Comparative Environmental Sustainability Assessment of Bio-Based Fibre Reinforcement Materials for Wind Turbine Blades

Over the recent decades biomaterials have been marketed successfully supported by the common perception that biomaterials and environmental sustainability de facto represents two sides of the same coin. The development of sustainable composite materials for wind turbine blades for small-scale wind turbines have therefore partially been focused on substitution of conventional fibre materials with bio-fibres assuming that this substitution was in the better for the environment and human health. The major question is if this material substitution, taking into account a multitude of environmental impact categories, not only climate change, actually is supporting sustainable development or if the development of sustainable composite materials is more complex and perhaps even contra-intuitive due to complex trade-offs. Based on a case study 4 different types of fibres and fibre mixtures (flax, carbon, glass and flax/carbon, flax/glass mixed fibres) are compared in terms of environmental sustainability. Applying one of the most recent life cycle impact assessment methods, we demonstrate that the environmental sustainability of natural fibre based composite materials is similar or even lower, within certain impact categories, than the conventional materials. This observation may seem contra-intuitive (i.e. most people would expect the bio-based to be most sustainable), but is primarily caused by the fact that the resin demand of biobased reinforcement materials is by far larger than that of conventional reinforcement materials. Since the environmental burden of the resin in addition is comparable to that of the fibres (especially in terms human health related impacts), the higher resin demand counterbalances the environmental sustainability improvements, obtained with the application of natural fibres.

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