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

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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 investigations of the of wood-plastic-composite profiles (NBBM3), produced by TerrainEco in Rychvald, a town with 7.5 thousand inhabitants on the northeastern city borders of Ostrava in the Czech Republic. The production processes carried out at TerrainEco are building the foreground system and forming 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

The results of the social risk analyses for the bark-enriched wood plastic composite (WPC) profiles show a low or medium risk level for most indicators analyzed (Fig. 3). A low-risk potential was found regarding unemployment among people with advanced education, fair wage potential, percentage of unemployment in the Czech Republic an incidents of racial motivated crime. Still, 13 out of 28 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, 3 indicators with a high-risk potential were identified i.e., a high share of unemployment among people in Roma communities. This implies that those people have unequal opportunities in the job market. Another high risk was identified regarding collective labor rights in the Czech Republic, where violations of internationally recognized labor rights by governments and employees are regularly reported. For the TerrainEco, no documents on agreements to sustainability issues nor sustainability reports could be found which 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 deliverable 5.6).

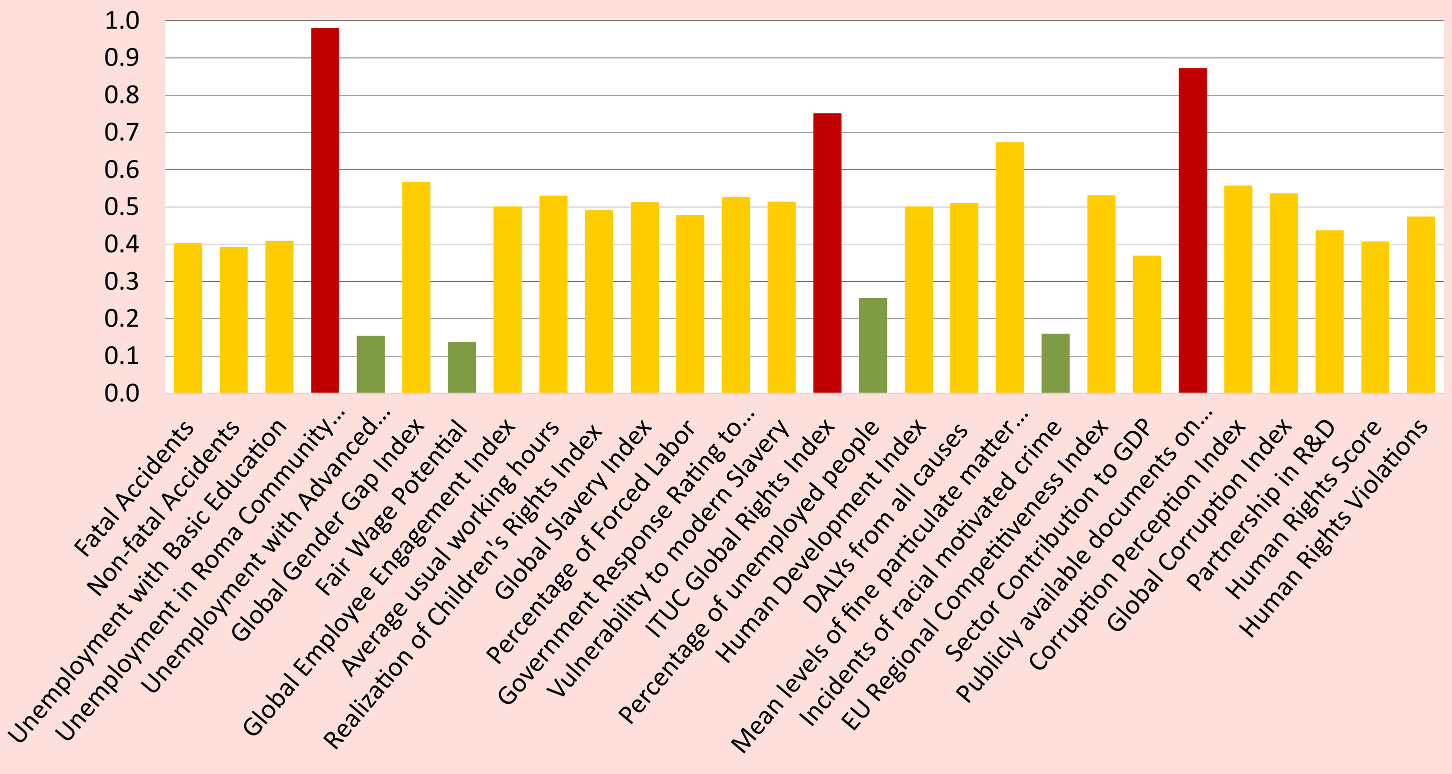

Figure 3: Selected social risks of the wood-plastic-composite profiles (green=lower risks; yellow=medium risk; red= higher risk)

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)) and cumulated energy demand (CED) are listed in Tab. 1. The contribution analysis shows that the highest contributor to the potential impacts in all categories except ODP is electricity (Fig.1). The electricity mix of the Czech Republic highly depends on coal and natural gas (IEA, 2020). The most electricity-consuming processes are blending, extruding and spray cooling. The second highest contributor is the production of PVC. Therefore, improvement potential were analyzed in different scenarios: 1) exchange PVC with PP; 2) PE instead of PVC; 3) increase of wood fiber content (60%); 4) exchanging PVC with biogenic PLA; 5) use of renewable electricity, and 6) modified recipe with lower PVC and wood content but higher content of additives. Fig. 2 shows the results of the scenario where the highest reductions can be achieved by the use of renewable electricity (scenario 5) and by increasing the amount of wood fiber (scenario 3) in most impact categories. Different for ODP, here the highest reductions can be achieved by scenarios 1,2 and 4 by exchanging PVC with other plastics. More detailed information on the results can be found in D5.8. Fig. 3 illustrates that a reduction of 55% in GWP can be achieved when several improvement strategies are implemented together (i.e. increasing material efficiency, energy efficiency, secondary plastic input, share of renewable electricity, end-of-life recycling, as well as replacing PVC with PLA), in which increased end-of-life recycling plays a key role (c.f. Brunnhuber et al. 202X).

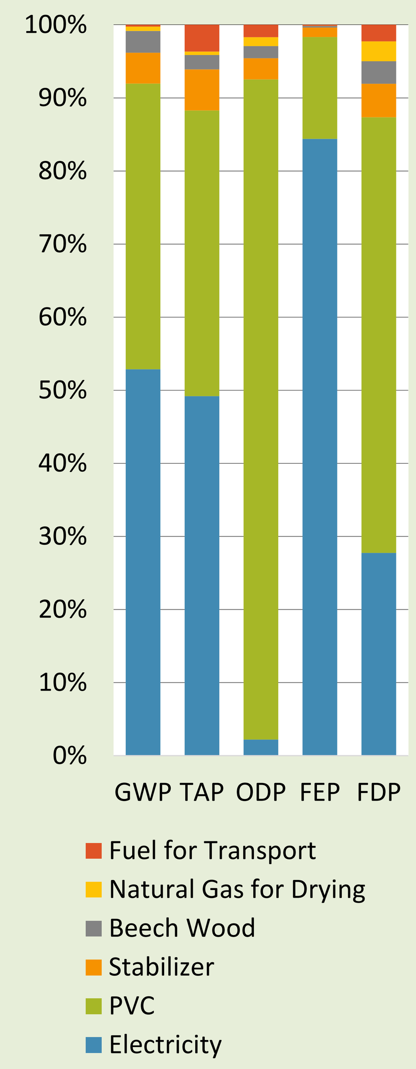

Figure 1: Contribution analysis of NBBM3 in different impact categories

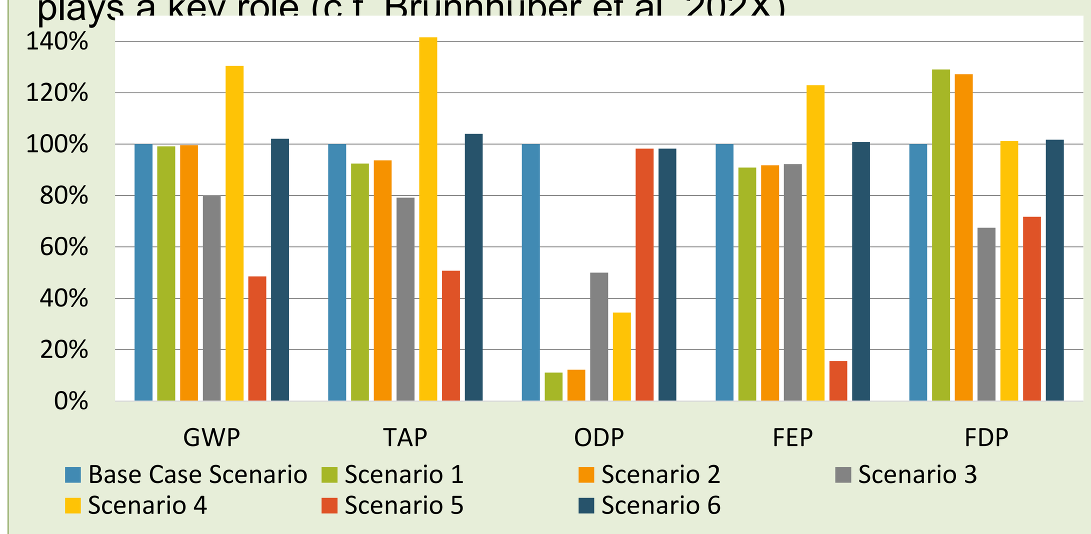

Figure 2: Scenario analysis NBBM3 for different impact categories relative to Base Case (100%)

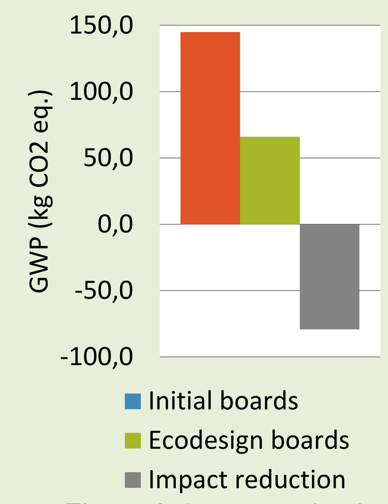

Figure 3: Impact reduction potential of GWP

Table 1: Potential environmental impacts of producing 1t NBBM3

Impact category	Value/1 ton NBBM3
GWP (kg CO_2-Eq)	1355.54
TAP (kg SO_2-Eq)	6.15
ODP (kg CFC_{11}-Eq)	0.00058
FEP (kg P-Ep)	0.7
FDP (kg oil-Eq)	704.76
CED (MJ)	5680.72

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;
- offer training and employment, especially for disadvantaged groups of people;
- ensure compliance with freedom of association and collective bargaining standards to reduce risks of violating collective labor rights;
- increase the share of regional available inputs for the production processes to increase value creation for the region;
- substitute the use of PVC by e.g., increasing the share of woody material;
- reduce impacts by using a different stabilizer with less zeolite content;
- switch to a renewable source of electricity and heat;
- increase the efficiency of the manufacturing process;
- use recycled PVC by implementing a product recovery system;
- reduce the use of toxic substances and emissions through a higher recycling and reuse rate of materials.
- increase productivity through enhancing the sustainable use of renewable resources (e.g. cascading use) or by extending the product's life or establishing product take-back aften use as secondary raw material source.

Further reading

Deliverables 5.5; 5.6 & 5.7 of tasks 4 in Dendromass4Europe

Brunnhuber, N., Windsperger, A., Perdomo E. E. A., Hesser F. (202X). Implementing Ecodesign During Product Development: an Ex-Ante Life Cycle Assessment of Wood-Plastic Composites. Progress in Life Cycle Assessment

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

Prosperity

Value creation happens through D4EU operations and upstream processes (Fig. 4). It is assumed that the machinery can produce 80 tons of WPC profiles per year. The amortization time of the machinery investment is considered to be 5 years with 4 % interest rate. Under the current assumptions and data basis used for calculating the value added of WPC Profiles production, the value added is negative, meaning that no value added 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 profiles could reach € 97,600 per year (Tab. 2). The fact that no positive value added can be created for NBBM 3 may be due to the nature that it is produced within a demonstration project at a low technology readiness level (TRL). When the production becomes more established it may differ to the current results. However, such an upscaling process cannot be determined under the current data basis. Tab. 3 summarizes the eco-efficiency calculations in different impact categories and Fig. 5 show the eco-efficiency results illustrated as revenue (RE) and the value added (VA) per global warming potential (GWP), were 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.

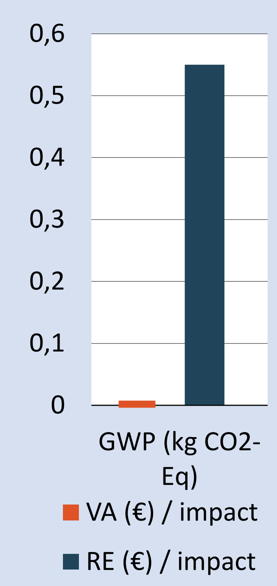

Figure 5: Revenue (RE) and value added (VA) per GWP for 1 t NBBM 3

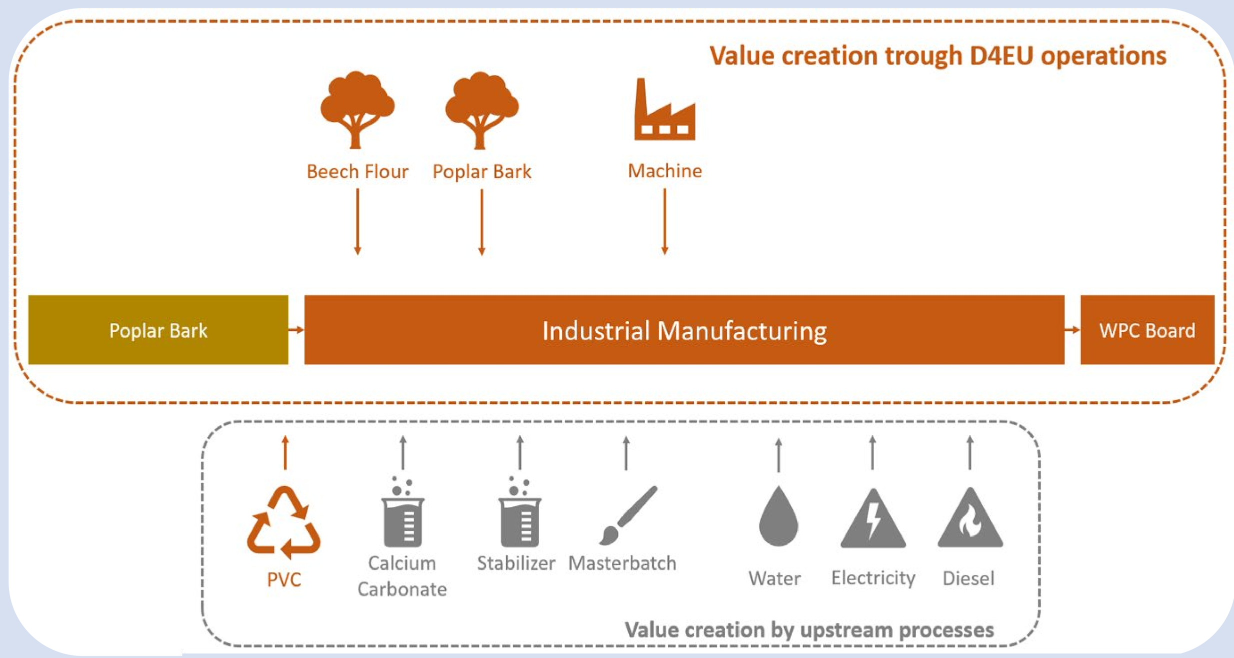

Figure 4: Processes considered for the value-added calculations of NBBM3.

Table 2: Potential of value creation for NBBM 3 in absolute numbers

NBBM 3	€/a*80 t
Value Added	- 56 531.00
Potential Revenue	97 600.00

Table 3: Eco-efficiency based on revenue (RE) and value-added (VA) NBBM3 per ton of product

NBBM 3	VA (€) / impact	RE (€) / impact
GWP (kg CO2-Eq)	0	0.55
TAP (kg SO2-Eq)	0	164.20
ODP (kg CFC11-Eq)	0	2 103 448.28
FEP (kg P-Ep)	0	528.14
FDP (kg oil-Eq)	0	1.40
CED (MJ)	0	0.21

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