CENTRE FOR SUSTAINABLE CONSUMPTION AND PRODUCTION

SUSTAINABLE CIRCULAR BIOECONOMY IN FOREST INDUSTRIES – HOW CAN LCA SUPPORT THE TRANSITION?

JÁCHYM JUDL, RIINA ANTIKAINEN, KAISA MANNINEN AND HELENA DAHLBO

Finnish Environment Institute SYKE

SETAC LCA CSS
20.-22.2016
Montpellier, France

SYKE

CENTRE FOR SUSTAINABLE CONSUMPTION AND PRODUCTION

Background and acknowledgements

RECIBI – Renewal of manufacturing towards a sustainable circular bioeconomy and implications for innovation policy (funded by Tekes - the Finnish Funding Agency for Innovations and VINNOVA – Sweden's Innovation Agency)

ARVI – Material Value Chains (funded by Tekes - the Finnish Funding Agency for Innovations)

SYKE

Hypothesis

Icons credits: The Noun Project

CENTRE FOR SUSTAINABLE CONSUMPTION AND PRODUCTION

Approach

- Two conceptual examples of closing the loops - wood cellulose textile fibres and wood polymer composites.
- Identifying circular bioeconomy benefits and challenges.

SYKE

Method

- Analysis of existing LCA studies on textiles and textile fibres.
- Attributional LCA on wood-polymer composite (WPC) terrace board.

CENTRE FOR SUSTAINABLE CONSUMPTION AND PRODUCTION

Results

Current textile fibres production

Man-made fossil fibres
- Made of non-renewable resources.

Concerns about the sustainability of cotton production
- Land use, water use, pesticides, fertilisers.

Offshored production
- Increased need for long-distance transport. Concerns about social sustainability (safety, heath impacts, income inequality and human rights).

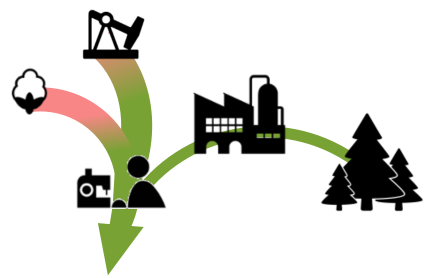
SYKE

Icons credits: The Noun Project

CENTRE FOR SUSTAINABLE CONSUMPTION AND PRODUCTION

Results

New wood cellulose textile fibres enter the market



Climate impacts up to 9 times lower compared to traditional textiles

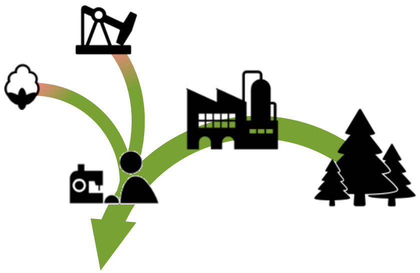
- Climate impacts of Ioncell® and fibres alike as low as 1 t CO_2-eq./t.
- No need for harmful solvents, unlike in viscose production.
- Beneficial material properties, recyclable.

SYKE

Icons credits: The Noun Project

Results

Increase in domestic and global production of new wood cellulose fibres



Icons credits: The Noun Project

CENTRE FOR SUSTAINABLE CONSUMPTION AND PRODUCTION

Results

Use phase of textiles

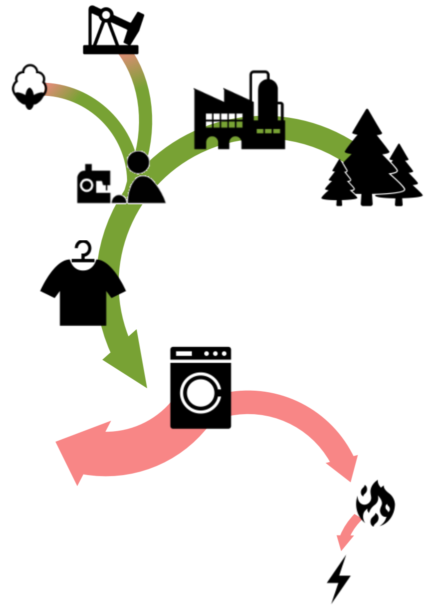
Use phase of textiles can dominate their environmental impacts

- Laundering (energy, water and detergent use)

Icons credits: The Noun Project

Results

EOL management



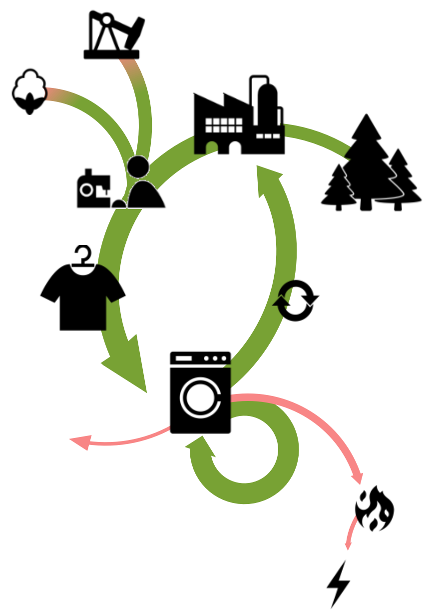
Globally majority of waste textiles ends up in landfills. In Finland, 82% of waste textiles are incinerated.

- Loss of material and embodied energy

Icons credits: The Noun Project

Results

Closing the loops



- Setting up recycling schemes for waste textiles is essential.
- Recycling technology under development. Near to market deployment.
- Economically feasible even in Northern Europe (note: oil prices!).

SYKE

Icons credits: The Noun Project

Results

Wood fibres in wood-polymer composites (WPC)

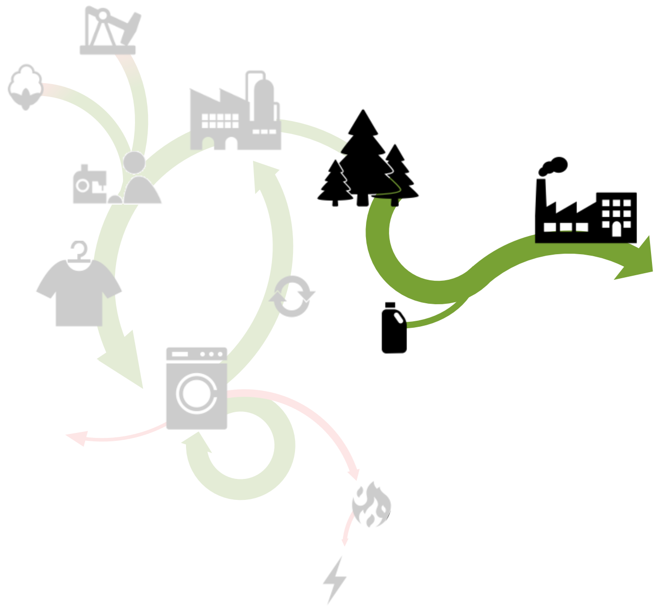
By-products of forest-based industries, such as pulp mills, can be utilised in WPC production. Waste wood can be also utilised.

- Climate impacts of C&D waste wood are negligible.
- Climate impacts of sawdust are minor compared to other inputs, too.

Icons credits: The Noun Project

Results

Polymers in wood-polymer composites (WPC)



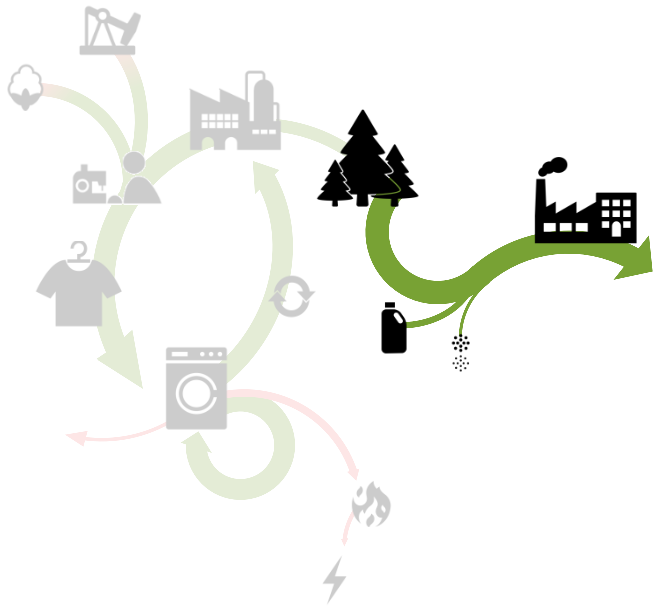
Both virgin polymers and recycled post-consumer plastic packaging can be utilized.

- Climate impacts of recycled polymer is approx. 10% of the virgin polymer.

Icons credits: The Noun Project

Results

Additives and extrusion of WPC



For WPC made of recycled raw materials the extrusion process dominates the climate impacts (8 kg CO_2-eq./ m^2)

Icons credits: The Noun Project

Results

Use and end-of-life phases of WPC

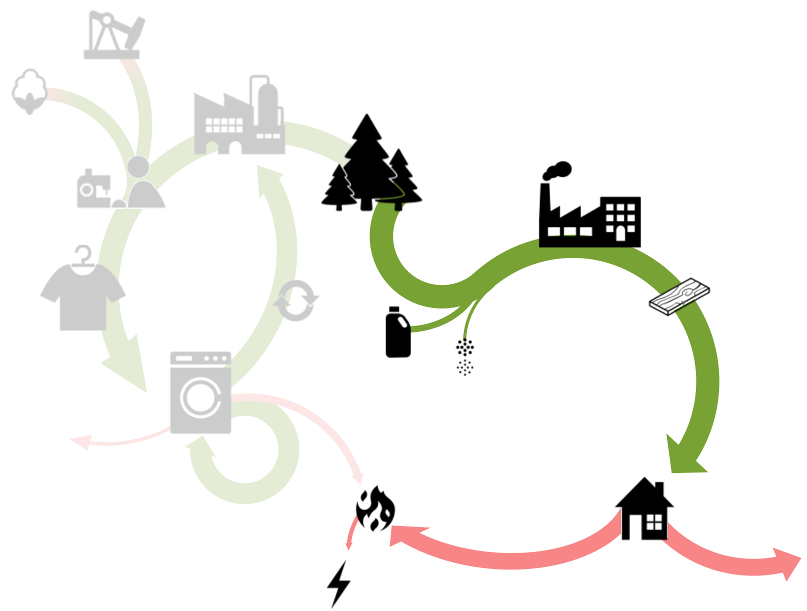
- WPC replaces chemically impregnated wood.
- No need for maintenance.

Icons credits: The Noun Project

CENTRE FOR SUSTAINABLE CONSUMPTION AND PRODUCTION

Results

Use and end-of-life phases of WPC



Non-existence of collection and recycling scheme.

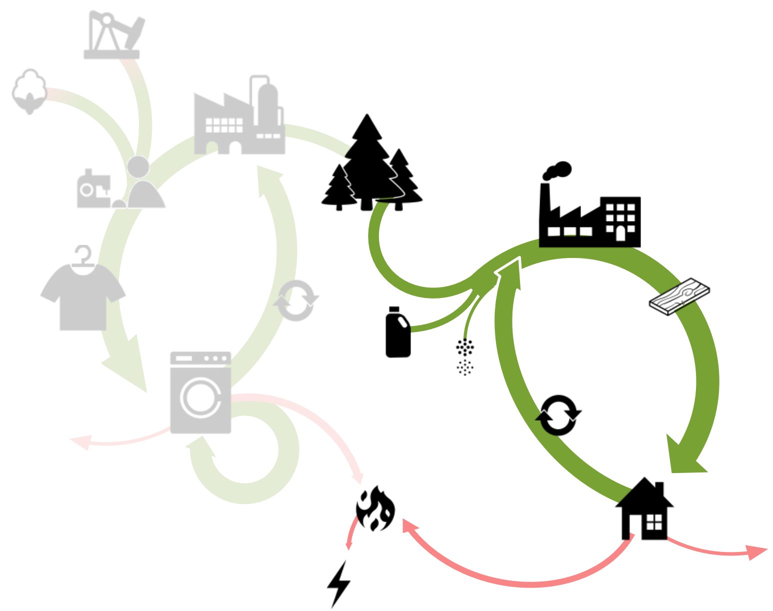
- WPC end up in incineration, or are left unhandled.
- Chemically impregnated wood is hazardous waste.

SYKE

Icons credits: The Noun Project

Results

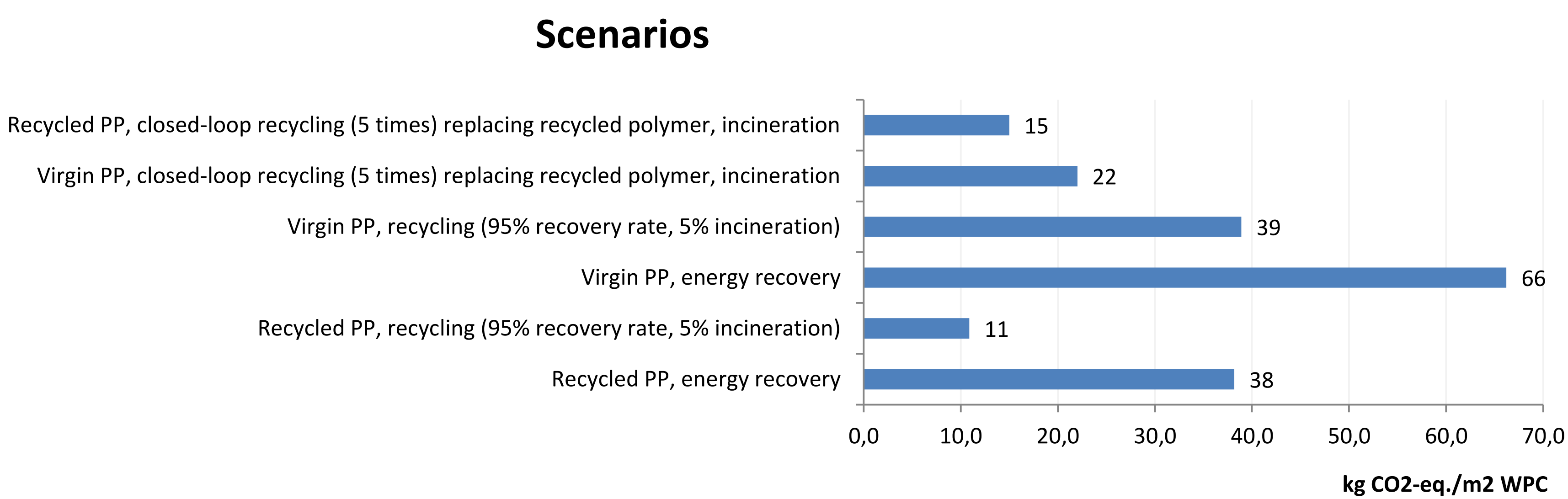
Use and EOL phases of WPC



- WPC can be recycled in closed-loops, multiple times.
- Reduced need for feedstock materials and other EOL treatment.

Results

LCIA results for the WPC life cycle strongly depend on the EOL scenario chosen and the modelling approach.



CENTRE FOR SUSTAINABLE CONSUMPTION AND PRODUCTION

SYKE

CENTRE FOR SUSTAINABLE CONSUMPTION AND PRODUCTION

Conclusions

- Interlinking forest-based industries to magnify environmental benefits.
- Enhancing (or establishing) recycling is essential for circular economy.
- New wood cellulose textile fibres may deliver environmental benefits compared to traditional fibres. Especially if made of wood from boreal forest.
- WPC can also bring benefits, especially if they substitute chemically impregnated wood. Results sensitive on EOL scenarios.

- LCA is an essential tool when assessing the benefits of circular economy. However, when modelling interlinked systems and multiple loop recycling it gets complicated. Strong methodological guidance is needed.

- Finland is well positioned in the circular bioeconomy.

SYKE

CENTRE FOR SUSTAINABLE CONSUMPTION AND PRODUCTION

References

Muthu, S. S. *Assessing the Environmental Impact of Textiles and the Clothing Supply Chain*. Elsevier Science (2014).

Shen, L. & Patel, M. K. Life Cycle Assessment of Man-Made Cellulose Fibres. *Lenzinger Berichte 88 (2010) 1-59* (2010).

Shen, L., Worrell, E. & Patel, M. K. Environmental impact assessment of man-made cellulose fibres. *Resources, Conservation and Recycling* **55**, 260-274 (2010).

Chapagain, A. K., et al. The water footprint of cotton consumption: An assessment of the impact of worldwide consumption of cotton products on the water resources in the cotton producing countries. Ecological Economics 60, 186-203 (2006).

Allwood, J. M., Laursen, S. E., Malvido de Rodríguez, C. & Bocken, N. M. P. Well dressed? The present and future sustainability of clothing and textiles in the United Kingdom (2006).

Dahlbo, H. et. al. More efficient re-use of textiles and recycling of textile waste in Finland; in Finnish. The Finnish Environment 4 | 2015 (2015).

SYKE

Thank you!

Jáchym Judl

Finnish Environment Institute SYKE, Helsinki, Finland

jachym.judl@ymparisto.fi

@judlj

SYKE