# D3.2 Market Study

AQUAMBIENTE
Circular Economy Solutions

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Clean Hydrogen
Partnership

# PROJECT INFORMATION

| | |
|---|---|
| GRANT AGREEMENT NUMBER | 101137792 |
| PROJECT TITLE | A novel multi-stage steam gasification and syngas purification demonstration plant for waste to hydrogen conversion |
| PROJECT ACRONYM | HYIELD |
| FUNDING SCHEME | Horizon Europe |
| START DATE OF THE PROJECT | 01/01/2024 |
| DURATION | 48 months |
| CALL IDENTIFIER | HORIZON-JTI-CLEANH2-2023-1 |
| PROJECT WEBSITE | https://hyield.eu/ |

# DELIVERABLE INFORMATION

| | |
|---|---|
| DELIVERABLE N° & TITLE | D3.2. Market Study |
| WP NO. | 3 |
| WP LEADER | ACES |
| DELIVERABLE CREATOR | ACES |
| CONTRIBUTING PARTNERS | - |
| AUTHORS | Adrián Francés, Ferran Barrera, Albert Badell, Valentina Álamos, Matilde Santiago |
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| CONTRACTUAL DEADLINE | M12 (January 2025) |
| DELIVERY DATE TO EC | 13 February 2025 |
| DISSEMINATION LEVEL | PUBLIC |

# DOCUMENT LOG

| VERSION | DATE | AUTHOR | DESCRIPTION OF CHANGE |
|---|---|---|---|
| V1.0 | 18/12/2024 | Adrián Francés, Ferran Barrera, Albert Badell, Valentina Álamos, Matilde Santiago | Table of contents, initial version |
| V1.1 | 31/12/2024 | Ignasi Gomez, Sònia Quintana | Draft for revision |
| V2.0 | 11/02/2025 | Álvaro Sánchez Sánchez de Puerta | Final review |

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## Acronym Glossary

| | |
|---|---|
| *EWC: European waste codes* | *KPI: Key Performance Indicator* |
| *WP: Work Package* | |

## Consortium Partners

| | Country | Country | Short name |
|---|---|---|---|
| 1 | MAGTEL OPERACIONES | ES | MAG |
| 2 | CEMEX ESPAÑA OPERACIONES | ES | CMX |
| 3 | VEOLIA (ACES) | ES | ACES |
| 4 | WASTE-TO-ENERGY ADVANCED SOLUTIONS | ES | WTE |
| 5 | H2SITE | ES | H2S |
| 6 | MINCATEC | FR | MIN |
| 7 | FUNDACIÓ EURECAT | ES | EUT |
| 8 | SINTEF AS | NO | SIN |
| 9 | ARISTENG | LU | ARI |
| 10 | SYNHELION | BE | SYN |
| 11 | CETAQUA-CENTRO TECNOLÓGICO DEL AGUA, FUNDACIÓN PRIVADA | ES | CET |
| 12 | INVENIAM GROUP | ESE | INV |
| 13 | LA FARGA | ES | FAR |
| 14 | ARCELORMITTAL | DE | ARC |
| 15 | ENAGAS | ES | ENG |
| 16 | CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS | ES | CSIC |

# 1. Introduction

This document constitutes the deliverable for Subtask 3.1.1: Feedstock Market Study, and Subtask 3.1.3 Feedstock transportation and logistics led by ACES with the participation of CET, WTE, and CMX. This study will be conducted between months 7 and 48 of the project, with the primary objective of identifying and classifying the available waste streams in the area of the plant location.

In the context of the EU's transition to a circular economy, which aims to reduce pressure on natural resources, foster sustainable growth and employment, and achieve climate neutrality by 2050, this market study presents itself as a fundamental step for the success of the project. The primary objective is to identify and classify available nearby waste streams, contributing not only to the plant's operational viability but also to the EU's goal of doubling the circular use of materials by 2030 and promote sustainable practices in the region [1].

The methodological approach of this study is based on two main pillars:

- Comprehensive mapping of potential waste producers within a 100 km radius around the plant location.
- Direct contact with identified suppliers to confirm their interest in contributing their waste to the project.

This document will detail the process, findings, and conclusions derived from this market study, providing a solid foundation for the subsequent phases of the project and contributing to informed decision-making regarding feedstock management.

# 2. Identification and selection of feedstock

## 2.1. Initial Approach and Expansion

In the initial phase of the research, an exhaustive mapping was carried out within a 100 km radius around the hydrogen production plant. This methodological approach aimed to identify and quantify potential feedstock sources in the immediate proximity of the facility. However, the results obtained revealed a significant insufficiency in the availability of raw materials within this predefined perimeter.

Faced with this limitation, the research team made the strategic decision to expand the geographical scope of the study. The search area was extended beyond the initial 100 km, potentially encompassing the entire national territory. This geographical expansion was complemented by a diversification in the categories of waste considered as viable feedstock.

In particular, new families of waste and subproducts were incorporated into the study, including types of biomass and meat meals, among others. This expansion, both in geographical terms and in the variety of raw materials considered, aimed to significantly increase the potential volume of feedstock available for hydrogen production, thus ensuring the long-term viability and sustainability of the project.

## 2.2. Selection Criteria

In the framework of our research on feedstock optimization for clean hydrogen production through gasification, several critical parameters have been identified that determine the suitability of waste. These selection criteria are based on technical, logistical, and environmental considerations.

**Technical criteria**

- High organic matter content: Essential for efficient hydrogen production through gasification.
- Waste recovery potential: ensure compliance with the <50% proportion of waste non-suitable for processing (% of rejection) KPI.
- Compatibility with gasification technology: The chemical composition and physical properties of the waste must align with the specific gasification process used.
- Material consistency: Feedstock should have consistent properties to ensure stable production.

**Logistical Criteria**

- Availability: Sufficient and consistent quantities of feedstock must be available to ensure long-term sustainable production.
- Proximity to production plant: Closer sources reduce transportation costs and environmental impact.
- Ease of collection and transport: Feedstock should be readily collectible and transportable.

**Environmental Criteria**

- Minimization of environmental impact: The feedstock selection should contribute to reducing overall environmental impact and greenhouse gas emissions.
- Valorization of waste streams: Priority given to feedstocks that provide a solution for problematic waste management.

**Economic Criteria**

- Low acquisition and processing costs: The feedstock should be economically viable to acquire and process (related to the KPI of <20€/tonne waste acquisition cost).
- Market dynamics: Consider current disposal routes and potential for creating value from waste streams.

- Scalability: The feedstock should be available in quantities that allow for potential scaling of production.

**Diversity and Replicability**

- Diverse representation: Selection of a wide range of wastes from different sectors to ensure finding the most appropriate for gasification. In line with the KPI: >20 types of waste identified and characterised.
- Replicability: Feedstock should be commonly available to facilitate replication of the process in various locations.

By applying these comprehensive criteria, we aim to identify feedstocks that not only meet the technical requirements of the gasification process but also contribute to sustainable waste management practices and economic viability of the project.

## 2.3. Potential feedstock categories for clean hydrogen production

Gasification technology offers a versatile approach to produce clean hydrogen from a wide range of feedstocks. The main categories of potential feedstocks include:

**Municipal Solid Waste [2,3,4]**

- Composition varies but typically includes food waste, plastics, paper, textiles, and other residential and commercial waste.
- Advantages: Abundant, addresses waste management issues.
- Challenges: Heterogeneous composition, potential contaminants, varying moisture content.

**Biomass [2,3]**

- Agricultural residues (e.g., straw, husks, corn stover).
- Forestry residues (e.g., sawdust, bark).
- Energy crops (e.g., switchgrass).
- Advantages: Renewable, potentially carbon-neutral.
- Challenges: Seasonal availability, moisture content variability.

**Industrial Wastes [2,3]**

- Manufacturing byproducts.
- Sludges (e.g., from wastewater treatment).
- Advantages: Often energy-rich, reduces industrial waste disposal costs.
- Challenges: Potential presence of hazardous materials, variability in composition.

**Sewage Sludge [2,3]**

- From wastewater treatment plants.
- Advantages: Continuous supply solves sludge disposal issues.
- Challenges: High moisture content, potential heavy metal contamination.

**Food Industry and Rendering Waste [2,3]**

- From restaurants, markets, households, food processing industries and rendering facilities. Includes:
    - Food waste from various sources.
    - Meat and bone meal (MBM).
    - Animal by-products not intended for human consumption.
    - Waste from food processing industries.
- Advantages: High organic content, reduces methane emissions from landfills, Continuous supply from food industry.
- Challenges: High moisture content, rapid decomposition.

There has been a selection of the European waste Codes (EWC) with high organic content and that present potential to be used as sources for the biohydrogen production (See details in Annex 7.1 Organic waste from EWC).

## 2.4. Annual production for each EWC code, 100 km radius

Initially, a study was conducted to determine the availability of waste within a 100 km radius of the CEMEX Alcanar Cement pilot plant location. This radius was chosen to optimize logistics efficiency and minimize transportation costs. The study focused on two provinces: Tarragona and Castellón.

The analysis of waste production in this area covered the period 2018-2022, considering a five-year period to account for potential anomalies caused by events such as the COVID-19 pandemic or economic fluctuations. This approach ensures a more representative picture of waste availability over time. As with the local study, while the full range of data was analyzed, particular emphasis was placed on the 2022 figures as the most current and relevant for project planning.

The analysis revealed a total available waste quantity ranging from 65,000 to 115,000 tons per year over the studied period, with approximately 100,000 tons available in 2022. While significant, this amount falls short of the project's key performance indicator (KPI) of identifying more than 10 million tonnes of organic waste potential per year.

Below is the list of waste, indicating production in thousand metric tons per year:

*Table 1. Waste list (metric tons per year*

| | | Production 2018 to 2022 (kTons/y) | | Production 2022 (kTons) |
|---|---|---|---|---|
| EWC | Code name | Min | Max | |
| 19 05 03 | Off-specification compost | 14 | 24 | 24 |
| 03 03 11 | Sludges from on-site effluent treatment other than those mentioned in 03 03 10 | 20 | 28 | 22 |
| 19 08 05 | Sludges from treatment of wastewater | 17 | 24 | 20 |
| 19 03 05 | Stabilised wastes other than those mentioned in 19 03 04 | 6 | 18 | 18 |
| 20 01 38 | Wood other than mentioned in 20 01 37 | 2 | 4 | 4 |
| 02 03 04 | Materials unsuitable for consumption and processing | 1,5 | 3 | 3 |
| 02 02 01 | Sludges from washing and cleaning | 0 | 3 | 3 |
| 02 02 04 | Sludges from on-site effluent treatment | 2,5 | 4 | 3 |
| 20 01 08 | Biodegradable kitchen and canteen waste | 0 | 3 | 1,8 |
| 19 08 01 | Screenings | 0,9 | 1,5 | 1 |
| 16 03 06 | Organic waste other than those mentioned in 16 03 05 | 0,3 | 0,6 | 0,6 |

| | | | | |
|---|---|---|---|---|
| 19 08 14 | Sludges from other treatment of industrial waste water other than those mentioned in 19 08 13 | 0,4 | 1,3 | 0,6 |
| 20 02 01 | Biodegradable wase | 0,5 | 1 | 0,5 |
| 02 03 05 | Sludges from on-site effluent treatment | 0 | 0,3 | 0,3 |
| 07 02 12 | Sludges from on-site effluent treatment other than those mentioned in 07 02 11 | 0,2 | 0,8 | 0,2 |
| 02 01 03 | Plant-tissue waste | 0,04 | 0,45 | 0,1 |
| 08 04 10 | Waste adhesives and sealants other than those mentioned in 08 04 09 | 0 | 0,1 | 0,1 |
| 19 08 12 | Sludges from biological treatment of industrial wastewater other than those mentioned in 19 08 11 | 0 | 0,08 | 0,08 |
| 19 05 01 | Non-composted fraction of municipal and similar wastes | 0,03 | 0,13 | 0,05 |
| 02 02 03 | Materials unsuitable for consumption processing | 0,02 | 0,07 | 0,02 |
| 20 01 25 | Edible oil and fat | 0,001 | 80,08 | 0,01 |
| 17 02 01 | Wood | 0,005 | 0,015 | 0,005 |
| **Total** | | **65** | **115** | **100** |

## 2.5. Annual production for each EWC code, national level

With the aim of analysing the replicability potential of the pilot plant, taking into account the availability of waste at a regional level, and in line with the KPI objective of mapping more than 10 million tonnes of waste (>10Mt/year of organic waste potential identified in territory), an analysis has been carried out at the level of the Spanish State.

This national-level analysis provides a comprehensive overview of waste availability across Spain, offering insights into the potential for scaling up the technology and identifying regions with sufficient waste resources to support similar plants.

As in the previous section, data from 2018 to 2022 was analysed, with a particular focus on the 2022 figures as the most current and relevant for project planning. This approach allows for a consistent comparison between local and national data while accounting for potential anomalies caused by events such as the COVID-19 pandemic or economic fluctuations.

As a result of this national-level analysis, we identified a significantly larger waste potential, ranging from 3 to 9 million tonnes per year over the studied period, with approximately 7 million tonnes available in 2022. This 2022 figure is considered the most accurate representation of current waste availability. While this figure is closer to the project's KPI, it still falls short of the 10 million tonne target, highlighting the importance of considering multiple waste streams and potentially exploring additional sources to meet the project's objectives.

Below is the list of waste at the national level, indicating production in thousand metric tons per year:

*Table 2. list of waste at the national level, indicating production in thousand metric tons per year*

| EWC | Code name | Production 2018 to 2022 (kTons/y) Min | Max | Production 2022 (kTons) |
|---|---|---|---|---|
| 02 02 03 | Materials unsuitable for consumption processing | 60 | 2.300 | 2.300 |
| 19 08 05 | Sludges from treatment of wastewater | 900 | 1.150 | 1.150 |
| 03 03 11 | Sludges from on-site effluent treatment other than those mentioned in 03 03 10 | 600 | 800 | 800 |
| 02 02 04 | Sludges from on-site effluent treatment | 240 | 350 | 315 |
| 19 05 03 | Off-specification compost | 240 | 300 | 250 |
| 19 05 01 | Non-composted fraction of municipal and similar wastes | 200 | 300 | 230 |
| 02 01 03 | Plant-tissue waste | 35 | 190 | 185 |
| 19 05 99 | Wastes not otherwise specified | 90 | 185 | 185 |
| 19 06 04 | Digestate from anaerobic treatment of municipal waste | 120 | 160 | 155 |
| 19 03 05 | Stabilised wastes other than those mentioned in 19 03 04 | 35 | 200 | 145 |
| 02 03 04 | Materials unsuitable for consumption and processing | 60 | 120 | 120 |
| 03 01 05 | Sawdust, shavings, cuttings, wood, particle board, and veneer other than mentioned in 03 01 04 | 7 | 110 | 110 |
| 19 08 12 | Sludges from biological treatment of industrial wastewater other than those mentioned in 19 08 11 | 60 | 115 | 113 |
| 19 08 14 | Sludges from other treatment of industrial wastewater other than those mentioned in 19 08 13 | 60 | 100 | 100 |
| 19 06 06 | Digestate from anaerobic treatment of animal and vegetable waste | 70,5 | 90 | 90 |
| 02 05 02 | Sludges from on-site effluent treatment | 72 | 85 | 80 |
| 03 03 10 | Fibre rejects, fibre, filler- and coating sludges from mechanical separation | 38 | 75 | 75 |
| 02 03 05 | Sludges from on-site effluent treatment | 50 | 75 | 65 |
| 20 01 08 | Biodegradable kitchen and canteen waste | 50 | 85 | 65 |
| 02 04 03 | Sludges from on-site effluent treatment | 30 | 60 | 60 |
| 20 01 25 | Edible oil and fat | 6,5 | 60 | 60 |
| 20 02 01 | Biodegradable wase | 30 | 400 | 50 |
| 20 01 38 | Wood other than mentioned in 20 01 37 | 43 | 50 | 45 |

| | | | | |
|---|---|---|---|---|
| 19 06 99 | Waste no otherwise specified | 3,8 | 55 | 45 |
| 02 05 01 | Materials unsuitable for consumption or processing | 25 | 50 | 40 |
| 02 07 05 | Sludges from on-site effluent treatment | 30 | 40 | 40 |
| 19 08 01 | Screenings | 35 | 1.100 | 35 |
| 03 03 01 | Waste bark and wood | 23 | 115 | 24 |
| 03 03 02 | Green liquor sludge (from recovery cooking liquor) | 13 | 23 | 23 |
| 02 02 01 | Sludges from washing and cleaning | 9 | 21 | 21 |
| 02 07 04 | Materials unsuitable for consumption or processing | 7 | 20 | 10 |
| 02 01 99 | Waste not otherwise specified | 0,2 | 7 | 7 |
| 16 03 06 | Organic waste other than those mentioned in 16 03 05 | 4 | 9 | 6,5 |
| 02 06 01 | Materials unsuitable for consumption or processing | 5 | 9 | 5 |
| 17 02 01 | Wood | 3,5 | 22,5 | 4,5 |
| 08 04 10 | Waste adhesives and sealants other than those mentioned in 08 04 09 | 4 | 7 | 4,5 |
| 03 03 05 | De-inking sludges from paper industry | 4 | 70 | 4 |
| 02 07 01 | Wastes from washing. Cleaning and mechanical reduction of raw materials | 2 | 4 | 4 |
| 02 01 01 | Sludges from washing and cleaning | 4 | 290 | 4 |
| 03 03 08 | Wastes from sorting of paper and cardboard destined for recycling | 4 | 10 | 4 |
| 07 02 12 | Sludges from on-site effluent treatment other than those mentioned in 07 02 11 | 1,5 | 3 | 3 |
| 03 01 01 | Waste bark and cork | 1 | 6 | 1 |
| 04 02 20 | Sludges from on -site effluent treatment other than those mentioned in 04 02 19 | 0,3 | 1,2 | 0,9 |
| 02 01 07 | Waste from forestry | 0,6 | 5,5 | 0,6 |
| 02 07 02 | Wastes form spirits distillation | 0,1 | 2,5 | 0,1 |
| 04 02 21 | Waste from unprocessed textile fibres | 0,001 | 0,25 | 0,001 |
| **Total** | | **3.000** | **9.000** | **7.000** |

## 2.6. Annual production for biomass, national level:

The pilot plant is designed to operate for 100 hours using easy-to-handle biomass as feedstock. In this context, wood chips and other types of residual biomass are considered equally. This broad range of options includes various forms of forest exploitation residues and waste wood, significantly expanding the possibilities for feedstock utilization.

To accommodate this variety of biomass options, the waste mapping process has been extended to include all these additional resources. This comprehensive approach allows for greater flexibility in feedstock selection and utilization, without prioritizing one specific type over another.

The utilization of these diverse biomass types will depend on several factors, including:

- Local availability of different biomass resources
- Agreements established with local producers and suppliers
- Seasonal variations in biomass production
- Logistical considerations for collection and transportation
- Specific requirements of the gasification process

Several types of biomass have been considered for the study

According to the Spanish Biomass Association (2023), the production of wood chips and olive pits in Spain can be summarized as follows (5):

- **Wood chips**: of the set of wood chip producing plants in Spain, for which data is available (43 plants out of a total of 64, one of them in Castellón), their theoretical production (production capacity) was between a minimum of 430 k tons, if we take into account the minimum value of the ranges provided by the source, and more than 1.090 k tons per year. Taking into account the areas closest to the location of the pilot plant, Tarragona and Castellón, only a production capacity of between 10 and 30 k tons per year is observed.
- **Olive pit**: There are 23 olive pit producers at the national level in Spain. The production capacity was between 100 kTn and 279 kTn in 2023.

Regarding other types of biomass, the following table shows the annual biomass statistics, which is a yearly statistical operation aimed at providing complete and reliable information on the primary supply of solid biomass in Spain (6):

*Table 3. Annual biomass statistics*

| | Energy Production (TJ) | Calculated Residue KTones 2022 (Dry base) |
|---|---|---|
| **Forest biomass used for energy production** | **120.793** | **11.200** |
| **Primary forest biomass** | **100.816** | **5.600** |
| Tree branches and crowns | 93.686 | 5.200 |
| Stumps | 6.073 | 340 |
| Rolled wood (firewood) | 1.056 | 60 |
| **By-products of the forestry industry** | **19.665** | **1.100** |
| Crust | 5.181 | 280 |
| Chips, sawdust, and other wood particles. | 14.484 | 800 |
| **Post-consumer wood** | **312** | **20** |
| **Organic waste biomass** | **22.629** | **1.550** |
| **Organic fraction of industrial waste** | **8.064** | **550** |
| **Organic fraction of urban solid waste** | **14.231** | **975** |
| **Residual sludge** | **334** | **25** |

The calculations of approximate kilotons for each type of biomass have been carried out taking into account an average LHV (Lower Heating Value) for biomass, between 14-18 MJ/Tn.

It is important to note that not all biomass categories presented in this table are eligible for use in the pilot plant due to their specific characteristics. Factors such as size, condition, and composition of the biomass can limit its suitability for the gasification process. For example, stumps are generally not suitable due to their large size and processing difficulty. The final selection of biomass for the pilot plant will focus on those categories that are most compatible with the technical requirements of the gasification process and are locally available in sufficient quantities.

This diverse biomass landscape offers multiple options for the pilot plant operation. The substantial production of various types of biomass at the national level ensures a robust and diverse supply chain for biomass-based energy production in Spain, offering numerous alternatives for feedstock selection based on availability and operational requirements.

# 3. Volumes and sources selected

Based on the comprehensive selection criteria outlined in section 2.2, a range of waste materials for this project have been identified and selected. The selection process considered multiple factors, including the annual production volumes at both local (100 km radius) and national levels, as detailed in the previous sections. These production data are crucial in assessing the availability and sustainability of each potential feedstock. Additionally, it has been considered the strategic importance of each waste stream in terms of its potential for hydrogen production and contribution to sustainable waste management.

The analysis uses annual production data from 2018 to 2022, allowing to identify trends and ensure consistent availability of the selected feedstocks. This approach, combining historical production data with the selection criteria, allows to make informed decisions that balance immediate availability with long-term sustainability.

The following categories of waste have been selected for the project:

- Wood-based waste: Includes various forms of wood residues and processed wood materials.
- Wastewater Treatment Plant waste: Consists of different types of sludge from water treatment processes.
- Green byproducts: Comprises plant-based materials, often from landscaping or agricultural activities.
- Municipal solid waste: Includes processed waste from household and commercial sources.
- Animal byproducts: Consists of waste materials from animal processing industries.
- Paper industry waste: Includes residues and by-products from paper manufacturing.
- Mixed waste: Encompasses various types of waste that don't fit into the other categories.

This selection represents a diverse range of waste streams, ensuring a broad spectrum of feedstocks.

Key considerations in selection process:

- Diverse Representation: In order to ensure finding the most appropriate waste for the gasification process, a wide range of wastes and sectors have been selected for the study.
- Technological Compatibility: To ensure that the waste that will finally be selected meets the specifications of the HYIELD consortium technologist, a Characterization Plan will be carried out throughout the project (see details of the proposed Plan in deliverable D3.1 Waste Feedstock Supply).
- Economic Viability: Current market prices of the feedstocks have been considered to ensure the economic feasibility of the waste management solutions being developed. Since the pilot will be carried out in 2026-2027, prices will be reviewed when the time comes to supply feedstock.
- Volume and Availability: While high-volume wastes have been included such as off-specification compost (EWC 19 05 03) and various sludges (EWC 03 03 11, 19 08 05), waste with lower annual production has also been considered, due to its characteristics and potential interest in being analyzed in the project...
- Current Waste Destination: The existing disposal or treatment methodologies for each waste category are systematically evaluated, with emphasis placed on identifying waste streams where enhanced management strategies could yield the most substantial environmental and economic benefits. This analysis takes into consideration that certain waste types may already have established disposal routes and present greater accessibility challenges. The assessment of current waste destinations facilitates the identification of optimization opportunities within the waste management chain, enabling the implementation of more efficient and sustainable solutions and respecting the Waste hierarchy [9]. Furthermore, this approach allows for the prioritization of resources and efforts towards waste streams with the highest potential for improvement in their management practices.

- Replicable feedstock: With the aim and focus on replicating the HYIELD project on a larger scale and in other locations throughout Europe, the main waste families selected are waste derived from human activity, and very common in other European cities. In any case, as new locations are selected to replicate this valorization route, the selection must be completed with local waste.

This multi-faceted approach to waste selection allows us to address both the most abundant waste streams and strategically important lower-volume wastes.

By balancing these various factors, the selection aims to develop waste management strategies that are not only effective for current high-volume waste streams but also adaptable to evolving waste management challenges in the region.

The waste selection process has produced a diverse and promising range of feedstocks for our clean hydrogen production project. By balancing factors such as availability, technological compatibility, and environmental impact, we have created a foundation for developing innovative and sustainable waste management solutions.

# 4. Logistics and transport

The logistical process for waste management and transportation developed within this project's framework is a comprehensive system encompassing multiple stages and considerations. It is important to distinguish between two main phases of transport:

1. Characterization Phase Transport:

   During the initial characterization plan, the transport involves small samples of approximately 15 kg, from the waste producers to the ACES laboratory. This phase is crucial for the project's research and development aspects. The logistics for these samples are managed internally within the project framework. A specific safety protocol has been developed for these sample-sized quantities, including proper packaging in sealed, labelled containers, detailed documentation, use of appropriate personal protective equipment, vehicle preparation with safety equipment, careful route planning, established emergency procedures, and a strict chain of custody. This protocol ensures careful handling and preservation of waste characteristics for accurate analysis, while maintaining safety standards and environmental protection throughout the transport process.

2. Operational Phase Transport:

   Once the pilot is operational, the transport of larger quantities of waste will be subcontracted to specialized waste transport companies. These companies will be responsible for loading, unloading, and transporting the waste materials.

   For both phases, a thorough assessment of solid waste characteristics forms the fundamental basis for all logistical decisions. It is important to note that all waste to be managed in the project is not hazardous and solid, and therefore logistics and transport are simpler. This assessment includes identifying the specific format of the solid waste, precise quantification using appropriate measurement units such as tons or kilograms, and consideration of external factors that could influence the properties of the waste during transport or storage.

Based on this assessment, the most suitable containers for each type of solid waste are selected, and the optimal means of transport is determined. This decision considers operational efficiency, safety aspects, and regulatory compliance.

The logistical planning includes the identification of necessary equipment and materials for effective solid waste management. This encompasses specialized containers, loading and unloading machinery, and appropriate transportation systems, all complying with relevant safety and regulatory standards.

For the operational phase, the selection of appropriate vehicles will be carried out in collaboration with the subcontracted transport companies, ensuring their vehicles meet all necessary specifications for solid waste transport.

Safety protocols will be implemented by the subcontracted transport companies, which have their own specialized training and real-time tracking systems, covering crucial aspects such as appropriate waste management, occupational safety protocols, and efficient driving techniques. This preparation is essential to ensure that the transfer of solid waste, from its point of origin to its final destination, is carried out safely, efficiently, and in compliance with current regulations.

In conclusion, the logistical process designed for solid waste management and transport in the project is characterized by its comprehensive and multifaceted approach, adaptable to both the initial characterization phase and the subsequent operational phase. By meticulously considering technical, regulatory, and economic aspects across both phases, this system maximizes efficiency in solid waste handling, ensures rigorous compliance with all applicable regulations, optimizes transport-associated costs, and minimizes the environmental impact of logistical operations. Periodic review and update of this process are recommended to maintain its effectiveness and adaptability in the face of potential regulatory changes or technological advances in the solid waste management sector.

# 5. Conclusion

The main conclusions of this report are:

- Feedstock Diversity: The study has successfully identified a wide range of potential organic waste feedstocks, ensuring a robust and flexible supply for the hydrogen production plant.
- Volume and Availability: While some high-volume waste streams have been identified (e.g., off-specification compost, various sludges), the study also highlights the importance of strategically important lower-volume wastes.
- Economic and Environmental Considerations: The selection process has balanced economic viability with environmental impact, considering current waste destinations and potential for improved management.
- Logistical Feasibility: A comprehensive logistical framework has been developed, addressing key aspects such as waste characteristics, regulatory compliance, and cost optimization.
- Replicability: The selection approach ensures that the chosen feedstocks are likely to be available in other locations, supporting the potential for project replication.

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# 7. ANNEX 1 - Organic waste from EWC (European waste codes)

02 01 Wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing:

- 02 01 01 Sludges from washing and cleaning
- 02 01 03 Plant-tissue waste
- 02 01 07 Wastes from forestry
- 02 01 99 Wastes not otherwise specified

02 02 Wastes from the preparation and processing of meat, fish and other foods of animal origin:

- 02 02 01 Sludges from washing and cleaning
- 02 02 03 Materials unsuitable for consumption or processing
- 02 02 04 Sludges from on-site treatment

02 03 Wastes from fruit, vegetables, cereals, edible oils, cocoa, coffe, tea and tobaco preparation and processing; conserve production, yeast and yeast extract production, molasses preparation and fermentation:

- 02 03 03 Wastes from solvent extraction
- 02 03 04 Materials unsuitable for consumption or processing
- 02 03 05 Sludges from on-site effluent treatment.

02 04 Waste from sugar processing:

- 02 04 03 Sludges from on-site effluent treatment

02 05 Wastes from the dairy products industry:

- 02 05 01 Materials unsuitable for consumption or processing
- 02 05 02 Sludges from on-site effluent treatment

02 06 Wastes from the baking and confectionery industry:

- 02 06 01 Materials unsuitable for consumption or processing
- 02 06 03 Sludges from on-site effluent treatment

02 07 Wastes from the production of alcoholic and nonalcoholic beverages (except coffee, tea and cocoa):

- 02 07 01 Wastes from washing, cleaning and mechanical reduction of raw materials
- 02 07 02 Wastes from spirits distillation
- 02 07 04 Materials unsuitable for consumption or processing
- 02 07 05 Sludges from on-site effluent treatment

03 01 Wastes from wood processing and the production of panels and furniture:

- 03 01 01 Waste bark and cork
- 03 01 05 Sawdust, shavings, cuttings, wood particle board and veneer other than those mentioned in 03 01 04 (Sawdust, shavings, cuttings, wood particle board and veneer containing dangerous substances)

03 03 Wastes from pulp, paper and cardboard production processing:

- 03 03 01 Waste bark and cork

- 03 03 02 Green liquor sludge (from recovery of cooking liquor)
- 03 03 05 De-inking sludges from paper recycling
- 03 03 08 Wastes from sorting of paper and cardboard destined for recycling
- 03 03 10 Fibre rejects, fibre-, filler- and coating-sludges from mechanical separation
- 03 03 11 Sludges from on-site effluent treatment other than those mentioned in 03 03 10

04 01 Wastes from the leather and fur industry:

- 04 01 01 Fleshing and lime split wastes
- 04 01 07 Sludges, in particular from on-site effluent treatment free from chromium

04 02 Wastes from the textile industry:

- 04 02 10 Organic matter from natural products (for example grease, wax)
- 04 02 20 Sludges from on-site effluent treatment other than those mentioned in 04 02 19 (Sludges from on-site effluent treatment containing dangerous substances)
- 04 02 21 Wastes from unprocessed textile fibres.

07 02 Wastes from the MSFU of plastics, synthetic rubber and man-made fibres:

- 07 02 12 Sludges from on-site effluent treatment other than those mentioned in 07 02 11 (Sludges from on-site effluent treatment containing dangerous substances)

08 04 Wastes from MFSU of adhesives and sealants (including waterproofing products):

- 08 04 10 Waste adhesives and sealants other than those mentioned in 08 04 09 (waste adhesives and sealants containing organic solvents or other dangerous substances)
- 08 04 12 Adhesive and sealant sludges other than those mentioned in 08 04 11 (adhesive and sealant sludges containing organic solvents or other dangerous substances)

16 03 off-specification batches and unused products:

- 16 03 06 Organic wastes other than those mentioned in 16 03 05 (organic wastes containing dangerous substances)

17 02 Wood, glass and plastic:

- 17 02 01 Wood

19 03 Stabilised/solidified wastes:

- 19 03 05 Stabilised wastes other than those mentioned in 19 03 04 (Wastes marked as hazardous, partly stabilised)

19 05 Wastes from aerobic treatment of solid wastes:

- 19 05 01 Non-composted fraction of municipal and similar wastes
- 19 05 03 off-specification compost
- 19 05 99 Wastes not otherwise specified

19 06 Wastes from anaerobic treatment of solid wastes:

- 19 06 04 Digestate from anaerobic treatment of municipal waste
- 19 06 06 Digestate from anaerobic treatment of animal and vegetable waste
- 19 06 99 Waste no otherwise specified

19 08 Wastes from waste water treatment plants not otherwise specified:

- 19 08 01 Screenings
- 19 08 05 Sludges from treatment of urban waste water
- 19 08 12 Sludges from biological treatment of industrial waste water other than those mentioned in 19 08 11 (sludges containing dangerous substances from biological treatment of industrial waste water)
- 19 08 14 Sludges from other treatment of industrial waste water other than those mentioned in 19 08 13 (sludges containing dangerous substances from other treatment of industrial waste water)

20 01 Separately collected fractions (except 15 01):

- 20 01 08 Biodegradable kitchen and canteen waste.
- 20 01 25 Edible oil and fat
- 20 01 38 Wood other that mentioned in 20 01 37 (wood containing dangerous substances)

20 02 Garden and park wastes (including cemetery waste):

- 20 02 01 Biodegradable waste