LAYMAN'S REPORT

"Demonstration of an integrated waste-to-energy system for energy generation from biodegradable organic waste & wastewater"

INTER-WASTE Life 08/ENV/CY/000457

Project Beneficiaries

Cyprus University of Technology (CUT) : coordinator

Unit of Environmental Studies – University of Nicosia (UES)

National Technical University of Athens (NTUA)

PROPLAN Ltd. (PRO)

Department of Environment of the Ministry of Agriculture, Natural Resources & Environment (ES)
Introduction

One of the major challenges presented in the new energy landscape of the 21st century is sustainable power generation in order to cover humankind’s continuously rising needs, ensuring energy security and stable economic conditions, as well as taking effective actions against climate change. Having established that the use of fossil fuels presents an imminent danger for the environment, power generation utilizing alternative fuel-stocks, in order to preserve the carbon life cycle and minimise the process’s environmental impact, becomes one of the most important challenges of the era. To do so, it is necessary to utilize the biomass produced nowadays, rather than the worldwide common utilization of fossil fuels, which releases carbon that was removed and stored eons ago back to the environment. Furthermore, it is well established that special care must be taken concerning municipal solid biomass waste in order to minimize environmental impact of waste discharge. Thus, treatment and utilization of biomass wastes as fuel-stock in an energy generation process may lead to a minimised environmental impact, while maintaining the energy production process at a viable level. The biodegradable fraction of Municipal Solid Waste (MSW) accounts for the largest proportion of MSW composition. On the other hand, sludge generated by wastewater treatment plants is mostly biodegradable. Therefore, treatment of these wastes is an important component of an integrated solid waste management strategy and reduces both the toxicity and volume of waste requiring final disposal in a landfill.

INTER-WASTE Objective

INTER-WASTE project focuses on the design, construction and demonstration of an innovative integrated pilot system (MBR-AD) consisting of a Membrane Bioreactor unit (MBR) for wastewater treatment and an Anaerobic Digestion (AD) unit for biodegradable organic waste treatment. The project aims to provide a viable solution for insular and/or isolated communities or units (e.g. hotels) to effectively manage wastewater, sludge and biodegradable organic waste while producing (a) renewable energy through biogas combustion to cover local electricity and thermal requirements, (b) clean water supply for agricultural purposes and (c) stabilized solid organic matter which can be exploited as organic fertilizer for land application.
MBR-AD system

Schematic representation of the MBR-AD unit
Results

- Demonstration of an integrated stand alone and energy autonomous MBR-AD pilot system which uses waste products of one technology as feedstock material for the other (symbiotic approach).
- The AD unit produces 12.1 m³/d of good quality biogas that contains 59% methane.
- The dried solid digestate resulting from the AD unit, after bag filtering and drying, acquires good quality characteristics for land application as organic fertilizer.
- The MBR unit treating wastewater and liquid digestate from the AD unit produces high irrigation water that conforms to the stringiest Cypriot water reuse limits.
- The overall energy balance of the MBR-AD unit is positive meaning that the system is energy autonomous while the excess energy (i.e. electric and thermal) can be utilized for other purposes e.g. supply the electricity grid, provide heat to facilities or places at the vicinity of the unit.

The system can be applied in a small community of 1000 people in Cyprus to treat the produced food waste and wastewater, to cover the electricity needs of around 20 households, and to produce 150 m³/d of irrigation water and about 12 kg/d of organic fertilizer.

The system can be applied in an all inclusive 5 star hotel of 1,200 beds to treat the produced food waste and wastewater, to cover 3.5% of its energy requirements (electric and thermal energy) and to produce 250 m³/d of irrigation water and about 26 kg/d of organic fertilizer.
MBR-AD application in a small community of 1000 inhabitants

MBR-AD application in a 5 star HOTEL 1200 beds
Benefits

The MBR-AD system provides a complete solution to the problems of waste and wastewater management and can ensure local electricity availability, clean water for irrigation and organic fertilizer for enhancing infertile soils. The organic waste along with sludge produced from MBR is utilized for methane production through AD, minimizing the volume that has to be landfilled and consequently the transportation environmental impact. The MBR produces a final effluent that is of very high quality, providing a water source, much needed in water scarcity areas (e.g. Cyprus). Therefore, the integrated system provides solutions to various environmental areas of concern i.e. waste management integration, renewable energy production, reduction in fossil fuel dependency, reuse of treated water, water sources conservation, soil fertility etc.

This integrated system has a very high level of innovation and has never been implemented before. The process of the MBR-AD unit is based on a ‘zero’ waste symbiotic approach that uses waste of one process as feedstock material to the other. In this way all organic waste streams (including sludge) are effectively managed using a standalone treatment system. MBR and AD systems are increasingly being applied in the waste and wastewater industry due to the effectiveness of the processes in treating wastewater and organic waste respectively, while delivering added value products. The combination of these two well established technologies in an integrated and efficient manner has been demonstrated and was shown that it constitutes a novel approach with increased application potential in Cyprus and EU at local communities and/or insular communities facing similar problems of renewable energy supply and waste disposal.