H.F.R.I.
Hellenic Foundation for Research & Innovation

Description of the funded research project

1st Call for H.F.R.I. Research Projects to Support Faculty Members & Researchers and Procure High-Value Research Equipment

Basic info of FORWARD-WATER

Title of the research project: Investigating the application of forward osmosis and downstream processing for resource recovery of wastewater

Principal Investigator: Dr Simos Malamis

Reader-friendly title: FORWARD-WATER

Scientific Area: Engineering Science and Technology

Institution and Country: National Technical University of Athens, Greece

Host Institution: National Technical University of Athens (NTUA)

Collaborating Institution(s): Brunel University London

Project webpage:https: www.forwardwater.gr

FORWARD WATER

RESEARCH TEAM

Dr. Simos Malamis (Principal Investigator)

Dr. Constantinos Noutsopoulos

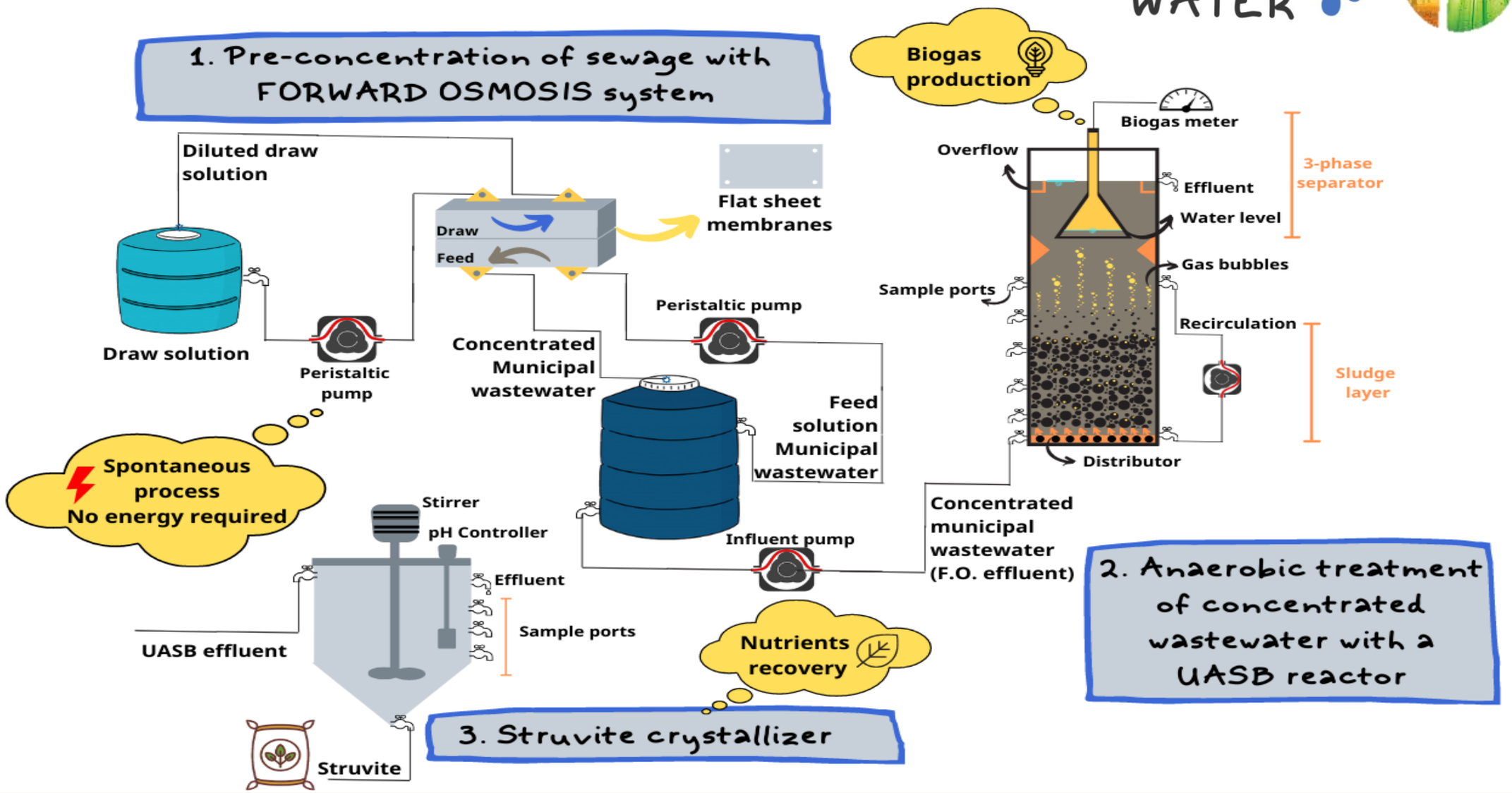
PhD Candidate: Eua Themeli

PhD Candidate: Stavroula Kappa

Budget: 190,000.00 €
Duration: 36 months

H.F.R.I. Hellenic Foundation for Research & Innovation

Synopsis of FORWARD-WATER



FORWARD-WATER will develop and implement **a revolutionary process for treating wastewater, which consists of pre-concentration using the spontaneously occurring forward osmosis (FO) process followed by suitable downstream processes to recover energy and materials. These processes consist of anaerobic treatment to recover energy and chemical precipitation to recover nutrients.** Through FO, we will convert municipal sewage **into a low-volume effluent characterized by high organic carbon and nutrient concentrations**, thus increasing the efficiency of downstream recovery processes.

Originality of FORWARD-WATER

The **pioneering combination of the FO with the Upflow Anaerobic Sludge Blanket (UASB) process and struvite precipitation** is one of the **most innovative aspects of the project**, as, based on the current literature, it has never been implemented before. During the implementation of the project, critical operating conditions and parameters will be investigated and evaluated in each system, some of which are the following:

- **Long-term investigation** of the FO system on a laboratory scale against different operating parameters
- Development and demonstration of **an innovative draw solution selection protocol**, defining the selection criteria for the most suitable draw solution(s) for the FO process, by considering also the downstream anaerobic treatment process
- Development and demonstration of **an alternative membrane cleaning protocol** based on the assessment and comparison of the effectiveness **of both physical and chemical cleaning techniques**
- Implementation of the **UASB** process for the treatment of concentrated FO effluent **at relatively low temperatures** (20 ℃)
- **Development/cultivation of a resistant microbial community** to high salt concentration for **energy recovery** in the form of **biogas**
- Production of **soil conditioner in the form of struvite** by applying chemical precipitation in the **nutrient-rich effluent** of UASB reactor
- Providing data/results and feedback for the conduction of **LCA and LCC evaluation**, as currently there is insufficient evidence of the long-term environmental effects and the economic benefits of this process

Impact of FORWARD-WATER

Expected Results	Research Project Impact
• Determination of the **most effective draw solution and membrane material** for FO application, and its compatibility with the downstream anaerobic treatment • Optimization of **membrane fouling and concentration factor** as a function of operating parameters in the FO process • Maximize **energy recovery** through the application of the anaerobic process • Minimization of **inhibitory effects** through the development of **a resistant microbial community** in the anaerobic process • Accomplish **nutrient recovery** from the concentrated FO effluents by chemical precipitation • Evaluation of the **overall environmental, social and economic benefits** of the envisaged processes	• Increasing the **efficiency of wastewater management systems** with particular regard to **energy saving and low cost infrastructure** • Reducing **dependence on fossil fuels** and simultaneously **minimizing the treatment cost** of sewage • Enhancing the **agriculture sector** through the **recovery of nutrients** from sewage, and **reducing the consumption of chemical fertilizers** • Minimizing **carbon footprint and climate change** • Promoting **knowledge transfer** regarding wastewater management and resource recovery to the wider scientific society • Obtaining **socio-economic, environmental and technical information** to influence European country policies in terms of wastewater management • Raising **public awareness** about the importance and benefits of resource recovery and the use of a **circular wastewater management system**

Importance of FORWARD-WATER

Through the materialization of the project, the research team has the opportunity to **develop and investigate a novel wastewater treatment system**. In addition, the project will enable **the P.I**. to organize, conduct and supervise a new scientific project, thus providing the means **to upgrade his research excellence**. Moreover, **the three PhD candidates**, who will participate in the project, will **gain significant scientific and research experience** by conducting both laboratory-scale experiments and evaluation studies using LCA & LCC tools. FORWARD-WATER will provide to one of them the opportunity **to complete part of his/her doctoral studies**, thus strengthening the research team of the H.I.. From a financial perspective, it strongly **supports the H.I.**, as within the project, useful **laboratory equipment and consumables** will be purchased. Finally, it significantly enhances **cooperation between universities and the competitiveness of the H.I.**, as **various dissemination activities** will be carried out including participation in conferences and networking events.

www.forwardwater.gr

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