Rural BioUp
Grow local, go global

# Deliverable 2.2

## D.2.2 - Report on biobased feedstocks availability

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| **Project Title** | RuralBioUp (Empowering EU Rural Regions to scale-Up and adopt small-scale Bio-based solutions: the transition towards a sustainable, regenerative, inclusive and just circular bioeconomy) |
| **Contract No.** | 101060618 |
| **Instrument** | HORIZON Coordination and Support Actions |
| **Thematic Priority** | Mainstreaming inclusive small-scale bio-based solutions in European rural areas |
| **Start of Project** | 1 October 2022 |
| **Duration** | 36 months |

Our Consortium

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| **Abstract** | The RuralBioUp project enhances bio-based economies in rural areas by identifying and harmonizing biomass resources, technologies, and business models for bio-based products. Delivrable 2.2. focuses on biomass feedstock availability, introducing the Biomass Model Tool (BMT) for data integration and analysis. It also introduces the link with RuralSpot, a tool to support rural actors by providing relevant information for new value chains. Deliverable 2.2. also emphasizes aligning bio-based product chains with environmental goals by exploitation of local biomass feedstock, with supporting local circular bioeconomy. |
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| **1** | **4/10/2024** | **Karolina Jurkiewicz** | **Final review and editing** |

# Table of Abbreviations and Acronyms

| Abbreviation | Meaning |
|---|---|
| **Anaerobic Digestion** | A process through which microorganisms break down organic materials in the absence of oxygen, producing biogas (methane) and digestate, used for renewable energy generation and soil improvement. |
| **Best Practices** | Methods or techniques that have consistently shown results superior to those achieved with other means and are used as benchmarks for success. |
| **Bio-Based Economy** | An economy that uses renewable biological resources, such as crops, forests, fish, animals, and micro-organisms, to produce food, materials, and energy. |
| **Bio-Based Products (BBPs)** | Products wholly or partly derived from materials of biological origin, excluding materials embedded in geological formations and/or fossilized. |
| **Bio-Based Solutions** | Technologies, processes, or products that derive from renewable biological resources as opposed to fossil fuels, used across sectors like energy, agriculture, chemicals, and more. |
| **Bioeconomy** | An economy where the basic building blocks for materials, chemicals, and energy are derived from renewable biological resources such as plants and microbes. |
| **Bioeconomy Strategy Accelerator Toolkit (BSAT)** | A tool developed by the Power4Bio project, designed to support the acceleration and scaling of bio-based solutions through strategic guidance and resources. |
| **Bioenergy** | Energy derived from biological sources, including plant materials, animal waste, and other organic matter, used to produce heat, electricity, or biofuels. |
| **Bioethanol** | A type of ethanol produced from biomass such as corn, sugarcane, or other organic materials. It is commonly used as a renewable fuel additive for gasoline. |
| **BMT (BMT)** | A dynamic tool used in the RURAL-BIO-UP project to continuously assess biomass feedstock availability, industrial processes, and market opportunities, helping regional hubs make informed decisions. |
| **Biopolymer** | A type of polymer that is biodegradable and made from biological substances. Common biopolymers include PHA and PLA. |
| **Biorefineries** | Facilities that integrate biomass conversion processes and equipment to produce fuels, power, heat, chemicals, and materials from biomass, similar to conventional refineries but using renewable inputs. |
| **Biosuccinic Acid** | A platform chemical derived from the fermentation of sugars using microbes. It is used as a building block for producing bioplastics, resins, and solvents. |
| **Circular Bioeconomy** | A bioeconomy concept that integrates the principles of a circular economy, aiming to minimize waste and make the most of available resources through reuse, recycling, and sustainable design. |
| **Cellulosic Biomass** | Biomass derived from non-edible parts of plants, including agricultural residues, grasses, and wood chips, used for producing biofuels and bio-based chemicals. |

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| **DNSH (Do No Significant Harm)** | A European Union principle ensuring that any investment or policy action does not cause significant harm to the environment or other sustainability goals. |
| **Extraction** | A process used to separate valuable components from biomass or other materials, commonly used in the production of bio-based chemicals and oils. |
| **Feedstock** | Raw material supplied to a machine or processing plant, in this context, biological material used for producing bioenergy or bio-based products. |
| **Fermentation** | A biochemical process in which microorganisms like bacteria, yeast, or fungi convert organic substances (such as sugars) into biofuels, bioplastics, or other valuable products. |
| **Innovation** | The process of translating ideas into goods or services that create value or for which customers will pay. |
| **LCA (Life Cycle Assessment)** | A technique used to assess the environmental impacts associated with all the stages of a product's life, from raw material extraction through processing, manufacture, distribution, use, and disposal. |
| **Market Maturity** | The stage of a market where it has reached a point of full development, typically involving widespread product adoption and competition. |
| **Multi-stakeholder Approach** | A collaborative effort involving different groups such as government, business, civil society, and others to address complex challenges. |
| **Nutrient Recycling** | The process of recovering nutrients from various sources (e.g., waste) and reusing them, particularly in agriculture, to enhance soil health and reduce dependence on synthetic fertilizers. |
| **One-Stop Shop** | A single platform or resource that offers comprehensive information and services to stakeholders, typically used to simplify processes and provide easy access to resources, data, or assistance. |
| **PHA (Polyhydroxyalkanoates)** | A family of biodegradable polyesters produced by microbial fermentation of sugars or lipids. PHA is used in the production of bioplastics and can degrade in natural environments, including soil and water. |
| **PLA (Polylactic Acid)** | A biodegradable thermoplastic made from renewable resources like corn starch or sugarcane. PLA is commonly used in packaging materials, disposable cutlery, and biodegradable medical devices. |
| **Policy Framework** | A structured set of guidelines or principles used by governments or organizations to make decisions and to ensure coordinated actions. |
| **Pyrolysis** | A thermochemical process that breaks down organic materials by heating them in the absence of oxygen. Pyrolysis produces bio-oil, biochar, and syngas, which can be used for energy or as raw materials for other bio-based products. |
| **Regional Hubs** | Centers or focal points within specific geographic areas that coordinate activities, share information, and act as collaborative networks for regional bioeconomic development. |
| **Resource Management** | The efficient and effective development and use of resources such as land, water, and biodiversity in a way that balances ecological, economic, and social factors. |
| **Rural Areas** | Geographic areas located outside towns and cities, typically characterized by low population density and large areas of agricultural or natural landscapes. |

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| **Stakeholders** | Individuals or groups that have an interest in any decision or activity of an organization, particularly those who are affected by the outcome. |
| **Sustainable Development** | Economic development that is conducted without depletion of natural resources. |
| **TRT (Technology Readiness Level)** | A system used to assess the maturity level of a particular technology. Ranges from 1 (basic principles observed) to 9 (system ready for full-scale deployment). |
| **Value Chain** | The full range of activities that businesses go through to bring a product or service from its conception to its end use and beyond. |

# Index of Contents

# Index of Tables

# Index of Figures

# 1 EXECUTIVE SUMMARY

The RuralBioUp project aimed to enhance bio-based economies in rural regions by identifying and harmonizing biomass resources, technologies, and business models for bio-based products (BBPs). The project offer a comprehensive tool, named RuralSpot, which support the key actors of rural areas by providing relevant information and exploitation of new value chains.

Within this context, Deliverable D2.2. “Report on Biobased Feedstock Availability” focuses on the availability and sustainable use of biomass feedstock in European rural regions involved in the project. It presents methodologies and tools developed within the RuralBioUp project to assess and harmonize biomass availability across regional hubs. Working as a complementary tool for the RuralSpot, the report introduces the Biomass Model Tool (BMT), a critical resource designed to facilitate data collection, integration, harmonization and analysis of biomass feedstock data The tool enables regional stakeholders to monitor biomass availability, match it with industrial processes, and assess market opportunities, supporting the growth of bio-based economies.

Through the harmonization of biomass data, the RuralBioUp project aims to foster collaboration between regional hubs, promote best practices, and enhance cross-regional innovation. The BMT also serves as a "living document," continuously evolving to reflect technological advancements and changing biomass resources, ensuring the project's long-term value thereafter the end of the project, for regional bioeconomy stakeholders. Additionally, the report highlights the importance of aligning bio-based product chains with sustainability goals, minimizing environmental impact, and promoting circular bioeconomy practices. Key insights are drawn from several EU projects, newly information related to soil, innovative technologies and business models have been presented.

In summary, the implementation of RuralSpot tool with key tool and up to date resources can provide valuable insights into structuring a production supply chain within the bioeconomy sector.

# 2 INTRODUCTION

## 2.1 PURPOSE AND STRUCTURE

The purpose of Deliverable D2.2 is to describe the integration of biomass availability data, business models, technologies for biobased products (BBPs) and relevant soil information into the RuralSpot Tool. This effort builds on the information data and methodologies established in Deliverable D2.2, where a Biomass Model Tool (BMT) was developed to assess and harmonize the availability of biomass and identify industrial processes relevant to biobased production.

Deliverable 2.2 "Report on the Biobased feedstock availability" includes the explanation of BMT (as calculation matrix), with its associated instructions for compilation, and:

- Assessment of the regional biomass availability (ST.2.2.1)

- Assessment of the soil, market, business model, technologies and best practices, (ST2.2.2)

All information is organized into an integrated dataset (ST 2.2.3) collected through a harmonized matrix that complies with the requirements of the RuralSpot tool. The aim is to develop a practical tool that can be utilized by stakeholders from various Regional Hubs in the participating territories, as well as for industrial processes and demand.

The BMT for BBPs has been also developed as an Excel workbook file with a Cover Page, Maps Tool, Biomass Calculation Sheet for each regional Hubs involved and Industrial Processes Identification Sheet. The model tool was developed to help partners utilize diverse data and results by linking information across biomass feedstock, potential new value chains, industrial processes, and related insights. It is designed to be a "*Living Document*", allowing updates throughout the duration of the RuralBioUp project as new technologies, existing and emerging value chains, and additional information on biomass resources become available, both during the project and beyond its completion.

## 2.2 OBJECTIVE AND SCOPE

Deliverable D2.2 "Report on the Biobased feedstock availability" offers a template and guidelines to support data collection for comprehensive mapping and characterization of both:

• biomass resources available in the participating regions (Regional Hubs) or territories;

• resources related to soil, technologies, business models and market application that can be implemented either within those regions or in areas compatible with the development of sustainable supply chains.

The BMT included in this deliverable integrates these functionalities into a user-friendly system designed to support regional hubs in identifying and developing sustainable value chains for biobased products.

The deliverable and calculation matrix elaborated represent a set of tools able to provide to facilitators and all regional stakeholders to assist in the identification of innovative bio-based value chains, highlighting the available and suitable technologies and business models for their exploitation within a circular bioeconomy framework aimed at minimizing environmental impact, avoiding competition with other sectors of interest and zero waste.

# 3 METHODOLOGY

## 3.1 DATA AND BIOMASS COLLECTION FOR NEW BIO-BASED PRODUCT CHAINS IN REGIONAL HUBS

The availability and collection of biomasses play a crucial role in developing sustainable bio-based product (BBPs) chains within regional bioeconomy strategies, especially from rural, agro-forestry, agro-industrial, and zootechnical sectors. In the context of the RuralBioUp project, which aims to strengthen regional bioeconomy hubs across Europe, the harmonization of data related to biomass availability is essential for optimizing supply chains and resource allocation. This is particularly important in implementing a smart strategy that can sustainably exploit biomass feedstock.

The RuralBioUp approach described in this chapter outlines the methodology for collecting and harmonizing biomass data in line with the goals defined in the RuralBioUp project. It includes insights drawn from several EU projects such as Enabling[1], Power4bio[2], BioEastUp[3], Be Rural[4], and others like Branches[5], Bioreg[6], ICT Biochain[7], open Bio[8], StarPro-Bio [9]and the LIFT project[10]. Further integrations have also been made with Statistical Regional Datasets by using the BMT and applied for RuralBioUp-Regional Hubs.

Above mentioned EU projects provided valuable insights and approaches into biomass availability, quality, and supply chain optimization. The integrated approaches have then been summarized within the Biomass Model Tool, which represents an available tool to regional hubs able to harmonize different biomass feedstock into the potential biobased products through technology and processes currently available on the market. Further details concerning *BMT* and how works, will be described in the coming sections.

The BMT was inspired by the approach of the ENABLING project and has been integrated and revised to harmonize biomass data from various regional areas. The model was adapted based on available data provided by partners and customized for different regional hubs. The implementation and application of the biomass model aimed to identify and support the development of sustainable regional bio-based value chains and, facilitating connections between biomass producers and bioeconomy stakeholders in each regional hub. By harmonizing data through the biomass model, there is an opportunity to validate and replicate the approach across EU regions. This project's approach to bridging the gap between supply and demand in the bioeconomy sector provides insights into how RuralBioUp can enhance collaboration among stakeholders to streamline biomass utilization across regions.

1 https://www.enabling-project.com/
2 https://power4bio.eu/
3 https://bioeast.eu/
4 https://be-rural.eu/
5 https://www.branchesproject.eu/
6 https://eubionet.eu/bioreg-project/
7 https://eubionet.eu/ict-biochain-project/
8 https://www.biobasedeconomy.eu/projects/open-bio/
9 http://www.star-probio.eu/
10 https://www.lift-h2020.eu/

Furthermore, *Bioreg and Branches projects* emphasized the importance of ensuring a reliable and high-quality biomass supply by mapping regional availability and identifying best practices for the sustainable use of biomass feedstocks. This aligns with the goals of RuralBioUp, which relies on an accurate understanding of local biomass availability to optimize resource allocation. Although the RuralBioUp project does not map biomass distributions for the selected regional hubs, a harmonized data model has been provided. This model is designed to be integrated with GIS software to visualize the distribution of available biomass for regional biobased value chains

In addition, *ICT Biochain* contributed further to this narrative by showing the potential integration of digital tools and technologies into the biomass supply chain. This project is important with aim to demonstrate how smart technologies, such as sensors, data analytics, and ICT (Information and Communication Technologies), can enhance transparency and traceability in the biomass supply chain, despite it is not possible to integrate those methodologies in the selected regional areas so far.

For RuralBioUp, this digital integration could provide real-time data collection to be integrated into the harmonized model implemented, enabling better decision-making at both regional and hub levels.

Similarly, the *Open-Bio project* focused on the use of standards and certifications to facilitate the market uptake of bio-based products, ensuring that biomass is used sustainably and efficiently. Certification schemes will be useful to the stakeholders of the regional hubs, once the biomass availability and novel BBP chains will be highlighted and included in the respective regional action plans.

Integrating these insights into RuralBioUp could help standardize the chains based on biomass availability and quality, supporting the project's broader aim of creating sustainable regional bioeconomy hubs.

Also, *STAR-ProBio project* that focus on the sustainability assessment of BBPs is useful to assess the sustainability of the potential chains selected by the stakeholders of regional hubs. It includes evaluating environmental, economic, and social impacts of the biobased chains, and it can offer another layer of understanding to the RuralBioUp methodology. RuralBioUp project includes a key sustainable KPI based on the competitive uses of the biomass already used in existing markets. By incorporating this sustainability assessment into the evaluation of biomass availability and quality, RuralBioUp project can ensure that the supply chains it develops are both resilient and environmentally and economic sustainable.

The harmonization of biomass data has focused on rural crops, residues, and biomass sources from agro-forestry, agro-industrial, and zootechnical sectors of different regional areas by using the same model. The model aims to provide a preliminary evaluation of the potential volume of the biomass feedstock available for the biobased sector for a regional area, and in relation to the above-mentioned field like cultivated crops, potential biomass residues and by-products available, as well as traditional uses of the considered biomass for other competitive sectors like food, feed and bioenergy by excluding biobased sector. These KPIs let to avoid distortion of the market and to highlight, as much possible, the real amount of the biomass feedstock available to biobased purposes and implementation of the regional action plans that could be generated to support a successful circular regional bioeconomy in the coming years.

This approach potentially replicable to other EU regions, can be able to ensure that each regional hub is equipped with accurate data able to support sustainable and innovative bio-based product chains across

the EU. Finally, the optimized collection and utilization of biomass across these sectors is vital for ensuring the sustainability and efficiency of bio-based product supply chains, which are key to building a resilient bioeconomy in Europe.

# 4 BIOMASS MODEL TOOL

This Biomass Model (BMT) is a tool designed for partners involved in Task T2.2 and respective subtasks T2.2.1 on the assessment of regional biomass availability and T.2.2.2, on technology, business model and best practices. The aim is to facilitate data collection on biomass resource availability and industrial processes in the participating regions with respective stakeholders.

The **BMT** is an Excel workbook including several KPIs components and information organized within several sheets:

- *Cover Page* (Fig.1),

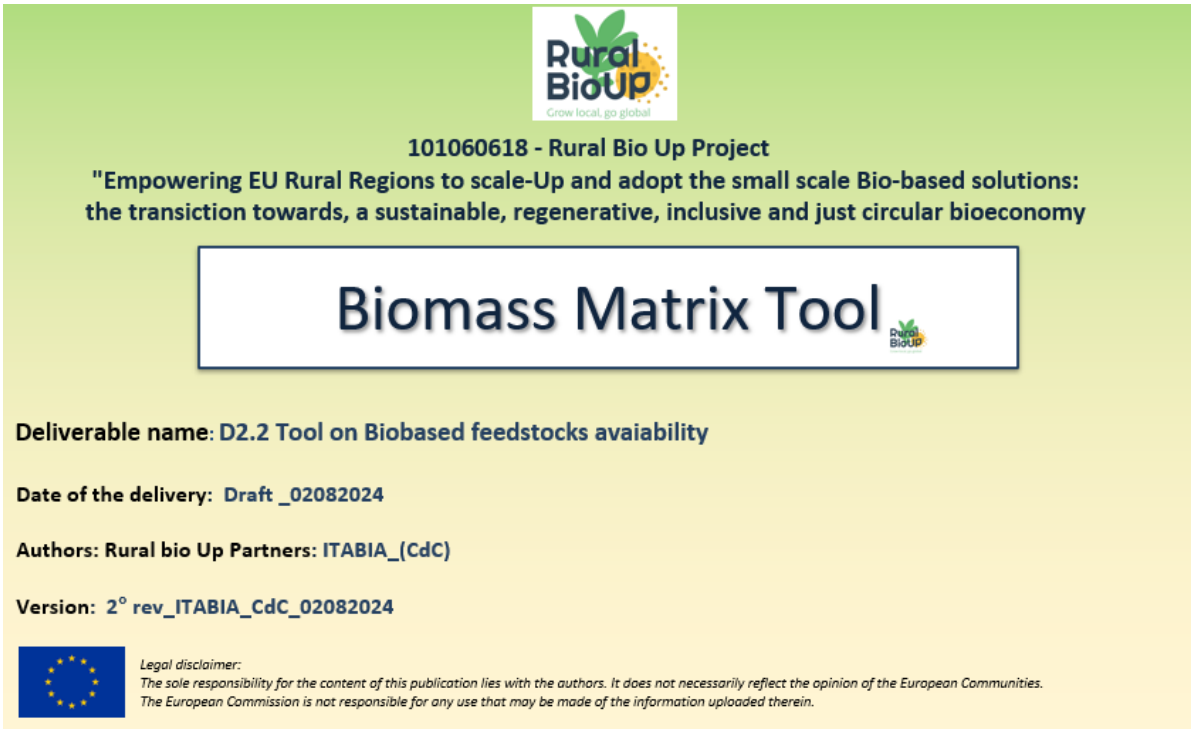


**Figure 1. Cover Page of the BMT, (Itabia, Rural BioUp Project 2024)**

- *Maps Tool* (Fig.2) is a conceptual map created to illustrate the complete connection between various types of biomass (from sectors such as rural, forestry, agro-industrial, and livestock), the technologies compatible with biomass processing and treatment, and the extraction and transformation into potential biobased products, ultimately showcasing the related biobased market sectors.

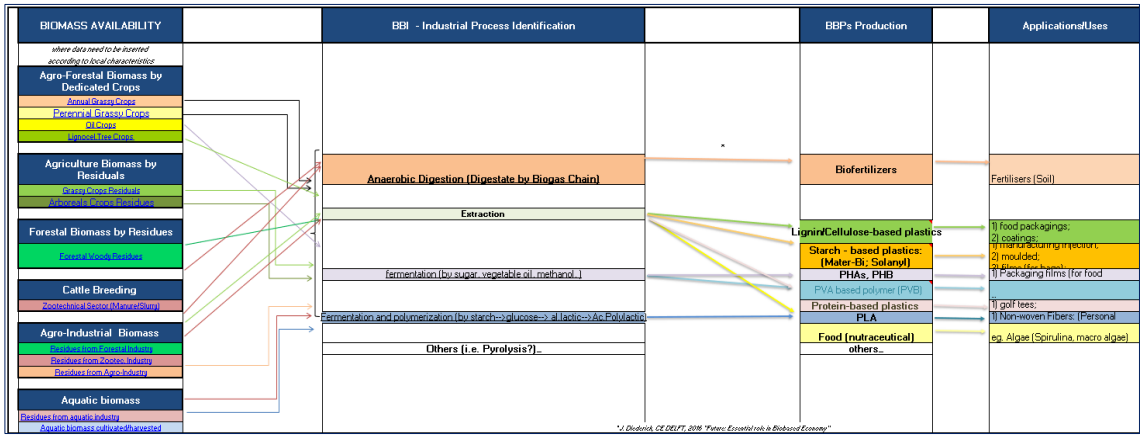


**Figure 2. – Maps tool and cross-link among Biomass feedstock, Technologies and processes, Biobased production and Market applications, (Itabia, RuralBioUp 2024)**

- *Biomass Calculation Sheet* (Fig.3), is an Excel spreadsheet that identifies various categories of biomass (classified as crops, residues, and underutilized co-products from agro-industrial processes) and links them to their respective technical parameters (e.g., hectares cultivated or designated for specific crops, conversion rates of agro-forestry, livestock, and agro-industrial residues, moisture content, percentages of chemical building blocks, and extractable compound percentages). It calculates the potential biomass available for the production of bio-based products, as well as biomass used for other traditional purposes.

This spreadsheet automatically calculates the biomass potential for the bio-based market on a regional scale, with the ability to connect and elaborate new BBPs-Biomass maps. Furthermore, the results derived by spreadsheet can be integrated with Corin land Cover databases through Geographic Information Systems GIS Software (i.e. QGis and ArchGis software) for a final mapping of the biobased products at the regional scale.

Thus, further mapped results for both residual biomass and potential bio-based products might be set up, and this enables the identification of the most promising regional biomass pools. Finally, the calculation matrix can be linked to the respective bio-based market sectors in order to better identify the most promising sector in relation to the regional stakeholders' interests.

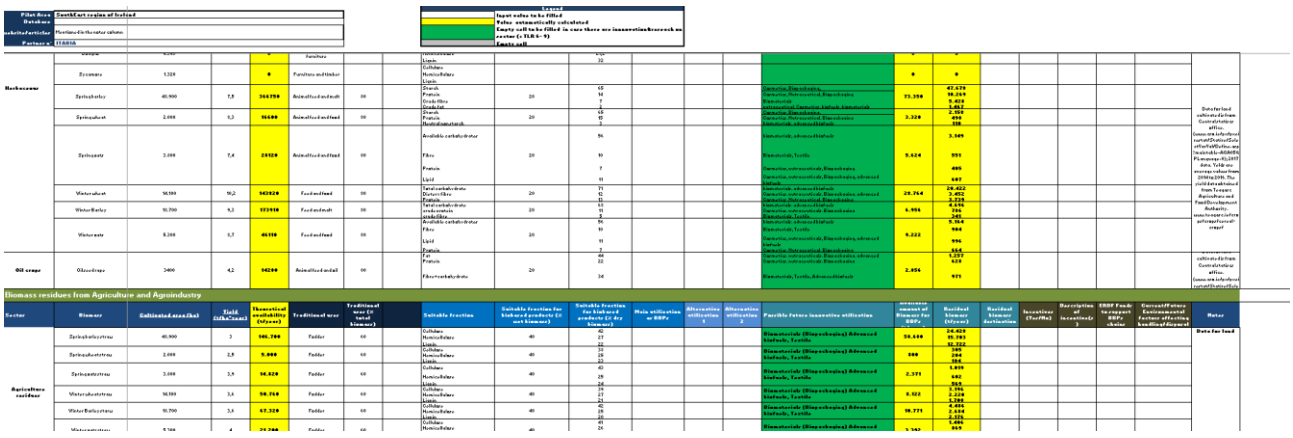

**Figure 3. - Biomass Calculation Sheet and cross-linking among KPIs for calculations from Biomass feedstock to BBPs production), (Itabia, RuralBioUp 2024).**

- *Industrial Processes Sheet* (Fig.4): This section of the model provides a comprehensive list of best practices currently implemented at the regional or national level. It serves as a direct source of information for gathering insights on industrial or research processes used for the exploitation of specific biomass types, from initial stages to the commercial production or prototype development of market-relevant bio-based products.

The list of existing bio-based pathways is also a valuable tool for industrial stakeholders, enabling them to identify which business models have been established, which could be strengthened or expanded, and which novel value chains could be explored from scratch.

Furthermore, sharing this list across various regional hubs fosters enhanced knowledge exchange among industrial and non-industrial actors alike. The aim is to strengthen know-how sharing and promote real collaboration between regional hubs, while also highlighting the strengths and weaknesses of innovative pathways that have already been explored by other hubs.

BMT – BMT represents a dynamic tool, it allows RuralBioUp Partners and stakeholders to update information throughout the RuralBioUp Project as new biomass resources emerges, linking them with processes,technologies, novel BBPs and best practices chains .

| Pilot Area | Example from Pilsen region, Moravian-Silesian region (Czech Republic) |
|---|---|
| Database | |
| website/articles | |
| Partner n° | |

| Legend | |
|---|---|
| | Input value to be filled |
| | Value automatically calculated |
| | Empty cell |

| Technology | Status | Constituent Used | Minimum Requirement | Products | Process | Mass Yield (%) | Plant Location | Country | Link | Comments |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| | | | | | | | | | | |
| Extraction of protein | Commercial | potato tuber juice | | feed protein | ph modifying, extraction, separation | 60 | Horazdovice (Pilsen region) | CZ | http://www.lyckeby.cz/o-firmo/ | |
| Fermentation of sludge and stable waste | Commercial | Stable waste, sludge, wood waste | | fertilizer | fermentation | | Opava (Moravian-Silesian region) | CZ | http://www.ekolum.cz | |
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**Figure 4. – List of biobased chains and existing best practices and interesting for regional hubs, (Itabia, RuralBioUp 2024).**

One of the core challenges addressed by the BMT is the harmonization of biomass feedstock data from diverse sources, including the rural, agro-forestry, agro-industrial, and livestock sectors. Given the wide range of data sources—ranging from national and regional agricultural databases to remote sensing technologies like GIS and satellite data—ensuring consistency and comparability is a key focus of this deliverable. Harmonizing this data is critical for providing stakeholders with a coherent view of biomass availability, processing technologies, and market potential for Bio-Based Products (BBPs).

Detailed instructions for using the tool, can be found in Annex 1 of this deliverable.

## 4.1 COLLECTION METHODS OF DATA SOURCES

Biomass data were collected from various sources to ensure a comprehensive understanding of biomass availability in the regional hubs. The data collected and utilized primarily came from regional and national statistical sources, with much of it being directly updated by each partner serving as a facilitator within their respective regional hub.

The primary data sources harmonized for this project include regional and national data. These consist of the latest national and regional agricultural databases, research documents, EU statistical reports (e.g., Eurostat), and data from previous initiatives (e.g., Enabling Project). Additionally, remote sensing data from geographic information systems (GIS) and satellite imagery, used for mapping land use, agricultural

production, and forest biomass, will be updated next year. However, harmonization of this data type has not yet been addressed. Further updates will be provided in the coming year

## 4.2 DATA HARMONIZATION AND REGIONAL INTEGRATION

Harmonizing the data is crucial for ensuring consistency across the regional hubs. To achieve this, the following measures have been implemented by considering specific KPIs as: standardization of units, temporal analysis, and possible spatial resolution.

*Standardization of units*: Biomass availability data is harmonized using common metrics, such as dry matter per hectare, moisture content, energy content in gigajoules (GJ) per ton, and the percentage of specific fractions, including hemicellulose, lignin, and cellulose, for further utilization in relevant Chemical Building Blocks (CBBs). Additional metrics include the area (in hectares) dedicated to the cultivation of specific crops, the number of animals, and the corresponding quantity of manure produced by livestock. Various biomass conversion indices have been integrated, using data sourced from EU projects (e.g., Enabling). Further updates to these conversion indices, incorporating more detailed scientific data and actual data received from stakeholders in each regional hub, will be provided in the coming months.

*Temporal analysis*: Biomass availability data can be continuously monitored and updated over multiple harvest cycles to account for seasonal fluctuations and to observe long-term trends. Using regional and national statistical data, biomass availability is reported over the course of a year, ensuring consistency in data collection and allowing for a more organized data management process. The most recent data are utilized to provide the most up-to-date analysis. As newer data become available, both partners and regional stakeholders will be able to update the provided model to keep the analysis of bio-based products as current and realistic as possible.

*Spatial resolution*: Regional specificity is essential for accurately assessing biomass availability. In relation to available EU data (e.g., Corine Land Cover), GIS tools could be employed to generate detailed maps illustrating biomass availability and distribution by highlighting regional variations and identifying potential biomass hotspots. This action could be included in the final year, once the potential biomass types of interest for the development of promising bio-based value chains have been identified.

The methodology based on mentioned KPIs of the BMT will support a consistent and regionally integrated approach to biomass data collection and analysis, facilitating a clear understanding of biomass resources and their potential utilization across European regions. Further updates on data harmonization efforts, particularly regarding remote sensing technologies, will be provided in the coming year, if any.

## 4.3 TYPES OF BIOMASS CONSIDERED

The diversity of biomass types across European regions is extensive, and their heterogeneity often complicates the identification of both the type and sector of origin. Additionally, linking these biomass types to the appropriate industrial processes and technologies for conversion into sustainable biobased products presents further challenges.

To ensure accurate data harmonization, biomass types have been categorized into two main groups: residual biomass and dedicated biomass. Residual biomass includes waste materials from agro-industrial

processes, agricultural and forestry residues, and livestock sector waste. Dedicated biomass refers to biomass derived from purpose-grown crops within both the forestry and agricultural sectors.

For each major sector—forestry, agriculture, agro-industry, and livestock farming—the relevant biomass types have been identified in relation to their sector of origin. While classification and biomass types naturally vary by region, the analysis framework applied allows for harmonization of data and supports replication across other European regions.

The primary biomass classifications considered are as follows:

- **Agricultural crops**: This category encompasses primary agricultural production, focusing on crops suitable for biobased products, such as wheat, maize, rapeseed, and dedicated energy crops (e.g., miscanthus, switchgrass).
- **Agricultural residues**: Residues from cereal production (e.g., straw, husks) and other underutilized by-products from the agricultural sector with potential for conversion into biobased products.
- **Agro-industrial residues**: By-products from the agro-industrial sector, including residues from food processing industries (e.g., fruit pulp, seeds, oil residues).
- **Agro-forestry biomass**: Residues from forestry activities, such as thinning wood, bark, and other by-products from sustainable forestry management. This type of biomass is particularly relevant for regions with significant forest areas.
- **Zootechnical biomass**: Biomass derived from livestock farming activities, especially manure and other by-products from animal husbandry (e.g., poultry litter, pig slurry), which can be converted into bio-based fertilizers or biogas.

This classification offers a clear framework for understanding the different types of biomass across European regions, enabling data harmonization and facilitating replicability across sectors and regions.

## 4.4 BEST PRACTICES OF INDUSTRIAL PROCESSES, AND TECHNOLOGIES TO CONVERT BIOMASS IN NOVEL BBPS

Within the context of the RuralBioUp project, this combination of technologies and industrial processes has provided greater insights into the untapped potential of regional biomass resources. This approach highlights their capability to contribute to the sustainable development of a circular bioeconomy with added value. The selected industrial processes and technologies, chosen for their TRL 9 (Technology Readiness Level) status, ensure real-world applicability and enable the concrete implementation of the bioeconomy action plans within the respective regional hubs. The integration of technologies such as anaerobic digestion, extraction, fermentation, and pyrolysis allows for the efficient conversion of diverse types of biomass into valuable bio-based products. These technologies support the goals of sustainable development by reducing dependence on fossil resources and offering innovative materials for industries such as agriculture, packaging, and consumer goods. By utilizing residual biomass from agricultural, forestry, and aquatic sources, there are vast opportunities to advance the bioeconomy.

The BMT provides data on the potential amount of biomass suitable to be converted into Biobased products by including the system of technologies for transforming residual biomass from different sources into bio-

based products through several industrial processes. Table 1 shows key processes and technologies included in the BMT and based on their role in converting various types of biomass into usable materials (Tab.1).

| Technologies and BBPs | Technologies – Industrial processes | Market Applications of Bio-based Products |
|---|---|---|
| **Anaerobic Digestion for Biofertilizers** | Anaerobic digestion is a biological process where microorganisms break down organic material in the absence of oxygen. In the context of residual biomass, it is used primarily for converting **agricultural residues, agro-forestry by-products, and livestock manure** into **biogas** and **digestate**. The digestate, a nutrient-rich by-product, can be further processed into **biofertilizers**, which are used to improve soil fertility. These biofertilizers return organic matter and nutrients to the soil, fostering sustainable agricultural practices.<br><br>Anaerobic digestion is an effective way to utilize low-value biomass streams such as:<br>• **Cattle breeding residues** (manure),<br>• **Agro-industrial biomass** (e.g., residues from food processing industries),<br>• **Aquatic biomass** (such as algae). | **Agriculture**:<br><br>**Biofertilizers** derived from anaerobic digestion improve soil health and crop yields. |
| **Extraction Processes for Valuable Compounds (Bioplastics, biomaterials, Mater-Bi, PLA, Protein-based plastics)** | Extraction technologies are vital for isolating specific bioactive compounds or materials from biomass. Different biomass sources contain valuable molecules that can be isolated and used in a range of industries. For example:<br>• **Lignin and cellulose** can be extracted from **forestry residues** or **agro-forestry residues**. These materials serve as raw materials for creating **lignin/cellulose-based bioplastics**. Lignin, in particular, is gaining traction as a substitute for petroleum-derived compounds in the production of polymers.<br>• **Starches** can be extracted from **agricultural residues** like corn or potatoes. These starches are used to produce **starch-based bioplastics** such as **Mater-Bi** and **PLA** (Polylactic Acid), which are widely used in food packaging, molded products, and other applications.<br>• **Proteins** extracted from specific biomasses are increasingly being used in the development of **protein-based plastics** and food-related products. | **Packaging Industry**:<br><br>**Bioplastics** like **PLA**, **PHA**, and **PVB** are used for food packaging, disposable tableware, and films, providing alternatives to petroleum-based plastics.<br><br>**Textile and Consumer Goods**:<br><br>Bio-based polymers and fibers are increasingly being used in the textile sector, especially for **non-woven fibers** and **personal care products**.<br><br>**Food and Nutraceuticals**: Proteins and other compounds extracted from biomass, particularly from algae, are applied in nutraceuticals and dietary supplements, promoting health benefits through bio-based sources |

| | | |
|---|---|---|
| **Fermentation for Chemical Building Blocks**<br><br>**(PLA, Lactic Acid, PHA, PVB, PHB)** | Fermentation processes play a critical role in converting biomass into valuable chemical intermediates or building blocks, particularly those that can serve as feedstock for bioplastics and biochemicals. The types of fermentation processes include:<br>• **Sugar fermentation**, where sugars derived from crops such as corn or sugarcane are fermented into **ethanol**, a biofuel, or into other chemicals such as **lactic acid**, which can be polymerized to form **PLA (Polylactic Acid)**. This type of plastic is biodegradable and widely used in food packaging, textiles, and disposable items.<br>• **Vegetable oil fermentation**, where oils from crops like soy or palm can be transformed into **PHA (Polyhydroxyalkanoates)**, another class of biodegradable plastics. These materials are particularly useful in packaging and agricultural films.<br>Through fermentation, **biobased polymers** such as **PVB (Polyvinyl Butyral)** and **PHB (Polyhydroxybutyrate)** can also be produced. These polymers are sought after for creating high-performance bioplastics with a lower environmental footprint. | **Packaging Industry**:<br><br>**Bioplastics** like **PLA**, **PHA**, and **PVB** are used for food packaging, disposable tableware, and films, providing alternatives to petroleum-based plastics.<br><br>**Food and Nutraceuticals**: Proteins and other compounds extracted from biomass, particularly from algae, are applied in nutraceuticals and dietary supplements, promoting health benefits through bio-based sources |
| **Pyrolysis and Other Advanced Technologies**<br><br>**(poly-oil, soil conditioner)** | Pyrolysis is a thermochemical process where organic material is decomposed at high temperatures in the absence of oxygen, converting biomass into **bio-oil**, **biochar**, and **syngas**. Pyrolysis has shown potential for converting **woody biomass** and **agro-industrial residues** into energy-dense products that can either be used as fuels or further processed into chemical precursors.<br><br>In addition to traditional applications, modern pyrolysis processes are being explored for the production of **bio-based chemicals** and **carbon materials** for electronics and advanced composites. | **Agriculture**:<br><br>**Biofertilizers** derived from anaerobic digestion improve soil health and crop yields. |
| …. | …. | …. |

**Table 1. - Cross link among Technologies, Industrial Processes, and Market Applications for Bio-Based Products and biomass feedstock by BMT of RuralBioUp Project (data elaborated, 2024).**

# 5 BIOMASS MODEL TOOL INTEGRATION IN THE DATASET

The harmonized data and BBPs' chains assessment through the BMT played a pivotal role in aligning the various tasks and subtasks of the RuralBioUp project, acting as a comprehensive resource that integrates data from different domains, including biomass feedstock availability, market business models, technologies, and best practices.

The tool's dynamic, "*living document*" (also linked with T2.3 and T2.4) nature ensures it will continuously evolve to reflect the latest regional data, technological advances, and bio-based market opportunities.

Below is a detailed explanation of how the BMT was able to integrate with other crucial subtasks within the project. The BMT represented a key outcome of Task 2.2, which focused on the mapping, analysis, and harmonisation of regional biomass data. The BMT ensured that the data gathered were structured coherently into a usable form for stakeholder's decision-making process.

More in-depth, the assessment of regional biomass feedstock availability is directly provided into the BMT, making it a vital resource for providing up-to-date information on biomass availability in different rural regions involved in the project. The BMT integrated data from regional actors, existing partner networks, and macro-data sources, ensuring that partners and stakeholders can access comprehensive feedstock data. This integration of harmonized data by BMT helped identify new biomass pathways and regional potential for bio-based feedstocks, which is essential for market competitiveness.

The BMT also serves as the repository where this data is upgraded, analysed and mapped from time to time. The information is categorised based on its potential application in the selected Regional Hubs. The integration of Technology Readiness Levels (TRL) included within industrial processes, and technologies within BMT ensures that stakeholders can evaluate technologies in relation to the local requirements and conditions.

This creates an invaluable link between technology maturity and practical applications, empowering regional hubs to explore new business models and identify gaps that need to be addressed in the other subtasks (i.e. ST2.2.2. Assessing the value chains).

At last, harmonisation of the data will be foreseen in ST2.2.3. is crucial for the BMT's operational effectiveness. This subtask ensures that data collected from regional hubs, other EU projects, and scientific sources is structured into a matrix that can be easily linked with the BMT in relation to regional needs. This harmonised dataset helped to match feedstock availability with technologies and market opportunities, thereby facilitating the development of new bio-based value chains.

Furthermore, BMT is also able to highlight weak points of the potential novel chain. For example, BMT can point out:

- the missing data for some biomass feedstock at macro level,

- regional innovation capabilities, for example in case the region has got the biomass feedstock, but no novel chain is still implemented.

Additionally, the use of the standardized BMT Model in combination with the RuralSpot provided by RuralBioUp fosters collaboration between regions by identifying best practices and solutions that can be applied in areas with similar characteristics.

## 5.1 "LIVING DOCUMENT" CONCEPT.

The Biomass Model Tool aims to harmonize several biomass data from several EU projects. The first collection and harmonization of data carried out so far is shown below (Fig.5). BMT will be opened to incorporate further insights from European sources, such as projects within other Best Practices & Technologies, (like from Tech4BioWaste, ABC Economy), as well as Market Business Models (e.g., BioSwitch, CELEBIO, and SmartChain), and Nutrient Recycling and Soil Health (e.g., BioRego, Nutr2Cycle, and Soil Care).

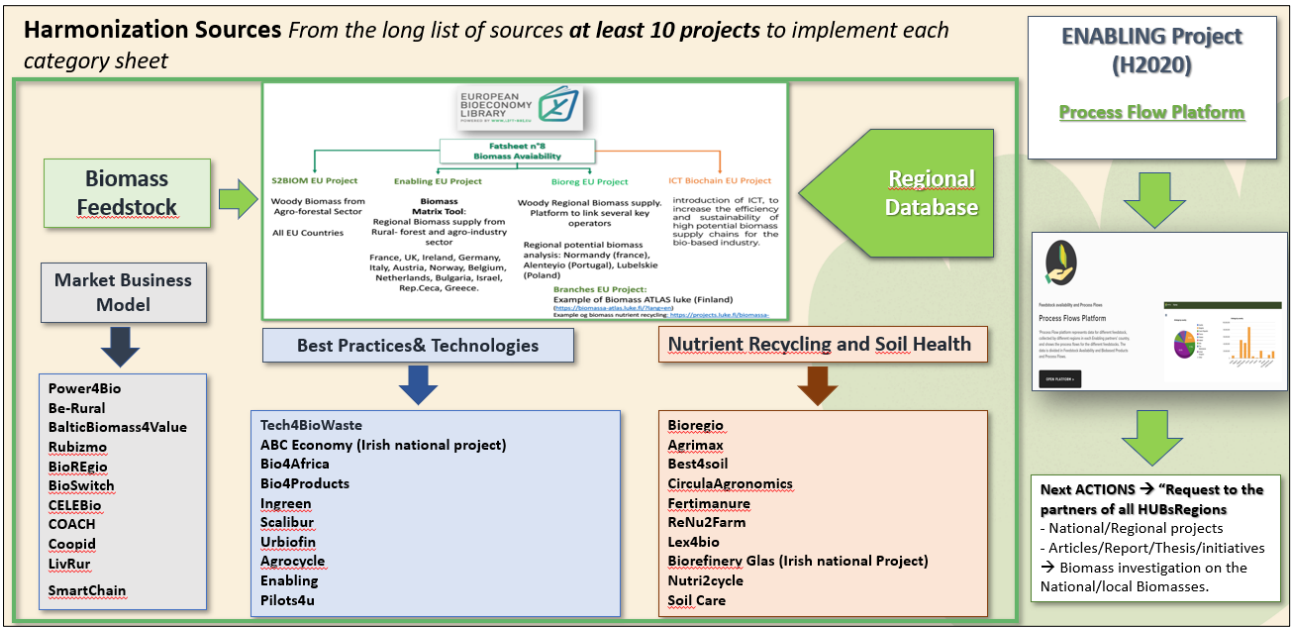


**Figure 5. - Harmonization of Biomass Resources and Technologies used in BMT: Data Integration and Project Collaboration for Regional Bioeconomy Development, (Itabia, 2024)**

Moreover, the RuralSpot flexibility, including the BMT, allows for continuous input and updates from stakeholders, creating a collaborative ecosystem. The integration of various categories such as biomass feedstocks, best practices opens up the possibility for stakeholders to contribute new data and adjust business models. This collaborative platform, which aim to

incorporate further projects (like for example *Fertimanure, RefinaFarm, and FlexBio*, and others based on regional interests) will reflect the evolving market conditions in the bio-based industry. By leveraging input and approaches given from EU initiatives (like for example *Power4Bio, CircularEconomics, and AgriMax*), the tool will ensure that the RuralBioUp project delivers long-term value to regional stakeholders.

In conclusion, the ongoing updates and living document approach of the BMT will play a critical role in aligning biomass resources, technological advancements, and market opportunities.

The ongoing evolution of the BMT, driven by input from EU projects, will help hubs stay competitive and agile in the rapidly growing bio-based industry (WP3 and WP4). By treating the BMT as a living document, the partners will be able to foster collaboration and enhance knowledge exchange across regional hubs. As each hub uploads and harmonizes its own biomass feedstock and industrial data, other hubs can benefit from this shared information, identifying potential synergies, gaps, and new value chains to explore. This iterative process, supported by the growing regional database, not only strengthens regional capacities but also promotes cross-regional innovation, ensuring that the project as a whole contributes to the advancement of sustainable economies across EU.

# 6 ASSESSING THE VALUE CHAIN

For assessing the value chain (ST.2.2.2) , information on business models and technologies were mapped. The data was collected using a template created in Task 2.1. The data on technologies and business models was collected from various reliable sources to update the template, combining scientific research, industry insights, and EU-funded project websites. A significant portion of the business model examples, including those relevant to regional hubs like construction materials from hemp, forestry biomass for fuel and biobased chemicals from lignin, and whey from dairy water, was derived from critical projects such as *BalticBiomass4Value, Rubizmo*, and *BE-Rural*. The technologies section comprises regional hub value chains and biomass feedstock availability. Projects by *ABC Economy, Tech4Biowaste*, and *Bio4Africa* provided vital information about relevant technologies, including industrial fermentation and bioenergy solutions.

To update data for both technologies and business models is collectively sourced from various scientific journals and research platforms like ResearchGate, Google Scholar, and ScienceDirect and scientific journal websites like MDPI. It provides in-depth insights into the latest advancements in bio-based technologies and business models. Industry platforms like Bioenergy News and Agro-Chemistry update on biogas and biomass-generated energy business innovation data and EU-funded project websites and publications provide detailed outcomes from European projects.

Company websites like *Lenzing, Spawn Foam*, and Protein Plant, and bioeconomy clusters like *BioVale* provide real-world examples of technology applications and business models. Additionally, reports from bioeconomy initiatives such as *After Biochem, Agrichemwhey*, and *Bioeconomy for Change* provided concrete case studies. All the data was gathered from a wide range of reliable and trusted sources to ensure the credibility of the information, which is comprehensive and up to date.

There are currently 50 examples of Business Models and 50 examples of Technologies on the platform. RuralBioUp partners will update these with relevant examples from the regional hubs.

# 7 RURALSPOT DATA HARMONIZATION

The work involved in creating the model tool was initially outlined in Deliverable D2.1 "RuralBioUp Handbook for Data Mapping and Assessment." This document laid the foundation for the data collection process, which was subsequently carried out to develop a specific dataset, as documented in Deliverable D2.4 "RuralBioUp Dataset". Building upon these foundational deliverables and incorporating insights from the focus group results in Task 2.4, a newly enhanced version of the data matrix was developed. The purpose of this updated version was to include additional information necessary for the Regional HUB stakeholders, ensuring the model tool is comprehensive and tailored to meet their specific needs.

## 7.1 INTEGRATED MATRIX AND DATASET ANALYSIS.

The data harmonization process was essential to integrate data from various sources, ensuring consistency and comparability across different categories. This integration was particularly important because the original data collection matrix, derived from the one presented in D2.1, needed to be expanded with additional information to create a more comprehensive and robust dataset. The enhanced data collection matrix includes both common columns shared across different categories and specific columns tailored to particular areas. These shared columns facilitate a unified approach to data collection, encompassing categories such as biomass, technology, business models, and soil, while allowing for specific information pertinent to each category.

The Table 2, outlines the structure of the matrix, providing explanations of the types of columns it contains, distinguishing between those that are shared across categories and those that are specific to each category.

**Table 2. - Dataset matrix outline with description of columns per categories.**

| Column content shared | Description |
|---|---|
| Title | It indicates the resource name added |
| Featured Image | Link to a specific image to be used on the RuralSpot |
| File to download | Link to the document for the download |
| Summary/Description | It describes of the resource content |
| Source Partner | It indicates the RuralBioUp partner adding the resource |
| Source of Information | It describes from where the information have been acquired.<br>It can be chosen from a drop-down list:<br>• EU project<br>• National project<br>• Regional project<br>• Online material<br>• Publication<br>• Other |
| EU Project Name | Name of European project from where the resource have been obtained |

| | |
|---|---|
| Other Sources | Name of Other sources from where the resource have been obtained |
| Link to Information | It indicates the direct link to the resource |
| Contact Name | It indicates the external contact's name for the resource |
| Organisation/Institution | It indicates the affiliation of the contact's name |
| Contact Email | |
| Target Groups | It describes the type of stakeholder groups the resources are targeting. Select from a drop-down list:<br>• Policy and Administration Stakeholders<br>• R&I and Academia Stakeholders<br>• Civil society Stakeholders<br>• Business Stakeholders |
| Regional HUBs | It indicates the Regional HUB name to which the resources can be assigned |
| **Column content for Biomass category** | |
| Feedstock (general) | It indicates the kind of feedstock as macro-area.<br>It can be chosen from a drop-down list:<br>• Agro-forestry dedicated crops<br>• Agro-forestry residues<br>• Zootechnical/Animal agriculture<br>• Food residues |
| Feedstock (specific) | It indicates more specifically the type of biomass. |
| Plant | If the info is available, it indicates the precise plant. |
| Geographical coverage | It indicates the geographical coverage of the data/infos. It can be chosen from a drop-sown list:<br>• Local<br>• Regional<br>• National<br>• EU<br>• International |
| Kind of Information | It describes the format of the data/infos. It can be chosen from a drop-down list:<br>• Project Deliverable<br>• Publication<br>• Web platform/tool<br>• Website<br>• Presentation<br>• Other |
| Covered countries | It indicates the countries where the biomass can be found. |
| Covered regions | It indicates the regions where the biomass can be found. |
| **Column content for Technology category** | |
| Category | It indicates which kind of technology is implemented.<br>It can be chosen from a drop-down list:<br>• Biochemical<br>• Thermochemical<br>• Chemical |

| | |
|---|---|
| | • Thermal<br>• Mechanical |
| Sector | It indicated the macro-sector where the technology is applicate/applicable.<br>It can be chosen from a drop-down list:<br>• Animal agriculture<br>• Agriculture<br>• Plant agriculture<br>• Forestry<br>• Marine<br>• Food |
| Feedstock (general) | It indicates the kind of feedstock as macro-area.<br>It can be chosen from a drop-down list:<br>• Agro-forestry dedicated crops<br>• Agro-forestry residues<br>• Zootechnical/Animal agriculture<br>• Food residues |
| Feedstock (specific) | It indicates more specifically the type of biomass. |
| TRL | It indicated the technology readiness level of the technology.<br>It can be chosen from a drop-down list, where the considered TRLs are between 6 and 9. |
| Specific Product Title | It indicates the type of biobased product produced with that technology |
| Specific Product Description | It indicates the description of the product itself |
| Specific Product Image URL | It indicates the link to the product image |
| Pre-Treatment | It indicates if any pre-treatment is needed and, if so, which kind |
| Post-Treatment | It indicates if any post-treatment is needed and, if so, which kind |
| Benefits | It indicates the main benefits of the technology |
| Limitations | It indicates the main limitation of the technology |
| **Column content for Business Model category** | |
| Country | It allows to insert as free text the related Country |
| Product/Service | It indicates the general indication of the product/Service.<br>The added product/service so far are:<br>• Sustainable packaging<br>• Biobased material<br>• Biobased chemical<br>• Fuel from biogas<br>• Fuel from wood<br>• Alternative protein<br>• Soil remediation<br>• Food processing<br>• High added value biobased product<br>• Bioenergy production |
| Sector | It indicated the macro-sector where the technology is applicate/applicable.<br>It can be chosen from a drop-down list:<br>• Animal agriculture<br>• Agriculture<br>• Plant agriculture |

| | |
|---|---|
| | • Forestry<br>• Marine<br>• Food |
| Partners | It indicates the other stakeholders/partners involved in value chain |
| Activities | It describes the activities developed within the company |
| Resources | It indicates the resources need to implement the solution |
| Cost Structure | It describes the different kind of costs to be considered for implementing the solution |
| Revenue Streams | It describes the different kind of revenues |
| Value Proposition | It describes the value proposition for the identified business model/market application |
| Market | It describes the possible markets targeted by the solution |
| Channels | It describes the different distribution/marketing channels |

All the information used to populate the matrix and create the dataset was gathered from various sources, including European projects, online materials, publications, and national and regional projects. Throughout the last year of the project, partners expanded the list of sources to include up-to-date and newly developed information. As a result, 21 relevant European projects and 15 additional sources were added to the list, increasing the total number of sources to 401. This expansion ensures that the dataset reflects the valuable outcomes of ongoing European projects.

The Table 3 give a quantitative understanding on how European projects and other sources selected cover the categories of the matrix. A comparison between the first and the second year of the project has been provided, showcasing the increase/decrease in numbers.

**Table 3. - Number of European projects and other sources per RuralSpot Dataset categories.**

| Categories | Source_EU projects | | Sources_Other | |
|---|---|---|---|---|
| | Year 1 | Year 2 | Year 1 | Year 2 |
| Biomass | 38 | 40 | 17 | 22 |
| Business model & Market application | 145 | 150 | 88 | 101 |
| Technologies | 113 | 126 | 84 | 93 |
| Soil | 32 | 38 | 9 | 10 |

WP2 partners collaborated to populate newly and relevant examples of biomass, technologies, business models and soil information. The data was obtained from the long list of sources and was selected based on specific indicators presented in D2.4. The **Errore. L'origine riferimento non è stata trovata.** shows a quantitative overview of dataset for each category.

**Table 4. - Amount of information per category on the RuralSpot Dataset.**

| Categories | Year 1 | Year 2 |
|---|---|---|
| Biomass | 86 | 19 |
| Business model & Market application | 14 | 50 |
| Technologies | 13 | 50 |
| Soil | 12 | 16 |

In the course of the work carried out by ITABIA in ST2.2.1, the Biomass Model Tool (BMT), which was derived from the Enabling project[11], was developed and updated. During this phase, the need emerged to optimize the management of the input data by consolidating them under a single, homogeneous structure. This process made it possible to simplify the biomass model by reducing the overall amount of data showcased on the dataset previously presented in D2.4. It is important to emphasize that the reduction in the amount of data does not imply a decrease in the quantity or quality of the information provided. On the contrary, this process made it possible to further enhance the data collected from the HUB Facilitators, helping to develop a more effective tool, the Biomass Model Tool,which will be included on the RuralSpot online platform as a download file. This simplified and optimized tool is designed to offer concrete support to rural actors in each regional hub, facilitating access to information and promoting the sustainable use of available biomasses.

In the following section, a quantitative analysis of the data set for each category is provided.

**Table 5. - Number of technologies per feedstock utilized in the RuralSpot Dataset**.

| Feedstock (general) | N° Technology | % |
|---|---|---|
| Agro-forestry dedicated crops | 17 | 34% |
| Agro-forestry residues | 15 | 30% |
| Zootechnical/Animal agriculture | 10 | 20% |
| Food residues | 8 | 16% |
| **Total** | **50** | **100%** |

**Table 6. - Number of technologies per category in the RuralSpot Dataset.**

| Category | N° Technology | % |
|---|---|---|
| Biochemical | 35 | 70% |
| Chemical | 8 | 16% |
| Thermochemical | 4 | 8% |
| Thermal | 2 | 4% |
| Mechanical | 1 | 2% |
| **Total** | **50** | **100%** |

**Table 7. - Number of technologies per sector in the RuralSpot Dataset.**

| Sector | N° Technology | % |
|---|---|---|
| Plant agriculture | 17 | 34% |

[11] https://www.enabling-project.com/

| | | |
|---|---|---|
| Animal agriculture | 8 | 16% |
| Agriculture | 7 | 14% |
| Food | 7 | 14% |
| Marine | 6 | 12% |
| Forestry | 5 | 10% |
| **Total** | **50** | **100%** |

**Table 8. - Number of business models per sector in the RuralSpot Dataset.**

| Sector | N° Business Model | % |
|---|---|---|
| Agriculture | 14 | 28% |
| Plant agriculture | 12 | 24% |
| Food | 10 | 20% |
| Forestry | 6 | 12% |
| Animal agriculture | 5 | 10% |
| Marine | 3 | 6% |
| **Total** | **50** | **100%** |

## 7.2. IDENTIFIED FOCUS AREAS FOR TECHNOLOGICAL DATA DEVELOPMENT

Based on the analysis of feedstock usage, technology categories, sector distribution, and business model representation, several key areas have been identified for strategic focus within the project dataset.

### 7.2.1. FEEDSTOCK UTILIZATION AND SECTOR FOCUS

Significant attention is already given to agro-forestry dedicated crops and agro-forestry residues (64% combined), however there is potential to expand the focus to other feedstocks and sectors. In particular, zootechnical/animal agriculture (20%) and food residues (16%) offer potential for technologies that convert these residues into bioenergy or valuable by-products. Expanding efforts in agriculture, animal agriculture and food sector could contribute to sustainability and circular economy goals, reducing waste and recovering resources. The marine biomass sector (12% in technologies, but only 6% in business models) and forestry residues (10% in technologies and 12% in business models) also represent underexplored opportunities for innovation in bioenergy and material production. Utilizing renewable and less land-intensive feedstocks, such as algae, seaweed, and wood waste, could help diversify the resource base.

### 7.2.2. TECHNOLOGICAL CATEGORIES AND DIVERSIFICATION

The predominance of biochemical technologies (70%) suggests room for diversification into chemical (16%), thermochemical (8%), thermal (4%), and mechanical technologies (2%). Increased focus on chemical processes can drive innovations in bio-based chemicals and materials, while thermochemical and thermal technologies offer potential for improving waste-to-energy systems and maximizing biomass conversion efficiency. Though minimally represented, mechanical processes could be explored in sectors like forestry and marine, where processing innovations can enhance resource extraction. This aligns with the lower business model presence in these sectors, particularly the marine sector (6%), which offers room for expansion.

### 7.2.3. EXPANDING BUSINESS MODELS FOR A CIRCULAR ECONOMY ACROSS KEY SECTORS

The current distribution of business models highlights opportunities for expanding cross-sector integration and circular economy initiatives. Agriculture (28%) and plant agriculture (24%) are well-established, but there is potential for new models focused on precision agriculture, waste valorisation, and sustainable farming practices. The food sector (20%) offers significant opportunities for upcycling food waste into bioenergy or new products, while animal agriculture (10%) can benefit from innovations in manure management and the creation of value-added by-products. Forestry (12%) presents untapped potential for converting residues into bioenergy and bio-based products, supported by sustainable forestry practices. Although the marine sector (6%) remains a smaller focus, it offers promising opportunities in marine biomass for biofuels and bioplastics. By prioritizing underrepresented sectors like animal agriculture, forestry, and partially food while recognizing the complementary role of the marine sector, the RuralSpot can promote new business model opportunities aligned with the implementation of circular bioeconomy in rural areas.

### 7.2.4. RURALSPOT DATASET

The RuralSpot data set has been created on an excel file in order to facilitate the data acquisition by the owner of the online tool. The data set is continuously improved. All the guidelines for data entry in the data set have been provided in D2.1.

The data set can be accessed by the following link in the RuralBioUp Zenodo community : https://zenodo.org/records/13889577/files/RuralSpot_Data%20Set_4102024.xlsx?download=1

## 7.3. RURALSPOT DEVELOPMENT AND DATASET INTEGRATION PROGRESS REPORT

The development of RuralSpot has made substantial progress, both in terms of its technical infrastructure and dataset integration. As part of the RuralBioUp project, the platform was designed to be a comprehensive resource for stakeholders involved in the bioeconomy, regional development, and sustainability sectors. The platform's core strength lies in its accessibility and user-friendly structure, which organizes key data in a way that facilitates easy navigation and resource discovery.

### 7.3.1. DEVELOPMENT AND MILESTONES OF RURALSPOT INTEGRATION

RuralSpot evolution has been driven by the collaborative efforts of multiple teams. The initial phase of development focused on gathering and structuring the data necessary to populate the platform, a task spearheaded by the leaders of Task 2.1 and Task 2.2. These tasks involved collecting relevant datasets, organizing them coherently, and structuring them for integration into RuralSpot. Simultaneously, LOBA took charge of the technical aspects of development under Task 2.3, ensuring that the platform's updates and maintenance were carried out smoothly and efficiently.

The design of RuralSpot was developed to be consistent with the broader visual identity of the RuralBioUp project. This not only includes a distinct logo but also ensures a cohesive user experience throughout the platform. RuralSpot is accessible either via the RuralBioUp website or directly at ruralspot.eu.

### 7.3.2. KEY MILESTONES

The development process followed a series of key milestones, starting with data structuring and culminating in the progressive enhancement of the platform's features. The early work began in **October 2022**, when data collection efforts were initiated under Task 2.1 and Task 2.2. Over the next several months, the collected data was organized and structured, laying the groundwork for RuralSpot's future content.

By **April 2023**, the technical specifications for RuralSpot had been defined by LOBA, marking a significant turning point. This phase outlined the functional and technical requirements for the platform, ensuring that the development work adhered to the needs of its users and stakeholders. Shortly afterward, in **June 2023**, the project partners finalized the first dataset, a key step in preparing the platform for its official launch.

The initial version of RuralSpot was successfully launched in **October 2023**, providing users with their first glimpse of the platform's capabilities. Although this version represented a working prototype, it was intended to serve as a foundation for future iterations based on user feedback and real-world use cases.

Building on this, a second version of RuralSpot was released in **November 2023** and subsequently validated through a focus group held in Iasi. This iteration introduced updates based on early feedback and offered stakeholders the chance to evaluate the platform's functionality. The focus group provided valuable insights, which were instrumental in shaping the platform's next phase of development.

Following this event, in **December 2023**, a consortium training session was organized to address the feedback gathered during the focus group. Using the MoSCoW prioritization method, the team categorized feature requests and development priorities. This method allowed the consortium to streamline the platform's development, ensuring that essential features were addressed promptly while less critical aspects were scheduled for future updates.

From **January to March 2024**, RuralSpot saw the release of its third version, which incorporated much of the stakeholder feedback received in previous months. This update introduced several key features aimed at improving the user experience and expanding the platform's functionality. Among these were a language selector supporting six languages (French, Italian, Czech, Latvian, Romanian, and English) and the inclusion of a "Glossary of Terms and Definitions" developed using the BIOSWITCH Glossary. Other enhancements included a mini-tutorial via tooltips to guide users, a submission form for uploading new resources, and a new taxonomy for categorizing target groups. Furthermore, a disclaimer was added to inform users when external links would redirect them outside RuralSpot.

Looking ahead, between **April and September 2024**, LOBA has designed a new section within RuralSpot that will focus on the Regional Hubs. This page will offer an overview of the nine hubs, showcasing key resources related to biomass, business models, technologies, soil, and financial support. A new set of filters will be introduced, allowing users to search resources by hub, providing a more tailored experience. This update is set to go live soon and will be highlighted in key project deliverables, including D2.5 RuralBioUp One-Stop Shop Handbook (M35) and D2.3 Report on Data Mapping & Assessment (M36), which will showcase the final version of the RuralSpot dataset.

# 8 CONCLUSIONS and RECOMMENDATIONS

The *RuralBioUp* project has made significant strides in identifying the key factors necessary to support the sustainable development of the bioeconomy in rural areas. The key outcomes highlight the need for a multi-stakeholder approach, involving policymakers, farmers, industries, and research institutions. By fostering collaboration between these parties, rural regions can optimize their resources, encourage innovation, and adapt to changing environmental and economic challenges.

A crucial component of this Deliverable 2.2. is the development of a biomass model that collects and harmonizes data by linking it with other sources concerning technologies, existing best practices, and industrial processes. The adopted model, let collect and harmonize the data within a common model, with further aim to be integrated within Rural Stop tool. It can be able to support the multi-stakeholder framework by providing a centralized knowledge base that encourages cooperation, resource optimization, and innovative solutions.

Furthermore, during the implementation of the model and integration of data, the project underscored the importance of education and training initiatives. These initiatives are essential to bridge the knowledge gap among stakeholders, particularly in relation to biomass feedstock exploitation and the technologies available for improving their use. Such efforts can empower local communities, enhance resource management, and stimulate rural bio-based economies by promoting greater stakeholder engagement and capacity building.

**Key Recommendations are also provided by the partner involved in this activities as follow:**

1. **Strengthening the Policy Framework**: To better support bioeconomic ventures in rural areas, a robust policy framework is needed. This should focus on fostering more inclusive decision-making processes that take into account the unique characteristics and needs of rural communities. This will ensure that rural stakeholders, such as biomass suppliers, are adequately represented in bioeconomy strategies.

2. **Enhancing Stakeholder Knowledge**: There is a pressing need for more technical knowledge among various stakeholders, particularly those directly involved in rural biomass supply. This could be addressed through targeted training programs and educational initiatives that focus on the technical aspects of bioeconomy value chains.

3. **Enhancing Bioeconomy Value Chains**: It is essential to strengthen bioeconomy value chains to ensure they are resilient, adaptable, and capable of generating long-term socio-economic benefits for rural areas. This can be achieved by optimizing sustainable practices and fostering innovation through continued support for research and development.

In conclusion, the RuralBioUp project emphasizes the key role of collaboration, knowledge-sharing, and policy support in realizing the full potential of bioeconomic opportunities across rural Europe. The tools described in this deliverable are implemented to reach the mentioned target addressing the technical and educational gaps among stakeholders and enhancing the

bioeconomy's value chains, so the rural regions can better position themselves to overcome environmental and economic challenges while generating sustainable development.

# ANNEX I

## BMT – How works

(BMT) Biomass Model Tool was created to assist users in assessing the potential and availability of biomass and industrial processes, taking into account the various pathways for bioproducts.

This BMT aims to provide a broad overview of the biomass available for Bio-Based Products (BBPs) in a selected Regional Hubs and to help determine which bio-based product chains might be most appropriate for different categories of biomasses, also considering the use of innovative technological pathways.

The Model is structured as an Excel file with several sheets:

1. The Cover page titled "*BMT*," which includes details like the version, the date of the latest revision, and the partner responsible for updating the Biomass Model (Itabia).
2. The "*Maps Model Sheet*," which presents a conceptual map linking different biomass categories to relevant BBP industrial processes and their potential uses or applications.
3. The "*Biomass Calculation Sheet*."
4. The "*Sheet of existing Best Practices about Industrial Processes*"

***The Biomass Calculation Sheet***:

General data about the regional area, along with the databases, articles, and websites used for data collection, should be entered. Each partner or stakeholder can replicate this sheet for each region area. Note that when duplicating the Biomass Calculation Sheet, it's important to highlight that columns in yellow and named "theoretical amount", "available amount" and "residual biomass" have to ensure function correctly once the data are filled in the other white columns (i.e. C/D) as signed int he legenda of the sheet. During this fisrst year, Itabia implemented the sheet and filled the data in close collaboration with the partners involved in the different regional hub. Each partner is responsible for completing the calculation sheet by selecting the types of biomass (whether cultivated or residual) that are relevant to own region.

A brief legend explaining the data input and automatic calculations is provided next. Subsequently, the analysis of biomass and its specific uses is conducted based on various parameters (columns A-B):

**1. Agro-forestry and Aquatic dedicated crops and their biomass subcategories**

• Biomass:

- Woody crops (i.e. oak, willow, pine, fir, birch etc.)

- Herbaceous crops (i.e. cardoon, sorghum, hemp, etc.)

- Aquatic biomass (i.e. spirulina algae, macro algae (e.g. seaweed, kelp) etc.)

- Other

**2. Biomass residues**

• Sectors:

- Agriculture and Forestry (i.e. cereal straw, pruning residues, etc.)

- Zootechnical sector (i.e. waste wool, others)

- Agro-Industry sector (i.e. olive milling wastewater, wine dregs, fruit and berry residues etc..)

- Aquatic biomass

- Other.

The chosen cells in the corresponding columns must be populated, considering the available and most typical Biomass for each designated regional area, together with the associated values of production yield (t/ha), moisture content, and cultivated area (ha/year).

The document is now filled with examples, and it is anticipated that partners will modify them to represent their own locations. It is feasible to append sheet rows to include further biomass crops and subcategories or biomass leftovers. Be advised that when you insert extra rows, you must replicate the calculation formatting in the two yellow-highlighted cells by clicking the bottom right corner of the cell above and dragging it down to the new cell below.

The mentioned parameters to be filled are (**Columns C - D**):

- Involved area (**Column C**),

- production yield (**Column D)**.

The **theoretical amount of biomasses, as well as Available amount of Biomass for BBP2 and Residual Biomass** will be automatically calculated (tons/year) **(Yellow Column E, O, P respectively)**.

The uses of them could be different on the basis of needs and local market conditions, thus not all biomass might be used for **traditional uses** (**Columns F - G**) but part of them could be used for:

- **BBPS sector (Column K)**

**- the biomass not used yet for BBPs could be exploited taking in consideration the suitable fraction of its components , like cellulose, hemicellulose and lignin** (**Columns H, I,J**)

- **Alternative uses 1, 2, (n+1) (Columns L, M).**

- **Possible Innovative uses** still in research phase but promising for marketplace during coming years (with TLR 5 - 8), (**Column N**).

**Column H** has drop down boxes to identify the suitable fraction.

Once the selected cells are filled, the **Available amount of Biomass for BBPs (t/year)** will be automatically calculated as well as the **biomass residues which will be not used** either for **traditional uses or BBPs productions (Column O),** but that could be destined for **other sectors (Column P)**.

It would also be useful to know if potential biomass destined for BBPs production is supported by any **incentives mechanism** or specific **regional/national funding programs** such as **ERDF (European Regional Development Funds) or Regional Policy Incentives**, (**Column R-S-T-U)**.

These mechanisms could make the difference for a strong promotion of BBPs within the Regional Hub.

**Column U** allows for a short description of current and/or future factors affecting handling /disposal (where known).

Where there is no current utilization, we are not asking for further explanations in the model. There will be a specific chapter explaining the reasons so that we have a bit more context on the challenges in a given region (technical barriers, logistic challenges, etc.)

**The Industrial Processes Sheet:**

The Industrial Processes Sheet is currently populated by using the table shown in the sheet. It is expected partners will add industrial processes to column A to reflect differing technologies in their own regions. It is possible adding sheet rows to include additional existing best practices about industrial processes and technology used and further subcategories.

**Column C** is designed to list the constituent components of biomass source (i.e. cellulose). This links to **Column D** which indicates the minimum requirement % of constituent component of the biomass source for the industrial process to be viable, if data are available.

**Column E** lists the products of the industrial process (i.e. alginate from algae).

**Column F** lists the chemical/mechanical and physical processes to extract the constituent components in the biomass source and used in the best practices represented both industrial sector that small and medium enterprises.

**Column G** showing the Mass yield % from the industrial process.

Business information relating to the industrial processes including links to websites of the businesses / research institutions is found in **Columns H, I and J.**

# References


1. https://www.enabling-project.com/
2. https://power4bio.eu/
3. https://bioeast.eu/
4. https://be-rural.eu/
5. https://www.branchesproject.eu/
6. https://eubionet.eu/bioreg-project/
7. https://eubionet.eu/ict-biochain-project/
8. https://www.biobasedeconomy.eu/projects/open-bio/
9. http://www.star-probio.eu/
10. https://www.lift-h2020.eu/

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