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Technological Forecasting & Social Change 73 (2006) 302–315
Technological Forecasting and Social Change

Industrial ecology and waste infrastructure development: A roadmap for the Dutch waste management system

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Received 1 July 2002; accepted 16 March 2004

Abstract

Decision-making on waste infrastructures is difficult because waste management is a complex, politically loaded and emotionally charged issue that is neither well structured, nor well understood. While sustainability is the ultimate goal of the EU environmental policy, there is no commonly accepted approach for its realisation. Industrial ecology has been suggested as a roadmap to sustainability. Its prescriptive tier can provide organising principles for more sustainable practices: closed material cycles, cascaded energy use and flexible system configuration. The engineering concepts, grade and recovery, provide a simple yet powerful means to assess policies and infrastructure concepts with respect to sustainability. When combined, industrial ecology and engineering yield sound infrastructure design specifications and decision-making support for waste infrastructure.

Keywords: Industrial ecology; Waste management; Waste policy; Recycling; Residue grade; Sustainability; Infrastructure development; Roadmap

1. Introduction

While sustainable development is the ultimate goal of EU waste policy, there is no commonly accepted approach to accomplish this objective. In this paper, a combination of industrial ecology

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0040-1625/$ - see front matter © 2006 Published by Elsevier Inc.
doi:10.1016/j.techfore.2004.03.009

principles with the practice of engineering is investigated to make the concept of sustainable development operational. The operational concept is then applied to the Dutch waste system to evaluate and specify waste infrastructure design for sustainable development, and to test the applicability of such synthesis to support the decision-making on waste infrastructures.

1.1. Waste infrastructure

Infrastructures contain the basic facilities of a system, country, society or organization, which enabling it to function. For countries, infrastructures comprise large-scale technological systems that consist of immovable physical facilities, and deliver an essential public or private service through the storage, conversion and/or transport of certain commodities [1]. The essential service the waste infrastructure delivers concerns the removal, disposal and recovery of municipal solid wastes (MSW). The waste infrastructure is the set of physical facilities necessary/dedicated to perform that function.

Since the 1970s the waste infrastructure has become an increasingly critical infrastructure. Sound waste management is an integral part of environmental protection [2]. Improper disposal of municipal waste can result in unsanitary conditions, which in turn can lead to pollution of the environment and to diseases. Robust, durable infrastructures have been constructed to safely dispose off the waste generated, and minimise impacts on environment and public health. These infrastructures include waste collection systems, a network of transshipment and separation points, and a limited number of disposal options such as landfilling, incineration and composting.

Generally, waste is collected in a multi-stream collection system. Each waste stream is transported via various transshipments and/or pre-treatment nodes that have a buffer function also. To a limited extent also sorting of waste occurs after collection. As illustrated in Fig. 1, final disposal of the remainder, the non-separated waste, is limited to a number of allowable operations, viz. landfill, incineration and composting. The waste infrastructure converts remaining waste into electric power and heat, fertiliser, and ashes usable in road construction and cement production. Final residues must be landfilled. Besides those obtained from separate collection systems, and some scrap metals and electricity, the resources recovered are of relative low quality. Current waste management represents an enormous loss of

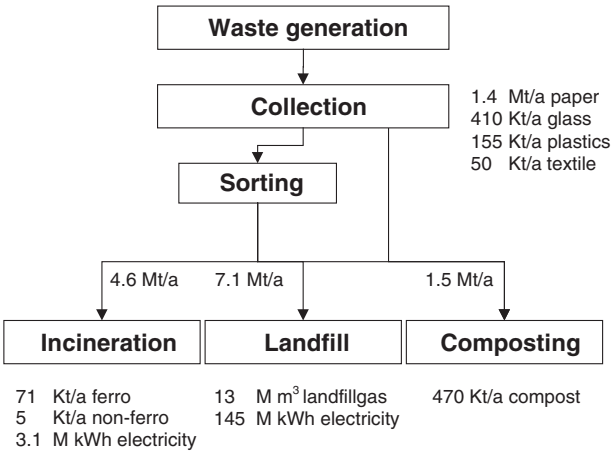

Fig. 1. A schematic of the Dutch waste infrastructure. Figures indicate material flows involved.