Wastewater (WW) and municipal solid waste (MSW) volume coming from domestic activities is dramatically increasing, due to the increment in worldwide population and activities in the urban areas. Water pollution and overproduction of waste, which lead to shortages in natural resources, requires innovations in waste treatment. These innovations must be based on a new paradigm: from a waste management to a resource management philosophy. Through energy and material retrieval, wastes are considered to be a resource that can and must be drawn upon, which is the concept of waste recovery.

This Ph.D. thesis has as the overall objective the study of the joint treatment of WW and the organic fraction of the MSW (OFMSW), combining both treatments for energy recovery. Specifically, evaluates the joint treatment feasibility of using the AnMBR (Anaerobic Membrane BioReactor) technology, obtaining methane-enriched biogas as a product, which could be used in combustion engines to produce electricity. For this purpose, an exhaustive OFMSW characterization was carried out. An experimental device with a food waste disposer (FWD) was used to incorporate the OFMSW to the AnMBR pilot plant, where an experimental study to a biological level and an economic feasibility study was carried out. The pilot plant is located in Carraixet WWTP (Alboraia, València) and is fed with the degritter's effluent and the organic fraction of the waste produced in the UPV restaurants.

FWD use in households entails a negligible extra water consumption (1.9%, according to this study). OFMSW physicochemical characterization revealed that OFMSW COD concentration (59400±14000 $mg \cdot L^{-1}$) is a hundred times higher than the average values of COD in the WW fed on the AnMBR pilot plant or a typical WW. Therefore, an important increment in biogas production is expected. Besides that, OFMSW and WW sulphate concentration has similar concentration ranges, so COD/S-SO_4 ratio increases and methanogenic *Archaea* (MA) is favoured in its competition for the available substrate against sulphate-reducing bacteria (SRB). OFMSW total nitrogen concentration is two times higher than in the WW. OFMSW total phosphorous concentration, is 10 times higher in comparison to WW.

The particle size distribution study says that only 13% of the particles will be removed in a restrictive pre-treatment, as a 0.5 mm fine screening membrane protector. Therefore, most of the organic matter will pass through the sieving process and will be fed into the anaerobic digester for valorisation. OFMSW anaerobic biodegradability, obtained from BMP tests, is 72±3%.

The pilot-plant was operated for 536 days, during which six different periods can be distinguished according to different sludge retention times (SRT) and OFMSW penetration factor (PF). OFMSW addition did not affect the process stability, as the absence of VFA in the effluent and the low ratio VFA Alkalinity per Total Alkalinity demonstrated.

OFMSW COD concentration increases the organic load of the influent which feds the AnMBR reactor. OFMSW proportion with regard to the total flow (1,1%) has a dilution effect that makes no change in nutrient concentration. Therefore, COD/S-SO_4

ratio increases from 5.1 in Period 1 (40 days of SRT and 0% PF) to 8.0 in Period 5 (70 days of SRT and 80% PF).

Methane production during joint treatment is significantly higher compared to Periods when only treating WW (Periods 1 and 6), reaching a 200% increment at 80% PF (Period 5) compared to Period 1. As expected, the longer the SRT the higher methane production with the same PF. At 40% PF and 70 days of SRT in Period 4, production is higher than 40 days SRT in Period 2 (114,9 $L\cdot kg^{-}1$ removed COD vs 80,4 $L\cdot kg^{-}1$ removed COD, respectively). However, production in Period 3, where no sludge is purged, is only 5% higher than the obtained in Period 4, while solids concentrations in the reactor doubled its value (28943 $mg\cdot L^{-1}$ and 15484 $mg\cdot L^{-1}$, respectively). This fact suggests that an SRT longer than 70 days does not yield higher methane production. Furthermore, doubling PF increased methane production by 30% (Period 4 vs Period 5) and by nearly 200% between P5 and P1 (from 0 to 80% PF).

Effluent obtained in the AnMBR is nutrient-enriched and, thanks to the membrane effect, there are no suspended solids or pathogens in it, becoming a high-quality effluent, which could be used as irrigation water. Besides that, COD concentrations were lower than the limit concentration allowed to accomplish the discharge requirements (125 mg COD $\cdot L^{-1}$).

OFMSW addition and SRT increment results in a population change in the anaerobic reactor because of the increment in the bacterial population in charge of hydrolysis and fermentation and also in MA, leading to a higher organic matter biodegradability. After the calibration of the BNRM2 model, the performed simulations confirmed this higher biodegradability during the joint treatment periods.

Membrane fouling was minimum during the different periods, transmembrane pressure (TMP) in the membrane was significantly low (-0.131±0.06 bar) compared to the limit TMP (-0.40 bar). Regarding the economic study of the operation, the lower cost was found in Period 5 (70 days of SRT and 80% PF), achieving a benefit of 0.022 $€\cdot m^{-3}$ treated, due to the biogas operation against Period 1 (40 days of SRT and 0% PF) with an operation cost of 0.039 $€\cdot m^{-3}$ treated, under optimal filtration conditions, demonstrating that the joint treatment of OFMSW in an AnMBR reduces the operation costs.

This Ph.D. thesis has demonstrated the technical and economic feasibility of the joint treatment of WW and OFMSW by using the AnMBR technology and the considerable interest in this treatment as a future option to convert the waste water treatment plants to water resource recovery facilities.