potential of 3.1 kg of phosphate equivalent and average occupation of 0.14 hectares of Grade 3a agricultural land.

ENVIRONMENTAL LIFE-CYCLE ASSESSMENT

Environmental life-cycle assessment (LCA) involves the collection and evaluation of quantitative data on all the inputs and outputs of material, energy and waste flows associated with a product over its entire life cycle so that the environmental impacts can be determined. LCA quantifies environmental effects against a range of impact categories (see page 3). LCA may also provide qualitative assessment of other environmental impacts such as on biodiversity and land-use that are less easy to quantify.

The LCA of The Wish List builds on a two-year study, commissioned by AHEC and undertaken by PE International, to assess environmental impacts associated with delivery of US hardwood material into world markets[a]. This involved a wide-ranging independent assessment of hardwood forestry practices and a survey of the hundreds of US companies engaged in the processing and export of hardwood products.

Life cycle inventory data from the LCA of US hardwoods was combined with data gathered during product manufacture at Benchmark in the UK. It was also combined with PE's existing life-cycle inventory database which covers an expanding range of non-wood materials and product groups. Using PE's Gabi software for LCA, the data was analysed to quantify environmental impacts.

To model the cradle-to-grave impact of the table, the following assumptions are made about waste disposal during manufacture at Benchmark and at the end of the product's life.

- 80% of hardwood waste is used as a fuel for biomass boilers, substituting for light fuel oil.
- The remaining 20% of hardwood waste is reused for other products (no benefits have been modelled for this option).
- Other parts (including glues, coatings, fittings, etc.) are incinerated with electricity and thermal energy recovery using appropriate datasets.

These assumptions are based on information gathered from Benchmark about its standard procedures for use of waste and from secondary sources about waste-disposal practices in the UK.

a. The PE LCA study of US sawn hardwood is available at http://www.americanhardwood.org/fileadmin/docs/sustainability/Final_LCA_Lumber_report.pdf