SLOVENSKI STANDARD
SIST CR 1460:1998

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Embalaža - Pridobivanje energije iz uporabljene embalaže

Packaging - Energy recovery from used packaging

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55.040	Materiali in pripomočki za pakiranje	Packaging materials and accessories

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Packaging - Energy recovery from used packaging

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SUMMARY

of the CEN/TC 261/SC 4/WG 4 Technical Report of 4 December 1993, titled "Energy Recovery from Used Packaging"

The European working group on "*Energy Recovery*" (WG 4) of the "*Packaging and the Environment*" sub-committe of the European Committee's for Standardization (CEN) "*Technical Committee on Packaging*" (TC 261) has reviewed existing knowledge and experience of technology and practice for recovering energy from combustible used packagings.

Energy recovery from municipal solid waste (MSW) plays an important role in integrated systems for resource and waste management. This is predominantly through mass burning MSW, and includes utilization of refuse-derived fuel (RDF) and packaging-derived fuel (PDF). Combustible used packaging contains a significant portion of the energy content within MSW, and has good fuel characteristics.

While, on average, about 20 per cent by weight of MSW in Europe consists of combustible used packaging (containing wood, paper, and plastics), this fraction represents at least 40 per cent of the energy content of MSW.

Presently some 28 per cent by weight of all MSW produced in Western Europe is incinerated, and energy is recovered from 23 per cent of the total. This corresponds to about 7 million tonnes of combustible used packaging, which makes energy recovery one of the recovery options for used packaging most widely in use.

There is, however, technical and commercial potential for a considerable increase in energy recovery from used packaging. The total potential amounts to nearly 30 million tonnes a year, which is equivalent to more than 14 million tonnes of oil. A forecast indicates that by the year 2000 nearly two thirds of the amount of packaging consumed in Europe will be a potentially valuable fuel for thermal energy generation.

Since packaging in a majority of applications is subject to functional and legal requirements, which do not normally apply for alternative uses of the material, combustible used packaging has generally lower contents of toxic substances and heavy metals. Such legal requirements are found in food contact legislation, and in legislation such as the CONEG laws in the U.S.A., which apply to all packaging. Energy recovery has the additional advantages of reducing potential bacterial hazards, providing stable landfill material (which may be considered for road building and other

applications), and reducing the need for space for and management of landfills.

A large amount of information about established technology and practice suitable for the clean production of energy from MSW exists. Techniques for waste treatment (sorting, shredding, etc.), combustion, and emission abatement with a long record of industrial use and well suited for thermal energy recovery from MSW are commercially available.

Fuel properties of technical and economic importance, such as heat value, ash content, etc., can be determined using internationally recognized standard methods, as can emissions from boiler plants. Experience and results from such measurements and evaluations are well documented in the scientific and technical literature.

Evidence shows that there are considerable advantages in utilizing energy from MSW, and, particularly, from the combustible part of used packagings. The required technology is commercially available, including highly efficient pollution control systems. These technologies are subject to continuous development and improvement.

FOREWORD

This technical report considers the recovery of energy from used packaging - within municipal solid waste (MSW) or as a refined, cleaner fuel - and has been prepared by experts of the CEN working group TC 261 (*Packaging*)/SC 4 (*Packaging and Environment*)/WG 4 (*Energy Recovery*). The working group has reviewed existing knowledge and experience related to technology and practice for recovering energy from combustible used packagings.

The role of used packaging within an integrated philosophy of resource management is assessed. The value of used packaging as a fuel is discussed, together with a review of its characteristics and potential environmental impact.

The terms used in the report are explained in an Appendix.

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CHAPTER 1. INTEGRATED RESOURCE MANAGEMENT

All activities consume resources, create wastes, and have some impact upon the environment. According to one model biophysical resources (energy and materials) flow from the ecosystem into the economy, while degraded products flow (as pollution) back into the ecosystem (Siddayo 1993). As society has grown in size and complexity, resource consumption and waste creation have also increased, causing louder demands for higher standards of environmental protection. Differences in national standards and practices can create barriers to trade, which should be overcome through harmonization where possible.

The World Commission on the Environment and Development (Brundtland Report, 1987) declared that the world should strive for sustainable development to "*meet the needs of the present without compromising the ability of the future generations to meet their own needs*". Amplifying this theme, the fifth environmental action programme ("*Towards Sustainability*") of the European Commission (EC) set down a philosophy towards the management of wastes as: minimization (prevention), re-use, material recovery (recycling), energy recovery, incineration without energy recovery, and landfill. Of course, each of these activities themselves consume resources and create wastes, which must be fully considered when assessing the best practicable environmental options. The waste produced by people at home and at work - municipal solid waste (MSW) - is clearly a waste of no further value to those who produce it. Yet MSW in general, and in particular combustible used packaging material within it, remains a resource with some residual value.

The amount of MSW created is now typically around one kilogram per person per day. Figure 1.1 illustrates the principal options available within an integrated resource and waste management scheme for packaging.

The EC recognises the need for an integrated view on resource and waste management taking all options into consideration when striving for the best possible solution. The 1991 EC Framework Directive on Waste stipulates that Member States must adopt appropriate measures to prevent or reduce waste production and environmental impact by re-use, recycling, and recovery to obtain energy or secondary raw materials from the waste.

Energy recovery is one of the resource management options to be considered together with re-use and material recovery. It is important to recognize that local conditions are relevant factors when making waste management decisions.

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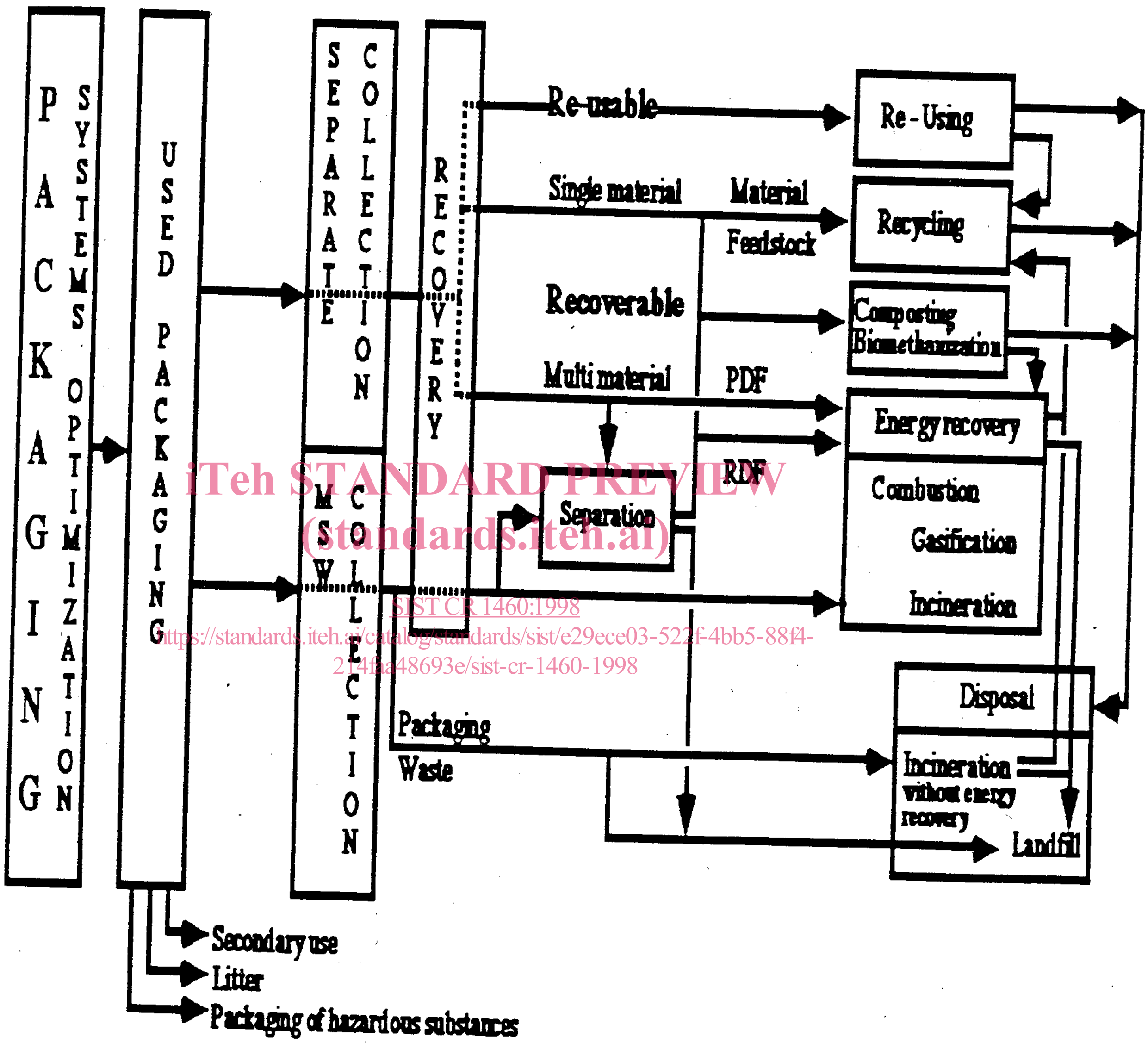

Figure 1.1. Flow chart showing an example of possible resource recovery options. MSW = Municipal solid waste; RDF = Refuse-derived fuel; PDF = Packaging-derived fuel.

Towards the end of the 1980's, the annual generation of all solid wastes within the EC was estimated at more than two thousand million tonnes, as shown in Table 1.1 (Renaux 1993).

Table 1.1. Waste categories and amounts (per cent by weight) in the EC at the end of the 1980's. Mt a^{-1} = million tonnes per year. (Renaux 1993).

Type of Waste	Mt a^{-1}	%
Agricultural	1100	51
Mining and power generation	400	19
Sewage sludge	230	11
Industrial	160	8
Household	90	4
Waste oils	2	0
Rubble	160	7
Total	2142	100

According to Rijpkema (1993), MSW in Europe amounts to some 140 million tonnes per year, and thus constitutes less than 7 per cent by weight of the whole waste stream (see Table 1.2). The proportion of MSW consisting of used packaging is variable, usually between one quarter (Reeves 1993) and one third (Hitchins 1993). Thus, packaging might only constitute about 2 per cent by weight of the total waste stream.

Table 1.2. Composition and energy data of European MSW.

Material	Amount/Fraction Mt/a	%	Net Calorific Value as Received, MJ/kg	Energy PJ/a[3)]	Mtoe/a[4)]	%
MSW[1)]	141	100	Ca. 10	1410	35	100
out of which:						
- Putrescibles	56.3	40	5.6	315	7.7	22
- Paper	38.0	27	12.5	475	11.7	34
- Plastics	9.9	7	33.4	330	8.1	23
- Glass	11.3	8	-	-	-	-
- Metals	8.5	6	0.4	-	-	-
- Miscellaneous	18.3	13	-	Ca. 290	7.1	20
out of which:						
- Combustible Packaging[2)]	29	21	20[5)]	582	14.3	40

1) Source: Rijpkema 1993. 2) Source: European Packaging 1992; Pira Int.
3) 10^{15} joule (Petajoule) per year.
4) Million tonnes of oil equivalents.
5) An estimate; source separated.

An indication of the amount of MSW incinerated with energy recovery in Western Europe, 23 per cent by weight, is found in

Table 1.3 (Rijpkema 1993). This corresponds to some 7 million tonnes of combustible used packaging, making energy from waste one of the recovery options most widely in use.

Table 1.3. European MSW data (Rijpkema 1993).

Country	Total MSW Mt/a	Combustion Capacity Mt/a	% of total capacity with energy recovery	MSW1) density t/km^2
Austria	2.8	0.3	100	33
Belgium	3.5	2.2	62	113
Switzerland	3.7	2.9	90	90
Germany	25.0	11.2	100	101
Denmark	2.6	2.1	100	60
Spain	13.3	0.7	79	26
France	20.0	10.3	75	37
Greece	3.2	-	-	24
Ireland	1.1	-	-	16
Italy	17.5	1.5	72	58
Luxembourg	0.2	0.2	100	69
Norway	2.0	0.4	100	6
Netherlands	7.7	2.8	97	188
Portugal	2.6	-	-	29
Sweden	3.2	1.8	100	7
Finland	2.5	0.1	100	7
UK	30.0	3.6	29	123
Total:	141	40.1	Weighted Mean: 83	58

1) Calculated by WG 4.

While increasing interest is being shown in waste minimization and prevention, most political and social effort is directed at recovering materials from waste for recycling.

Inevitably, re-use and recovery of materials demand that components of the waste stream are collected and sorted. Combustible used packaging may either be separated before or after becoming a constituent of MSW (see Figure 1.1). The earlier sorting occurs, the more effective can be the subsequent recovery process.

A valuable means of upgrading the waste stream for energy recovery rests in source separation to eliminate undesirable, potentially contaminating constituents, such as components containing mercury, lead, cadmium, or chromium. In the most effective integrated re-source management schemes, the separation of these potential sources of pollution assists materials and energy recovery alike. It also achieves a much higher product quality where compost production or anaerobic digestion is undertaken.

Mechanical separation of MSW into recyclables, combustibles, and compostibles/digestibles is one of the methods available. About half of the MSW waste stream can be recovered through mechanical separation as a refuse-derived fuel (RDF). A fuel with higher energy content can be obtained from source separated combustible packaging (packaging-derived fuel, PDF). Both RDF and PDF can be utilized as primary and secondary fuel in solid-fuel fired power plants, and thus save fossil fuels.

There is no conflict between materials and energy recovery, for these two approaches are compatible (van Santen 1993). Under most recovery schemes, the calorific value of the remaining fraction increases (Cabanes 1991). A recent survey (Kayser 1993) showed that areas in the U. S. A. with the highest degree of energy recovery enjoyed the greatest levels of materials recovery.

Within the waste management industry, awareness of the importance of source separation in combination with composting and waste-to-energy conversion is increasing (Rylander *et al.* 1993). Incineration provides a route whereby the energy content of MSW may be recovered. It offers a means of conditioning waste prior to final disposal, and achieves an overall reduction in solid volume of up to 90 per cent. Combustion of waste prior to landfill disposal also ensures that sterilization takes place, reducing occupational and public health risks of contamination by pathogenic organisms. After combustion, the ash and slag residue may have some value as construction materials. The UK Royal Commission on Environmental Pollution (1993) concludes that "*incineration* (of waste), *followed by landfilling of the solid residues, will in our view prove to be the best practicable environmental option*".

Where energy is recovered from waste, a mainly renewable resource, this displaces a proportional amount of fossil fuels and limits that source of carbon dioxide greenhouse gas formation. If the energy could be recovered from all MSW arising within Europe, this resource would save some 35 million cubic metres of oil (Table 1.2). Moreover, any waste burned is prevented from contributing to the landfill generation of methane, a far more potent greenhouse gas than carbon dioxide. A recent study in Britain concluded that if all MSW in the UK was incinerated rather than landfilled, the net reduction in greenhouse gas emission would be equivalent to 12 million tons of carbon as CO_2 per year, or approximately 5 % of the total UK emissions of greenhouse gases (Royal Commission 1993).

Table 1.3 (Rijpkema 1993) sets out the total amount of MSW, the extent to which MSW can be incinerated in Europe, and the proportion incinerated with energy recovery. It also demonstrates the