Aalto University
School of Chemical
Technology

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COST Action FP1407

1st Conference "Life Cycle Assessment, EPDs and modified wood"

Life cycle impacts of modified wood products

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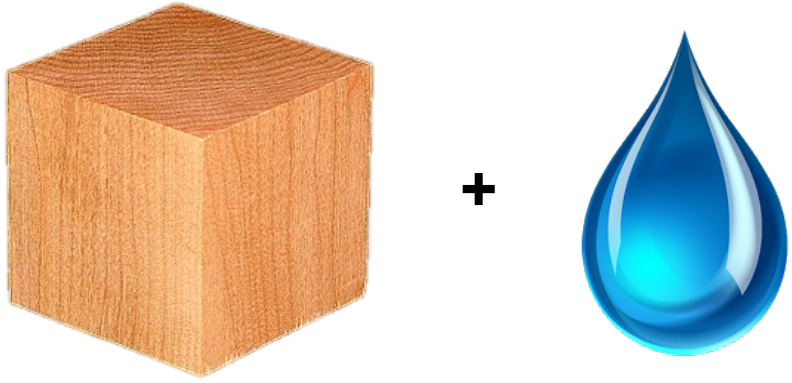
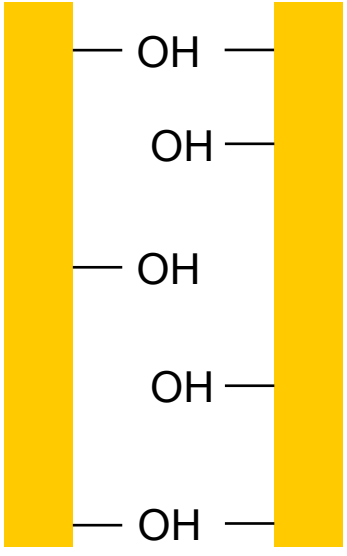
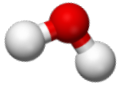
Wood water behavior



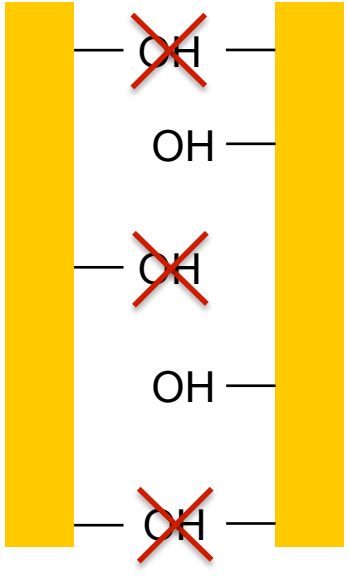
Changes in dimensional stability, strength, and biological durability

Wood modification





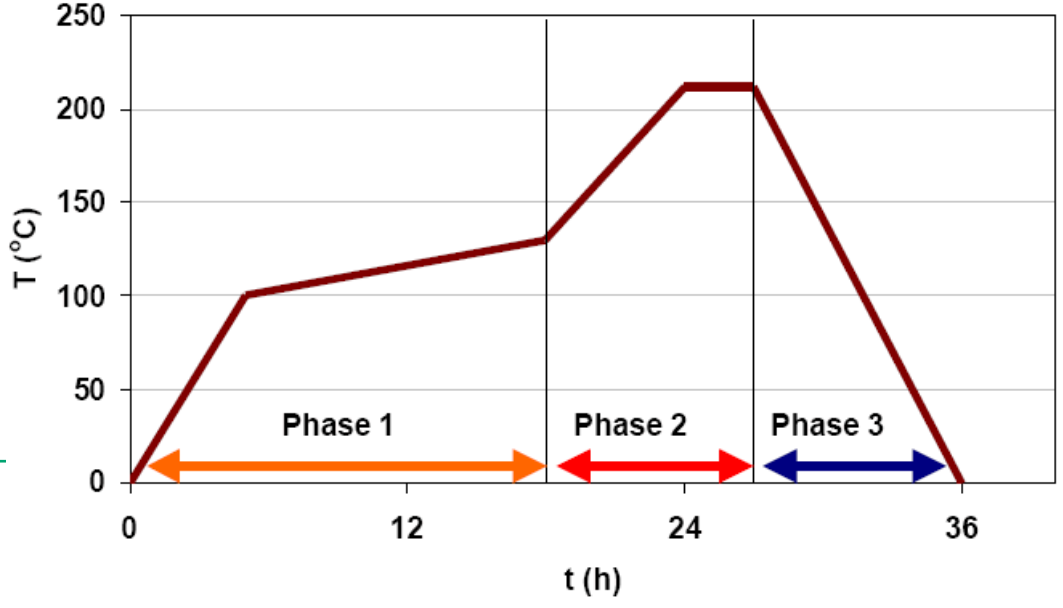
Water-molecules bond with the accessible OH-groups (in hemicellulose, amorphous cellulose and lignin)



During thermal modification part of the OH-goups are degraded leading to less interaction between wood and water

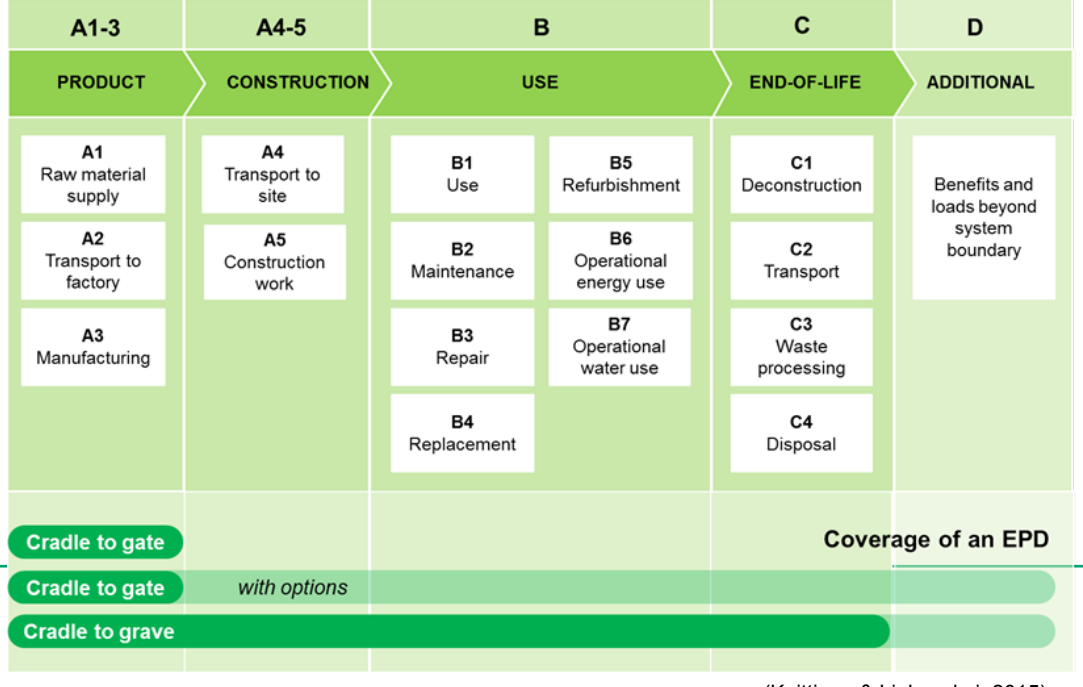
ThermoWood process

1. **Temperature raising** to 100°C, with steam injection (to inhibit cracking, etc), **wood drying** -> 130°C (wood MC 0%)
2. Temperature raising + **thermal modification** at 185-230°C for ~2-3 h (depending on wood species and desired properties)
3. **Cooling and stabilisation** at 80-90°C (with steam) to final moisture content ~4-7 %.



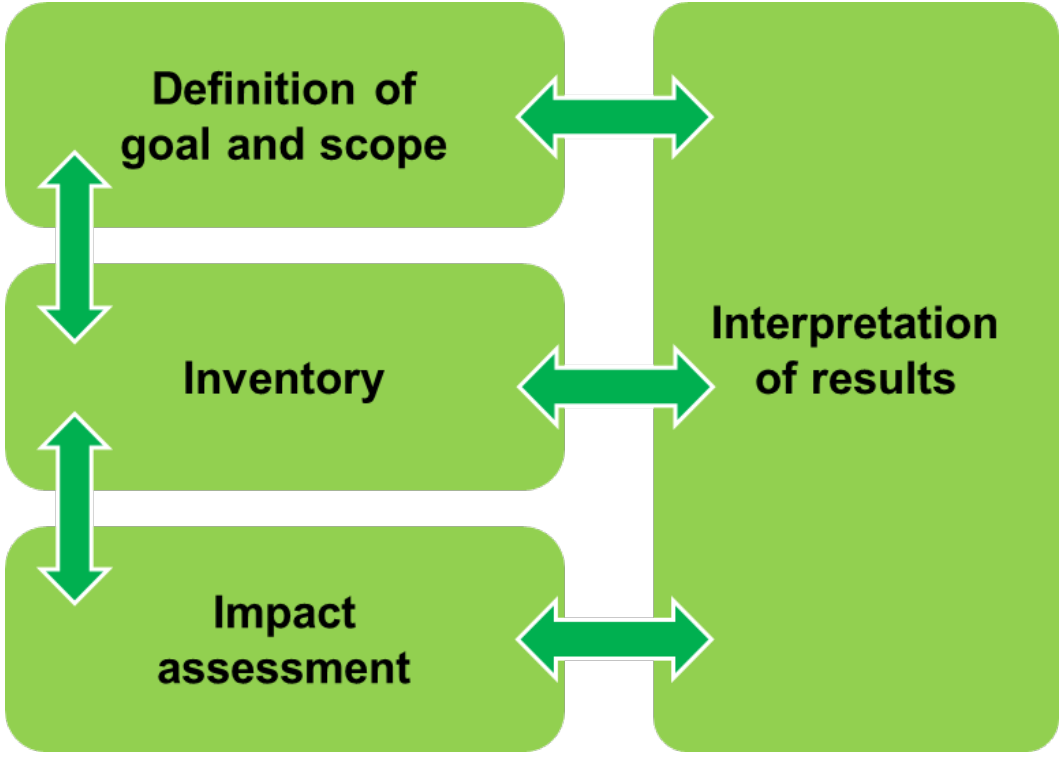
Environmental Product Declaration

- **EN 15804 – Environmental declaration for building products**
- **Define system boundary for the assessement**
- **Declare emissions to air, ground and water**



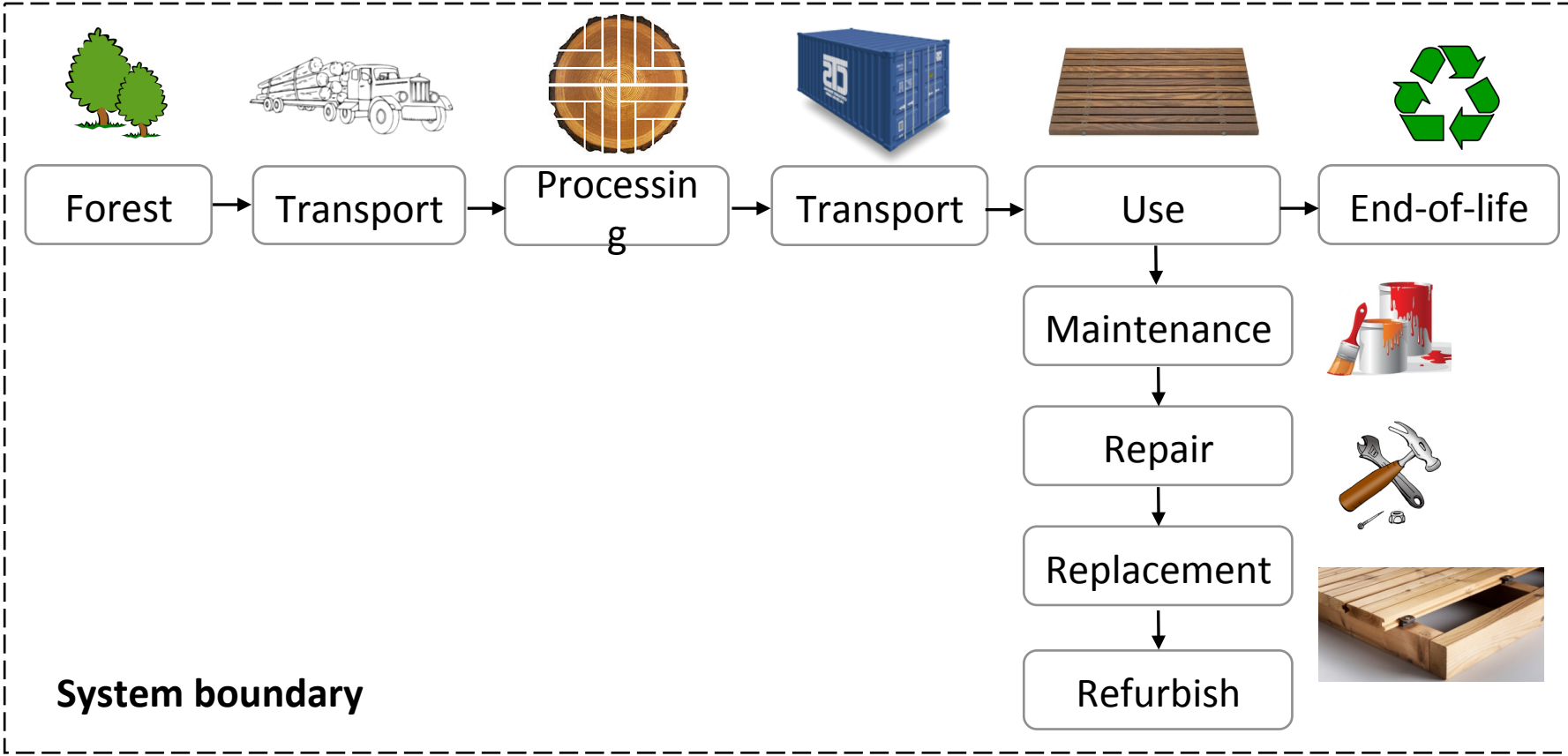
(Kuittinen & Linkosalmi, 2015)

Life cycle assessment



(Kuittinen & Linkosalmi, 2015)

System boundary for assessment

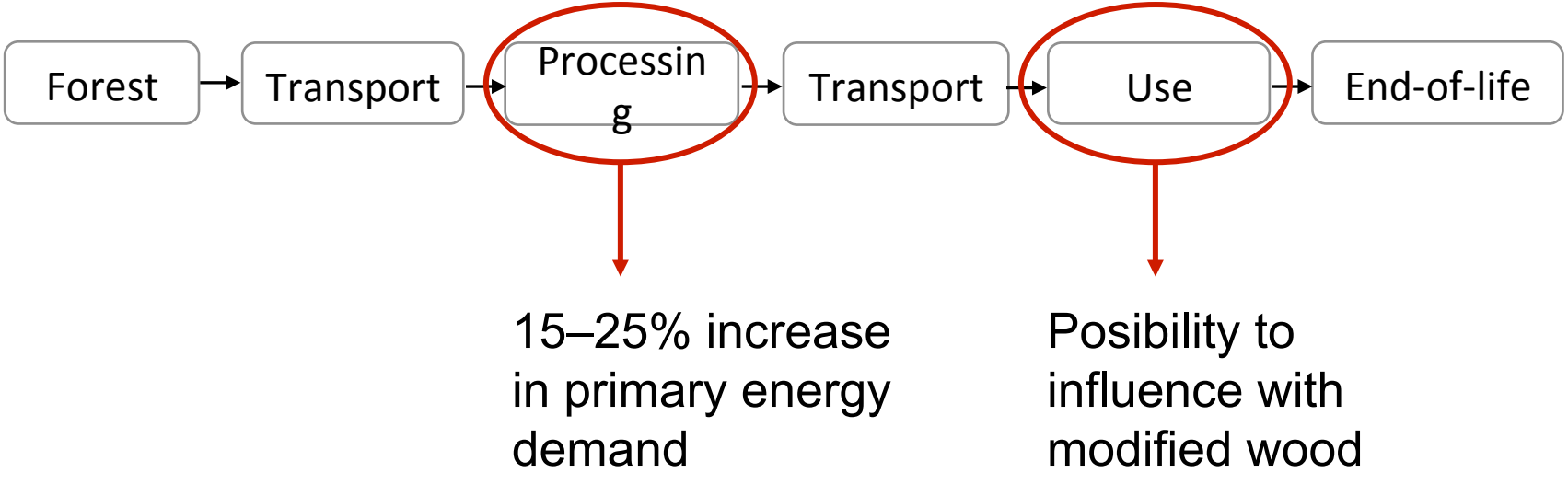


Life cycle impacts

Environmental impacts

Economical impacts

Social impacts



Primary energy need in production stage

PE

	Unit	Sawn timber (pine) [1]	Sawn timber (softwood) [2]	Sawn timber (softwood) [3]	Heat treated sawn timber (pine) [4]
Density	kg/m^3	420	420	413	420
MC	%	15	15	15	5
PERE	MJ	2270	853	1330	2761
PENR	MJ	6850	1650	330	7697
GWP	kg CO_2 -e	-672	-679	-784	-258
ODP	kg CFC11 -e	0,00000551	0,00000000298	0,000000000497	0,0000461
POCP	kg C_2H_4 -e	0,0203	0,0486	0,0825	0,12
AP	kg SO_2 -e	0,339	0,612	0,242	2,12
EP	kg PO_4^{3-} -e	0,0752	0,106	0,0493	1,88
ADPE	kg Sb -e	0,0000948	0,00000781	0,0000142	0,000402
ADPF	MJ	623	1390	318	7794

Data sources 1) EPD-Norway 2) Wood for Good 3) IBU 4) EPD-Norway. Abbreviations: MC Moisture content, PERE Use of renewable primary energy, PENR Use of non-renewable primary energy, GWP Global Warming Potential, ODP Ozone Depletion Potential, POCP Photochemical Ozone Creation Potential, AP Acidification Potential, EP Eutrophication Potential, ADPE Abiotic Depletion Potential (Elements), ADPF Abiotic Depletion Potential (Fossil).

Conclusions

- **Primary energy need increases by approximately 15–25% in heat treated timber compared to kiln dried sawn timber in production phase**
- **This primary energy needs to be gained back in later life cycle phases (use phase)**
- **Emissions are always energy production related**
- **More specific data from use stage is required to make meaningful comparison of the whole life cycle**

References

EPD-Norway. 2015. EPD Skurlast av gran eller furu. Available at
http://www.epd-norge.no/getfile.php/PDF/EPD/Byggevarer/NEPD-307179NO%20Skurlast%20av%20gran%20eller%20furu%20GK.pdf

EPD-Norway. 2014. EPD Termotre av gran og furu. Available at
http://www.epd-norge.no/getfile.php/PDF/EPD/Byggevarer/NEPD00259N%20Termotre-av-gran-og-furu%20MoelvenWood%20GODKJENT.pdf

IBU EPD. 2015. EGGER Schnittholz technisch getrocknet. Available at
http://construction-environment.com/download/CY84e88afX14dbf344596X31f5/Schnittholz_trocken.pdf

Kuittinen & Linkosalmi. 2015. Compiling environmental product declarations for wood-based construction products - Instructions for inventory, life cycle assessment and documentation. Aalto University

ThermoWood Handbook. 2003. International ThermoWood Association. 66 p.

Wood for Good Lifecycle Database. 2013. Kiln Dried Sawn Softwood. Available at
http://woodforgood.com/assets/Downloads/Kiln_Dried_Softwood_v1.2_2014-03-18.pdf