LIFE Project Number

LIFE09 ENV/ES/454

FINAL Report

Covering the project activities from 01/09/2010 to 31/03/2014

Reporting Date

15/07/2014

LIFE+ PROJECT NAME or Acronym

LIFE WOODRUB

Project Data

Project location	Spain, Italy, United Kingdom, Greece, Germany
Project start date:	01/09/2010
Project end date:	31/12/2013 **Extension date:** 31/03/2014
Total Project duration (in months)	43 months (including **Extension of 3 months**)
Total budget	1.838.368,00€
Total eligible budget	1.838.368,00€
EU contribution:	918.192,00€
(%) of total costs	50%
(%) of eligible costs	49.95%

Beneficiary Data

Name Beneficiary	AIDIMA
Contact person	Mr.Manuel I.Belanche
Postal address	C/Benjamín Franklin, 13. E46980 Paterna
Visit address	C/Benjamín Franklin, 13. E46980 Paterna
Telephone	+34-961366070
Fax:	+34-961366185
E-mail	mbelan@aidima.es
Project Website	www.WOODRUB.com

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1. Executive Summary

Project objectives

About 4 million tons of waste tires and 30 million tons of wood waste are generated each year in the countries of the European Union.

The large volume of wood and rubber waste generated annually Europe has now new business opportunities and new markets through WOODRUB project, which makes available to the company a range of materials with low carbon footprint and economically competitive.

The WOODRUB project "Utilization of recovered wood and rubber for alternative composite products" aims to offer the market new value-added applications using novel composite boards for various uses.

WOODRUB is a European project funded by the Directorate General Environment of the European Commission through the LIFE + Programme.

The main objective of this project is to develop, analyse and generate new sustainable products, which will be respectful with the environment and made from recycled wood and rubber from tires.

Secondary objectives include:

• Providing both, tires and wood waste managers, a solution for the products in their last phase of the life cycle.

• Offering new materials to public and private entities in the building and construction sector.

• Providing a solution for the accumulation of unused waste for other purposes.

• Increasing the CO_2 stored in buildings or replacing other construction materials less sustainable in terms of emissions and carbon storage.

Key Deliverables

The WOODRUB project was structured in 8 different Actions and all of them were essential for the right development of the project. In any case, Actions 4, 5 and 6 are the technical Actions with the main objectives and results of the project, because of that the key deliverables belong to these three actions. The key deliverables of the project are the following:

- Deliverable 4.3- This deliverable provided information about WOODRUB particleboard processing methodology. There are two main WOODRUB composite types, from which functional prototypes were developed, namely WOODRUB particleboard with mixed constituents and WOODRUB sandwich board with stacks layers of wood and rubber.

  In the second part of the deliverable prototype products selected for the further realisation by the WOODRUB project were presented. Description of developed prototypes with justification of functionality was presented also.

  A function and performance demand model and initial tests, suitable composites for use in prototypes were selected.

Optimisation of the mechanical properties of processed prototypes along with sound absorption properties were considered as the two most important aspects. Therefore, processing method and factors settings are results of performed tests.

- Deliverable 4.4- Test methodology and performance of the developed wood rubber composites was discussed. In the first part, test methods used for WOODRUB particleboard and sandwich composite materials were described with reference to the theory and relevant standards.

  In the second section of this report, results of conducted tests were presented and discussed.

  Mechanical tests and sound absorption tests report were based on tests results, project meetings, discussions and consortium expertise.

- Deliverable 5.2- This deliverable contains the development details of the different products successfully manufactured with WOODRUB materials. All of them have the accurate design required and the most important properties (strength, acoustic, etc.) have been tested on them using the appropriate standards.

  Each application of the different manufacturing processes is schemed in a flow diagram that showed the consecutive steps of manufacturing. In addition the tables of the prototypes and standards specifications were written to evaluate the different products.

- Deliverable 5.3- This deliverable was focused in the evaluation of the new wood rubber components, main objective was to evaluate WOODRUB applications, to give useful information for the stakeholders of why to choose these materials in future applications.

  The evaluation is based on the test results and behaviour of the materials developed. The results were bundled with the results on eco-efficiency of the new developed components and their production processes.

- Deliverable 6.3- The main objective of this deliverable was to assess the environmental aspects associated with the new materials and products deriving from the project. To achieve this objective, the most promising applications developed and tested with composite prototypes developed during the previous activities of the project, were environmentally compared with their identified competitor alternatives in the market. Finally, eco-efficiency of each application or intended use alternatives was compared, considering not only the environmental issues, but also the economic ones.

  As the scope of the LCA is from “cradle to gate”, the life cycle stages studied are from the raw material extraction, to the final product manufacturing. No equipment or infrastructures, or final product packaging were included. Conclusions from the diverse studies were explained in this deliverable.

Outputs

Different types of boards have been obtained combining different percentages of particles with different sizes (those most used in the market), using different adhesives in different proportions and analyzing production parameters and their influence on the characteristics of the obtained boards.

The behaviour and mechanical, thermal and acoustic characteristics have been also analyzed to select those most appropriate for the different uses proposed.

The innovative solutions generated have allowed developing prototypes with various applications:

- WOODRUB ACOUFRAME: Its main function is to act as a sound barrier to absorb the noise generated by traffic on roads, etc.
- WOODRUB ACOUSAND: The combined use of wood and rubber to absorb the sound and noise is also applicable indoors (offices, public premises, etc.) by installing specific panels for walls and ceilings, doors, etc. Temporary barriers for construction works is other possible application of these panels.
- WOODRUB SAFETYMATH / SAFETYDECK: It consists of a working platform with non-slip and antivibration properties, which can be used, among others, in industrial environments, either indoors or outdoors.
- WOODRUB PATHWAY: Currently there are different materials used for sidewalks and trails in parks and gardens. However, the combination of wood and rubber has been particularly suitable for producing tiles because the surface obtained is uniform, it does not slip and is capable to cushion falls, with a thickness of 3 cm. The tiles can be manufactured in many shapes and sizes, being applicable to any surface and designed for different environments.
- WOODRUB PLAYMAT: A useful application for children as a padded surface in play areas to minimize the risk of injury from falls.
- WOODRUB RURBAN: Mixed compound boards of rubber and wood particles can also be used in the furniture manufacturing. As an example of urban furniture, WOODRUB offers the following prototypes: bins, pots and semi-sitting benches for outdoor use. In addition to the tests performed to assess the durability for exterior use, they have been subjected to mechanical tests in order to ensure the safety and the requirements specified by the standards and regulations.
- WOODRUB BRICKS: Wood particles and recycled rubber may also be employed as reinforcing elements to produce elements such as gypsum bricks, which are used for interior building partitions. For this application, it also includes an addition of fibres from the same tire recycling process (which has no commercial output and solution at the moment).

Testing results of the various prototypes presented have enabled the success of the project, in as much as the acoustic, thermal and mechanical properties of new composite materials in accordance with international standards have been assessed. In this way, WOODRUB has developed innovative recycled wood and rubber panels adapted to the different requirements of the respective end applications, and they have been environmentally analysed using the methodologies of life cycle assessment (LCA) and eco-efficiency.

The main long term environmental benefit is waste recycling by providing new market outputs to these recycled materials.

The socio-economic impact in the long term is the waste utilization, savings in management costs as well as saves in their landfilling, social awareness and expanding the use of recycled wood and rubber.

This project has demonstrated technical viability of developed composites and final applications by testing the manufactured prototypes. In consequence, the new opened opportunities to use wood and rubber recycled materials will help the substitution of

alternative virgin materials currently employed. In some cases they are as eco-efficient as other recycled alternative materials or even more.

Environmental evaluation has been performed by using Life Cycle Assessment methodology. Results regarding WOODRUB panels indicate that the main manufacturing impact is due to the glue content, because recovered wood particles and rubber granulate from end of life tyres have a very low environmental impact. For example, synthetic rubber has about 40 times more environmental impact than recycled one. Also the production process, with cogeneration power plant fed with residual wood, has a low environmental impact.

By each m^3 of WOODRUB panel used, about 900 kg of wastes are recovered avoiding their landfilling. On the other hand, recycled materials demand less energy in their production steps than virgin ones.

In several applications (urban furniture, anti-slip decks) WOODRUB panels can substitute recycled plastics or wood plastic composites lumbers.

Comparing by weight environmental results of WOODRUB panels (aprox. 1040 kg/m^3) compared with treated softwood for outdoor use (480kg/m^3) and with recycled plastic lumbers (950 kg/m^3), any of WOODRUB panels has lower impact expressed in Ecoindicator 99 points that the other materials (between 5,5% and 58%).

By comparing 1 m3 of material, the most impacting WOODRUB panel (WR 50-10: wood-rubber particles at 50% of each one, and 10% of PU glue), has a very similar impact to recycled plastic lumber but higher than virgin wood (due to the avoiding climate change impact by the CO_2 fixed in the wood).

On the other hand, the WOODRUB panel with less impact (WR 70-6: woodrubber particles at 70% and 30% respectively, and 6% of PU glue), lightly improves the impact of treated softwood. This means that some of the developed compositions of WOODRUB panels are environmentally as good as virgin wood.

2. Introduction

According to COST Action E31, the annual quantities of recovered wood in Europe reach about 30 million tonnes. The current strategies in managing wood waste include landfilling, incineration and recycling.

Landfilling of organic material leads to CH4 emissions, which result in greenhouse gas potential 21 times higher than that of CO2. During the combustion of particleboard it is important to have the appropriate conditions; otherwise incomplete combustion can result in the formation of toxic compounds. The alternatives to incineration or the disposal of wood waste in landfills constitute low-profit solutions that can also be hostile to the environment. On the other hand, recycling causes less harm to the environment. The 48% rubber content of tyres makes them a high energy source and therefore a potential fuel. One application for this valuable energy source is to power high-temperature kilns used by cement industry. However, burning the tyres produces emissions that have to be carefully controlled to ensure they do not enter the environment.

For a waste recovery system to be widely adopted it must be economically viable to use waste rather than virgin energy sources. At present, use of tyre waste in cement kilns is economical but if emissions limits are tightened, the cost of installing purification equipment may outweigh the cost saving using tyre waste as fuel. Tyres cannot be re-treated or reused

indefinitely. Instead of disposing of them they can be recycled. Recovery and recycling can convert the waste into either a useful material or energy.

In this scenario, the WOODRUB project was considered, with the overall objective of developing, testing and demonstrating different innovative environmental friendly products made from recycled wood and recycled rubber from tyres. With these innovative products conventional construction materials would be designed and demonstrated to the different stakeholders. The project would provide novel end of life routes for rubber and wood waste managers.

To obtain this objective we have developed at laboratory pilot plant scale different particleboards and sandwich composites using different compositions with particles from rubber and wooden wastes with different sizes. We have used different matrix binder system mainly epoxy and polyurethane systems. Then we have analysed the different new products according several European standards to study the mechanical properties, durability, sound absorption and acoustic characteristics, etc. to determine their usefulness in different applications. Having in mind the properties of the new materials we have selected the possible applications. Then we have make different prototypes which we have analysed their behaviour in real conditions.

A deep life cycle assessment has been made on the products developed and the different products developed have been compared with other conventional building materials and other end of life routes of waste wood and waste rubber.

Through the WOODRUB implementation and studies conducted within the framework of the project it is evident that market conditions affect the decisions with regard to the management schemes, processes and business plan to be finally implemented by the industry. In general, the implementation of successful waste management schemes pursuing high quality waste streams materials will result both in the accomplishment of better environmental results and in the increase of income for the management of manufacturing products obtained, thus giving as a result cost-effective and high value products from wood and rubber wastes.

The main long term environmental benefit is waste recycling by providing new market outputs to these recycled materials. The socio-economic impact in the long term is the waste utilization, savings in management costs as well as saves in their landfilling, social awareness and expanding the use of recycled wood and rubber.

This project has demonstrated technical viability of developed composites and final applications by testing the manufactured prototypes. In consequence, the new opened opportunities to use wood and rubber recycled materials will help the substitution of alternative virgin materials currently employed. In some cases they are as eco-efficient as other recycled alternative materials or even more.

3. Administrative part

3.1 Description of the management system

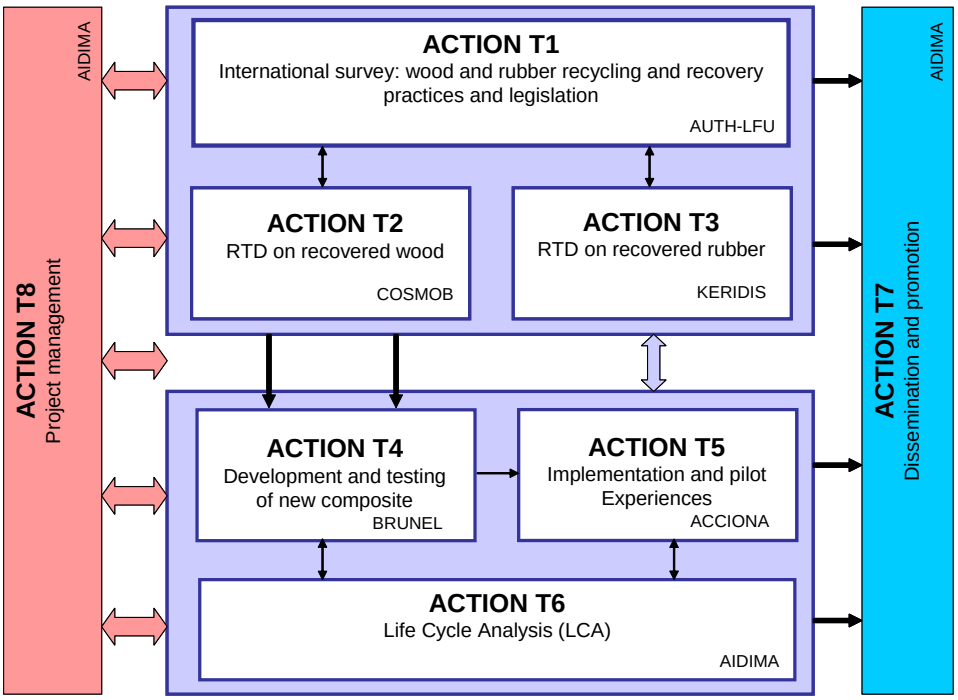


Figure 1. Overall structure of the WOODRUB project, including task leaders

WOODRUB overall tasks structure is clearly shown in the figure X representing relationship between the tasks, and showing who is the responsible for each task.

On the other hand WOODRUB management has been divided in four different tasks:

1.- Strategic management, dealing with consortium business beyond the end of the project;

2.- Administrative management, dealing with project reporting and contract stuff;

3.- Financial management, taking care of the payments and project figures;

4.- Technical management and monitoring, that has taken care of the document monitoring and the effectiveness of the project actions as per comparison with what initially programmed and scheduled.

On the other hand table 1 below shows the different involvement of the project partners in the project activities and the project scheduling can be observed in figure X (Gantt chart).

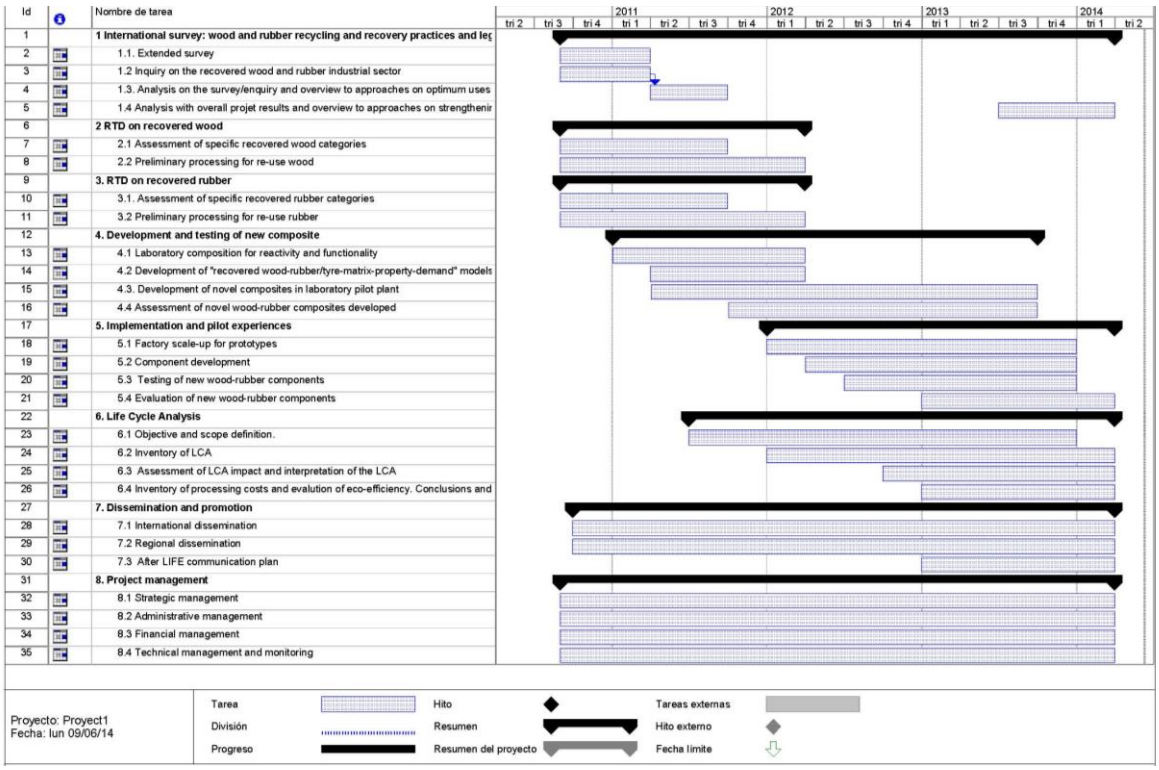
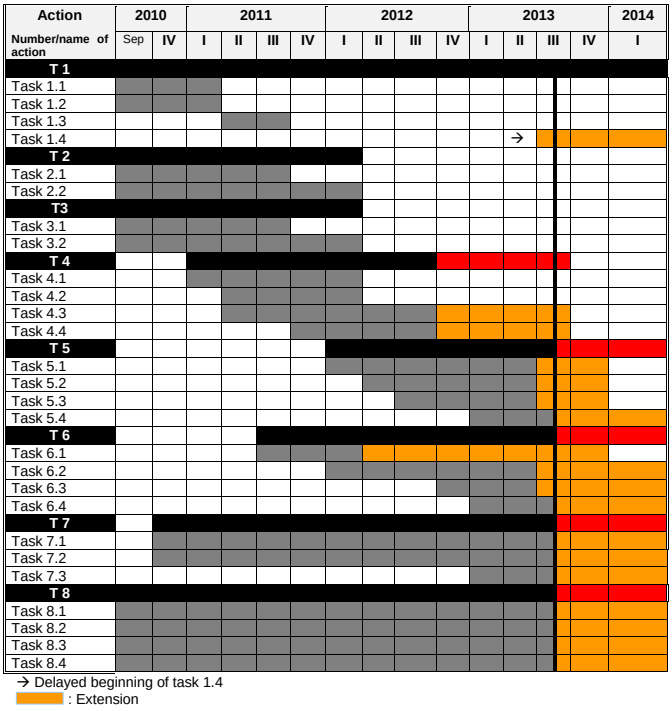


Figure 2. WOODRUB gantt including phases/activities and tasks.

AIDIMA, one of the largest technical institutes at European level in the field of wood products and composites, has been the WOODRUB project coordinator. AIDIMA has a large experience in coordinating and managing EU projects.

Figure 3. WOODRUB project organigram



F*igure 4. WOODRUB Gantt chart*

4. Technical part

4.1. Technical progress, per task

ACTION 1.- INTERNATIONAL SURVEY: WOOD AND RUBBER RECYCLING AND RECOVERY PRACTICES AND LEGISLATION: led by AUTH-LFU

Task 1.1) Extended survey (literature, databases, internet) on wood and rubber recovering

The existing definitions and classification of recovered wood and rubber according to EU Legislation and Standards, literature, relevant ongoing or finished projects and industrial supply practice were searched and compiled. A comparison between the different classification systems according to standards and industrial supply practice was performed and finally definitions and classification of recovered wood and rubber were adopted within the WOODRUB project (Deliverable D1.1, other partners involved: ACCIONA, KERIDIS, AIDIMA). Furthermore, detailed information on existing knowledge and technologies on wood and rubber recovering was collected as well data on the present situation in Europe: current use and additional potential supply of recovered wood in each country, the waste flows for waste wood in Europe, tyre accumulation by each country, estimates of post-consumer tyre routes (Deliverable D1.2, other partners involved: other partners involved: ACCIONA, KERIDIS, AIDIMA).

The objective in this Task was a compilation of information on existing knowledge-technologies-definitions-classification on wood and rubber recovering. The objective was achieved through Deliverables D1.1 and D1.2 while no quantified indicators were foreseen in the DoW. Thus the Milestone M1.2: Quantities and qualities of recovered wood and rubber in Europe, was achieved through deliverable D1.2.

Task 1.2) Inquiry in the recovered wood and rubber industrial sector: practical know-how and experience on recycled wood and rubber raw materials and recycled wood and rubber manufacturing/sales/prices

Two inquiries for the wood and rubber sector in Europe to get information on practical know-how and experience on recycled raw materials were prepared after brainstorming at the kick-off meeting, and afterwards a selection and formulating of questions was done. Also, addresses of European wood and rubber companies were gathered and two separate lists were prepared per wood and rubber. The inquiries were sent (post, e-mail and telephone calls) to 155 wood companies and 88 rubber companies in three submission rounds: May-July-September 2011. All participating beneficiaries of Action T1 were involved.

Task 1.3) Analysis of survey/inquiry and overview of approaches on optimum uses of recycled wood and rubber raw materials for industrial products and applications

The replies received were analysed but provided a rough description of the actual situation in a local level. Besides, the European Panel Federation (EPF) and the European Tyre Recycling Association (ETRA) were contacted and provided reliable data that could give a description of the wood and rubber sectors in relation to the use of recovered wood and rubber. A report was prepared on the actual situation of the recovered wood and rubber sectors in Europe: qualitative and quantitative data. In March 2012 (project month 19), a proposal on future scenarios for the recovered wood and rubber sector was proposed. In April 2012 (project month 20), information was exchanged with The European Panel Federation (EPF) and The European Tyre Recycling Association (ETRA) for the best possible description of the scenarios and 2 meetings were scheduled. The descriptions of scenarios were based on items originally planned to work with through the questionnaires (e.g. legislation, raw materials availability, prices, competitive sectors and their prospects, regional differences, innovation in manufacturing processes, contamination of raw materials, etc.). The discussions with EPF and ETRA led to the identification of 6 realistic scenarios with the following hierarchical order of significance: (1) Competitive sectors and their prospects (2) Legislation (3) Raw materials availability and quality (4) Prices (5) Innovation in manufacturing processes (6) Markets. For the descriptions, the latest reports, documents, publications, legislation and data at European and global level were used. In May 2013 (project month 33), the report on the future scenarios of the wood and rubber sectors was prepared.

The objective “Compilation of information on practical know-how and experience regarding the purchase/use of recycled wood and rubber raw materials in the industrial sector”, was achieved in project month 18 by Deliverable D1.3 (Actual situation of recovered wood and rubber sector in Europe: Qualitative & Quantitative data). The other objective “Identification of optimum uses of recycled wood and rubber raw materials for industrial products and applications” was achieved in project month 33 by Deliverable D1.4 (Future scenarios for the recovered wood and rubber sector). All participating beneficiaries of Action T1 were involved.

Task 1.4) Effect of scenarios on the competitiveness of the sector

The aim of Task 1.4 was to analyse the effect of the future scenarios described previously on the competitiveness of the European wood and rubber sectors. The partners in this Action 1 cooperated closely with the European Panel Federation EPF (wood-based panels) and the European Tyre Recycling Association ETRA for identifying the effects of every of scenario on the competitiveness as well as the impact of the new wood/ rubber composite products.

Therefore, approaches on strengthening the linkages among waste wood/ rubber suppliers and companies utilising these materials were identified and specific actions regarding the new prototypes were proposed: (1) WOODRUB prototypes should be able to compete or even replace other commercial products (2) WOODRUB prototypes should be integrated in the manufacturing process of the industry (3) WOODRUB prototypes, e.g. WOODRUB ACOUSAN, WOODRUB ACOUFRAME, and WOODRUB SAFETYMAT that use directly wood based panels and not mixed wood-rubber composites, should be integrated in the construction of highways and residential building sectors. Of course under the condition that the markets for highways facings and acoustic walls/ anti-slip floors are big enough, so the industry can really make a profit by selling wood based panels for these constructions (4) WOODRUB URBAN prototypes products present some advantages that make them more competitive than the traditional products.

The intention of the project was to help wood and rubber industries to process their stock materials in an optimal manner as well as to utilise them in new innovative products (WOODRUB prootypes). Thus, the Milestone M1.1 strengthening the linkages among waste wood and rubber suppliers-users was achieved through Deliverable D1.5. All participating beneficiaries of Action T1 were involved.

Comparisons between the classification of recovered wood and rubber according to standards, literature and industrial supply practice in Europe were summarized in the following tables:

Comparison between the classification of recovered wood according to standards, literature and industrial supply practice

Definitions and classification of recovered wood					
EU legislation and Standards		Literature		Industrial supply practice	
Definitions	Classification	Definitions	Classification	Definitions	Classification[3]
• Forest Stewardship Council (FSC) standards	• Commission Decision 2000/532/EC (European Waste Catalogue, EWC)[1] • European standard EN 14961-1[2, 3] • Forest Stewardship Council (FSC) standards[1]		• Okopol report for the EC (2004)[3] • UNECE/ FAO report (2008) • Jungmeier et al. (2007) for COST Action E31	• European Panel Federation (EPF industrial standards)	• European Panel Federation (EPF industrial standards) [4] • Wood Recyclers Association (WRA, UK)[5] • Wood Recyclers Association (WRA, UK)[6]

[1]A partial matching exists but different categorization. FSC is more detailed

[2]It refers to wood fuel specification and classes. Four categories are distinguished

[3]Industrial classification, EN 14961-1 standard and Okopol (2004) report distinguish contaminated and non contaminated material

[4]Waste wood is classified into three categories: untreated, non-hazardous treated and hazardous treated wood

[5]Two categories are distinguished: acceptable and non-acceptable material types

[6]Categorization of packaging and non-packaging materials

Comparison between the classification of recovered rubber
according to standards and industrial supply practice

Definitions and classification of recovered rubber					
EU legislation and Standards		Literature		Industrial supply practice	
Definitions	Classification[1]	Definitions	Classification	Definitions	Classification[1]
• European Committee for Standardisation (CEN/ TS 14243, 2010-04-00)	• Commission Decision 2000/532/EC 1[2] • European Committee for Standardisation (CEN/ TS 14243, 2010-04-00)[3]	• Basel Convention report[4]	• Basel Convention report[4] • Rubber Waste report[5]	• European Twowheel Retailers' Association (ETRA)	• European Twowheel Retailers' Association (ETRA)[6]

[1] The CEN/ TS 14243 standard classification is based upon tyre source material while the industrial classification (ETRA) refers, also, to primary processing of tyres
[2] It presents a preliminary classification of recovered rubber
[3] It refers to end-of-life tyres. Seven categories of tyre source material are distinguished with corresponding codes
[4] It refers to three categories of used tyres
[5] It refers to classification of the principal rubber recycling processes
[6] Four principal categories of recycled tyres are distinguished with subgroups

ACTION 2.- RTD ON RECOVERED WOOD: led by COSMOB

Task 2.1) Assessment of specific recovered wood categories

The main objective of the Action 2 was to obtain detailed information about wood recovery process, both at European and regional scale. In this regard, a detailed analysis was carried out according to the final aim of Task 2.1 (other partners involved: AIDIMA, AUTH-LFU, BRUNEL, SONAE, MARCHE MULTISERVIZI., ENJILY INT.), and the first emerging datum concerned the identification of four types of recovered wood, depending on whether the scraps are subjected to specific treatments, contaminations or if a certain degree of hazard is attributed to them. In details, it's possible to distinguish:

- untreated wood recovered,
- treated wood recovered,
- contaminated recovered wood,
- hazardous recovered wood.

For all them, the possibility of recycling with the involvement of the particleboards industries and the energy recovery are contemplated taking into account of a specific pattern of collection, treatment and disposal, applicable regardless of the waste generating sector (packaging, construction, furniture, etc.).

However, it should be noted that, although the recovery timber process is planned at European level, the organizing approaches and the subsequent results may not necessarily be the same, as highlighted by the results of a research carried out about the state of the art in several countries.

UK. The policies are focusing on domestic waste production rather than the industrial one because, despite a lower flow, there is a significant influence on the amount of scrap disposed in landfills. Moreover, according to statistics published by the “Association Wood Recylcing” (WRA), the overall material annually recycled by the entire industry has gradually increased.

Germany. There is a specific ordinance according to which wood waste has to be recovered or, if not possible, disposed of by thermal processes: landfilling is than not permitted. Furthermore, scraps are divided into four categories, respectively named A I, A II, A III and A IV, depending on the contamination degree.

Italy. In Italy, most of the wood recycling management is assigned to “Rilegno”, which is part of the CONAI (the National Packaging Consortium); its main task is to collect and recover packaging waste wood, to give them new life. It also provides to gather wood waste from the municipal circuit and from private users too. The consortium prevents that every year about 1.6 millions of tons of wood waste is sent for recycling.

Spain. Spanish association of wood "ASERM" is a reference within the sector and it gives information about waste they manage: specifically, during last years there has been a significant decrease of the overall recycled scraps, both because of the current economic situation which has a negative impact on industrial production and because of unresolved issues under an organizing point of view.

In summary, only in Germany there is a specific regulation of the subject, even though different solutions have been applied in Italy and UK. More in general however, the development level of recycling techniques is not the same for all European countries and some of them still need a technical and scientific improvement.

Task 2.2) Preliminary processing for re-use wood

Still concerning Action 2, Task 2.2 was aimed to obtain detailed information about preliminary processing for re-use wood (other partners involved: AIDIMA, AUTH-LFU, BRUNEL, SONAE, MARCHE MULTISERVIZI., ENJILY INT.): in this sense, a survey for a better comprehension about techniques for wood recovery process was prepared and applied; more in detail, from a practical point of view, 10 companies dealing with wood recovery and localized in 4 different countries (6 in Italy, 2 in Spain, 1 in UK and 1 in Greece), was directly performed in field in order of a better comprehension of the process; for each of them a questionnaire divided into 5 sections was submitted with the aim to obtain information of different types: general data, process description, quality control, technologies for reprocessing wood waste and other.

In detail, it was confirmed that, among various positive aspects related to wood recovery process, there is the possibility to obtain raw material useful to the manufacturing of new products, such as particleboards for the furniture industry, according to a procedure divided into several stages:

1. Receiving
2. Sorting/Picking
3. Pre-shredding
4. Shredding
5. Ferrous metal removal

6. Non-ferrous metal removal
7. Screening
8. Density separation
9. Processed wood chip

Specifically, during the visits performed, it was noted that the process generally follows the same scheme: after a first receiving step, there's a volumetric reduction of treated and non-treated waste, subsequently followed by cleaning operations, in order to remove non-wooden materials, such as ferrous metals, glasses and plastics. Necessary checks are then required; after them it's possible to go on with the elimination of smaller foreign matters by physical processes (sieving, air classifying, magnets) and then with the further reduction in chips, which may have different destinations of use (particleboards manufacturing, compost, etc.).

The above mentioned wood cleaning techniques can be manual and mechanical, and they are essentially related to the operators and equipment efficiency. Unfortunately, however, these methods do not guarantee 100% of recovered wood purity: in fact, there are other types of contaminants such as preservatives used for treatments and coatings very difficult to separate because of their different physical and chemical properties.

In this sense, there are several techniques for the identification and measurement of these substances, with the aim of avoiding as much as possible the recycling of contaminated material, not suited to the achieving of secondary products. In detail, in line with the objective of task 2.2, a research activity was carried out by doing a complete literature reviewing covering a period of more than 10 years, through which it was demonstrated that, for a qualitative detection, the possible colour variation of a particular substance as a result of chemical reaction with another one is one of the best solution, whereas from a quantitative point of view there are many techniques listed below and depending on whether the object of the analysis are metals, halogens or organic compounds.

- AAS (Atomic Absorption Spectroscopy)
- ICP (Inductively Coupled Plasma)
- LIBS (Laser Induced Breakdown Spectroscopy)
- XRF (X-Ray Fluorescence)
- Wickbold Combustion Method
- GC (Gaschromatography)
- NIR (Near Infrared)
- HPLC (High Performance Liquid Chromatography)

The research activity continued in order to individuate at least three options for processing recovered wood and to select the most appropriate for the implementation of the project: in such regard, current technology guarantees accurate measures of all contaminants but sometimes they can be impractical because of high costs; among all of them, however, Inductively Coupled Plasma (ICP), Laser Induced Breakdown Spectroscopy (LIBS) and X-Ray Fluorescence (XRF) are the most reliable, inexpensive and easy to apply for a metal analysis.

More specifically, under an economical point of view, an analysis of costs was realized complementarily to the technical one, and it was noted that wood recovery is an organized process and each phase may involve many costs; during the operative collection for example, necessary expenses are required for the purchase of vehicles and containers, just like for their maintenance and for the employees' salaries; also transport and processing

imply some costs, not only for fuel and energy consumption but for the negative environmental impact too, even if less measurable in terms of money. Moreover, in case of material recovery, the lack of energy production may represent an economic loss. Expenses are obviously variable and they depend on several causes like the involved area, whose size affects the distances to be travelled and the number of vehicles to be used, the per-capita waste production, the collection model adopted (door to door, platforms, etc.), and the possible outsourcing of services.

On the other hand, there are benefits associated to the value of material produced and to the possible reuse of packages; a positive effect for economy and environment is also due to the avoided disposal in landfills, to the emissions reduction in atmosphere and, under a social perspective, to the concrete possibility of employment increasing.

There are several benefits associated to the research activities carried out in Action 2: in this sense, it is important to monitor the continuous technological innovations concerning the most appropriate material produced in Europe and their properties of recycling and reusing which make theme suitable for many industrial and commercial application; positive effect for economy and environment can be then obtained even because disposal in landfills is avoided, as well as the reduction of emissions in atmosphere and because there is a concrete possibility of employment increasing.

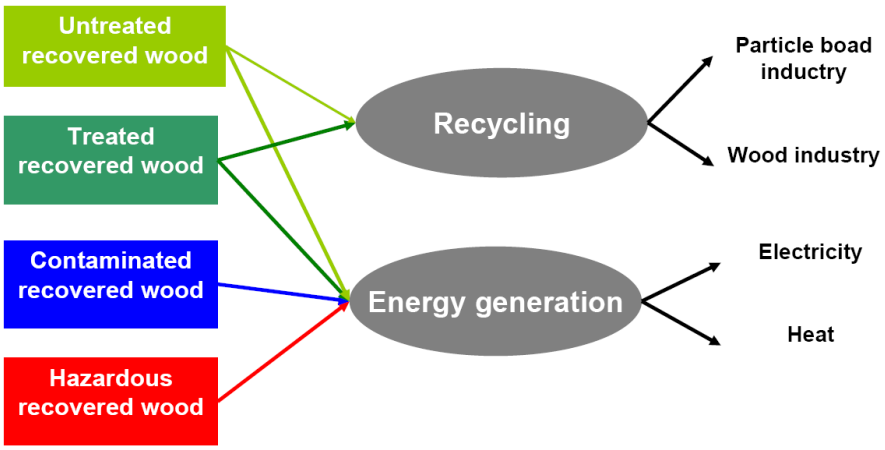


Figure 5. *- Recovered wood management*

Substance	AAS	ICP	LIBS	XRF	Wickbold	GC	NIR	HPLC
As	?	x	x	x				
Cd	x	x	x	x				
Cr	x	x	x	x				
Cu	x	x	x	x				
Pb	x	x	x	x				
Hg	?	x	x	x				
Cl					x			
F					x			
PCP						x	?	
Creosote						?	?	x

Tab. 2.1 - Techniques for each contaminant

Cost	Collection	Transport	Processing
Purchase and maintenance of containers	x		
Purchase and maintenance of machines	x		x
Purchase and maintenance of the vehicles	x	x	
Fuel		x	
Employees' salaries	x	x	x
Energy and auxiliary materials	x	x	x
Plants			x
Environmental impact	x	x	x

Tab. 2.2 - *Cost for each step of wood recovery*

ACTION 3.- RTD ON RECOVERED RUBBER: led by KERIDIS S.A.

Action 3 had to provide the knowledge regarding recovered rubber to the project. For that reason two deliverables were prepared, the first one (D3.1) was a report on the recovered rubber categories and the second one (D3.2) was a report on the processing techniques for recovered rubber.

The main information included in D3.1 were general details about tyres as a source, classification of recovered rubber, a description of the regulatory framework in EU, the five possible routes of recovered rubber, the main applications of recovered rubber and a quantitative analysis. In order to do so, a complete literature review (e.g. handbooks, scientific magazines, world wide web etc.) was carried out. As Keridis SA is directly linked to ETRA (European Tyre Recycling Association), action 3 had full access to their archives (including statistic databases).

D3.2 is describing the processes used for the recovery of tyres, focusing on the most appropriate and common used. In cooperation with the other project partners, 8 visits to rubber recovery facilities were carried out (4 by Keridis SA, 1 by Cosmob, 1 by Acciona and 2 by Brunel).

ACTION 4.- DEVELOPMENT AND TESTING OF NEW COMPOSITES: led by BRUNEL

The summarized literature review of recent recycled rubber binding technologies was presented in Task 4.1. (*Laboratory composition for reactivity and functionality*). Processing factor variables and initial test results were discussed. The feasibility study, conducted in this task, was focused on the reactivity and functionality of resins and recycled tyre rubber. A series of experiments were carried out to examine the reactivity between binders with car tyres granules. Two main factor groups were taken into account, which are related with either desired minimum performance or manufacturing process.

Three different matrix binder systems were selected and evaluated during laboratory trials, namely two part epoxy system and two polyurethane systems: polymeric diphenylmethane diisocyanate (pMDI) resin and two part (polyol + isocyanate) polyurethane systems. A ratio between rubber, wood and binder was controlled and curing process was validated by means of mechanical tests, optical microscopy and SEM observations. Reactivity and functionality of the resin systems were based on following factors: resin types, curing type, curing temperature and resin content. A study report consists of presentation and

description of prototypes developed based on the processing parameters established by feasibility study. After trials pMDI was selected for development of the wood rub composites.

The task was complemented with Deliverable 4.1. Deliverable was complemented by detailed research report attached as an annex in the deliverable.

In Task 4.2 (Development of 'recovered wood-rubber/tyre-matrix-property-demand' models for manufacturing novel composites), two main WOODRUB materials, namely particleboard and sandwich composites, together with WOODRUB gypsum material, are the basis for a development of the all WOODRUB prototypes. In order to address main requirements for the development of the prototypes, design factors were named and taken into account during development stage.

The mechanical performance was established in relation with the design specifications. This allows for the prediction of the material behaviour and selection of a composition for specific prototype design. The work in this Task was based on the initial material trial tests and discussions. Specific materials were selected for comparison with the WOODRUB composite materials. Moreover, the prototypes for particular WOODRUB materials were selected and competing market solutions were named, which allowed for the selection of the material and prototype standards. Function and Performance model (FP) is a 'formula' of selecting materials, processing technologies and achievable properties with the requirements of the developed products in use. The FP will also identify the need for optimising processes or other parameters in order to achieve the desired performance. A study of material prototype requirements and means of comparison was conducted. Basic information for design, possible limitations and obstacles were highlighted with a list of contingency activities that can be undertaken.

The task is complimented with Deliverable 4.2 which is composed out of tables naming key aspects which have to be taken into account during development of a prototype from particular WOODRUB material.

Task 4.3 (Development of novel composites in laboratory pilot plant) provided information about WOODRUB particleboard and sandwich processing methodology. There are three WOODRUB composite materials developed, namely WOODRUB particleboard, WOODRUB sandwich and WOODRUB gypsum.

The WOODRUB particleboard has rubber and wood particles bonded together with pMDI resin, to form a uniform mixture of both constituents. Composition of the material can be manipulated with changes in the ratio between rubber granulate and wood particles. To process WOODRUB particleboards, hot pressing is used. Particleboard panels were processed with pressures between 4.5MPa and 11MPa. Panels with 1cm thickness for mechanical and sound absorption testing were hot pressed at 100˚C during 1hour. This solution was used for comparison between different composite mixtures. Thicker WOODRUB particleboards and slabs for use in urban furniture applications need slightly different thermal process due to the heat transfer and increased thickness of material. The procedure which was selected was composed of pressing material in the mould for 12 hours at maximum pressure of 16.6MPa and 81 ˚C with gas depressurization for 1min after 3hours. Reducing processing temperature allowed for decrease of CO_2 production at this stage, thus reducing environmental impact of the material.

WOODRUB sandwich panels are composed out of wood outer skins and rubber granulate composite core. Panels are designed for use in the environmental noise barrier prototype

application. Melamine-urethane formaldehyde (MUF) is used for wood particleboard skins, which is specific for the continuous process and elevated humidity application. Polyurethane resin is used to bond the big (<4mm) rubber granulate. Wood particleboard panel facing the source of the noise i.e. road, is drilled with multiple holes to facilitate “sound openness”.

WOODRUB gypsum plasterboard material is made by casting gypsum with wood or rubber particulate filler. After analysis it maximum usable content of the filler at 20% was established, which can be composted out of rubber, wood or a 50/50 mixture of both. Mixture can be moulded in various shapes and forms i.e. bricks or bards.

More detailed information about processing has been included in Deliverable 4.3. It is composed out of two parts where processing methodology was described and prototype products description with justification of functionality was included.

Task 4.4 (Assessment of novel wood-rubber composites developed), assessed the developed WOODRUB composites. The tests, which were performed, can be divided into five categories, namely material morphology tests, mechanical tests, moisture and weathering influence tests, heat transfer tests and sound absorption tests. Material morphology tests included macroscopic and microscopic observations, wetting, size measurements (EN 317) and density measurements (EN 323). Mechanical tests included internal bond test (EN 319), surface soundness test (311), modulus of resilience test (EN 310), modulus of elasticity test (EN 310) and compression test for WOODRUB gypsum composite. Moisture and weathering tests included measurements of internal bond after cyclic test (EN 313), swelling after cyclic test (EN 313) and swelling after 2h and 24h exposure test (EN 317). Sound absorption tests were made with custom made impedance tube method, which is described in a standard EN ISO 10534. Aforementioned tests were used to analyse most of the WOODRUB particleboards composites, wood particleboards and rubber core material for sandwich applications.

Analysis of the composite material mechanical tests results indicate that properties can be proportionally changed by manipulation of the mix composition and processing parameters. Most of the composites performed better than the IB 0.45 N/mm^2 requirements for the P5 class of particleboards (EN 312). The values for swelling fall well below the required limit. MOR ranged from 1.37N/mm^2 for the sample with a high rubber granulate content to 25.5 N/mm^2 for the sample with a high wood content and bonded with PMDI. MOE ranged from 280 N/mm^2 for the samples with high rubber content to 3120 N/mm^2 for samples with high wood content bonded with PMDI or MUF. Standard requires that MOR and MOE were above 12 N/mm^2 and 1900 N/mm^2 respectively for the 30mm P5 type particleboard. Thermal conductivity of WOODRUB particleboards was tested for selected composite types and ranged from 0.12 to 0.18 W/mK and WOODRUB gypsum composite performed with values from 0.209 to 0.344 W/mK. Variety of wood-rubber composite particleboards was tested to assess their sound absorption properties.

Deliverable 4.4 discusses test methodology and performance of the developed wood rubber composites

ACTION 5.- IMPLEMENTATION AN PILOT EXPERIENCES: led by ACCIONA

The principle objectives of this action are to scale up the novel composites developed in Action 4 and make the composites readily attainable, i.e. commercial composite products and components made from recovered wood and tyre wastes. To achieve the overall objectives, the Action has been subdivided into four-subtasks.

Task 5.1) Factory scale –up for prototypes has been done in conjunction with Action 4, where the recovered wood and rubber were utilised to develop eight types of sustainable and low cost composites products with good environmental profiles.

The task 5.1 has been very useful to compare different laboratory processing parameters with the factory environment and production procedures, because some necessary adjustments and optimisation processes were needed in order to ensure the best performance of the novel composites which has to be developed with the specific properties defined in Task 5.2.

In order to think about the factory scale-up, the following table shows the proposed applications for each prototype and the different partners involved on it:

Prototypes	Proposed Applications	Selected Applications	Responsible
1. WOODRUB ACOUSAN	1. Acoustic Panel 2. Ceiling 3. Highways facing 4. Sport hall 5. Music, entertainment 6. Works wall (office partitions)	1. Highways facing	ACCIONA, AIDIMA Y SONAE
2. WOODRUB ACOUFRAME	7. Acoustic Panel 8. Ceiling 9. Highways facing 10. Sport hall 11. Music, entertainment 12. Works wall (office partitions)	2. Acoustic panel 1. Works wall	ACCIONA, AIDIMA Y SONAE
3. WOODRUB PLAYMAT	13. Playground, 14. Athletic tracks, 15. Noticeboard, 16. Dartboard	3. Playground	ACCIONA (PLAYGROUND)
4. WOODRUB SAFETYMAT	17. Anti-slip floor, 18. Safety cushion (parking columns, nursery walls)	4. Anti-slip floor, 5. Safety cushion	BRUNEL (ANTI-SLIP FLOOR) AND COSMOB (SAFETY CUSHION)
5. WOODRUB PATH	19. Garden path, 20. Event temporally floor	6. Garden path	ACCIONA
6. WOODRUB RURBAN	21. Bench 22. Bin 23. Sign board 24. Flower pot 25. Separation walls	7. Bench 8. Bin and flower pot	AIDIMA
7. WOODRUB BRICKS	26. Internal walls 27. Decor cladding	9. Internal walls	AUTH
8. WOODRUB LAMINRUB	28. Flooring underlayment 29. Working surfaces	10. Flooring underlayment	BRUNEL

The manufacturing processes performed for each application/prototype, have been exposed in a visual and schematic way in order to achieve a better compression and they are reported in the Deliverable 5.2. The theoretical aspects are detailed in previous deliverable D.5.1.

The manufacturing processes are explained on a medium scale and possibly in a future industrial scale it would suffer several modifications.

Task 5.2) Component development defined the specific properties for residential and civil construction products. The development of each prototype has been done by each partner.

Different components developed:

- WOODRUB Rurban. Outdoor furniture prototypes have been constructed by AIDIMA to ensure the specific requirements of the final applications.
- WOODRUB Playmat. ACCIONA has developed a new playmat, where the mixture of wood and rubber materials represents a more economical surface for parks or schools than the traditional ones due to the presence of wood particles, generally cheaper than rubber. Design has been developed in order to obtain an HIC (Critical Height Criterion) of 1000mm, for its use in spring rockers that should have a maximum fall height of 400mm above the underlying ground surface, it required a safety Area of $6m^2$, and its use in seesaw that should have a maximum fall height of 600mm above the underlying ground surface, it required a safety Area of $12m^2$.
- WOODRUB Acouframe. ACCIONA, AIDIMA, GLUZ have developed modular acoustic barriers for highway formed by modules, in which the manufacturing modules stacked on one another to form the barrier height obtained from a previous acoustic study in the area where the barrier will be installed.

  The dimensions for the design of the barrier were decided by its standardization and easy assembly, the acoustic modules would be a height of 0,5m and a length of 2m. With this size for example to obtain barriers 2m or 3m of height, commonly used, it would need only 4 or 6 acoustic modules stacked on each other.
- WOODRUB Acousand. ACCIONA, AIDIMA, GLUZ have developed acoustic panels for indoor environment (auditoriums, public places, etc.). It can be used even outdoor as temporary acoustic barrier, especially in proximity of working areas. The structure is approximately the same as Acouframe.
- WOODRUB Safetydeckt. BRUNEL has developed an anti-vibration/ anti-slip platform, which is composed out of wood and rubber laminate boards. Rubber sides face outward from the deck. Single board thickness is adjusted to withstand the flexural loads as a standard wooden deck. Surface of the wooden particleboard is smooth and a surface of the rubber can be smooth or texturized.
- WOODRUB Pathways. ACCIONA has developed useful elements for parks and gardens with the main function of avoiding walks on grass or mood.
- WOODRUB Bricks. The bricks have been developed by AUTH-LFU mixing in a proper manner and within a gypsum matrix, textile fibres and particles of recycled wood and rubber, that represent the reinforcement component.

According to the grant agreement, the Action 5 indicators are at least 5 prototypes and 10 wood-rubber applications. So, objectives of Action 5 were achieved and overcome with the collaboration of the WOODRUB partners.

Task 5.3) Testing of new wood-rubber components. After the manufacturing, the next step was the characterization of the prototypes. Each application has different properties and they depend on the characteristics related with the base material obtained in Action 4.

Acoustic characteristics or mechanical properties of different mixtures of rubber and wood, for example, were described in Action 4. For this reason in this task we have described all

the test related with the final product at real scale. The results are detailed on the Deliverable D.2.

The next table shows different test that have been done:

Prototype	Test
WOODRUB Rurban	Different test related with outdoor furniture. Back Seat fatigue Test UNE-EN 581-2, Environmental Aging Internal AIDIMA procedure, Determination of strength of storage furniture UNE EN 11016, Impact Test UNE 1728
WOODRUB Playmat	HIC Test (UNE-ENV-12633). It determines the fall height required depending on the toy product installed.
WOODRUB Acouframe	Acoustic test: UNE EN 17-193-1:1998. Intrinsic characteristic of sound absorption. UNE EN 1793-2:1998 Intrinsic characteristics of airbone sound insulation. Adhesive test UNE EN 1793-3.
WOODRUB Acousand	Acoustic test: UNE EN 17-193-1:1998. Intrinsic characteristic of sound absorption. UNE EN 1793-2:1998 Intrinsic characteristics of airbone sound insulation. Adhesive test UNE EN 1793-3.
WOODRUB Safetydeck	Density, Flexure, internal bond, swelling and slip test.
WOODRUB Pathways	Wheel Tracking Test (UNE-EN 12697-22). It consists on evaluating the deformation depth of the sample subject to cycles of passes of a loaded rubber wheel under constant and controlled temperature conditions.
WOODRUB Bricks	Density, Compressive strength ASTM C39/c39M-12a, Thermal conductivity test ASTM E1530, Acoustic behaviour.

Task 5.4) Evaluation of new wood-rubber components.

The evaluation on the new wood-rubber components has been done providing a list of advantages for the stakeholders why to choose for these materials in future application. The evaluation has been based on the test results of Action 6 on eco-efficiency of the new developed components and their production processes.

ACTION 6.- LIFE CYCLE ANALYSIS: led by AIDIMA

The main objective of A6 is to assess the environmental aspects associated with the new materials and products deriving from the project in a comparative way with alternative market products. This has been performed, coordinated (and mainly executed) by AIDIMA, by following next horizontal tasks:

Task 6.1) Objective and scope definition. Definition of eco-efficiency evaluation and establishment of the economical concepts involved in.

Task 6.2) Inventory of LCA. Collection of data, calculation procedures, quantification of inputs and outputs of the system.

Task 6.3) Assessment of LCA impact and interpretation of the LCA.

Task 6.4) Inventory of processing costs and evaluation of eco-efficiency.

To achieve the objective, most promising applications developed and tested in Action 5 with WOODRUB composites, have been environmentally compared with their identified competitor alternatives in the market.

Finally, eco-efficiency of each application or intended use alternatives was compared, considering not only the environmental issues, but also the economic ones. Some prices and composition (weight and characteristics of several component materials) have been estimated, both for WOODRUB products but especially when not complete and detailed info of market competitors were available. In conclusion, results should be considered just as an approximation and depending on final design and competitors selected.

To each application, the main function and related functional unit to compare WOODRUB products and competitors are shown:

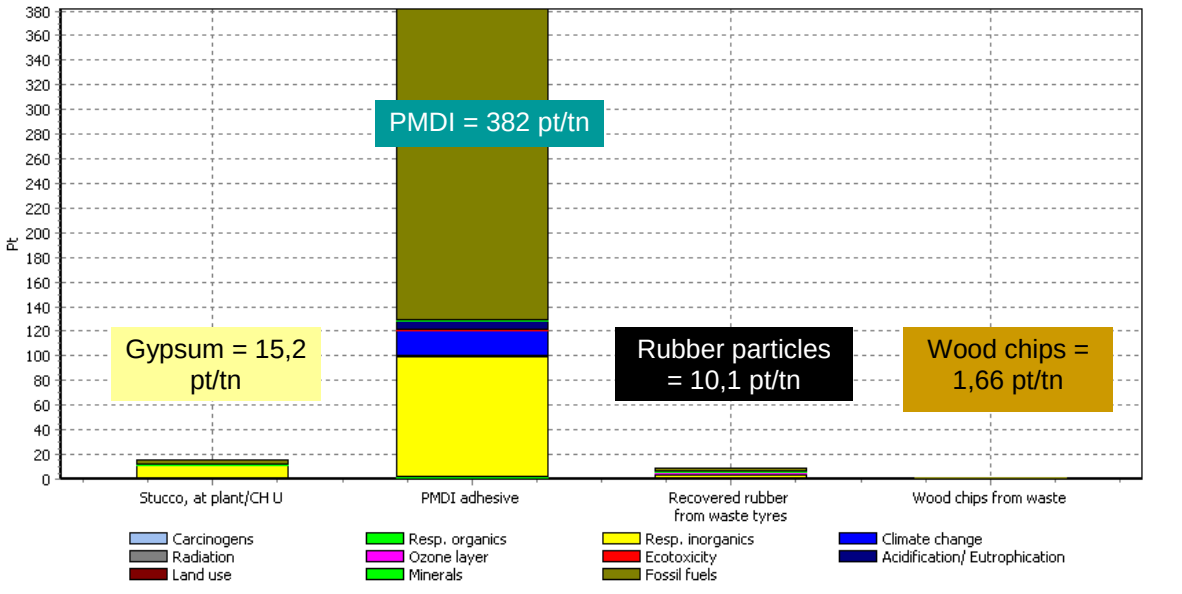
	Function	Functional unit
1. WOODRUB Acouframe	Highways facing	1 m^2 of acoustic module with minimum sound attenuation of aprox. DL_α=8dB and sound attenuation of 25-30 dB (Indoor applications will not be evaluated because only outdoor models have been constructed and tested)
2. WOODRUB Acousan	Acoustic panel (indoor) and temporary work wall (outdoor)	
3. WOODRUB Playmat	Playground	1 m^2 of playground with a minimum fall high of 1,2 m and lower of 1,3 m.
4. WOODRUB Safetydeck	Anti-slip floor, safety cushion	1 m^2 of anti-slip elevated surface (descks).
5. WOODRUB Pathway	Garden and other public areas paths, sportive pavements…	1 m^2 of anti-slip and sock-absorbent pathway (0,4m > fall height <1,2 m)
6. WOODRUB Rurban	Bench, Bin Flower pot	1 semi-sitting of 1 m length 1 bin with capacity of 35 - 50 liters 1 flowerpot with capacity of 0,163 liters
7. WOODRUB Bricks	Internal walls	1 m^2 of internal wall.

As the scope of the LCA is from “cradle to gate”, the life cycle stages studied are from the raw material extraction, to the final product manufacturing. No equipment or infrastructures, or final product packaging have been included.

As key raw materials, wood and rubber particles recovery from wastes have been described and the energy and ancillary materials quantified, to obtain the related environmental impact. This has been done with the support of Action 2 (COSMOB) and Action 3 (KERIDIS) leaders. In the case of rubber, were the life cycle inventory from real data was uncompleted, AIDIMA has obtained it from bibliography. Results comparing both recovered particles (collection transport 100km plus processing) shows that wooden ones have lower impact by kg of material than rubber granulate. Though lightly differences between rubber and wooden particles have been found, when comparing with the environmental impact of 1 kg of polyurethane (PU) adhesive (also called polydimethyl diisocyanate glue, PDMI), this last raw material results in the key factor to consider in panel production environmental impact.

Different compositions of WOODRUB panels from Action 4 were environmentally studied and conclusions regarding the effect of their composition explained. When analysing the complete panel manufacturing, regarding raw materials, it is clear that the higher is the PMDI % the higher is the impact. To the same PMDI %, has higher is the wood %, lower is the impact, but differences are not very significant.

On the other hand, regarding the process, which LCI was provided by Glunz based on real data from their annual production, the electricity demand is the main factor generating environmental impact, but thanks to the cogeneration system using residual wood, the factory generates the needed heat to the process and an electricity which is shelled to the greed and partially compensates the consumed one.



Comparing 1 ton 'Stucco, at plant/CH U', 1 ton 'PMDI adhesive', 1 ton 'Recovered rubber from waste tyres' and 1 ton 'Wood chips from waste'; Method: Eco-indicator 99 (H) V2.1

Anyway, when comparing the environmental impact of raw materials with the manufacturing process, this last one represents less than 7,5% of total impact (4,8% in the case of W50-10 panel).

From results of Action 5, to each final application there have been obtained and described in these deliverables (including from raw materials to final product manufacturing):

- The **product system**: function, functional unit, system boundaries, technical description WOODRUB prototypes (made with the support of each responsible partner) and selected market competitors[1] trying to ensure they are adequate to the functional unit. *Explained in Deliverable 6.1.* Made by AIDIMA with the support of Gluntz, Acciona, Cosmob, Keridis and Brunel.
- **Life cycle inventories**: product composition and quantification of all the raw materials and needed transforming processes **of all WOODRUB and market compared products**. *Explained in Deliverable 6.2.* Made by AIDIMA with the support of Gluntz, Acciona, Cosmob, Keridis and Brunel.
- **Estimation of prices** of all compared products: from Glunz estimation regarding panel production, and from a deep market research of different components (metallic parts, recycled plastic extruded, treated solid wood, etc.) or when available, final market price made by AIDIMA. *Explained in Deliverable 6.2.*
- **Modelling** several LCI **in SimaPro software** and obtaining **LCA results and analysis** (of WOODRUB prototypes and in comparison with competitors) by applying the life cycle environmental assessment methodology of Eco-inciactor 99. *Explained in Deliverable 6.3.* Made by AIDIMA.
- Comparative **eco-efficiency analysis**. *Explained in Deliverable 6.3.* Made by AIDIMA.

Conclusions from the diverse studies are summarised below.

Acoustic barriers: Acouframe and Acousand.

In Acouframe acoustic module design, the higher impact is due to the wooden particle boards, and more specifically, the 70% of it is due to the high pressure laminate (HPL) covering both panel faces. Next impact is the rubber panel. Acousand desing to outdoor use is very similar to previous one, but as wooden and rubber panels are bonded, HPL in only needed in the external surface, and in consequence, it has lower environmental impact: 5,13 pt/m2 regarding the 7,27 pt/m2 of Acouframe.

Two alternative outdoor acoustic barriers from with metallic and wooden frame and rock wool as insulator material were compared with WOODRUB ones. Acouframe has the higher impat of all them, but Acousand has a similar to the competitor ones, but slightly higher. Despite this, when considering the estimated prices to WOODRUB options, they would be preferable to competitors (market final prices).

As Acousand has indoor potential applications as acoustic panels, the reduction of impact due to the direct reduction of thickness have been calculated vs the outdoor barrier to partitions or covering wall panels.

Playmat and pathway flooring.

In this both products, main raw material is rubber, with different small proportions of wood particles. Main difference between both models is that WOODRUB Playground includes 1 cm thickness upper layer of virgin EPDM rubber, while WOODRUB pathway used only recycled wood and rubber particles.

[1] Selection of competitors to the comparative LCA and eco-efficiency analysis was made mainly by AIDIMA (due to the specific information needed not always available to competitors selected in Action 5 by the other partners, but when possible some of them have been maintained).

When analysing different compositions of WOODRUB prototypes for playground and pathway, both from technical and environmental point of view, to increase wood to the recycled rubber material has a undesiderable effect: lower fall height and more glue needed.

10% of PU resin has been considered in all the commercial products, as it seems the most common practice.

EPDM is the material with higher environmental impact by kg (even slightly higher than PU glue). So when comparing 1 m2 of WR Playmat with commercial products (from two different companies), all of them with a fall height in the range of 1,2-1,3 m, and made as continuous flooring or with tiles, the environmental results shows that: products without the upper EPDM layer, with lower EPD thickness or even with lower density, have better environmental profile than rubber ones. In definitive, only one selected product with more absolute quantity of virgin EPDM than WOODRUB ones, has more impact.

Anyway, when eco-efficiency is assessed including estimated (for WOODRUB prototypes) and final product to competitors, WOODRUB alternatives are founded between the best ones, jointly with totally recycled ones or the lighter ones.

Finally WOODRUB Pathway compositions have been compared to products from the same previous companies, but with fall height lower than 1,2 m or even without that parameter (no needed to pathways). Results are on the previous line; WOODRUB prototypes have significant lower impact than commercial products including EPDM, and are only comparable to also totally recycled ones. When considering eco-efficiency analysis, Pathway 1 and ASSA continuous pavement of 30mm 100% recycled rubber (black) is very similar and the best choices. Pathway 2, 3 and 4 follow them by near. ASSA recycled pavement in red or green colours have the same impact than black one, but their price is higher, so in terms of eco-efficiency, follows Pathway 4. Euroflex recycled blocks and paving tile have more material by m2 because their thickness is 4 cm, and their environmental impact in on an upper level than previous products, and also their price is too expensive. The other alternatives, as include a layer with EPDM, have significant higher environmental impact and price.

Anti-slip deck.

Bilayer panels employed to manufacture WOODRUB Anti-slip deck, have the same main environmental aspect in their composition as the other project composite panels: the PU resin with the 74,4% (mainly because of the low impact of recovered particles). The second impact generating are the screws to assembly the slats, with only a 12,6%.

This prototype have been compared with two plastic recycled options, one of virgin HDPE but very lightweight, and one of IPE solid wood.

Though Ipe deck is the option with less environmental impact, according to the prices from the market and estimated in the case of our prototype, WOODRUB deck would be the most preferable alternative in terms of eco-efficiency. Ipe deck is the second one. So between them, the definitive factor is the price. On the other side, there is the virgin HDPE deck, which by its high environmental impact is the worst option. In the middle there are the other two decks made of recycled plastic.

Urban Furniture: RURBAN.

Several products from urban furniture sector have been studied (semi-sitting, bin and flower pot or planter). In this category of products, specific design has a definitive influence.

Regarding developed WOODRUB prototypes, taking as a base our design or a commercial real product, usually panels are used as part of the product with other structural metallic parts or fittings. In all the cases, these metallic pieces are keep the same, and WR50-10 panel have been compared with recycled plastic lumber (extruded) and with treated solid pine wood. To the same volume, recycled thermoplastic panels (950 kg/m3) have the same impact than WOODRUB ones (1045 kg/m3), but solid wood has lower environmental impact (550-705 kg/m3 depending on the specific specie).

When metal parts have an important % of total weight, the relative difference between panels is not relevant. This is the case of semi-sitting, where metal parts (mainly the tubes of reinforced steel) has the 80% of the impact.

When using alternative competitors like pre-manufactured concrete or cast iron flower pot, cast iron has the highest environmental impact with an important difference regarding others, and in the other extreme, concrete has the lower impact with also a significant difference regarding panel options. Regarding eco-efficiency analysis, WOODRUB flower port and concrete one are quite similar.

In the case of bins, two different designs with 25 (small) and 40 L (heavy) capacity have been studied, and also another two totally different alternatives to panel ones have been included in bin comparison, a very light one of virgin HDPE injected pieces (50L), and one made of steel sheet (35L). In this case, even a unit by unit comparison has been made, bin capacity should be considered as a functional parameter, and a second comparison considering a total urban bin collection system with capacity of 1400L has been considered.

In both cases recycled plastic heavy model and steel bins are the worst options in terms of eco-efficiency.

On the other side, WOODRUB small model is the best choice also in both cases, followed very close by solid wood small bin. That is, when comparing unit by unit, smaller model is the winner in each of its variants.

The difference between both comparisons is that when considering also their capacity, the third selection choice would be virgin plastic bin, which is very light and has the highest capacity (50 L), and which eco-efficiency is practically equal to solid wood heavy model. In this case, they would be followed by near in fifth position by Recycled plastic small bin.

Finally, WOODRUB (WR50-10) heavy model, has in both comparisons an intermediate eco-efficiency level, but better positioned when capacity is considered.

In any case, it must be repeated that estimated prices can be lower than those coming directly from e-shops or catalogues, and in consequence, eco-efficiency comparison results must be taken carefully. To demonstrate that point, there is the case of solid wood heavy bin, which real market price is 263€, about 10 times more than the used estimated price.

WOODRUB BRICKS

Results from WOODRUB bricks show that 70% of the impact is due to the manufacturing process and only 30% from needed raw materials, (20% gypsum, 7,5% rubber and the rest to the other materials).

Most commonly used types of bricks in indoor applications have been compared with WOODRUB ones: clay bricks, autoclaved aerated concrete blocks, gypsum blocks and concrete blocks. 1 kg of each kind of brick have been compared and concrete option has stands out by its higher impact (146 mPtos/kg) regarding the others: 22,9 mPts/kg gypsum

block; 14,4 mPts clay brick; 12,5 mPts/kg WOODRUB brick and finally 11,8 mPtos aerated concrete block.

In all cases but gypsum block, two different positions or alternatives of the brick have been considered (resulting in different wall thickness and different kg of material by m2 of wall.

Environmental results of several wall alternatives, and also eco-efficiency analysis confirm that concrete options are the worst with a very important difference regarding the others.

From remaining options, and in another level, gypsum blocks have about double impact than WOODRUB ones and about 46,5% higher density and they are the most expensive (even including concrete blocks).

Regarding environmental best choices, WOODRUB bricks and Aerated concrete blocks, they very similar when comparing similar thickness wall options, but aerated concrete blocks are slightly preferable regarding WOODRUB bricks. Following preferable alternative would be clay bricks, both for their impact by kg and their density, but as they are the cheapest alternatives, regarding eco-efficiency, clay bricks are a serious alternative to consider but technical requirements and wall thickness should be more carefully selected in further studies.

In any case, it should be remembered that processing parameters and brick design would be able to change the apparent density of the final product, so this bricks and blocks would have a high potential of environmental improvement through ecodesign.

4.2 Dissemination actions

4.2.1 Objectives

The dissemination level will increase the bonds between the waste wood and rubber suppliers and provide the knowledge in industry about the use of both recycled wood and recycled rubber for producing this kind of composites. The action will raise the general public's awareness of and increase its knowledge about the project and its potentials and benefits.

4.2.2 Dissemination: overview per activity

- *TASK 7.1.- INTERNATIONAL DISSEMINATION (OUTPUTS D.7.1, D7.2; D7.3; D7.4; D7.5; D7.6)*

Information on the project will be disseminated throughout Europe to raise awareness of the initiative among key target groups and on different levels, e.g. local authorities, consumer associations, wood and rubber waste management AUTH-authorities and managers, development agencies, centres of environmental expertise, NGOs related to the environmental issues, etc. The project's horizontal approach to regions will guarantee a high degree of transferability, one of the LIFE+ program's main objectives. To facilitate this process, a separate task will focus on the creation of a sustainable institutional, financial and operative framework for the project.

Based in Brussels, the dissemination partner is ideally situated targeting a European audience as well as European bodies and networks to disseminate information on and raise interest in the project. To this end, the project will be presented at various relevant events such as seminars and conferences.

The project will set up standard dissemination channels (website, newsletter, thematic conference events and print information material). Each partner will be in charge of its respective regional and national dissemination activities.

Subtask 7.1.1.- Communication management and evaluation

A dissemination and communication plan drafted and coordinated by the communication partner and including input from all partners and detailing pertinent information; periodic communication and dissemination review reports on the results of dissemination and communication actions, specifically in relation to the indicators specified in the dissemination and communication plan; a comprehensive review report compiled by the action leader with the supported of a multimedia expert and issued at the end of the project; final report dissemination package, including final update of activities, final report and assessment on results achieved.

Outcomes of the subtask:

- *Dissemination review reports (dissemination progress report).*
- *Final report dissemination package.*

Subtask 7.1.2.- Website management and promotion

A project website with basic functions; project website management overseeing hosting, updating of general and contextual (EU environmental policies) project information, provision of deliverables and dissemination materials, maintenance of a news sections with updates on project results and events and a private area accessible with ID and password used as a chat forum, maintenance of document repository, etc.; newsletter issued every six months…

Subtask 7.1.3.- Elaboration of informational material

Production of audio-visual materials, specifically a 15 second spot to present the project and its potentials to the general public; publication of a 3 page leaflet with general information about the project designed by the dissemination partner for general dissemination and distribution at professional and EU events; publication of a 4 page brochure focusing on the project results; creation of a roll up banner for use by all partners at different events, conferences and trade fairs to disseminate the project; PowerPoint presentations for use by all partners; production of a CD-ROM (as well as updated 2nd and 3rd edition) with all important facts and aspects.

Outcomes of the subtask:

- *Leaflet international dissemination (3 page).*
- *Brochure international dissemination (4 page).*
- *Roll up banner.*
- *Project Power-Point presentations.*
- *News of the project in the Press releases.*
- *Publications in specialized journals.*
- *Networking and lobbying dissemination.*
- *Mass media and other communication channels.*

Subtask 7.1.4.- Dissemination

Audio- visual material made available on the website and for broadcast on local/national radio and TV; English, Spanish, Italian, German and Greek leaflets and brochures made available on the website, the English version being for international dissemination partner; press releases for all relevant project events (key actions, training sessions, presentation at third party events); publications in specialized journals; project dissemination at interregional conferences and meetings as well as through the group forming networks to which the dissemination partner's organization will belong; organization of the final project conference of the project in Brussels with support from all partners; partners' attendance of and contribution to all key events (published scientific reviews, attendance of professional conventions, fairs, exhibitions, etc.); dissemination of project information through each partner's communication channels.

- *TASK 7.2.- REGIONAL DISSEMINATION (OUTPUTS D.7.1, D7.2; D7.3; D7.4; D7.5; D7.6; D7.7)*

Based on the dissemination plan and schedule (Action 1) developed to identify relevant regional dissemination channels, target groups and appropriate media, promotional materials (logo, corporate identity, flyers, brochures, etc.) for the different regions involved in the project will be designed and compiled for wide distribution at different stages of the project. The consortium will also demonstrate its presence with publications, exhibition stands, etc. at relevant events.

Subtask 7.2.1.- Development and publication of dissemination materials

Identification of relevant regional target groups (technology providers, logistic service providers, etc) for regional dissemination; partner contributions to the project website; development of materials based on the target groups addressed; preparation of presentations for conferences and other events; development of materials for the WOODRUB public workshop/conference; distribution of materials to target groups through identified communication channels and consortium networks.

Additionally, notice boards describing the project will be erected and maintained at the relevant regional locations. So, these notice bards will be placed at strategic sites accessible and visible to the public. The LIFE logo will appear on them.

This task and its subtasks will start early after the start of the project. Concrete dissemination activities will be coordinated on the basis of the dissemination plan developed in Task 1.

Subtask 7.2.2.- Organization of Public workshops

Workshops adapted to interests of the selected target groups are planned to present the results of the project to a wider audience including several target groups. The workshops will entail development of a workshop concept (type of event, target group, programme, etc.); communication with stakeholders; organization of programme and invitation of speakers; organization of logistics, conference facilities, catering, etc.; compilation of mailing lists; distribution of developed promotional materials; setup of a workshop desk; preparation of workshop materials and a feedback questionnaire; holding of the actual workshops; workshop review and follow-up.

- *TASK 7.3.- AFTER-LIFE COMMUNICATION PLAN (OUTPUT D7.8)*

The “After-LIFE Communication Plan” will be produced as a separate chapter of the final report. It will be presented in English, in paper and electronic format. It will set out how the consortium plans to continue disseminating and communicating the results of the project after the end of the project. It includes a LAYMAN’s report with the purpose of providing a general and brief overview of the WOODRUB project and its outcomes. In particular, the following points will be addressed in the Layman's report:

- *Summary of project scope and objectives,*
- *Description of the techniques/methodology implemented and the results achieved,*
- *Assessment of the environmental impact of the project, describing the environmental benefits,*
- *Cost-benefit discussion on the results (economic and environmental benefits), and*
- *Transferability of project results.*

ACHIEVEMENTS:

There were carried out several Dissemination Actions, structured in these Progress Indicators:

Dissemination and communication plan (deliverable 7.1) It was set up a Dissemination and Communication Plan, including input from all partners and detailing pertinent information. All the beneficiaries were responsible for the implementation of the Dissemination Plan.

- *Project presentation (deliverable 7.2)*
- *Project website (deliverable 7.3)*
- *Promotional materials (deliverable 7.4)*
- *Corporate identity (deliverable 7.5)*
- *CD and video (deliverable 7.6)*
- *Report on final conference (deliverable 7.7)*
- *After-Life communication plan (deliverable 7.8)*

Deliverable 7.2: Project presentation

This deliverable is connected with the Quantified Indicators:

- *Milestone 7.1. Project dissemination and interregional conferences and meetings:*
  1. *2nd Congreso de Innovación Forestal (December 14, Madrid) (responsible AIDIMA)*
  2. *The LIFE +Kick off meeting (January 12, Madrid) (responsible AIDIMA)*
  3. *Project presentation at the Faculty of Forest Sciences and Forest Ecology, Georg-August University of Goettingen, Germany (February 2, 2011, Goettingen)*
  4. *Area Demo “Workshop on LIFE projects” in ECOFIRA the International Fair for Water, Soil, Air, Wastes and Their Technologies and Services (February, 18, Paterna) (responsible AIDIMA)*
  5. *18th Annual ETRA Conference, (March 23-25, Brussels) (responsible AUTH-LFU)* http://*www*.WOODRUB.com/publicaciones_detalle.asp?id=233

6. *ACCIONA's facilities dissemination and ACCIONA Workshop (responsible ACCIONA)*
7. *Global R&D Report; SOI-wide spreading (responsible GLUNZ)*
8. *Sonae Indústria (SOI) internal promotion at SOI CITO & CMSO ; SOI alignment meeting (responsible GLUNZ)*
9. http://*www.cosmob*.it/notizie-ed-eventi/130-eventi-cosmob/621-zero2-emission-furniture-20-maggio-2011.html *(responsible COSMOB)*
10. *Green Week 2011(responsible COSMOB)*
11. *Project presentation at "FIMMA MADERALIA Trade Fair" (November 2011, Valencia)(responsible AIDIMA)*
12. *5th Conference of the European Construction Technology (October 4-5, 2011, Warsaw)*
    http://www.ectp.org/enewsportal/index.php?option=com_content&view=article&id=532:-ectp-e2ba-conference-4-5-october-2011-warsaw-reserve-these-dates-in-your-agenga&catid=90:ectpe2ba-internal-info&Itemid=61 *Distribution of some WOODRUB Project leaflets (responsible ACCIONA and COSMOB).*
13. *NATIONAL CONFERENCE: 15th Panhellenic Forestry Conference, (October 16-19, 2011, Karditsa, Greece)(responsible AUTH-LFU) Adamopoulos, S., Voulgaridis, E. and C. Passialis. 2011. Wood recycling in Europe. In Proceedings of the 15th Panhellenic Forestry Conference "Multipurpose Forestry and climate change - protection and exploitation of natural resources", 16-19 October 2011, Karditsa, Greece. Comment: academic community within the Greek forest products sector, more than 150 participants*

    http://www.wfdt.teilar.gr/15_th_Panhellenic_Forestry_CONFERENCE/index.html
14. *Salone del Mobile 2012 – Milan – Italy (April 2012) (responsible COSMOB)*
15. *Ambienta Fairs 2011 – Zagreb – Croatia (October 21th, 2011) (responsible COSMOB)*
16. *ACCIONA's facilities dissemination and ACCIONA Workshop. Distribution of some WOODRUB Project leaflets (responsible ACCIONA).*
17. *JEC Europe 2012* http://www.jeccomposites.com/events/jec-europe-2012 *(responsible ACCIONA)*
18. *Workshop on Diffusion of Waste Related Technologies Distribution of some WOODRUB Project leaflets (responsible ACCIONA).*
19. *SOI CTO project update 28/08/2012 (responsible GLUNZ)*
20. *SOI Global Marketing meeting 09/10/2012 (responsible GLUNZ)*
21. *Project presentation at Glunz Website:* www.glunz/Unternehmen/WOODRUB-Projekt *(responsible GLUNZ)*
22. *Display of German leaflets at public entrances of Glunz plants (Germany) (responsible GLUNZ)*
23. *WOODRUB presentation and dissemination action at a COST meeting 12/04/2012 (responsible AIDIMA)*

24. *Potenziamento dei servizi di Raccolta Differenziata Comune di Piobbico February 2012 (responsible MARCHE MULTISERVIZI)*
25. *Exel Composite Ldt. Workshop, August 12. 27th April 2012. A workshop to identify innovative composites for construction organized by the Netcomposites (NGCC: National Group for Composites in Construction): the outcomes of the WOODRUB project was discussed in the workshop. (responsible BRUNEL UNIVERSITY)*
26. *Meeting in Cardiff University, November 2011, with Composite Research Group to discuss the possible new type of WOODRUB product development. (responsible BRUNEL UNIVERSITY)*
27. *On 22nd March 2013 the WOODRUB project was presented at the European Tyre Recycling Association (ETRA) 20th Conference by KERIDIS team, Evaggelia Choleri, Pavlos Damianidis and Kostis Keridis. The presentation material was prepared by cooperation with the AUTH-LFU team, Dr. Stergios Adamopoulos, Dr. Elias Voulgaridis. The Conference was attended by 40 participants, mainly tyre recycling managers and scientists from all over Europe.*

    http://www.WOODRUB.com/adjuntos_publicaciones/WOODRUB%20Presentation_ETRA%202013.pdf
28. *LIFE+ Networking Event, May 2013: WOODRUB project presentation at a LIFE+ Networking Event by AIDIMA team, by Mr. Michelle Vavallo.*
29. *COSMOB distributed informative leaflets about WOODRUB project during the sixteenth fair concerning materials and energy recovery as well as sustainable development (November 2012). The event is annually organized by Ecomondo, the most reliable platform in Southern Europe and in the Mediterranean area for the development and reuse of materials and more in general for the largest industry in the future, also called Green Economy. Many companies dealing with collection, management, disposal, treatment, recovery and valorization of waste are involved during the period of the fair.*
30. *SOI CEO project update 05/03/2013 (responsible GLUNZ)*
31. *Budapest conference, May 13. This is an international conference on 'Structural performance of construction materials, their requirements'. As this is very relevant to potentially how can our WOODRUB products to be used for construction applications, the project has sent one of our colleagues in our research group to the conference. Indeed this also communicated to other potential stakeholders for possible take up of our project outcomes. (responsible BRUNEL UNIVERSITY)*
32. *Forestry congress in China, August 13. 'Forestry Congress', 12-19/9/2013, Division 'Wood Based Composites'. Presentation 'Wood-Rubber bonding systems'. (responsible BRUNEL UNIVERSITY)*
33. *Conference on 'Natural Aligned Fibres and Textiles for Use in Structural Composites - Natex' held in Chesterfield on 18th of April 2012. WOODRUB tentative outcomes were discussed. (responsible BRUNEL UNIVERSITY)*
34. *International conference on 'Composites and Nano Engineering' 22-27 July. Presentation 'Characterization and mechanics of natural fibre composites (part of it is wood-rubber composites)'. (responsible BRUNEL UNIVERSITY)*

35. *EUROPEAN PRESENTATION: Voulgaridis, E., Adamopoulos, S., Passialis, C., Foti, D. and E. Voulgaridou. 2013. Properties of gypsum bonded solid bricks manufactured with recovered wood and rubber. In Proceedings of the Annual Meeting Prosylva Europe and 16th Panhellenic Forestry Conference, 6-9 October 2013, Thessaloniki, Greece (responsible AUTH-LFU)*

    Comment: academic community within the European forest products sector, more than 150 participants. Translation of the WOODRUB leaflet in Greek, dissemination to the Greek academic community during the 16th Panhellenic Forestry Conference, 6-9 October 2013, Thessaloniki, Greece (more than 150 participants)

36. *PRESENTATION TO STAKEHOLDERS: Adamopoulos, S. Utilisation of Recovered Wood and Rubber for Alternative Composite Products (WOODRUB). Tire Rubber Recycling Forum 2013, November 19-20, Le Chatelain, rue du Chatelain 17, Brussels 1000, Belgium. There was a very big interest in our prototypes and informed the participants for the final Valencia event.*
    Some concerns and questions were related to odor, leaching and fire behavior of rubber. Comment: industrial community within the European rubber sector, more than 50 participants, very positive feedback – great interested in our prototypes. (responsible AUTH-LFU)

37. *International workshop Zero.3 Emission furniture. (Pesaro). Presentation by COSMOB, ACCIONA and AIDIMA.*

38. *VALENCIA HABITAT FAIR, presentation made by AIDIMA and ACCIONA*

39. *VALENCIA HABITAT FAIR 2014: presentation of prototypes (responsible AIDIMA).*

40. *Net Composites. 18th and 19th March 2014. Distribution of leaflets, presentation of poster and video (responsible ACCIONA).*

41. *WORKSHOP: "Green industries and eco-industrial/ enterprise zones: key issues, challenges and opportunities" http://ceeivalencia.emprenemjunts.es/index.php?op=8&n=8342 (responsible AIDIMA).*

42. *Presentation of prototypes in AIDIMA´s facilities to these attendees (responsible AIDIMA):*

    - *CENTRO SERVEF DE PATERNA*
    - *CIPFP MISERICORDIA*
    - *B&S FORMACIÓN*
    - *CIPFP CATARROJA*

43. *FIQ - Feira Internacional da Qualidade em Máquinas, Matérias Primas e Acessórios para a Indústria Moveleira - 11-14 March 2014 (responsible COSMOB)*

44. *SOI CMSO project update 07/06/2013 (responsible GLUNZ)*

45. *SOI CEO project update 11/12/2013 (responsible GLUNZ)*

46. *Presentation of WOODRUB project (Objectives, Participants, Prototype WOODRUB products) in 110 undergraduate and post graduate students (50 undergraduate and 10 postgraduate students of the School of Forestry and Natural Environment,*

Aristotle University of Thessaloniki, GR and 50 undergraduate students in the School of Design and Technology of Wood and Furniture, TEI Thessalias,GR) - March 2014 (responsible AUTH-LFU)

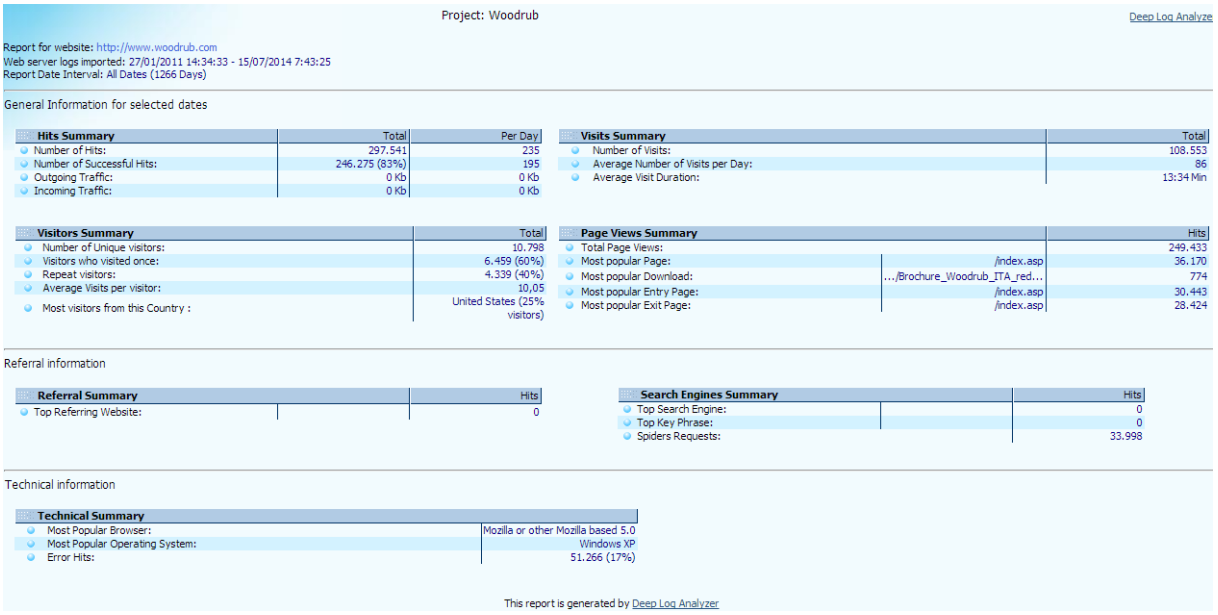
47. *WOODRUB: LIFE Infoday - Networking Event (10 Julio, Escuela de Negocios Lluís Vives)(responsible AIDIMA)*

Deliverable 7.3: Project Website *(responsible AIDIMA)*

It was created the WOODRUB project Website with basic functions: www.WOODRUB.com, with a public and private area, where it can be found information about LIFE+ Programme, WOODRUB project (background, project description, objectives, and project steps), the partnership (the project team and location), legislation on recovered wood and rubber, news (events, press room and newsletter), and publications, interesting links and project contact. The project website management has been overseeing the hosting, the updating of general and contextual project information, providing deliverables and dissemination materials, maintaining the news sections with updates on project results and events and a private area accessible with ID and password used as document repository.

A website specifically dedicated to the project was established at the beginning of the project and updated during the life of the project. The website presents the content, progress and outcomes of the projects. It has arisen significant interests from many interested end users or stakeholders (industrial associations, composite companies, waste managers, innovation and research entities, universities, environmental public administrations, training bodies, environmental advisors, specialised media and mass media, etc).

At its ending date the website has had 297.541 hits.



Project: Woodrub — Deep Log Analyze

Report for website: http://www.woodrub.com
Web server logs imported: 27/01/2011 14:34:33 - 15/07/2014 7:43:25
Report Date Interval: All Dates (1266 Days)

General Information for selected dates

Hits Summary	Total	Per Day
Number of Hits:	297.541	235
Number of Successful Hits:	246.275 (83%)	195
Outgoing Traffic:	0 Kb	0 Kb
Incoming Traffic:	0 Kb	0 Kb

Visits Summary	Total
Number of Visits:	108.553
Average Number of Visits per Day:	86
Average Visit Duration:	13:34 Min

Visitors Summary	Total
Number of Unique visitors:	10.798
Visitors who visited once:	6.459 (60%)
Repeat visitors:	4.339 (40%)
Average Visits per visitor:	10,05
Most visitors from this Country :	United States (25% visitors)

Page Views Summary		Hits
Total Page Views:		249.433
Most popular Page:	/index.asp	36.170
Most popular Download:	.../Brochure_Woodrub_ITA_red...	774
Most popular Entry Page:	/index.asp	30.443
Most popular Exit Page:	/index.asp	28.424

Referral information

Referral Summary		Hits
Top Referring Website:		0

Search Engines Summary		Hits
Top Search Engine:		0
Top Key Phrase:		0
Spiders Requests:		33.998

Technical information

Technical Summary	
Most Popular Browser:	Mozilla or other Mozilla based 5.0
Most Popular Operating System:	Windows XP
Error Hits:	51.266 (17%)

This report is generated by Deep Log Analyzer

Deliverable 7.4: Promotional materials

These promotional materials were done. All publications can be found in www.WOODRUB.com/publicaciones.asp?tipo=3 and www.WOODRUB.com/publicaciones.asp?tipo=2 for the dissemination materials. Reports and scientific-technical publications in environmental magazines at European level.

1. A publication of a **leaflet with general information about the project** was drafted by the dissemination partner to be used for general dissemination and to be distributed at professional and EU events. This is a bilingual leaflet in English-Spanish, English-Italian, English-German and English-Greek language (responsible AIDIMA).

   - LEAFLET ENGLISH-SPANISH:

   http://www.WOODRUB.com/adjuntos_publicaciones/Brochure_WOODRUB_ESP_red.pdf

   - LEAFLET ENGLISH-GERMAN:

   http://www.WOODRUB.com/adjuntos_publicaciones/Brochure_WOODRUB_GER_red.pdf

   - LEAFLET ENGLISH-GREEK:

   http://www.WOODRUB.com/adjuntos_publicaciones/Brochure_WOODRUB_GRE_red.pdf

   - LEAFLET ENGLISH-ITALIAN:

   http://www.WOODRUB.com/adjuntos_publicaciones/Brochure_WOODRUB_ITA_red.pdf

2. Moreover, it was created a roll-up banner for use by all partners at different events, conferences and trade fairs to disseminate the project and common templates and PowerPoint presentations for use by all partners. (responsible AIDIMA)
3. Publication AIDIMA ECOBOLETÍN – 44, 04 November 2010 (responsible AIDIMA)
4. Publication AIDIMA ECOBOLETÍN – 46, 07 February 2011 (responsible AIDIMA)
5. Magazine Boletín Plataforma Tecnológica Forestal Española “Casos de éxito en el I+D+i del sector forestal español”(December, 2010) (responsible AIDIMA)
6. Specialized journal Tecnimadera, No. 198 – November 2010 (responsible AIDIMA)
7. Specialized journal Correo del Mueble, No. 21 – 2011 (responsible AIDIMA)
8. Specialized journal Economía 3 “Materiales innovadores con Madera y caucho reciclados” (nº216, Febrero 2011) (responsible AIDIMA)
9. Specialized journal Arquitectura y Construcción CIC, No. 483 – February 2011 (responsible AIDIMA)
10. Press release El Mundo “Ecomateriales de madera y caucho reciclados” (Diciembre 2010) (responsible AIDIMA)
11. Press release Noticias Habitat – September 2010

    http://www.noticiashabitat.com/2010/WOODRUB-utilization-of-recovered-wood-and-rubber-for-alternative-composite-products/ (responsible AIDIMA)

12. Press release in the Valencian Community – November 2010 http://www.notasdeprensacv.es/las-empresas-de-la-comunitatvalenciana-interesadas-enmateriales-innovadores-a-base-de-madera-y-caucho-reciclados-se-veran-beneficiadas-por-elproyecto-WOODRUB-28356 (responsible AIDIMA)
13. Press release – November 2010 http://www.20minutos.es/noticia/863646/0/ (responsible AIDIMA)
14. Press release – December 2010

    http://www.izaro.com/contenidos/ver.php?id=es&se=2&su=22&co=1292340367 (responsible AIDIMA)
15. Publication AIDIMA INFORMA No. 65: WOODRUB. Madera recuperada y caucho vulcanizado de neumáticos – May 2011 in digital and in paper versión. http://extranet.aidima.es/serviciosOnline/aidima_digital/ficheros/AIDIMA%20INFORMA%2065 (responsible AIDIMA)
16. Publication AIDIMA ECOBOLETÍN – 48, 29 November 2011 (responsible AIDIMA)
17. Panel notice board erected in a visible public place
18. Newsletter No.1 – November 2011. Periodical reports were produced and circulated to the relevant stakeholders and the Commission. 2-6 scientific papers are expected be produced/published at the end of the project, and 5 Newsletters have been made. Newsletters compile events occurred during the project, international and regional events where WOODRUB has been presented, conferences, seminars or workshops organised by the project or in which the project partners have participated and also interesting news on recycling, new products and techniques for the wood and rubber suppliers and managers.
19. http://dl.dropbox.com/u/11921268/WOODRUB/NEWSLETTER.pdf (responsible COSMOB)
20. Newsletter 02(responsible COSMOB)
21. Press release Noticias Info – November 2010: http://www.noticias.info/2010-11-04/news-161557-source-160-aidima-coordina-5-paises-y-10- entidades-europeas-para-crear-materiales-innovadores-a-base-de-madera-y-caucho-reciclados (responsible AIDIMA)
22. Newsletter 03 http://www.WOODRUB.com/adjuntos_publicaciones/WOODRUB_Newsletter_MayOct2012.pdf (responsible COSMOB)
23. Publication AIDIMA ECOBOLETÍN – 49, 26 March 2012 (responsible AIDIMA)
24. Publication AIDIMA ECOBOLETÍN – 50, May 2013 (responsible AIDIMA)
25. Publication AIDIMA INFORMA No. 70 – September 2013 in digital and paper version(responsible AIDIMA)
26. Press release Wood recycling sector makes real progress – June 2012

    http://www.trada.co.uk/news/view/F6AE9E64-287B-4820-A91C-713BFC47D81F/Wood_recycling_sector_makes_real_progress%20?intDispatchID=1193460 (responsible BRUNEL)
27. Flash Tecnológico (responsible AIDIMA)

28. WOODRUB Poster from AUTH-LFU (responsible AUTH-LFU)
29. Publication AIDIMA ECOBOLETÍN – 51, 05 December 2013 (responsible AIDIMA)
30. Publication AIDIMA ECOBOLETÍN – 52, May 2014 (responsible AIDIMA)
31. Publication AIDIMA Informa – 72, July 2014 (responsible AIDIMA)
32. Newsletter 04
33. Newsletter 05 http://www.WOODRUB.com/adjuntos_publicaciones/WOODRUB%20Final%20Newsletter.pdf
34. Press release Project news in "Karditsa news" website and "Neos Agon" newspaper (November 12, 2013) http://www.karditsanews.gr/archives/80218. Comment: coverage in Karditsa regional unit, population about 120,000
35. WOODRUB poster, exhibited by:
    - ACCIONA has installed a poster in the composites' laboratory.
    - AUTH-LFU: at their facilities
    - AIDIMA: at the UNIVERSITY and the 12th InnovaWood Genera Assembly
    - GLUNZ: Display of German posters at public entrances of Glunz plants
    - COSMOB: Fair held in Civitanova about innovators in Marche Region. Another one is about an important workshop held in Cosmob.
    - KERIDIS: at their facilities
36. Dissemination of the videos through Social Networks (responsible AIDIMA)

Deliverable 7.5: Corporate identity *(responsible AIDIMA)*

A **corporate identity** was designed with the **WOODRUB logo and documents for the project partner's use** (templates for deliverables, excel workbooks, power point presentations, etc.). It included quality guidelines for the project.

Deliverable 7.6: CD and video

A video has been produced to demonstrate how recovered wood and used tyres/rubber can be used / merged to produce a series of value added products. The video also includes the processes of the prototype composites and components. This provides a best opportunity for stakeholders from both sectors to understand the potential linkage between them. It was also created a more commercial video, a spot.

The video has been made with inputs of all partners, both the script and the visual material.

Deliverable 7.7: Report on final conference

It was done right after the conference; it can be seen in D7.7. It meets the Quantitative Indicator Q2, as there were more than 100 participants who joined the conference, taking advantage of a massive habitat Fair located in Valencia.

Deliverable 7.8: After-Life communication plan

The established plan will ensure the outcomes from the project to be disseminated extensively and successfully during the life and after the completion of the project. Besides, it includes the Layman's report, which is a 16 page report in English and Spanish targeted at a non-specialist audience, including political decision-makers. The Layman's report is included in the final report in paper and electronic format as well. It is located here: http://www.WOODRUB.com/publicaciones_detalle.asp?id=308

4.3 Evaluation of Project Implemention

Raw materials analysed were rubber, wood and glue. At the beginning, different glues were tested to check which one fit better binding the wastes. During these studies the wood-rubber glued unions were studied for different components rates and particle sizes with techniques like Scanning Electron Microscopy. A bigger amount of link points were observed with lower particles sizes of rubber and increasing glue rates up to 10 %. And among all the glues used the best one for binding the wastes of the project was a glue of isocyanate for furniture production. It was a success to analyse the proper glue in previous test, like this the subsequent process and prototypes were done using a proper binder. These studies were carried out by University of Brunel in UK, and the porosity of the rubber material of Keridis gave better union properties to the mixtures.

Later on ACCIONA realised that this glue was too rigid for one of its prototypes (floor for the parks), so they had to change it for a more flexible polyurethane resin.

Afterwards, boards with the proper raw materials were made at laboratory. To manufacture the best kind of boards different parameters were studied, like: the proportion of glue-wood-rubber, the particle size, the pressure in the press, etc. When the best conditions were achieved, the different products were obtained.

A small problem detected during the project was regarding the differences of the press machines used in different laboratories. This was the case of absorption materials manufactured with different machines in AIDIMA and ACCIONA, which use different concept of applying the same quantity of pressure with different results on the sound absorption. It was detected at the last part of the project, and this acquired knowledge will be passed to the stakeholders to avoid problems and get a better optimisation of the final products thanks to the experiences got during the WOODRUB project.

With these new products, different properties, which could give to the developed material a final proper use, were measured in order to assess the manufactured products and compare them with the traditional ones in the market. Some standards were tested for structural, sound absorption panels, outdoor furniture, non-slice floors, and manufacture parameters were fixed.

Once the boards were manufactured and tested, the consortium designed the WOODRUB prototypes. These designs were also tested and lead in a success, because the WOODRUB prototypes combined the quantitative properties of the boards and their qualitative properties (like the external final appearance and needs of the market) in very interesting WOODRUB prototypes.

The WOODRUB project was structured in 8 different Actions and all of them were essential for the right development of the project. In any case, only Actions 4, 5 and 6 are the

technical Actions with the main objectives and results of the project, because of that in the next table only these Actions are presented.

Task	Foreseen in the revised proposal	Achieved	Evaluation
Task 4.1	Homogeneous wastes have been obtained from wood wastes. Different crumbed rubber has been obtained, different particle sizes Different glues have been tested, epoxy, isocyanate …	Residues have been defined and prepared to next evaluations. Glue has been chosen for the lots of the pieces of applications.	Wood chips and crumb rubber have proper join through isocyanate glue although some applications like playmats could be not adequate for its hardness.
Task 4.2	It has been noticed the need of new composites made of recycled materials.	In this project, composites of WOOD and RUBBER recycled have been proceeding for many applications of human life.	It has been elucidated that board composite developed fulfills P5* standard board classification for indeed outdoor applications.
Task 4.3	Scale up of the processes for composite manufacturing has been calculated and plants have been designed.	All units needed for the wood and rubber wastes transformation into composite materials have been specified. Mounting and finishing of the product has been elucidated.	Some pre-prototypes were made in pilot plants which have enough equipment with some exceptions which have been solved through the progress of the project for each pre-prototype.
Task 4.4	The required standards for each use have been applied to different compositions of the WOODRUB composites to evaluate the proper application or to look for some others.	Outdoor use of board standards, grounds for play places and paths standards, inner wall standards, sound absorption standards… has fulfilled their own requirements for each application.	One thing to mind is that different equipment from different partners is designed differently and indeed gives different properties of, for example sound absorption. Equipment with pressure controller gave lower porosity in the same material than other with pressure stop dispositive. Minded that, the results have been achieved.
Task 5.1	Improve of the composites and WOODRUB products have been projected to assure the better quality and proper uses with economical success.	Products developed meets technical criteria and standards of proper use. Economical evaluation is complex because depends on the markets and marketing expenses required.	Products have been evaluated and improved for outdoor, sound absorption and so on with success and minimized the costs of production depending on the know-how achieved during the project.
Task 5.2	Development of at least ten prototypes were proposed.	It has been achieved: A.- WOODRUB ACOUSAN for (1) highways facing developed by	Products A and B were tested and made with different machines with different

		ACCIONA, AIDIMA and SONAE. B.- WOODRUB ACOUFRAME for (2) Acoustic panel and (3) Works wall, by ACCIONA, AIDIMA and SONAE. C.- WOODRUB PLAYMAT for (4) playground by ACCIONA. D.- WOODRUB SAFETYMAT for (5) Anti-slip floor by BRUNEL. E.- WOODRUB PATH for (6) Garden path by ACCIONA. F.- WOODRURBAN for (7) bench, (8) bin and (9) flower pot by AIDIMA. G.- WOODRUB BRICKS for (10) Internal walls by AUTH. Although it is not closed to develop more products depending on the demand.	concepts of the pressure applied and results were obtained later in the development. They were developed successfully. Product C was some changes in the glue respect to other materials for obtaining visco-elastic properties for its application. It was developed successfully. Product D was developed successfully. Product E was developed successfully. Products F were developed successfully. Product G was developed successfully.
Task 5.3	Manufacturing, testing and optimization of the products according to standards or normalized procedures established.	Optimized according to: A.- WOODRUB ACOUSAN. UNE EN 1793-1/2 B.- WOODRUB ACOUFRAME. UNE EN 1793-1/2 C.- WOODRUB PLAYMAT. UNE EN 1177 D.- WOODRUB SAFETYMAT. UNE-ENV-12633 E.- WOODRUB PATHWAY UNE-EN 12697-22 F.- WOODRURBAN Bench: EN 581-1/2, and EN 12727. Bin and flower pot: UNE EN 11016 The three: Aging internal procedure. G.- WOODRUB BRICKS. ASTM C39/C39M-12a	All prototypes met standards criteria in advanced or very last stages of the project. All products were also optimized according these procedures. Results have been reporting in each deliverables and meetings and it is been disseminating nowadays.
Task 5.4	According to the standards and composites developed required equipments were set.	It has been projected the equipment required for manufacturing WOODRUB products: A.- ACOUSAN for (1) highways facing developed by ACCIONA and SONAE. B.- ACOUFRAME for (2) Acoustic panel and (3) Works wall, by ACCIONA and SONAE. C.- PLAYMAT for (4) playground by ACCIONA. D.- SAFETYMAT for (5) Anti-slip floor by BRUNEL. E.- PATHWAY for (6) Garden path by ACCIONA. F.- RURBAN for (7) bench, (8) bin and (9) flower pot by AIDIMA. G.- BRICKS for (10) Internal walls by	Nowadays partners are disseminating and looking for commercial distribution for their WOODRUB products.

		AUTH.	
Task 6.1)	Objective and scope definition. Definition of eco-efficiency evaluation and establishment of the economical concepts involved in.	To each prototype developed in Action 5, functional unit, composition and system boundaries of WOODRUB products and a selection of market competitors have been described.	It has been very difficult to select the market competitors to each application due to the lack of available technical and economical information. There is also a high variability of alternative products, and uncertainty in their composition and needed processes, what joined with the lack of specific data bases, extremely difficult the step of life cycle inventories development.
Task 6.2)	Inventory of LCA. Collection of data, calculation procedures, quantification of inputs and outputs of the system.	LCA databases of materials and processes have been used and completed with market information and bibliographic resources to collect all the quantitative information needed to develop the Life Cycle Inventories (LCI), regarding each modelled WOODRUB prototype and their market competitors.	
Task 6.3)	Assessment of LCA impact and interpretation of the LCA.	WOODRUB products and their market competitors (real ones and technological material options when the design has a great influence) have been compared, and LCI have been transformed into environmental impacts by applying the Ecoindicator-99 methodology.	The higher environmental impact in WOODRUB boards is due to the glue, because recycled particles have a very low environmental impact. Depending on the final application and especially in Rurban products, depending on the design, WOODRUB some products have lower impact than alternative ones yet in the market, but not always. In general, they are preferable to other virgin materials, with the exception of solid wood, wich is also a very good environmental alternative.
Task 6.4)	Inventory of processing costs and evaluation of eco-efficiency.	By normalisation of compared end point environmental impact obtained in Task 6.3, and the estimated or real market prices (depending on available information), the eco-efficiency of WOODRUB products vs market competitor have been compared.	In general, WOODRUB products can be considered as serious competitors in current market, but the wide differences in market prices of real and very similar products between brands, and the uncertainty when estimating final price of WOODRUB products, generate the recommendation of consider these results as a first approach, and would be necessary further market exploitation plans to assess more realistic eco-efficiency comparison.

*P5 particle board classification corresponds to next properties measured by the related standards

P5 Boards for humid conditions		
Load bearing		
humid		
Width	[mm]	> 6-13
EN 319	IB [N/mm²]	0,45
EN 310	MOR [N/mm²]	18
EN 310	MOE [N/mm²]	2.550
EN 317	24h swelling [%]	13/11*
EN 321	IB after cyclic test [N/mm²]	0,25
EN 321	Swelling after cyclic test [%]	12
EN 1087-1	IB boil test [N/mm²]	0,15

*Long/Wide

The immediately visible results of the project are the different prototypes. They were exposed in the fair "Feria Valencia Hábitat" in February 2014 and currently are exposed in the main hall of AIDIMA. The prototypes have also been disseminated via different activities, publications, website, newsletters, etc. and this is all reflected in the Deliverables 7.

The results that will only become after a certain time period are the final products to be sold in the market. These results will only come if some of the project prototypes achieve to reach the market. These final products will probably have a different finishing appearance or will be part of a bigger product.

The dissemination has been effective as the planned actions have been carried out. There have been some problems that the consortium has encountered, such as the drop of the partner FCVRE. There was a need of reorganising the dissemination activities, and the following coordination between COSMOB and AIDIMA made possible to cope with the gap and to cover the dissemination.

It can be seen that Indicators have been fulfilled, as well as the number of the Website hits, which has been quintupled.

This delay did not affected other actions as the Dissemination and Promotion is a horizontal action and do not affect the development of the rest of the actions.

4.4 Analysis of long-term benefits

1. Environmental benefits

This project has demonstrated technical viability of developed composites and final applications by testing the manufactured prototypes. In consequence, the new opened opportunities to use wood and rubber recycled materials will help the substitution of alternative virgin materials currently employed, or in other cases they are as eco-efficient as other recycled alternative materials or even more.

Environmental evaluation has been performed by using Life Cycle Assessment methodology, and results regarding WOODRUB panels indicate that the main impact of their manufacturing is due to the glue content, because recovered wood particles and rubber granulate from end of life tyres have a relative very low environmental impact. For example (synthetic rubber has about 40 times more environmental impact than recycled one). Also the production process, with cogeneration power plant feeded with residual wood, has a low environmental impact.

By each m^3 of WOODRUB panel used, about 900 kg of wastes are recovered, avoiding their landfilling. On the other hand, recycled materials used to in their production steps be less energy demanding that virgin ones.

In several applications (urban furniture, anti-slip decks…) WOODRUB panels can substitute extruded recycled plastics or wood plastic composites.

Comparing by weight environmental results of WOODRUB panels (aprox. 1040 kg/m^3) with treated softwood for outdoor use (480kg/m^3) and with recycled plastic lumbers (950 kg/m^3), any of WOODRUB panels has lower impact expressed in Ecoindicator 99 points that the other materials (between 5,5% and 58%).

By comparing 1 m3 of material, the most impacting WOODRUB panel (WR 50-10: wood-rubber particles at 50% of each one, and 10% of PU glue), has a very similar impact to recycled plastic lumber but higher than virgin wood (due to the avoiding climate change impact by the CO_2 fixed in the wood). On the other hand, the WOODRUB panel with less impact (WR 70-6: wood-rubber particles at 70% and 30% respectively, and 6% of PU glue), lightly improves the impact of treated softwood. This means that some of the developed compositions of WOODRUB panels are environmentally as good as virgin wood.

When comparing several market products, specific design and densities have an important influence in the final environmental profile, but WOODRUB products are definitively comparable and sometimes better than other market alternatives (both in environmental and eco-efficiency terms).

Also in the case of WOODRUB bricks, the introduction of rubber and wood particles reduces the environmental impact of gypsum bricks. When comparing with other kind of bricks they are better than concrete or gypsum ones and competitive regarding aerated concrete or clay ones.

a. Relevance for environmentally significant issues or policy areas

The achievements of the project are highly relevant for environmentally significant issues and policies:

- They show that current panel manufacturing (hot pressing with the addition of a release agent), or gypsum blocks technologies can be used to manufacture new composites with wood and end of life tyre wastes. So, a new environmentally friendly material are made now available to the industry to manufacture products with lower environmental impact.
- They demonstrate technical viability on the market of developed recycled composite materials, by testing material performance in terms of resistance, anti-slipping, acoustic and thermal properties (depending on the final application functional parameters). This opens new final applications to these wastes, which are annually generated in huge amounts in Europe (and worldwide), and their

amount is expected to increase in the future, as the current recycling options are decreasing. In consequence, project´s results will help to withdraw from landfilling the current wood and rubber wastes not recovered for other purposes.

- As far as the dissemination campaign concerned, it clearly awakened consciousness amongst companies on ecological (recycled) material issues. The increase of awareness and information amongst professionals of the building, furniture and related sectors, result to be the real vehicles for market spreading of eco-compatible and energy efficient technologies and materials.

Foresaid achievements impact mainly on three distinct policy areas:

- Waste, offering a substantial contribution to implementation of the Thematic Strategy on the prevention and recycling of waste and the Waste Directive, by offering waste recycling technologies but as well new composite materials which an be integrally recycled at end-of-life.
- Resources preservation, contributing to the implementation of the Thematic Strategy on the Sustainable Use of Natural Resources, by offering secondary raw materials to several industrial sectors such as construction.
- Energy and climate change strategy, contributing directly to energy savings in the manufacturing industry, because when analysing studied products, energy demand in manufacturing steps is a major source of greenhouse-gas emissions, making available new materials with lower embodied energy is a key element of the European climate change strategy. The achievements may contribute to the EU's 2020 and 2050 targets for cutting CO_2 emissions.

On the other hand, there are links to the Strategic Implementation Plan on Raw materials (H2020) by supporting innovative and flexible processing inside the priority area of technologies for secondary raw materials production and end-of-life products recycling regarding the Technology Pillar. Other links of the project supporting this EIP are indicated below as long term benefits.

2. Long-term benefits and sustainability

a. Long-term / qualitative environmental benefits

Through the study of wood and end of life tyres end of life management, and the development of new composites to be uses as raw materials in the production of eco-efficient products, this project will promote the commercialization and widely use of recycled materials, changing the citizen perception of wastes, towards a new one as alternative raw materials.

This will positively affect the development of innovative approaches and infrastructures for reuse and recovery these materials wastes and develop the related end-of-waste criteria to promote the requirements of quality to a safe introduction of these materials into the supply chain and avoiding barriers associated to their legal classification as wastes.

Finally, dissemination tasks will contribute to generate an SME network on recycled materials (raw material partnerships) to optimised raw materials flows along value chains, in cascading use of both: wood and rubber.

From the point of view of the manufacturing industry, the project represents a good opportunity to increase their competitiveness at the same that that eco-innovation is introduced in the raw materials supply chain.

Regarding Non-Technology Pillar, other qualitative targets that project will help to achieve in the long term are the optimisation of waste flows for increased recycling and the resulting avoidance of landfill for recyclable waste (especially wooden materials which are biodegradable.

By offering successful final applications of added value, it will be generated a market demand of wood and rubber recovered materials, and in consequence, waste collection systems and Extended Producer Responsibility (EPR) Schemes will be boosted. So, the project results will help to improve Europe's raw materials framework conditions and development of sustainable circular business models.

Project also demonstrates product design for optimised use of raw materials and increased quality and will encourage industry to adopt and raise awareness of the extent to which industry adheres to the voluntary codes.

From the citizens point of view, current social rejection of recycled products is based on a negative perception of their quality, or even the association with a dirty or unwanted, no valued material source (wastes is a word with negative connotations). The project and further industry implementation of WOODRUB composite materials will fight against this negative public image, by demonstrating not only their high technical performance, but also the environmental benefit achieved and their economic viability; in sum, their sustainability.

b. Long-term / qualitative economic benefits

The nature of the project is related to a number of activities of economic cost and benefits referring to the environmental benefits deriving from implementation and improvement of recycling with a final economic benefit. Through the high valued final products from waste raw materials the user will be encouraged to consider the environmental and final use benefit of wood and rubber wastes.

The project allowed the manufacturing of products, from rubber and wood wastes as raw materials, with technical properties as good as the same kind of products made from virgin raw materials, that are nowadays in the markets. Moreover, as it can be seen in the table, the recycled raw materials are cheaper than virgin raw materials (especially in the case of the rubber), and this will also allow the companies to have a reduction in the cost for the raw material adquisition.

Recycled Rubber	**Recycled Wood**
150 €/Ton	99 €/Ton
Synthetic Rubber	**Virgin Wood**
1.280 €/Ton	200 €/Ton

The WOODRUB products will also have an added value thanks to their environmental, social and economical (reducing the taxes of landfilling) benefits. The techniques used to manufacture WOODRUB products are the same that the techniques used for the

traditional products, so the companies will not have the need to make extra investments to produce WOODRUB products.

On the other hand, recycled materials demand less energy in their production steps than virgin ones and recycling in general adds significance to the nation's economy.

c. Long-term / qualitative social benefits

The implementation of cost-effective recycling schemes is expected to benefit local communities. In particular more employment opportunities for administrative and management personnel, on-site workers, engineers… will become available through the implementation of waste management activities as transform of wood and rubber wastes, transport, existing equipment use, formulations, products and business designs. Positive impacts on environment health issues as resources preservation will also become evident: Recicling reduces the need to dispose waste materials somewhere and achieves a significant reduction in the amount of waste generated along with their associated emissions and land undecorating issues to local communities. Finally the results aim to encourage a shift to more sustainable consumtion patterns resulting in the reuse of wood and rubber wastes produced.

d. Continuation of the project actions by the beneficiary or by other stakeholders.

WOODRUB consortium stakeholders' intention is to exploit the achieved results in forthcoming years by industrializing the developed production process. This would permit the recovery of an important volume of high valued wood and rubber waste, once the product would be sufficient introduced on market, implying an important reduction in landfilling and greenhouse gas production.

WOODRUB consortium started during the project to produce WOODRUB prototypes of boards, bricks and non-slip floors for promotional purposes. This activity was meant to facilitate the future introduction of the wood and rubber high value products from wastes to be used in acoustic absorbers in roads and auditoriums, outdoor furniture, non-slip floors and house partition walls mainly, and it was also studied the future industrial production of these products if they achieve a high interest in the market.

Stakeholders will take alternatively production activities and dissemination activities to achieve enough requests to this products at the market. The lower market interest than expected is directly to be explained by the severe crisis in the financial sector, which is not favorable to the investment on new products on the market: in Europe, during 2011 the building sector built about 12% less of new houses while 2012 saw a further decrease of about 10%, meaning about 20% reduction with respect to 2010.

WOODRUB consortium is faithful that, if in the future, we can define with accuracy the performance parameters and characteristics then a better presentation of the demonstration products will be available, thus market penetration can be facilitated. Moreover the following activities are also planned:

- In collaboration with industries of the related developed product sector, with which a joint venture could be created for commercialization of wood and rubber designed products, for acoustic sound absorption, non-slipping floors, pathways, walls and outdoor furniture, an illustrative video has been realized in many European languages. This video explains the large variety of use modalities of the wood and

rubber composites, with indication of the main applications of the products developed.

- WOODRUB consortium has many customers and commercial agreements could be stablished with the manufacturers constituting the consortium. Joins ventures could be created in the future for commercialization. When market interest increases again and makes favorable to invest on new products, WOODRUB products could also be presented to distributors which could organize visits to the pilot plant productions.
- If the market starts to demand the WOODRUB products, agreements could been taken with the producer of boards, which could intend to make enough production to cover demand for the products designed. The intention would be to apply the materials contributing thus to further diffusion of the most challenging application of wood and rubber boards.
- Opportunities to be in the market could be assessed and that could require an important marketing approach to make the particular composition of the WOODRUB composites and products desirable compared to normal commercial products. A marketing campaign was pursued during dissemination, based on the outcomes of performance monitoring of the demonstration through the standards applicable for each product use. It is expected that these environmental and technical benefits make a difference with respect to what can be shown to potential clients today.
- Stand with the best products were shown in an important Fair (Feria Hábitat Valencia, February 2014) and are nowadays at the main entrance of the WOODRUB coordinator office (AIDIMA), to be shown and to promote the use of WOODRUB products. Posters in different languages and with the main results and prototypes of the WOODRUB project are and will be exposed in important events, institutes, research centers, Universities and strategic points to inform citizen about the project and the results.
- Convention's rooms from each stakeholder at the production plant could be used in the future to meet with companies, designers and merchandising organizations, to present the WOODRUB products and its potential applications, offering examples on site.

3. Replicability, demonstration, transferability, cooperation: Potential for technical and commercial application (transferability reproducibility, economic feasibility, limiting factors) including cost-effectiveness compared to other solutions, benefits for stakeholders, drivers and obstacles for transfer, if relevant: market conditions, pressure from the public, potential degree of geographical dispersion, specific target group information, high project visibility (eye-catchers), possibility in same and other sectors on local and EU level, etc.

There is need for commercialization of the project's outcomes. Both wastes as raw materials and final high value products described in the project's deliverables could be provided for business activities in an effort to be sinkhole of wood and rubber wastes and offer a competitive product with high environmental value, low environmental impact. The project intended to be an example of cost effective recycling by transformation of wastes in useful products. Therefore the benefits for potential stakeholders and decision makers in the field of wood and rubber wastes management are significant allowing them to identify the most cost-effective and environmentally friendly business product and implementation of best

available techniques for transforming waste into high value products. The need for implementation of the EC directives regarding waste recycling in all member states currently acts as a driver for the EC member states in order to stablish successful environmental and cost-effective management schemes and achieve the set targets for the recovery and recycling of the various waste streams. While this is the case for member states, the implementation of environmentally friendly management schemes is also deemed necessary for states that comprise part of the countries given the fact that disposal in dumping areas is no longer considered as an acceptable solution. In general, the implementation of cost-effective and environmentally friendly wood and rubber waste management schemes is necessary given by the fact that wood and rubber wastes are considered to have high volume production. The main target groups of WOODRUB consortium in a international level are collective business schemes in collaboration with public and private enterprises who would be the beneficiaries of the WOODRUB products.

Through the WOODRUB implementation and studies conducted within the framework of the project it is evident that market conditions affect the decisions with regard to the management schemes, processes and business plan to be finally implemented by the industry. In general, the implementation of successful waste management schemes pursuing high quality waste streams materials will result both in the accomplishment of better environmental results and in the increase of income for the management of manufacturing products obtained, thus giving as a result cost-effective and high value products from wood and rubber wastes.

Regarding the replicability potential of WOODRUB, the technologies used to manufacture WOODRUB products are the same ones as the traditional technologies to manufacture panel boards and gypsum bricks building elements. The main difference regarding wooden particleboards is the need of applying a release agent to the hot plate of the press, in order to avoid the rubber adhesion due to the melting of this component. In addition, tDEhe ten products developed by our consortium could serve as a basis for other products to be applied and merchandising made in other sectors for which implementation of the relevant EC Directives applies in either waste streams and reuse of high valued wastes.

4. Best Practice lessons: briefly describe the best practice measures used and if any changes in the followed strategy could lead to possible adjustment of the best practices

Lessons learned draw on both positive experiences and negative ones. Positively we have learned some points summarized below:

- ✓ Having flexible stakeholders fulfills objectives.
- ✓ The high transnational level of the team gave to the project a general European point of view.
- ✓ The coordinator kept a good work atmosphere through all the partners and it was essential to have: good results, high participation and to stablish good relations to create future project partnerships' associations and/or business.
- ✓ The partners also fulfilled all the necessary areas to achieve the best goals.

Next we summarized some difficulties were had to copy:

- ✓ Some delays in the delivery of the work or documents due to the amount of work.
- ✓ Few changes of human resources during the years of the project produced small problems that were corrected.
- ✓ Unexpected transport payments and delays

- ✓ Small unexpected process behavior that were readjusted and achieved during the project.

Practically, all the pilot plants have shown the proper behavior to fulfill objectives, but optimization and scaling up of the processes are still to pursue as WOODRUB's product demand will increase. Thanks to waste managers from the WOODRUB consortium, raw materials were enough homogeneous and reproducible. In addition, the designers found solutions with these materials to arise standards of their own applications, and business plans will be stablished to get a qualified product.

5. Innovation and demonstration value: Describe the level of innovation, demonstration value added by EU funding at national and international level (including technology, processes, methods & tools, organisational & co-operational aspects);

The WOODRUB consortium has provided for the wood and rubber wastes a number of business products to be considered by the relevant public authorities, private organizations and additional stakeholders in the participating countries. The consortium has involved all the stakeholders through their participation in the different events organized and especially during the Final Conference, where WOODRUB project results were demonstrated and discussed.

WOODRUB project is a very innovative example of providing applications for manufacturing and managing waste all around EC. The evaluation of the implementation of the relevant EC Directives in the participant member states resulted in interesting applications in relation to recycling wood and rubber as high valued wastes. The innovative idea of WOODRUB was to focus on the particular case of wood and rubber wastes for implementing sinkhole business activities of high value wastes that have received relatively little attention in the past. And this was achieved by the implementation of the project's objectives and the conclusions drawn.

The project provides significant added product value for the sustainable management of wood and rubber wastes through the implementation of best available techniques of manufacture transformation into valued products from high value wastes. The EU added value of this project is also evident since research institutes, manufactures, and waste managers from five EU countries participated in the project and exchanged their experiences and know-how on the field of these kinds of wastes. It is thus apparent that the project was benefit from the multinational character of its consortium and used facts and figures from the manufacturers, research centers and waste managers from five EU countries in order to develop the WOODRUB project and achieve all its objectives.

The funding provided by the EU funding, through co-financing by the LIFE program, enabled the close collaboration of the enterprises, research institutes and universities in the field of wood and rubber waste recycling in order to achieve the objectives of WOODRUB project and it also made possible the dissemination of the project results to an international level:

a) through the provision of the project's outcomes, deliverables and the products to targeted stakeholders and the general public via the project's website,
b) allowing the participation of international stakeholders and countries in the project's Final Conference that took place in February 2014,
c) through allowing the publishing of articles relevant to the project's implementation in the website and newsletter of WOODRUB project as a part of the wider dissemination activities of WOODRUB. Worth mentioning is also the fact that WOODRUB website has

received more than 108.000 of visits, with an average number of visits per day of 86. The country that the website received more visitors was United States, with the 25% of the visitors.

6. Long term indicators of the project success: describe the quantifiable indicators to be used in future assessments of the project success, e.g. the conservation status of the habitats / species.

Quantifiable indicators that could be used in future assessments of the project's success include the following:

- ✓ Accomplishment of the EC Waste Directive targets for wood and rubber high value wastes.
- ✓ Accomplishment of the EC Waste Directives targets regarding reuse and sustainable sinkhole wastes.
- ✓ Number of consortium members in the EU implementing business activities from recycling of wood and rubber wastes.
- ✓ Number of people and/or organizations having used the WOODRUB data in order to assess both financial and environmental benefits when examining existing or potential business options and number of persons using the on-line dissemination through the project's website.
- ✓ Number of wood and rubber wastes' tons intend for WOODRUB products.
- ✓ Number of products in the market which have one or more elements developed in the WOODRUB project.