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# A geothermal energy system for wastewater sludge drying and electricity production in a small island

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## Abstract

Waste management and energy production are becoming critical issues in geographically disadvantaged areas, like small islands. For waste disposal the most common strategy is shipping to the mainland, due to the scarcity of land and local suitable treatments. Electricity generation is based on the importation of fossil fuels for local production, due to the lack of connections with continental energy networks. Both, waste shipping and fuels importation determine strong dependence on the mainland, as well as high economic and environmental cost for small islands. Therefore, using local renewable energy sources is extremely attracting. In this work, geothermal energy is considered for thermal drying of wastewater sludge and electricity supply of the whole wastewater treatment. The system is analysed for the case study of Pantelleria, a small island in Southern Italy, where sludge is currently dewatered to a final water content of 70-80%, and then shipped to mainland. The proposed system decreases wastewater sludge to be transported and disposed by 73.3%. Its profitability is demonstrated by several economic indicators, showing a Simple Payback time equal to 8.34 years and a Net Present Value of 502 k€. In addition, a sensitivity analysis for the main parameters affecting plant operation is carried out.

*Keywords:* Renewable energy, ORC, Heat recovery, Thermal drying.

## 1. Introduction

Several physical, demographic and economic issues, such as limited land and resource availability, environmental restrictions, isolation from mainland, contribute to increase vulnerability of geographically disadvantaged areas, like small islands. As a consequence, several common issues, such as waste management and electricity supply, cannot be addressed using conventional strategies, becoming crucial challenges in small islands [1]. In addition, touristic activity, that often represents a significant economic income for small islands, increases waste generation and electricity demand during summer season. Simultaneously, in such touristic areas the safeguard of quality, environment and aesthetic value of the landscape is crucial and it limits the adoption of several common technologies for waste management and electricity production [2–4]. Concerning waste disposal, considering the scarce land availability and the environmental restrictions, options for waste management, such as landfilling, incineration or composting, are very limited [5]. This circumstance, along with scale diseconomies and deficiencies of the system, makes the cost of waste management higher than in continental regions [6]. Therefore, the most common disposal strategy is based on shipping waste to the mainland [5], with dramatic economic, energy and environmental costs. Shipping to the continent is common practice also for sewage sludge, that is the solid by-product of wastewater treatment. In small islands, the capacity and the technology of the existing wastewater facilities are inadequate for the requirements of the local population, and the discharge of untreated or not properly treated sewage causes severe problems of water contamination, with serious consequences for human health and habitats biodiversity [7–10]. In small urban or rural areas, the use of septic tank is a common practice for wastewater treatment, but several problems, such as lack of sludge removal and sludge disposal, have to be faced [11]. Over the last years, wastewater and sludge treatments have been improved to satisfy the recent standards concerning the quality of water effluents [12]. Both wastewater and sludge treatments are high energy-intensive [13], and improving the quality of the process is also increasing their energy demand [14]. This represents a crucial challenge in small islands, where energy is usually produced through diesel generators, determining high polluting emissions [15]. In addition, the imports of fossil fuels, due to scarce sources

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