RETASTE Conference Abstracts
Vol. 1 RETASTE-W2E-101
Athens, Greece, 6-8 May, 2021

Quantifying the Future Energy and Nutrient Recovery Potential of the Organic Fraction of Municipal Solid Waste

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Abstract

Anaerobic digestion (AD) arises as the most promising strategy to enhance the recovery of resources from the organic fraction of municipal solid waste (OFMSW). Understanding the future availability and characteristics of the OFMSW is therefore paramount to establish the role of AD in waste management plants. In this study we applied Material Flow Analysis to systematically quantify the mass availability and energy recovery potential of the OFMSW by 2030. The assessment focussed on Madrid, Spain, and the main assumption was that the rate of separate collection of the OFMSW can reach 70% by 2030. Based on this premise, we developed a range of scenarios for the year 2030, including alternative evolutions of food waste generation. The energy recovery potential was quantified by the biochemical methane potential (BMP), while the nutrient recovery potential was quantified by the mass of nitrogen, phosphorus, and potassium contained in the OFMSW. In 2017 (reference year), only 2,122 t/year of OFMSW was collected separately in Madrid and about 458,000 t/year was separated from the residual waste at centralised facilities (the so-called residual organic waste). Under the scenarios 2030 defined in this study, the mass of organic waste collected separately increases up to 154,000 - 343,000 t/year, while the mass of residual organic waste drops to 213,000 - 319,000 t/year. The BMP reached $53 \cdot 10^6$ m^3 methane/year in 2017, while by 2030 the BMP ranges from $30 \cdot 10^6$ to $68 \cdot 10^6$ m^3 methane/year. This large variation is mainly caused by the evolution of food waste generation. The lowest BMP is achieved under a scenario that assumes halving per capita food waste generation by 2030 as fixed by the United Nations. The highest BMP is achieved under a scenario that assumes an increase in food waste generation proportional to the GDP. On the other hand, the nutrient recovery potential generally increases accross all the 2030 scenarios compared to 2017. For example, the phosphorus recovery potential ranges from 0.92 to 1.16 kt/year under the scenarios 2030, which is substantially higher than the 0.68 kt/year achieved in 2017. Overall, the results show that the future energy and nutrient recovery potential of the OFMS strongly depends on the evolution of food waste generation. However, while the energy recovery potential may decrease in the future, the nutrient recovery potential is likely to increase driven by the improvement of separation collection rates.

Keywords: energy recovery; nutrient circularity; material flow analysis; future scenarios

Acknowledgments: This research has been supported by the Spanish Ministry of Science, Innovation and Universities through the project REDEFINERY (RTI2018-097227-B-I00) and the Government of the Community of Madrid through the project BIO3 (S2018/EMT-4344)