Case study factsheet

WRRF - UNIPA - Water Resource Recovery Facility - University of Palermo

Last update on 2024-12-09

Project WIDER UPTAKE

University of Palermo, Italy , **Italy**



Description

An innovative and unique water resource recovery hub (namely, Water Resource Recovery Facility - WRRF), was built at Palermo University, Italy. The UNIPA-WRRF was inaugurated on October 17, 2022, after a construction phase that lasted one year. The hub stands as a leading model in applying the circular bio-economy paradigm to the water sector locally, in the region of Sicily, and worldwide. Through experimental activities, the facility aims to address climate change challenges and propose novel sustainable solutions in the wastewater treatment processes.

The main goal of the UNIPA - WRRF is the recovery of the following resources from wastewater treatment:

1. **Nutrient Recovery**: employing adsorption/desorption columns filled with biochar and zeolite. This process allows the recovery of nitrogen and phosphorous which are reused in agriculture as fertilizers at slow-realize.
2. **Bioplastic Production**: through the processing of wasted sewage sludge, the facility produces polyhydroxyalkanoates, a bioplastic precursor. This initiative reduces harmful waste that needs high money and energy demand treatment while providing a sustainable alternative to conventional petroleum-based plastics.
3. **Water Reuse**: The UNIPA - WRRF hub employs innovative, water smart solutions to treat and reuse wastewater. This reclaimed water can be used in agriculture for crops irrigation.
4. **Sewage sludge composting**: by converting wasted sewage sludge into compost, the facility supports organic agriculture practices and contributes to soil enrichment.

The UNIPA-WRRF is composed by four main elements: i) an innovative pumping station for the collection and transport of wastewater produced in the university campus; ii) a pilot plant hall where the nutrient recovery, bioplastic production and water reuse practice are carried out; iii) greenhouse for water reuse experimentation on plant in vessels where the fertilizers, the compost and the treated water are tested to analyze the soil-water-crop interaction; iv) resource recovery laboratory for chemical-physical analysis, greenhouse gas emission monitoring and environmental impact assessment.

Applied technology:

1. Wastewater treatment
2. Water Reuse
3. Nutrient recovery
4. Bioplastic recovery

Outcome of assessments

The experimental activities carried out at the WRRF were based on a holistic approach to comprehensively compare the water smart solutions studied by considering their efficiency and their environmental impact. Overall, ten different solutions were studied to achieve treated water for reuse. The effect of the treated water and the recovered fertilizers was studied on three different types of crops. Four innovative solutions were studied and optimized in view of producing polyhydroxyalkanoates from sewage sludge. The results of the project implementation are expressed by the scientific publications produced in the last three years, summarized below. The project results were also presented at the International Conference on Wider-Uptake of Water Resource Recovery from Wastewater Treatment - ICWRR2024, organized in Palermo, 18-21 June 2024. Moreover, the results produced within the Wider Uptake project are publicly accessible at the link: https://database.wider-uptake.eu/. Finally, the water smart solution studied at the pilot plant hall of the WRRF have been applied to full scale wastewater treatment plants (WWTP) of Corleone and Marineo, Sicily (Italy).

Water Resource Recovery Facility - UNIPA

Legislation and policy recommendations

The local policy makers engagement produced a legislation focusing on the limits and parameters to regulate the water reuse practice in Sicily (Law 22 March 2022, n. 4; Implementing decree 6 February 2024, n. 6). The national government engagement produced a memorandum of understanding agreement discussed by the Italian republic.

Applied technologies

- **Ammonium adsorption on zeolites**
- **Biological systems**
- **Civil and Environmental Engineering**
- **Membrane Bioreactor (MBR)**
- **Nutrient recovery**
- **Nutrients/Material recovery technologies**
- **Resource for Circular Economy**
- **Wastewater Treatment and Sludge Valorization**
- **Wastewater treatment technologies for water reuse**
- **Water and Wastewater Engineering**
- **Water recovery technologies for water reuse**
- **Water Reuse and Recycling**

Publications and references

Water Resource Recovery Facilities (WRRFs): The Case Study of Palermo University (Italy)
https://doi.org/10.3390/w13233413

Water reuse from wastewater treatment: The transition towards circular economy in the water sector
https://doi.org/10.1016/j.biortech.2022.127951

Nutrient recovery from wastewater treatment by ultrafiltration membrane for water reuse in view of a circular economy perspective
https://doi.org/10.1016/j.biortech.2022.127929

Trading-off greenhouse gas emissions and 741/2020 European Union water reuse legislation: An experimental MBR study
https://doi.org/10.1016/j.biortech.2023.129794

Polyhydroxyalkanoates production by an advanced food-on-demand strategy: The effect of operational conditions
https://doi.org/10.1016/j.cej.2023.145007

Polyhydroxyalkanoate production from fermentation of domestic sewage sludge monitoring greenhouse gas emissions: A pilot plant case study at the WRRF of Palermo University (Italy)
https://doi.org/10.1016/j.jenvman.2023.119423

Water reuse of treated domestic wastewater in agriculture: Effects on tomato plants, soil nutrient availability and microbial community structure
https://doi.org/10.1016/j.scitotenv.2024.172259

Assessing the aerobic/anoxic enrichment efficiency at different C/N ratios: polyhydroxyalkanoate production from waste activated sludge
https://doi.org/10.1016/j.watres.2024.122687

Scale

Operational scale of this case study related to the application of tools and technologyies

- Local scale

Challenge

Challenge that is addressed through the application of tools and/or technologies to the case study

- Need for reuse and recovery schemes for wastewater & sludge

Related tags

sludge treatment | wastewater | Resource recovery | wastewater treatment technologies | Wastewater reuse | Nutrient recovery | Wastewater management

Contact data

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https://wideruptake.unipa.it/water-resource-recovery-facility