ENVIRONMENTAL LIFE - CYCLE ASSESSMENT

VES-EL

TABLEWARE BY GARETH NEAL WITH ZAHA HADID

MADE IN AMERICAN WHITE OAK

SUMMARY

A large proportion of the wood required to manufacture the tableware 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 greater than the final mass of the product. As a result the credits from processing are greater than those from end of life.

A significant proportion of the tableware's carbon footprint is due to use of grid energy to power the CNC machine at Benchmark. This exceeds the carbon emissions resulting from all stages to extract process and transport the US hardwood to the UK.

WOOD RESOURCE

The tableware is composed of American white oak, one of the most abundant hardwoods in the U.S. forest accounting for 15% of wood volume. U.S. government forest inventory data[1] shows that U.S. white oak is growing 36 million m^3 per year while the harvest is 19.3 million m^3 per year. After harvesting, an additional 16.7 million m^3 of white oak accumulates in U.S. forests every year. It takes less than a quarter of a second for the U.S. hardwood logs harvested to manufacture the tableware to be replaced by new growth in the U.S. forest.

CARBON FOOTPRINT

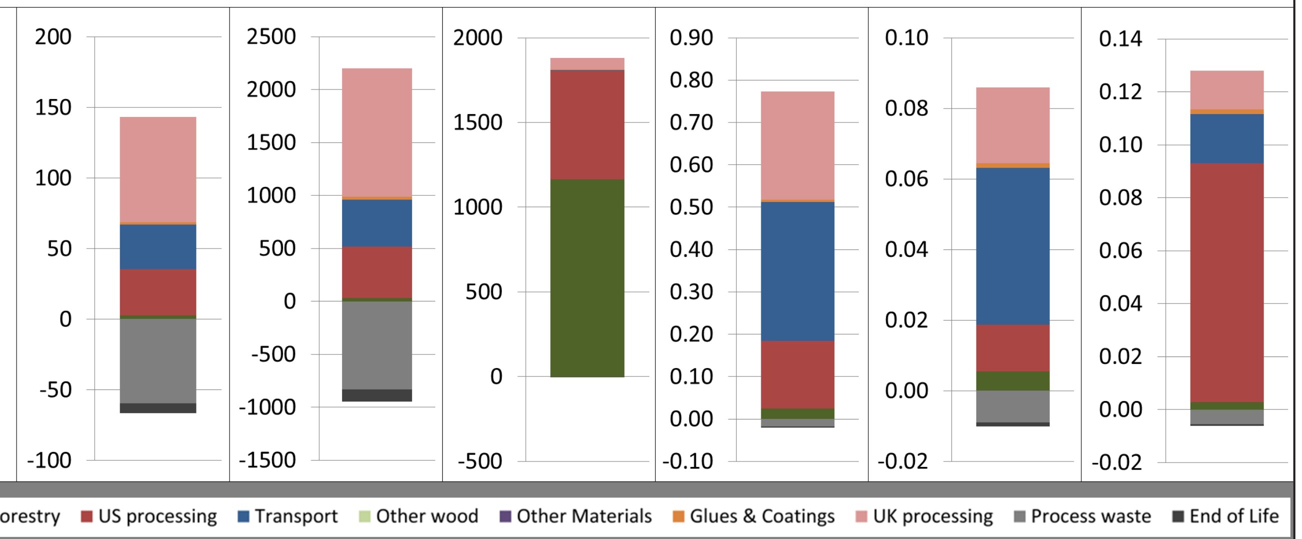
On a cradle to grave basis, the carbon footprint of the tableware is 76 kilograms of CO_2 equivalent. That's roughly equivalent to the carbon emissions of driving 340 miles (550 km) in the average UK car[2].

Carbon emissions during all stages of material extraction and processing, product manufacturing, and transport are 143 kilograms of CO_2 equivalent. These emissions are offset by 67 kilograms of CO_2 equivalent resulting from substitution of fossil fuels through use of wood waste generated both during manufacturing and at end of life for energy production.

CRADLE TO GRAVE ENVIRONMENTAL IMPACT OF VES-EL

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	76	1253	1878	0.75	0.08	0.12

Data by process steps



OTHER IMPACTS

The total eutrophication potential of the tableware is 0.08 kg of phosphate equivalent, about the same as caused each year by conventional farming of 34 square meters of land for wheat in the UK[3]. Nearly all eutrophication potential of the tableware 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.

Given the low impact across other categories, the tableware's acidification potential of 0.75 kg of SO_2 equivalent is relatively more significant. Much of the acidification potential is due to emissions during shipping of hardwoods from the U.S. to the UK due to the relatively high sulphur content of marine fuels.

The other major contributor to acidification potential is use of grid electricity during processing of hardwood in the United States – mainly to power the fans in the kilns – and at Benchmark to power the CNC machine.

The tableware's POCP of 0.12 kg of Ethene equivalent is also significant. The processing of U.S. hardwood is the major contributor to POCP due to the presence of terpenes, naturally occurring VOCs, in wood resin. Although terpenes are released naturally as trees grow, processes in which wood is heated (such as kiln drying) lead to more significant emissions.

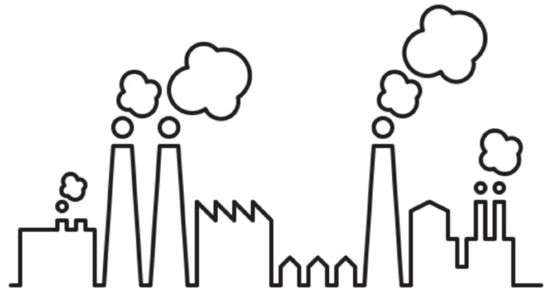
The large input of renewable energy – 1878 mega-joules – is due partly to the high proportion of thermal energy derived from burning of wood waste during the hardwood kiln drying process. At least 90% of all thermal energy used for kiln drying in the U.S. hardwood sector is derived from biomass.

The high proportion of renewable energy attributed to the forestry stage is a peculiarity of life cycle rules for wood products and has nothing to do with the energy used during forestry operations. It is the solar energy 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 VES-EL

Materials	Materials	Quantity
American white oak sawn 54mm	Structure	0.095634 m3
Cascamite glue	Bonding	500 ml

ENVIRONMENTAL IMPACT CATEGORIES

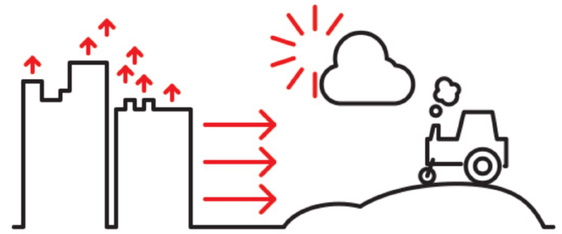


❶ PRIMARY ENERGY DEMAND (NON-RENEWABLE RESOURCES)

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.

❷ 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

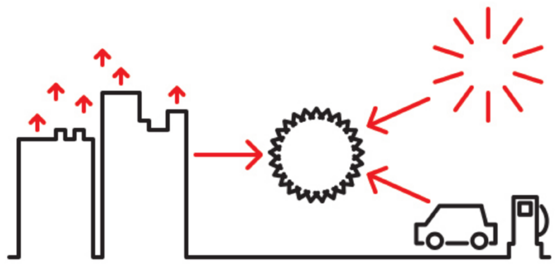


❸ GLOBAL WARMING POTENTIAL (GWP)

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.

❹ 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.



❺ 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.

❻ 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 tableware, 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