Installation of a Sewer Mining Unit in the Athens Urban Tree Nursery

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Abstract
Within the framework of the Horizon 2020, a European project called NextGen evaluates and champions transformational circular economy solutions and systems around resource use in the water sector. The Athens demo site is located in the Athens Urban Tree Nursery which is part of the Goudi Park, an area in the process of redevelopment and regeneration to become the key metropolitan park of the capital. The innovations that are being implemented within the project are the installation of a sewer mining modular unit for urban green irrigation at the point of demand with a capacity of 25m^3/d. Additionally, compost-based eco-engineered growing media products will be reused as an onsite fertilizer, as part of a portfolio of autonomous, decentralized water, energy and materials circular solutions for cities in water scarce area. This paper involves information about the way the sewer mining will be implemented and also information about the wastewater treatment, the compost that will be produced and the energy balance of the whole system.
Keywords: sewer mining; wastewater reuse; circular economy;

1. Introduction

Closing the loop of product lifecycles through greater recycling and reuse is the new goal that set in 2015 by the European Commission (EC) within the new Circular Economy Package (JRC ,2014). According to EC, the EU potential for wastewater reuse is estimated to be six times greater than the existing one (approximately 6 billion m^3). More specifically, in Europe, more than 40,000 million m^3 of wastewater are treated annually and only 964 million m^3 of this treated wastewater in actually reused (BIO by Deloitte, 2015). Around the Mediterranean region, some 20% of the population lives under constant water stress and in summer, over 50% of the population is affected by water stress (Amec Foster Wheeler et al., 2016). Despite the situation, counties like Greece, Italy and Spain reuse between 5-12% of their treated effluents, thus revealing a high potential for further increase. Also, annual quantities of waste generated by water sector utilities in Europe amounts to more than 10 million tons, with associated costs of more than 60 billion euros annually.

The NextGen project will evaluate and champion innovative and transformational circular economy solutions and systems that challenge thinking and practices around resource use in the water sector. The City (CoA) and the Water Company of Athens (EYDAP) will demonstrate an autonomous, local, CE solution in the Athens Tree Nursery which is located in the center of Athens, in order to address real world problems in water scarce cities The application includes sewer mining (mobile wastewater treatment units in containers able to treat and provide reused water at the point of demand in dense urban environments) with energy and resource reuse coupled with bio-makeries. In this demonstration, wastewater will be mined from sewer, treated at the point of demand through a mobile modular treatment unit and reused directly for urban green irrigation and aquifer recharge during the winter. The reject flux from the treatment as well as appropriate organic waste streams from the housing units will be treated and re-used as fertilizer and to produce biomass which be reused as part of a renewable energy solution for the area to support more complete autonomy.
Sewer mining is a technology that was first pioneered in Australia (Makropoulos et al., 2017). The first time that sewer mining was applied in Greece as a decentralized wastewater treatment method is the DESSIN Athens's pilot plant, which was implemented under the European Union Seventh Framework Programme.("Athens (Greece) | Dessin-Project," n.d.). The technology that is used in Dessin's demo case is a dual-membrane process that consists of a Membrane bioreactor (MBR) followed by a Reverse Osmosis unit. The experimental results support the conclusion that the application of sewer mining practice through the implementation of an on-site compact treatment system consisting of a pre-treatment unit followed by a membrane bioreactor and a UV disinfection unit can reliably meet all the national and international criteria set for all types of non-potable

wastewater reuse at a rather moderate cost. The application of the integrated MBR-RO process is financially justified only in the case of saline wastewater. Therefore, in NextGen application the treatment scheme consists only of an MBR unit followed by a UV disinfection.

In view of the above, the objective of the present study is to Describe the Athens Tree Nursery application and provide data for later implementation of this technology in other areas of Athens or Greece.

2. Materials and Methods

2.1. Description of the Athens Tree Nursery pilot application

The Athens Urban Tree Nursery is part of the Goudi Park, an area in the process of redevelopment and regeneration to become the key metropolitan park of the capital. The area, which lies in the heart of Athens, is a mixed-use area, comprising of urban green and urban agriculture spaces as well as administration and residential uses. The regeneration is an effort to boost both the local economy and improve quality of life for the 4.000.000 citizens of the Attica Region. The nursery comprises 4 ha of vegetation, supplies all urban parks and green spaces of Athens with plant material and uses potable water from Athens's Water Supply and Sewerage Company (EYDAP) for its irrigation. The city is seeking alternative water sources to achieve environmental, social and financial benefits for the installation of a sewer mining modular unit for urban green irrigation at the point of demand would be of direct benefit for the sustainability of the new metropolitan park. Additionally, biomass produced from sludge treatment, can be treated and reused as fertilizer onsite as part of a portfolio of autonomous, decentralized water, energy and materials circular solutions for cities in water scarce areas. The flow diagram of the entire process from pumping the sewage until the production of recovered water and fertilizer is shown in **Figure 1.**

In Greece, it is the first time that the sewer mining technology is implemented in a real environment. A pre-built pumping station has been installed to supply the compact MBR unit. The pumping station's supply is occurred by the EYDAP's gravity sewage pipeline passing through a well which is located within the premises of Athens City Fountain (Goudi). The wastewater is treated by a membrane bioreactor, while a UV disinfection unit assures that the water quality lies within the legislation limits. Dessin's unit proved that the effluent water lies within the limits that have been set by the Greek Legislation (JMC 114116/2011) (Plevri et al., 2016, 2018) .

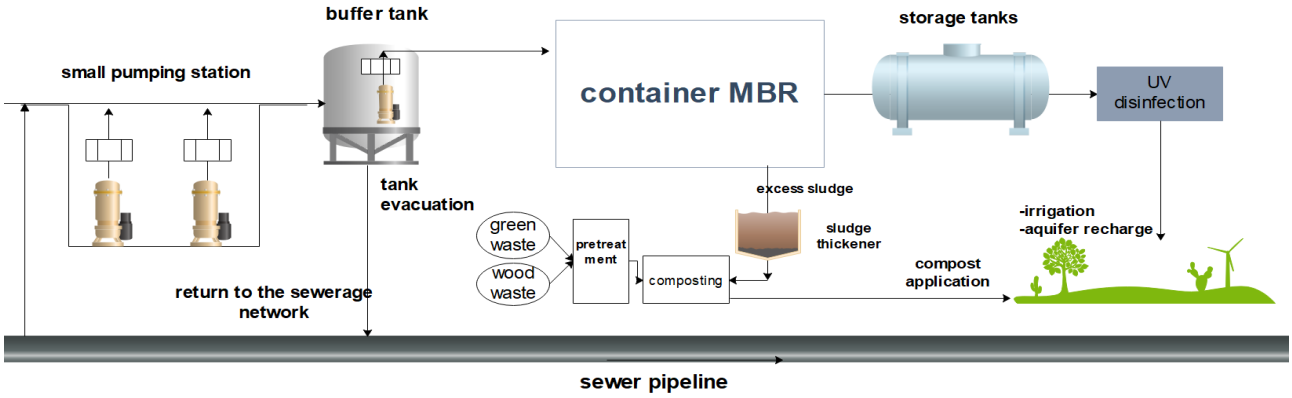

Figure 1. Flow diagram of the Athens Tree Nursery Application

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