Energy savings of reuse design furniture: Upstyle Kistkruk case study

Life cycle energy assessment of furniture made of second hand particleboard and alternatives made of new materials.

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Upstyle Industries

Background

Products designed to be made with pre-used materials are becoming more and more common in our lives. This form of material reuse by design, reuse design, can be seen as addressing at the same time waste problems (less waste to get rid of) and resource problems (less virgin resources required).

This study quantifies some of the actual benefits from an environmental perspective by looking at the energy needs (and gains) along the life cycle of a reuse-design product in comparison with equivalent products made with first-hand materials.

Goal and scope of the analysis

This study focuses on the life cycle energy of an Upstyle Kistkruk, a small piece of furniture that is used as seat and storage, which is made out of particle board that is recovered from old furniture that would normally be incinerated. Old "waste" particle board furniture is widely available in every city.

The comparison is made between the Upstyle Kistkruk and two comparable products: a wooden one, mass-produced in Europe with European wood and a particle board stool, mass produced in China with the use of Chinese wood. Both type of products are regularly sold in the Netherlands.

The analysis is limited to energy use, i.e. Cumulative Energy Demand. We chose energy as the main indicator because it can be seen as a proxy of use of all resources, since all human processes require energy. Energy use is also almost directly proportional to CO2 emissions, but more tangible.

Functional unit and considered alternatives

The aim of the research was to compare the Upstyle Kistkruk with similar products made of first-hand materials. The functional unit is therefore one stool for everyday use with the lifetime of 10 years.

The three products chosen for this comparison are the following.

Upstyle Kistkruk –Reclaimed particle board stool

Materials:

8,5 kg	Second hand particle board
0,005 kg	Second hand wooden pins (dowels)
0,02 kg	Clay paint

Produced in Rotterdam, bought in Amsterdam

European wood

Materials:

8,4 kg Birch wood
0,02 kg Acryl varnish
0,02 kg Wood stain
0,02 kg Stainless steel screws
0,05 kg Wood glue
0,005 kg Wooden pins (dowels)

Produced in Sweden, bought in Amsterdam

Chinese new particle board

Materials:

7,6 kg Particle Board
0,02 kg Acryl varnish
0,02 kg Wood stain
0,02 kg Stainless steel screws
0,05 kg Wood glue
0,005 kg Wooden pins (dowels)

Produced in China, bought in Amsterdam

Life cycle model

The life cycle of furniture can be seen as material production, manufacturing, retail, use and incineration, with transport between each stage.

Here retail and use are assumed to be the same for all products and therefore left out of scope.

Raw material production was not included in the LCA of the Upstyle Kistkruk, because Upstyle Industries makes use of second-hand wood that has already had a useful life and would be otherwise disposed of.

For the same reason incineration was also not included in this scenario, while it generates energy in the other two.

Upstyle Kistkruk
(blue=energy consuming process, gray = out of scope)

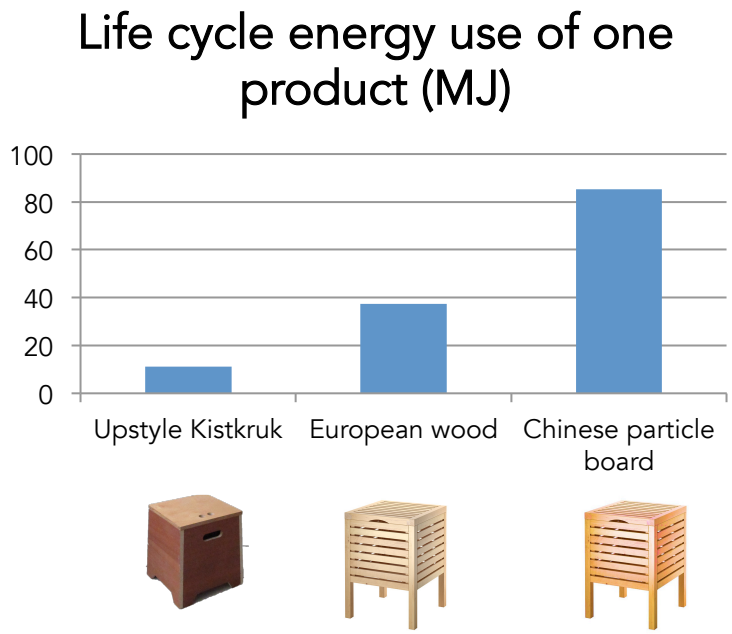
European wood
(blue=energy consuming process, green = energy generating process, gray = out of scope)

Chinese particle board
(blue=energy consuming process, green = energy generating process, gray = out of scope)

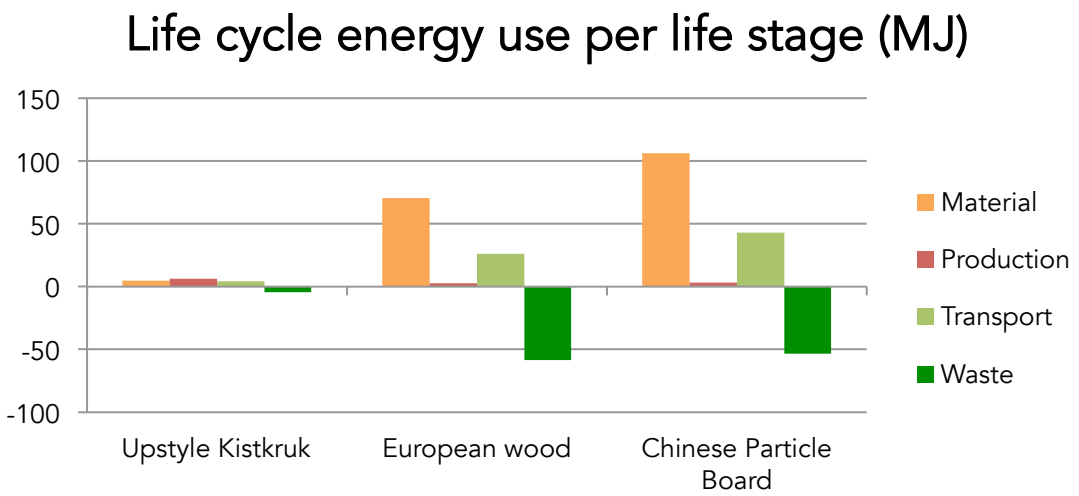
If furniture is transported to the final user by car, this trip constitutes often the biggest energy use in its life cycle. Here however we assumed the furniture to be delivered by a courier or a company van, for two reasons: to evaluate a scenario based on e-commerce and to give more space to the analysis of parts of the life cycle that are actually influenced by the choice of the material (raw materials, manufacturing and incineration). A study of how the results would change with transport by car is included in this document.

Results

- The Upstyle Kistkruk requires 70% less energy than the European wood alternative across the lifecycle and 87% less energy than the Chinese particle board alternative.

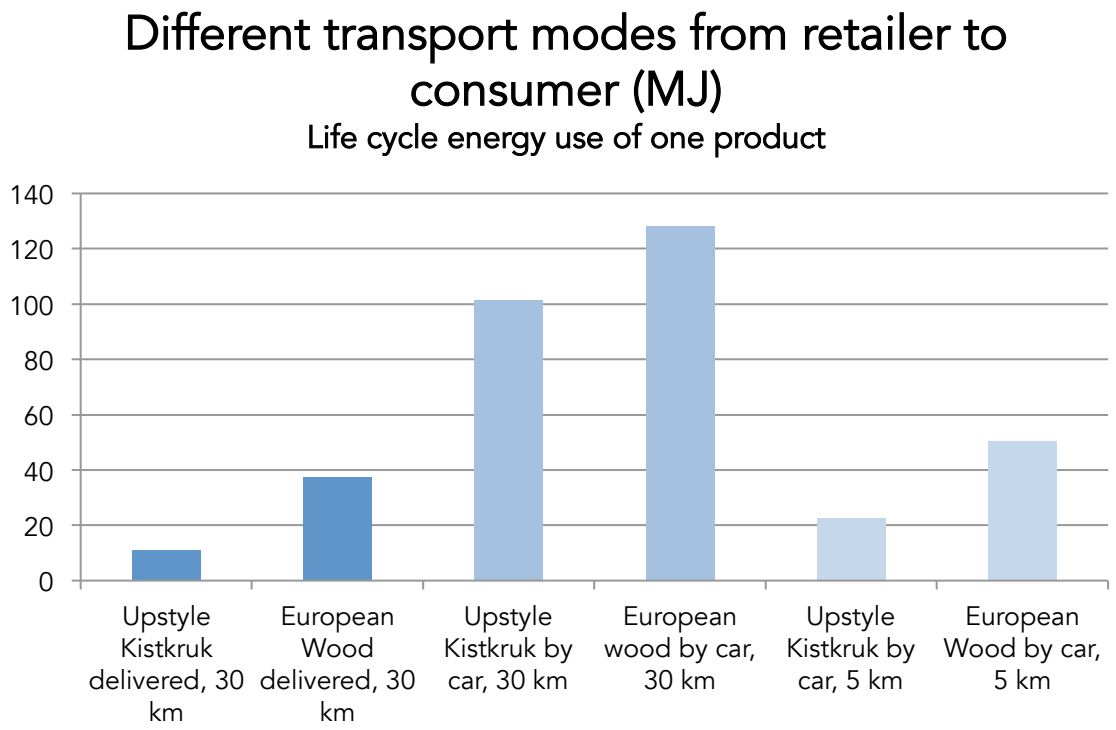


- Using second hand particle board leads to large energy savings. Materials contribute for the largest share of energy use in the lifecycle for the new particle board model (61%) and for the second largest share for new wood (33%, after transport), even taking into account energy recovery at the end of life.
- Transport is the other major impact in the lifecycle, and another important energy saving comes from local production in the Upstyle scenario.



Sensitivity of the results to assumptions about transport

- If the products are not delivered by courier but picked up by car by the consumer, this becomes by far the largest energy consumption in the lifecycle of these products. This is because manufacturing of
- It is thus recommended to promote a delivery service.



APPENDIX _ Data and assumptions

The calculations used Cumulative Energy Demand (CED) data from the open source Ecocost database (2012) from TU Delft[1].

While performing the Life Cycle Analysis, the following assumptions were made.

Models:

- Comparison between the Upstyle Kistkruk, a comparable mass-produced European model made out of wood and a comparable mass produced model made in China out of new particle board. For the latter two models the same design was assumed for simplicity.
- The latter model was made of new particle board in China, to assess the influence of inter-continental transport on life cycle energy demand.
- It was assumed that the lifetime of all three products would be similar.

Material:

- The industrialized-model was modeled after the example of the IKEA Molger, made of Birch wood and finished with varnish and it represents a generic piece of furniture made in Europe. The Chinese model is assumed to be finished with varnish as well.
- Cradle to gate figures for energy demand were used for particle board and birch wood.
- Varnish is assumed to be one layer thickness of 20 micrometer.
- Clay paint for the Upstyle Kistkruk is assumed to contain approximately 50% clay, 20% quicklime and 20% limestone, 5% starch, 0.5% titanium dioxide. The other ingredients, carnauba wax, cellulose binder, preservative, anti-foaming agent and water softener, where not found in the Ecocost 2012 database and were assumed to be in too small quantities to have an influence on the outcome.
- We assumed the screws in the European and China model to be made of stainless steel.
- Cardboard packaging was assumed to be comparable for all three models.
- We assumed the wooden pins in the European and China model to be made of oak. Wooden pins in the Upstyle model were assumed to be recovered from old furniture and therefore not considered in the LCA.

Production:

- Energy use figures used for sawing, drilling and sanding the edges of the particle board and the birch wood, originate from the "processes + EoL (in CES)" page of the Ecocost2012 database. These numbers were derived from data from the CES (Cambridge Engineering Selector) database. They however only mention the eco-cost. The data for Carbon Footprint and CED were derived from the eco-cost data using the same ratio as the Idemat2014 Chain sawing ratio between eco-cost, Carbon Footprint and CED. This was considered the closest estimation, since it both considers wood processing data.
- The production of the Upstyle Kistkruk was assumed to be four times less efficient than for the other two products, because of the smaller scale of manufacturing.

[1] http://ecocostsvalue.com

Transport:

- Transport of wood and particleboard to the furniture manufacturing place is assumed to be road transport by truck. Transport between manufacturing and retail is assumed to be by truck for the two made in Europe models and by sea freight + truck for the made in China model. Transport between retail and use is assumed to be done with a post delivery van for the Upstyle Kistkruk and with a company delivery van for the other two cases.
- Energy consumption for transporting the Kistkruk by courier is expressed in km in the Ecocost2012 database. We divided it by 100 assuming that the van will be delivering other packages during the same drive. The estimation was based on the volume of a Kistkruk to the volume of a delivery van.
- The transport by delivery van for the European wood product from Haarlem to Den Helder was divided by 50, since it is assumed that this private delivery van also transports bigger products than the stool and therefore can take less products at once.
- It is assumed that the wood for the particle board for the China model originates from China. The amount of kilometers travelled within China (1000 km) is a rough estimation.
- It is assumed that the wood for the European wood model originates from Norway.

End of life:

- It is assumed that after disposal of the products 25% of the waste wood will go to waste incinerators and 75% to co-firing in biomass power plants, based on the paper: Nederlandse houtstromen in beeld by Probos[2].
- Energy recovery from incineration and co-firing is not included in the Upstyle Kistkruk scenario, since this scenario makes use of second-hand wood which would have been otherwise incinerated. Therefore the material (particle board) is not included in the life cycle, nor is the waste management of the material.
- The end of life from the waste wood of the factory was out of scope for this research.

[2] http://www.probos.net/rapporten-2012/37-nederlandse-houtstromen-in-beeld

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About Upstyle Industries
Upstyle Industries aims at reducing waste mountains and overconsumption of natural resources by product design. We scale up resource efficiency by collaborating with existing businesses to turn their waste into successful products, with a three-fold approach.

- *Connect*: We connect the waste of companies with the right designers, and we find where products can be produced on a larger scale.
- *Design*: We test what is possible to do with each waste flow and we develop the right solutions based on its characteristics and the market.
- *Research*: We research under which conditions reuse is better, the same or worse than other eco-design or waste management methods. We investigate what are the best business models to scale up good reuse.

www.upstyleindustries.nl