Selection of environmental sustainable fiber materials for wind turbine blades - a contra intuitive process?

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 such as blades for small-scale wind turbines have thus partially been focused on the substitution of conventional fiber materials with bio-fibers. The major question is if this material substitution actually, is environmental sustainable. In order to assess a wide pallet of environmental impacts and taking into account positive and negative environmental trade-offs over the entire life-span of composite materials, life cycle assessment (LCA) can be applied. In the present case study, four different types of fibers (carbon, glass, flax and carbon/flax mixture) are compared in terms of environmental sustainability and cost. Applying one of the most recent life cycle impact assessment methods, it is demonstrated that the environmental sustainability of the mixed carbon/flax fiber based composite material is better than that of the flax fibers alone. This observation may be contra-intuitive, but is mainly caused by the fact that the bio-material resin demand is by far exceeding the resin demand of the conventional fibers, and since the environmental burden of the resin is comparable to that of the fibers, resin demand is in terms of environmental sustainability important. On the other hand is the energy demand and associated environmental impacts in relation to the production of the carbon and glass fibers considerable compared to the impacts resulting from resin production. The ideal fiber solution, in terms of environmental sustainability, is hence the fiber composition having the lowest resin demand and lowest overall energy demand. The optimum environmental solution hence turns out to be a 70:30 flax:carbon mix, thereby minimizing the use of carbon fibers and resin. On top of the environmental sustainability assessment, a cost assessment of the four fiber solutions was carried out. The results of the economical assessment which turns out to not complement the environmental sustainability, pin-point that glass fibers are the most effective fiber material.