Factsheet – The Sustainability of Bark-enriched Wood Plastic Composite Granulate

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Introduction

Dendromass4Europe demonstrates the establishment of short-rotation wood Cropping in Western Slovakia and its complete dendromass-material use for bio-based materials. Innovations are seen as drivers of economic and social progress as well as environmental degradation. Anticipating the potential impacts of innovations—already during their development--is essential for sustainable development. The objective of this task is to anticipate critical environmental and socio-economic hotspots and derive measures for improvement together with the project partners. In this poster, the focus lies on the results of the production of bark-enriched wood plastic composite profiles only. The results of the total D4EU impacts as well as of each product system are presented in separate posters.

Production System

The wood-plastic-composite granulate (NBBM4) is produced by Pulp-Tec Compound GmbH & Co KG located in Neustadt / Sachsen in Germany. The production processes carried out at Pulp-Tec compound are building the foreground system and form the system boundaries, including all production activities at the site. All inputs from outside the company build the background system. The retail is outside the scope of the study, as it is not part of the project.

People

In total the least number of indicators with higher social risk potential were identified for NBBM 4 compared to the other product systems (NBBM 0-3). The results of the social risk analyses for the wood plastic composite (WPC) granulate show a low or medium risk level for most indicators analyzed (Fig. 3). A low-risk potential was found regarding fatal accidents, fair wage potential, modern slavery, or unemployment among people with advanced and basic education and unemployment rate in Germany. Still, 8 out of 27 indicators yield a value equal to or higher than 0.5 – which means that the situation is worse than the performance reference point and special attention should be paid to these aspects. Especially, 2 indicators with a high and very high risk potential were identified i.e., the highest risk regarding non-fatal accidents compared to the other product systems (NBBM 0-3) which is surprising since one might assume that safety standards are rather high for companies in Germany. Only one indicator was identified connected with a very high risk potential i.e., the availability of documents on sustainability issues. This implies that the organization does not publicly commit to sustainability standards and is therefore not engaged in reducing its negative impacts on sustainability. A more detailed presentation and discussion of these results can be found in the publication from Fürtner et al. (202X) and in D5.6).

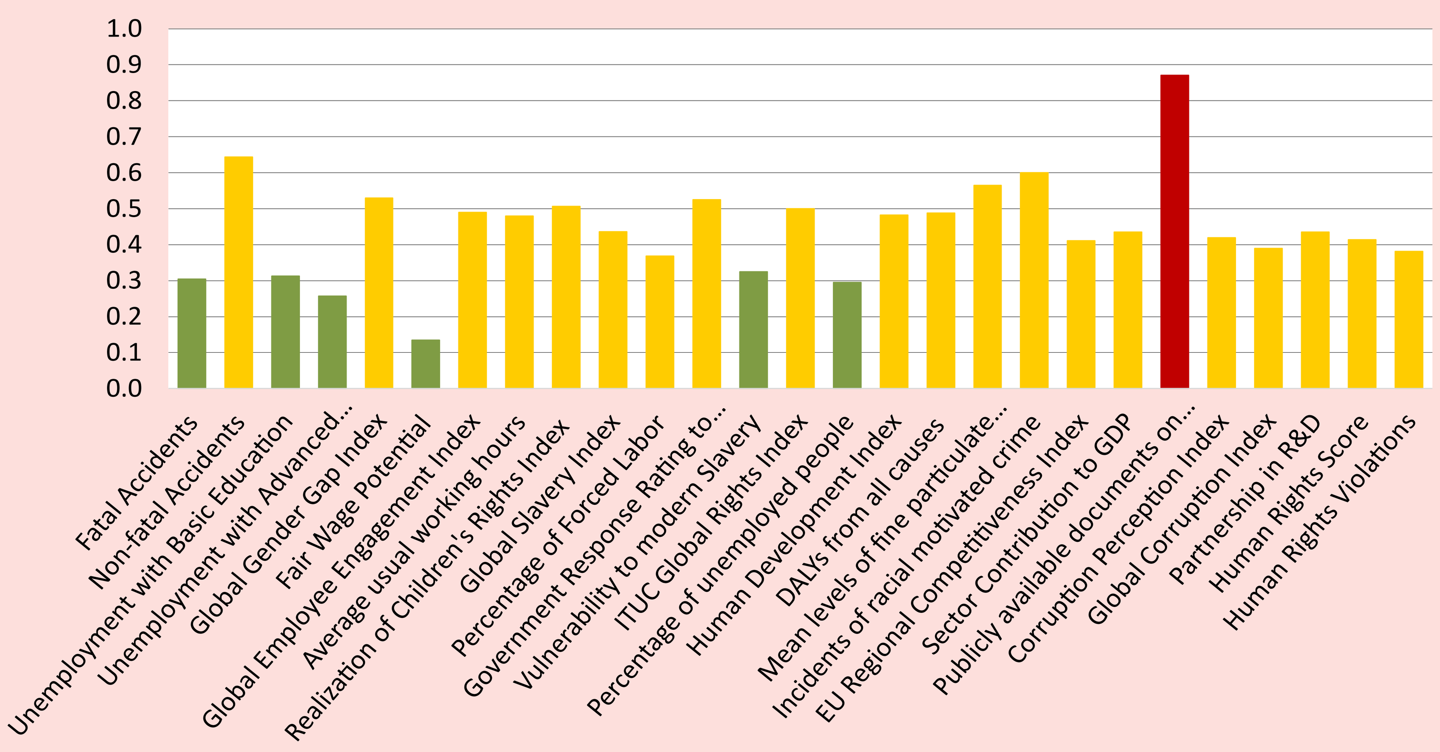

Figure 3: Selected social risks of the wood-plastic-composite granulate (green=lower risks; yellow=medium risk; red= higher risk)

Actions for Improvement

Sustainability assessments during R&D help to generate actionable knowledge for all involved stakeholders, especially for companies. The WPC profiles producer of D4EU have now the opportunity to improve their sustainability performance by taking action like:

- preparation of publicly available documents like sustainability reporting and make it publicly available;
- ensure safe and healthy working conditions for all workers;
- increase the share of regional available inputs for the production processes to increase value creation for the region;
- using less fossil-based inputs by e.g., using secondary (recycled) PVC;
- use recycled PVC by implementing a product recovery system;
- increase productivity through enhancing the sustainable use of renewable resources (e.g. cascading use) or by extending the product's life;
- reduce the use of toxic substances and emissions through a higher recycling and reuse rate of materials
- increase the share of wood to replace PVC content;
- use renewable energy to reduce potential impacts;
- increase energy efficiency of the manufacturing process to yield further improvements.

Further reading

Deliverables 5.5; 5.6 & 5.7 of tasks 4 in Dendromass4Europe

Fürtner, D., Mair-Bauernfeind, C., Hesser, F. (202X). Proposing a multi-level assessment framework for social risks of bio-based value chains and its contribution to the Sustainable Development Goals. Progress in Life Cycle Assessment

Planet

The environmental impacts of one ton of the wood-plastic composite profiles in different impact categories (global warming potential (GWP), terrestrial acidification potential (TAP), ozone depletion potential (ODP), freshwater eutrophication potential (FEP), fossil depletion potential (FDP), cumulative energy demand (CED) are listed in Tab. 1. The production of one ton of WPC granulate results in a GWP of 2408 kg CO_2 eq. production and electricity make up more than 80% of the potential impact in all categories (Fig.1). The most energy-intensive processes are injection molding, cooling, and granulation. In a next step improvement potentials were analyzed in different scenarios: 1) PVC matrix was replaced by polypropylene (PP); 2) polyethylene (PE) instead of PVC; 3) using 40 wt% of wood instead of 24.67 wt%; 4) PLA instead of PVC, and in 5) the usage of renewable electricity instead of the country-specific electricity mix was analysed. Fig. 2 shows the results of the scenario where the highest reductions can be achieved in most impact categories by switching to renewable electricity (scenario 5) except for ODP. Different for ODP, here the highest reductions can be achieved by scenarios 1,2 and 4 by exchanging PVC with other plastics. The use of PLA in Scenario 4 show that the impacts are increasing in GWP, TAP, FEP, and FDP. This can be explained by the fact that the production of PLA has high energy and fuel input. There is a trade-off between energy demand and fossil-based material. More detailed information on the results can be found in deliverable 5.8.

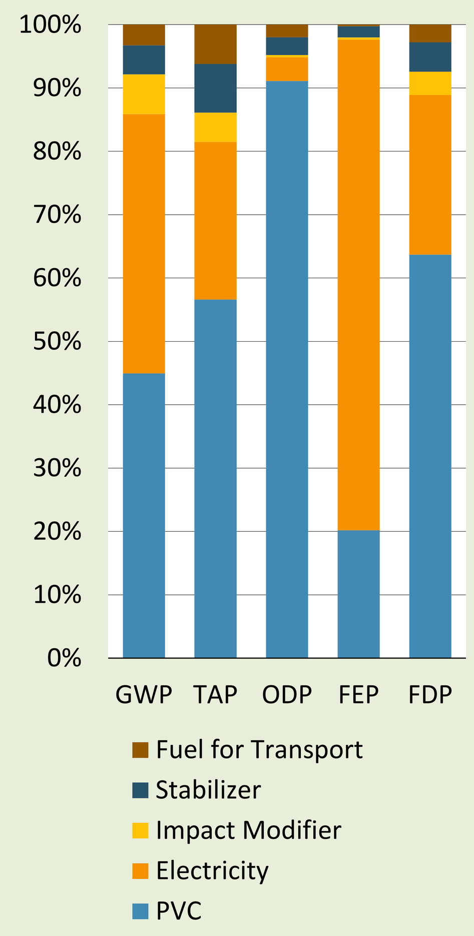

Figure 1: Contribution Analysis of NBBM4 in different impact categories

Table 1: Potential environmental impacts of producing 1t of NBBM4

Impact category	Value/1 ton NBBM4
GWP (kg CO_2-Eq)	2408.55
TAP (kg SO_2-Eq)	6.73
ODP (kg CFC_{11}-Eq)	0.00073
FEP (kg P-Ep)	2.0077
FDP (kg oil-Eq)	1135.59
CED (MJ)	6627.69

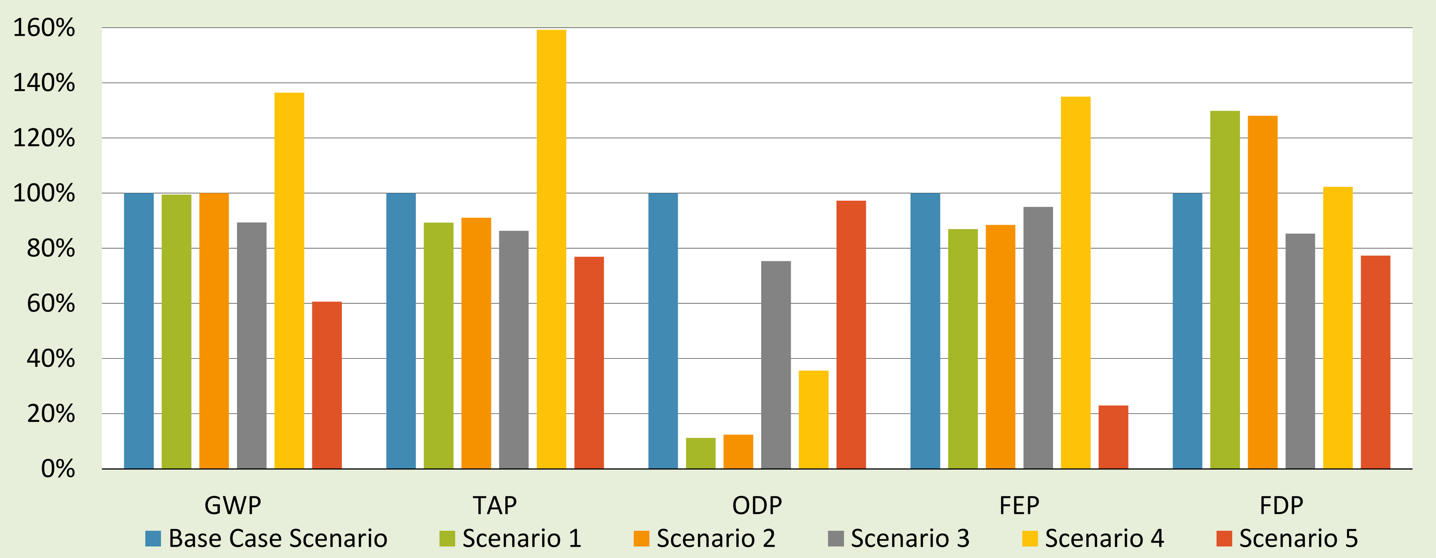

Figure 2: Scenario analysis NBBM4 for different impact categories relative to Base Case (100%)

Prosperity

Value creation happens through D4EU operations and upstream processes (Fig. 4). It is assumed that the machinery can produce 7.2 tons of WPC granulate per year with an amortization time of the machinery investment of 5 years with 4% interest rate. Under the current assumptions and data basis used for calculating the value-added (VA) of WPC granulate production, the VA is negative, meaning that no VA is created (Tab. 2). The share of regional inputs could not be calculated due to lack of data. It is estimated that the market potential for the produced WPC granulate could reach € 7,391 per year (Tab. 2). The fact that no positive value added can be created for NBBM4 may be due to the nature that it is produced within a demonstration project with not yet fully maturead technology readiness level (TRL). When the production becomes more established it may differ to the current results. However, such an upscaling process cannot be demonstrated under the current data basis. Tab. 3 summarizes the eco-efficiency calculations in different impact categories and Fig. 5 shows the eco-efficiency results illustrated as revenue (RE) and the VA per global warming potential (GWP) where no value for VA is shown since the VA is currently negative. The higher the value the better which means that more value can be created by less environmental impact. More information can be found in deliverables 5.6 and 5.7

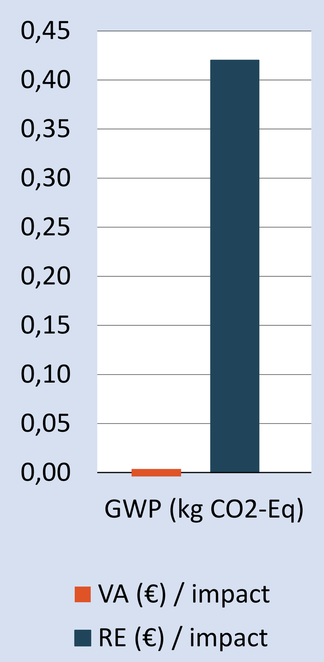

Figure 5: Revenue (RE) and value-added (VA) per GWP for 1t NBBM 4

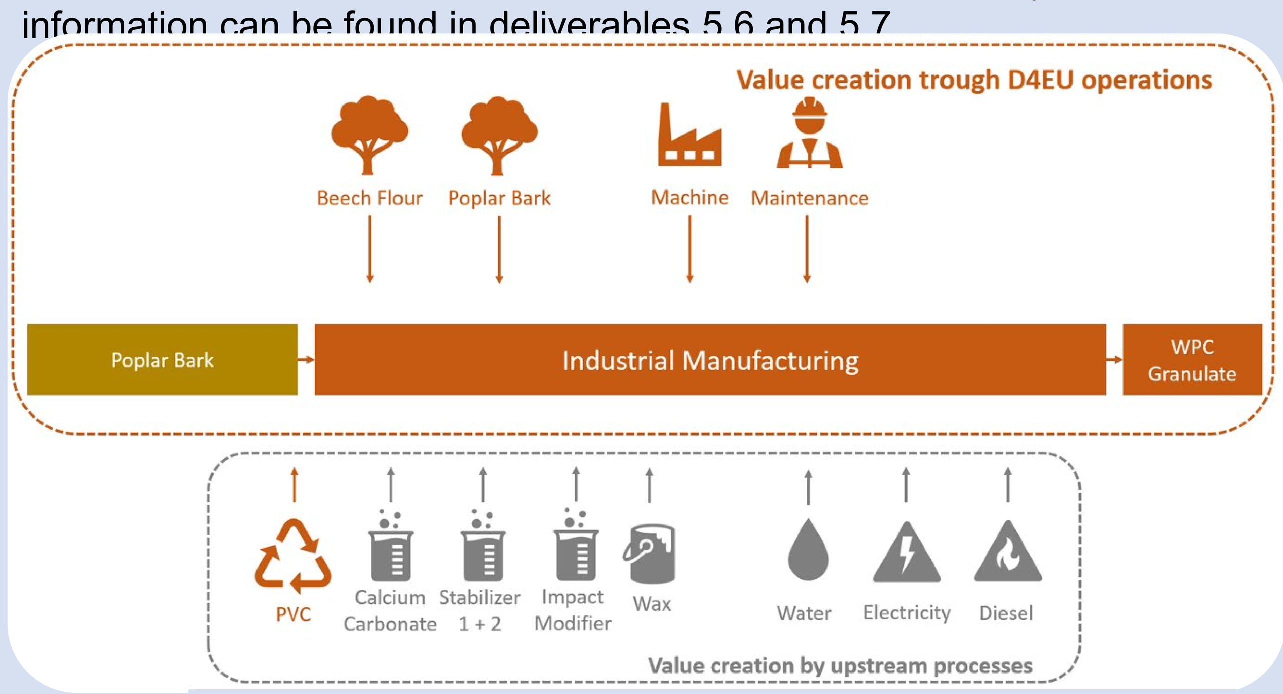

Figure 4: Processes considered for the value-added calculations of NBBM4.

Table 2: Potential of value creation for NBBM4 in absolute numbers

NBBM4	€/a*7.2 t
Value Added	- 43,713.00
Potential Revenue	7,391.00

Table 3: Eco-efficiency based on revenue (RE) and value-added (VA) NBBM 4 per ton of product

NBBM 4	VA (€) / env. impact	RE (€) / env. impact
GWP (kg CO2-Eq)	0.00	0.42
TAP (kg SO2-Eq)	0.00	152.08
ODP (kg CFC11-Eq)	0.00	1 406 202.44
FEP (kg P-Ep)	0.00	511.22
FDP (kg oil-Eq)	0.00	0.90
CED (MJ)	0.00	0.15

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