Material and energy flows in waste collection logistics of a municipal and rural region in Styria 1996

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Customer: Styrian Provincial Government - Specialised Division 1c

Date of Publication: May 1996

1. Summary

By means of measured numbers, the expenditure required for the collection and transport of different categories of waste (tailings, bio-waste, problematic materials, etc.) in a municipal region (City of Knittelfeld) was compared with that of a rural region (District of Knittelfeld without Municipality). The system limits selected were, on the one hand, the production of waste at the producer's and, on the other hand, the processes of recycling and waste disposal resp.
The highest expenditure required in the two regions is the collection of paper, tailings and plastics, the second highest is that for the collection of bulky waste and in the bin for bio-waste. The largest difference between the two regions is that the expenditure required for collection and transport in the rural area is double that of the expenditure required in the municipal area. The specific energy demand for collection differs a lot among the categories of waste. For example, the collection of problematic materials requires energy that is more than ten times that of tailings. Plastics and metals also require much collection work, the quantities thus collected are low as compared to the quantities remaining in the tailings. In the rural regions, large material consumption is, above all, required for the round trip so that the erection of several sites seems desirable. An energy related consideration of all the types of waste for which thermal treatment is conceivable proves that a positive energy balance may be reached because of the high energy potential of the waste despite longer distances to be covered.
The project suggests that the existing collecting systems for problematic materials, waste metals and light fractions are made to be contradictory to the principle of saving resources by the overproportionate expenditure required for the separate collection. Future collecting logistics should increasingly provide for a highly efficient collection that is tailored to the regional needs and covers waste that can be collected at a low expenditure of energy, material and money and whose recycling and disposal makes a considerable contribution to achieving the goals specified by the AWG ("Abfallwirtschaftsgesetz" - "Waste Management Act") relating to environmental protection and optimal housekeeping with resources.

2. Starting Position

Due to the constantly increasing consumption of raw materials and goods, the quantity of the produced waste as well as the environmental impact also continue to increase. Waste management in Austria is closely linked to both ecological and economic aspects and cannot be seen as an isolated item in the sense of sustainable development. It would be wrong only to be pleased with decreasing quantities of tailings and increasing quantities of waste material collected without having scrutinised our entire waste management system as to its usefulness beforehand. The main goals defined by the AWG ("Abfallwirtschaftsgesetz" - "Waste Management Act") are the protection of people and the environment, saving raw materials and energy reserves and the preventive principle. This means that the waste disposal lines for the different types of waste are to be designed as to make sure that they load the biosphere as little as possible. Such principles as waste prevention, recycling and disposal should only serve to achieve these goals of waste management more efficiently.

3. Goals

Material flows in the field of collecting logistics of waste disposal companies were to be acquired quantitatively in order to make more detailed statements on the differences between rural and municipal regions, which principally

differ in their landscapes and their population structure, and to hint at strong and weak points of logistic companies of the existing waste management system. Furthermore, the energy necessary for the provision of the required infrastructure and its maintenance were to be balanced in order to compare the expenditure and yield of energy for the collection and transport of single types of waste or their thermal treatment. Besides, a calculation of the CO2 emissions during the collection and transport of the different types of waste was to give information on the environmental impact of waste collecting logistics.

4. Procedure

For achieving the goals, the method of a material and energy flow analysis was selected. A system analysis was to help to delimit the complex system of waste collecting logistics, the companies participating, different types of waste and regional or time related limits to such an extent that it would be easy to grasp.

System limit:

The system limit was selected as to make sure that the types of waste would enter the system as input from the time of their production, pass defined processes and leave the system as output at the entry into a certain further treatment process. The time related system limit was fixed at one year (1994). The regional limit was fixed to be the District of Knittelfeld and the Municipality of Knittelfeld. All the data relating to waste management were taken from the "Bundesabfallwirtschaftsplan" ("Federal Waste Management Plan") (UBA 1995 - UBA - Umweltbundesamt - Austrian Environmental Protection Agency) and the "Amt der Steiermärkischen Landesregierung (FA 1c)" ("Styrian Provincial Government (FA - Fachabteilung - Specialised Department 1c)").

Process description:

Within a waste collecting logistic system, different processes were selected. The first process described is the "collection" of waste, which starts from emptying the collecting bins and leads to emptying the waste collection lorry. "Delivery" is the process containing the private distance the respective households have to cover to get to the waste collecting centre. The process "round trip" corresponds to the distance to be covered from the starting point of the waste collecting lorry to reaching the first container to be emptied and the last emptying of the waste collecting lorry at the waste treatment site back to the starting point of its tour. "Transport" is defined as a process in which waste is transported after its collection over large distances to a facility for further treatment. For biomass collection, "container cleaning" is described as a separate process because it only takes place there.

Calculation (execution):

The designation "materials" does not only imply the individual types of waste but also the deliveries of materials and energy in the form of wash water and fuel, which are necessary to maintain the selected processes. Then the exports coming from the processes and the imports to the atmosphere will be calculated and stated as materials and material flows in the form of "exhaust gases" and "fresh air". An energy balance will only be made for the types of waste that can be used thermally in an incinerator. For the types of waste that are collected in containers, the degree of utilisation was calculated. Based upon the number of containers, the respective volume and the emptying frequency, the collecting volume per inhabitant and year can be calculated. This volume will be compared to the actual waste by calculating the degree of utilisation. As there are mostly only records on the mean fuel consumption of the respective transporting lorries, the mean fuel consumption will also be used to calculate the process "round trip" and the processes "collection" and "transport". For determining the CO2 quantities entering the atmosphere during the processes, still another formula was found.

5. Result / Benefits

A comparison of the types of waste that were treated showed for the two regions that the collection of problematic materials, waste metals and light fractions, in particular, required much energy. In analogy the expenditure required for the collection in bins for bio-waste in the rural region was very high, a separate collection of grass clippings seeming advantageous in the municipal region, in particular. Like for other types of waste, the quantity of waste paper collected by households also is closely linked with the density of the provision of containers. Waste disposal in business lanes in the rural region did not seem very useful. Collecting the light fraction along with the tailings could be equated with a low increase in the expenditure required for collecting the tailings in both regions. Due to a lack of data, the collection of sewage sludge and building residues could not be discussed in further detail. Considering the results, such collecting systems as those for problematic materials, waste metals and light fractions must be judged to be insufficiently efficient when it comes to achieving the goals of the AWG ("Abfallwirtschaftsgesetz" - "Waste Management Act"). This is due to the fact that the separate collection of these types of waste cannot be said to imply good housekeeping with resources. In general there are large saving potentials in the common collection of tailings and light fractions as well as in the round-trip processes of the regional partners, which make it desirable to provide for several sites of the waste disposal companies.
As combustible waste requires low collecting and transporting expenditure but has a high energy potential, a

positive energy balance may even be expected for larger distances to be covered to use this waste thermally.
In general preceding expeditious collections should be made dispensible by suitable waste disposal processes that are in accordance with the AWG ("Abfallwirtschaftsgesetz" - "Waste Management Act").