INTEGRATED WASTE MANAGEMENT

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Summary

The issue of managing waste is as old as civilization itself but the concept of Integrated Waste Management (IWM) has developed only during the past 30 years. IWM systems combine waste streams, waste collection, treatment and disposal methods into a practical waste management system. Each system can be region-specific, combining an appropriate mix of waste treatment options to reduce overall environmental burdens in

an economically affordable and socially acceptable way. The level of integration and the particular mix of waste treatment methods implemented in any IWM system will be dependent upon the prevailing local conditions. This flexibility encourages continuous improvement of processes, to pursue best technology and to customize solutions, all of which are necessary to accommodate shifts in the quantity and quality of the waste stream. The fundamental aim of any IWM strategy therefore, should be maximization of resource efficiency by promoting sustainable waste management that leads to reduced environmental emissions in a socially and economically acceptable manner.

1. A Historical Perspective

Human cultural development from nomadic to sedentary societies and the subsequent development of towns and cities created the need to manage solid waste. The earliest forms of waste management, referred to even in the Bible, involved burial and burning both of which, in more refined form, continue to be management options within modern Integrated Waste Management systems.

The move towards an integrated approach to waste management began in 1962 when this approach was described as “viewing the problem in its entirety as an interconnected system of component operations and functions”. This recognition of the full complexity of waste management practices and acceptance that systems analysis and mathematical modeling were necessary to optimize waste management operations and strategy development was a fundamental move towards the concept of IWM.

During the 1970’s, the concept further evolved within certain Solid Waste Authorities in the United States. These authorities began to implement waste management programs that integrated solid waste transportation, processing, recycling, resource recovery and disposal technologies.

The recognition that IWM systems would need to be implemented on a case-by-case basis came in 1978 when the U.S. Environmental Protection Agency stated that “[Waste] Management methods, equipment, and practices should not be uniform across the country since conditions vary, and it is vital that procedures be varied to meet them.” This was a shift away from a hierarchical approach to waste management to an approach that was more flexible in its application of waste management techniques.

In 1991, a task force from the Economic Commission for Europe published a Draft Regional Strategy for Integrated Waste Management that defined IWM as a “process of change in which the concept of waste management is gradually broadened to eventually include the necessary control of gaseous, liquid and solid material flows in the human environment.” This brought all waste arisings under the umbrella of IWM. The concept of IWM now included all waste types, the option of using a range of treatment technologies depending on the situation and an overall approach being taken with respect to the analysis, optimization and management of the whole system.

Another important development during this period was the establishment of the concept of sustainable development as development that ‘meets the needs of the present without compromising the ability of future generations to meet their own needs’. The

Brundtland report of the World Commission for Environment and Development (WCED) "Our Common Future" clearly spelled out that sustainable development would only be achieved if society in general, and industry in particular, learned to produce "more from less"; more goods and services from less of the world's resources (including energy) and less pollution and waste.

Thus waste management needs to be sustainable if it is to play a pivotal role in any overall sustainable development system. It is clear that because IWM takes into consideration the environmental, economic and social aspects of waste management, it offers the greatest opportunity to develop sustainable waste management systems.

2. Definition of Integrated Waste Management

IWM systems combine waste streams, waste collection, treatment and disposal methods into a practical waste management system that aims to provide environmental sustainability, economic affordability and social acceptance for any specific region. This is achieved by combining a range of treatment options including waste reduction, reuse, recycling, composting, biogasification, thermal treatment and landfilling (Figure 1). The key point is not how many waste management options are used, nor whether they all apply at the same time, but that they are combined in an optimum way as part of a single approach. IWM considers the total system and looks for the best mix of treatment methods to minimize economic costs and to maximize environmental protection and social benefits.

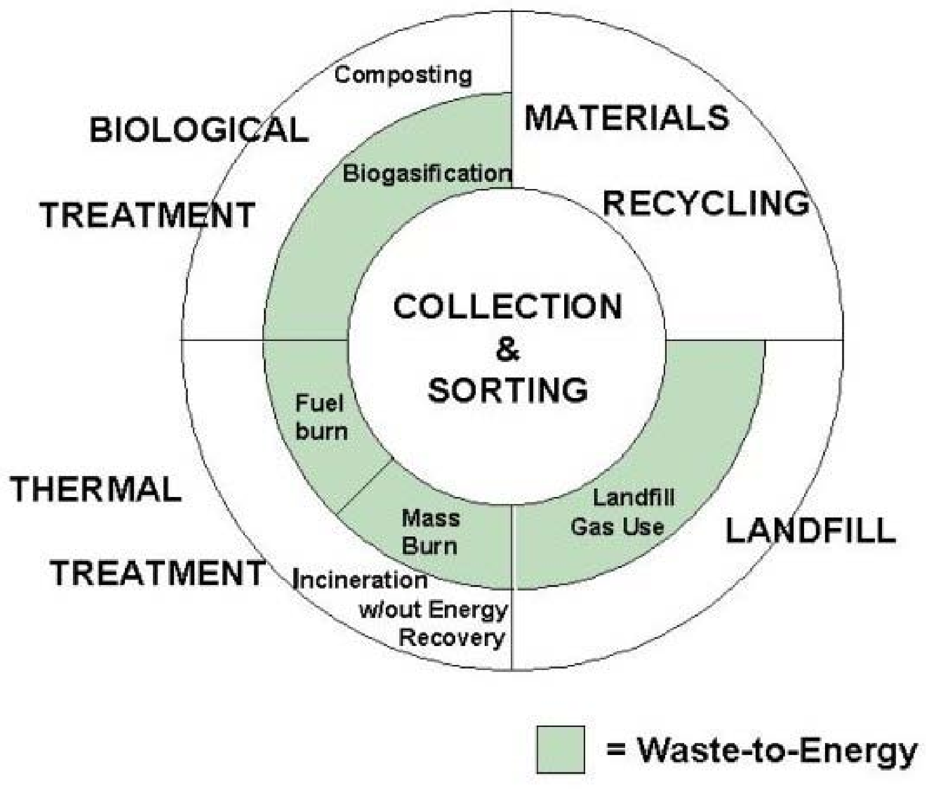

Figure 1: Elements of an Integrated Waste Management (IWM) System

The level of integration within any IWM system will be dependent upon the prevailing local conditions. A system in one municipality which incorporates recycling, incineration with energy recovery and landfill may be quite unlike another municipality's system which includes recycling, composting and landfill. This is not important as long as one retains the single overriding objective of the IWM principle: to find the most environmentally effective, economically efficient and socially acceptable way to manage the waste of a given region. The model (Figure 1) stresses the inter-relationships of the parts of the system and does not attempt to predict what would be the "best" system. There is no universal best system.

Figure 1 represents the possible elements of an IWM system in a developed country designed to manage municipal solid waste (MSW). The waste stream would be a complicated mix of materials requiring a corresponding mix of treatment options. The infrastructure and financial and technical resources would be available to implement and support such a system. In many developing countries, MSW is often a relatively less complicated mix of materials containing in excess of 50 per cent organic material. The infrastructure and technical and financial resources would be considerably more limited. In such a case the "best" model might be divided among biological treatment (e.g. composting), recycling and simple sanitary landfill. Over time, the model could change to meet changes in local conditions by incorporating a greater range of treatment technologies.

3. The Waste Management Hierarchy

IWM now supersedes the commonly referred to "waste management hierarchy". The waste hierarchy varies in its exact form but usually ranks waste management options in a preferred order: waste minimization, re-use, materials recycling, biological treatment, incineration with energy recovery, incineration without energy recovery, landfilling. The hierarchy intuitively 'feels right' and as such has greatly influenced waste management decisions and strategy at the local, national and international level during the past 25 years. Although such a hierarchy is widespread and often suggested, the value of this approach has limitations:

1. The hierarchy has little scientific or technical basis. There is no scientific reason, for example, why materials recycling should always be preferred to thermal treatment with energy recovery.
2. The hierarchy is of little use when a combination of options is used, as in an IWM system. In an IWM system, the hierarchy cannot predict, for example, whether composting combined with incineration of the residues would be preferable to materials recycling plus landfilling of residues. What is needed is an overall assessment of the whole system, which the hierarchy cannot provide.
3. The hierarchy does not address costs. Therefore it cannot help assess the economic affordability of waste systems.

The hierarchy should now be used as a simple menu of possible waste management options. It is also useful as a simple presentational tool to be used when discussing waste management with the public, although it should not be presented as a rigid set of preferences.

4. The Basic Elements of Integrated Waste Management

Within the context of sustainable development it has been recognized that there is a need to curb the growth in the quantity of waste produced. Where waste is created there is a need to recognize it as a resource and recover more value from it. The fundamental aim of any waste strategy, therefore, should be maximization of resource efficiency by promoting sustainable waste management. This will lead to reduced environmental emissions in a socially and economically acceptable manner. Clearly it is difficult to minimize the two variables - cost and environmental impact - simultaneously. There will always be a trade-off. The balance that needs to be struck is to reduce the overall environmental impacts of the waste management system as far as possible, within an acceptable level of cost. Deciding the point of balance between environmental impact and cost will always generate debate. Better decisions will be made if data on impacts and costs are available; such data will often prompt ideas for further improvements.

An economically and environmentally sustainable solid waste management system then is likely to be integrated, market-oriented and flexible. Such a system must handle all types of solid waste materials. The alternative of focusing on specific materials, either because of their ready recyclability (e.g. aluminum) or their public profile (e.g. plastics) is likely to be less effective, in both environmental and economic terms, than taking a multi-material approach. Furthermore, emphasis on specific materials may lead manufacturers to design products and packaging for recycling, perhaps at the expense of source reduction. Such misallocation of resources represents added environmental burdens that cannot be consistent with sustainable waste management.

The system must be capable of handling wastes from multiple sources such as domestic, commercial, industrial, institutional, construction and agricultural. Even hazardous waste needs to be dealt with within the system, but in a separate stream, so that it can benefit from any synergies. Focusing on the source of a material (on packaging or domestic waste or industrial waste) is likely to be less productive than focusing on the nature of the material, regardless of its source.

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Bibliography

Coleman, T. (1998). Life Cycle Program for Waste Management Program Profile. UK Environment Agency, Rio House, Bristol. [This is a Life Cycle Assessment computer program based on UK conditions].

European Recovery and Recycling Association (1998). Towards Integrated Management of Municipal Solid Waste. Avenue E. Mounier 83, bte 5, B-1200 Brussels. [This report characterizes leading-edge waste management systems in Europe and presents 11 case studies].

Gaskell, D.J. and White, P. R. (1996). Affordable Recycling of Household Waste. In Proceedings of Globec 96/Recycle 96, Davos, Switzerland. [This provides examples from across Europe of how material recycling can be achieved at low cost].

Nordone, A.J. and Franke, M. (1999). Application of Integrated Waste Management to Developing Economies. In Proceedings of the International Conference on Biological Treatment of Waste and the Environment. Weimar, Germany. [This presents a review of how experience with the development of IWM systems in developed economies can be used to implement IWM systems in developing economies].

Skumatz, L.A. (1993). Variable Rates for Municipal Solid Waste: Implementation Experience, Economics and Legislation. Reason Foundation, Policy Report No. 160. [This is a review of the effect of charging individuals for collection and disposal of municipal solid waste].

Thorneloe, S. A. (1997). Application of Life Cycle Management to Evaluate Integrated Municipal Solid Waste Management Strategies. USEPA National Risk Management Research Laboratory Air Pollution Prevention and Control Division. Research Triangle Park, NC 27711. [This is a Life Cycle Assessment computer program based on USA conditions].

White, P.R. (1997). Managing Towards Sustainability - Sustainable Product Life Cycles. ICHEME Environmental Protection Bulletin 052. [This presents an environmental management framework to assist in the development of sustainable products].

White, P.R., Franke, M. and Hindle, P. (1995) Integrated solid waste management: a life cycle inventory, 362 pp. Blackie Academic and Professional, Glasgow. [This presents a comprehensive discussion of Integrated Waste Management and Life Cycle assessment, providing a decision tool for waste managers and policy makers and includes the IWM-1 model].

World Commission on Environment and Development (1987). Our Common Future. Oxford Univ. Press. [This outlines the principal of sustainable development and the need for more efficient use of resources in the future]

Biographical Sketches

Dr. Adrian Nordone

Adrian Nordone is a manager within Procter and Gamble's Corporate Sustainable Development Department, Newcastle, UK. He received a Ph.D. in Environmental Toxicology from Clemson University, South Carolina, USA in 1994. He has worked for a number of environmental consulting companies in the area of human and ecological risk assessment for both contaminated sites and product safety. His current interest is the development and implementation of sustainable business practices.

Peter White MA (Oxon), MSc. (Lond). D.Phil (Oxon)

Peter White is Procter & Gamble's Associate Director for Corporate Sustainable Development, based at their Newcastle Technical Centre, UK. After a first degree in Zoology, he taught Health Science, Agricultural Science and Biology in Northern Nigeria for three years with Voluntary Service Overseas. He then took an MSc in Applied Hydrobiology in London, and a D.Phil in Chemical Ecology at Oxford, followed by post-doctoral research and teaching in the biological and environmental sciences, including posts at the Universities of Oxford, Arizona and California. Peter White joined P&G in 1991 where he has worked on sustainable solid waste management systems. He helped create and lead P&G's global team promoting the implementation of Integrated Solid Waste Management (ISWM) systems to handle municipal solid waste around the world. In 1995, together with two P&G colleagues, he wrote *Integrated Solid Waste Management: A Lifecycle Inventory*, a book which pioneered the use of Life Cycle methodology to plan sustainable solid waste systems. Peter has since chaired the Peer Review Panels for both the US Environmental Protection Agency and the UK Environmental Agency work in this area.

Dr. Forbes McDougall

Forbes McDougall joined Procter & Gamble in 1997 after completing 2 years post-doctoral work in the field of waste management in the UK, Holland and Malaysia. He obtained his PhD in Environmental

Engineering from the University of Newcastle upon Tyne in 1994. Since joining Procter & Gamble as a member of the Global Integrated Solid Waste Management Team, Dr McDougall has developed a user friendly and transparent Life Cycle Inventory computer model for integrated waste management systems and has been compiling case studies on the potential environmental and economic advantages of an integrated approach to waste management systems with respect to both planning and operation.

Glenn G. Parker

Glenn Parker is Manager of Corporate Sustainable Development for Procter & Gamble Inc. in Toronto, Canada. He has a Bachelors degree in Chemical Engineering from McGill University in Montreal, Canada and a Masters in Business Administration from McMaster University in Hamilton, Canada. He has had product development responsibility for a broad range of consumer products including household, personal care, paper and food products, as well as several year's experience in various professional, regulatory, human and environmental safety and environmental quality matters. Currently, he is active on the Brand Owner Council of Corporations Supporting Recycling, the industry association for solid waste matters for the food and consumer goods industry.

Ana-Maria Garmendia

Ana-Maria Garmendia is a Chemical Engineer from the Metropolitan University, Mexico City. She has worked in the consumer goods industry for the last 18 years, participating in technical external committees that have to do with health, trade and environmental matters. Holds the Presidency of SUSTENTA, an industrial organization that promotes integrated solid waste management to achieve sustainable development in Mexico. She is also President of the Latin American Federation of Industrial Solid Waste Associations. She is responsible for Environmental Technical Affairs in Latin America North within Procter & Gamble.

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