Life cycle assessment of a bioreactor and an engineered landfill for municipal solid waste treatment

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Potential environmental impacts associated with the treatment of municipal solid waste (MSW) in two types of landfills, the engineered landfill and the bioreactor landfill, were assessed using a life cycle assessment (LCA). The hypothetical case study was the treatment of 600 000 tonnes of MSW generated over a period of two years. Since the landfill gas produced from the bioreactor landfill can be energetically valorized to either electricity or heat, this additional energy production function must be added to the systems considered through system boundaries expansion. The potential impacts were evaluated using the EDIP method, stopping after the characterization step. The CO_2 produced from the MSW placed in the landfill was considered to be biomass CO_2 and was not counted in the greenhouse gases inventory. A fraction of the potential landfill gas was assumed not to be produced since the conditions in the landfill are not ideal; the carbon contained in this un-emitted fraction remaining in the landfilled MSW, the CO_2 that would have been produced from this carbon, was assumed to be removed from the atmosphere and the carbon cycle and represents an environmental credit. A first observation from the inventory phase of the LCA is that the bioreactor landfill uses fewer natural resources and generates fewer wastes throughout its life cycle. This is mainly due to the fact that MSW is assumed to take up 25% less space in this type of landfill thus the material needs, proportional to the size of the landfill cell, and associated generated wastes are also reduced. The evaluated impacts are essentially associated with the added energy production unit processes (natural gas electrical power station and boiler) and the landfill gas, either the treatment of the collected fraction or the direct release to the atmosphere of the uncollected one.. Since, in the case of the engineered landfill, 1) no energy is recovered from the landfill gas and 2) the landfill gas is produced much slower so more of it is released untreated (the methane and chlorinated compounds it contains are not destroyed, i.e. transformed to biomass CO_2) after the end of the post-closure monitoring period, the evaluated impacts are on average 85% higher than for the bioreactor landfill.