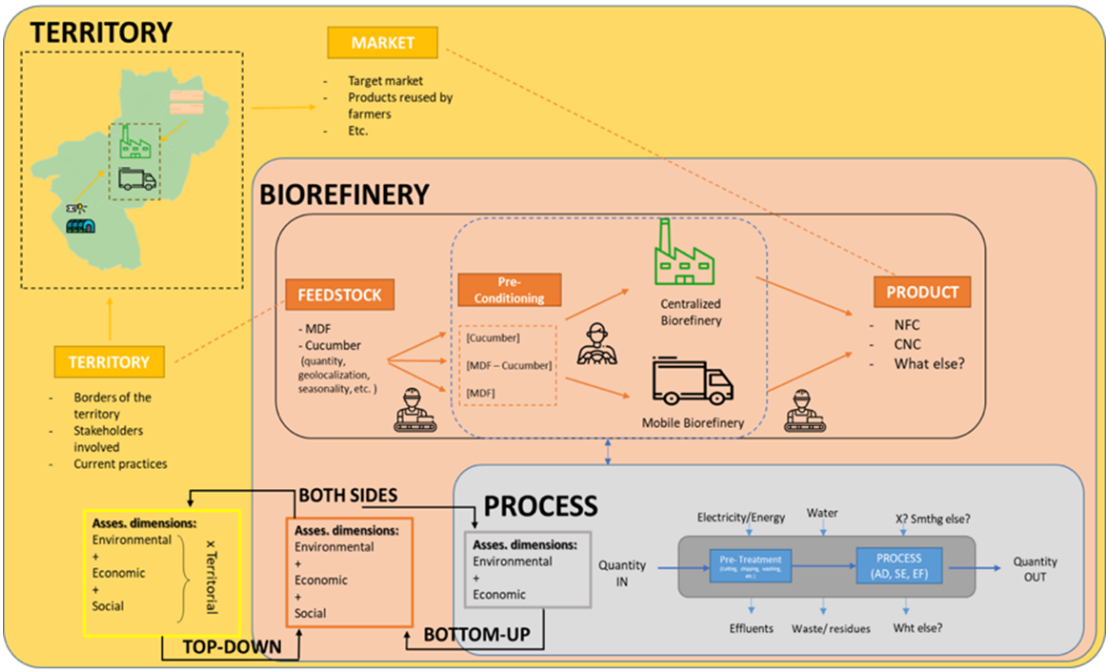
# FLEXIBI

## EXPERIMENTAL EVALUATION OF SMALL-SCALE FLEXI-FEED BIOREFINERIES AND DEVELOPMENT OF A DECISION SUPPORT TOOL DEVOTED TO URBAN AND PERI-URBAN WASTES

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| **Coordinator:** | Mr. Bernard Cathala, INRAE, France<br>Email: bernard.cathala@inrae.fr |
| **Project partners:** | BIA/INRAE Nantes, France; University of Hamburg (UHH), Germany; Hamburg University of Technology (TUHH), Germany;, Groupe Ecole Supérieure du Bois (ESB), France; University of Helsinki (UHE), Finland; KU Leuven - University of Leuven, Belgium. |
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## BACKGROUND

Biorefinery can be defined as a "sustainable processing of biomass into a spectrum of marketable products and energy". Cities and urban areas produce large amounts of biomass consisting of many types of waste including plant derived wastes such as tree pruning, grass, post-consumer wood wastes, residues or co-products from local agriculture or horticulture, etc., which represent a potential source of carbohydrate, lignin, protein, fibers and other valuable products. Nevertheless, to achieve sustainable use of this biomass, the quantities and qualities must be assessed as well as the technological pathways to transform them in valuable products. Technical drawbacks must also be combined with local constraints that are related to economy, logistic, environmental and societal concerns. All these elements are diverse and related to the specificity of the local context. Nevertheless, with regard to increased societal concerns over sustainability and the need to create a circular bioeconomy, there is a need to find the most efficient solutions adapted to the local constraints in terms of scale/process/ product/implementation. In this framework, flexible small scale biorefinery (SSB) can offer a real opportunity since they can provide tailored technical solutions with relatively low investment costs and societal services if they are designed for a specific context.

## OBJECTIVE

FLEXIBI combine coordinated modelling and experimental approaches to create a decision support tool devoted to assess the most efficient and sustainable SSB for under-utilized sources of biomass from agri-industrial and peri-urban wastes. The main driving force of the project being to identify and study the parameters influencing the implementation of lexible and predictable processes that are able to manage variable biomass (in composition and time) in a local context.

## METHODOLOGY

FLEXIBI methodology combines three main approaches:

- Quantitative process modelling: this part of the project will model the material balances on the basis of experimental assessments, for different types of processed biomass using various biorefinery pathways.
- Knowledge engineering: The relation between different players that are relevant for implementation of SFBs will be represented and modelled based on knowledge from a multitude of stakeholder groups (i.e. biorefinery stakeholders, public authorities and scientific).
- Experimental assessment: Three representative "pilot feedstocks" from different urban and peri-urban waste origins (agriculture and agro-industry, landscaping and gardening, post-consumer wood wastes) and their mixtures will be investigated using selected biorefinery pathways for the transformation into different product categories.

## RESULTS

The first step was to afford a definition of SSB to help stakeholder to capture the main characteristic features of SSB. This was achieved by analyzing data from 15 operational biorefineries using a multivariate analysis combined with a hierarchical clustering. Small-scale biorefineries are characterized by a small investment cost (less than 2M€), a low processing capacity (less than 100t/day), a low process complexity while the end-products added value is variable. Quantitative and qualitative evaluations of biomass were studied via three case studies based in Hamburg (DE), Leuven (BE and Nantes (FR).

GIS, biomass quality data were supplemented via interviews with biomass producers and this enabled a successful evaluation of biomass in the three case studies regions. For experimental evaluation different substrate models were created including lignocellulosic wastes (tree pruning and medium density fiberboard wastes) and market gardening (cucumber and tomato leaves and stems from greenhouse production) have been fractionated by steam-refining and chemical fractionation. Valuable products such as fiber for paper industry, hemicellulose with tenside properties and cellulose nanocrystals for composite reinforcing have been obtained and fully characterized. Storage of biomass to answer the question seasonality has also been evaluated.

Decay of agricultural waste when mixed with post-consumers MDF waste from peri urban areas can be delayed for long period. These data have been combined in modeling approach offering new opportunity to answer the complex question of locally adapted SSB implementation.