

# LIFE CYCLE ASSESSMENT OF LIGNIN BASED CARBON FIBRES

## -Future environmental opportunities

Carbon fibres are usually made from polyacrylonitrile, PAN, a fossil-based polymer. Research has shown that a possible route to reduce the environmental impact from carbon fibres is to replace PAN with a bio-based alternative, such as lignin. Lignin is a main by-product of many biorefinery processes that use ligno-cellulosic material as feedstock.

The goal of the study was to compare future environmental impacts of lignin-based carbon fibres to today's PAN-based carbon fibres of today's predominant technology

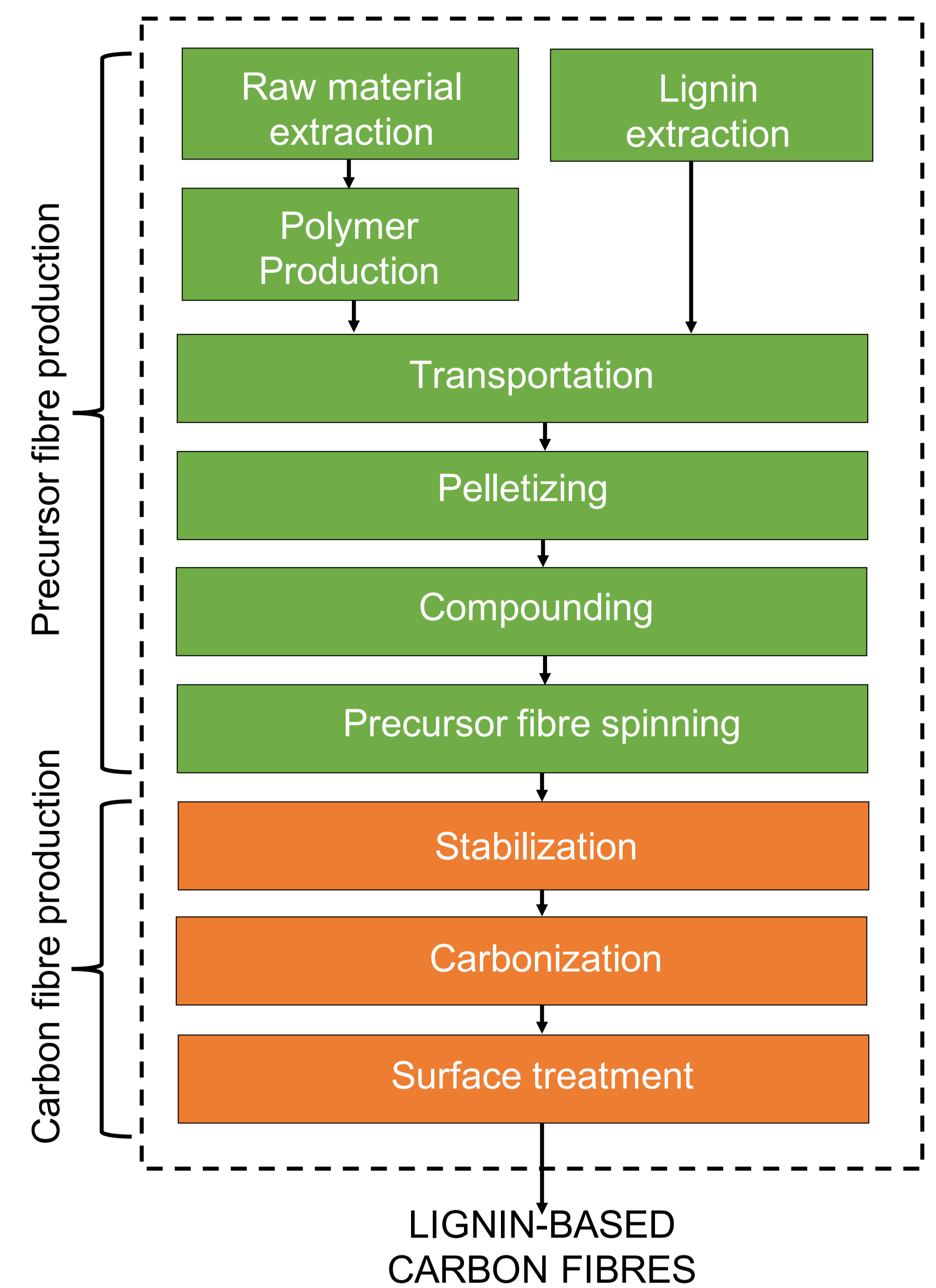


Carbon fibres made from lignin and polymer blend

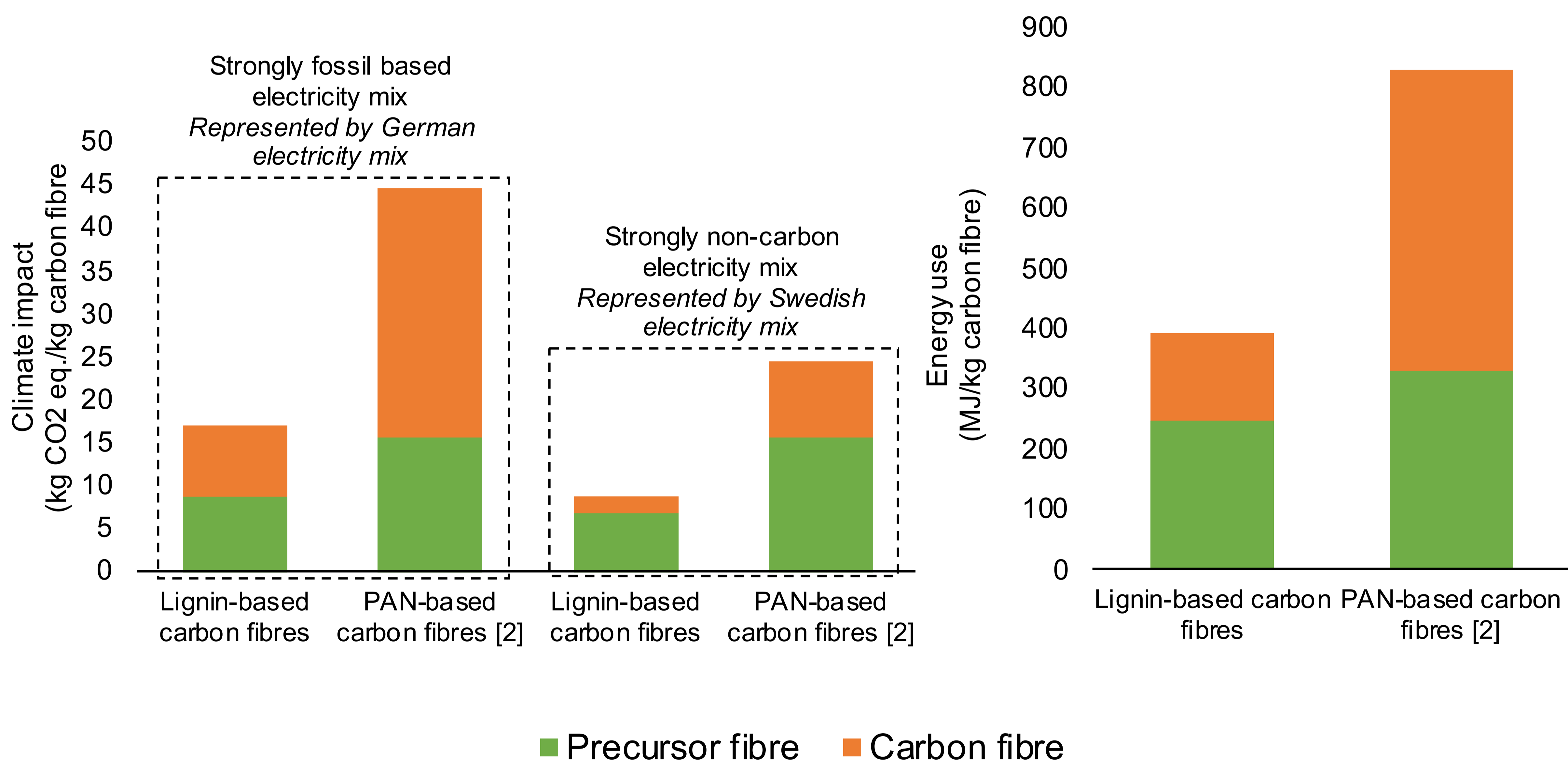
### ANALYZED SYSTEM

Assumptions on potential future improvements for lignin-based carbon fibre production

- The lignin-based carbon fibres consisted of a combination of polymer (40% TPU) and lignin (60%)
- The lignin production was assumed to be from Kraft pulping and was modelled using data from [1]
- Lignin was assumed to require 50% less energy for stabilization and 30% less energy for carbonization than PAN
- Plasma surface treatment was assumed to replace electrochemical surface treatment



### RESULTS



### CONCLUSIONS

- Lignin-based carbon fibres could in the future have a lower climate impact and energy use compared to today's PAN-based carbon fibres
- The choice of electricity mix has a large effect on the climate impact of the carbon fibres

### REFERENCES

- [1] Culbertson, C., Treasure, T., Venditti, R., Jameel, H., & Gonzalez, R. (2016). Life cycle assessment of lignin extraction in a softwood kraft pulp mill. *Nordic Pulp & Paper Research Journal*, 31(1), 30-40.
- [2] Romaniw, Y. A. (2013). *The relationship between light-weighting with carbon fiber reinforced polymers and the life cycle environmental impacts of orbital launch rockets* (Doctoral dissertation, Georgia Institute of Technology).

### ACKNOWLEDGEMENT

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### FURTHER FUTURE IMPROVEMENTS

- The use of plasma technology in carbonization could decrease the energy use further
- Increasing the share of lignin in the precursor fibre could also decrease the environmental impact of the carbon fibre