Potential application of renewable energy sources at urban wastewater treatment facilities in Palestine – three case studies

Manal Taha*, Rashed Al-Sa’ed

Institute of Environmental and Water Studies, Birzeit University, P. O. Box 14, Birzeit, Palestinian Authority, email: manal.taha@student.birzeit.edu (M. Taha), rsaed@birzeit.edu (R. Al-Sa’ed)

Received 23 January 2017; Accepted 29 October 2017

ABSTRACT
This paper aimed to assess the energy consumption and the removal efficiency of three wastewater treatment plants (WWTPs) in Palestine and explores the potential application of renewable energy with associated impacts on unit operations. National rules and regional guidelines for treated water are regulatory instruments for the construction approval of WWTPs in Palestine. Three urban WWTPs of various technologies were selected as case studies for the assessment. The technologies applied were conventional activated sludge with anaerobic sludge digestion, extended aeration and membrane bioreactor (MBR) serving Nablus, Al-Bireh and Altira cities, respectively. Analysis of collected data on the BOD_5 removal were 96%, 98% and 99%. The removal efficiency of nitrogen reached 85% and 95% for Al-Bireh and Altira and not accounted for in Nablus WWTP. The energy required for both liquid and sludge lines was calculated based on the available data and correlated with the treatment efficacy. Results analysis revealed wide variations in the energy consumption among the three WWTPs. Altira MBR showed normal trends compared to published literature with 2.88 kWh/m^3, of which 40% was consumed by the biological treatment stage. Al-Bireh WWTP consumed 1.86 kWh/m^3 with 35% of the electrical consumption for biological stage, and 24% for the sludge line. Nablus-WWTP consumed 2.25 kWh/m^3 with 62% of the energy consumed by the biological stage and 34% for sludge line. Under load operation below the design capacities, the specific energy consumption for Al-Bireh and Nablus WWTPs are contradicting common published data for activated sludge treatment systems. Use of renewable energy could assist in the reduction of the annual energy operational costs. Assessment of solar photovoltaic (PV) application could yield electricity sufficient for Altira and Al-Bireh pump station facilities covering 9%, 15%, and 1% of their energy demand. PV installation at Nablus WWTP showed marginal impacts if connected off-grid or if combined heat and power are not operational until 2020, payback periods were estimated at 7.5 and 18.7 years, respectively.

Keywords: Wastewater treatment; Removal efficiency; Treatment cost; Renewable energy

*Corresponding author.