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LIFE ECO-PULPLAST DEMONSTRATION PLAN

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Contributions	All partners

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1. Introduction and scope of deliverable D05

This deliverable concerns the definition of a detailed plan of the demonstration operations. The plan was elaborated and will be periodically updated by the technical demonstration team coordinated by the responsible of the demonstration operations.

The clear definition of the demonstration plan is crucial to effectively perform all demonstration activities required to comprehensively evaluate all different aspects related to the prototype line and technological solutions: technical, economic, environmental and social.

The starting point for the definition of the demonstration plan was the expertise gained by the project partners during previous activities and tests, in particular those conducted in the course of the LIFE ECO-PULPLAST project. This includes also meetings with technology suppliers, market expectations and upscale to industrial level.

The plan defines a list of activities and a list of partial objectives. It also sets procedures, responsibilities and timetables. Such activities include, for example, logistics aspects (pulper waste collection from the different paper mills and stocking, etc.), operative guidelines (operation of machineries, sampling for laboratory tests, data collection, etc.) and testing of process parameters configurations.

The plan takes into account also practical aspects related to the demonstration activities, such as effort distribution and the interaction and integration with other project actions and activities, such as data collection and analysis, evaluation of the results and replicability and scalability issues.

2. Action B2: Prototype line operation and demonstration

This action concerns the actual implementation, testing and demonstration of the technological solutions identified for recycling the paper industry's pulper waste to produce plastic euro-pallets.

The demonstration of the prototype line is the key action of the LIFE ECO-PULPLAST project, as it allows the demonstration of the identified recycling technology in terms of pulper waste process workability, development of new plastic compounds and production of euro-pallets from waste mixed plastics. Several other actions of the project are based on the activities and results of this action, i.e. data analysis, pilot monitoring and evaluation, the impact assessment and the development of a business plan and a business model.

The prototype line operation and demonstration are based on the demonstration plan, object of the current deliverable, produced by the technical demonstration team and composed of SELENE, LUCENSE and SERVECO representatives, and by the responsible of the demonstration operations, which were appointed in the first month of the action.

Technical activities will be conducted by the operators with the help and guidance provided by the technical support group, according to Action B.3.

The data and information produced during pilot demonstration will be collected into Data Collection Logs (Action C.2) according to the indicators and methodologies established in the Evaluation Plan (Action C.1).

The main focus of the pilot demonstration is related to the innovative use of pulper waste



in the processing line and production of plastic pallets. Consequently, special attention is put on the composition of pulper waste, especially on the average content of cellulose fibres and on the mixed plastics composition.

Based on the technology solutions selected and on the current design of the prototype line, this action will tackle several technological and operative aspects:

- Logistics and support facilities;
- Characterisation of pulper waste and of the mixed plastic fraction obtained after the pre-treatment phase;
- development of new compounds based on pulper waste from different paper mills;
- commissioning of the prototype line and optimization of process parameters;
- evaluation of line productivity and operating costs;
- plastic pallets specifications.

The results achieved during the prototype operation will be used to evaluate the pilot demonstration, develop a business plan for a larger production plant and elaborate a business model to assess the replicability and transferability of the method and solutions at national and European level.

3. Demonstration plan

First of all, the Steering Committee appointed Camillo Cardelli (Selene) as Responsible for demonstration operations and appointed Francesca Paoli (Selene), Federico Sebastiani (Lucense) and Andrea Moretti (Serveco - Cartiere Cardella) as members of the Demonstration team.

The activities and partial objectives are defined according to the expected results, and in view of the subsequent data analysis, impact assessment, business plan for the industrial upscale and business model for replicability and transferability evaluations.

Expected results of the demonstration activities are, among others:

- Characterisation and use of pulper waste produced by at least three different paper mills;
- Development of at least three different compounds with pulper waste content well above 50% and sufficient process workability, with different physical/mechanical characteristics;
- Line productivity of at least 80% of the nominal value;
- Downtime below 5%;
- Manufacturing of plastic euro-pallets with all the required physical/mechanical properties (in compliance to technical regulations);
- Production efficiency above 90% (processing waste below 10%);
- Operating costs (energy consumption, maintenance, additives, etc.) in line with the preliminary business plan.



The experimental activities can be divided in three main parts:

- a) Input materials and new plastic compounds;
- b) Prototype line operation
- c) Characteristics of plastic pallets.

The data and information produced during the prototype line operation will be collected according to the form for data acquisition described in D09 – Evaluation plan and will be analysed in Actions C.2 and C.3.

The demonstration plan is schematically reported hereafter, in terms of activities, objectives and GANTT. The plan will be periodically updated, in consideration of the periodic evaluation of the pilot activities and the partial results achieved. Corrective actions will be taken, if necessary.

Input materials and new plastic compounds:

- Characterisation of pulper waste, with samples collected from at least three different paper mills and at different moments, in terms of physical and chemical composition, presence of impurities, water content, etc.;
- Periodic characterisation of pre-treated pulper waste, after pre-treatment, through different material separation technologies, of the different materials composing pulper waste, in order to evaluate the residual presence of impurities (metals, fibres and other impurities) and the water content;
- Development of new compounds, mixed plastics from pulper waste mixed with specific additives to confer the required characteristics. The aim is to achieve the required physical/mechanical characteristics while at the same time maximising the amount of pulper waste in the mix;
- Extrusion of samples to evaluate at laboratory scale the physical/mechanical properties of the mixed plastics materials from pulper waste and of the new compounds.

Prototype line operation:

- Training of operators during line commissioning, provided by technology suppliers. Procedures and operative guidelines will be provided to operators;
- Optimisation of process parameters, in terms of line productivity and operating costs. Tests will be performed with at least three input materials and plastic compounds, with different characteristics in terms of water content, amount of residual cellulose and levels of impurities.

Several parameters will be taken into account: line productivity, homogeneity of mixed plastics, extrusion temperature, degassing effectiveness, cooling time, moulding quality (number of defected pallets).

- Evaluation of productivity and operating costs of the complete prototype line, including downtime, production efficiency and maintenance.
- Correlation between pallet performances and pulper waste quality
Through the comparison of results of physical, chemical and mechanical analyses,



correlation tables will be realized in order to guarantee the required performances of plastic pallet realized with mixing different types of pulper waste.

The results of the tests and analysis conducted in Action B.3 will provide valuable feedbacks that will be used to vary the experimental conditions, adjust process parameters, use different additives and, if required, make small modifications and improvements to the prototype line.

Characterisation of plastic pallets.

- Pallet overall quality: pallet colour, odour, surface quality;
- Physical properties: pallet dimension (length, width, height, etc.) and weight;
- Mechanical properties: tests at laboratory scale of density, elastic modulus, strength yield, Young's modulus, etc.;
- Tests of pallet performance requirements in compliance to technical regulations: static tests, *i.e. bending strength and stiffness, compression, staking and racking*; dynamic test load, *i.e. corner drop test and shear impact test*; friction tests.

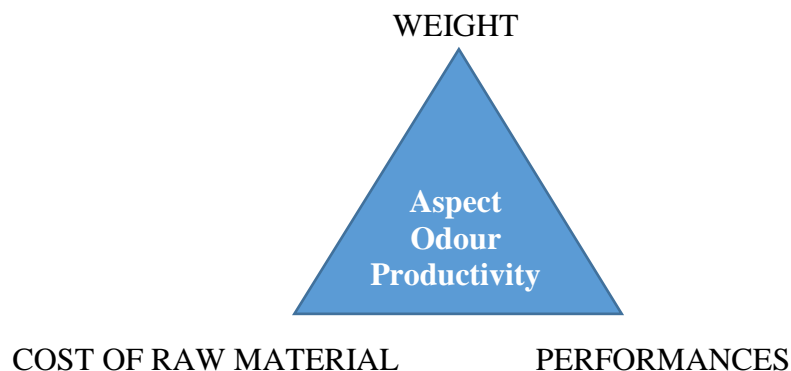
Furthermore, through iterative methods, the correlation tables will be tested and refined in order to fulfil both the technical regulation's requirements and market's functional performances of the plastic pallets.

KEY INDICATORS AND CONSTRAINTS

Pallets optimisation needs to take into consideration economic and technical constraints. Above all are the overall cost of the input materials composing the plastic compounds (pulper waste, other plastics and additives), the pallet total weight and its mechanical performance.

The experimental conditions used in the demonstration activities conducted during the project will thereby remain within the triangle represented in the following figure.

Additional relevant parameters to be considered are the general aspect of the pallets, including their odour, and the line productivity, which is crucial for the industrial scalability.





Hereafter we report the expected impact of the different demonstration activities on the pallets performance and the line productivity.

INPUT MATERIAL	PALLET	PRODUCTIVITY
<u>Pulper waste</u>		
- Periodic sampling	High	
- From different paper mills	High	Low
<u>Mixtures</u>		
- Of different scraps/waste	High	High
- With recycled plastics	High	Low
- With additives	High	High
<u>Treatments</u>		
- Level of impurities	High	High
- Humidity		High
- Physical aspect	Low	High

PROCESS PARAMETERS	PALLET	PRODUCTIVITY
<u>Productivity and operational costs</u>		
- Injection pressure	Low	High
- Temperature	High	High
- Mould pressure	High	
- Cooling time		High

PALLETS REQUIREMENTS

The main physical parameters and requirements for the plastic pallets are the following:

- Dimensional stability and pallet curling
- Weight
- External aspect
- Roughness and sliding friction

In addition, pallets must fulfil mechanical requirements, which have to be verified according to the international standard ISO 8611. The most important test methods to measure the pallet performance are the following:

- Bending test
- Fork lifting test
- Compression test for blocks
- Corner drop test

OVERALL GANTT OF DEMONSTRATION ACTIVITIES

	2017												2018					
List of activities	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	
A. Input material and new plastic compounds																		
Characterisation of pulper waste	█																	
Characterisation of pre-treated pulper waste		█																
Development of new compounds					█													
Sample tests							█											
B. Prototype line operation																		
Line commissioning		█																
Optimisation of process parameters					█													
Evaluation of prototype line productivity and operating costs							█					█						
Correlation between pallet performances and pulper waste quality									█			█						
C. Characterisation of plastic pallets																		
Overall quality		█																
Physical properties				█														
Mechanical properties							█					█						
Compliance with performance requirements									█			█						