Integrated environmental and economic assessment of waste management systems - DTU Orbit (18/08/2019)

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The Solid Waste Management (SWM) sector has evolved from a simple control of emissions towards a resource recovery sector while still being constrained by strict emission regulations. For that waste authorities are paying increased attention to the waste hierarchy as a set of priorities for solid waste treatment options to boost this shift towards higher resource recovery. In this hierarchy, waste prevention has the highest priority, followed by re-use and recycling options, and what cannot be recycled should be energy recovered; and, finally, the least favoured option is disposal in landfills. However, the waste hierarchy does not consider the local needs/conditions of each geographical area, and it cannot be used to identify sustainable SWM options by itself. Environmental impact assessment can help with this task as holistic decision-support tool. Nevertheless, waste authorities need economic assessment of SWM systems alongside environmental impacts assessment to take budget constrains into account.

In light of the need for combined environmental and economic assessment of SWM, this PhD thesis developed a consistent and comprehensive method for integrated environmental and economic assessment of SWM technologies and systems. The method resulted from developing further the generic Life Cycle Costing (LCC) framework suggested by Hunkeler et al. (2008) and Swarr et al. (2011) to apply it on the field of SWM. The method developed includes: two modelling approaches (Accounting and Optimization), three cost approaches (Conventional, Environmental and Societal LCCs) and two goal perspectives (Planning and Analysis).

• The modelling approach describes how the scenarios are defined. The “Accounting approach” defines the technological pathway of each scenario before the study is performed, while in the “Optimization approach” the scenarios are the results of an optimization process.

• The cost approach describes cost principles and level of LCA integration. Conventional and Environmental LCCs are financial assessments, i.e. include marketed goods/services, but while Environmental LCCs include environmental impacts in a parallel LCA, Conventional LCCs do not. Societal LCC is a welfare economic assessment, i.e. includes marketed goods/services and effects outside the economic system (externality costs).

• The goal perspective differentiates between “Analysis” and “Planning” perspective. Analysis LCCs evaluate current status of a SWM system, while Planning LCCs focusses on the consequences a change in a system with respect to the status quo.

The applicability of the LCC framework was tested through four case studies from which the following conclusions can be drawn:

• Organic source-segregation incurs financial and social costs mainly related to the cost of bags and bins used by households, as well as extra collection costs related to the additional collection scheme for organics collection as well as extra cost of residual waste collection (compared with mixed waste).

• The environmental benefits related to food waste prevention (due to avoided food production) could be overtaken by the environmental loads associated with the alternative consumptions purchased with the savings generated from the prevented (unpurchased) food. This could be avoided if prevention campaigns were accompanied by other policies aiming at reducing the impact of alternative consumption patterns. The inclusion of these income effects is especially critical when the alternatives being compared in an LCC have significant differences on the use of scarce resources such as income, land and time. In these cases, LCC studies should be supplemented by specific analysis of potential behavioural changes in consumption patterns (defining alternative consumptions) associated with the SWM systems being assessed.

• Recycling and prevention strategies can have significant economic consequences in existing waste facilities whose operation will have to be adjusted based on the waste changes. Marginal costs of diversion strategies in existing WtE facilities depend completely on the response in such facility. However, regardless of the response type, it was demonstrated that marginal costs of diversion are several times different than average costs. Hence, when performing Planning LCC the dynamics of the SWM system (including effects in existing waste facilities) should be taken into account to avoid misleading conclusions.

• Optimization of SWM using Societal LCC demonstrated that the social optimal solution results from balancing economic and externality costs. Contrary, optimizing using either economic costs or externality costs lead to socially suboptimal solutions.

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