WOOD2WOOD

A Wood-to-Wood Cascade Upcycling Valorisation Approach

» Deliverable 4.1

Mapping of the actors and key stakeholders

WP No.	4
WP Title	Transformation Framework for Sustainable by-design Construction Demolition Wastes Biorefining
WP Leader	DRAXIS
Due Date:	31/10/2024
Submission Date	31/10/2024
Authors	Vasiliki Papatheologou, Thanasis Karagkounis, Artemis Lavasa (DRAXIS)
Contributing Partners	ICCS, NTUA, LERMAB, CIRCE, POLIMI
Status	Final
Peer Reviewers	1. ICCS 2. POLIMI

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or HADEA. Neither the European Union nor the granting authority can be held responsible for them.

GA Number	101091801
Project Full Title	Wood2Wood
Project Acronym	W2W
Funding Scheme	Horizon RIA
Start Date	01/01/2024
Duration	48 months
Coordinator	Dr. Angelos Amditis, Research and Development Director, ICCS
Project Website	https://www.wood2wood-project.eu/

PROJECT INFORMATION

REVISION AND HISTORY CHART

Version	Date	Author	Description of changes
0.1	30/09/2024	Vasiliki Papatheologou, Thanasis Karagkounis, Artemis Lavasa (DRAXIS)	Internal Review
0.2	24/10/2024	Vasiliki Papatheologou, Thanasis Karagkounis, Artemis Lavasa (DRAXIS)	Internal Review

Dissemination Level		
PU	Public	X
RE	Restricted to a group specified by the consortium	
CO	Confidential, only for members of the consortium (including the European Commission Services)	

Legal Disclaimer

TABLE OF CONTENTS

EXECUTIVE SUMMARY 7

1. INTRODUCTION 8

1.1. Project intro 8

1.2. Purpose of the deliverable 8

1.3. Intended audience 8

1.4. Structure of the deliverable 9

2. METHODOLOGY OF STAKEHOLDER MAPPING AND ANALYSIS 10

2.1. Step 1: Identification - Drafting an initial list of stakeholders 11

2.1.1 Partners' contribution 11

2.1.2 Additional research by DRAXIS 13

2.2. Step 2: Categorization - Ensure diversity & balanced representation 13

2.3. Step 3: Mapping – Recognize key interactions between stakeholders 13

3. MAPPING AND ANALYSIS PROCESS 15

3.1. Use Case 1: cascade refinement technologies for wood waste upcycling 15

3.1.1. Background 15

3.1.2. Stakeholder analysis 16

3.1.3. Visualisation of stakeholder interactions 26

3.2. Use Case 2: chemical and bioremediation technologies for wood waste upcycling 28

3.2.1. Background 28

3.2.2. Stakeholder analysis 29

3.2.3. Visualization of stakeholder interactions 33

3.3. Use Case 3: energy & gas valorisation technologies for contaminated wood waste 34

3.3.1. Background 34

3.3.2. Stakeholder Analysis 35

3.3.3. Visualisation of stakeholder interactions 40

4. NEXT STEPS 42

5. CONCLUSIONS 43

6. REFERENCES 44

GLOSSARY OF ACRONYMS

Acronym	Extended Definition
BWI	Building and Wood Worker's International
C&D	Construction & Demolition
CDW	Construction & Demolition Waste
CEETTAR	European Confederation of Agricultural, Rural and Forestry Contractors
CEPI	Confederation of European Paper Industries
CEPF	Confederation of European Forest Owners
CNF	Cellulose NanoFiber
ECHA	European Chemicals Agency
ENRD	European Network for Rural Development
EPF	European Panel Federation
EWA	European Waste Management Association
FSC	Forest Stewardship Council
HTC	HydroThermal Carbonisation
MWS	Management of Waste Streams
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
TRL	Technology Readiness Level
W2W	Wood2Wood
ZWIA	Zero Waste International Alliance

List of Tables

Table 1: General Actor Categories 11
Table 2: Stakeholder Mapping Questions - Template 12
Table 3: Strength of interaction between actors, ranking scale. 14
Table 4: Waste Owners/ Generators for use case 1 18
Table 5: Sorting providers for use case 1 19
Table 6: Waste Management Companies and Operators for use case 1 20
Table 7: Lignin & Cellulose Fibers' End Users for use case 1 21
Table 8: Composite pellets' End Users for use case 1 21
Table 9: Facades' & Wallboards' End Users for use case 1 22
Table 10: Public Authorities for use case 1 23
Table 11: Standardization Actors for use case 1 24
Table 12: Waste Owners/ Generators for use case 2 30
Table 13: Waste Management Companies and Operators for use case 2 31
Table 14: Bio Polyols, Green Glue and Wood Pulp End Users (Intermediate products) for use case 2 31
Table 15: Mycocomposites and Wood Panels End Users (End products) for use case 2 32
Table 16: Waste Owners/ Generators for use case 3 36
Table 17: Waste Management Companies and Operators for use case 3 37
Table 18: Hydrochar End Users for use case 3 38
Table 19: Syngas End Users for use case 3 39
Table 20: Dodecanol End Users for use case 3 39
Table 21: Nutrients End Users for use case 3 39

List of Figures

Figure 1: Methodological steps for stakeholders mapping and analysis 10
Figure 2: Flow-chart of use case 1 16
Figure 3: Stakeholder representation by category for use case 1 17
Figure 4: Stakeholders' key interactions for use case 1 27
Figure 5: Flow-chart for use case 2 29
Figure 6: Stakeholder representation by category for use case 2 29
Figure 7: Stakeholders' key interactions for use case 2 34
Figure 8: Flow-chart of use case 3 35
Figure 9: Stakeholder representation by category for use case 3 36
Figure 10: Stakeholders' key interactions for use case 3 41

EXECUTIVE SUMMARY

Wood2Wood (W2W) is a European Union (EU) funded project aiming at revolutionizing how wood is used and reused in Europe, addressing the critical need for sustainable practices that can keep pace with the demands of our planet.

The present deliverable i.e. Deliverable 4.1 “Mapping of the actors and key stakeholders” has been conducted in the context of Work Package (WP) 4 “Transformation Framework for Sustainable-by-design Construction Demolition Wastes Biorefining” and under Task 4.1, “Actors mapping and key stakeholders’ interactions”.

The W2W project demonstrates efficient and sustainable value chains in 3 Use Cases focused on upcycling processes and technologies regarding multi-dimensional cascade valorisation of wood waste from construction and demolition activities and furniture waste. These Use Cases develop mechanical, chemical, bioremediation and gasification processes to recover wood or resources from waste and use them in new products which have the same quality as the ones produced by primary resources, particularly focusing on the production of: wood without pollutants; biocomposite building materials; biopolymers; polyols; chemical detergents; and the recovery of nutrients. To support the successful implementation of the Use Cases, Task 4.1 focuses on mapping of all the relevant actors and analysing key stakeholders' interactions within the value chains.

To achieve these goals, a co-creation process was conducted with project partners to develop an initial identification list, gathering information on existing or potential stakeholders. Subsequently, a consistent approach was applied in the mapping process which was facilitated by classifying stakeholders into six general categories: waste generators, wood waste sorting providers, waste management companies and operators, product end users, public authorities, and standardization bodies. Furthermore, stakeholder relationships and interactions were analysed to understand their dynamics, with their interconnections illustrated in color-coded tables. A ranking system was applied to assess the importance of each interaction: Very High indicated interactions that were highly needed, High for those that were mandatory, Medium for preferable interactions, Low for suggested (optional) ones, and Very Low for interactions considered not quite useful or not applicable.

Following this methodology, a total of 200 stakeholders were identified: 67 of them from Use Case 1, 63 of them from Use Case 2 and 70 of them in Use Case 3. Strong communication among dependent actors in the value chain is essential, with unique interactions between general actor categories identified for each use case. The comprehensive lists of stakeholders in each actor category as well as the interaction tables between the key actor categories, produced in this deliverable, provide valuable guidance for the project's upcoming stakeholder engagement, collaboration strengthening, and communication enhancement, thereby supporting the achievement of project objectives and maximizing its impact.

1. INTRODUCTION

1.1. PROJECT INTRO

The W2W project aims to establish and validate a comprehensive framework for multi-dimensional cascade valorisation of wood waste derived from construction, demolition and furniture sectors. With Europe facing a potential wood shortage by 2030 due to rising demand, the project addresses significant challenges in wood waste management, by minimizing waste sent to landfills or incineration and fostering a transition towards circular economy.

Four essential pillars are the core of the W2W framework:

i. development of cutting-edge technologies for advanced separation and sorting,
ii. implementation of innovative upcycling processes,
iii. creation of digital tools that enhance circular flows of secondary materials,
iv. establishment of supportive frameworks in policy, market dynamics and skills development.

The W2W project aspires to achieve a Technology Readiness Level (TRL) of 6 by its conclusion, showcasing efficient and sustainable value chains through three practical use cases that will generate: pollutant-free wood, bio-composite materials for construction, biopolymers, polyols, cleaning agents, and nutrient recovery solutions.

1.2. PURPOSE OF THE DELIVERABLE

This deliverable presents the work undertaken in Task 4.1 “Mapping of the actors and key stakeholders” has been conducted in the context of Work Package (WP) 4 “Transformation Framework for Sustainable-by-design Construction Demolition Wastes Biorefining”. The purpose of this deliverable is to identify and categorize the stakeholders involved in each of the value chains of the use cases developed the W2W project, as well as to recognize important relationships between key actors.

Eventually, this task aims to provide a comprehensive understanding of the stakeholder landscape, which is vital for project partners to effectively identify and engage with key actors throughout the value chains developed within the W2W project.

1.3. INTENDED AUDIENCE

The dissemination level of D4.1 is public (PU). This means that the deliverable is accessible to a wide audience, including stakeholders, industry professionals, policymakers, researchers, and the public interested in sustainable wood management practices.

This document will be especially valuable for project partners, as it will provide informed proposals on effective collaboration networks that need to be developed. By enhancing collaboration and ensuring alignment with the project’s objectives, this deliverable aims to maximize the impact of their contributions. Overall, D4.1 serves as a comprehensive resource that promotes a shared understanding of effective stakeholders' interactions.

1.4. STRUCTURE OF THE DELIVERABLE

This document is organised into the following chapters:

i. **Chapter 1**: Introduces the document, outlining its scope, the purpose of stakeholders mapping, and the key contents of the deliverable.
ii. **Chapter 2**: Details the methodology for stakeholder mapping and analysis, which is structured as a three-step process encompassing the Identification, Categorization, and Mapping of key interactions among stakeholders.
iii. **Chapter 3**: Describes the results obtained from the implementation of the methodology process. In detail, stakeholders are further classified into subcategories to ensure comprehensive representation of all relevant parties, and key conclusions regarding their interactions are drawn to highlight important dynamics within the network.
iv. **Chapter 4**: Suggests the next steps for utilizing the outcomes of this deliverable in order to advance the progress of the W2W project.
v. **Chapter 5:** Outlines important outcomes of the deliverable.

2. METHODOLOGY OF STAKEHOLDER MAPPING AND ANALYSIS

To achieve the project goals outlined in Task 4.1, stakeholder mapping and analysis was conducted, aiming to provide an overview of different stakeholders related to W2W project value chains. In this frame, a three-step methodology was applied, firstly identifying the most relevant stakeholders in each use case, then categorizing them to ensure a wide diversity and finally mapping their key interactions. This methodology is adapted from established practices in stakeholder analysis, as outlined by Gilmour et al. (2006).

The implementation of this methodology requires co-creation processes between DRAXIS and all project partners to ensure its relevance and alignment with the evolving needs and value chains of the project. The approach emphasizes that value is created through the active participation of all stakeholders, rather than by a single entity. Furthermore, know-how sharing, and joint development are crucial components of the co-creation process. By combining the technical expertise of research institutions, the practical experience of industry partners, and the insights from environmental groups, innovative solutions in stakeholder mapping can be co-developed.

The three-step process is presented in Figure 1.

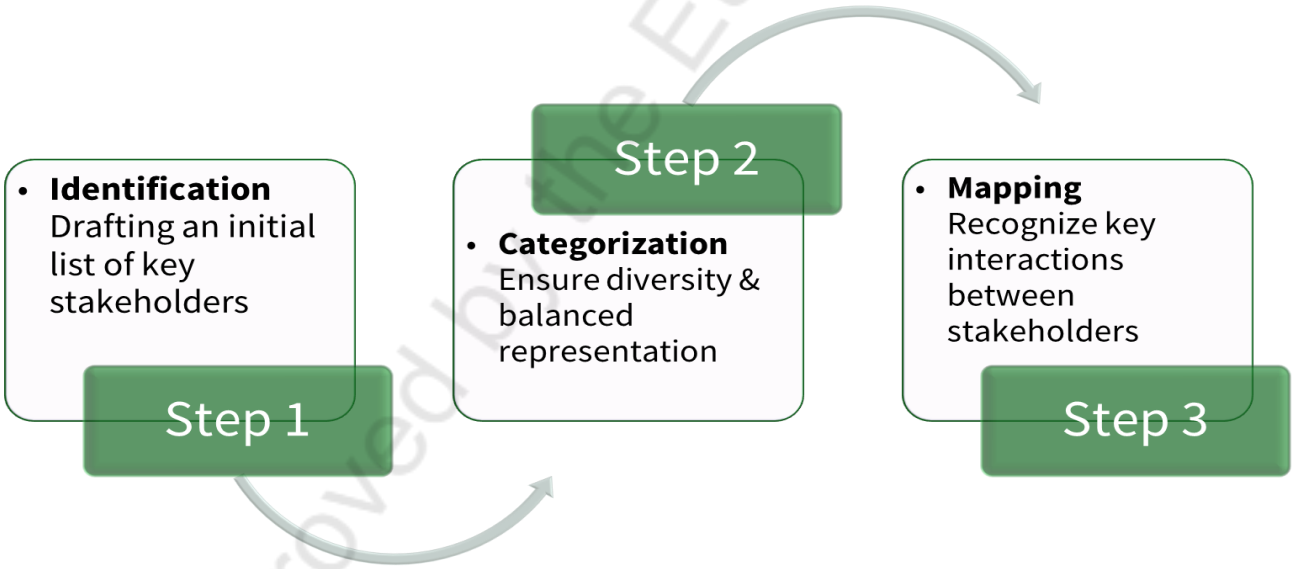

Figure 1: Methodological steps for stakeholders mapping and analysis

2.1. STEP 1: IDENTIFICATION - DRAFTING AN INITIAL LIST OF STAKEHOLDERS

To ensure effective stakeholder identification for the participatory process, we considered two methods: data extraction from the partners involved in the project and supplementary research regarding each value chain for additional potential stakeholders.

In order to facilitate the identification process and after careful consideration of the value chains developed in the project, it was necessary to define the main general actor categories applying to all three use cases. The actor categories and a brief description of them are concluded in Table 1.

Table 1: General Actor Categories

General Actor Category	Description
Waste Owners/ Generators	Entities that generate wood waste through activities of construction, demolition, manufacturing etc. Feedstock producers in each use case.
Wood Waste Sorting Providers	Entities related to the wood waste sorting system development, implementation and expansion.
Waste Management Companies & Operators	Entities responsible for developing the upcycling technologies, as well as processing and transforming wood waste into reusable materials or products.
Products' End Users	Entities interested in the valorisation or direct usage of intermediate and end products.
Public Authorities	Entities responsible for creating policies and regulations for wood waste management.
Standardization Actors	Entities involved in setting quality, safety and environmental standards for wood waste management.

This framework guided the development of our initial stakeholder list, ensuring comprehensive representation across the value chain.

2.1.1 Partners' contribution

The development of the initial list of stakeholders was a collaborative effort involving all partners to achieve a comprehensive understanding of the stakeholder landscape related to the project's value chains. Each partner contributed by developing a preliminary list of potential stakeholder groups, relevant to the specific value chains they are engaged in. Specifically, the partners were encouraged to list organisations known to be relevant to the project's use cases and tasks that they participate in. In addition, they were expected to leverage their networks, in order to track stakeholders who may have an indirect but significant impact on the project's success. It is noted, that the entire process was conducted without violating GDPR regulations.

To ensure consistency in the stakeholder identification process, a structured questionnaire was provided to all partners. It is divided into two sections: 1. Stakeholder Identification 2.

Stakeholder's description. The responses from these questionnaires were collected and served as a foundational tool for forming the stakeholder lists, presented in Chapter 3.

The template of the questionnaire is the following:

Stakeholder Mapping Questionnaire

Section 1: Stakeholder Identification

i. Who are the key stakeholders involved in the value chain?
ii. Please list any organisations, institutions, or companies currently engaged in activities related to the value chain.
iii. Are there any stakeholders who may have an indirect but significant impact on the project's success? If yes, please specify.

Section 2: Stakeholders' Description

*Please provide this information for all the identified stakeholders according to the template presented in Table 2.

Table 2: Stakeholder Mapping Questions - Template

Stakeholder Mapping Questions	
Name of the stakeholder	
Topic area/sector	What are their main areas of work?
Type of organisation	What type/category of organisation is the stakeholder?
Role in the project & level of influence	How do you envision their involvement and engagement throughout the project lifecycle? What is the level of influence of the stakeholder on the project's activities?
Important considerations	Challenges in engaging the stakeholder. What are the potential risks associated with engaging each stakeholder?
Communication & Engagement Plan	Do you have previous collaboration with the stakeholder? Have you identified the most suitable channels / contact person to approach them?

2.1.2 Additional research by DRAXIS

In addition to the input collected by the questionnaires, supplementary research, including primarily internet searches, was conducted to identify additional stakeholders.

The goal of this procedure was to identify key players in the main public, academic and industry sectors involved in each actor category of the W2W value chains. Regarding the geographical context, the research primarily focused on a European level, while in some cases it was associated with the specific country where the process was developed.

The findings of this step, combined with the stakeholder list developed with the partner's contribution, are presented in Chapter 3 following the implementation of categorization, which is described as follows.

2.2. Step 2: Categorization - Ensure diversity & balanced representation

Upon completion of STEP 1, categorizing the stakeholders will facilitate the assessment of whether a balanced representation of different actor categories is achieved.

In order to ensure an accurate and detailed stakeholder categorization, subcategories were created for every general actor category. The definition of the subcategories was a rational outcome of the general categories analysis in each use case. As a result, some subcategories, primarily in the case of wood waste owners and the products end users differ in each use case, according to the feedstock needed and the final products produced, accordingly. The subcategories were codified under "NACE Rev2: Statistical classification of economic activities in the European Community" (European Commission 2007) to ensure a common basis for their understanding.

When considering the number of stakeholders, it's important to recognize that there is no ideal number. The focus should be on the quality and commitment of stakeholders rather than the quantity. It's essential to involve participants from all various sectors mentioned earlier, ensuring that the diversity of actor types is adequately represented. Maintaining a balance in sectoral representation is crucial to prevent any sector from having excessive influence, unless the co-design and co-creation processes are specifically targeting actions related to that sector.

2.3. Step 3: Mapping – Recognize key interactions between stakeholders

Understanding and showcasing key relationships/interactions between stakeholders is essential, especially in complex value chains, like those developed within the W2W project. The goal of this final step is to clearly identify which stakeholders interact and influence each other, as well as to highlight which categories of actors have minimal or no interaction between them. Therefore, this analysis assesses the ideal interaction strengths, based on DRAXIS team evaluation, that takes into account the requirements of each value chain, further described in the sections 3.1.1., 3.2.1., 3.3.1.

The ranking has been performed separately for each of the three value chains by DRAXIS team according to the ranking scale presented in Table 3. This approach ensures uniformity and enables easier comparison and analysis of interactions within and across the value chains. Finally, the ranking results are illustrated through visual diagrams for each use case in chapter 3.

Table 3: Strength of interaction between actors, ranking scale.

Ranking	Criterium: the interaction between the actors is considered:
Very high	Highly mandatory (highly needed)
High	Mandatory (must)
Medium	Preferable (should)
Low	Suggested (optional)
Very low	Not quite useful / not applicable

3. MAPPING AND ANALYSIS PROCESS

In this chapter, the stakeholder analysis developed based on the data collected, is conducted aiming to include all key stakeholders across each value chain. Additionally, the key interactions between the project's stakeholders will be presented.

Stakeholder analysis was performed at use-case level, providing an overview of the actors involved in wood waste management within each value chain. First, a use-case description is provided. Next, the identified stakeholders are organised in tables according to their relevant category and subcategory, which is generated according to the value chain processes and specifications. Finally, a figure is provided to visually illustrate the results of the stakeholders' interaction mapping.

3.1. USE CASE 1: CASCADE REFINEMENT TECHNOLOGIES FOR WOOD WASTE UPCYCLING

3.1.1. Background

The partner responsible for use case 1 is NTUA (contributing partners are: UHE, BLOOM, LEVERY). The aim of this use case is to produce composite materials from wood waste following a four-stage process:

i. production of lignin and cellulose fibers from the wood waste (UHE),
ii. production of pellets by combining the produced fibers with biopolymers (NTUA),
iii. formation of pellets into building material components (NTUA),
iv. testing of the new building materials in mock-ups, like facades or wall boars (BLOOM-LEVERY collaboration).

In this use case two main concerns will be addressed: the shorter length of fibers from waste wood compared to native wood and the contamination of these fibers with debris, plastics and additives like glues and paints. To tackle these issues, the partners focus on developing and optimizing technologies for extracting cellulose nanofibers (CNFs) from waste wood, improving their compatibility through functionalization and producing sustainable composite materials. The goal is to integrate these composites into a prefabricated façade system. Key technologies to be tested include organosolv pulping for wood waste fractionation, mechanical treatment for CNF production, functionalization of CNFs, lignin isolation and purification and composite material fabrication, ensuring the final products meet performance and quality standards similar to conventional materials.

The wood waste material of this value chain is Construction & Demolition Waste (CDW) being processed in the sorting system developed by ICCS, in the frame of the project. It is important to mention that the development of the advanced wood waste separation & sorting system – which also represents the first pillar of the project, has its own stakeholders' value chain. CDW is used as feedstock in every use case, thus the value chain of the sorting system will be incorporated as an extension to the value chain of each use case and the relevant stakeholders can be found under the category of wood waste sorting providers.

The sorting system for management of waste streams (MWS) is led by ICCS (with IRIS as a contributing partner). Using advanced optical and spectroscopic technologies, along with robotic and human-robot collaboration, the system efficiently sorts materials into high-purity wood

streams (classes A, B, and C) and glass streams of varying quality. In the context of use case 1, class B and class C wood waste is used as feedstock, standing for lightly admixed products and heavily admixed products, respectively.

Finally, a flow chart of use case 1 is presented in Figure 2, as provided by POLIMI in the context of task 16.2. At this stage of the W2W project, the Figure below is at a draft version and have yet to be finalized, considering also the replacement of FOCCHI by BLOOM-LEVERY cooperation, as contributing partners in use case 1.

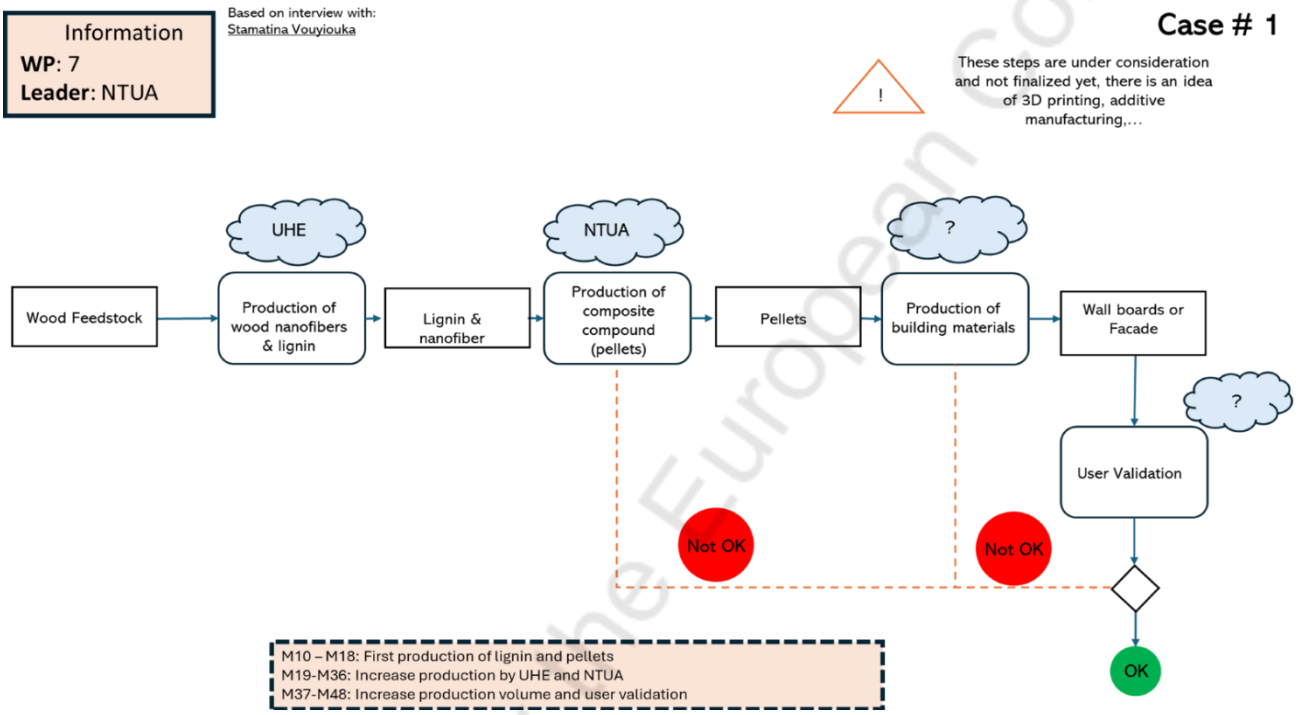

Figure 2: Flow-chart of use case 1

3.1.2. Stakeholder analysis

As described in the methodology section, stakeholders were identified in six general actor categories: waste generators, wood waste sorting providers, waste management companies and operators, products end users, public authorities and standardization actors.

The stakeholder analysis for Use Case 1 resulted in the identification of 67 stakeholders. It is noted that some of them are included in more than one general actor category. The identification process was conducted, using a combination of methods (described in chapter 2.1) to guarantee comprehensive stakeholder inclusion. The breakdown of stakeholder representation by category is presented in Figure 3.

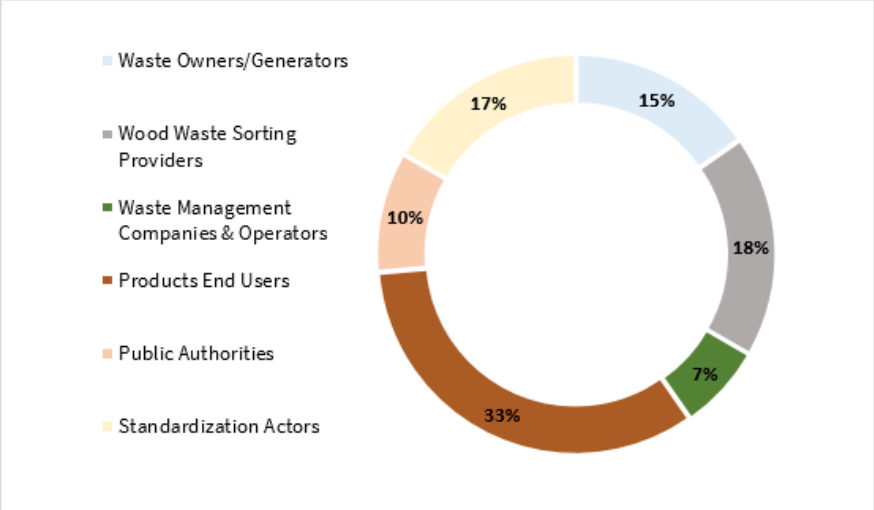

Figure 3: Stakeholder representation by category for use case 1

To achieve a balanced distribution, the selection of stakeholders was designed to ensure a good quantitative representation across categories, as illustrated in Figure 3. Notably, the predominant number of stakeholders are identified within the category of end users, reflecting the presence of three intermediate and final products that can be leveraged by a diverse range of industries.

As follows, each category is analysed further into subcategories and necessary information about specific stakeholders in this use case are provided. As explained in the methodology section, all subcategories were associated with the related classifications of "NACE Rev2: Statistical Classification of Economic Activities in the European Community" (European Commission 2007), establishing an approach based on the classification of economic activities, while allowing flexibility in naming in the context of the present study.

Waste Owners / Generators

The identification of the stakeholders included in this general actor category is directly linked with the feedstock needed for the implementation of each use case. As outlined in the description of use case 1, the primary raw material for this process is CDW. In this context, the stakeholder sub-categories focus specifically on those who produce or own CDW.

The first subcategory includes **construction companies** (codified 41.2, 42.1, 42.2, 42.9 under NACE Rev.2), which are significant contributors to CDW through their activities. These companies create waste during the construction of new buildings, renovations and infrastructure developments. Their practices in waste management can directly impact the quantity and quality of the CDW provided.

Another key subcategory is **demolition companies** (codified 43.1 under NACE Rev.2), which specialize in dismantling buildings and other structures. These companies play an important role in CDW generation, as their operations result in substantial amounts of waste.

Lastly, **CDW collection authorities** (codified 38.12 under NACE Rev.2) is a subcategory that includes municipalities and collaborating private companies. These entities are responsible for the management and transportation of CDW from construction sites and demolition projects, thereby owning the waste until it is processed. Their role is vital in ensuring that CDW are effectively

collected and directed towards appropriate recycling or disposal facilities, supporting local sustainability efforts and contributing to circular economy models.

Following the generation and collection of CDW, the next step is the sorting process, which in project's frame is implemented by ICCS, in Greece. Therefore, most of the stakeholders listed in Table 4, are located there. Nevertheless, additional research conducted by DRAXIS aimed to identify major wood waste generators across Europe, so some examples of these stakeholders are also included in the table.

Table 4: Waste Owners/ Generators for use case 1

Construction Companies		Demolition Companies		CDW Collection Authorities	
ELAK [1] (GR)	https://ellaktor.com/	**NORTH AGEAN SLOPS** [3] (GR)	https://www.northaegeanslops.gr/en/egnatia-odos-s-a-pollution-control-units/	**ANAKEM** [3] (GR)	https://anakem.gr/
VINCI Construction [3] (FR) – Global	https://vinci-construction.com/en/	**Keltbray** [3] (UK) - Europe	https://www.keltbray.com/	**Veolia** [3] (FR) - Global	https://www.anz.veolia.com/
Skanska [3] (SE) – Global	https://www.skanska.com/	**BAM Construction** [3] (UK) – Europe	https://www.bam.co.uk/		
ACCIONA [3] (ES) – Global	https://www.acciona.com/?_adin=11734293023	**MLD DEMOLITION** [3] (FR)	https://www.northaegeanslops.gr/en/egnatia-odos-s-a-pollution-control-units/		
BOUYGUES CONSTRUCTION[3] (FR) - Global	https://www.bouygues-construction.com/				

Index 1: Partner of the W2W project.
Index 2: Stakeholder identified through the questionnaires distributed by project partners—these stakeholders have or can have an established line of communication with the project team.
Index 3: Stakeholder identified through DRAXIS research—there is currently no communication established with these stakeholders.

Wood Waste Sorting Providers

The identification of stakeholders in the sorting providers category is crucial for the efficient processing of wood waste after its generation and collection. All stakeholders in this category act as technology providers and are also involved in the implementation of the technologies they

develop. As a result, they are distinguished based on the sector in which they operate: academic or private.

The first subcategory includes **research and academic institutions** (codified 72.1 under NACE Rev.2). These institutions are instrumental in advancing sorting technologies and developing new methodologies.

The second subcategory refers to **private companies** (codified 38.32 under NACE Rev.2) which contribute to the system's design and implementation. These companies are currently exploring or applying relevant technologies and have the capacity to play a key role in further development and expansion of the wood waste sorting system.

Table 5: Sorting providers for use case 1

Private Companies		Research & Academic Institution	
ELAK [1] (GR)	https://ellaktor.com/	**ICCS** [1] (GR)	https://www.iccs.gr/
IRIS [1] (ES)	https://www.iris-eng.com/	**SINTEF** [3] (NO)	https://www.sintef.no/en/projects/2022/resource-refractory-sorting-using-revolutionizing-classification-equipment/
FANUC [2] (JP) - Global	https://www.fanuc.eu/uk/en	**Fraunhofer Institutes** [3] (DE)	https://www.iis.fraunhofer.de/en/ff/zfp/research-areas/Sensor-based-sorting.html
ABB [2] (CH) - Global	https://new.abb.com/products/robotics	**Frederick Research Center** [3] (CY)	https://www.frederick.ac.cy/en/research-news/175-demonstration-of-an-innovative-robotic-separation-method-of-the-construction-and-demolition-waste
KUKA [2] (DE) - Europe & Asia	https://www.kuka.com/		
Staubli [2] (CH) - Global	https://www.staubli.com/global/en/robotics.html		
Universal Robots [2] (DK) - Global	https://www.universal-robots.com/		
Doosan Robotics [2] (KR) - Global	https://www.doosanrobotics.com/en/Index		
YASKAWA [2] (JP) - Global	https://www.motoman.com/en-us		

Index 1: Partner of the W2W project.
Index 2: Stakeholder identified through the questionnaires distributed by project partners—these stakeholders have or can have an established line of communication with the project team.
Index 3: Stakeholder identified through DRAXIS research—there is currently no communication established with these stakeholders.

Waste Management Companies & Operators

This category plays a critical role in the upcycling of wood waste, transforming it into reusable materials. It includes two main subcategories:

i. **Upcycling technology providers** (codified 72.1 under NACE Rev.2): These stakeholders contribute to the development and innovation of upcycling technologies, which are then utilized by recycling companies to process wood waste into valuable materials.

ii. **Recycling companies** (codified 38.22 under NACE Rev.2): These companies are responsible for implementing the upcycling processes on a larger scale. They efficiently process the wood waste and direct the resulting intermediates or the final products to businesses for reuse, supporting the implementation of circular practices. While upcycling technology providers often apply the technologies directly (as in use case 1), identifying potential recycling companies capable of scaling these processes and connecting with extensive business networks is crucial for guaranteeing the widespread reuse of products.

Table 6: Waste Management Companies and Operators for use case 1

Upcycling Technology Providers		Recycling Companies	
UHE[1] (ES)	https://www.ehu.eus/en/en-home	**REMONDIS** [3] (DE) - Europe	https://www.remondis.de/en/home/
NTUA[1] (GR)	https://www.ntua.gr/en/	**Veolia** [3] (FR)- Global	https://www.veolia.com/en
		Wood Recyclers [3] (UK)	https://woodrecyclers.org/

Index 1: Partner of the W2W project.
Index 3: Stakeholder identified through DRAXIS research—there is currently no communication established with these stakeholders.

Products End Users

The identification of stakeholders in the products end users category is based on industries interested in the intermediate and final products resulting from the upcycling process. In use case 1, these are: **lignin and cellulose nanofibers (CNFs)**, **composite pellets**, and **building material components** (like wallboards and facades). To organise the stakeholders within this category, subcategories are defined based on the specific product they are interested in.

For lignin and CNFs, the end users include manufacturers from various industries. Paper and pulp manufacturers (codified 17.1 under NACE Rev.2) use cellulose fibers to produce sustainable paper products, reducing the need for virgin wood (Eugenio et al., 2019). Textile manufacturers (codified 13.1 under NACE Rev.2) incorporate these fibers into eco-friendly fabrics, supporting sustainable fashion practices (Jain, 2024). Bioplastics and composite manufacturers (codified 22.2 under NACE Rev.2) utilize lignin and cellulose to create bio-based plastic alternatives and composites (Yang,

Ching and Chuah, 2019). Additionally, the chemical industry (codified 20.1, 20.3, 20.7 under NACE Rev.2) employs lignin in the production of adhesives, resins and other industrial chemicals (Sharma et al., 2020).

Table 7: Lignin & Cellulose Fibers' End Users for use case 1

Manufacturers of paper and pulp products		Manufacturers of textile		Manufacturers of bioplastics and composites		Chemical Industry	
StoraEnso [3] (FI) - Europe & Asia	https://www.storaenso.com/en	**Lenzing** [3] (AT) - Global	https://www.lenzing.com/investors	**Avantium** [3] (NL)	https://avantium.com/	**BASF** [3] (DE) - Global	https://www.basf.com/global/en
UPM [3] (FI) - Global	https://www.upm.com/	**H&M Group** [3] (SE) - Global	https://hmgroup.com/sustainability/	**Novamont** [3] (IT)	https://www.novamont.com/	**Solvay** [3] (BE)	https://www.solvay.com/en/

Index 3: Stakeholder identified through DRAXIS research—there is currently no communication established with these stakeholders.

For composite pellets, the end users can be diverse. Building materials manufacturers (codified 23.9 under NACE Rev.2) use these pellets to create sustainable construction materials. The packaging industry (codified 17.29 under NACE Rev.2) incorporates composite pellets into durable, eco-friendly packaging solutions. In the automotive industry (codified 29.3 under NACE Rev.2), these materials are applied in vehicle components to improve sustainability and reduce emissions. Furniture manufacturers (codified 31.01, 31.02, 31.09 under NACE Rev.2) and retailers leverage composite pellets to produce durable, environmentally friendly furniture products (Khan, Srivastava and Gupta, 2020).

Table 8: Composite pellets' End Users for use case 1

Manufacturers of Building Materials		Packaging Industry		Automotive industry		Furniture Manufacturers/Retailers	
Knauf Insulation [3] (DE) - Global	https://www.knaufinsulation.com/	**Smurfit Kappa** [3] (IE) - Global	https://www.smurfitkappa.com/	**Volkswagen Group** [3] (DE) - Global	https://www.volkswagen-group.com/en/a	**IKEA** [3] (SE) - Global	https://www.ikea.com/

					bout-us-16013		
BLOOM [1] (CH)	https://www.bloombiorenewables.com/	**Mondi Group** [3] (AU) - Global	https://www.mondigroup.com/	**BMW Group** [3] (DE) - Global	https://www.bmwgroup.com/en.html	**Steelcase** [3] (DE) - Global	https://www.steelcase.com/
LEVERY [1] (IT)	https://www.levery.it/						
EGOIN wood group [2] (ES)	https://egoin.com/en/						
EGGER [3] (AU) - Global	https://www.egger.com/en/						
STEICO [3] (DE)	https://www.steico.com/en/						

Index 3: Stakeholder identified through DRAXIS research—there is currently no communication established with these stakeholders.

Lastly, for the building material components (wallboards/facade), the main end users are construction companies (codified 41.2, 42.1, 42.2, 42.9 under NACE Rev.2). These companies integrate the sustainable wallboards and facade components into new buildings or renovations, contributing to greener construction projects.

Table 9: Facades' & Wallboards' End Users for use case 1

Construction Companies	
Saint-Gobain [3] (FR) - Global	https://www.saint-gobain.com/en
VINCI Construction [3] (FR) – Global	https://vinci-construction.com/en/
Skanska [3] (SE) – Global	https://www.skanska.com/
ELAK [1] (GR)	https://ellaktor.com/

Index 1: Partner of the W2W project.
Index 3: Stakeholder identified through DRAXIS research—there is currently no communication established with these stakeholders.

Public Authorities

Public authorities encompass key stakeholders involved in shaping the regulatory, operational and implementation frameworks for waste management, including the management of CDW. This category is divided into **policymakers** (codified 84.11 under NACE Rev.2), **municipalities** (codified 84.11 under NACE Rev.2) and **international organisations** (codified 94.99 under NACE Rev.2) aiming to ensure that CDW management practices align with national laws, local-level waste handling systems and international guidelines, respectively.

Table 10: Public Authorities for use case 1

Policy Makers		International Organisations	
European Network for Rural Development (ENRD) [3] Europe	https://ec.europa.eu/enrd/home-page_en.html	**Building and Wood Worker's International (BWI)** [3] Global	https://www.bwint.org/
DGs [3] Europe	https://commission.europa.eu/about-european-commission/departments-and-executive-agencies/internal-market-industry-entrepreneurship-and-smes_en	**Zero Waste International Alliance (ZWIA)** [2] Global	https://zwia.org/
EOAN [3] (GR)	https://www.eoan.gr/	**ISWA** [3] Global	https://www.iswa.org/
		EIT RawMaterials [3] Europe	https://eitrawmaterials.eu/

Index 2: Stakeholder identified through the questionnaires distributed by project partners—these stakeholders have or can have an established line of communication with the project team.
Index 3: Stakeholder identified through Draxis research—there is currently no communication established with these stakeholders.

Standardization Actors

The Standardization Actors category is crucial for ensuring that the technologies, processes and products developed in the project meet established industry standards and certifications. This category is divided into two subcategories: **industry associations** (codified 94.12 under NACE Rev.2) and **certifying bodies** (codified 71.20 under NACE Rev.2). Industry associations consist of businesses and professionals who work together to establish best practices, guidelines and industry-wide standards for the use of recycled materials, such as wood waste. Certifying bodies are responsible for verifying that the technologies, processes and products developed comply with established standards and certifications. These bodies play a crucial role in ensuring that materials like cellulose nanofibers and composite pellets, produced from wood waste, meet required performance and safety benchmarks. Furthermore, certification is essential for gaining market acceptance and ensuring legal compliance across different regions.

Table 11: Standardization Actors for use case 1

Industry Associations		Certifying Bodies	
European Confederation of Agricultural, Rural and Forestry Contractors (CEETTAR)[3] Europe	https://www.ceettar.eu/	**CEN & CENELEC**[3] Europe	https://www.cencenelec.eu/
European Waste Management Association (EWA)[3] (BE) - Europe	https://fead.be/	**Forest Stewardship Council (FSC)**[3] Global	https://fsc.org/en
Confederation of European Forest Owners (CEPF)[3] Europe	https://www.cepf-eu.org/		
Wood Recyclers Association[3] (UK)	https://woodrecyclers.org/		
Confederation of European Paper Industries (CEPI)[3] Europe	https://www.cepi.org/		
European Federation of Woodworking Machinery Manufacturers[3] Europe	https://www.eumabois.com/		
Orgalim[3]	https://orgalim.eu/		

Europe			
A. SPIRE [3] Europe	https://www.aspire2050.eu/aspire/the-association		
P4P [3] Europe	https://www.europarl.europa.eu/topics/en/article/20181212STO21610/plastic-waste-and-recycling-in-the-eu-facts-and-figures		
European Panel Federation (EPF) [3] Europe	https://europanels.org/		

Index 3: Stakeholder identified through Draxis research—there is currently no communication established with these stakeholders.

3.1.3. Visualisation of stakeholder interactions

After the identification and description of stakeholders, it is important to identify their interactions in the value chain under study. The dynamics of stakeholder relationships and positions, relative to each other, stem from flows of materials, technologies, information and advice within a stakeholder network. This section, as also outlined in the methodology, presents the optimal interactions that need to be established (or in some cases, already are) between the general actor categories, as evaluated by DRAXIS team taking into account the value chain of the use case under study. Starting from **CDW owners/generators**, they are naturally expected to maintain regular communication with the sorting providers, as they are responsible for supplying the waste that requires sorting. As an example, in use case 1, ELLAK (a key project partner) performs both construction and sorting activities, establishing a direct link between these two critical categories. At the same time, in the context of use case 1, CDW owners are closely related to end users. Specifically, the end-products derived from the process (biocomposite building materials - facades/wallboards) position construction companies as both waste owners and end users. Additionally, municipalities involved in the CDW collection, act also as public authorities as they regulate wood waste management processes in a regional level. Finally, many construction and demolition companies are members of industry associations taking an active role in the CDW management.

Sorting providers, in terms of the value chain, interact closely with both CDW generators (as previously explained) and with the waste management companies and operators, as they supply them with the sorted wood waste. Also, the subcategories of sorting providers, namely private companies and research and academic institutions, have strong interactions between them to collaboratively establish the required technologies and effectively implement the sorting process. Finally, sorting providers have a moderate level of interaction with standardization actors in defining the categories of wood waste distinguished by the sorting system.

Waste Management Companies & Operators play a crucial role in the interactions among various stakeholders, demonstrating varying levels of engagement. They maintain a high level of interaction with sorting providers, as these companies supply the essential raw materials for processing. Furthermore, the collaboration between technology providers like UHE and NTUA reflects a high level of interaction inside the category, as they work closely to ensure that the fibers produced meet the required specifications. Waste management companies, e.g. recycling companies, also connect with product end users, as building extensive business networks is vital for the reuse of materials produced. Furthermore, their interactions with standardization bodies are marked by a medium level, as the connect in terms of industry associations activities regarding the recycling processes. Finally, public authorities e.g. international organisations, also offer a level of support by facilitating access to business networks, enhancing the distribution and adoption of the produced materials.

Products end users primarily engage with the product developers. If end users utilize the developed materials to create new products, e.g. manufacture of pulp and paper products from cellulose fibers, they also interact with standardization actors to ensure that these new products meet the market standards and receive the necessary certifications. Finally, there is a notable connection between product end users and waste owners, particularly because construction companies are involved in both areas and their dual role enhances the interaction between these two groups.

As previously noted, **public authorities**, actively interact with wood waste owners and sorting providers while they do not necessary need direct relationships with waste management operators and end users. Additionally, public authorities need to closely interact with one another (specifically, policy makers with international organisations and municipalities) to shape the regulatory, operational and implementation frameworks for waste management, including the management of CDW. Furthermore, international organisations and industry associations (standardization actors' category) collaborate closely in terms of establishing best practices and guidelines for the use of recycled materials.

Finally, the interactions needed to develop between **standardization actors** and all the other stakeholders' categories have already been outlined. It is noted that the subcategories, certifying bodies and industry associations also maintain established interactions as they work together to develop standards that ensure product quality and safety. This ensures that the standards reflect industry needs and best practices.

The interactions among stakeholders in Use Case 1, which have been analysed in detail, are visually represented in Figure 4. This figure illustrates the relationships between the main actor categories involved in the project, ranking their interactions according to the methodology presented in the section 2.3.

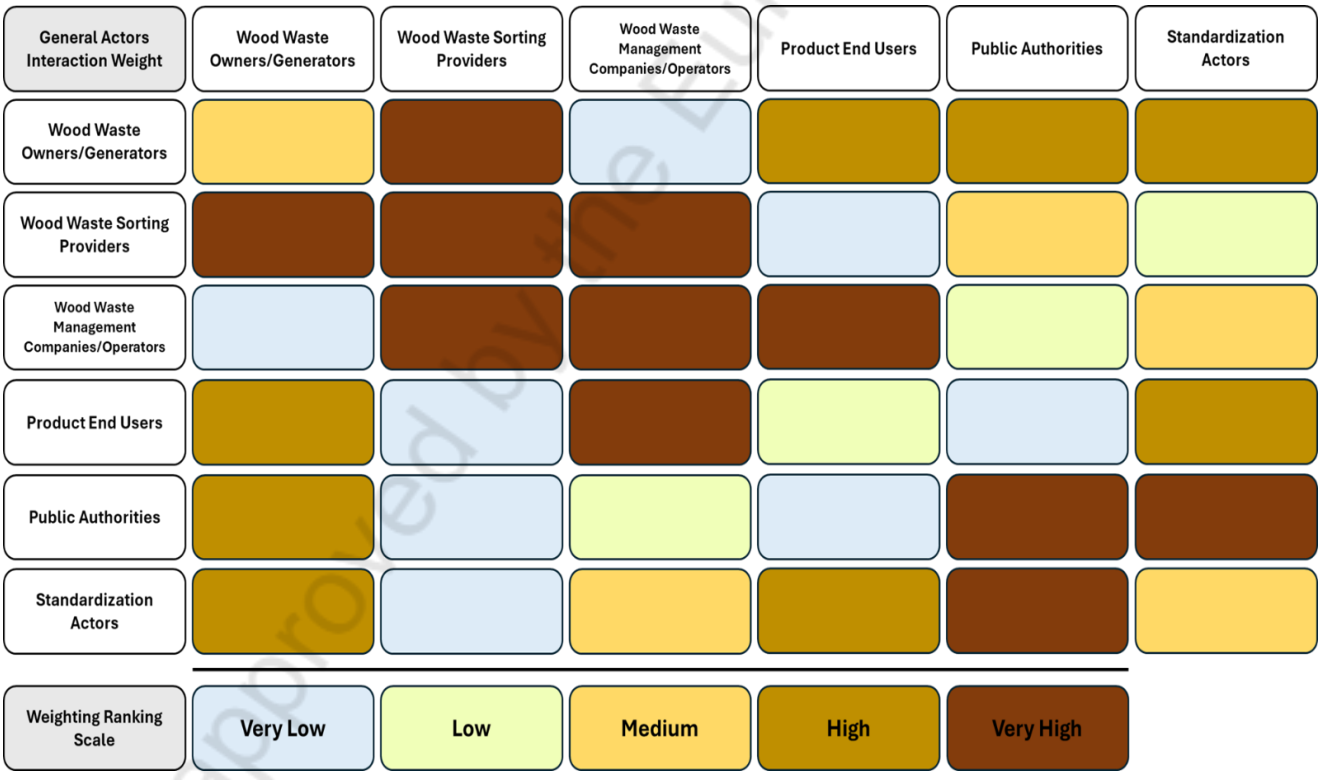

Figure 4: Stakeholders' key interactions for use case 1

3.2. USE CASE 2: CHEMICAL AND BIOREMEDIATION TECHNOLOGIES FOR WOOD WASTE UPCYCLING

3.2.1. Background

The partner responsible for use case 2 is LERMAB (contributing partners are: UHE, ECOM, ICCS). The aim of this use case is to produce polyurethane panels (and secondly, wood board panels) from wood waste originating from furniture waste and CDW.

LERMAB focuses on the valorisation of wood containing adhesives/pollutants with potential of removal, while UHE on the liquefaction of mixed wood waste with the usage of various catalysts. ECOM is the provider of feedstock regarding furniture material, whereas CDW is to be provided as a result of the W2W sorting process. Sorting of waste is led by ICCS, while the types of wood waste involved in this case study are types A (without additives), BR1 (low amount of glue/coatings), BR2 (no hazardous substances) and C (hazardous substances).

Recycling wood waste requires the removal of pollutants, such as glues and chemical additives. LERMAB has demonstrated that environmental-friendly steam explosion process can effectively eliminate a large proportion of urea formaldehyde glues, the most widely used glue in the panel industry. For its part, UHE has been interested in the production of green glue from wood using a liquefaction process. Thus, the final aim of case study 2 is to use these skills to produce, at Technology Harmfulness Level (THL) 5, 100% recycled wood panels by combining purified wood particles and glue derived from the liquefaction of waste wood. The main objectives of use case 2 are:

i. the optimization of the steam explosion process for cleaning waste wood at TRL 4 and TRL 5 (LERMAB),
ii. the bioremediation of the waste wood and of the water effluents of the process using fungi (LERMAB),
iii. the liquefaction of waste wood (UHE),
iv. the production of adhesive resin from liquefied wood (UHE),
v. and finally, the production of green panels meeting current specifications (CF2P).

Finally, a flow chart of the processes considered in use case 2 is presented in the Figure below, as provided by POLIMI in the context of task 16.2. At this stage of the W2W project, the diagram is in its draft version and has yet to be finalized.

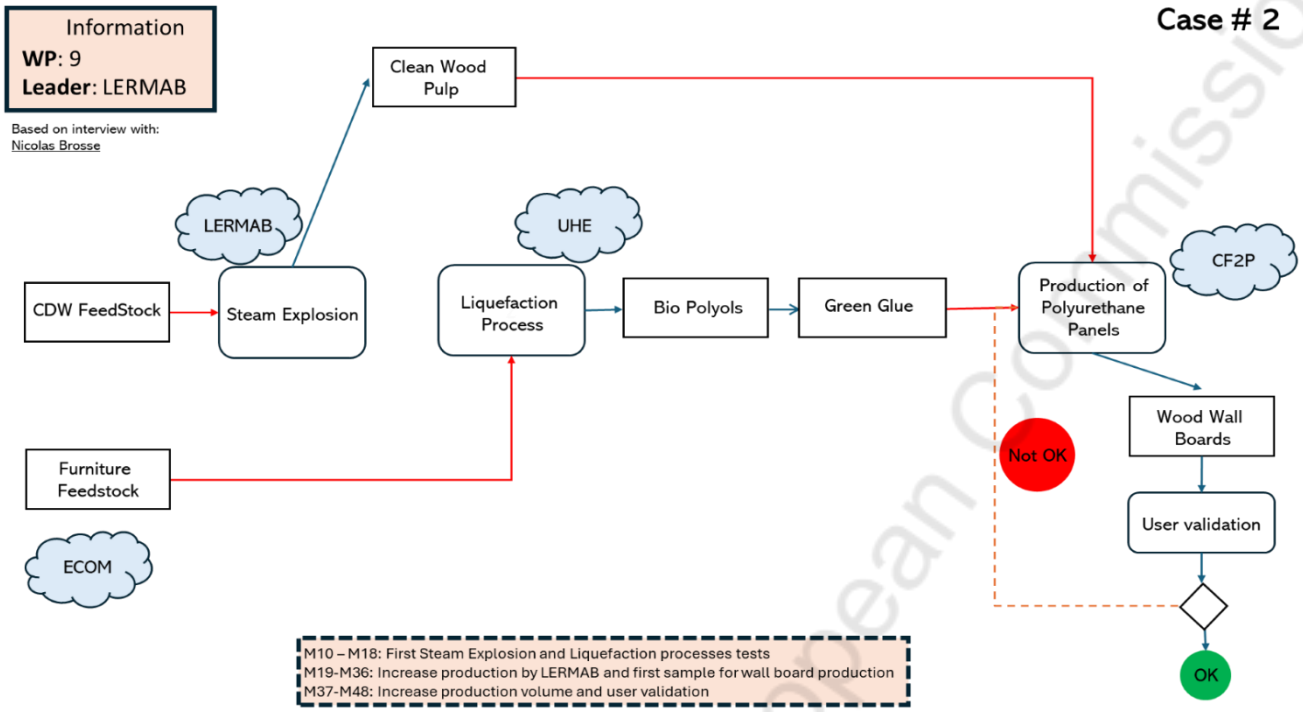

Figure 5: Flow-chart for use case 2

3.2.2. Stakeholder analysis

Stakeholder analysis of Use Case 2 identified 63 unique stakeholders (noting that some of them are included in more than one general actor category), providing an adequate representation of each actor category across the value chain. The breakdown of stakeholder representation by category is presented in Figure 6.

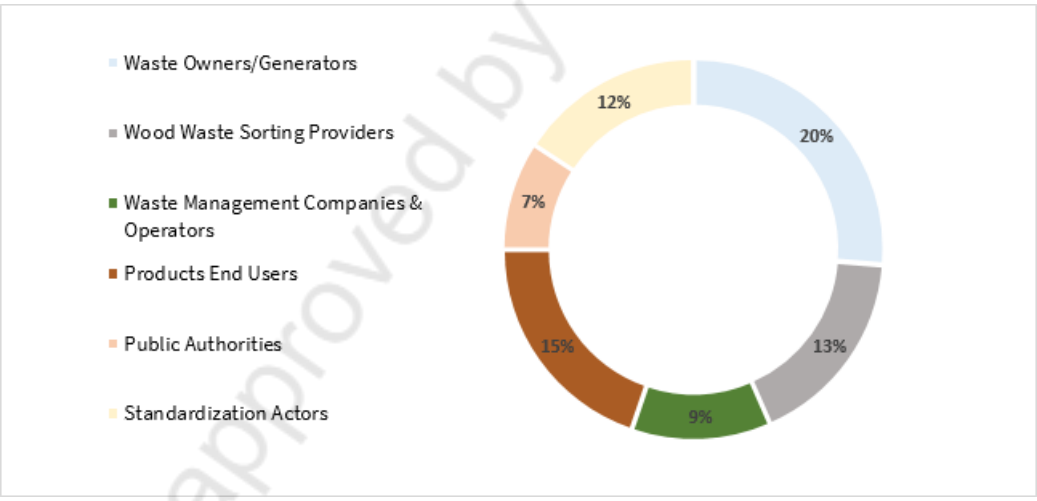

Figure 6: Stakeholder representation by category for use case 2

Waste Owners / Generators

In this use case, providers of wood waste are CDW and furniture waste owners/generators. The sub-categories responsible for CDW supply are **construction and demolition companies** (codified 41.2, 42.1, 42.2, 42.9 and 43.1 respectively, under NACE Rev.2) which are demonstrated in Table 4 of use case 1, as the two use cases share the same feedstock, and accordingly stakeholders. In addition,

in this use case **waste collection authorities** (codified 38.12 under NACE Rev.2) ,presented in Table 12, include private companies activating in old furniture collection and management. Finally, potential furniture waste providers can be **wood panels and furniture manufactures/retailers** (codified 16.21 and 31.0 respectively, under NACE Rev.2), also listed in Table 12.

Table 12: Waste Owners/ Generators for use case 2

Wood Panels / Furniture Manufacturers & Retailers		Collection Authorities	
CF2P [1] (FR)	https://www.cf2p.eu/en/home-2/	**ANAKEM** [3] (GR)	https://anakem.gr/
UNILIN [2] (BE) - Global	https://www.unilin.com/en	**ECOM** [1] (FR)	https://ecomaison.com/en/
EGGER [2] (AU) - Global	https://www.egger.com/el/?country&country=GR		
KRONOSPAN [2] (IT) - Global	https://kronospan.com/el_GR		
FINSA [2] (ES) - Europe	https://www.finsa.com/es/		
EGOIN WOOD GROUP [2] (ES)	https://egoin.com/en/		
IKEA [2] (SW) - Global	https://www.ikea.com/		
P3G [3] (FR) - Global	https://www.cfp.fr/the-group/		
DEYA [3] (FR)	https://www.groupe-deya.com/fr/Groupe-DEYA/A-propos-du-Groupe		

Index 1: Partner of the W2W project
Index 2: Stakeholder identified through the questionnaires distributed by project partners—these stakeholders have or can have an established line of communication with the project team.
Index 3: Stakeholder identified through Draxis research—there is currently no communication established with these stakeholders.

Wood Waste Sorting Providers

The three use cases developed in the W2W project share the same wood waste sorting system and stakeholders involved in it. The stakeholders' analysis regarding this category is therefore presented in Table 5 of Section 3.1.2.

Waste Management Companies & Operators

In use case 2, all **upcycling technology providers** (codified 72.1 under NACE Rev.2) are located on a broad European level (e.g. Spain, Austria, Italy). **Recycling companies/associations** (codified 38.22 under NACE Rev.2) also include a stakeholder located in US.

Table 13: Waste Management Companies and Operators for use case 2

Upcycling Technology Providers		Recycling Companies/Associations	
LERMAB [1] (FR)	https://lermab.univ-lorraine.fr/	**ECOM** [1] (FR)	https://ecomaison.com/en/
UHE [1] (ES)	https://www.ehu.eus/en/en-home	**Wood Waste Association (WRA)** [3] (US)	https://woodrecyclers.org/

Index 1: Partner of the W2W project
Index 3: Stakeholder identified through Draxis research—there is currently no communication established with these stakeholders.

Products End Users

The end users in this use case are stakeholders interested in the recovered fibers and wood panels produced, as well as the intermediate products of bio polyols, green glue and wood pulp. Stakeholder identification is further presented for intermediate and end products users in Tables 13 and 14, accordingly.

A stakeholder subcategory is **energy companies**, as they are exploring bio polyols as part of their sustainability strategies. By incorporating bio-based materials into their product lines, they can appeal to environmentally conscious consumers and reduce reliance on fossil fuels.

Additionally, green glue could be utilized by **construction & building materials companies** as it is an environmentally friendly adhesive used primarily in construction and building materials. Specifically, it is typically formulated to be low in volatile organic compounds (VOCs), non-toxic and made from sustainable or recycled materials (Khoshnava et al., 2020).

As for wood pulp, it is a fundamental raw material in the manufacturing of paper, serving as the fibrous base from which various paper products are derived. It is primarily obtained from wood, which undergoes several processes to transform it into pulp suitable for paper production.

Specific examples of the above subcategories can be found in Table 14. It is noted that all the listed companies are based in counties across Europe, but with a global presence.

Table 14: Bio Polyols, Green Glue and Wood Pulp End Users (Intermediate products) for use case 2

Energy Companies (Interested in Bio Polyols)		Construction Company/ Building Materials (Interested in Green Glue)		Manufacturers of paper and pulp products (Interested in Wood Pulp)	
Repsol [3] (ES) - Global	https://www.repsol.com/en/index.cshtml	**Saint Gobain** [3]	https://www.saint-gobain.com/en	**Lecta Group** [3]	https://www.lecta.com/en

		(FR) - Global		(FR) - Global	
TotalEnergies [3] (FR) - Global	https://totalenergies.com/	**Knauf Insulation** [3] (DE) - Global	https://www.knaufinsulation.com/	**Stora Enso** [3] (SW) - Global	https://www.storaenso.com/en/

Index 3: Stakeholder identified through Draxis research—there is currently no communication established with these stakeholders.

Lastly, for the recovered fibers, the main stakeholders are related to **companies which manufacture wood panels** (codified 16.21 under NACE Rev.2), while on the other hand, produced wood panels could attract the interest of **furniture manufacturing/retailing companies** (codified 31.0 under NACE Rev.2), incorporating the sustainably manufactured wood panels into their production processes. Specific company examples are summarized in Table 15.

Table 15: Mycocomposites and Wood Panels End Users (End products) for use case 2

Furniture Manufacturers (Interested in wood panels produced)		Wood panel Manufacturers (Interested in mycocomposites produced)	
IKEA [2] (SE) - Global	https://www.ikea.com/	**CF2P** [1] (FR)	https://www.cf2p.eu/en/home-2/
LEORY MERLIN [3] (FR) - Global	https://www.leroymerlin.gr/gr/	**UNILIN** [2] (BE) - Global	https://www.unilin.com/en
PRAKTIKER [3] (DE) - Global	https://www.praktiker.de/	**EGGER** [2] (AU) - Global	https://www.egger.com/el/?country&country=GR
		KRONOSPAN[2] (IT) - Global	https://kronospan.com/el_GR
		FINSA [2] (ES) - Europe	https://www.finsa.com/es/
		GARNICA [3] (UK)	https://www.garnica.one/en-uk/

Index 1: Partner of the W2W project
Index 2: Stakeholder identified through the questionnaires distributed by project partners—these stakeholders have or can have an established line of communication with the project team.
Index 3: Stakeholder identified through Draxis research—there is currently no communication established with these stakeholders.

Public Authorities & Standardization Actors

In Section 3.1.2, Table 10 &Table 11 already list the public authorities and standardization actors relevant to all three use cases related to wood waste valorisation. Since the use cases share common challenges and regulatory requirements, the same public authorities and standardization bodies are involved across the board.

3.2.3. Visualization of stakeholder interactions

This step examines the interactions of the identified stakeholders within the value chain of use case 2.

Similar to use case 1, **wood waste generators** in use case 2 should establish a strong network with waste sorting providers, as this is the first step in the upcycling process outlined in use case 2. Moreover, their relationship with waste management companies/associations and product end users is ranked as very low, as their interaction may happen only through the sorting providers in the framework that W2W sets. Finally, public authorities and standardization actors are estimated to have a noteworthy role with waste owners/generators (high interaction rank), guaranteeing waste generation compliance with environmental standards. It is also noted, that the interaction between different waste owners/generators should mainly present between collection authorities (referring to municipalities and private companies) with all other sub-categories (seen Table 12), thus it was ranked as medium.

Regarding **waste management companies/associations**, upcycling technology providers and recycling companies/associations are expected to have a high ranked engagement, mainly related to the provision of scientific and know-how information. Furthermore, they are expected to have a very high interaction weight with the end product users (related to both intermediate and end products.

End product users could potentially have a very high interrelationship, mainly considering the dependence of furniture manufacturers and building materials companies with wood panel producers.

The interactions of **sorting providers, standardization actors and public authorities** were analysed in detail in use case 1 and apply also to use case 2.

Figure 7 presents all interactions of the identified stakeholders for use case 2, illustrating the relationships between the main actor categories involved, ranking their interactions according to the methodology presented in the section 2.3.

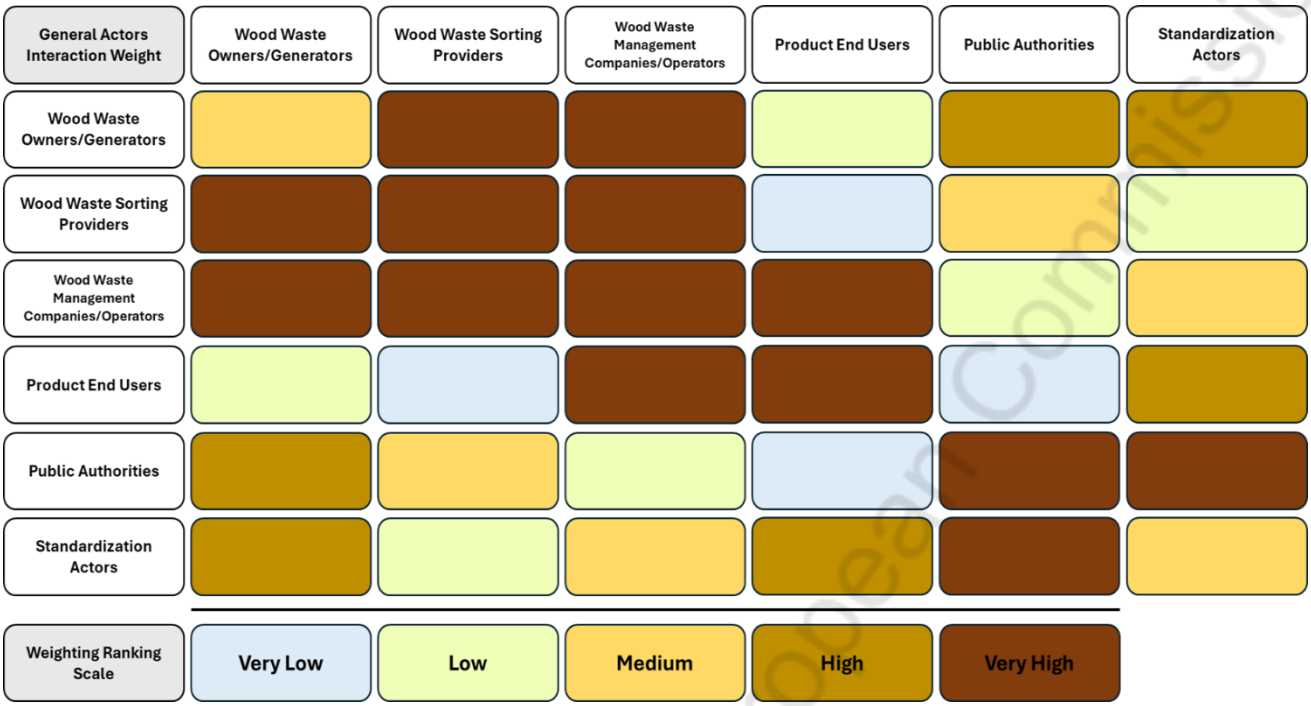

Figure 7: Stakeholders' key interactions for use case 2

3.3. USE CASE 3: ENERGY & GAS VALORISATION TECHNOLOGIES FOR CONTAMINATED WOOD WASTE

3.3.1. Background

The partner responsible for use case 3 is CIRCE (contributing partners are: KIVERDI, P&G). The increasing volume of contaminated wood waste from C&D and furniture residues presents a significant opportunity for energy recovery as it cannot be recycled or disposed of in landfill. At the same time, conventional energy transformation processes, such as combustion, produce a large volume of by-products (e.g., ash, wastewater), remaining a severe challenge from both environmental and economical perspective. This use case aims to address these issues by utilizing innovative thermochemical processes to produce high-added-value outputs, such as chemical surfactants for commercial detergents, alongside energy recovery.
The processes that will be followed in this use case are:

i. hydrothermal carbonisation (HTC) of mixed waste (contaminated wood waste and liquid waste) for hydrochar production (CIRCE),
ii. gasification of wood waste and HTC- derived hydrochar, for syngas production (CIRCE),
iii. anaerobic digestion of HTC process water for biogas generation (CIRCE),
iv. biotech- driven up-cycling of syngas into dodecanol for low impact detergents application (KIVERDI).

In further detail, the primary objectives include producing a suitable hydrochar through hydrothermal carbonisation (HTC), comparing microwave-assisted HTC with conventional heating methods to identify the most effective approach, demonstrating the viability of hydrochar gasification and comparing it with direct CDW gasification. A key focus will also be optimizing the

dodecanol production process, followed by validating the surfactants derived from this process. Challenges to address include, optimizing the feedstock for HTC, producing clean syngas, obtaining sufficient hydrochar for gasification and effectively managing contaminants from C&D incineration ashes. Technologies to be tested include the HTC process for both wood waste and ashes, fluidized bed gasification of hydrochar to generate valuable syngas and fermentation techniques for fatty acid biosynthesis, ultimately leading to the formulation of low-impact detergents using a micro falling film pilot reactor.

The initial feedstock for the HTC process consists primarily of contaminated wood waste, liquid waste (i.e. sewage, sludge, paper industry waste) and ashes from incineration of CDW. These materials contain valuable carbon content, making them ideal for hydrothermal carbonisation (HTC). The process converts these waste streams into hydrochar, a high-carbon product, while also recovering nutrients from the ashes. In the subsequent steps of this cascade valorisation, the products and byproducts from each process (such as hydrochar and syngas) are utilized as inputs for the next stage. This integrated approach maximizes resource recovery, demonstrating the efficiency and sustainability of cascade valorisation.

Finally, a flow chart of the processes which take place in use case 3 is shown in Figure 8, as provided by POLIMI in the context of Task 16.2. At this stage of the W2W project, the figure below is at its draft version and has yet to be finalized.

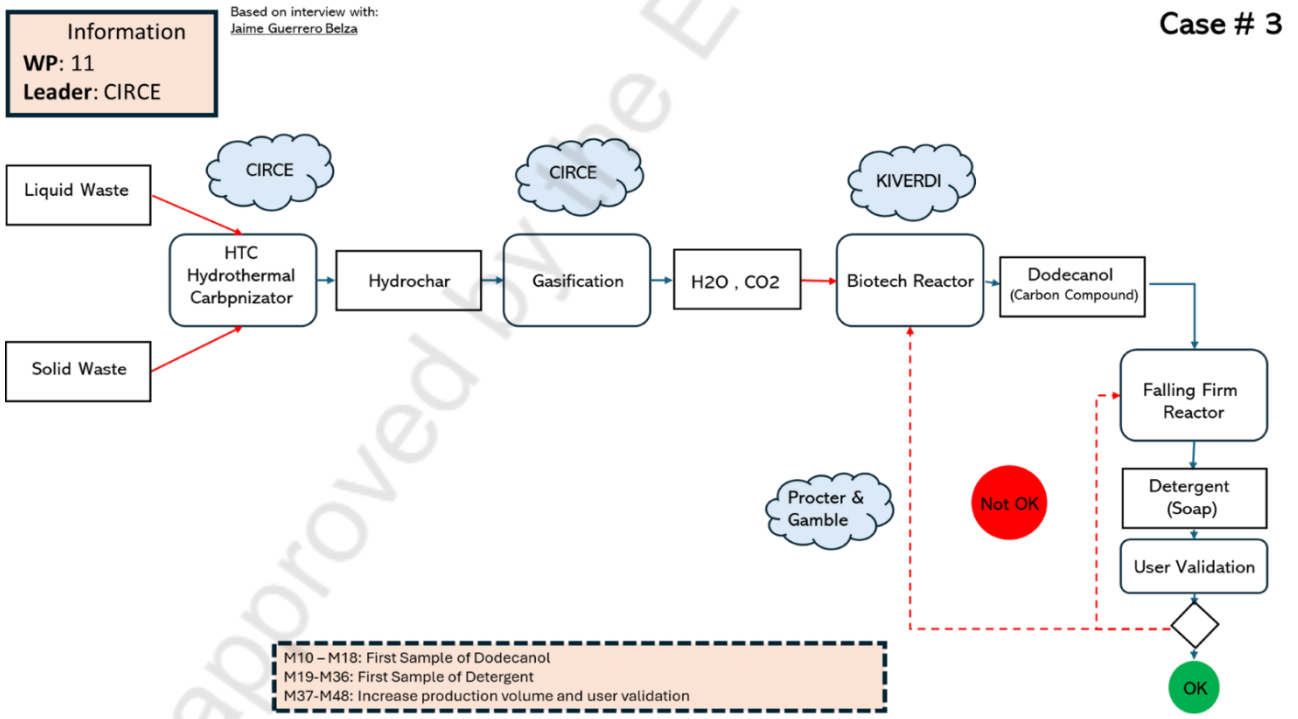

Figure 8: Flow-chart of use case 3

3.3.2. Stakeholder Analysis

Stakeholder analysis of use case 3 identified 70 stakeholders. It is noted that some of them are included in more than one general actor category. As in the other two use cases, the goal of the

identification process was to ensure comprehensive coverage of all key players within the value chain. The breakdown of stakeholder representation by category is presented in Figure 9.

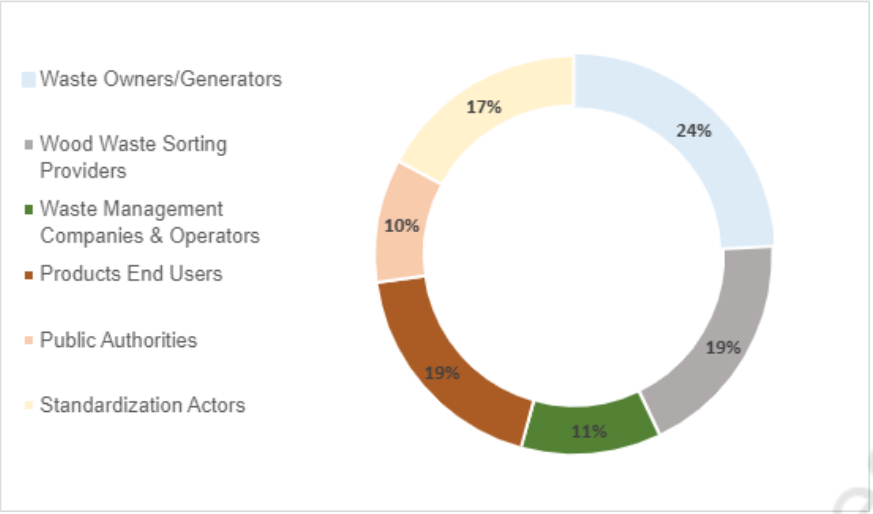

Figure 9: Stakeholder representation by category for use case 3

In comparison to the other use cases, a notably stronger representation of waste owners is established, to highlight the increased variety of waste sources valorised in terms of this use case. As follows, each category is analysed further into subcategories and necessary information about specific stakeholders in this use case are provided.

Waste Owners / Generators

As described in section 3.3.1, the primary raw materials for the first process (HTC) of the upcycling path developed in use case 3, consists of contaminated wood waste, liquid waste and ashes from the incineration of CDW.

In the context of this use case, contaminated wood waste is originating from CDW derived from the sorting system developed in the project. However, it can also potentially be used furniture or occur in the wood processing and pulp paper industries. The owners and generators of CDW who facilitate the sorting system utilized across all three use cases, include **construction and demolition companies and CDW collection authorities**, as further specified in Table 4.

Furthermore, **wastewater treatment plants** (codified 36.00 under NACE Rev.2) can be key generators and suppliers of liquid waste such as sludge. These plants process large volumes of wastewater, producing sludge rich in organic matter, contaminants and nutrients that necessitates effective disposal and management.

Finally, the flying CDW ashes required as feedstock, can be sourced from **waste-to-energy facilities** (codified 38.22 under NACE Rev.2) that incinerate construction and demolition waste, generating ashes rich in heavy metals and organic contaminants suitable for valorization processes.

Examples of companies from the newly identified subcategories (developed in use case 3) that can act as potential waste generators, are presented in Table 16. It is worth noting, that the HTC process is conducted by CIRCE in Spain, leading to the involvement of local stakeholders for efficient collaboration and resource availability.

Table 16: Waste Owners/ Generators for use case 3

Wastewater Treatment Plants		Waste to Energy Facilities	
Veolia Water Technologies [3] (ES) - Global	https://www.veoliawatertechnologies.com/en	**ACCIONA energia** [2] (ES) - Global	https://www.acciona-energia.com/?_adin=132415900
ACCIONA [2] (ES) - Global	https://www.acciona.com/?_adin=11734293023	**Urbaser** [3] (ES)	https://www.urbaser.com/
TSK [3] (ES) - Europe	https://www.grupotsk.com/en/	**SUEZ** [3] (ES) - Global	https://www.suez.com/en/waste

Index 2: Stakeholder identified through the questionnaires distributed by project partners—these stakeholders have or can have an established line of communication with the project team.
Index 3: Stakeholder identified through Draxis research—there is currently no communication established with these stakeholders.

Wood Waste Sorting Providers

The three use cases developed in the W2W project share the same wood waste sorting system and stakeholders involved in it. The stakeholders' analysis regarding this category is therefore presented in Table 5 of Section 3.1.2.

Waste Management Companies & Operators

The Waste Management Companies & Operators category plays a critical role in the conversion of the liquid and solid waste into building blocks (CO2 & H2) and in the development of the technology to produce valuable compounds (detergents). This category includes two main subcategories:

i. **Upcycling Technology Providers** (codified 72.1 under NACE Rev.2): These stakeholders contribute to the development and innovation of upcycling technologies, which are then utilized on a larger scale by waste to energy management companies and operators.
ii. **Waste Processing Facilities** (codified 38.22 under NACE Rev.2): This subcategory includes companies operating different types of units such as HTC, hydrochar production systems, gasification units and anaerobic digestion facilities. Notably, these companies do not need to possess all these technologies; instead, they may specialize in one or more processes. These facilities are essential for the valorisation of contaminated wood waste, as described in use case 3. Some companies may be classified under waste-to-energy facilities both as generators of flying ashes and as waste management operators. Nevertheless, in the case of waste management operations, additional companies are included to reflect the broader spectrum of stakeholders involved in the processes described above. Finally, in terms of distinguishing upcycling technology providers and waste to energy facilities, it can be highlighted that waste-to-energy facilities primarily focus on the operational conversion of waste into energy and valuable products. On the other hand, technology providers concentrate on the development and innovation of processes used in waste management, with many companies potentially fitting into both categories.

In use case 3, stakeholder identification for technology providers and implementors has primarily focused on Spain, while some major European industries are also considered.

Table 17: Waste Management Companies and Operators for use case 3

Upcycling Technology Providers		Waste Processing Facilities	
CIRCE [1]	https://www.fcirce.es/en	**INERCO** [3]	https://www.inerco.com/en/

(ES)		(ES) - Global	
KIVERDI [1] (ES)	https://www.kiverdi.com/	**EQTEC** [3] (ES) - Global	https://eqtec.com/
Aalborg University [3] (DK)	https://www.en.aau.dk/	**TerraNova energy**[3] (DE)	https://www.terranova-energy.com/en/
SUEZ [3] (ES) - Global	https://www.suez.com/en/waste	**PYREG** [3] (ES)	https://pyreg.com/company/

Index 1: Partner of the W2W project
Index 2: Stakeholder identified through the questionnaires distributed by project partners—these stakeholders have or can have an established line of communication with the project team.
Index 3: Stakeholder identified through DRAXIS research—there is currently no communication established with these stakeholders.

Products End Users

The identification of stakeholders in the Products End Users category is based on industries interested in the intermediate and final products resulting from the upcycling process. In terms of use case 3, the obtained intermediate products are: **hydrochar** produced from HTC, **syngas** produced from hydrochar gasification process, **dodecanol** and protein rich biomass produced from syngas. Meanwhile, the obtained end products are **chemical detergents** and nutrients recovered from HTC. To organise the stakeholders within this category, subcategories are defined based on the specific product they are interested in.

Hydrochar produced from hydrothermal carbonisation can be utilized as a soil amendment, improving soil quality and fertility. Its ability to enhance soil structure, retain moisture and provide nutrients makes it particularly beneficial for agricultural applications (codified 01.61 under NACE Rev.2) (Taskin et al., 2019). Additionally, hydrochar can serve as a renewable energy feedstock, in the energy sector (codified 35.11 under NACE Rev.2), through combustion or gasification processes, as also utilized in use case 3 (Masoumi et al.,2021).

Table 18: Hydrochar End Users for use case 3

Agriculture Industry		Energy Industry	
Bayer [3] (DE) -Global	https://www.bayer.com/en/	**Evero Energy**[3] (DE)	https://evero.energy/
Carbon Gold [3] (UK)	https://www.carbongold.com/	**Vattenfall**[3] (SE) - Global	https://group.vattenfall.com/

Index 3: Stakeholder identified through Draxis research—there is currently no communication established with these stakeholders.

Syngas generated from the gasification of hydrochar has significant applications in both the energy (codified 35.11 under NACE Rev.2) and chemical manufacturing (codified 20.1 & 20.5 under NACE Rev.2) sectors. In the energy sector, it can be utilized for electric power generation, especially in fuel cells that convert these gases into electricity. It is worth mentioning that industries in the energy sector that are end users of syngas will typically focus on utilizing it as a fuel source for power

generation through gas turbines or combined heat and power systems, while those that are end users of biochar will emphasize its use as a renewable energy source in biomass energy generation processes (Solarte, Chacón-Pérez, Y. and Cardona-Alzate, 2018). Additionally, within the chemical manufacturing sector, syngas serves as vital feedstock for producing essential chemicals such as methanol and ammonia (Chavando et al., 2023).

Table 19: Syngas End Users for use case 3

Chemical Industry		Energy Industry	
Linde [3] (DE) - Global	https://www.linde.com/	**KBR** [3] (UK) - Global	https://www.kbr.com/en-au
BASF [3] (DE) - Global	https://www.basf.com/global/en	**Ørsted** [3] (DK) - Global	https://orsted.com/
		E.ON [3] (DE) - Europe	https://www.eon.com/en.html

Index 3: Stakeholder identified through Draxis research—there is currently no communication established with these stakeholders.

Dodecanol is primarily used in manufacturing of chemical products for personal care and household use (codified 20.4 under NACE Rev.2) (Fan et al., 2014). Particularly in use case 3, is used for the manufacture of detergents.

Table 20: Dodecanol End Users for use case 3

Personal Care & Cleaning Products Industry	
Procter & Gamble [1] (BE) - Global	https://us.pg.com/
Unilever [3] (NL) - Global	https://www.unilever.com/

Index 3: Stakeholder identified through Draxis research—there is currently no communication established with these stakeholders.

The recovery of **ammonia from process water** plays a crucial role in the fertilizer manufacturing (codified 20.15 under NACE Rev.2). As a key component in nitrogen fertilizers, recovered ammonia supports crop production and food security, making it essential for sustainable agricultural practices.

Table 21: Nutrients End Users for use case 3

Manufacturers of fertilisers	
Fertiberia [3] (ES) - Europe	https://www.fertiberia.com/en/
COMPO [3] (DE) - Europe	https://www.compo.com/int/

Index 3: Stakeholder identified through Draxis research—there is currently no communication established with these stakeholders.

Finally, the **chemical detergents** produced from the upcycling process are primarily designed for household and industrial cleaning applications.

Public Authorities & Standardization Actors

In Section 3.1.2, Table 10 &Table 11 already list the public authorities and standardization actors relevant to all three use cases related to wood waste valorisation. Since the use cases share common challenges and regulatory requirements, the same public authorities and standardization bodies are involved across the board.

However, in Use Case 3, an additional regulatory body, included in the category of policy makers, becomes relevant due to the production of **dodecanol**, a chemical compound with industrial applications. The **European Chemicals Agency (ECHA)** plays a crucial role in regulating chemicals produced during the process, such as dodecanol, ensuring its safe handling and compliance with **REACH** (Registration, Evaluation, Authorisation and Restriction of Chemicals). This ensures that the chemical is produced and utilized in a manner that meets stringent safety and environmental standards.

3.3.3. Visualisation of stakeholder interactions

This section examines the various interactions among stakeholders involved in waste management and product development within use case 3, aiming to better understand the collaborative dynamics and facilitate effective valorisation of contaminated wood waste.

As mentioned before, in use case 3, **waste generators** include providers of CDW, liquid waste and CDW flying ashes. While these groups typically do not engage with one another, they all interact with collection authorities, including municipalities. Flying ashes providers may also connect with construction and demolition companies in order to supply them with CDW. Furthermore, waste owners and generators collaborate closely with wood waste sorting providers and waste management companies for effective disposal. Finally, waste generators maintain strong relationships with public authorities, particularly municipalities, which regulate waste management processes and often engage with industry associations to ensure compliance with standards and policies. This interaction with public authorities and standardization bodies is crucial for aligning practices with regulatory requirements.

Sorting providers operate similarly across all three use cases. As previously discussed, they maintain strong interactions with CDW generators for sourcing CDW and with waste management companies to supply the necessary wood waste. Additionally, they collaborate closely with each other to develop and enhance the sorting system.

Waste management companies and operators closely collaborate with sorting providers and waste owners to secure the necessary waste for processing, while also engaging regularly with end users to valorise products across various industries. In use case 3, technology providers and waste processing facilities work together to develop and test new technologies, maintaining medium-level interactions with standardization bodies to ensure compliance with regulatory requirements and quality standards. Public authorities, including policymakers, influence these developments by establishing sustainability regulations. At the same time, international organisations also offer limited support by facilitating access to business networks and enhancing the distribution and adoption of produced materials.

The previous paragraphs have outlined the interactions between **products end users** and waste generators, sorting providers and waste management companies/operators. It is noteworthy that distinct end users do not require interaction with one another. However, as they leverage the developed materials to produce new products, such as detergents from dodecanol, they engage with standardization actors to ensure compliance with market standards and secure the necessary certifications.The interactions between **public authorities** and **standardization actors** and the other general actor categories have already been described in section 3.1.3 and are consistent across the three use cases.

The interactions among stakeholders in Use Case 3, which have been analysed in detail, are also visually represented in Figure 10. The ranking of the interactions is performed according to the methodology presented in the section 2.3.

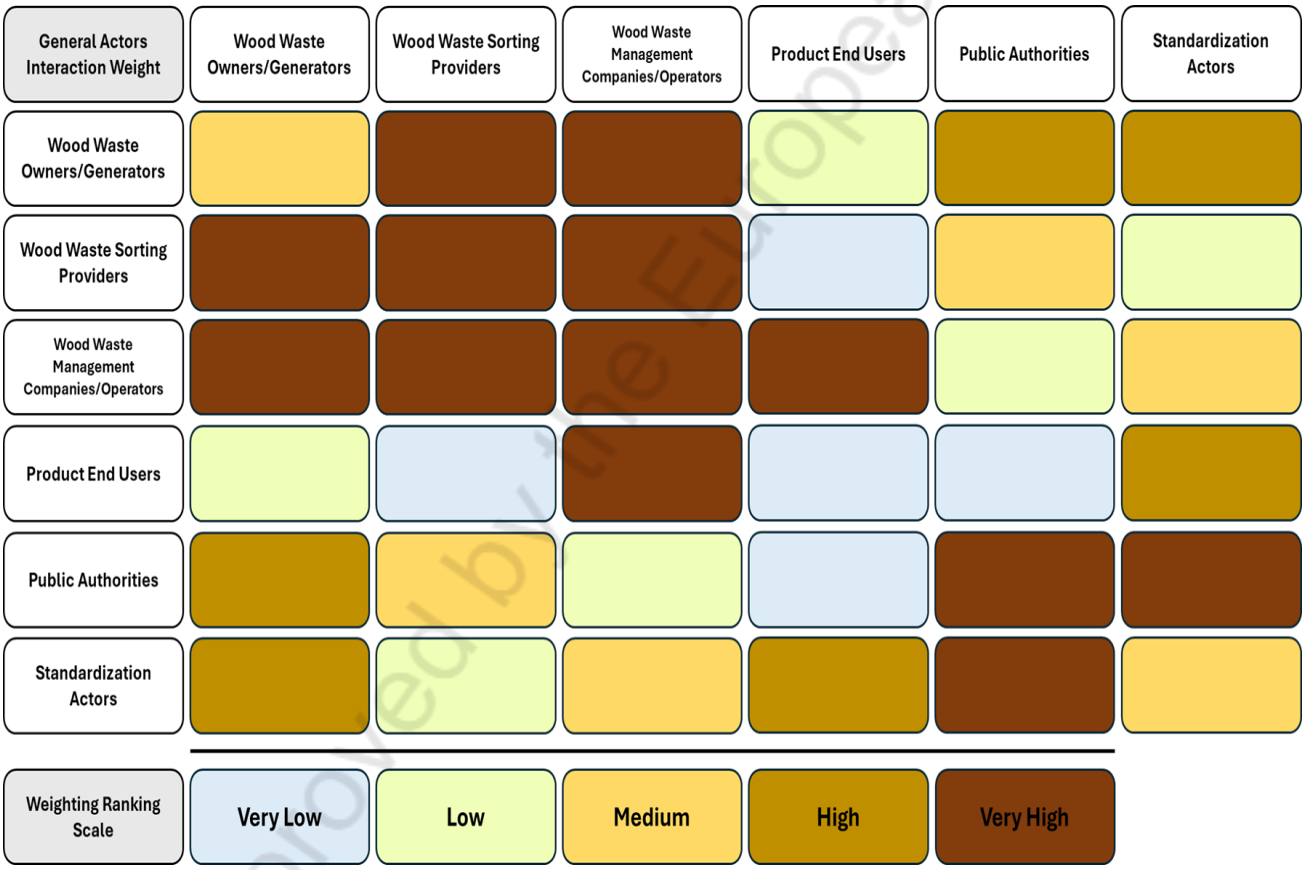

Figure 10: Stakeholders' key interactions for use case 3

4. NEXT STEPS

Utilising the observations produced in this deliverable is crucial for guiding key future project activities. These activities include dissemination strategies, organizing targeted communication campaigns and fostering collaborations between stakeholders. They are actions essential for maximising the project's impact, ensuring the engagement of the right audiences and promoting the adoption of sustainable practices developed within the use cases. In terms of W2W, these activities are mainly addressed in WP19, which focuses on impact maximisation, dissemination, communication, and cross-sectoral collaboration. Specifically, in terms of stakeholder engagement, the categorized lists of stakeholders can help the partners working in this work package identify target groups for specific dissemination efforts, making outreach more efficient and effective. Meanwhile, the visual diagrams offer a clear overview of stakeholder interactions and can be used to guide the organization of networking events, workshops, or other engagement activities. By understanding the varying levels of interactions among stakeholder groups the dissemination, communication, and exploitation of projects results can be more targeted and, consequently, more successful. Furthermore, this deliverable provides valuable input for any project task where a targeted approach to engage specific groups would be beneficial, as well as for other activities related to similar wood waste valorisation efforts.

5. CONCLUSIONS

In summary, a total of 200 stakeholders were identified across the project, with 67 stakeholders in Use Case 1, 63 in Use Case 2, and 70 in Use Case 3. A crucial aspect of this task was the organisation of stakeholder categories, which played a vital role in ensuring the inclusion of all relevant stakeholders. The six main actor categories were further analysed by creating relevant subcategories for each use case and providing specific company examples. This resulted in detailed stakeholder networks, including both current project partners and potential stakeholders identified through their activities. The detailed analysis aims not only to facilitate stakeholder engagement within the project but also to serve as a framework that can potentially be expanded and applied to other networks related to wood waste valorisation, such as waste from the paper and pulp industry or wood processing.

A common conclusion across all use cases is that dependent actors in the value chain must establish strong communication and interaction to facilitate the project's success. Nevertheless, in exploring stakeholder relationships and interactions, the analysis went beyond the obvious connections depicted in the flow charts for each use case. Specifically, each use case has specific characteristics that must be considered, which can lead to different interactions among stakeholders. These suggested interactions may further support the operation of the value chains developed and consequently help achieve the overall objectives. Finally, in terms of public authorities and standardization actors, that are not directly participating in the value chains, it was generally concluded that their interaction with waste owners/generators should be highly encouraged. It is also recommended to maintain interactions with the other main stakeholder categories.

In conclusion, the outcome of this task provides a comprehensive understanding of the stakeholder landscape, which is vital for project partners to effectively identify and engage with key actors throughout the value chains. Practically, this understanding facilitates stronger collaborations and enhances communication among all relevant stakeholders ensuring their meaningful involvement in project activities, particularly through the efforts of WP19. This proactive approach to engagement aims to support the efficient implementation and coordination of the project's objectives and maximise its overall impact.

6. REFERENCES

Chavando, J.A.M. et al. (2023) 'Future prospects and industrial outlook of syngas applications,' in Elsevier eBooks, pp. 427–463. https://doi.org/10.1016/b978-0-323-91878-7.00017-4.

Eugenio, M.E. et al. (2019) 'Alternative raw materials for pulp and paper production in the concept of a lignocellulosic biorefinery,' in IntechOpen eBooks. https://doi.org/10.5772/intechopen.90041.

European Commission. (2007). Eurostat regional yearbook 2007. Publications Office of the European Union. https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF.pdf/dd5443f5-b886-40e4-920d-9df03590ff91?t=1414781457000.

Fan, Z. *et al.* (2014) 'Preparation of bio-based surfactants from glycerol and dodecanol by direct etherification,' *Green Chemistry*, 17(2), pp. 882–892. https://doi.org/10.1039/C4GC00818A.

Jain, S. (2024) Man-Made cellulose fibers: a sustainable alternative to cotton fabrics. https://wiser.eco/man-made-cellulose-fibers/.

Khan, M.Z.R., Srivastava, S.K. and Gupta, M.K. (2020) 'A state-of-the-art review on particulate wood polymer composites: Processing, properties and applications,' Polymer Testing, 89, p. 106721. https://doi.org/10.1016/j.polymertesting.2020.106721.

Khoshnava, S. M., et al. (2020). The role of green building materials in reducing environmental and human health impacts. International Journal of Environmental Research and Public Health, 17(7), 2589. https://doi.org/10.3390/ijerph17072589.

Masoumi, S. et al. (2021) 'HydroChar: A review on its production technologies and applications,' Catalysts, 11(8), p. 939. https://doi.org/10.3390/catal11080939.

Sharma, S. et al. (2020) 'Lignin as potent Industrial Biopolymer: An Introduction,' in Springer series on polymer and composite materials, pp. 1–15. https://doi.org/10.1007/978-3-030-40663-9_1.

Solarte-Toro, J.C., Chacón-Pérez, Y. and Cardona-Alzate, C.A. (2018) 'Evaluation of biogas and syngas as energy vectors for heat and power generation using lignocellulosic biomass as raw material,' Electronic Journal of Biotechnology, 33, pp. 52–62. https://doi.org/10.1016/j.ejbt.2018.03.005.

Taskin, E. et al. (2019) 'Multianalytical characterization of biochar and hydrochar produced from waste biomasses for environmental and agricultural applications,' Chemosphere, 233, pp. 422–430. https://doi.org/10.1016/j.chemosphere.2019.05.204.

Yang, J., Ching, Y. and Chuah, C. (2019) 'Applications of lignocellulosic fibers and lignin in bioplastics: a review,' Polymers, 11(5), p. 751. https://doi.org/10.3390/polym11050751.

WOOD2WOOD