European Waste Management in a Global Warming Perspective

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Waste management in Europe has for decades been governed by the waste hierarchy, but statistics show that the 27 different member states represent a wide range of approaches. Many countries still rely strongly on landfilling, while other countries have reduced landfilling of MSW to less than 5%. Many factors play a role here: degree of implementation of the regulation, availability of land, and the possibility of utilization of heat recovered from the waste.

We modeled the greenhouse gas profile of the waste management systems of six European countries representing different waste management approaches, by using an attributional approach. It was clearly shown that countries like Germany and Denmark strongly supporting material recovery and energy recovery have waste management systems with substantial savings with respect to green house gas emissions. The interaction of the waste management system with the energy system appeared to be of major importance.

With a view to future development in waste technologies we performed a generic study comparing 40 different waste management systems as they could appear in Europe in the future using a consequential approach and assuming that biomass in a foreseeable future will become limiting. The results were expressed for each system in terms a Global Warming Factor representing the overall CO_2-eq per tonne waste managed, including direct emissions, material savings and energy savings, and also sequestered biogenic carbon. The GWFs were modeled by EASEWASTE (www.easewaste.dk) using various recycling schemes and up-to-date treatment technologies. The results showed that the most rational waste management scenarios can lead to substantial savings in CO_2-emissions per tonne municipal waste (Figure 1). Scenarios with landfilling of the residual waste showed savings in the range of 0-400 kg CO_2-eq tonne^{-1} municipal waste, scenarios with incineration of the residual waste showed savings in the range 200-700 kg CO_2-eq tonne^{-1} municipal waste, and scenarios with mechanical-biological treatment of the residual waste showed savings in the range 200- 750 kg CO_2-eq tonne^{-1} municipal waste. The estimated savings were affected by the waste composition (various European waste compositions), the crediting of the electricity produced in the waste management system (substitution of hard-coal-based electricity), the assumption that wood made excessive by paper recycling would substitute for fossil fuel in the energy sector, and that biogenic carbon bound in the landfill 100 years after its landfilling is a saving with respect to GHG accounting. These factors control the overall results and may each affect the results as much as 200 kg CO_2-eq tonne^{-1} municipal waste.

The scenario modeling and the sensitivity analysis showed that paper-rich waste as typical for northern Europe provides a better basis for GHG savings that waste rich in kitchen organics as expected to be found in southern Europe. This is independent of how the residual waste is treated. The energy recovery is very significant for the overall outcome of the scenarios and those scenarios with high

electricity recovery and high heat recovery - typical for incineration systems - or with direct use of RDF as a coal-substitute in coal-fired power-plants obtain the best GWF, i.e. the most savings. The more dirty the energy substituted the more savings obtained in the waste management system.

The GWFs for the 40 generic waste management systems show that waste management in addition to offering safe and hygienic management of the waste also may contribute to reducing the GHG emissions in society. The generic scenarios provide insight into which factors are important, but savings provided by a specific system must always be assessed paying attention to local waste composition and waste management technologies.

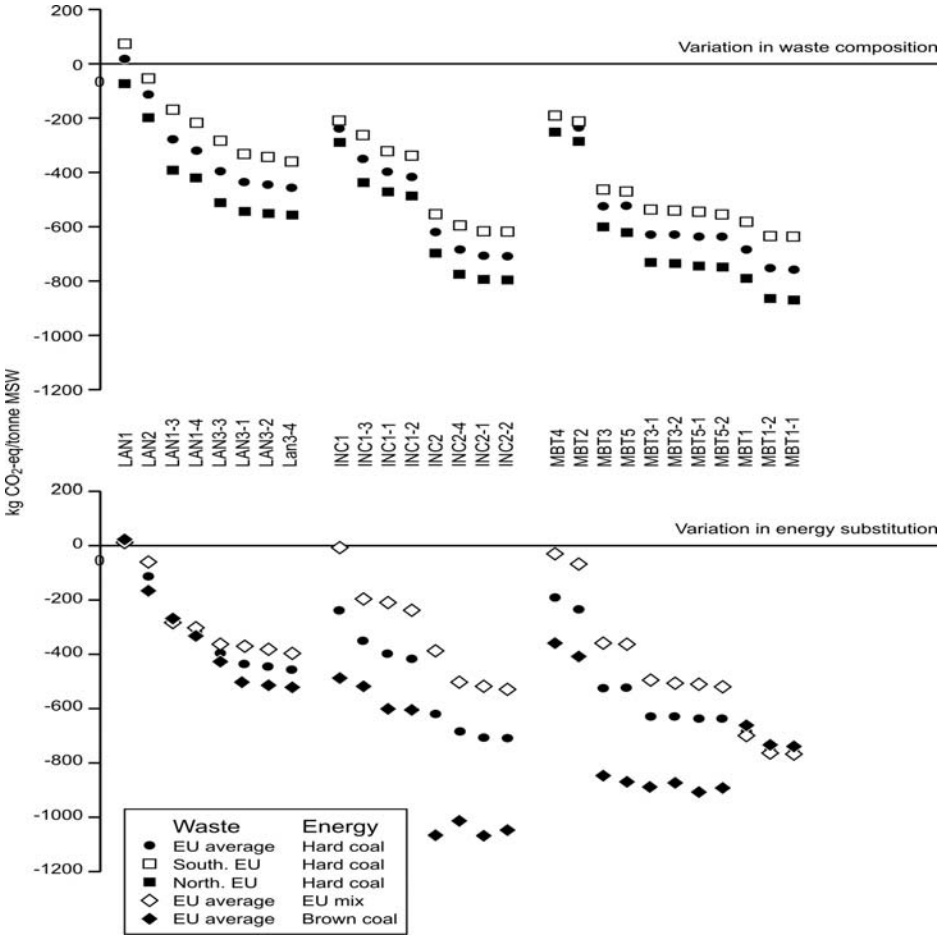

Figure 1. GHG savings in CO_2-eq per 1000 kg municipal waste for a range of waste management scenarios organized according to the treatment of the residual waste (landfill, incineration, MBT). The dot represents the basic scenarios while the two other markers for each scenario represent the variation caused by the waste composition and the energy substitution, respectively