

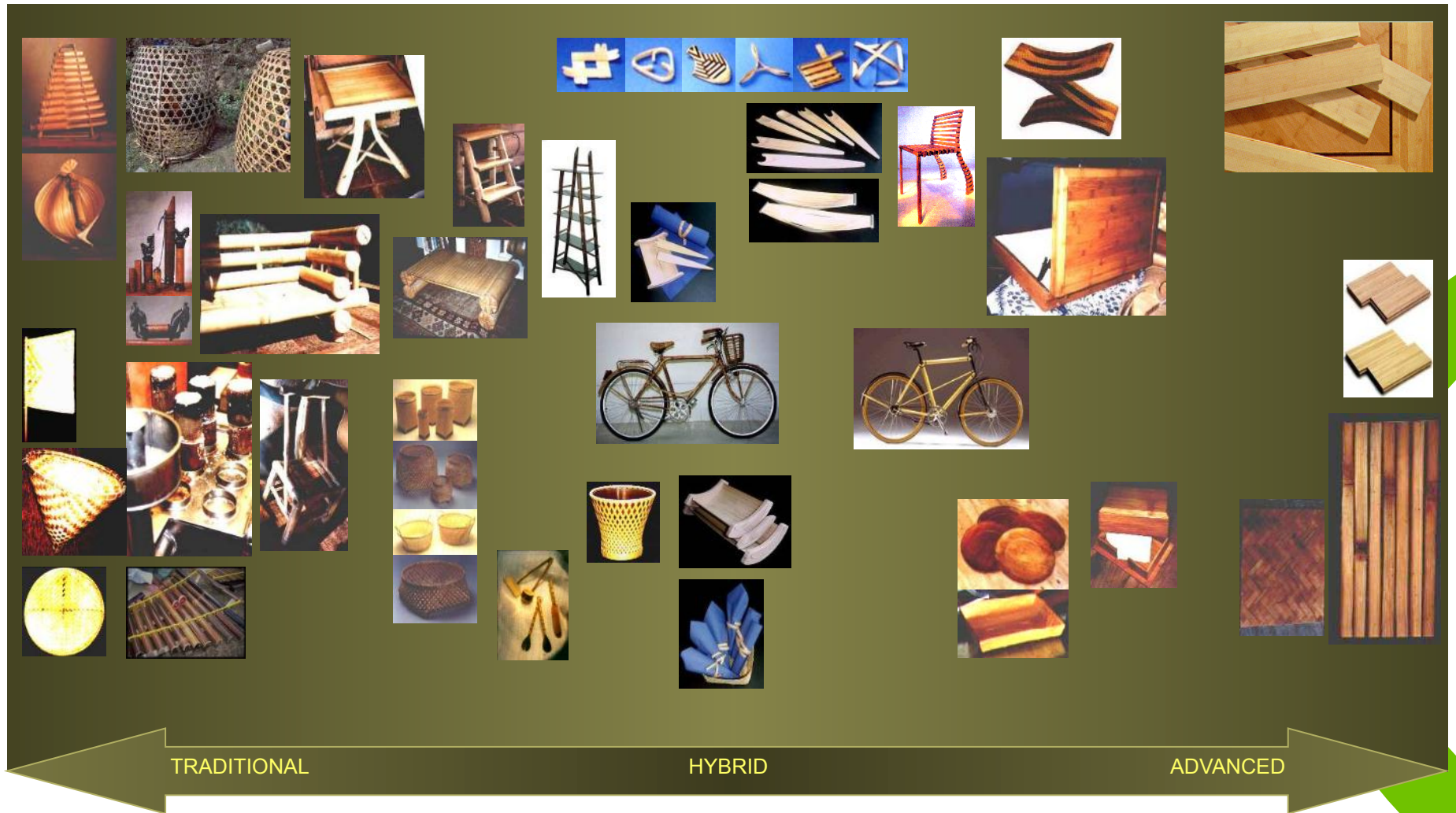


The Environmental Impact of Industrial Bamboo Products

Life-cycle Assessment and Carbon Sequestration

Pablo van der Lugt - MSc Eng PhD

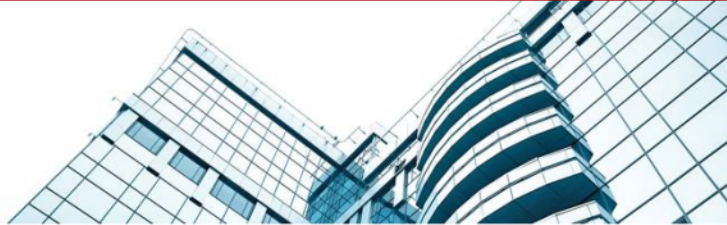
MOSO International / Delft University of Technology



Source: T. Larasati

11/12/15

Sustainability Trends



Investors will continue to divest from carbon intense assets, whatever the outcome of the UN Climate Summit >>

On the path to 2050? Real estate companies start publishing carbon reduction targets to get us there >>

The business benefits of tackling diversity trigger concerted action >>

Green = prime. Healthy becomes a differentiator >>

Income inequality and the skills crisis enter Boardroom discussions >>

The future is here. Leading real estate players look ahead to protect their business models >>


Collaboration by landlords and tenants to comply with the Energy Savings Opportunity Scheme >>

Energy compliance dominates the workload of real estate sustainability professionals >>

Scope 3 footprinting in real estate takes off >>

Sustainability training for whole workforces becomes the norm >>

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- Generates additional income
- Stand out from Crowd

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Park 20 20 – Hoofddorp, Netherlands



Park 20 20 – Hoofddorp, Netherlands



Results have been better than expected:

- Realized in the heart of the worst real estate crisis Holland has ever seen.
- No problem financing projects.
- Renting at a market premium of 37.5%
- Zero concessions required to obtain commitment.
- Exit yields = +/- 40 basis points better than the market average.
- Satisfied customers and a thriving community.



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BMW Dashboard



How green is bamboo? sceptics



BAMBOO PRODUCTS AND THEIR ENVIRONMENTAL IMPACTS: REVISITED

DR. JIM BOWYER

KATHRYN FERNHOLZ

MATT FRANK

DR. JEFF HOWE

DR. STEVE BRATKOVICH

DR. ED PEPKE

10 MARCH 2014

DOVETAIL PARTNERS INC.
A Trusted Source of Environmental Information



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In fact, the rise in bamboo production has come with environmental harm, the Dovetail study says, including:

- Over-harvesting and, because one species of bamboo in particular is favored, monoculture plantations, encouraged by the authorities and financial gain
- Other types of forests have been clear-cut to make way for bamboo plantations
- Because it grows fast, bamboo demands a lot of nutrients, and requires fertilizers, herbicides and pesticides whereas maple needs none

However, bamboo's social benefits are many, the study says. Increased production has reduced poverty and swelled household incomes. Planting bamboo on terraced slopes once used for agricultural production causes less runoff and erosion.

Bottom line, the study says, is that those benefits come at a cost when bamboo forests are not managed properly, and ultimately "should never be designated as environmentally preferable materials without at the very least carefully judging its environmental impact throughout the supply chain.



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COMMENTS 16

HIDE COMMENTS ▾

« 1 2 »

Rick Kellso Wednesday, 16 April 2014

Tree Hugger website has been publishing articles about bamboo not being green for many years. The arguments are very hard to ignore. Boo Bamboo!!!

QUOTE REPLY

Report Abuse

Aaron Roworth Wednesday, 16 April 2014

FINALLY! It is great to finally see an article on Bamboo and it's apparent green qualities. I have long been a skeptic of Bamboo and it's 'green' properties, however more due to the manufacturing aspects. Hard to believe that these chinese mills aren't soaking it in formaldehyde. Great article. I am sure they could have written a book on their study, not just a short article.

QUOTE REPLY

Report Abuse



MinervaMink33 Wednesday, 16 April 2014

It's about time someone looked into this! I am so sick of having to sound like 'Debbie downer' when people come into the showroom with green dreams about saving the planet by choosing bamboo. It comes from from the other side of the planet, it's not like they're rowing those boats over here. Also, we

How green is bamboo? believers

BAMBOO FACTS YOU DIDN'T KNOW

Antibacterial

Bamboo has the ability to withstand and kill bacteria like strep throat. Studies have shown that products made from bamboo retain those antimicrobial properties.

Antifungal & Pest Resistant

Bamboo can resist all kinds of fungus and pests.

Fastest Growing Woody Plant

Bamboo grows 1.6 Inch per hour. The Moso species can grow up to 39 inches in 24 hours = 1.6 feet in a day.

Oxygen Production

Bamboo produces 35% more oxygen than hardwood trees.

Tensile Strength

Bamboo's tensile strength is 28,000 psi versus steel 23,000 psi.

Hypoallergenic

Bamboo fibers are free of lanolin, making it a much more hypoallergenic choice than most animal-based fabrics.

Moisture Wicking & Breathable

Bamboo's natural ability to wick away moisture, allows you to wear tight clothes, without trapping bacteria or irritants to your skin.

Temperature Adaptability

Bamboo maintains its core temperature, which helps it grow in a diverse selection of climates.

Blocks Ultraviolet Rays

Bamboo naturally blocks harmful ultraviolet rays from the sun.



Sustainability as principle – the MOSO case

- Proof: Increasing importance of ecolabels & environmental assessments
 - FSC (forestry)
 - BREEAM & LEED (green building)
 - C2C, Svanen, Blaue Engel, etc (material health)
 - VOC and formaldehyde (indoor emissions)
 - LCA & carbon footprint



breeam



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breeam



LCA – carbon footprint



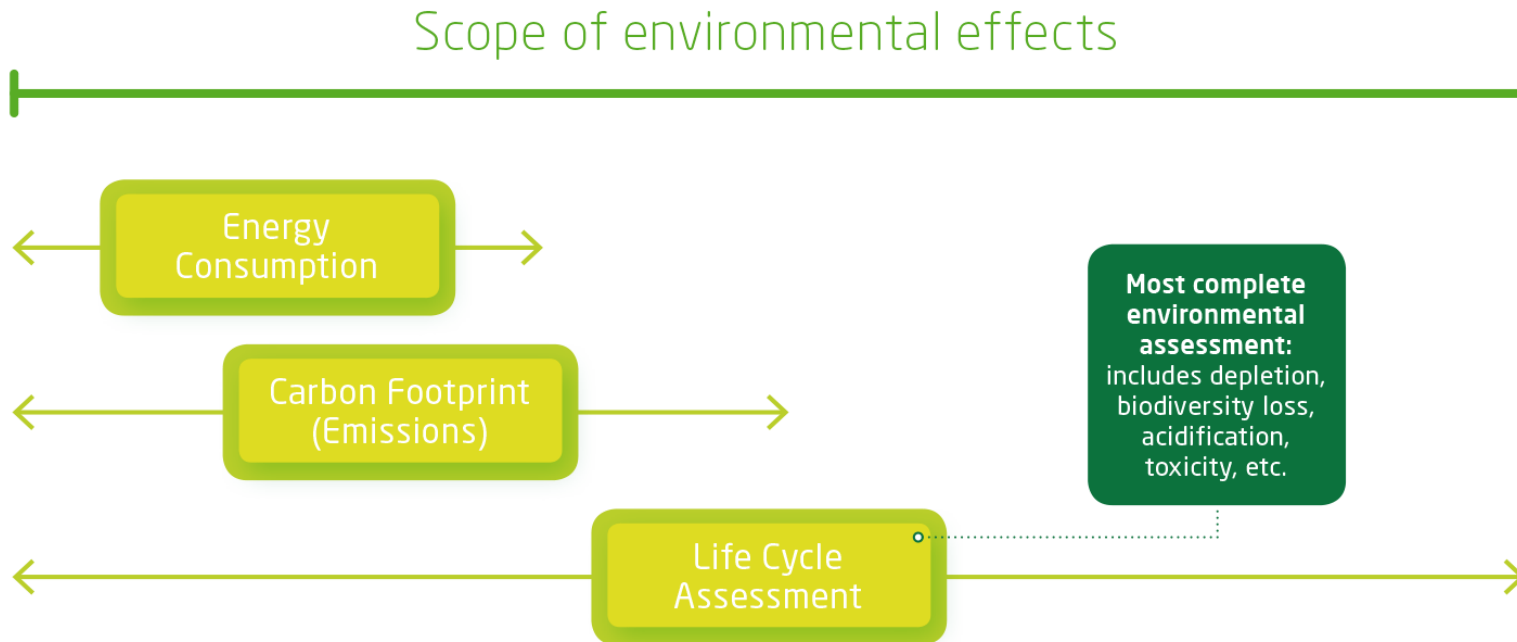
**bamboo
products**

Green Credentials over Life Cycle

- For full picture of environmental impact:
- Analyse complete life cycle from 'Cradle till Grave':

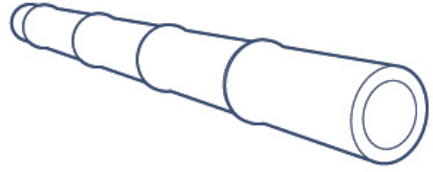


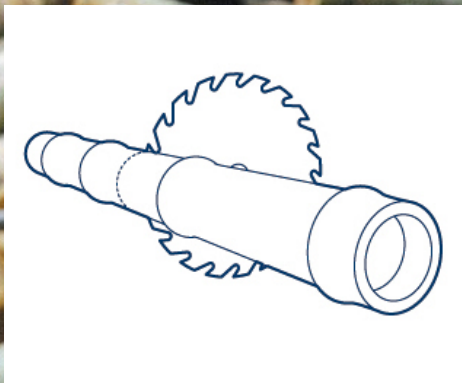
Measuring environmental impact

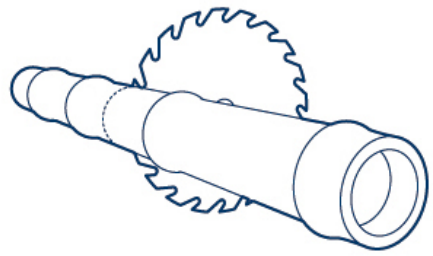


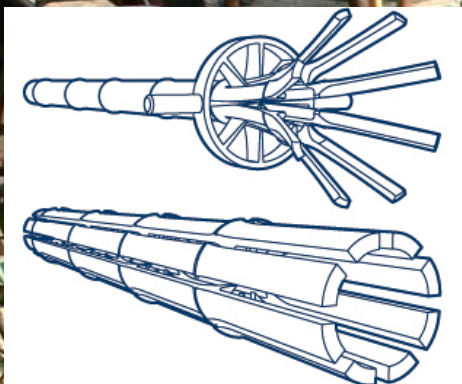
- Based on MOSO production chain – best practice
- 2010: LCA & carbon footprint executed by TU Delft
- 2014: Update (new products, latest production figures)
- ISO 14040 & 14044 compliant

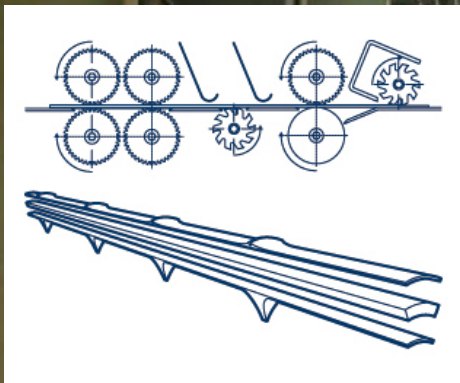




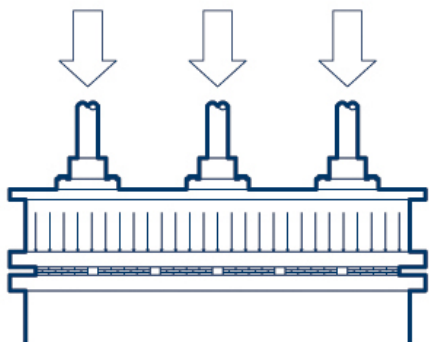
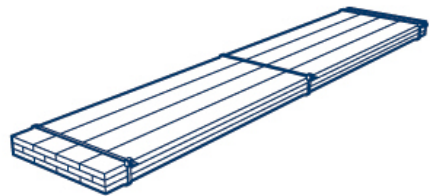












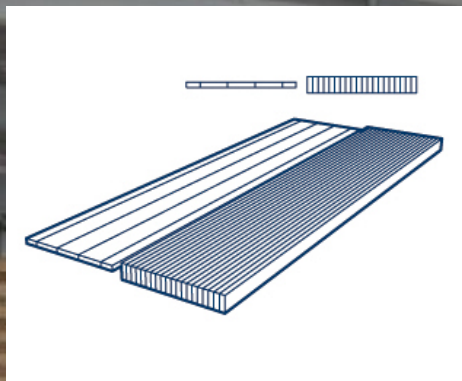
械有限公司

TEL: 0532-88313105

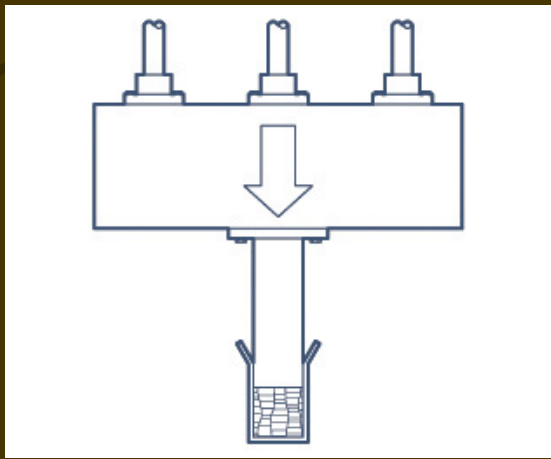
规范操作
小心压伤

4





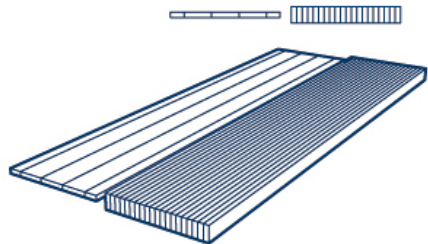








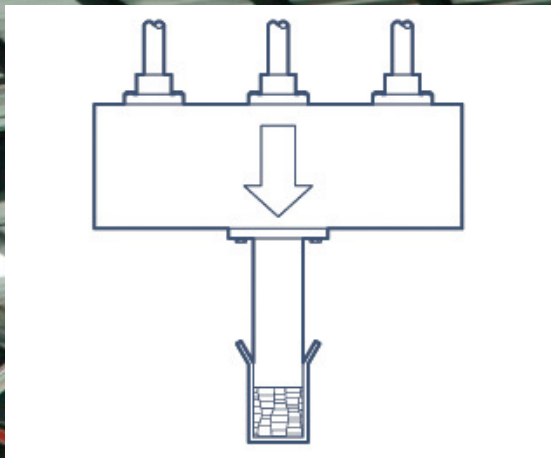
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Thermally modified bamboo strips





Pressing







Emissions per Process

- 3 main production technologies:
 - Laminated strips (sidepressed / plain pressed)
 - Compressed strips – Strand Woven Bamboo (high density)
 - Flattened bamboo (MOSO Bamboo Forest)



Description of process step	amount	unit	CO2equ/FU	CO2equ/kg	percentage
1. Cultivation and harvesting from plantation					
Gasoline consumption	0,224	liter / FU	0,651	0,0156	1,5%
2. Transport from plantation to strip manufacturing facility					
Eco-costs of a 5 tons truck (EURO 3, transport of 23.1 FUs)	30	km / truck	0,699	0,0168	1,6%
3. Strip making	1,38	kWh/ FU	0,797	0,0191	1,9%
4. Transport from strip manufacturing facility to factory					
Eco-costs (28 tons truck EURO3, 300km)	12,51	ton.km / FU	2,314	0,0555	5,5%
5. Rough planing	8,62	kWh/ FU	4,977	0,1193	11,7%
6. Strip selection					
7. Carbonization	4,73	kWh/FU	2,731	0,0655	6,4%
8. Drying carbonized strips	9,66	kWh/FU	5,577	0,1337	13,1%
9. Fine planing	5,8	kWh/FU	3,349	0,0803	7,9%
10. Glue application (1-layer boards)					
Added amount of Melamine formaldehyde (dry condition)	0,483	kg / FU	1,657	0,0397	3,9%
11. Pressing strips to 1- layer board	1,89	kWh/FU	1,091	0,0262	2,6%
12. Sanding 1- layer board	1,62	kWh/FU	0,935	0,0224	2,2%
13. Glue application (3-layer board)					
Added amount Emulsion Poly Isocyanate (dry condition)	0,908	kg / FU	1,476	0,0354	3,5%
14. Pressing three layers to one board	1,65	kWh/FU	0,953	0,0228	2,2%
15. Sawing	0,29	kWh/FU	0,167	0,0040	0,4%
16. Sanding 3-layer board	0,86	kWh/FU	0,497	0,0119	1,2%
17. Dust absorption (during all steps)	8,67	kWh/FU	5,005	0,1200	11,8%
18. Transport from factory to harbour					
Eco-costs (28 tons truck EURO3, 300km)	12,51	ton.km / FU	2,314	0,0555	5,5%
19. Transport from harbour to harbour					
Eco-costs (20ft container in a transoceanic freight ship, 19208 km)	801	ton.km / FU	6,456	0,1548	15,2%
20. Transport from harbour to warehouse					
Eco-costs (28 tons truck EURO5, 115km)	4,80	ton.km / FU	0,806	0,0193	1,9%
TOTAL carbonized			42,45	1,018	100,0%

Emissions per Process

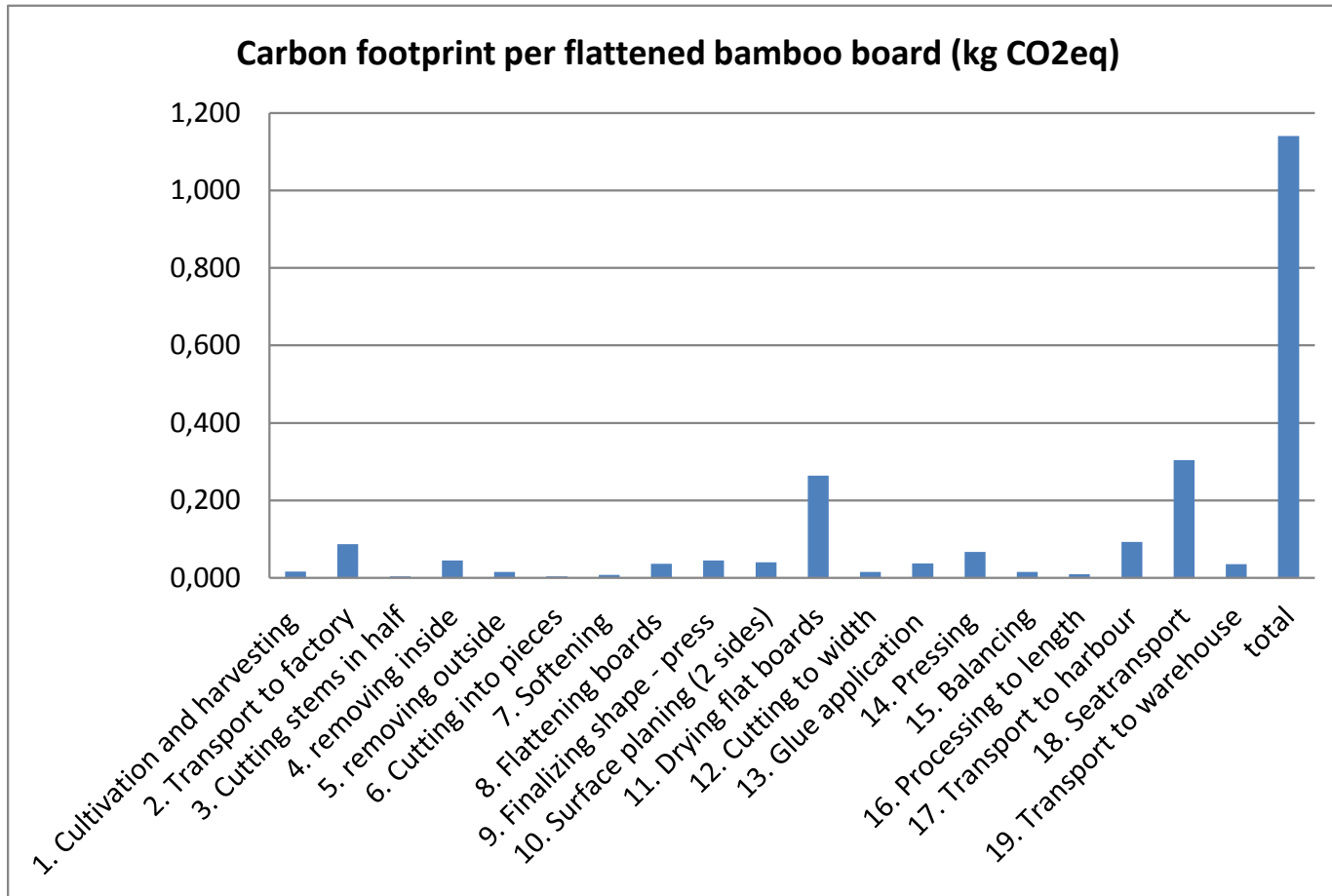
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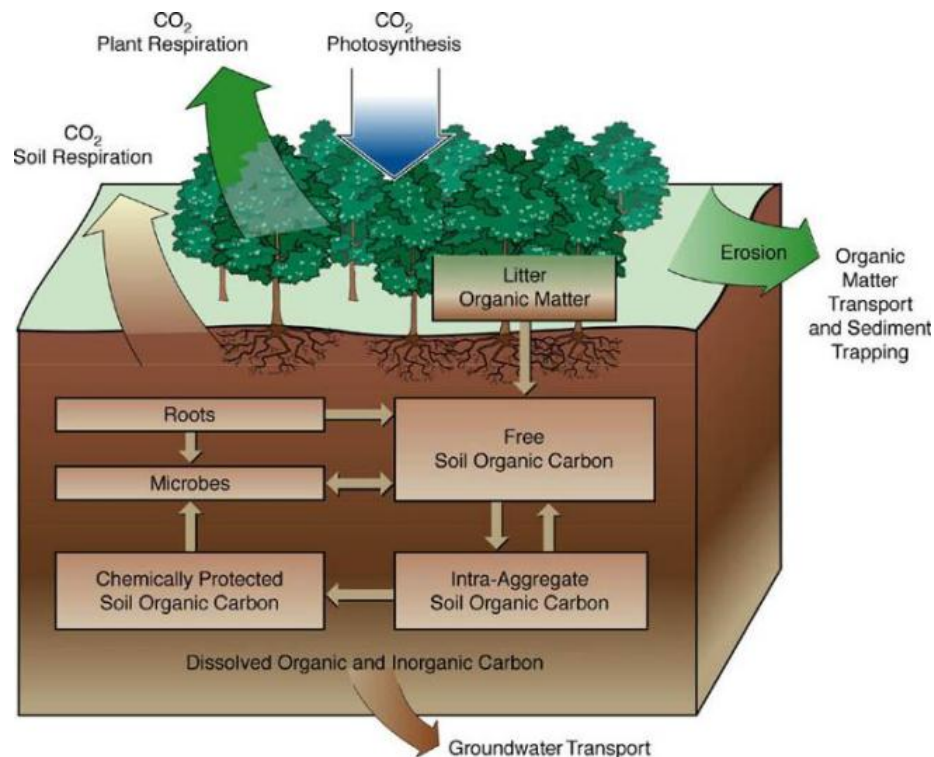
Emissions per Process

- Example: Flattened bamboo (MOSO Bamboo Forest)

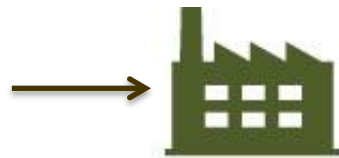
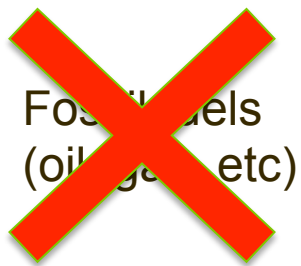
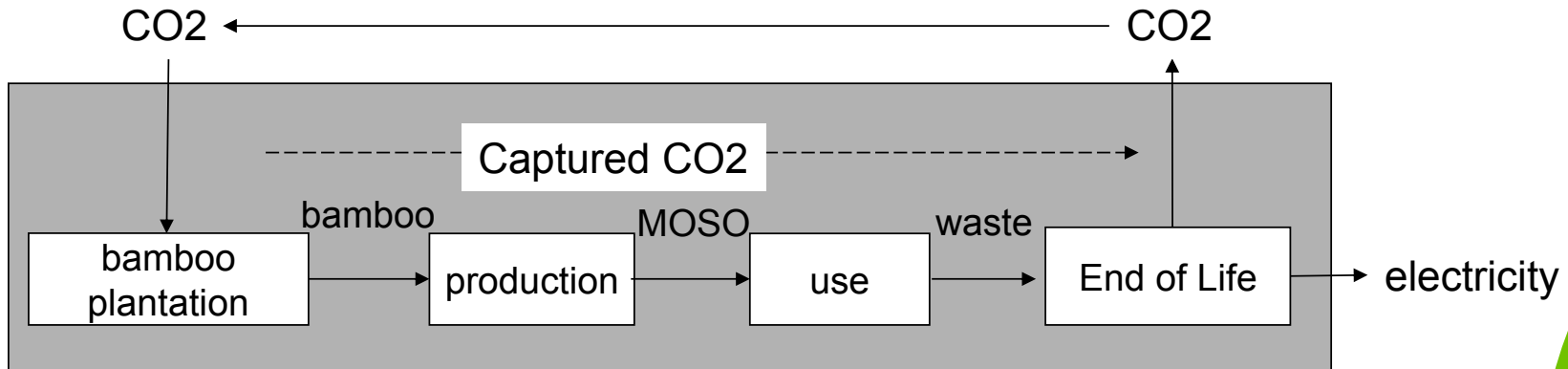


Carbon Sequestration – Product level

- Bamboo absorbs CO₂ during growth – locked in plantation / forest
- CO₂ locked in the material during Use phase



Carbon Sequestration – Product level



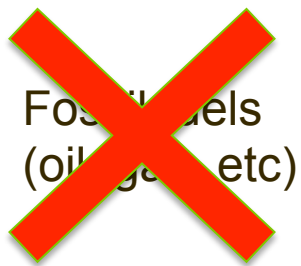
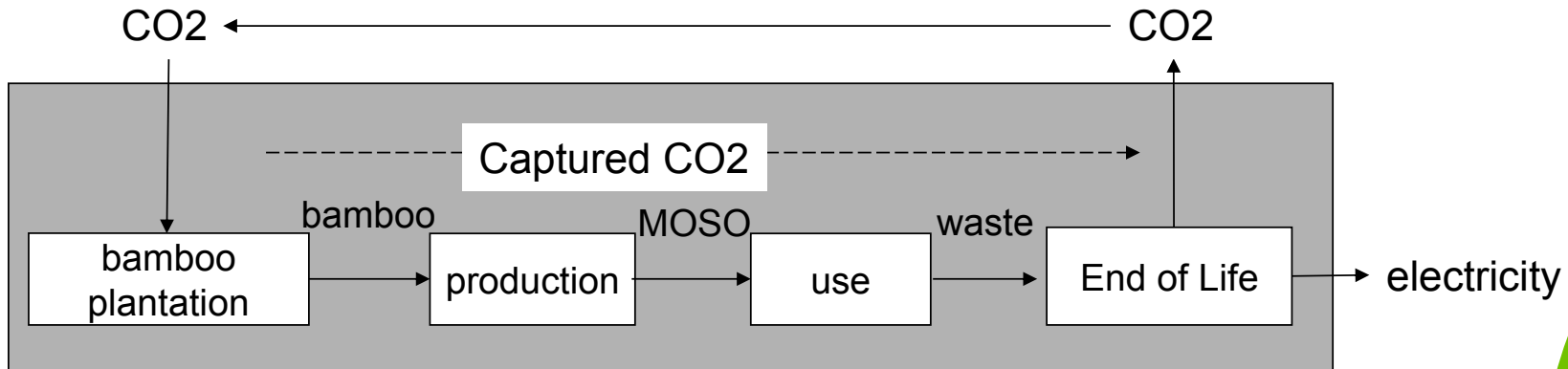
electricity

Carbon footprint Bamboo - Assumptions

- At end of life:
 - Dump: 10%
 - Incineration for bioenergy: 90%
 - For Netherlands credible assumption
 - Based on Eco-invent v3.1 & Idemat 2015
 - **Result: credit 0,704 kg CO₂ / kg**



Carbon Sequestration – Product level

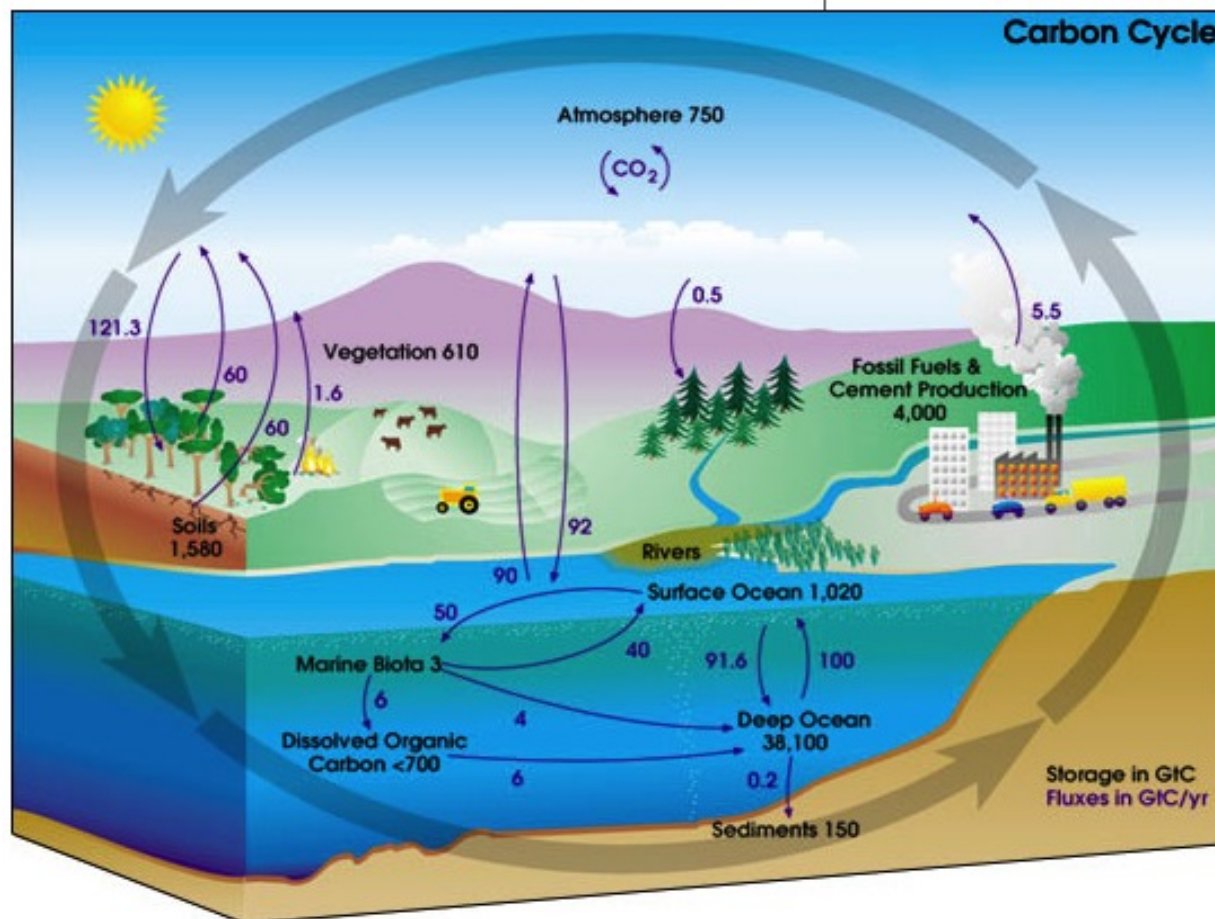


- Optional credit for temporary storage in some LCA systems (ILCD, PAS 2050: 2011) > not very realistic

Carbon Sequestration – Global level

The human role of the CO₂ emissions is three-fold (period 2000-2010):

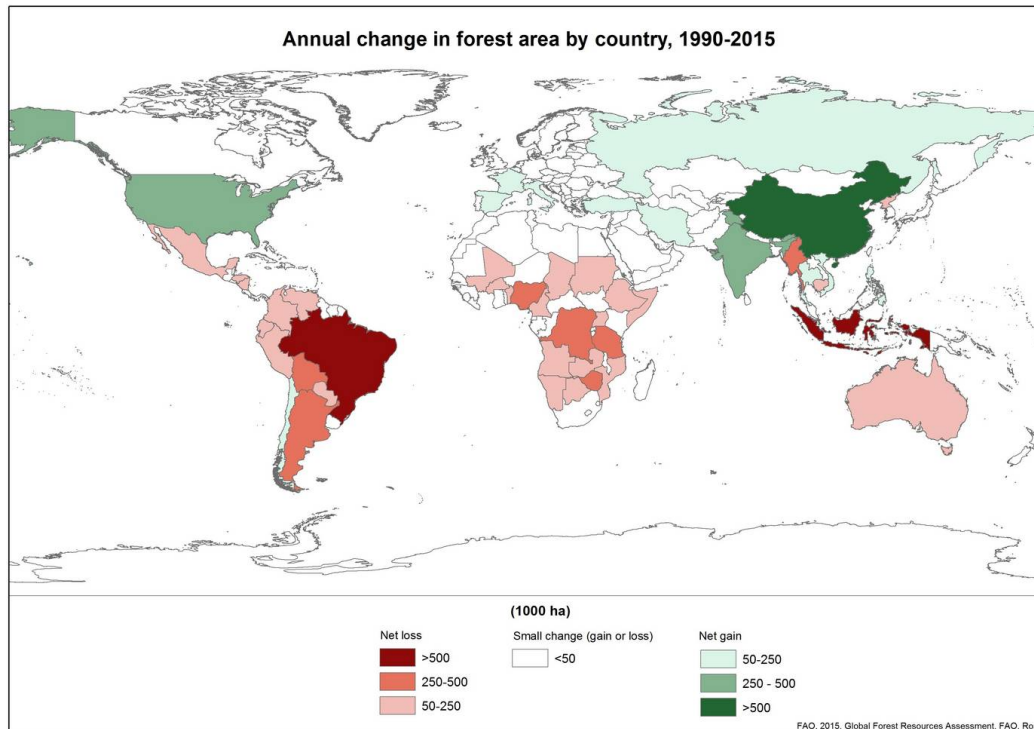
- **6.4 Gt carbon** emissions per year caused by burning of fossil fuels
- **1.93 Gt carbon** emissions per year caused by deforestation
- **0.85 Gt carbon** sequestration per year by re-growth of forests



Carbon Sequestration – Global level

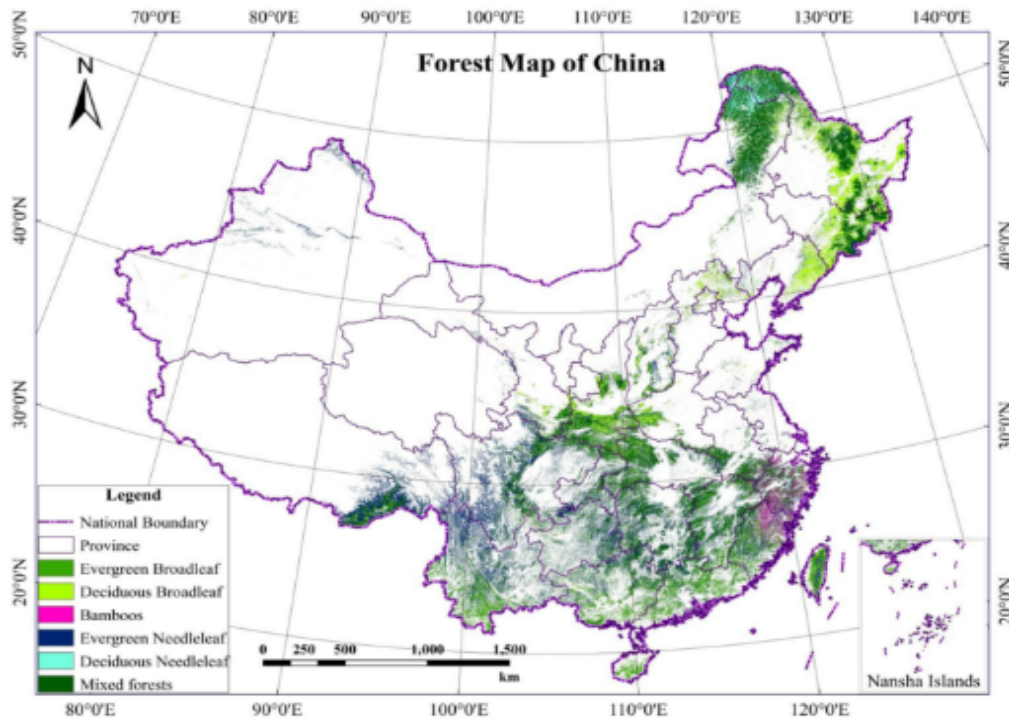
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Carbon footprint Bamboo - Assumptions

- Global carbon sequestration driven by increasing demand
- Market growth: 20-25%
- Actual Moso resource surface growth 2004-2011: **5,5%** annual growth
- Carbon store Moso plantation 55 tC/ha (Zhou and Jiang 2004); conservative assumption



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- Land conversion following IPCC guidelines:
 1. New plantations on (barren) grassland or poor farming ground > 30%
 2. Natural expansion on grassland > 35%
 3. Natural expansion in secondary / wild forests > 35%
- **Result: credit 0,51 – 0,54 kg CO₂ / kg**



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- **Result: credit 0,51 – 0,54 kg CO₂ / kg**
- **Excludes** potential carbon sequestration gain through better management

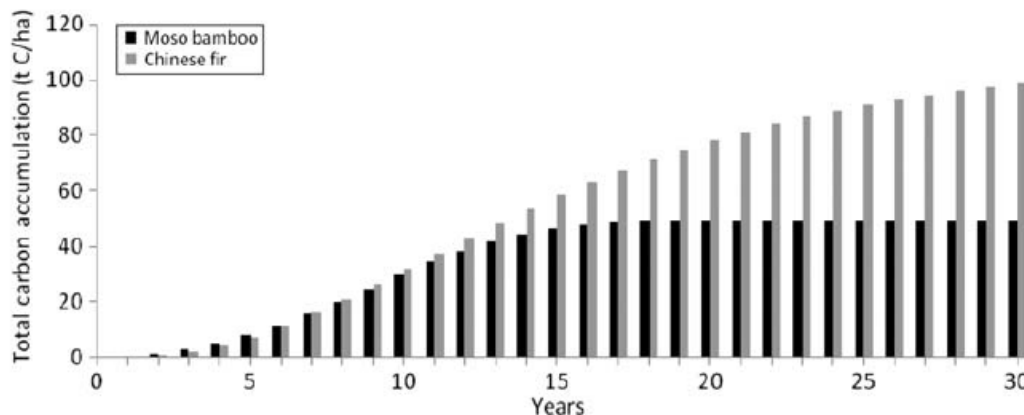


Figure 5. Patterns of modelled aggregated carbon accumulation of newly established Moso bamboo – **no-harvest scenario** – and Chinese fir plantations.

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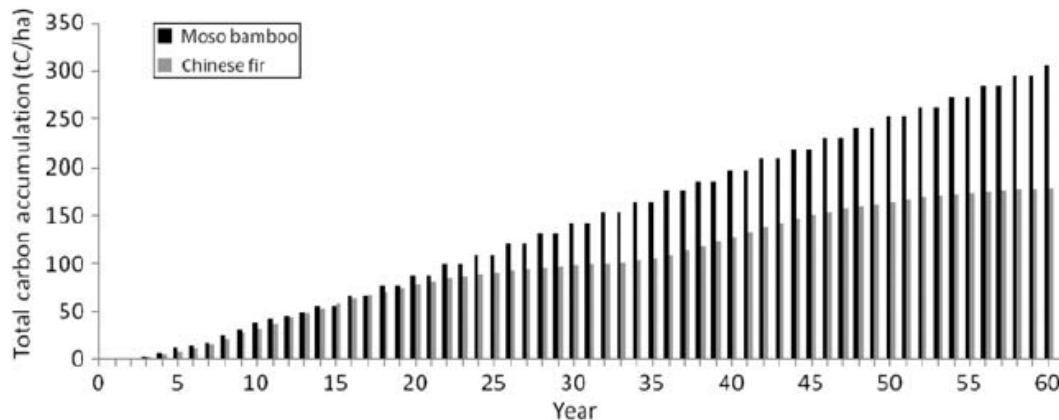


Figure 3. Patterns of modelled aggregated carbon accumulation of newly established Moso bamboo – **regular-harvest scenario** – and Chinese fir plantations within 60 years.

Carbon footprint Bamboo - Results

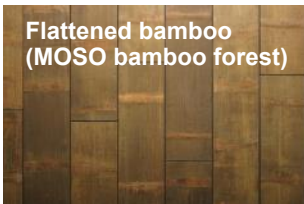
Note: SP = Side Pressed, PP = Plain Pressed, D = Density / Compressed, N = Natural (bleached), C = Caramel (Carbonized), E0 = produced with glues with No Added Formaldehyde (Formaldehyde emission: Class E0, < 0,025 mg/m3).

Outdoor				Carbon Footprint (CO2eq) per kg final product					Eco-costs (€) per kg final product				
				PRODUCTION cradle to gate CO2equ/kg	EOL CO2 cradle CO2equ/kg	CO2 storage CO2equ/kg	CO2 total CO2equ/kg	CO2 Neutral CO2equ/kg	PRODUCTION cradle to gate Euro/kg	EOL Eco-costs Euro/kg	eco-costs CO2 Euro/kg	eco-costs Total Euro/kg	
Thickness(mm)	type	style	Color										
Decking & cladding (MOSO Bamboo X-treme)	20		DT	C	1.193	-0.704	-0.607	-0.1176	Yes	0.356	-0,132	-0.082	0.142

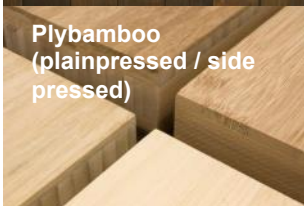
Flooring				Carbon Footprint (CO2eq) per kg final product					Eco-costs (€) per kg final product				
				PRODUCTION cradle to gate CO2eq/kg	EOL CO2 cradle CO2eq/kg	CO2 storage CO2eq/kg	CO2 total CO2eq/kg	CO2 Neutral CO2eq/kg	PRODUCTION cradle to gate Euro/kg	EOL Eco-costs Euro/kg	eco-costs CO2 Euro/kg	eco-costs Total Euro/kg	
Thickness(mm)	type	style	Color										
Solid strip (MOSO Purebamboo)	15		SP	N	0.925	-0.704	-0.629	-0.4084	Yes	0.257	-0,132	-0.085	0.040
	15	E0	SP	N	0.911	-0.704	-0.629	-0.4217	Yes	0.253	-0,132	-0.085	0.036
	15		PP	N	0.951	-0.704	-0.629	-0.3822	Yes	0.268	-0,132	-0.085	0.051
	15	E0	PP	N	0.945	-0.704	-0.629	-0.3884	Yes	0.266	-0,132	-0.085	0.049
	15		SP	C	0.964	-0.704	-0.629	-0.3690	Yes	0.265	-0,132	-0.085	0.048
	15	E0	SP	C	0.951	-0.704	-0.629	-0.3824	Yes	0.262	-0,132	-0.085	0.045
	15		PP	C	0.990	-0.704	-0.629	-0.3429	Yes	0.276	-0,132	-0.085	0.059
	15	E0	PP	C	0.984	-0.704	-0.629	-0.3491	Yes	0.275	-0,132	-0.085	0.058
	15		DT	C	1.048	-0.704	-0.623	-0.2795	Yes	0.301	-0,132	-0.084	0.085
	15		DT	N	1.008	-0.704	-0.623	-0.3194	Yes	0.292	-0,132	-0.084	0.076
Solid wide board (3 ply) (MOSO Bamboo Elite)	15		SP	N	1.015	-0.704	-0.629	-0.3176	Yes	0.286	-0,132	-0.085	0.069
	15	E0	SP	N	0.957	-0.704	-0.629	-0.3764	Yes	0.271	-0,132	-0.085	0.054
	15		PP	N	1.006	-0.704	-0.629	-0.3266	Yes	0.283	-0,132	-0.085	0.066
	15	E0	PP	N	0.952	-0.704	-0.629	-0.3807	Yes	0.269	-0,132	-0.085	0.053
	15		SP	C	1.055	-0.704	-0.629	-0.2783	Yes	0.294	-0,132	-0.085	0.077
	15	E0	SP	C	0.996	-0.704	-0.629	-0.3371	Yes	0.280	-0,132	-0.085	0.063
	15		PP	C	1.046	-0.704	-0.629	-0.2873	Yes	0.291	-0,132	-0.085	0.074
	15	E0	PP	C	0.992	-0.704	-0.629	-0.3414	Yes	0.278	-0,132	-0.085	0.061
	13		DT	N	1.004	-0.704	-0.623	-0.3227	Yes	0.288	-0,132	-0.084	0.071
	13		DT	C	1.042	-0.704	-0.623	-0.2846	Yes	0.296	-0,132	-0.084	0.080

LCA & Carbon Footprint - Results

- CO2 neutral over full life cycle (all solid MOSO bamboo materials)
- Credits for carbon sequestration and green electricity production compensate emissions by transport, energy and glue



Flattened bamboo
(MOSO bamboo forest)



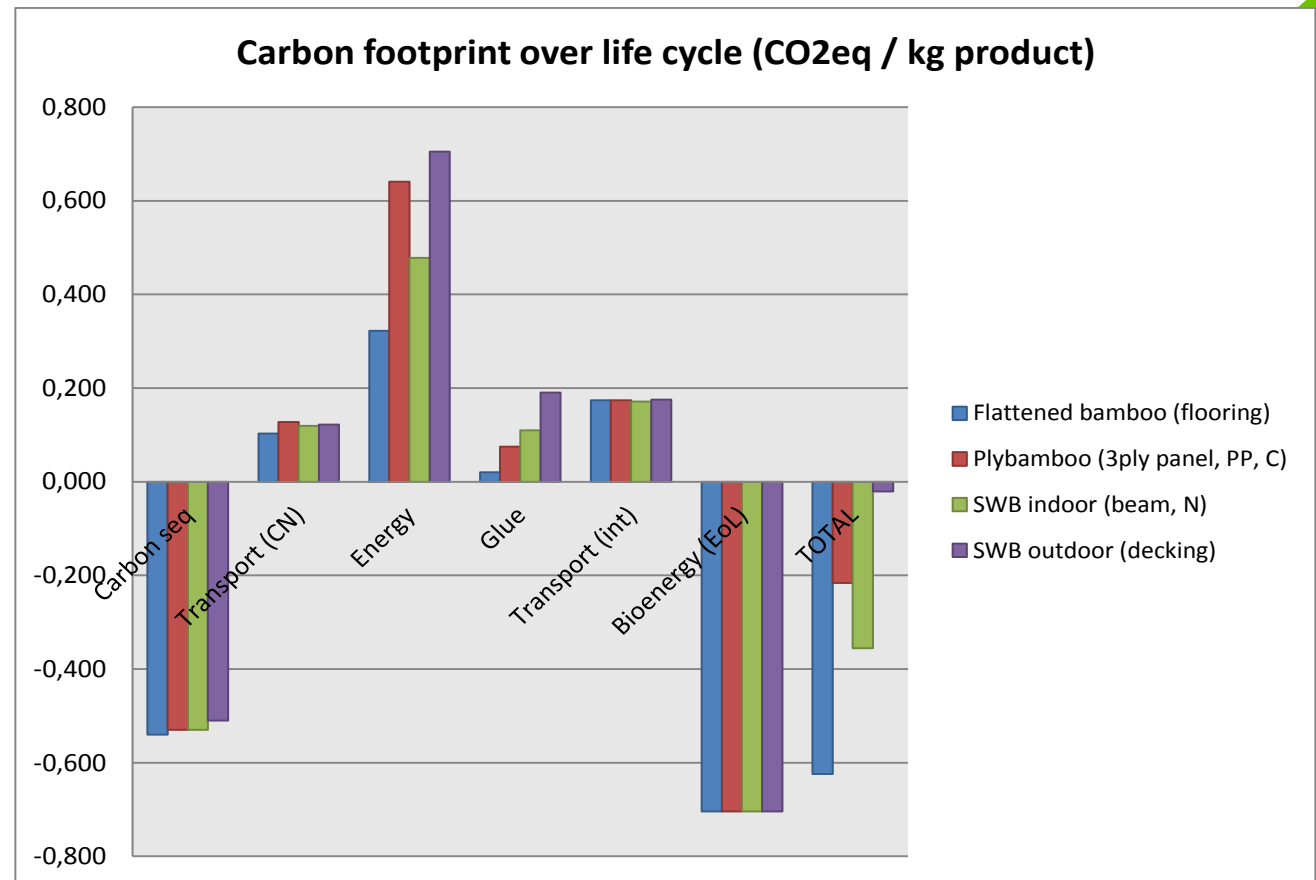
Plybamboo
(plainpressed / side pressed)



SWB indoor (High Density)

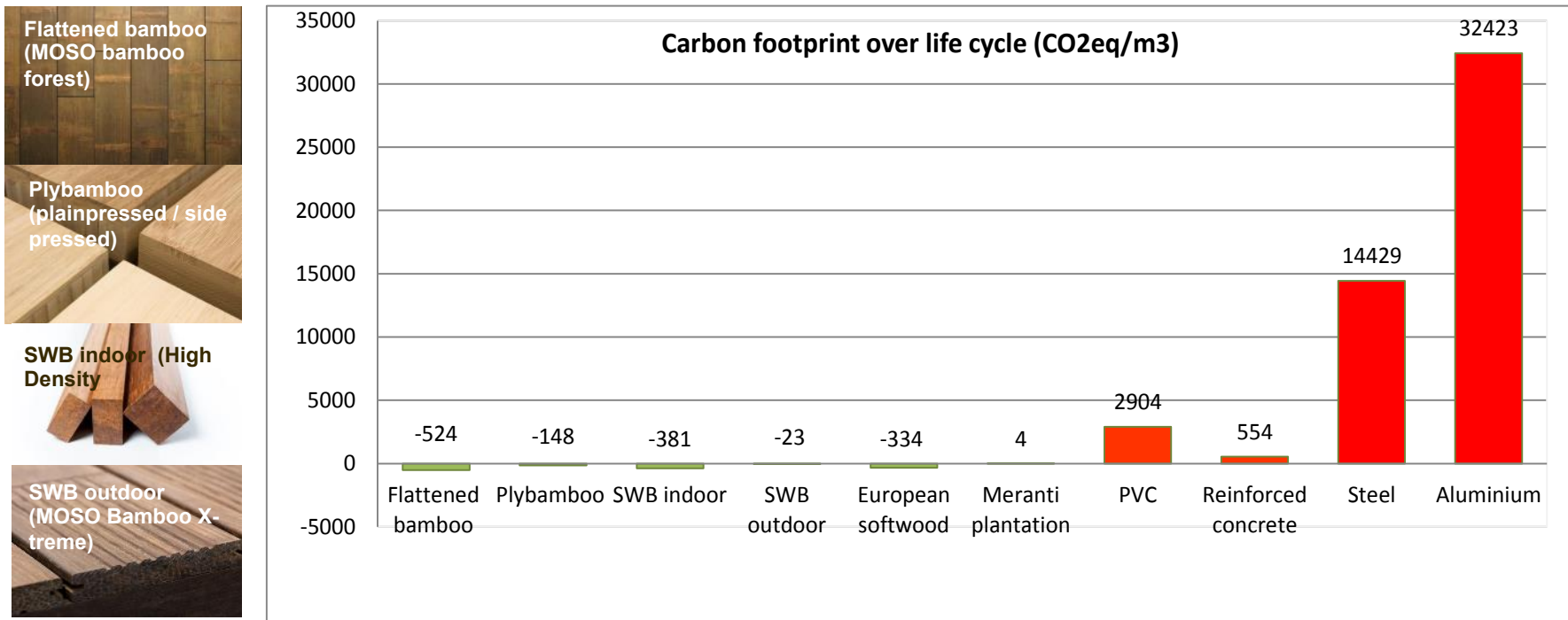


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LCA & Carbon Footprint - Results

- Compared to other commonly used building materials
- Carbon footprint per cubic meter material

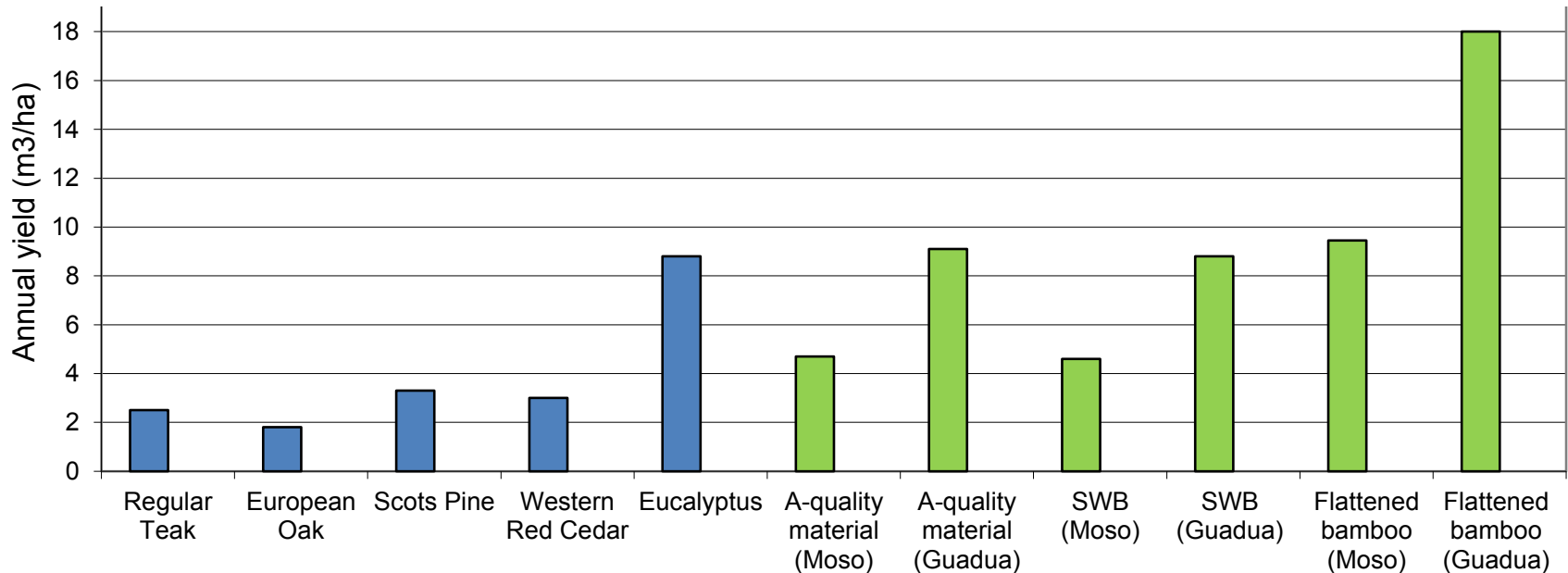


- Bamboo materials & softwood outperform hardwood, plastics & metals
- Flattened bamboo most sustainable option available



Carbon footprint - Excluded

- Annual yield = additional benefit excluded in LCA



- Additional growth related environmental benefits vs wood:
 - annual harvesting provides better growth > no deforestation
 - reforestation on degraded land possible
 - short establishment time

Points for improvement

- Energy (52-63%):
 - Higher energy efficiency; e.g. co-generation electricity & heat
 - Sustainable energy; e.g. PV panels on factory
- Transport
 - International (15-25%): closer sourcing (e.g. Africa, Latin America)
 - National (10%): larger and more efficient trucks (e.g. EURO 5)
- Resins (3-16%)
 - More formaldehyde free resins (e.g. EPI)
 - Use of fully biobased resins



Some final thoughts (i)

- Bamboo stem interesting only in the countries of harvest
 - From market perspective
 - From carbon footprint perspective due to inefficient seairansport:
 - Bamboo stem used locally: 0,19 kg CO₂ / kg stem (cradle to gate)
 - Bamboo stem used in Europe: 1,45 kg CO₂ / kg stem (cradle to gate)



Some final thoughts (ii)

- Sell the green story well, but only when it is complete and correct (no copy – paste)

MOSO principle 1:

sustainability

We believe that MOSO bamboo is one of the most promising alternatives in the required shift to a sustainable economy. As one of the **fastest growing**, renewable resources in the world it **absorbs CO₂** in large quantities yet has **hardwood properties**, making it the ideal alternative to tropical hardwood. We value **honesty, Integrity and transparency**, we therefore back up our sustainability claims with comprehensive testing reports and **Internationally respected certifications and ecolabels** from independent, acknowledged institutions. We clearly communicate our best performing products in our **Green Premium** line. We are the only bamboo company with a full carbon footprint and LCA revealing that our 100% bamboo products are **carbon neutral** (or better) over their full life cycle. The use of MOSO products, especially in **Green Premium**, contributes to a higher score in the leading sustainable building certification systems **LEED and BREEAM**.



breeam



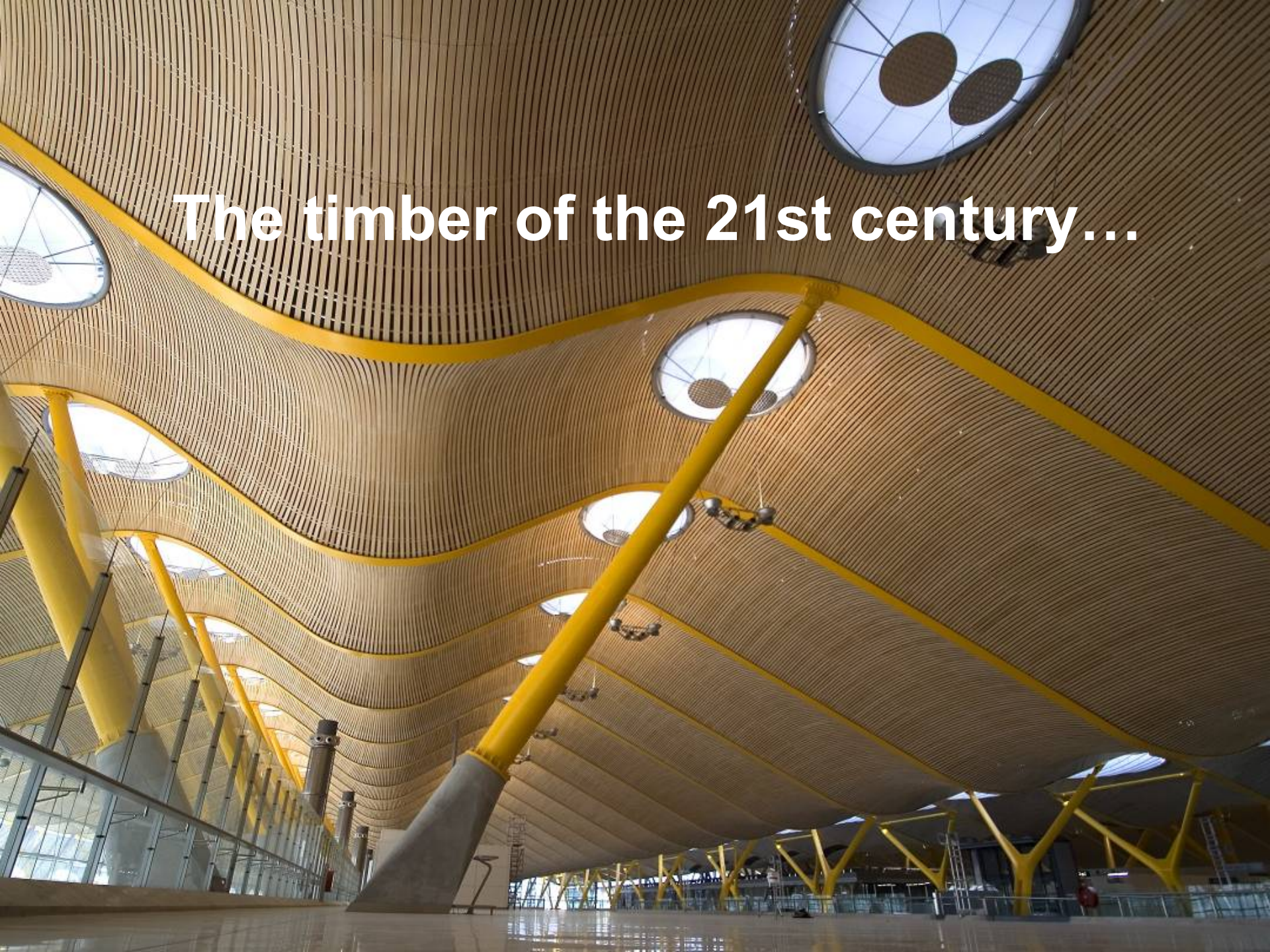
CO₂ neutral hardwood alternative

Some final thoughts (ii)

- Sell the green story well, but only when it is complete and correct (no copy – paste)
- Make bamboo more mainstream → inclusion in standards for quality, health, environment (CE, ISO, FSC, IPCC)



The timber of the 21st century...



- INBAR Technical Report no. 35

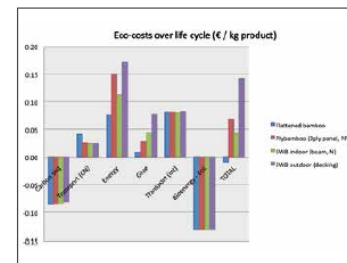
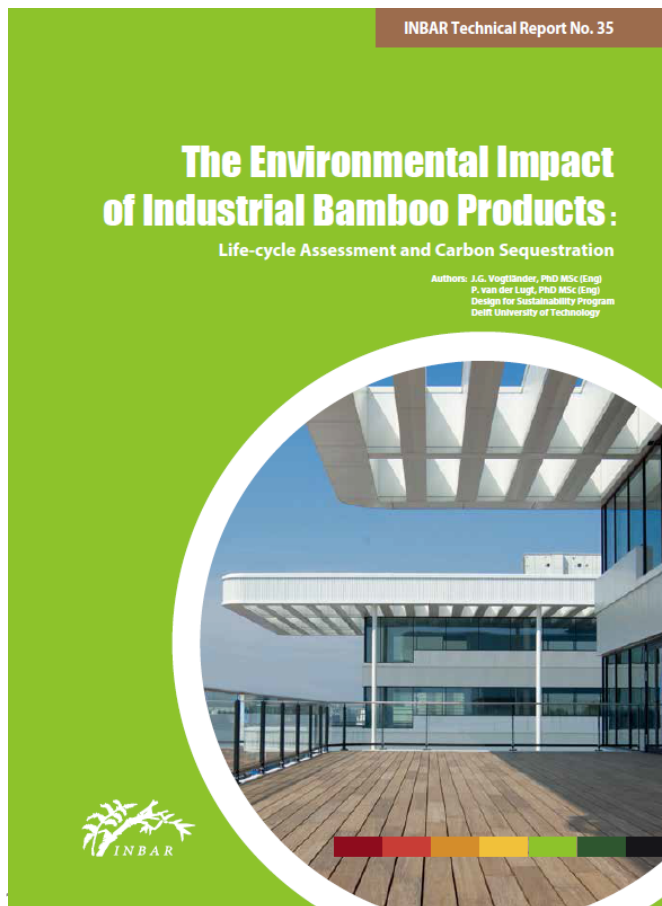


Figure 14: Eco-costs over life cycle (kgCO₂eq / kg product), for various industrial bamboo products based on different production technologies.

If we look at the process categories we can make the following conclusions from an environmental point of view:

Energy consumption in processing the industrial bamboo product provides the largest contribution to the environmental impact, being responsible for 36 – 53% (eco-costs) and 52–63% (carbon footprint) of the total eco-burden. Since the bamboo processing facilities in general use biomass (bamboo waste) for heat, the energy is only electricity from the local grid. This electricity from the grid might be replaced by electricity from a combined power generator (bamboo waste is abundantly available) at the production facility, or on-site production of solar energy.

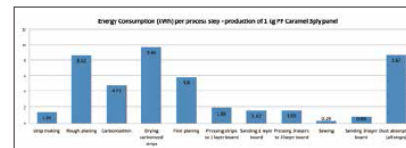


Figure 15: Carbon footprint for electricity consumption over life cycle (kgCO₂eq / kg product), in this case for a 3ply carbonized solid bamboo panel.

The image shows the interior of a large, modern building, likely a train station or airport terminal. The ceiling is a prominent feature, with a wavy, undulating design made of light-colored, ribbed material. Several large, circular skylights are integrated into the ceiling, allowing natural light to enter. A series of thick, yellow structural columns support the ceiling, creating a rhythmic pattern. The floor is a polished, reflective surface. In the background, more of the building's interior is visible, including glass railings and additional structural elements.

Questions?

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