OPTIMIZATION OF MUNICIPAL SOLID WASTE MANAGEMENT USING EXTERNALITY COSTS

Veronica Martinez-Sanchez, Technical University of Denmark (DTU)
vems@env.dtu.dk
James W. Levis, North Carolina State University (NCSU)
Anders Damgaard, Technical University of Denmark (DTU)
S. Ranji Ranjithan, North Carolina State University (NCSU)
Joseph F. DeCarolis, North Carolina State University (NCSU)
Morton A. Barlaz, North Carolina State University (NCSU)
Thomas F. Astrup, Technical University of Denmark (DTU)

Key Words: Externality Cost, Waste management, Optimization, LCC

Economic and environmental impacts associated with solid waste management (SWM) systems should be considered to ensure sustainability of such systems. Societal life cycle costing (S-LCC) can be used for this purpose since it includes "budget costs" and "externality costs." While budget costs represent market goods and services in monetary terms, i.e. economic impacts, externality costs include effects outside the economic system such as environmental impacts (translated in monetary terms).[1] Numerous models have been developed to determine the environmental and economic impacts associated with SWM systems (e.g., EASETECH[2]) by using "what-if" scenario analyses. While these models are an essential foundation that enables a systematic integrated analysis of SWM systems, they do not provide information about the overall optimal solution as done with optimization models such as SWOLF.[3] This study represents the first attempt to optimize SWM systems using externality costs in SWOLF. The assessment identifies the waste strategy that minimizes externality costs and other criteria (budget costs and landfilling) for a specific case study. The latter represents a hypothetical U.S. county with annual waste generation of 320,000 Mg. The externality cost includes the damage costs of fossil CO_2, CH_4, N_2O, $PM_{2.5}$, PM_{10}, NO_X, SO_2 , VOC, CO, NH_3, CO, Hg, Pb, Cd, Cr (VI), Ni, As, and dioxins.

Table 1 shows the results of the optimization including: i) optimization criteria, ii) waste flows and iii) eco-efficiency indicator (ratio between externality costs and budget costs). Minimal externality costs are obtained when incinerating most of the waste (88%) and commingled collection of recyclables (12%). The eco-efficiency of this waste strategy corresponds to -0.6, i.e. its environmental benefits (negative externality costs) correspond to approximately half of its budget costs. On the other hand, there is the solution with minimal budget costs (100% of the waste is landfilled) in which the environmental load (positive externality cost) represent one third of the budget costs (positive eco-efficiency indicator). In between these options, there is a strategy with minimal landfilling in which the organic waste is sent to anaerobic digestion, the recyclables to a single stream MRF and the residual to a mixed waste MRF. Most of the externality costs of the three strategies stem from SO_2, NOx and GHG as suggested by Woon & Lo.[4] The case study shows that waste solutions identified by optimization modelling differ from common SWM systems selected for analysis in state-of-the-art accounting modelling.

Table1: Optimization results of the case study. EC = Externality Cost, GHG = Greenhouse Gas, LF = Landfilling, BC=Budget Cost, AD=Anaerobic Digestion, MW-MRF=Mixed Waste MRF and SS-MRF=Single Stream MRF

Optimization Criteria	Waste Flow (%)					Eco- Efficiency
	Incineration	Landfill	AD	MW-MRF	SS-MRF	
Minimal EC	88				12	-0.6
Minimal LF			50	32	18	-0.2
Minimal BC		100				+0.3

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