ENVIRONMENTAL LIFE - CYCLE ASSESSMENT

# THE HOLE CHAIR

CHAISE LONGUE BY LOLA LELY WITH ALLEN JONES

MADE IN AMERICAN MAPLE AND BLACK WALNUT

## SUMMARY

The large mass of MDF required for the mould makes a significant contribution across all environmental impact categories. As this is a one-off, the full impact of the MDF mould is allocated to the chaise longue. However, if the chaise longue were produced commercially, the MDF moulds would be reused and this impact would be allocated among multiple products.

There is very little manufacturing waste associated with this product. The credits received from disposal at end of life are therefore greater than those received from disposal of manufacturing waste.

While it's reassuring that the environmental burden can be offset by burning the product at end of life, as a durable and timeless piece of furniture, the chaise longue should last a life time. This minimises the impacts of replacement and means that the carbon stored in the product supplements the accumulating carbon store in the U.S. forest.

## WOOD RESOURCE

The chaise longue is composed primarily of American hard maple with a smaller volume of American walnut. Hard maple is one of the most abundant hardwoods in the U.S. forest accounting for over 7% of wood volume. Walnut accounts for 0.8% of total U.S. hardwood growing stock.

U.S. government forest inventory data[1] shows that U.S. hard maple is growing 17.6 million $m^3$ per year while the harvest is 8.3 million $m^3$ per year. U.S. walnut is growing 3.5 million $m^3$ per year while the harvest is 1.1 million $m^3$ per year. After harvesting, an additional 9.3 million $m^3$ of hard maple and 2.4 million $m^3$ of walnut accumulate in U.S. forests every year.

It takes less than a quarter of a second for new growth in the U.S. forest to replace the U.S. hardwood required to manufacture the chaise longue.

## CARBON FOOTPRINT

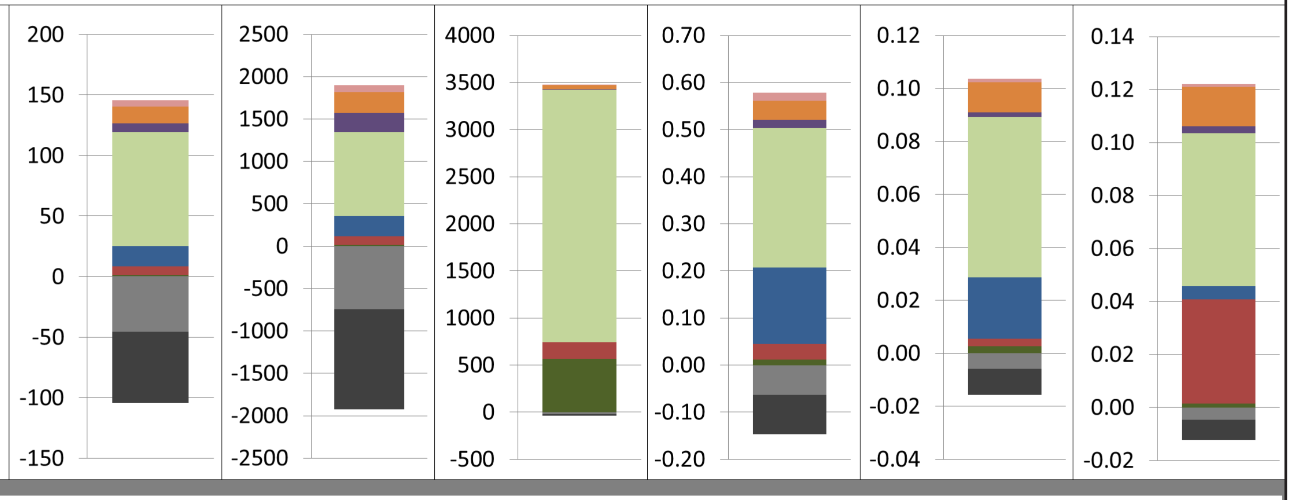
On a cradle to grave basis, the carbon footprint of the chaise longue is 41 kilograms of $CO_2$ equivalent. That's roughly the same as the carbon emissions of driving 183 miles (295 km) by car in the UK[2].

Carbon emissions during all stages of material extraction and processing, product manufacturing, and transport are 145 kilograms of $CO_2$ equivalent. These are offset by 104 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 THE HOLE CHAIR

| 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 | 41 | -26 | 3436 | 0.43 | 0.09 | 0.11 |

**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 chaise longue is 0.09 kg of phosphate equivalent, about the same as caused each year by conventional farming of 40 square meters of land for wheat in the UK[3].

Nearly all eutrophication potential of the chaise longue 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 chaise longue's acidification potential of 0.43 kg of $SO_2$ equivalent is relatively more significant. Much of the acidification potential is due to the energy required to produce the MDF mould. Also significant are the emissions during shipping of hardwoods from the U.S. to the UK due to the relatively high sulphur content of marine fuels. These emissions are partly offset by use of wood waste to substitute for fossil fuels in energy production.

The chaise longue has a POCP of 0.11 kg of Ethene equivalent. The processing of MDF and U.S. hardwood make a significant contribution to the POCP of the chaise longue. This is 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 lead to more significant emissions.

Coatings make only a minor contribution to POCP for this product due to reliance on a vegetable oil based product which has relatively low VOC emissions.

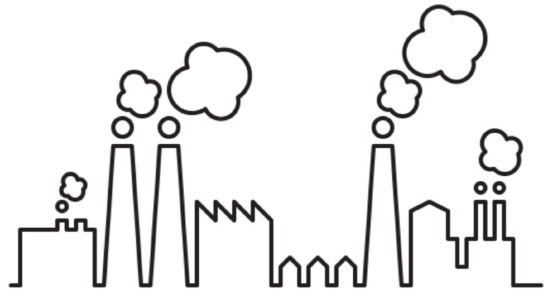
The large input of renewable energy – 3436 megajoules – during the life cycle of the chaise longue is due to a peculiarity of LCA rules for wood products. Although largely attributed to the forestry phase of the life cycle, it has nothing to do with the energy used during forestry operations. It is the 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 HOLE CHAIR

| Wood materials | Use | Volume ($m^3$) |
|---|---|---|
| Hard maple sawn (35mm-40mm) | Dowel and pocket for shaft | 0.002615 |
| Hard maple veneer | Main structure | 0.025363 |
| Walnut sawn (40mm) | Pocket of the shaft | 0.0009 |
| Walnut veneer | Main structure | 0.005 |
| MDF | Mould | 0.178608 |
| **Other materials** | **Use** | **Weight (g)** |
| Polystyrene | Mould for Chair | 2800 |
| Glues | Mainly for binding veneers | 4087 |
| Osmo oil | Finish | 560 |



# ENVIRONMENTAL IMPACT CATEGORIES

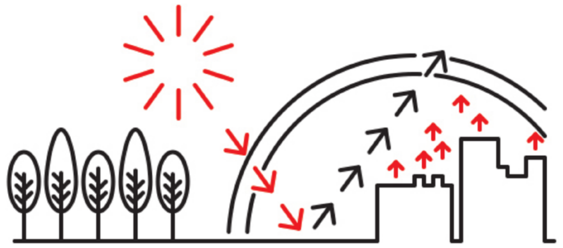


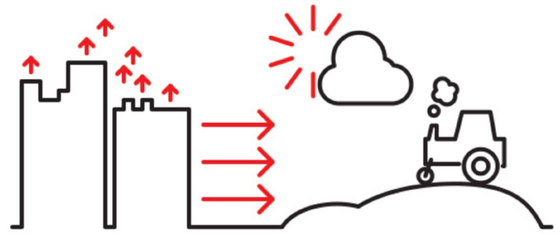
## 1 PRIMARY ENERGY DEMAND (NON-RENEWABLE RESOURCES)

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



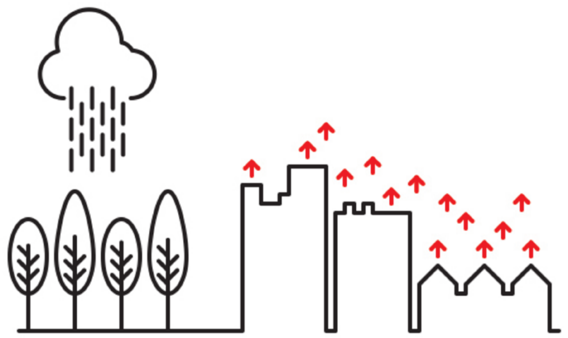


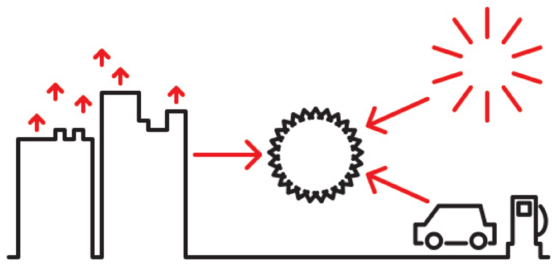
## 3 GLOBAL WARMING POTENTIAL (GWP)

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 CO2 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 chaise longue, 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 on other products (no benefits have been modelled for this option).
- 50% of the MDF for the moulds is discarded and sent for waste incineration with electricity and thermal energy recovery. This is reported at the 'process waste' stage.
- The final disposal of the MDF mould (the remaining 50%) occurs in the same way but is reported in the 'End of Life' stage
- 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*