Announcing the Final Examination of Mousa Maimoun for the degree of Doctor of Philosophy

Time & Location: February 19, 2015 at 1:00 PM in Engineering I 288
Title: Life-cycle Greenhouse Gas Emissions and Water Footprint of Residential Waste Collection and Management Systems

Three troublesome issues concerning residential curbside collection (RCC) and municipal solid waste (MSW) management systems in the United States motivated this research. First, reliance upon inefficient collection and scheduling procedures negatively affect RCC efficiency, greenhouse gas (GHG) emissions, and cost. Second, the neglected impact of MSW management practices on water resources. Third, the implications of alternative fuels on the environmental and financial performance of waste collection where fuel plays a significant rule.

The goal of this study was to select the best RCC program, MSW management practice, and collection fuel. For this study, field data were collected for RCC programs across the State of Florida. The garbage and recyclables generation rates were compared based on garbage collection frequency and use of dual-stream (DS) or single-stream (SS) recyclables collection system. The assessment of the collection programs was evaluated based on GHG emissions, while for the first time, the water footprint (WFP) was calculated for the most commonly used MSW management practices namely landfilling, combustion, and recycling. In comparing alternative collection fuels, two multi-criteria decision analysis (MCDA) tools, TOPSIS and SAW, were used to rank fuel alternatives for the waste collection industry with respect to a multi-level environmental and financial decision matrix.

The results showed that SS collection systems exhibited more than a two-fold increase in recyclables generation rates, and a ~2.2-fold greater recycling efficiency compared to DS. The GHG emissions associated with the studied collection programs were estimated to be between 36 and 51 kg CO2eq per metric ton of total household waste (garbage and recyclables), depending on the garbage collection frequency, recyclables collection system (DS or SS) and recyclables compaction. If recyclables offsets are considered, the GHG emissions associated with programs using SS were estimated between $787$ and $589$, compared to between $279$ and $217$ kg CO2eq per metric ton of total waste for DS programs. In comparing the WFP of MSW management practices, the results showed that the WFP of waste landfilling can be reduced through implementing bioreactor landfilling. The WFP of electricity generated from waste combustion was less than the electricity from landfill gas. Overall, the WFP of electricity from MSW management practices was drastically less than some renewable energy sources. Finally, the MCDA of alternative fuel technologies revealed that diesel is still the best option, followed by hydraulic-hybrid waste collection vehicles (WCVs), then landfill gas (LFG) sourced natural gas, fossil natural gas and biodiesel. The elimination of the fueling station criterion from the financial criteria ranked LFG-sourced natural gas as the best option; suggesting that LFG sourced natural gas is the best alternative to fuel WCV when accessible.

In conclusion, field data suggest that RCC system design can significantly impact recyclables generation rate and efficiency, and consequently determine environmental and economic impact of collection systems. The WFP concept was suggested as a method to systematically assess the impact of MSW management practices on water resources. A careful consideration of the WFP of MSW management practices and energy recovered from MSW management facilities is essential for the sustainable appropriation of water resources and development.

Major: Environmental Engineering

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Approved for distribution by Debra Reinhart, Committee Chair, on February 19, 2015.

The public is welcome to attend.