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I-PAN

INNOVATIVE POPLAR LOW DENSITY STRUCTURAL PANEL

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Document information

Abstract

One of the main activities of CIAOTECH within the I-PAN project is to assess the environmental benefits of the proposed innovative process, and to produce the related Life Cycle Assessment (LCA) study, according with ISO 14040 and 14044.

LCA is a technique to assess the environmental aspects and potential impacts associated with a product, process or service through all stages of its life cycle, from raw material extraction and production, through manufacturing, packaging and distribution, use, as well as final disposal or recycling.

This report details the preliminary activities performed by CIAOTECH in order to define the product processes to be compared and the system boundaries; the functional unit; the inputs and outputs of each stage of the product process in terms of material, energy, waste and emissions.

Keywords

Poplar, wood, wood-based panels, engineered wood, environment, LCA, carbon footprint, GWP

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LIST OF ABBREVIATIONS AND DEFINITIONS

EW	Engineered Wood
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
LCIA	Life Cycle Impact Assessment
LSB	Lightweight Strand Board
GWP	Global Warming Potential
VOC	volatile organic compound

INTRODUCTION

I-PAN project aims at providing novel and highly environmental friendly solutions in the field of the engineered wood (EW) based boards.

The concept of the I-PAN project is to boost the utilization of traditional wood-based panels by engineering their properties to match lightweight applications requirements, reducing the manufacturing cost along the overall process and allowing a highly sustainable approach at the same time, through the reduction of raw material process input, the use of re-cycled material, the minimization of wastes and energy consumption and the reduction of pollutant compounds emissions.

The I-PAN project aims in fact at designing a breakthrough wood-made lightweight panel, adopting 50% of its volume recycled poplar wood and for the remaining 50% poplar wood by using the upper part of the tree that is commonly underused. To this purpose, a novel manufacturing process is designed and innovation to existing resins is defined in order to require less energy during the drying and pressing process, minimizing VOC emission and reducing the overall cost of production.

The I-PAN project specific objective is to develop and demonstrate the environmental benefits brought by its advanced solutions by:

(i) reducing the pressure on forests derived raw materials use, thanks to the maximization of use of selected poplar plantations allowing 7-8 years poplar growth cycle.

(ii) reducing the quantity of wood as an input of the overall process, thanks to the use of 50% made of recycled poplar wood for the development of an innovative EW based technology for Lightweight Strand Board (LSB) production, recyclable at the end of the product lifecycle.

(iii) reducing the wastes and consumptions along the overall manufacturing process, starting from an optimal use of raw material (poplar wood) to the several steps needed for wood treatment (e.g. lower energy for fast drying and blending processes) an final product release.

(iv) reducing the quantity and presence of hazardous and volatile chemicals by developing a new formaldehyde-based resin suitable for the necessary bonding recycled wood.

(v) reducing the carbon footprint by innovating the production process and decreasing the number of felled trees.

1 THE LIFE CYCLE ASSESSMENT

Life cycle assessment (LCA) is a technique to assess the environmental aspects and potential impacts associated with a product, process or service through all stages of its life cycle. The life cycle embraces all the activities from raw material extraction and production, through manufacturing, packaging and distribution, use, as well as final disposal or recycling.

Energy, material and water resources are used in creating, packaging, transporting and using a product whilst the associated process generates emissions to air, land and water, causing strong environmental impacts.

The leading standards used for performing LCA are ISO 14040 and 14044 where ISO 14040 outlines general principles and framework and ISO 14044 provides requirements and guidelines.

1.1 THE LIFE CYCLE ASSESSMENT APPLICATION FIELDS

LCA can be useful as a conceptual framework and as a set of practical tools: originally developed to create decision support tools for distinguishing between products, product systems, or services on environmental grounds, it is now used in several applications: internal industrial use in product development and improvement; internal strategic planning and policy decision support in industry; external industrial use for marketing purposes; governmental policy making in the areas of eco-labelling, green procurement and waste management opportunities.

1.2 THE 4 STEPS OF LIFE CYCLE ASSESSMENT

LCA can be performed at conceptual, simplified or detailed level depending on data availability, scope and application definition. It will be conducted by experienced consultants, following four main stages.

Step 1 – The scope definition

The goal and scope definition sets out the context of the study and explains how and to whom the results are to be communicated; this analysis includes technical details such as the description of the functional unit and of the system boundaries.

Step 2 - The Life Cycle Inventory (LCI)

Life Cycle Inventory (LCI) analysis aims at creating an inventory of data about water, energy and raw materials inputs, and releases to air, land and water, within the whole life cycle.

The result is a LCI which provides information about all inputs and outputs in the form of elementary flow to and from the environment from all the unit processes involved in the study.

Step 3 - The Life Cycle Impact Assessment (LCIA)

Life Cycle Impact Assessment (LCIA) is the evaluation of the potential impacts associated with the identified forms of resource use and environmental releases.

It is based on the LCI flow results: in order to assess the total impact, all contributions are brought back to the same unit of measurement and then summed.

Step 4 - The results interpretation

This step implies the interpretation of the results from the previous phases of the study, the identification of significant environmental issues, the evaluation of the analysis results, as well as conclusions and recommendations.

Life cycle interpretation is also a process of communication designed to give credibility to the results of the more technical phases of LCA, namely the inventory analysis and the impact assessment, in a form which is both comprehensible and useful to the decision makers.

2 LCA INITIALIZATION

The present activity consists in a report on the initial LCA assessment, regarding the formalization of the industrial processes and the collection of relevant information that will be used in the LCA study.

In particular, the scope of the preliminary activities performed on LCA study is to define:

- the product processes to be compared and the system boundaries;

- the functional unit;

- the inputs and outputs of each stage of the product process in terms of material, energy, waste and emissions.

The majority of the modelling and analysis will be performed using a specific LCA software, chosen between:

- CCalC software, a specific tool developed by University of Manchester reviewed with the collaboration of several industries. The tool basis on two database for material and energy inventories, the specific developed CCalC and the Ecoinvent database. It uses a transparent framework for constructing LCA models of systems of interest. It tabulates a detailed inventory of system inputs and outputs, determining the impact of each of these on the environment using an impact assessment method available to the analyst;

- SiMaPro software, a professional tool allowing to collect, analyse and monitor the sustainability performance of products and services, in order to measure the environmental impact of products and services across all life cycle stages and in all aspects of the supply chain, from extraction of raw materials to manufacturing, distribution, use, and disposal.

2.1 PRODUCT PROCESS AND SYSTEM BOUNDARIES

Basing on Grant Agreement, the following process schemes have been depicted as starting point for the improvements sought by I-PAN ongoing activities.

The conventional process scheme reported in Figure 1 clearly shows in yellow areas what are main areas for intervening through I-PAN project in reducing carbon footprint (namely the GWP identified by KgCO2eq indicator) of the manufacturing chain.

The I-PAN production process has been therefore analysed and divided into phases, each representing a particular step of the overall industrial process, in order to evaluate the environmental benefits of the innovative process compared with the existing one.

The results of the analysis are reported in Figure 2, in which the I-PAN process is defined in terms of system boundaries and life cycle stages.

In particular the general scheme of the I-PAN process is similar to the conventional one, while the specific inputs and outputs of each steps will be different, with particular reference to the expected effects on environment.

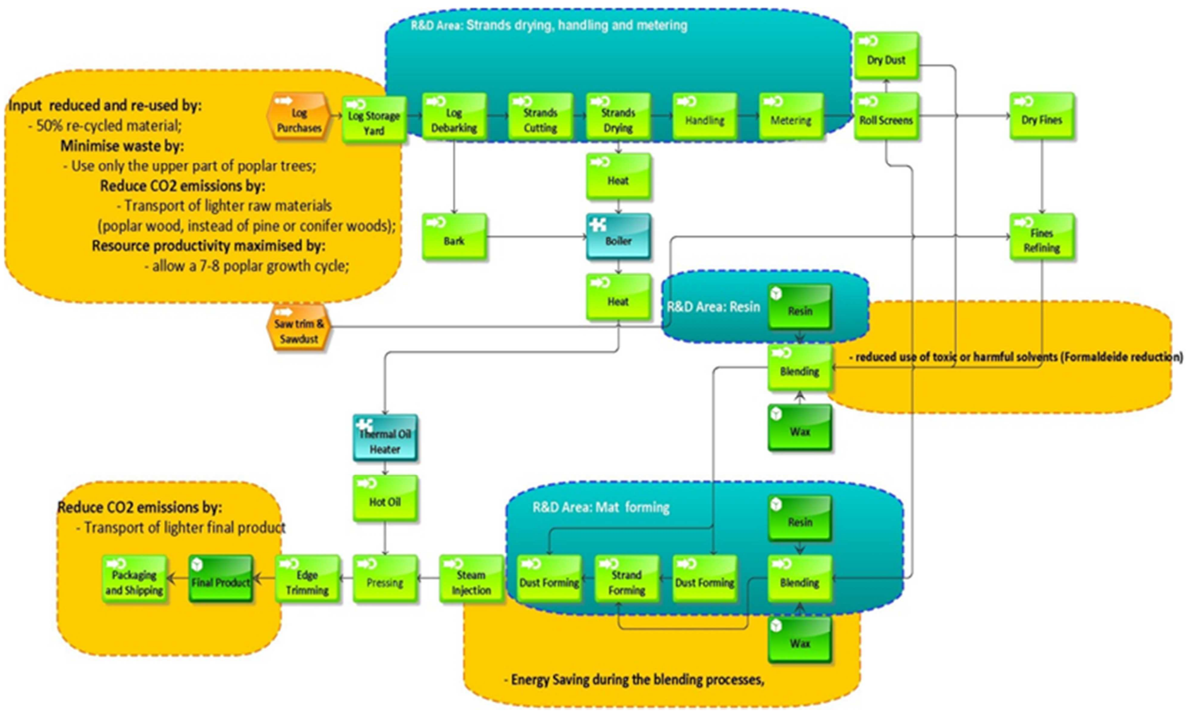

Figure 1 - General scheme of conventional process flow as referred in Grant Agreement

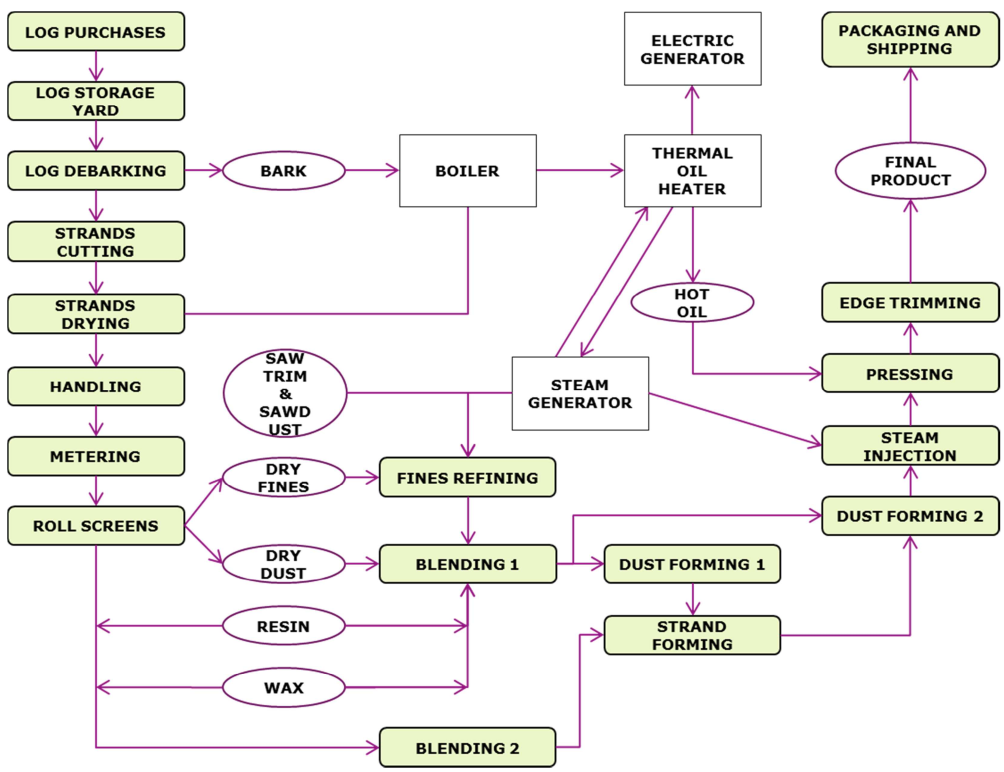

Figure 2 - General scheme of I-PAN process flow

2.2 Functional unit

The aim of the Life Cycle Inventory (LCI), as part of the LCA study, is to calculate the quantities of different resources required and emissions and waste generated per functional unit. The definition of the functional unit is therefore a central point of the analysis.

The functional unit for this life cycle analysis will be 1 wood-based panel, characterized by the following parameters: length 1250 mm, width 2500 mm and thickness 10 mm.

2.3 The materials flow

The model of the product system is typically a static simulation model that is composed of unit processes, which each represent one or several activities - such as production processes, transport, or retail. For each unit process, data are recorded on the inputs of natural resources, the emissions, waste flows, and other environmental exchanges as shown in Figure 3. The environmental exchanges are typically assumed to be linearly related to one of the product flows of the unit process.

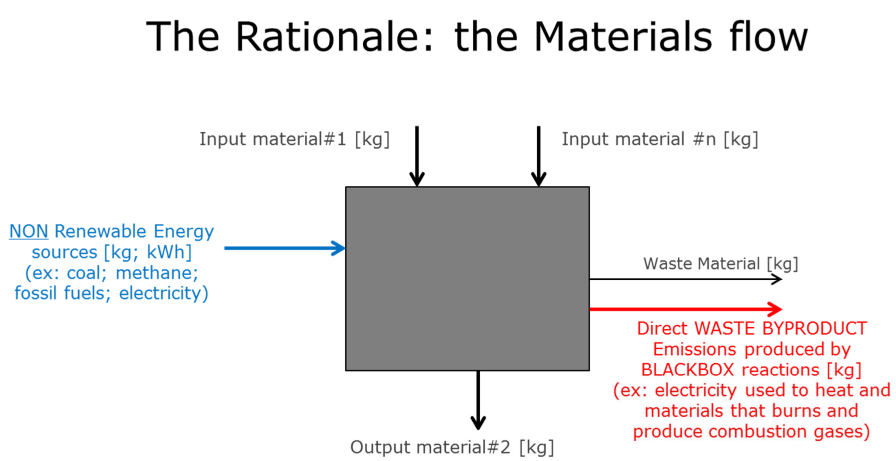

Figure 3 - Black box representing each step of process activity

Each step of process activity is simplified with a black box in which materials flow to be transformed (or delivered) from an input to an output by producing eventually some waste material and some direct emissions produced by chemical reactions inside the black box. The transformation is realized by consuming some energy (i.e. MJ) that can be provided by various sources (electricity, steam, fossil fuels, etc.).

3 COLLECTED DATA

In the following table are reported the specific inputs and outputs of each stage defined in the scheme of Figure 2.

The definition of the quantities and the subsequent analysis and interpretation of results will be performed during the LCA study.

stage	*input materials*	*output materials*	*by-product / waste*	*energy sources*	*direct emissions*
LOG PURCHASES	poplar wood	poplar wood	-	-	-
LOG STORAGE YARD	poplar wood	poplar wood	-	fuel	moisture
LOG DEBARKING	poplar wood	debarked poplar wood	bark	electric energy	-
STRANDS CUTTING	debarked poplar wood	undried strands	-	electric energy	-
STRANDS DRYING	undried strands	dried strands	-	electric energy, methane, biomass	warm moist air
HANDLING	dried strands	dried strands	-	electric energy	-
METERING	dried strands	dried strands	-	-	-
ROLL SCREENS	dried strands	dried strands	fines, dust	electric energy	-
FINES REFINING	fines	fines	-	electric energy	-
BLENDING 1	resin, water, paraffin wax, dust	mat	-	electric energy	-
BLENDING 2	resin, water, paraffin wax, dried strands	mat	-	electric energy	-
DUST FORMING 1	mat	regular mat	-	electric energy	-
STRAND FORMING	mat	regular mat	-	electric energy	-
DUST FORMING 2	mat, regular mat	regular mat	-	electric energy	-
STEAM INJECTION	regular mat, steam	regular moist mat	-	methane, electric energy	fumes
PRESSING	regular moist mat	OSB continuous panel	-	methane, electric energy	fumes
EDGE TRIMMING	OSB continuous panel	OSB panel	scraps	electric energy	-
PACKAGING AND SHIPPING	OSB panel, timbers, streps	OSB panels package	-	electric energy	-
BOILER	biomass, bark and fines	-	-	from methane and electric energy to thermal energy	-
THERMAL OIL HEATER	-	-	-	methane, electric energy	-
STEAM GENERATOR	water	steam	-	thermal energy	-
ELECTRIC GENERATOR	-	-	-	from thermal energy to electric energy	-

Table 1 – Inputs and outputs of each process stage

4 CONCLUSIONS

The specific objectives of this preliminary activity on LCA study have been:

- the definition of the product processes to be compared and the system boundaries: the general schemes of the two industrial processes to be compared are reported in the Figure 1 and 2 of the present report;

- the choice of the functional unit, that will be the wood-based panel;

- the analysis of the inputs and outputs of each stage of the product process in terms of material, energy, waste and emissions, reported in the table 1.

The data collected and results achieved will be essential in order to perform the complete LCA study according with ISO 14040 and 14044, that will be the subject of Deliverable D2.6 “Life Cycle Analysis Study and Report”, to be delivered at month 36.