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State-of-the-art of technologies for the production of bioproducts from biowaste and wastewater

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1. Executive summary

The management of urban biowaste, such as Organic Fraction of Municipal Solid Waste (OFMSW) and Urban Wastewater Sludge (UWWS), is a challenge for most of the cities and regions in Europe due to the large amount generated every year. The Waste Framework Directive establishes that selective collection of urban biowaste should be implemented in the European Union within 2023. However, the drawbacks in composting, anaerobic digestion and the need of social engagement are challenges to overcome. Urban circular bioeconomy provides technologies treating the waste as raw material for the production of bioproducts with higher added-value than the existing ones. Therefore, the increase in the availability of urban biowaste provides high-quality and stable feedstock, which offers the opportunity for the development of circular urban bioeconomy.

The scope of the HOOP project is to foster urban bioeconomy through unlocking investments for the implementation of technologies to obtain novel bioproducts. The knowledge and understanding about these technologies for valorisation of urban biowaste is fundamental for cities and regions in order to go beyond composting and anaerobic digestion and to establish the basis of urban circular bioeconomy. The present deliverable describes and evaluates seventeen technologies, most of which come from H2020 projects (especially SCALIBUR, Valuewaste and WaysTUP!). They have a technology readiness level (TRL) of at least 5, which means that there are existing pilots.

The described circular bioeconomy technologies make use of different approaches and strategies to get high added-value from the biowaste, including the by-products from anaerobic digestion and composting. In addition, the technologies are flexible, as they might be applied to more types of biowaste than the ones originally attributed. However, most of them are actually industrial processes with several steps. Therefore, optimisation is required to adapt them to the corresponding feedstock and guarantee smooth operation. This can imply different TRL depending on the feedstock.

The technologies cover very different value-chains such as agriculture, chemistry, nutrition, bioplastics or cosmetics. Bio-based biodegradable and compostable biopolymers with increasing market volume can be produced from OFMSW, UWWS and used cooking oils by different technologies.

Agriculture value-chain can benefit from the production of biostimulants, biopesticides, biochar and the recovery of key nutrients (phosphorus, nitrogen) from by-products from anaerobic digestion. Nutrition value-chain is an option for urban biowaste valorisation into animal feed or food products, being insects, microalgae and methanogenic bacteria sustainable sources of proteins, lipids and other functional substances despite the identified limitations due to legislation.

Bio-based chemical building blocks, such as volatile fatty acids, 2,3-Butanediol, ethanol or acetate are obtained from different paths on a biorefinery approach and can be processed into biosolvents or included into different chemical routes. In addition, technologies to valorise specific streams of biowaste, like used cooking oils, animal by-products and spent coffee grounds, are also provided. These feedstocks are employed to obtain functional ingredients, cosmetics and nutraceuticals of high added-value. For a same technology different bioproducts might be obtained depending on the degree of processing (downstream). This involves different TRL according to the bioproduct, but offers a driving force for the development of the following steps in the circular economy chain.

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Each of the seventeen technologies has been described to provide comprehensive information about their functioning and the bioproducts obtained, including flowcharts. Then, each of them has been evaluated through a multidisciplinary analysis to provide practical information about their advantages and disadvantages from different points of view (technology readiness, economy, environment, social acceptance, legislation, etc.). This evaluation provides guidance to help cities and regions for making the selection of the most suitable technology. A detailed discussion comparing the characteristics of the technologies is provided after all the descriptions, completed by complementary tables showing the enabling factors and challenges of each technology, their current or potential commercial status and their compatibility with the traditional technologies for urban biowaste treatment (composting and anaerobic digestion). It is not possible to establish a ranking of technologies, as there are different parameters to consider with different influence depending on the city or region.

This deliverable will be updated by September 2023 due to the expected evolution and changes in TRL from the described technologies, as well as the extension of the list to new technologies.

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