Commission of the European Communities,
DG-XI

Financial Costs of Plastics Marking

Final Report

August 1999

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Acronyms

STANDARDISATION	
CEN	European Committee for Standardization
ISO	International Organization for Standardization
IUPAC	International Union of Pure and Applied Chemistry

PLASTIC INDUSTRY	
AHPI	Association of the Hungarian Plastics Industry
APME	Association of Plastics Manufacturers in Europe
BPF	British Plastics Federation
CEPMC	Council of European Producers of Materials for Construction
CIPAD	Council of International Plastics Associations Directors
ERRA	European Recovery and Recycling Association
DPF	Danish Plastics Federation
EUPC	European Plastics Converters
EUROPEN	European Organization for Packaging and the Environment
FP	French Plastic Federation
INCPEN	Industry Council for Packaging and the Environment
IVK	German Plastic Federation
ORGALIME	European Mechanical, Electric, Electronic and Metal Working Industries
SPI	Society of the Plastics Industry
UNIONPLAST	Italian National Union of the Plastic Transformers In-

	dustry

PLASTIC RESINS	
ABS	Acrylonitrile Butadiene Styrene
HDPE	High Density Polyethylene
L/LDPE	Linear Low Density Polyethylene
LDPE	Low Density Polyethylene
PC	Polycarbonate
PE	Polyethylene
PET	Polyethylene Terephthalate
PETE	Polyethylene Terephthalate
PP	Polypropylene
PS	Polystyrene
PU	Polyurethane
PUR	Polyurethane
PVC	Polyvinyl Chloride
V	Vinyl

NATIONAL AND INTERNATIONAL AGENCIES	
ADEME	Agency for Energy the Environment (France)
CEC	Commission of the European Communities
EBRD	European Bank for Reconstruction and Development
EU	European Union
OECD	Organisation for Economic Co-operation and Development

MISCELLANEOUS	
CEE	Central and Eastern Europe
Eurostat	Statistical Office of the European Communities
GDP	Gross Domestic Product
SME	Small and Medium-sized Enterprise

Executive Summary

The Study on "Financial costs of Plastics Marking" was launched by the Commission of the European Communities (DG-XI) in February 1999. COWI Consulting Engineers and Planners AS has conducted the study under the framework contract for "Scientific and Economic Assessment in Relation to Community Waste Policy". The study has been carried out in the period February 1999 to June 1999.

Background and purpose

Background

Recycling and reuse of plastic material can assist reducing the amounts of plastic waste to dispose of, and reducing resource use in plastic production. Mandatory marking of plastics presents a possible means for increasing the current rates of recycling and reuse. Mandatory marking would however lead to cost increases in the plastic converting industry. An assessment of these costs thus constitutes an important input into the further considerations on mandatory marking schemes as an appropriate means to increase recycling and reuse.

Objective

Consequently, the objective of the study is to determine the financial costs for the EU plastic converter industry of using certain compulsory marking schemes. The study includes also assessments of the impacts on sub-sectors within the converter industry, impacts on the SME's, trade implications and finally, the study comprises a brief appraisal of the implications for the CEE accession countries. The study does not include any considerations on the possible benefits from mandatory marking.

Mandatory schemes considered in this study

The study considers the following possible marking schemes:

- **ISO code.** Identification marking of plastic is covered by ISO 11469. The standard was issued eight years ago. It specifies a uniform marking of products that have been fabricated from plastic material. The standard is currently under revision. It is expected that the revised standard will be published towards the end of year 2000.

- **SPI code**. The American "Society of the Plastics Industry, Inc." introduced its resin coding system in 1988 to meet the recyclers' needs for a method of identifying plastic material used in packaging. The SPI code is simpler than the ISO standard implying that it contains less information than the use of the ISO standard. The use of the code is mandatory in most states in the US. In Europe, the SPI code has become the dominating system for marking of plastic material used in packaging on a voluntary basis.

- **Combined SPI and ISO codes**. Finally, the study also considers a combination of the above two schemes. This last option would consist in man-

datory use of the SPI standard for packaging materials, and use of the ISO standard in all other cases.

Introduction periods

In addition to the three marking alternatives, two alternative options for the length of the introduction period has been addressed. One introduction alternative is called fast introduction implying an almost immediate compliance with the marking requirements. The other alternative is called gradual introduction, where compliance is required only five years after approving the mandatory marking scheme.

Methodology

Study phases

The study has consisted of four distinct phases:

- Overview of use of plastic in the European plastic converter industry.
- Development of an operational methodology for cost assessment.
- Assessment of the financial costs of mandatory marking schemes.
- Sensitivity analysis.

Collection of data and information

The collection and validation of data have constituted an important component of the study throughout the execution of all of the above phases. This has been accomplished by collecting and reviewing literature and statistics, and through a questionnaire based survey which was followed-up by further personal consultations with key experts. The questionnaire survey was essential in deriving estimates of unit costs, current shares of marked products and production processes. The personal consultations served to provide guidance on the accuracy of estimates provided during the questionnaire survey, and to obtain information of the work of ISO and SPI.

Cost assessment

The financial costs of mandatory marking in the EU has been estimated in the following way. First the total amount of plastic products has been estimated, which for the EU converter industry is approximately 27 million tons per year. It is estimated that two-thirds of the total amount can be marked using printing while the remaining third can be marked during the moulding process.

The share of products currently marked varies between the two marking methods. It is estimated that only one-third of the products applicable for printing is marked today. For marking through moulding, the share of currently marked products is approximately 50%. Having calculated the amount of products where printing has to be introduced or moulds have to be modified, unit costs of the two methods have been estimated and applied.

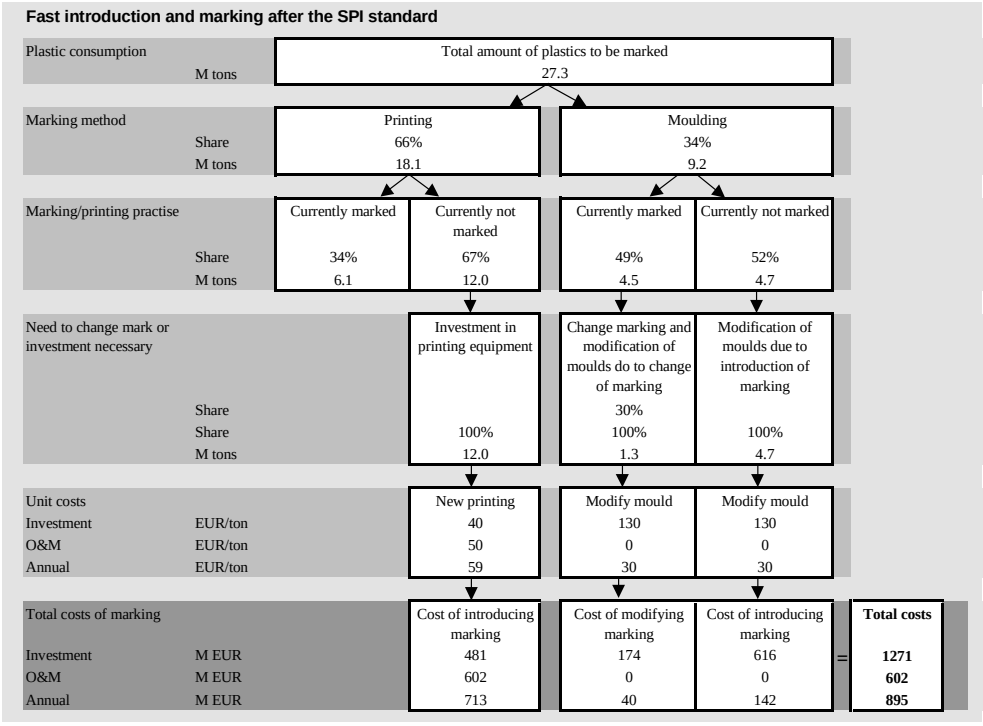
Marking through printing costs about 50 EUR/tons in annual operational and maintenance costs, while investment in printing equipment has been estimated to 40 EUR per tons. Annualising the investment cost over 5 years and with 5% as discount rate gives approximately 10 EUR/ton. Adding the annualised investment cost and the annual O&M cost, the total annual cost is around 60 EUR/ton.

For marking integrated in the moulding process, the costs include only investment costs in either replacing or modifying the moulds. When a mould is being replaced or repaired as part of the regular operation, a mark can be included at almost negligible cost. If a new mould has to be made for complying with the mandatory marking, costs will be substantial, as the price of a new mould can be very high.

Consequently and opposite to printing, the costs of a mandatory marking scheme can be substantially reduced, if the scheme is phased in gradually giving the industry the opportunity of postponing the necessary modification of moulds to the regular repair or replacement of the mould. Thus, the estimated unit costs differ between the two introduction alternatives. In this study, it is assumed that for the fast introduction of marking all moulds have to be either modified or replaced at cost of 130 EUR per tons. In the case of gradual introduction, it is assumed that only 25% of the moulds will have to be modified or replaced and the investment costs for these 25% of the moulds are estimated to about 40 EUR/tons. This unit cost is lower here than for fast introduction alternative as a lager share of the moulds can be just modified instead of replaced. Annualising the investment costs, total annual costs are estimated at 30 EUR/ton for the fast introduction and 10 EUR/ton for gradual introduction.

The results are presented in the next section. Here, an overview of the cost model is shown Figure 1 for the case of 1) fast introduction and 2) marking according to the SPI standard.

Figure 1 Cost model for estimation of the financial cost of identification marking



Study findings

Financial costs of mandatory marking

The financial costs of mandatory marking depend on both on the choice of introduction period and marking scheme. The total annual costs of marking for the six combinations of marking schemes and introduction alternatives are shown in Table 1.

Table 1 Estimated annual financial costs of mandatory marking for the EU plastic converter industry

Million EUR	Fast introduction	Gradual introduction
SPI	900	730
ISO	950	735
Combined SPI and ISO	900	730

Effect of introduction period

Starting with the effect of alternative introduction periods, the study estimates that the total annual costs in the EU of mandatory marking would amount to 730 million EUR for the gradual introduction period while the fast introduction alternative implies annual costs of around 900 million EUR per year. These estimates apply for both the case of using the SPI standard and the combined SPI and ISO schemes.

These total annual costs are composed of annualised investment costs and annual operational and maintenance costs. Gradual introduction implies investment costs of around 540 million EUR, while the investment cost are 1270 million EUR for the fast introduction alternative.

The annual O&M costs for printing amount to 600 million EUR and these costs are independent of the choice of introduction period. O&M costs of printing comprise two-thirds of the annual costs in case of fast introduction and 80% of total annual costs for the gradual introduction alternative. Thus, the most significant part of the total annual financial costs of mandatory marking is the O&M costs of printing.

Effect of marking alternative

An important result of the study is that the choice of marking alternative has only minor influence on the total costs. No cost difference has been identified for marking products currently not marked. Changing an existing mark is only costly in the case of moulding as marking method. Therefore, a difference in cost implication between the marking schemes appears only for the moulding method. As the SPI codes or standards are the most used due to the wide application in the packaging sector, the share of moulds that need to be modified are lower for both the SPI and the combined SPI and ISO scheme compared to the ISO scheme.

The additional annual costs of using the ISO standard for all products are estimated to be in the order of 50 million EUR. For the gradual introduction alternative, the additional cost of applying the ISO standard is only 5 million EUR per year.

No cost difference between the pure SPI and the combined SPI and ISO scheme can be estimated. Information on the current share of non-packaging products being marked with ISO or SPI respectively is too limited for identifying any cost difference.

Costs compared to turnover

The annual costs amounts to approximately 0.6% of the converter industry turnover for the fast introduction while being around 0.5% for the gradual introduction. The annual costs are calculated under the assumption that the investments are financed over of period of 5 years. This means that the annual cost estimates are the expenditures the companies will face the first 5 years after introduction of the mandatory marking. Afterwards, the annual costs will include only the O&M costs.

The maximum financial impact will appear if the investments have to be financed immediate. In that case, the investment costs make up 0.9% of turnover for the fast introduction and 0.4% for the 5-year adjustment period. Operational and maintenance costs amounts to 0.4% of turnover, so the maximum first year effect is 1.3% and 0.8% of turnover for fast and gradual introduction respectively.

The comparison of costs and turnover has shown the average for the whole industry. However, the costs for enterprises with no current marking could be higher. Assuming instead that all costs are related to the non-marked products, which comprise 60% of the total amount of plastic products, the annual costs compared to turnover would be around 1% in stead of 0.5-0.6%.

Sensitivity analysis

Assessing the financial costs of marking has included a number of estimates and assumptions and in order to test the sensitivity of the results, all input variable and assumptions have been analysed. For each variable a sensitivity indicator has been calculated measuring the relative change in total costs compared to change in the input variable. Furthermore, the scale of potential absolute variations in the input variables has been analysed.

The estimated costs are most sensitive to 1) the total amount of plastic products, 2) the share of products suitable for printing as marking method and 3) to the unit costs of printing.

The estimate of the total amount of plastic products is believed to be rather robust estimate, and the fact that a minor fraction of products might turn out not to be suitable for marking due to technical reasons will have only a limited influence on the cost estimate. Over the coming years, a general growth in the production of plastic products could increase the cost of mandatory marking, however, there are several factors working in the opposite direction. In parallel with an expected growth in the amount of plastic products, there is a trend of an increasing share of products being identification marked on a voluntary basis.

The packaging sector seems to grow faster than the other sectors and as this sector has a larger share of products currently marked, the cost of marking will grow less than proportional to the total increase in plastic production.

Extrapolating the trend in plastic production indicates a possible increase of 40% over the next 10 years, but due to the factors discussed above, the increase in costs of marking will most likely be lower than that.

The distribution of products by the applicable marking method has high relative impact, as the unit costs are very different between the two marking methods. For the type of products where the assignment of the appropriate marking method is most uncertain, the study has assumed that printing will be applied. A closer and more detailed examination of marking methods for specific products is thus more likely to result in a lower cost estimate than in a higher estimate.

The most important elements in the calculations are the unit cost factors. Comparisons to other studies that consider cost implications of marking schemes, and consultations with industry confirm that the estimates do provide a reasonable order-of-magnitude cost assessment. However, the heterogeneity of plastic production inevitable implies a high degree of uncertainty. Therefore, based on the cost assessment a set of low and high unit cost factors has been developed. Applying the range of unit costs values, the present study shows that the total annual cost could be as high as 1,400-1,900 million EUR (gradual and fast introduction respectively), or as low as EUR 270-330 million.

Assessment of SMEs, sector distribution, trade and CEE accession countries

Small and medium sized enterprises

The extent to which the impact on SMEs will be particular significant depends on whether there is economies of scale in marking. The fact that the assessment has indicated moderate investment costs, at least in the case of gradual introduction, suggests that this is not the case and accordingly the impact on SMEs will not exceed the average impact to a significant extent.

The survey has given some indications of small companies with low profit margins, and consequent little room for additional investments and operation costs. The extent to which this situation will constitute a factual constraint will however depend on the ability of the individual enterprises or sectors to add the extra costs to the selling price of the product, and the individual financial situation and production efficiency of each enterprise. As the plastic converter industry produces a huge number of different products, a more comprehensive assessment with identification of the sectors where SME are most frequent and the type of productions they are focused on is required for a further quantification of the SME issue.

Sector distribution

In the present study, the available aggregated data have only allowed for an indicative estimation of the sector distribution.

Comparing for each sector its share of total production of plastic products and its share of total costs indicates whether the sector impact is larger or smaller than the average impact. The packaging sector accounts for fewer costs than its share of production. On the other hand, the turnover per ton seems to be lower than average. Thus, it is not possible to determine whether the relative impact deviates from the average impact. The sectors 'Distribution' and 'Building/construction' account for higher shares of costs than their consumption, while electronics and automotive sectors have costs less than their share of plastic consumption. For these sectors, the lower share of costs is a result of a high share of products where the cheaper moulding method is used for marking.

Trade

Trade statistics indicate that the value of import is less than 10% of the total value of production of plastic products within EU. Assuming that the tonnage of import is proportional to value and that the unit costs factors apply to the import, the total cost impact on the importers will be around 70 to 90 million EUR annually, which is a rather insignificant costs.

CEE Accession countries

The plastic consumption of the converter industry in the CEE Accession countries is generally significantly lower than in the EU, approximately half the EU average. However, demand can be expected to increase in the future as consumption patterns approach those that apply in the EU. In countries such as Hungary, Czech Republic and Slovenia consumption levels are comparable to the EU levels. In these countries, the financial implications of a mandatory scheme would thus be close to those that apply to EU countries. In most if the countries obsolete production equipment still characterises the converter industry. However, in some countries the industry may be quite modern. This is the case in Hungary, where substantial international investments have facilitated a substantial technological upgrading. To the extent that similar developments take place in other countries, the cost of marking can be integrated into such modernisation programmes. Limited access to finance still constitutes an important constraint to the modernisation and upgrading of production equipment in some CEE countries. This is particularly the case in countries such as Bulgaria and Romania, but throughout the region it is still difficult for SMEs to obtain loans to finance investments.

Extending and improving the study results

Further validation of the study results should concentrate on the following issues:

- detailing of the cost of printing on more specific product types;
- extending the sector analysis allowing for more specific identification of sectors or sub-sectors where the relative cost impact would be high and where the SME issue is prevailing; and
- detailing the estimation of the necessary introduction period allowing for modification of moulds during regular renovation or replacement.

More detailed cost assessment will require a much larger survey and subsequent interviewing of industry representative. Thus, it can be suggested to focus a further assessment on the types of products where the benefit of increasing the marking effort is expected to be most significant.

1 Introduction

This is the report for the study entitled "Financial Costs of Plastics Marking". COWI Consulting Engineers and Planners has undertaken the study under a framework contract for 'Scientific and Economic Assessment in Relation to Community Waste Management Policy' with the Commission of the European Communities (Directorate General XI). The study commenced in February 1999 and was concluded in June 1999.

In March 1997 the European Council adopted a communication from the Commission on the review of the Community Strategy for Waste Management (COM(96)399). The review confirmed the hierarchy of waste management principles set up in Council Directive 91/156/EEC, giving preference firstly to prevention and secondly to recycling.

Concern over the low level of plastics recycling has stimulated focus on this sector. Consistent marking of plastics has been identified as one measure to facilitate the dismantling and sorting of plastic waste, and thereby promote recycling. Given the variety of marks and labels currently in use, policy makers as well as a significant portion of the industrial community have shown interest in establishing standards for plastic identification marks in the EU.

The Commission of the European Communities is therefore exploring possibilities of different plastics identification marking options, having regards of their economic costs, and launched the present study to gain insights on such costs.

1.1 Objective

The objectives of the study are clearly stated in the technical annex to the terms of reference, and repeated here for reference:

"The objective of the study is to determine the financial costs for the EU converting plastics industry of using certain compulsory marking systems."

Three marking systems are considered under two different introduction scenarios (fast and slow):

- all products should be marked according to the ISO standard;
- all products should be market according the SPI standard;

- a mixture, where packaging should be marked according to SPI and the rest after ISO.

The cost assessment focuses on EU Member States, but also considers the impact of mandatory labelling on the EU Accession Countries. Background on plastics consumption and marking, as well as related issues concerning international trade and SME impacts, are also addressed.

1.2 Study Approach

The breadth of information required in the terms of reference for the study coupled with the size and heterogeneity of the plastics sector, required some analysis of the sector itself. Thus, in addition to targeted assessments of marking costs for the industry, practical and market realities associated to the issue of plastics marking and recycling were analysed. Three main lines of investigation were pursued to develop study findings:

1. Literature review: a broad range of references was consulted to gain perspective on the costs associated with plastics marking (see "References", in appendices), and several cost assessments of the impacts of marking were identified and studied (see "Review of Cost Studies", in appendices). The literature was also used to gain an understanding of the structure and development of the plastics sector.

2. Statistics review: statistical data on trade volumes was obtained for all EU Member States and CEE Accession countries. Similarly, data on industry structure for the largest EU plastic processors as well as Estonia and Slovakia was collected and queried (see "National Statistics for Estonia, France, Italy, Slovakia, and the United Kingdom", in appendices). Eurostat data on the sector's turnover for al the EU Member States is also presented to contrast the sector's importance at the national level.

3. Surveys: a questionnaire-based survey was launched first among industry representatives (both large companies and SMEs) in a selection of EU Member States, and aimed at deriving basic correlations between key parameters in the sector (industry size, production processes, penetration of labels, and estimated unit costs). 26 questionnaires have been completed. A second survey (through telephone interviews) targeted to key experts in the field provided guidance on the accuracy of the conclusions drawn from the initial consultation with industry, and its applicability in the study.

Contacts with experts in the field indeed formed a part of each of the lines of investigation noted. This provided a check that the best available information was drawn on, while reinforcing the study's basis in practical realities confronting the sector.

1.3 Structure of the Report

Background information on the plastics industry in Western Europe and Accession Countries is presented in Chapter 2. In addition to statistics on plastic consumption and trade, background information is also presented concerning SMEs and labelling schemes in use. This section is extensively complemented by annexes.

Chapter 3 presents the model used to derive cost estimates for plastic labelling, and the cost assessment.

1.4 Acknowledgements

As noted above, the development of information for this study has largely depended upon information supplied by industry representatives, authorities from standardisation bodies, and other experts in the field.

In particular the Consultant would like to acknowledge the assistance provided by EUPC, APME, UNECE, AMWAY, Taylor Nelson Sofres Consulting, and those industry experts who supplied documentation and data (see "Contacts", in appendices). Findings reported here are, however, the sole responsibility of the Consultant.

2 Background

This chapter presents an overview of the plastics sector, and a discussion of issues of relevance to the question of marking. The reader is advised to consult the appendices to the report for further background information.

Work is ongoing (see section 2.5 below) to develop internationally agreed definitions on a variety of issues of relevance for this study. This report uses the term "marking" to refer to an identification mark cast on the plastic itself, whereas the term "labelling" is reserved for detachable (paper or plastic) labels. Similarly, transformation of plastic resins into manufactured products by the plastic converters industry is referred to as "plastic consumption".

The following list of the six main market groups provides illustrative examples as an aid to interpreting the data presented in this chapter:

Sector Name	**Examples of Activities**
Packaging	food, beverages, consumer goods in general
Building	window frames, insulation, pipes, floor coverings
Teletronic	electrical/electronics for offices, telecommunications
Automotive	automobiles
Other transport	railways, shipping, aircraft
Other markets	agriculture, leisure, toys, household, garden, furniture

The main source of data regarding the consumption of plastics in the converter industry is the statistics produced by the Association of Plastic Manufacturers in Europe (APME). The actual data collection and compilation is done by Taylor Nelson Sofres Consulting and they have provided additional data directly.

Unless otherwise specified, GDP and population values where obtained from Eurostat and EBRD for EU Member States and CEE Accession Countries, re-

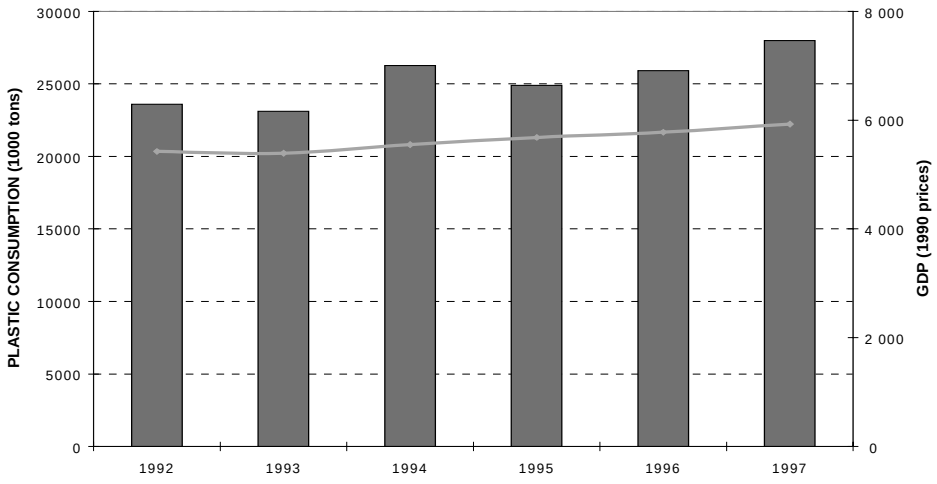
spectively. Currency conversions where calculated using the EUR rates supplied by the CEC for the period 1 to 31 May 1999.

Consumption statistics for EU are summarised in sections 2.1 followed by a brief discussion of the marking issue from the perspective of small and medium-sized enterprises (SME) in section 2.2. Consumption statistics for CEE Accession Countries are presented in section 2.3. Section 2.4 discusses trade issues arising from mandatory marking. Finally, section 2.5 reviews marking schemes in use.

2.1 Plastic consumption in the converter industry in EU

Plastic consumption in the converter industry in EU has been growing over the last 7 years, as noted in Figure 2.1 below.

Figure 2.1 Trends in conumsption of plastic in the EU converter industry



Source: Taylor Nelson Sofres Consulting for APME, Eurostat, and CEFIC

A variety of global as well as local economic phenomena (such as the price of basic chemicals, currency exchange rates, and trade) influence the sector, and account for the small annual variations shown in the figure. The trend is a growing use of plastics in the converter industry both in total amounts in relative to GDP.

The total consumption of plastics in the converter industry can be broken down by country, sector, product, and resin. It has not been possible to make all of the cross-tabulations, however the most important are shown below.

Trends in plastic consumption are distributed among main economic sectors in Table 2.1 below. Although packaging is not listed as a sector in the table, it accounts for the largest share of plastic consumption (64% of 'Households' consumption, and 100% of 'Distribution' consumption). The table indicates also the relative growth of the sectors from 1994 to 1997. The sectors 'Households',

'Electric & electronic' and 'Automotive' have experienced the highest rates of relative increase. As the 'Household' sector is the largest, it contributes most to the absolute growth.

Table 2.1 Plastic Consumption by Sector in EU (1000 tons)

1000 tons	1994	1995	1996	1997	Relative growth
Households	11 287	11 677	12 259	13 243	17%
Building & construction	5 247	5 004	5 042	5 495	5%
Distribution	3 148	2 942	3 089	3 338	6%
Large industry	1 148	970	990	1 170	2%
Electrical & electronic	1 857	2 129	2 196	2 398	29%
Automotive	1 374	1 659	1 725	1 682	22%
Agriculture	979	528	604	652	-33%
Total	25 040	24 909	25 905	27 978	12%

Source: Taylor Nelson Sofres Consulting for APME

Conversely, Table 2.2, which reflects the relative importance of the sectors among the Member States, has a column titled "others" which includes household goods, toys, and other items which are not covered elsewhere.

Table 2.2 Plastics Consumption by Sector and Country (% of total, 1994)

%	Building	Packaging	Electronic	Transport	Furniture	Agriculture	Others	Total
Austria	20	33	12	6	7	4	18	100
Belgium	29	29	1	11	7	1	21	100
Denmark	25	25	6	2	4	2	36	100
Finland	22	57	7	2	2	3	8	100
France	25	39	8	11			17	100
Germany	21	30	10	10	3	2	24	100
Greece	3	40	1	1	2	35	18	100
Italy	13	44	4	5	5	4	25	100
The Netherlands	13	38					48	100
Portugal	24	30	3	9			34	100
Spain	13	46	5	7	7	6	17	100
Sweden	25	26	17	14			18	100
United Kingdom	23	36	11	8	5	3	15	100
EU13	20	36	7	7	3	5	23	100
Norway	25	28	18	4			25	100
Switzerland	17	40	6	10		4	23	100
Japan	10	30	12	9	2	2	35	100
USA	20	31	5	5	4		35	100

Source: C IPAD - EUPC
Note: Luxembourg and Ireland are not included in the EU total.

The breakdown by country and sector shows the structure of the converter industry in the countries. The table indicates that the this structure is not that different among the European countries. The packaging sub-industry is the largest in almost all countries followed by the building and construction industry. Although the differences reflect the structure of the converter industry and not the final consumption in the countries, some relation between converter industry structure and final consumption can be seen. Thus, the tendency is that the countries with significant car industry have a relatively high share in the 'Transport' sector and countries with high use of plastics in agriculture have high shares of converter consumption in that sector.

Resins consumption by country is shown in Table 2.3 below, distinguishing between thermoplastics and thermosets. These terms denote two types of plastic. Thermoplastic refers to a type of plastic which after being formed still can be modified by heating the product, while thermosets only can be modified by cutting, polishing etc. and not by heating (see also "Background Information on Plastic Converters", in appendices). Thermoplastic is the type used most accounting for about 90% of the total plastic conversion.

Table 2.3 Plastic Converters 'Consumption by Polymer and Member State (EU15, 1997)

%	Total	Thermoplastics						Termosets	Total
	1000 tons	LDPE	HDPE	PP	PVC	PS	Others	All	
Austria	652	21	17	18	20	4	15	4	100
Belgium	1 247	28	14	11	16	9	14	8	100
Denmark	494	27	12	24	8	4	15	11	100
Finland	419	41	15	11	13	4	12	4	100
France	3 856	19	13	18	19	7	18	6	100
Germany	6 544	18	14	15	20	7	15	12	100
Greece	363	20	16	7	24	9	20	3	100
Ireland	202	15	9	7	20	20	24	4	100
Italy	5 429	21	11	20	17	8	16	8	100
Netherlands	1 202	20	9	18	19	10	15	9	100
Portugal	496	17	17	15	26	6	10	8	100
Spain	2 299	16	19	12	19	8	18	8	100
Sweden	569	37	12	13	16	7	10	5	100
United Kingdom	3 507	23	14	16	19	8	13	7	100
Total	27 279	21	13	16	19	8	15	8	100

Source: Taylor Nelson Sofres Consulting for APME

Table 2.4 presents aggregated information on the distribution of different product groups among the main economic sectors. These figures have been derived from Table 2.5, which correlates the polymer groupings in greater detail. The dominant importance of "others" in Table 2.4 results from a variety of product types grouped under "other" for each polymer listed in Table 2.5. As illustrated in these tables, packaging (entries under agro-food and distribution in columns,

and films, bags and sheets in rows) account for the largest shares followed by the blow-moulded products.

Table 2.4 Plastic Consumption by Sectors and Product Group (1997, 1000 tons and percentages)

	Total	Agriculture	Agro-food Industry	Detergents Pharmacy	Metal Products	Electric/Electronics	Automotive	Furniture	Building	Distribution	Total
Films	4 709	7	28	10	2	0	0	20	6	26	100
Sacks and bags	1 993	0	61	0	0	0	0	3	0	35	100
Sheets	1 229	0	83	1	0	8	0	8	0	0	100
Blow moulded	2 941	1	51	30	0	0	3	1	0	13	100
Injection moulded	3 366	0	10	9	2	14	19	28	5	12	100
Other	8 910	3	16	2	5	11	2	10	46	6	100
TOTAL	23 147	3	29	8	3	7	4	13	20	14	100

Source: Taylor Nelson Sofres Consulting for APME

Table 2.5 Plastic Consumption by Resin and Sector (1997, 1000 tons)

	Total	Agriculture	Agro-food Industry	Detergents Pharmacy	Metal Products	Electric/Electronics	Automotive	Furniture	Building	Distribution
Total LDPE	**5 734**	**362**	**1 730**	**479**	**54**	**366**	**0**	**583**	**267**	**1 893**
LDPE film	3 091	348	604	366	54	0	0	364	169	1 187
LDPE sacks and bags	1 604	0	836	0	0	0	0	62	0	706
LDPE others	1 040	14	290	114	0	366	0	157	98	0
Total HDPE	**3 920**	**112**	**1 045**	**808**	**164**	**75**	**109**	**417**	**356**	**833**
HDPE film	207	0	43	0	50	0	0	97	0	17
HDPE blow moulded	1 539	28	249	755	0	0	88	40	0	378
HDPE others	2 174	83	752	53	115	75	21	281	356	438
Total PP	**4 606**	**69**	**1 533**	**303**	**308**	**277**	**661**	**852**	**178**	**425**
PP film	707	0	569	28	14	0	0	74	0	21
PP sacks and bags	389	0	389	0	0	0	0	0	0	0
PP injection moulded	2 652	0	335	235	81	277	649	670	0	404
PP others	859	69	239	40	213	0	12	108	178	0
Total PVC	**5 021**	**80**	**534**	**130**	**91**	**561**	**111**	**605**	**2 908**	**0**
PVC film	621	0	48	55	0	0	0	388	130	0
PVC sheets thermo-formed	321	0	207	11	0	0	0	103	0	0
PVC blow moulded	343	0	279	64	0	0	0	0	0	0
PVC others	3 736	80	0	0	91	561	111	114	2 779	0
Total PS	**1 981**	**0**	**899**	**59**	**0**	**273**	**0**	**444**	**306**	**0**
PS sheets thermo-formed	908	0	815	0	0	93	0	0	0	0
PS injection moulded	691	0	0	59	0	180	0	289	163	0
PS others	381	0	84	0	0	0	0	155	143	0
Total EPS	**720**	**0**	**23**	**0**	**0**	**0**	**0**	**54**	**516**	**127**
Total PET	**1 166**	**0**	**1 033**	**74**	**0**	**23**	**0**	**36**	**0**	**0**
PET film	84	0	48	0	0	0	0	36	0	0
PET blow moulded	1 059	0	985	74	0	0	0	0	0	0
PET injection moulded	23	0	0	0	0	23	0	0	0	0
Total	**23 147**	**622**	**6 796**	**1 854**	**617**	**1 576**	**882**	**2 992**	**4 531**	**3 278**

Source: Taylor Nelson Sofres Consulting for APME

Table 2.6 provides a perspective on each Member State's consumption by presenting ratios of consumption with respect to GDP and population. These figures show that those Member States with the highest consumption levels

(France, Germany, Italy and the United Kingdom) do not present the highest ratios (only Italy shows a per capita consumption above the EU average).

Table 2.6 Plastic Converters' Consumption in the EU, 1997

Country	Absolute Consumption	Share Of Consumption	Per GDP Consumption	Per Capita Consumption
	(1000 tons)	% of total	(gram per EUR)	(kg per capita)
Austria	652	2	4.0	80
Belgium	1 247	5	6.3	123
Denmark	494	2	3.5	94
Finland	419	2	3.3	82
France	3 856	14	3.2	66
Germany	6 544	24	3.8	80
Greece	363	1	5.2	35
Ireland	202	1	3.1	57
Italy	5 429	20	4.9	95
Netherlands	1 202	4	4.0	77
Portugal	496	2	7.1	51
Spain	2 299	8	4.5	58
Sweden	569	2	2.6	65
United Kingdom	3 507	13	3.5	60
TOTAL	27 279	100	3.9	73

Source: Taylor Nelson Sofres Consulting for APME

Table 2.7 gives turnover values for the main sectors, contrasting differences in the economic importance of the plastics industry across Member States The four top producers (France, Germany, Italy and the United Kingdom) show the highest turnover values, followed by Spain, Belgium and the Netherlands (also with large gross outputs).

Table 2.7 EU Plastic Converters' Turnover (million EUR, 1996)

	Plates, sheets, tubes and profiles	Packaging	Building	Other plastic products	Total
Belgium	na.	na.	na.	na.	3 761
Denmark	484	450	164	577	1 675
Finland	588	208	85	194	1 075
France	3 401	4 830	1 870	6 087	16 188
Germany	7 271	3 727	5 370	14 273	30 641
Greece	na.	na.	na.	na.	486
Ireland	146	247	190	147	729
Italy	2 570	2 662	534	4 839	10 615
Netherlands	na.	na.	na.	na.	3 646
Portugal	na.	na.	na.	na.	649
Spain	na.	na.	na.	na.	7 445
Sweden	na.	na.	na.	na.	492
United Kingdom	5 561	3 320	2 576	5 211	16 669
Total					94 071
Sub total for 7 countries	20 019	15 445	10 789	31 330	77 582
Relative share of turnover	26%	20%	14%	40%	100%

Source: Eurostat, DEBA database
Note: na.= not available.

2.2 Small and Medium-sized Enterprises

The plastics sector is on the whole characterised by small and medium-sized enterprises (SMEs). It is estimated that the total number of enterprises in Europe is roughly 27,000, employing some 752,000 people in the EU (Eurostat, 1997). Only about a dozen companies employ more than one thousand persons.

The extensive and diversified demand for plastic goods has led to continuous development and innovation of products throughout the sector. There is a fair degree of specialisation even among mass-produced goods such as small injection mouldings and continuously produced low-density polyethylene packaging. On the other end of the spectrum are the manufacturers of specialised items, such as composite and structural plastics used in spacecraft or other high-tech applications.

In general SMEs in this sector are said to face difficult economic constraints because of the pressures exerted on them from both the supply and demand side of their business. The polymer producing companies are in general large multinational companies who have considerable latitude in setting and adjusting prices for raw materials. Similarly, the sale of goods is often through large scale industries like car manufacturers, manufacturers of electrical and electronic

equipment, and department store chains (all of whom exert considerable pressure to keep costs down).

Given the great heterogeneity of SMEs in the plastics sector, the cost implications of mandatory marking will vary according to the nature of each individual business.

2.3 Consumption in CEE Accession Countries

Table 2.8 below summarises trends in plastics consumption in the Accession Countries: The reported data are extracted from "The Chemical Industry in 1998", published by the United Nations Economic Commission for Europe (UNECE, 1997).

Table 2.8 Plastic Converters' Consumption in Accession Countries

Country	Total Consumption (tons per year)			Relative Consumption (kg per inhabitant)
	1995	1996	1997	1997
Bulgaria	144 330	132 890	117 249	14
Czech Republic	434 350	509 770	575 780	56
Estonia	19 884	20 276	35 029	24
Hungary	436 324	523 235	595 657	59
Latvia	45 987	49 754	53 364	21
Lithuania	55 594	42 665	66 762	18
Poland	993 876	1 165 313	1 347 124	35
Romania	216 172	193 107	239 506	11
Slovakia	189 699	:	121 586	23
Slovenia	47 746	67 123	165 670	83
Total			3 317 727	32

Source: UNECE Programme for the Chemical Industry

Consumption of plastics in the converter industry varies considerably among the CEE Accession Countries, and the impact of mandatory marking can be expected to differ accordingly. However, impacts should be quite similar among certain countries, such as the Czech Republic, Hungary, and Slovenia (whose consumption levels are comparable to western European countries).

The discussion presented here is general given the diversity of conditions faced in Accession Countries[1].

Viewed on the whole, there are some significant differences between the plastics sectors of the EU and CEE Accession Countries. Unlike other industrial branches in Accession Countries, the plastics sector has not been characterised

[1] Much of the discussion presented in this section is based on personal communications with Mr. Howard Hornfeld from the United Nations Economic Commission for Europe, Geneva, and Mr. Kalman Wappel, EUPC-Hungary.

by large centralised manufacturing facilities. SMEs are therefore quite common in the plastics sector. Small injection moulding companies are quite widespread, particularly in countries where the sector is not highly developed. Sectors with a significant portion of SMEs include packaging, toys, electrical components, and the construction sector (notably, pipes, window frames, and fittings).

Overall, per capita consumption in Accession Countries is far below that of Western Europe, and therefore small facilities have been able to adequately service the demand.

Locally manufactured plastics processing equipment has typically been of small scale and relatively poor quality. Most manufacturing technologies relied on in Accession Countries have still not reached the quality of their Western European counterparts. In many cases plant sizes are too small to accommodate western technologies, and where technology is imported, it is often not the latest.

Plastic recycling is largely restricted to the industrial sector and most plastics processing companies recycle their own scrap. This is particularly true in film producing plants, where edge trim is commonplace. Because some investment is needed to handle the scrap (that is, to prepare it for feeding back into the processing lines) it is likely that the recycle rate is somewhat lower than in the EU.

The relatively weaker economic conditions in the Accession Countries in general suggest that any equipment investments required for marking would be relatively greater than in Western Europe. The impact depends also on the stage of investment in new technology underway in the sector: where general modernisation of the industry is taking place, the costs of marking could be buffered as a minor component of the investment in new technology. On the other hand, modernisation among SMEs in the Accession Countries could be difficult due to limited access to loan capital to finance new equipment. Finally, to the extent that marking impacts manpower, the cost could be expected to be less than those experienced in Western Europe.

Additional quantitative information is appended under "National Statistics for Estonia, France, Italy, Slovakia, and the United Kingdom".

2.4 Trade Perspectives

Trade statistics in Table 2.9 below reflect, for the period 1985-95, an average annual growth rate in extra-EU imports of 10.0%, while extra-EU exports have grown at roughly half this pace (4.9%)[2]. Table 2.9 shows that despite the noted differences in relative growth rates, the trade surplus remained somewhat stable at roughly 2.2 billion *EUR*. Figure 2.2 and Figure 2.3 reflect the changes that have taken place between 1989 and 1994 in the destination of exports and ori-

[2] Sources: Eurostat, 1997; APME; EUPC

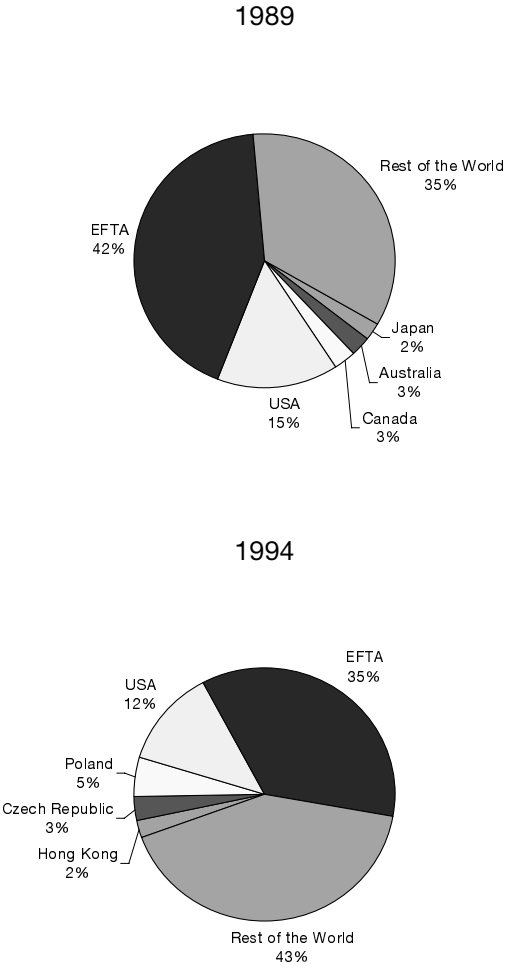
gin of imports respectively for the EU. Here it is interesting to note the growing importance of Accession Countries and China as trade partners.

Table 2.9 External Trade in Current Prices (million EUR*)*

(million ECU)	1990	1991	1992	1993	1994	1995
Extra-EU exports	9984	7228	7575	8349	9630	10546
Extra-EU imports	4824	5522	5821	6147	7148	7450
Trade balance	2160	1706	1755	2203	2482	3096
Ratio exports/imports	1.4	1.3	1.3	1.4	1.3	1.4
Terms of trade index	100	101.2	101.6	99.2	97.2	N/A

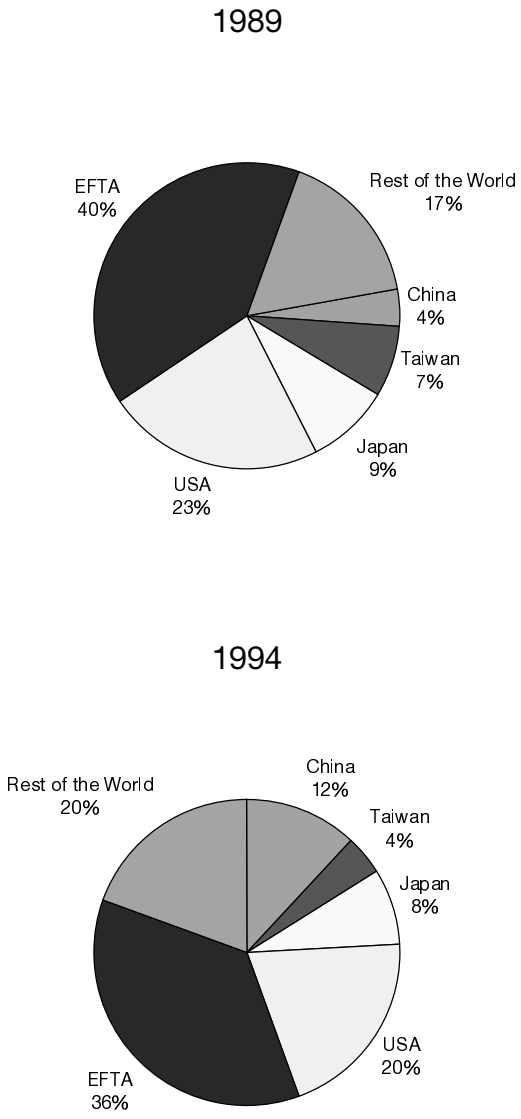
Source: Eurostat, 1997

Figure 2.2 Destination of EU Exports, 1989 and 1994



Source: Eurostat, 1997

Figure 2.3 Origin of EU Imports (1989 and 1994)



Source: Eurostat, 1997

The imposition of an EU marking standard for plastics could be perceived as a trade barrier. Non-EU business representatives have addressed this issue in the context of the Draft Directive on waste from electrical and electronic equipment[3], which requires Member States to apply the ISO 11469 mark to plastic parts weighing over 25 grams. Whether the trade barrier argument is justified can not be determined here. If a mandatory marking scheme can not be proven to influence plastics sorting or recycling for these products and the requirement therefore can not be justified on environmental grounds problems could appear

[3] Personal communication: American Electronics Association, and Olav Körner, Amway Europe

with the General Agreement on Trade and Tariffs (GATT) and the Technical Barriers to Trade (TBT) Agreement.

Labels and marks have a functional purpose where manual sorting of plastics is done (for example, large items such as automotive bumpers). Because a growing fraction of plastics recycling depends on automated processes, identification marks designed for the human eyes are used for sorting purposes in increasingly restricted cases. For many plastic film manufacturers, printed marks are undesirable because they can impede the intended use of the film. Inks and solvents can contaminate the product to be wrapped while also decreasing the market value of plastics for recycling (as impurities).

2.5 Review of Marking Schemes

Although this study is only concerned with the internationally recognised ISO and SPI schemes for plastics identification, note should be made of the variety of marking or labelling schemes in use. These include the following:

- EU marking scheme[4];
- ASTM - national standard, U.S.A. (also used in Asia and other parts of the world);
- DIN - the national standard used in Germany (similar to ISO);
- national labels for deposit-refund schemes;
- eco-labels;
- marketing labels which highlight the environmental merits of the product or packaging materials; and
- health and safety labels.

It should be noted also that some of these schemes have been used only at a very limited extend so far.

2.5.1 ISO Work on Plastics Marking

ISO's technical committee responsible for plastics is Technical Committee 61, and the American National Standards Institute (ANSI) holds the secretariat of the committee. Subcommittee 1 (ISO TC 61/SC1) deals with terminology in-

[4] Proposed as a voluntary identification system in Commission Decision of 28 January 1997, which establishes the identification system for packaging materials (including plastics) pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste (97/129/EC). This Decision was issued under Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste. The voluntary labelling scheme is essentially the same as the SPI standard, but uses a more extensive numbering system and lacks the chasing arrow logo.

cluding standardisation of symbols and abbreviated terms for plastics. The British Standards Institution (BSI) is the Secretariat for this work[5].

This subcommittee is currently revising ISO 11469 (Plastics – Generic identification and marking of plastics products, from 1993), which specifies a system for the uniform marking of products that have been fabricated from plastics materials. The revision of this standard has been undertaken to incorporate the identification of plasticisers and flame-retardants. Approval of the revised standard is expected in September of 1999 and its publication is expected towards the end of 2000. Because the revision is limited, it is not considered likely to have a cost impact on industries presently using the ISO mark.

However, the subcommittee has not concerned itself with recycling. No assessments of practical or cost implications of marking schemes have been carried out, nor are there statistics available on the percentage of different product groups currently using the ISO marking scheme. However, as with all ISO work, the motivation for developing the standard came from industry, primarily to enhance plastics recycling[6].

ISO follows the IUPAC rules for abbreviations of natural and synthetic polymers. The abbreviated terms for the basic polymers "may be supplemented by up to four symbols to differentiate between or among modifications of the polymer, if desired". Such symbols indicate special characteristics of the polymer, such as: brominated (B), expandable (E), plasticised (P), unsaturated (U), and others.

Figure 2.4 ISO Resin Identification Codes

PE - L L D	Linear Low-density Polyethylene
PS - HI	High-impact-modified Polystyrene
PVC - P	Plasticised Poly(vynil chloride)

It should be noted that ISO 11469 was first issued 8 years ago, since when significant innovations in mechanical sorting of plastics for recycling have occurred. These have been driven by low raw material prices and the fundamental barrier that high sorting costs pose to plastic recycling.

ISO Technical Committee 207 for Environmental Management is liaising increasingly with subcommittee TC 61[7]. Only preliminary work has been initiated concerning marking, however. For example, an ad-hoc group has been set up within TC207 to review standards concerning "design for the environment".

5 Contact: Mark Scudamore, BSI , secretary to ISO for Technical Committee 61, Subcommittee 1 (ISO TC61/SC1)
6 Personal Communication:: Dr. Helmut Meyer, Bayer. Convener of the Working Group for the revision of ISO 11469
7 Personal Communication: Dr. Tom O'Neill (Dupont, UK), Convener for Environmental Task Group within TC 61

The Technical Committee for Environmental Management might, on the basis of findings from the ad-hoc group, address issues (with a view towards standards) such as the use of recycled plastics in the design of products, or the design of products to facilitate material recovery and recycling. In this regard, marking standards reflecting these design considerations might be expected to come on the agenda.

The European committee for standardisation (CEN – Comité Européen de Normalisation), which adheres to ISO standards for marking, has recently set up an ad-hoc group on recycling within its Technical Committee TC 249 (plastics[8]). As with ISO, financial aspects are not considered and the focus here is on standardisation. Furthermore, the ad-hoc group has restricted its efforts to observing developments within the Recycling Forum established by the European Commission, DG III and DG XI[9]. The Forum's four working groups will report to the Commission by the end of 1999, and CEN's technical committee on plastics expects to develop a work-plan based on this information[10].

2.5.2 SPI Work on Plastics Marking

The marking scheme introduced by the Society of the Plastics Industry, Inc. (SPI) [11] is not consistent with ISO 11469. SPI introduced its resin coding system in 1988 to meet the recyclers' needs for a method of identifying plastic materials used in packaging. The overwhelming majority of plastic packaging is made with one of six resins. The SPI resin identification code therefore assigns each of these resins a number from one to six. This number is featured inside a triangle of chasing arrows, with the resin abbreviation printed underneath (the use of chasing arrows in the logo has been harshly criticised by environmentalists as a false message to consumers since it implies recycled material content). A seventh code, identified as "other", indicates that the product in

[8] Personal Communication: Dr Roland Dewitt (Solvay, Belgium), Chairman of CEN for Technical Committee 249 (CEN/TC 249)

[9] The DG III- C3 unit in charge of the Basic Industries (Non- Ferrous Metals, Glass, Ceramics, Lime, Advanced Materials) has conducted, in cooperation with DG XI- E3, a study on the Competitiveness of the Recycling Industries. As a result of this task, the Commission adopted in July 1998 a Communication entitled: "The Competitiveness of the Recycling Industries" (COM 98/463 Final). This Document provides for an extensive analysis of the recycling sectors and proposes a wide range of actions, which are to be discussed within the framework of the "Recycling Forum".

[10] The Forum's working groups are: A) Economic/environmental/social diagnostic and statistics, B) Market development and standards, C) Innovation and research, D) Regulatory approaches

[11] The Society of the Plastics Industry, Inc. (SPI) is a trade association of more than 2 000 members representing all segments of the plastics industry in the United States. Its membership includes plastics processors, raw material suppliers, machinery manufacturers, mould makers and other industry-related groups and individuals. SPI represents and serves as the spokesperson for the industry locally, nationally and internationally, with emphasis on influencing public policy on issues of concern to the industry.

question is made with a resin other than the main six, or is made of a combination of more than one resin.

Table 2.10 SPI Resin Identification Code Logos

Source: SPI

In 1993 thirty-nine states in the USA had passed laws for the SPI resin identification code to be mandatory. Thereafter, the National Recycling Council (NRC) and SPI agreed to improve the coding system and set up a strategy to:

- modify SPI's voluntary resin identification code on products mandated to carry the code;
- recommend the use of ISO 11469 standards for all other plastic products.

3 Approach to cost estimation

This chapter gives the approach for establishing unit cost factors and other key input data for deriving total cost estimates.

3.1 Methodology on costs

The cost assessment has been structured around the following steps:

- breakdown of plastic volumes according to marking methods (printing or moulding / embossing);
- estimation of the share of products currently being marked;
- estimation of the unit costs for printing and moulding/embossing under different implementation scenarios; and
- estimation of total costs.

Each of the first three steps is explained in detail below. The next chapter presents the final cost estimates. All the information has been collection during March to June 1999 and thus, the cost estimates are for 1999.

Given the broad number of materials manufactured by the plastic sector, the subject assessment naturally had to rely on a number of generalisations and assumptions. Significant effort went into collecting accurate data to back up such assumptions.

The cost estimation is primarily based on a questionnaire-based survey among European plastic converters that was followed up by telephone interviews. The questionnaire addressed the following issues:

- type of product, process and plastic resin
- current labelling practice
- costs of labelling
- type of cost items and cost estimate relative to the total product price/cost

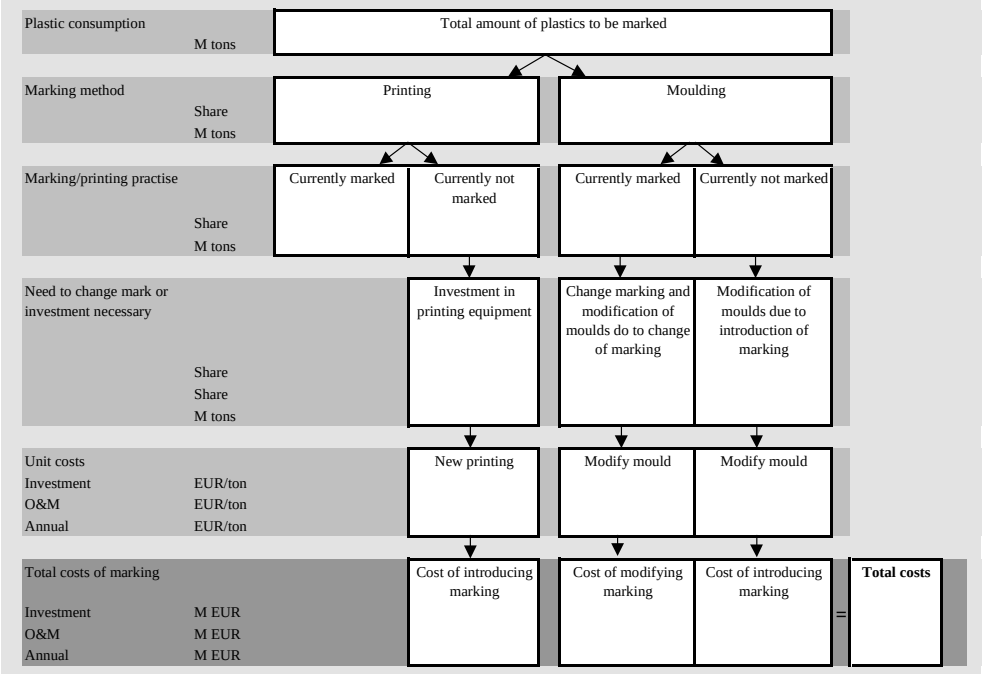
Altogether, 26 completed questionnaires were received. Survey results are presented in appendices (see Appendix 4 "Review of Cost Studies).

Additionally, the Consultant studied the following studies on cost implications of plastics marking (see Appendix 3 "Review of cost studies):

- study on costing of full plastics marking (EUPC, 1999);
- study on the cost implications for the packaging sector of mandatory labelling (DTI, 1996);
- SPI final recommendations on options to improve marking.

The approach to estimation of costs can be summarised in the figure shown below. Here, the main steps in the estimation are shown and in the subsequent sections of this chapter, each step and the associated assumptions are presented and discussed.

Figure 3.1 Model for cost estimation



3.2 Marking Methods and Shares

There exist two methods for marking plastics: printing / melt imprinting, and moulding / embossing.

The choice of method depends on the type of product to be marked. Printing or melt imprinting is the main methods for most of flexible plastic products (notably, films, sacks and bags). It can be performed as an integral part the main production process or as separate process. Blow and injection moulded products can be labelled as an integral part of the moulding process. In both cases, the mould is either modified or a mark is inserted in the mould.

Both the EUPC study and the Consultant's questionnaire-based survey distinguish between the above marking methods and provide estimates of the shares marked for each product type. These are summarised in Table 3.1.

Table 3.1 Marking Methods and Estimates of Marking Shares by Product

Type of product	Share of total production in %	Share being marked*	Marking method
Injection moulded products	19	50	Moulding/ embossing
Films	17	50	Printing
Blow moulded products	11	50	Moulding/ embossing
Bags	10	70	Printing
Thermosets	8	0	Printing
Pipes	8	30	Printing
Sheets - thermoformed	6	50	50% Moulding 50% Printing
Cables	3	30	Printing
Windows	3	10	Printing
Foams	3	30	50% Moulding 50% Printing
Extrusion coating	1	10	Printing
Others	11	30	Printing

* For films and bags, the values indicate not only the share being marked, but also the share being printed.
Source: Consumption data (APME)
Labelled shares (EUPC, 1999)

The are no statistical data on the present marking shares. Therefore, the rough estimates from EUPC have been used supplemented with indications from the survey. Assessing total costs, the impact of alternative marking shares has been displayed through a sensitivity analysis (see 4.1.5).

Table 3.2 below presents the distribution of plastic products according to marking technologies and shares currently being marked. The distribution

showing total amount has been calculated on the basis of the assumptions given in Table 3.1 above.

Table 3.2 Plastic Products by Marking Method and Current Marking Status (million tons)

	Currently labelled	Currently not labelled	Total
Moulding	4.5	4.7	9.2
Printing	6.1	12.0	18.1
Total	10.6	16.7	27.3

Source: based on Table 3.1

In the calculation model, the aggregated distribution of plastic products on marking methods and current marking shares enters as input and the amounts in tons are calculated (see Figure 3.2 below).

As stated in the objective for this study, the effect of three alternative marking schemes should be analysed. The alternatives are:

- all products marked according to the ISO standard;
- all products marked according to the SPI standard; or
- packaging products according to SPI and all non-packaging products according to the ISO standard.

For estimating the difference of the alternative marking schemes, the shares for marked products using either ISO or SPI need to be known. No specific data are available on the type of identification marks currently used. Accordingly, the shares of ISO and SPI in the amount of products currently being marked have been roughly estimated.

For printing there is no cost of changing a mark (see next section on unit costs), and the shares of the printed products currently using either ISO or SPI are not necessary for the costing and they have not been estimated. For non-marked products there are no difference between the marking alternatives, as all non-marked product will have to be marked in either case.

Only for marking through the moulding process, the marking alternatives cause different cost implications. For two type of products within this group, blow-moulded products and thermoformed foams, the main applications are in the packaging sector, see Table 2.4. Here, it is assumed that these types of products are marked with SPI symbol and among the other marked products in the group, the ISO or SPI standards are used in almost equal share.

Blow-moulded products and thermoformed foams amount to about 40% of the marking-through-moulding group. With the mentioned assumptions, it can roughly be estimated that for two of the marking alternatives, the SPI and the combined ISO and SPI schemes, the share of the products currently marked during moulding that need to change mark is around 30%. (Assuming that 50% of the non-packaging products currently being marked will have to change mark in any case, either ISO or SPI being the mandatory standard and that the non-packaging products amount to approximately 60% of group).

As the packaging products comprise the remaining 40% of this group, marking according to the ISO standard will imply that in total 70% of the products currently marked-through moulding will have to change mark and therefore incur the cost of mould modification.

Table 3.3 For each marking alternative, the shares of products where marking implies a cost; in % of the amount of products in each group

		SPI	ISO	Combined
Printing	Marked	0	0	0
	Non-marked	100	100	100
Moulding	Marked	30	70	30
	Non-marked	100	100	100

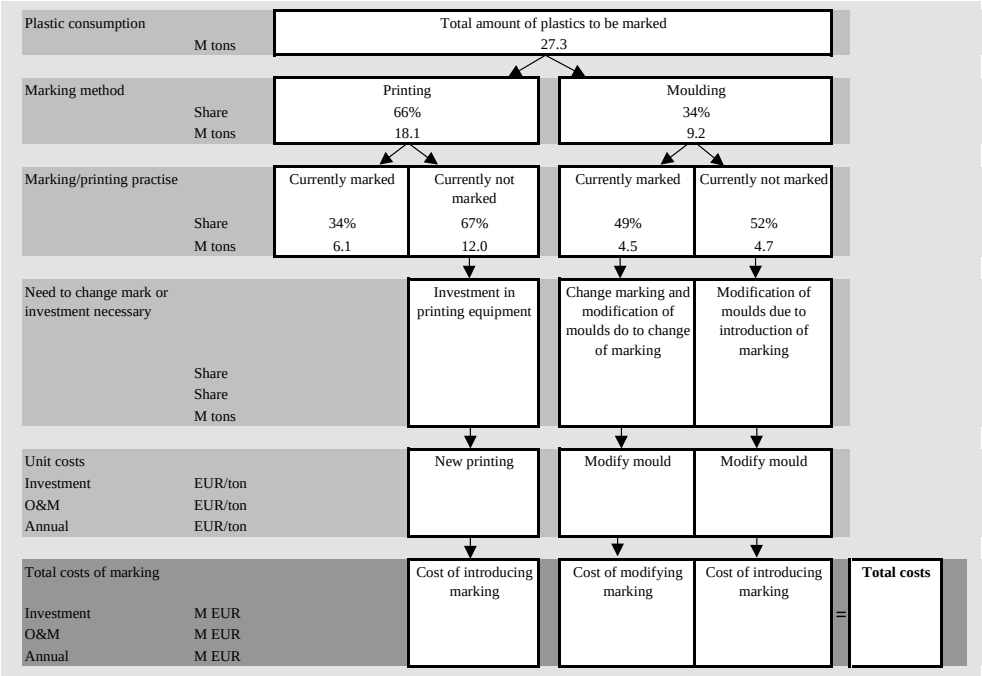
Source: Consultants estimates based on EUPC (1999) and survey results.

The table shows not directly the share currently being marked with either ISO or SPI. The shares presented indicate the part of the products where either changing an existing marking or introducing marking will have a cost implication.

To sum up, the only difference between the alternative marking schemes is the share of currently moulded and marked products where modification of the moulds is needed to comply with the marking scheme. In case of either all products using the SPI standard or the combined ISO-SPI alternative, this share is roughly estimated to 30%, while the pure ISO alternative imply that the share is about 70%.

Below, the cost model with the input on marking methods and current extent of marking is shown.

Figure 3.2 Cost model with shares on marking method and current extend of marking



The following section presents and discusses the estimation of the unit costs.

3.3 Unit Costs

Unit costs are presented for both marking methods, printing and moulding.

3.3.1 Cost of Printing

Estimates of printing costs are mainly based on data for films and on bags. These estimates of unit costs are then applied to all the products where printing is the main marking method.

The cost of marking already printed films or bags is generally negligible (a new stamp may however be needed for melt imprinting). It is assumed that there are no costs involved in the inclusion of an identification mark on already printed or melt imprinted products.

For printing on non-printed products, printing equipment is needed and the printing process generates operational costs. Printing on films and bags can be more or less integrated in the production process; e.g. printing through the extrusion machine or in separate printing machine. The exact design of production line determines the specific choice of printing.

Regarding the investment costs; a number of examples are presented below. Total investment costs are transformed into a unit investment cost by dividing with the annual capacity in tons. Annualised investments include the effect of lifetime or a depreciation period for the equipment.

- For stamp equipment for a bag-processing machine costs are around 4000 EUR for a capacity in the order of 500 tonnes per year[12]. This is equivalent to an investment of approximately 8 EUR per tonne.

- Investment costs amounts to 200,000 EUR for a four-colour printing machine with a capacity of 1000 tonnes per year and a lifetime of 10 years. The investment cost per ton of annual capacity is then 200 EUR. The operational costs of this machine are given as 25 EUR. Thus total cost per tonne is approximately 70 EUR[13].

- Printing with only one colour is cheaper. In this case, a printing machine can be bought for 15,000 EUR[14]. Then, investment costs amount to 15 EUR per ton.

- For melt imprinting on products like pipes, gutters, fittings and similar building materials a melt imprinting machine could cost around 5,000 EUR.

Although compliance with ISO and SPI standards does not require colour prints, they may be appealing to enterprises on competition and market grounds.

Given the above range of investment costs (between EUR 4000 and 200000), unit investment costs amount to some 8 to 200 EUR per ton. Although the equipment's lifetime is 10 years, depreciation over 5 years is assumed. This reflects that companies will have to finance the investment in less than the technical lifetime. Annualised investment cost estimates therefore amount to between 2 and 45 EUR per ton[15].

Given that existing evidence places investment costs closer to 8 than to 200, the geometric average is preferred to the simple average for obtaining a mid estimate of the investment cost per ton of annual production. Thus, this estimate is 40 EUR per ton.

Plastic converters currently marking their products estimate their operational cost values in the range of 15 to 40 EUR per ton of plastic films, bags or sheets[16]. Such figures correspond to average and typical films and bag qualities.

Printing costs primarily depend on the area being printed. Therefore, per ton costs are higher for thin films and bags, vis-à-vis thicker products. Similarly, per ton costs are larger for smaller bags at a given thickness.

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[12] Personal communication, Lars Gelstrup, Lindknud Plast, DK.
[13] Investment and operational costs from personal communication with John Sale, BPI.
[14] Personal communication, J. Sale, BPI, UK.
[15] A discount rate of 5% is assumed.
[16] From BPI values of £10 to £30 per tonne for plastic films costing between £700 and £5000 have been given. The Danish producer, Lindknud Plast, indicate 0.30 DDK per tonne for films and bags. The same value has been given by Nyborg Plast for labelling of agricultural films.

Given that films and bags account for a significant share of the plastic consumption (approximately 27%) a closer analysis of these products has been made. Table 3.4 below presents the assumed distribution of films and bags by thickness.

Table 3.4 Estimate of distribution of films and hags by thickness

Type of product	Thickness (µ)	Production share by weight (%)
Films	Thin (up to 20µ)	30
	Medium (50µ)	40
	Thick over 100µ	30
Bags	Thin (up to 15µ)	10
	Medium (100µ)	70
	Thick (over 150µ)	20

Source: Consultant's estimate

Having operational costs for medium films and bags at 15 EUR per ton, for thin films and bags, operational costs could be up to 75 EUR per ton, whereas thick products will be down to about 10 EUR per ton.

Weighting the costs for the three qualities by their roughly estimated share in production, an average operational cost of 30 EUR per ton for films and 20 EUR per ton for bags are calculated. Considering that the share of thin films and bags currently being printed is less than average, weighted cost per ton estimate could be even higher.

Stretchable films deserve special attention, because of their growing penetration in the market and the fact that marking is substantially more difficult due to their intrinsic properties. These films are not being printed today in any significant scale, if at all and it is therefore not possible to assess the cost of printing them.

Table 3.5 below presents a summary of unit costs for printing on non-printed films and bags, distinguishing between low, high and mid estimates.

Summarising this costs assessment, operational costs given by converters are from 15 to 40 EUR per tonne for an average film or bag. The effect of thickness has been estimated to implying up to a doubling of the unit cost. As a best mid estimate, the value of 50 EUR per tonne will be used[17]. As a high-low value range, costs are assumed to vary between 15 and 80 EUR per tonne.

[17] The average between 15 and 40 EUR per tonne and a doubling due the thickness effect (rounded off value).

Table 3.5 Unit Cost for Non-printed Products (EUR per ton)

	Investment cost	Operational cost	Annual cost
Low estimate	8	15	17
Mid estimate	40	50	60
High estimate	200	80	126

Source: Consultant's estimates

Annual costs are the annualised investment cost plus the annual operational costs.

The time horizon for the implementation of a mandatory marking scheme may have a cost impact. If obsolete equipment is replaced with new equipment, the latter could include printing facilities that would be less costly than the estimates discussed in this chapter. This notwithstanding, the cost examples provided in this section show that the bulk of costs are operational costs. Consequently, such a cost-reducing effect would be small, and it is assumed for the further cost analysis that costs of marking non-printed products are the same, regardless of the introduction period.

Cost estimates from EUPC show significantly higher values than those presented in the previous paragraphs: they range between 120 and 4000 EUR per ton (see Appendix 3). No cost evidence collected throughout the study supported such high estimates (only if printing in 8-12 colours on the whole surface of films and bags, could costs reach 2000 or 3000 EUR per ton).

Conversely, cost estimates provided in the study by the UK Department for Trade and Industry are in line with the Consultant's (70 EUR per ton in 1996).

3.3.2 Costs of Moulding / Embossing

Costs associated with changing or introducing moulded / embossed marks arise from changes in the mould (that is, costs are similar whether the product is currently being marked or not, since the mould has to undergo modifications either way).

The introduction period has been identified as a key parameter for the costs of the moulding method. Due to change in design or lifetime of the moulds, they are regular changed. However, there are products where the lifetime of the mould could be up to 10-20 years.

Marking can require very different types of modifications, from just inserting a small mark in the mould to making a new one. Yet, when the mould has been modified, no additional costs can be expected.

The examples below illustrate the possible range of costs:

- Investment in new moulds for blow moulding of jars and containers can vary between 14000 and 100000 EUR[18]. Since the annual production is in the range 50 to 100 tons per mould, the associated investment costs can reach between 280 and 1000 EUR per ton (should marking require completely new moulds).

- Moulds that are used over a long period are typically repaired every three years. Inserting a mark while the mould is being repaired can cost around 500 EUR[19] (which yields an investment cost per ton of some 5 to 10 EUR).

- For thermoforming of foams (mostly used in food packaging) total investment in changing tools is estimated at around 750000 EUR (this corresponds to an annual production of around 20000 tons[20]). Per ton investments can therefore be estimated at 38 EUR per ton.

- Other investment examples show values between 100 and 2500 EUR for production volumes of 10 to 50 tons per year.

- EUPC estimates give a value of 2500 EUR per mould for moulds with a capacity of 15 tons of injection moulded products, while the costs for blow moulded manufacture would be ten times higher (EUPC, 1999).

In general, the costs for investing in new moulds range from 150 to 1000 EUR per ton, while the costs of modifying moulds are much lower and vary between 10 to 50 EUR per ton.

Survey results and subsequent follow-up interviews indicate that modification of moulds is a feasible solution in most cases; at least if the marking requirements are introduced gradually.

Therefore, the unit investment cost for moulded products is estimated for both fast and gradual introduction. In the case fast introduction, it is assumed that 25% of the moulds need to be replaced causing relatively high costs, while modification will do for the rest of the moulds. Investment costs are then in range from 45 to 300 EUR per ton and a mid-estimate of 130 EUR per ton.

For gradual introduction, the investment costs vary between 10 and 150 EUR per ton of annual production. A mid-estimate of 40 EUR per ton (the geometrical average) is used.

The average lifetime of moulds is also a key parameter for estimating the total cost impact. If the lifetime on average is short (3 to 5 years), the financial impact would be significant in the event of immediate introduction of mandatory marking, but low if a gradual introduction is allowed. On the other hand, if the lifetime is generally high, significant investment costs could be expected even under a gradual introduction alternative.

[18] Personal communication: Mr. D. Hemmings, HPL Jars and Containers Ltd, UK.
[19] Personal communication: Mr. D. Hemmings, HPL Jars and Containers Ltd, UK.
[20] Personal communication: Mr. D Eggleston, LINPAC Plastics Ltd, UK.

For the gradual introduction of marking, it is assumed that 25% of all moulds have to be modified, while the rest has been replaced and thus, marking is included with no additional costs.

Estimating annualised investment costs, focus has been on the financial implications. They will depend not so much on the technical lifetime of the moulds, but on the financing period of the investment. Applying similar conditions as for the printing case (depreciation in 5 years), the annualised investment costs are calculated at around 30 EUR per ton per year (fast introduction) and around 10 EUR for gradual introduction.

Table 3.6 Unit Cost of Marking by Moulding (EUR per ton)

	Investment cost		Annualised investment cost	
	Fast	Gradual	Fast	Gradual
Low estimate	45	10	10	2
Mid estimate	130	40	30	10
High estimate	300	150	70	35

3.3.3 Unit Cost Assumptions

Table 3.7 below summarises the assumptions used to derive the unit costs for marking. The table presents unit costs according to marking method and current marking status. Such values are used, with the amounts of products in Table 3.2 above, to calculate the total cost.

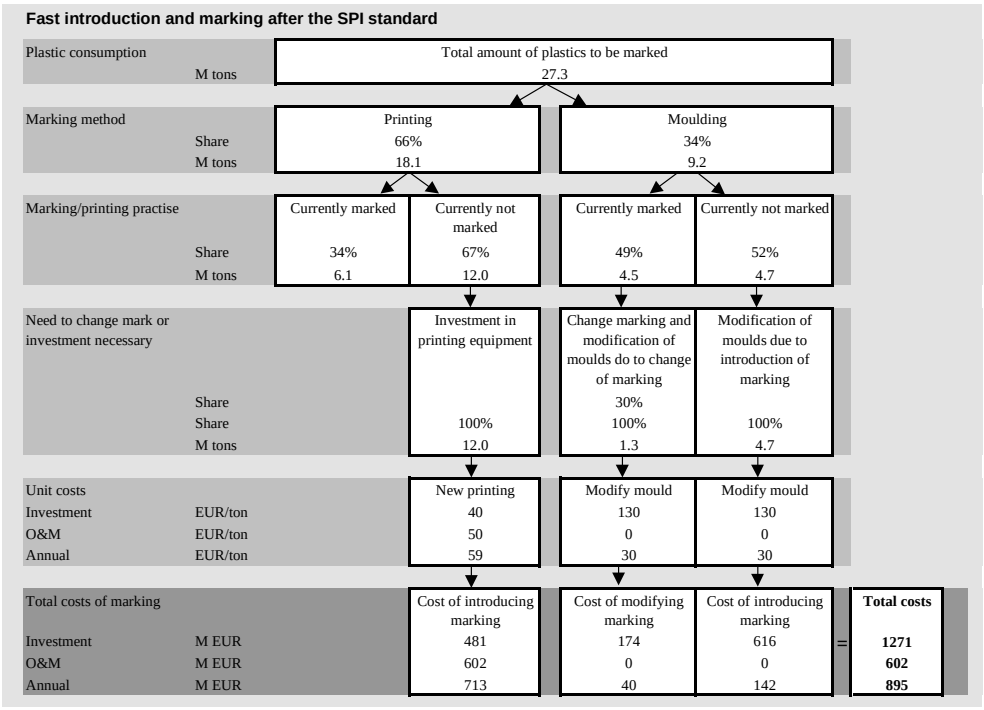
Table 3.7 Unit Cost Factors for Marking (EUR per ton of Plastic)

EUR per Ton of Plastic	Investment cost	Operational cost	Total annual cost
Moulding (fast introduction)	130	0	30
Moulding (gradual introduction)	40	0	10
Printing (non-printed products)	40	50	60
Printing (printed products)	0	0	0

Source: Consultant's estimates (see section 3.3.1 and 3.3.2)

After presenting the unit cost estimates, the cost model can be shown with both input and output variables. Below, the cost model is shown for the case of fast introduction and for SPI marking scheme or the combined ISO-SPI marking schemes as these two schemes impose the same costs. In the next chapter all the results of applying the cost model are presented and discussed.

Figure 3.3 Result of applying the Cost model



4 Financial Costs of Marking

This section gives the estimated financial costs. An assessment of the financial costs (and related implications) of mandatory marking of plastic products encompasses the following:

- assessment of total costs for the EU, including the effects for:
  - introduction period;
  - alternative marking schemes;
  - growth in plastics consumption;
  - variation and uncertainty of input variables (sensitivity analysis).
- assessment of disaggregated costs:
  - individual Member States;
  - individual product types;
  - individual sectors;
  - SMEs.
- assessment of cost implications for non-EU countries:
  - CEE accession countries; and
  - trade aspects.

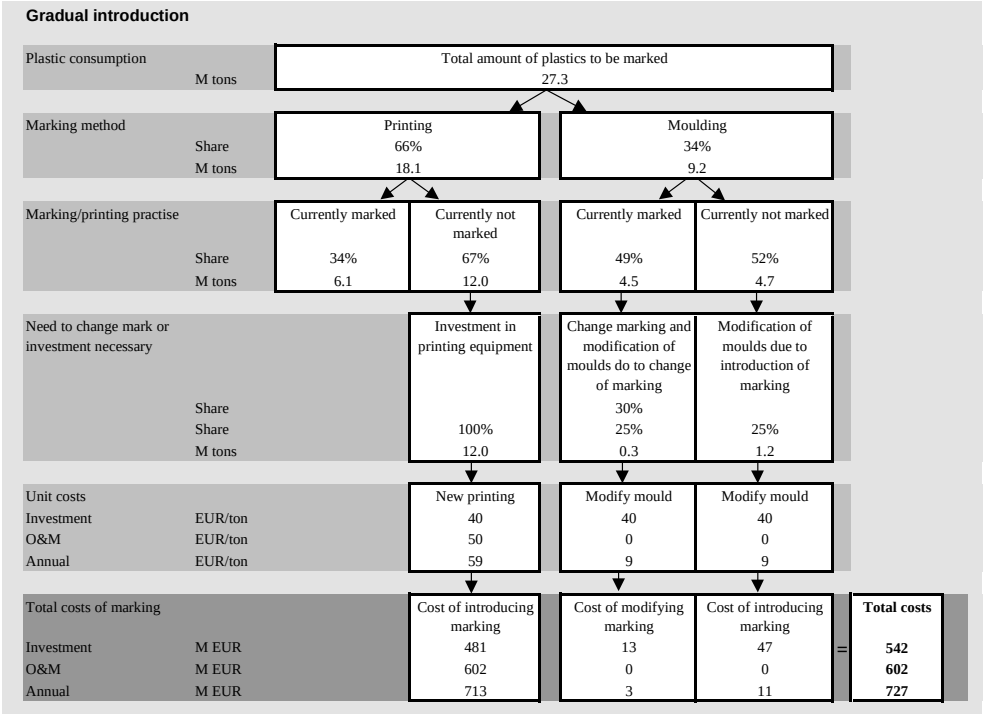
4.1 Total Costs at the EU Level

Assessments of the choice of implementation period and marking alternative are presented in the next two sections followed by a sensitivity analysis of the main input variables.

4.1.1 Fast and Gradual Introduction

The estimation of the fast introduction alternative has been shown in section 3.3.3. In case of the gradual introduction of the mandatory marking, Figure 4.1 illustrates the key assumptions and the results using the cost model.

Figure 4.1 Gradual introduction alternative



The estimated "total annual financial costs" correspond to the annualised investment costs plus the annual operational costs. This value has been estimated at 900 *million EUR per year* in the event of fast introduction, and at *730 million EUR per year* for gradual introduction.

Table 4.1 Estimated Financial Costs of Marking (million EUR)

	Investment costs	Operational costs	Total annual financial costs
Fast introduction	1270	600	900
Gradual introduction	540	600	730

A fast introduction would result in high investment costs, largely due to the associated immediate change or modification of moulds. An introduction with a delay period of 5 year will typically allow the identification mark to be included in the moulds as they are renovated or replaced.

The investment costs have been annualised based on 5 years of depreciation and 5% in interest rate. The annual costs comprising the annualised investment costs and the O&M costs express the annual expenditure for the industries during the first 5 years, after which only the operational costs have to be covered. Financing of the investments over a shorter period, the annual costs will by higher for this shorter period of time.

Given the total turnover of the European converter industry (around 140 billion EUR), the annual costs of marking costs make up approximately 0.6% of the industry's annual turnover for the fast introduction scenario and 0.5% for the gradual introduction.

As these values are average for the whole industry, the costs for enterprises with no current marking could be higher. Assuming that all costs are related to the non-marked products comprising 60% of the total amount of plastic products, the annual costs compared to turnover would be around 1% in stead of 0.5-0.6%. This result further assumes that turnover per ton is the same for currently marked and none marked products.

4.1.2 Alternative Marking Schemes

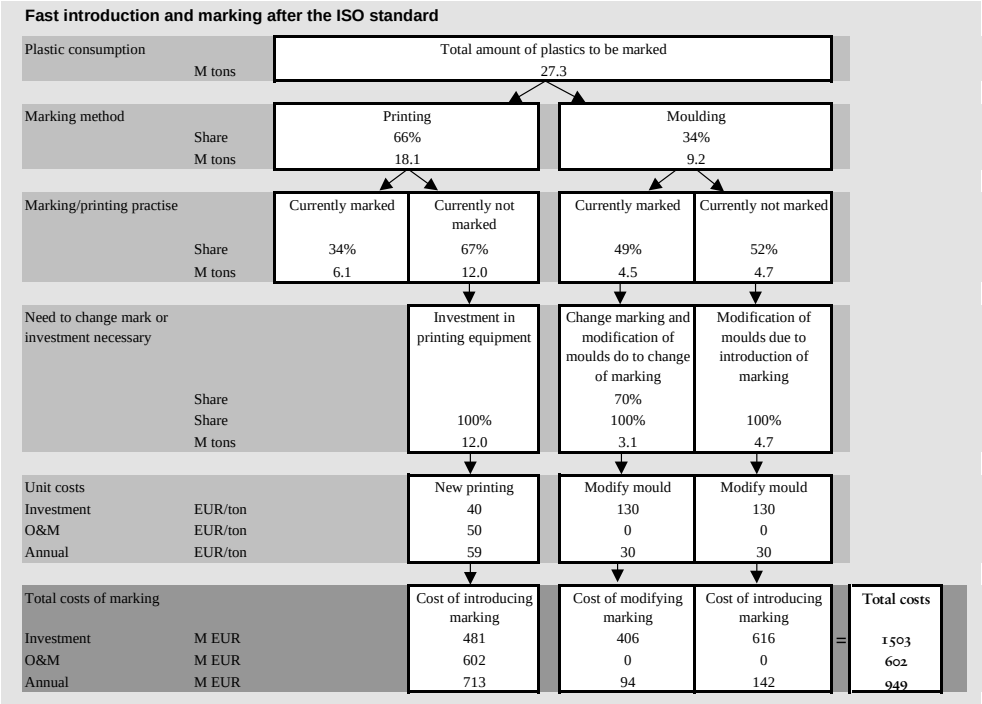
The three alternative marking schemes consider (i) marking with ISO codes, (ii) marking with SPI codes, and (iii) marking with both ISO and SPI codes.

Since the main costs associated with a mandatory marking scheme relate to printing of products that are currently not marked, the financial impacts of such a scheme are likely to be the same regardless of the code used. For moulding, however, differences can be expected because some manufacturers may have to switch to a new label. Given that the exact distribution of ISO and SPI marks among moulders is not known, only rough cost estimates are given.

As discussed in Section 3.2, the main difference is between marking with ISO codes (i) and the two other alternatives. The cost estimates presented in the previous section were based on either (ii) or (iii). The result of assuming instead that the ISO standards applied is shown below.

The difference is that the share of currently marked products (by the moulding method) needing the to change mark is estimated to be approximately 70% compared to the 30% in case of SPI or the combined SPI and ISO scheme.

Figure 4.2 Marking with ISO standard in the fast introduction alternative



The additional annual costs for applying the ISO standard will thus be 5*0 million EUR* and the total annual costs of the fast introduction scenario will thus be *950 million EUR*. The additional investment costs could be high; using the mid estimate of 130 EUR per tonne, the difference between applying SPI in the packaging sector and using ISO, will be *240 million EUR*.

For the gradual introduction, the difference will be much lower. The extra costs of the ISO standard is reduced to only *20 million EUR* for additional investments equivalent to less than *5 million EUR* difference in total annual costs.

Applying only SPI or the combined SPI and ISO will be less costly compared to introducing ISO as the general marking standard. The difference in costs between the marking alternatives depends much on the introduction period; the more gradual introduction the less difference in costs.

4.1.3 Sensitivity analysis of key assumptions

Assessing the robustness of the cost estimation has been done by sensitivity analysis of all the input variables to the cost model. Thereby, the variables that are most important for the total results are identified, however also the total potential absolute variations in the input data are important for the sensitivity of the final cost estimates.

Table 4.2 Sensitivity analysis

Relative change in result to change in input variable	Fast introduction			Gradual introduction		
Input variable	Invest-ment	O&M	Annual	Invest-ment	O&M	Annual
Amount of plastic to be marked	1	1	1	1	1	1
Marking method	0.8	1	0.4	0.7	1	0.9
Share of products currently marked (printing)	0.2	0.5	0.4	0.5	0.5	0.5
Share of products currently marked (moulding)	0.3		0.1	0.1		0
Share of marked products that need to change mark	0.1		0	0		0
Share of moulds that need modification	0.6		0.2	0.1		0
Investment costs for print-ing	0.4		0.1	0.9		0.2
Investment costs for moulding	0.6		0.2	0.1		0
O&M for printing		1	0.7		1	0.8

The sensitivity assessment has identified the following variables as most important for the robustness of the results:

- the total amount of plastic products;
- the distribution between the marking methods;
- the current share of products marked; and
- the unit costs of printing.

The absolute level of uncertainty varies among these input data. The total amount of plastics is a rather certain estimate although two factors can influence the value. One is that a small fraction of the plastic products due to technical constraints can not be marked. Secondly, growth in the total production can increase costs. This last issued is addressed in the next section.

The uncertainty about the marking method is particular for the minor applications and the group of other products (see Table 3.1). As the marking method for these applications is assumed to be printing, the probability that the share of products for printing should be higher is rather low. If the marking method for all products expect films and bags were assumed to be moulding, total annual costs would be reduced from 900 to 700 million EUR for the fast introduction and from 730 to 350 million EUR. The very unrealistic case of assuming printing for all plastics would increase annual costs to around 1000 million EUR.

If the share of currently marked products is substantially higher or lower than estimated or assumed for this study, the total costs will vary rather proportionally. Assuming that no products are currently marked gives the upper limit of the costs. Such a very unlikely case would increase the estimated total annual costs by 50% regardless of the introduction period.

The input variables discussed so far have all a low probability of giving a significantly higher estimate for the total costs. The only factors, which can influence the results in a more crucial way, are the unit cost factors. Their influence is addressed in 4.1.5.

4.1.4 Trends in Plastic Consumption and Marking

Total consumption by plastic converters is growing, as illustrated in section 2.1. Total growth during the 1992 to 1997 has been almost 20% corresponding to 4% of annual growth. Measured per capita, the increase has reached 15% between 1992 to 1997 (equivalent to almost 3% per year), while per GDP growth rates have been around 1.5% per year.

A simple projection of the current trend of almost 4% annual growth implies an increase in total plastic consumption in the converter industry by 40% over the next 10 years. Assuming a constant share of voluntary marking, the total costs would then increase also by 40% in 10 years (15% if measured against GDP). However, the relative cost impact, which is the financial costs compared to turnover, would not increase, if the turnover would grow more or less proportionally.

A difference could appear if the sectors increase with difference rates. The available data does not allow for the detailed sector assessment. The indication from the data in **Error! Reference source not found.** is that the packaging sector has increased more than the other sectors. As there is a larger share of marked products within the packaging sector, the total share of marked products could increase, and thus, costs would increase less than proportionally to the overall increase in plastic products.

Another factor influencing how the costs of a mandatory marking scheme will develop is the share of voluntary marking. In the interviews, it has been indicated that there is an expectation of increasing voluntary marking. Increasing

voluntary marking will reduce the effect of a growing amount of plastic products. In such case, the relative cost impact would even decrease.

Thus, there are a number of factors working in opposite direction and any major increase in costs relative to the industry turnover is not likely.

4.1.5 Sensitivity of the Unit Costs

The sensitivity analysis showed that the unit cost factors and in particular the costs of printing have a significant influence on the estimate of total costs.

Given the heterogeneity of the plastic industry, the unit costs applied are bound to present a high degree of uncertainty. Based on the survey and follow up interviews, as discussed in 3.3, a set of high and low cost estimates has been developed. Illustrating the calculations in the case of gradual introduction and the high unit cost estimates, it can be seen that it is the printing that creates the largest share of the costs.

Figure 4.3 Cost model illustration for the case of high unit cost factors and gradual introduction

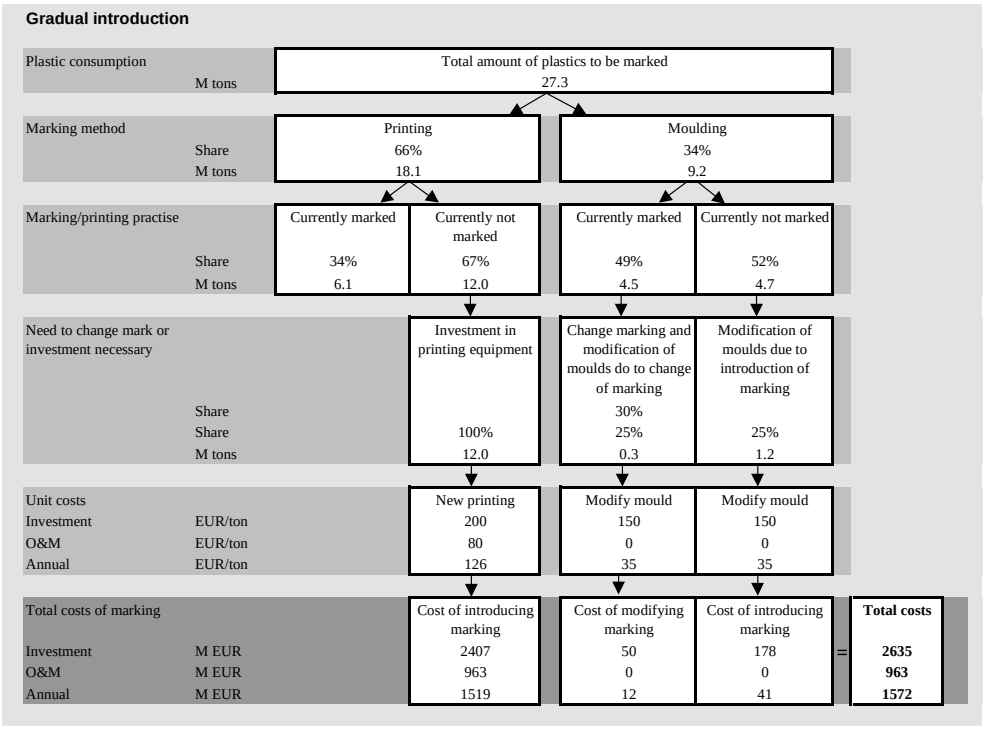


Table 4.3 below presents the results of applying either the low or high unit cost factors both for the fast and gradual introduction alternatives.

Table 4.3 Low and High Cost Estimates for Fast and Gradual Introduction (million EUR*)*

	Investment cost	Annual operation and maintenance cost	Total annual cost
Fast introduction			
Low estimate	370	180	270
High estimate	4230	960	1940
Gradual introduction			
Low estimate	110	180	210
High estimate	2640	960	1570

Source: Consultant's estimates (see section 3.3.1 and 3.3.2 above)

There is a factor of 7 in difference between the high and low estimate for the annual costs. This is the case for both introduction alternatives. A larger share of the total costs is caused by the annualised investment costs in the case of the high unit cost factors compared to the mid estimate. This is the result of the low-high range for the unit investment costs being larger than for the operational costs.

Comparing the high cost estimates to the turnover of the converter industry, this ratio increases to about 1.1% for the gradual introduction alternative and to 1.4% in case of the fast introduction.

From the survey question on the average costs of marking relative to the production costs, the results indicate that the relative cost range varies between less than 0.01% to 5% of the total costs. Costs do not exceed 1% of the production costs for those companies already printing their products.

The study by the UK Department of Trade and Industry estimated 50 million *EUR* cost for the packaging sector. Assuming that the sector accounts for 40% of the total consumption and that the UK plastic converters consume 11% of the total EU resins, an estimate for the EU can be calculated at about 1100 million *EUR*.

Cost estimates by EUPC are significantly higher: around 14000 million *EUR* (ten times more than the other estimates). Such high costs can be explained by the very large printing costs assumed. The average printing costs per m² is given as 0.16 *EUR*; if the average weight per m² is 0.1 kg, the resulting printing costs per ton amount to 1600 *EUR* (a value not supported by any other source of information). Similarly, printing machines are priced at 2.7 million *EUR* per unit, while other sources report no more 0.5 million *EUR* for a four colour printing machine.

In summary, available evidence supports the Consultant's central estimate of around *730 million EUR* per year for the gradual implementation scenario.

It is worth to point out here (see also the discussion above) that no information could be gathered for stretchable films, an increasingly popular material that might be very difficult to print. Neither the production volumes nor the cost implications of labelling this type of plastic are known, which introduces an element of uncertainty in the above cost estimates.

Assuming as illustrative example that stretchable films make up 50% of the total volume of thin films (some 700000 tons), and assuming a unit cost 10 times higher than the average (500 *EUR* per ton), the total costs of printing such films would amount some 350 million *EUR* per year.

This example supports that even if there are products with high costs not identified in the present study, the overall cost estimate is very unlikely to be outside the low to high range of total costs presented in Table 4.3.

No other plastic production with a risk of very high costs has been identified. There are products that present marking difficulties (such as audio and video films, where marking is not deemed possible), however their total volumes are estimated to be negligible.

4.2 Costs Estimates by Country and Sector

This section presents cost figures by country and sector. These disaggregated estimates are based on the country and sector breakdowns illustrated in 2.1.

4.2.1 Member State Analysis

Analysing the member state specific data requires that the distribution of costs by country can be made using data for each country on the distribution of products and thereby marking methods. Furthermore, turnover information needs to be country specific and the data given in is incomplete.

Therefore, total costs per Member State can only be estimated through data on plastic consumption by country. The table below gives the total annual costs by country for the two introduction alternatives.

Table 4.4 Total Annual Financial Costs of Plastics Labelling (EU15)

	Fast introduction	Gradual introduction	Percentages of EU average costs per GDP
	Total in M EUR	Total in M EUR	%
Austria	21	17	90
Belgium	41	33	146
Denmark	16	13	89
Finland	14	11	105
France	127	103	79
Germany	215	174	87
Greece	12	10	94
Ireland	7	5	91
Italy	178	145	141
Netherlands	39	32	96
Portugal	16	13	150
Spain	75	61	124
Sweden	19	15	71
United Kingdom	115	93	96
TOTAL[2]	895	727	100

The last column in the table shows how the costs per GDP in the countries differ from the EU average. As the costs are distributed by total plastic consumption in the converter industry, the indicator shows a similar pattern to production per GDP.

High impacts in countries like Belgium and Italy are caused by a relatively large converter industry, while the high relative impact in Portugal and Spain is more the result of a lower GDP.

4.2.2 Sector Distribution

A sector breakdown of the estimated costs has been made. Using the cross-tabulation of plastic products (such as injection-moulded, films, bags, etc) and sectors, it is possible to provide an estimate of costs at the sector level different from a simple distribution proportional to sector consumption. The basis for the distribution is the cross-tabulation of products and sectors shown in Table 2.4. It has been assumed that blow moulded, injection moulded products are marked through moulding while the rest is printed. One exception is building material, where the data do not allow for a breakdown, as the majority is in other category. Here, it has been assumed that half the category 'other' belongs to moulding and half belongs to the printing category.

Also another modification has been made taking the share of products currently marked into account. For the packaging sector, the share of marked products is around 50%, while the average share is approximately one-third for printing and 50% for the products marked through moulding. The implication is that

the packaging sector share of the printing costs is less than it share of products marked with printing.

The table below summarised the sector's share of printing and moulding costs respectively and total costs per sector for the two introduction alternatives. Finally, the ratio between each sectors share of costs relative to its share of total plastic consumption is shown.

Table 4.5 Distribution of Costs by Sectors

Sector	Share of printing costs	Share of moulding costs	Fast introduction	Gradual introduction	Fast introduction	Gradual introduction
	%	%	Annual cost in M EUR		Ratio between share of costs and share of consumption	
Packaging	35	37	317	254	0.84	0.83
Building/ construction	25	17	206	178	1.21	1.29
Distribution	25	9	198	182	1.38	1.57
Electronics	1	19	45	13	0.56	0.20
Automotive	2	13	42	19	0.67	0.38
Agriculture	4	0	29	29	1.63	1.98
Other	7	4	58	52	1.30	1.43
Total	100	100	895	727	1.00	1.00

The sector analysis presents indications of the variations in the cost impact. It should be underlined that the uncertainty of the input variables influences the sector distribution more than the overall total estimate. No data for turnover at the sector division used here has been identified.

The packaging sector seems to count for fewer costs than its share of consumption. For the building and construction sector, the estimated share of costs is higher than the share of consumption, likewise for distribution. For the electronic and automotive sectors the opposite is the case and they have lower cost shares.

These differences are caused by the sector's share of products suitable for marking through printing compared to moulding as marking method. The higher share of products that need printing, the higher is the share of total costs.

From Table 2.7 on turnover, it follows that the packaging sector has of the total converter industry turnover. Due to differences in sector definition, it not possible to estimate whether the share corresponds to be packaging sector consumption derived from the APME database. The indications is that the turnover per tons is less for the packaging industry, but as they also have a lower share of total costs, the final relative financial impact, costs per turnover, can not be determined.

4.2.3 SMEs

It is difficult to draw general conclusions on the cost implications that product marking may have on SMEs. As noted earlier, the plastics sector is very diverse, and data on industry structure shows that the number of SMEs is significant within all sub-sectors (see Appendix on National Statistics and data for France as example illustrated the importance of the SMEs in the various sub-sections of the converter industry).

Investments for printing could range between 2000 and 20000 *EUR*. Assuming that a typical SME has a turnover around 4 million *EUR*, the investment would amounts to 0.5% of the turnover, which is not significantly more than the average impact. So unless special production features prevents an easy printing procedure, the size of the investment should be manageable for most SMEs.

Investments for moulding may pose greater difficulties to SMEs. SMEs are largely present in the injection moulding industry, where they manufacture a diverse selection of products using a large number of moulds (most of which are old). Most of such small businesses are competitive because of the low capital costs (due to the fully depreciated moulds), and a large investment for modifying the moulds could be very difficult to finance[21].

With a gradual introduction of mandatory marking such examples would be the exception, and the overall effect on the industry structure is likely to be moderate.

4.3 Impact on the CEE Accession Countries

The impact on accession countries varies largely among the different countries. The EU cost per ton estimates is used below to assess the cost implications for accession countries.

Factors that may influence and/or cause the costs to deviate from consumption are:

- varying sector compositions;
- lower shares of marking;
- differences in unit costs.

While it could be expected that the packaging sector would account for less than 40% (the average EU share), this is not the case in the countries with higher per capita consumption values (the Czech Republic, Hungary, Poland and Slovenia).

Conversely, a lower share of marking seems likely, which points at higher costs (vis-à-vis consumption) than in EU.

[21] One small company has indicated that a mandatory marking requirement would be almost impossible to finance.

Finally, although investment in new printing equipment will be almost as expensive as in the EU, the lower man power and energy costs will help buffer the financial burden.

Assuming that the last two factors offset one another, and using the proportional per ton relationship total costs can be estimated.

Table 4.6 Financial costs of Marking in CEE Accession Countries (million EUR*)*

Country	Investment Costs	Annual Operational Costs	Total Annual Costs
Bulgaria	6	2	4
Czech Republic	28	9	19
Estonia	2	1	1
Hungary	29	9	19
Latvia	3	1	2
Lithuania	3	1	2
Poland	65	21	43
Romania	12	4	8
Slovakia	6	2	4
Slovenia	8	3	5
Total	*161*	*51*	*107*

The financial impact also depends on the technological situation of the industry. To the extent that the industry is in a process of general technological modernisation, it might be possible for companies to include printing facilities when investing in new production equipment. However, this is not always the case, and the Hungarian industry, for example, seems to be relatively modern and target of international investment[22].

Limited access to loan capital can threaten the financing of new equipment. Therefore compliance with mandatory marking could be difficult even when production itself is financially viable. As noted earlier, the need for additional investment is reduced with a lagged implementation and the main part of the costs are the variable printing costs.

4.4 Trade Issues

Trade and costing issues include two elements:
- the cost imposed on EU producers exporting outside EU;
- the cost imposed on non-EU countries exporting to EU.

Although a mandatory labelling of all plastics would not require goods exported outside EU to be marked, it could nonetheless increase production costs.

[22] Personal communication: Kalman Wappel, The Plastic Converters Association in Hungary.

Conversely, if the products for export are produced in special series, there would be no additional costs.

Export to countries outside the EU is relatively moderate, just as import (see section 2.4). The value of the export amount to approximately 10% of total production and the value of the import is only between 6% and 7% of the total production. The main exporters to the EU are USA, Switzerland, China, Japan and Taiwan.

Assuming that the tonnage imported to the EU are proportional to the above import value (10%), the import volume is of around 2,7 million tons of plastic products. At the above unit costs, the annual costs of labelling can be estimated at 70 to 90 million *EUR* depending on the implementation period.

Appendices

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Contacts

Name	Affiliation	Contact
Experts		
Mr John Sale	British Polythene Industries Plc. (United Kingdom)	Tel: +44 1642 664 203 Fax: +44 1642 664 299 e-mail: britpoly@compuserve.com
Mr Joachim Eckstein	EUPC	Tel: +49 69 305 7148 Fax: +49 69 305 16039 e-mail: joachim.eckstein@infraserv.hoechst.com
Mr Barry Overton	Oveconsult (United Kingdom)	Tel: +44 1438 798 301 Fax: +44 1438 798 399 email: oveconsult@aol.com
Mr John Swift	REXAM (Industrial Packaging Division, Group Technical Centre, United Kingdom)	Tel: +441455619727 Fax: +441455619747 e-mail: jswift@rexam.co.uk
Standards Organisations		
Mr Roland Dewitt	CEN (chairman of CEN/TC 249)	Tel: +32 2 264 28 21.
Ms Françoise Gérardie	FP (CEN representative)	Tel: +331 46223366
Ms Tricia Heffernan	ISO (British Standards Institute)	Tel: +44 181 996 9000
Mr Mark Scudamore	ISO (British Standards Institute)	Tel: +44 181 996 9000
Mr Helmut Meyer	ISO (working group for the revision of ISO 11469)	Tel: +41 22 749 01 11

Name	Affiliation	Contact
Mr Hugh Patrick Toner	SPI	Tel: +1 202 974 5200
Federation Representatives		
Mr. Kalman Wappel	AHPI	Tel: +36 13 43 58 83
Mr Freddy Maréchal	APME	Tel: +32 2 675 32 97
Ms Anne Meysmans	APME	Tel: +32 2 675 32 97
Ms Mercia Gik	BPF	Tel: +44 171 457 5015
Mr Philip Law	BPF	Tel: +44 171 457 5000
Mr Bennett	CEPMC	Tel: +32 2 775 84 91
Mr Ian MacIlwee	CIPAD	Tel: +44 1714575000
Mr Jacques Fonteyne	ERRA	Tel: +32-2-772 52 52
Mr Sergio Mastropietro	EUPC	Tel: +32 2 732 41 24
Mr Julian Carroll	EUROPEN	Tel: +32 2 736 36 00
Mr Jallon	FP	Tel: +33 1 4401 16 16
Ms Jane Bickerstaffe	INCPEN	Tel: +44 171 409 09 49
Mr Adrian Harris	ORGALIME	Tel: +32 2 706 82 35

Name	Affiliation	Contact
Mr Marino Lamberti	UNIONPLAST	Tel: +39 02 392 31 71
Industry Representatives		
Mr Niels Alexandersen	Bang & Olufsen (Denmark)	Tel: +45 96 84 11 22
Mr Jørn Sørensen	Icopal A/S (Denmark)	Tel: + 45 98 15 92 22
Mr Lars Gelstrup	Lindknud Plast (Denmark)	Tel: +45 75 36 14 11
Ms Pia Poulsen	Nyborg Plast (Denmark)	Tel: +45 63 31 30 00
Mr Ken Rasmussen	Siemens A/S (Denmark)	Tel: +45 44 77 46 00
Mr Knud Sørensen	Superfos A/S (Denmark)	Tel: +45 59 11 11 11
Mr Bo Sørensen	Uponor (Denmark)	Tel: + 45 98 57 11 22
Mr P. Marlin	Moulinex (France)	Tel: +33 2 31 06 80 66
Mr Philip Chinchole	Nicoll (France)	Tel: +33 1 45 636 797
Mr Bernard Seguier	Plastic Omnium (France)	Tel: +33 1 40 87 64 00
Mr Pacal Boll	Sommer Allibert (France)	Tel: +33 1 4120 40 40
Mr John Sale	British Polythene Industries Plc. (United Kingdom)	Tel: +44 1642 664203
Mr Wilf Davis	Broanmain Limited (United Kingdom)	Tel: +44 1306 885 809

Name	Affiliation	Contact
Mr D. Hemmings	HPL Jars and Containers Ltd. (United Kingdom)	Tel: +44 151 487 3353
Mr David Eggleston	Linpac Plastics Ltd. (United Kingdom)	Tel: +44 1977 671 111
Mr. Dainelli	Cryovac Europe (Italy)	Tel: +39029332351
Mr Pianesani-Maggiani	Ilpa SPA (Italy)	Tel: +39051832202
Dr. Gianpetruzzi	Nuova Pansac SPA (Italy)	Tel: +39 02 6957
Mr Roberto Novelli	Plasturopa Industrie SPA (Italy)	Tel: +39 0574 680 461
Mr Marco Severini	Selene SPA (Italy)	Tel: +39 0583 379 902
Ms Simona Emilguerri	Sirap-Gema SPA (Italy)	Tel: +39 030 936 81
National Authorities		
Mr. Darlot	ADEME	Tel: +33 2 4120 41 12
Mr Richard O'Neill	DTI	Tel:+44 171 215 18 44

Review of Cost Studies

Initiatives to standardise plastics marking so as to enhance recovery and recycling, were introduced in the mid- to late 1980s. Although marking has become widespread at an international level since then, the relevance of labels to recycling has diminished, particularly for products for which:

- automated sorting technologies now exist;
- manual sorting is too labour-intensive (typically, smaller-sized products).

Furthermore, industry is torn between designing for the environment (to enhance re-use or recycling) and optimising product properties, which often worsens environmental performance (for example, by combining polymers, or reinforcing plastics with non-plastic elements, thereby prohibiting recycling).

All the same, marking is increasingly gaining momentum in the political agenda, and shortly after the SPI code became mandatory in 39 states of the United States (1993), the European Commission tabled (1997) a similar (although clearly recycling-driven) initiative for the EU.

In these context a few cost assessments have been produced to shed light on the financial implications of such marking schemes, first in the United States but also within the European Union. The Consultant identified and studied three cost studies, produced by the following organisms:

- the Society of the Plastics Industry;
- the European Union of Plastic Converters;
- the UK Department of Trade and Industry.

Summaries of the three studies are provided below, together with a final comparison of per ton costs for marking packaging plastic. It is worth noting that available documentation for the studies are very brief and the cost per ton have been estimated for the SPI and the UK-DTI studies and that these estimates are very rough.

The lowest estimates (less than 10 *EUR* per ton) correspond to the SPI study, undertaken in 1993, and are comparable to those provided by the 1996 British assessment (some 80 *EUR* per ton). Conversely, EUPC's estimates (nearly 2000 *EUR* per ton) are well above those ranges.

SPI - Study on Options to Improve the Effectiveness of SPI's Resin Identification Code

(1) Background

The Society of the Plastics Industry, Inc. (SPI) is a trade association of more than 2000 members representing all segments of the plastics industry in the United States.

SPI membership is composed of plastics processors, raw material suppliers, machinery manufacturers, mould makers and other industry-related groups and individuals. SPI represents and serves as the spokesperson for the industry locally, nationally and internationally, with emphasis on influencing public policy on issues of concern to the industry.

SPI serves as a resource for members needing technical expertise, statistical information and regulatory compliance assistance. It maintains liaison with national and international technical and regulatory groups to develop standards for product performance and safety to protect existing markets for plastics and open new ones.

(2) Costs Survey

The SPI introduced its resin coding system in 1988 to meet the recyclers' needs for a method of identifying packaging plastic materials.

The overwhelming majority of plastic packaging is made with one of six resins. The SPI resin identification code assigns each of these resins a number from one to six. This number is featured inside a triangle of chasing arrows, with the resin abbreviation printed underneath. A seventh code, identified as "other", indicates that the product in question is made with a resin other than the main six, or that is made of more than one resin used in combination. Such a code system is not consistent with the ISO 11469 standard, which specifies a system for the uniform marking of products that have been fabricated from plastic materials.

In 1993 thirty-nine states in the USA had passed laws for the SPI resin identification code to be mandatory. Thereafter, NRC and SPI agreed to improve the coding system and set up a strategy to:

- modify SPI's voluntary resin identification code on products mandated to carry the code;
- recommend the use of ISO 11469 standards for all other plastic products.

In this context, SPI launched a survey among its packaging -related divisions to estimate the financial costs of introducing a modified mark.

The survey concluded that a change to a completely new code "would have increased conversion costs 3-5 times, to between US$ 20 million and US$ 80 million", depending upon the type of manufacturing involved. Given that the

life span of moulds ranges from several years to as much as 20 years, a four-year time-span was chosen as a compromise "to balance the need to expedite a change with the need to evaluate the economic impact on industry".

Gross 1993 sales and captive use of plastic resins in packaging in the USA were 8876 thousand tons in 1993. The financial implications of introducing a new code would therefore amount to between 2.25 and 9.01 US$ per ton of resin consumed (that is, roughly between 2.17 and 8.68 *EUR* per ton).

EUPC - Cost Implications of a Generic Identification System for Plastic Products

(1) Background

The European Plastics Converters Association (EUPC) represents an industry of about 30000 companies that employs over 1 million people. Up to 85% of the sector is composed of businesses with less than 100 employees. The individual members combine a processing capacity of more than 30 million tons of plastics a year.

Since the early nineties the European plastics converting industry has been using marking and coding systems: the ISO 11469 standard is mainly used for non-packaging plastic products (automotive and electronic sectors) and mainly upon customer request; the SPI code is largely applied on packaging material.

(2) Costs Survey

A 1998 EUPC survey on the financial implications of a mandatory marking scheme for plastic products found that such an initiative would affect an estimated total of 19000 companies, with costs varying largely within the sector.

Below is shown the EUPC cost model that comprises cost estimation for 12 groups of products. The principle methodology for the cost estimation is almost similar to the one applied in the present study. From the total volume within each product group type to the amount currently not marked and then multiplying with unit cost factors.

The main assumptions are the following:

- printing costs per m² of plastic is assumed to be 0.3 DM (0.16 EUR);
- investment costs for printing machines 5 million DM (2.7 M EUR);
- investment costs per mould for blow moulding 100,000 DM (54,000 EUR);
- the whole area of products is assumed to need printing; and
- for moulding, all moulds have to be replaced.

The implication of the cost assumption for printing is that the average annual cost per tons of printed products amount to on average 1000 EUR per ton. This average is almost 10 times higher than the high unit costs used in the present study. For moulding as marking, the average cost is about 450 EUR per ton, which 6 times higher than the present study.

For the printing cost, the assumptions used in the EUPC study has not been supported by any other cost evidence and both the operational and the investment costs are extremely high. Printing costs are based on the assumption that for example films and bags will be printed at a special printing shop. Costs applied in the study could correspond to the cost of establishing general printing facilities and full colour printing, however this does not reflects the need of adding the small one-colour identification mark.

For the moulding method, the investment costs for new moulds seem in line with the other cost evidence. Here, the main question on the assumption regards that all moulds are supposed to be changed in order for inserting a mark. According to information from the industry expert discussed before, only in a few cases a new mould need to be made. In most cases the existing mould can be modified even during normal operation to an almost negligible cost.

Based on these assumption, the total annual costs for the European plastics converters were estimated at about 28 billion DM (15 billion EUR). Similar, the investment costs were estimated as 40 billion DM (22 billion EUR).

As the costs estimated in the EUPC are much higher than any other evidence, the cost data have not be used in the present study. The estimates on the marking method and shares currently marked have been used as a starting point and used unless contradicted by other information gained through the survey and expert interviews.

Cost Assessnent Plastic Identification Scenario "full plastics marking,without fibers". All costs in DM	Injection mouldet products	Films	Blow mouldet products	Bags	Thermosets	Pipes	Sheets thermo-formed	Cables	Windows	Foams	Extrusion-coating	Others	Total	Companies	
Quantity kg	5337000000	4.709.000.000	3.074.000.000	2.666.000.000	2.324.000.000	2.285.000.000	1.556.000.000	930.000.000	700.000.000	720.000.000	295.000.000	3.282.000.000	22.541.000.000	15.305	companies involved
share with identification marking	0.5	0.5	0.5	0.5	0	0.3	0.5	0.1	0.1	0.3	0.1	0.3			
share without Identification marking	0.5	0.5	0.5	0.5	1	0.7	0.5	0.9	0.9	0.7	0.9	0.7			
way of identification marking	moulding	printing	moulding	printing	printing	printing	50% moulding 50% printing	printing	printing	50% moulding 50% printing	printing	printing	printing		
Printing plain products														10.560	companies involved
average thicknes		100		50	1000	0	150	0	0	5000	20	250			
kg per Qm		0.1	0	0.05	1	0	0.165	0	0	1.5	0.02	0.25			
total consumption Qm		47.090.000.000		53.320.000.000	2.324.000.000	0	9.430.303.030	0	0	480.000.000	14.750.000.000	13.128.000.000	140.522.303.030		
share unlabeled Qm		23.545.000.000	0	26.660.000.000	2.324.000.000	0	2.357.575.758	0	0	168.000.000	13.275.000.000	9.189.600.000	77.519.175.758		
Total costs printing		**7.063.500.000**	**0**	**7.998.000.000**	**464.800.000**	0	**707.272.727**	**0**	**0**	**16.800.000**	**1.327.500.000**	**918.960.000**	**18.496.832.727**		
Investment printing epuipment															
capacity of one printingmachine/qm	0	15.000.000	0	15.000.000	20.000.000	0	15.000.000	0	0	5.000.000	15.000.000	15.000.000			
needed number machines	0	1.570	0	1.777	116	0	157	0	0	34	885	613	3.582		
investment for one machine / DM	0	5.000.000	0	5.000.000	5.000.000	0	5.000.000	0	0	5.000.000	5.000.000	5.000.000			
total investment for printing equipm.	**0**	**7.848.333.333**	**0**	**8.886.666.667**	**581.000.000**	**0**	**785.858.586**	**0**	**0**	**168.000.000**	**4.425.000.000**	**3.063.200.000**	**25.758.058.586**		
depreciation over 10 years / p.a.	**0**	**1.177.250.000**	**0**	**1.333.000.000**	**87.150.000**	**0**	**117.878.788**	**0**	**0**	**25.200.000**	**663.750.000**	**459.480.000**	**3.863.708.788**		
Printing cylinders															
costs per cylinder	0	8.000	0	8.000	8.000	0	8.000	0	0	8.000	8.000	8.000			
number of cylinders	0	159.871	0	181.022	78.900	0	26.413	0	0	12.222	10.015	111.424	579.868		
Total costs printing cylinders	**0**	**1.278.967.917**	**0**	**1.448.175.182**	**631.200.136**	**0**	**211.305.381**	**0**	**0**	**97.776.269**	**80.122.220**	**891.393.651**	**4.638.940.757**		
Depreciation over 3 years / p.a.	**0**	**490.228.403**	**0**	**555.085.547**	**241.939.012**	**0**	**80.993.353**	**0**	**0**	**37.477.644**	**30.710.847**	**341.671.187**	**1.778.105.992**		
Total costs printing plain products p.a.	**0**	**8.730.978.403**	**0**	**9.886.085.547**	**793.889.012**	**0**	**906.144.868**	**0**	**0**	**79.477.644**	**2.021.960.847**	**1.720.111.187**	**24.138.647.507**	**2.285.892**	**av.costs p.company**
Total investment for printing equipm.	**0**	**9.127.301.250**	**0**	**10.334.841.849**	**1.212.200.136**	**0**	**997.163.967**	**0**	**0**	**265.776.269**	**4.505.122.220**	**3.954.593.651**	**30.396.999.343**	**2.878.548**	**av.investm. p.company**
Printing linear products														2.658	companies involved
aver.kg per meter	0	0	0	0	0	10	0	0.37	1.2	0	0	0			
total meters	0	0	0	0	0	159.950.000	0	2.262.162.162	1.575.000.000	0	0	0			
Costs printing linear products	**0**	**0**	**0**	**0**	**0**	**15.995.000**	**0**	**226.216.216**	**157.500.000**	**0**	**0**	**0**	**399.711.216**	**150.364**	**av.cost p.company**
Investment Printing epuipment															
capacity of one printingmachine/meter	0	0	0	0	0	585.000	0	15.810.811	4.875.000	0	0	0			
needed number machines	0	0	0	0	0	273	0	143	323	0	0	0			
investment for one machine / DM	0	0	0	0	0	100.000	0	100.000	100.000	0	0	0			
Total investment for printing equipm.	**0**	**0**	**0**	**0**		**27.341.880**	**0**	**14.307.692**	**32.307.692**	**0**	**0**	**0**	**73.957.265**	**27.821**	**av.investm. p.company**
Moulding / embossing units														3.633	companies involved
number of moulds per company	100	0	100	0	0	0	100	0	0	100	0	0			
number of companies	0	0	2.087	0	0	0	1.057	0	0	489	0	0			
costs for changing one mould	5.000	0	50.000	0	0	0	100.000	0	0	100.000	0	0			
Total Investment for mould changes	**0**	**0**	**5.218.129.350**	**0**	**0**	**0**	**2.641.317.264**	**0**	**0**	**1.711.084.705**	**0**	**0**	**9.570.531.319**	**2.634.579**	**av.costs p.company**
Depreciation over 3 years / p.a.	**0**	**0**	**2.000.108.980**	**0**	**0**	**0**	**1.012.416.907**	**0**	**0**	**655.858.768**	**0**	**0**	**3.668.384.655**	**1.009.834**	**av.costs p.company**
Total Investment Costs	**0**	**9.127.301.250**	**5.218.129.350**	**10.334.841.849**	**1.212.200.136**	**27.341.880**	**3.638.481.231**	**14.307.692**	**32.307.692**	**1.976.860.974**	**4.505.122.220**	**3.954.593.651**	**40.041.487.927**	**2.616.171**	**av.investm. p.company**
Total Costs per Year	**0**	**8.730.978.403**	**2.000.108.980**	**9.886.085.547**	**793.889.012**	**15.995.000**	**1.918.561.775**	**226.216.216**	**157.500.000**	**735.336.411**	**2.021.960.847**	**1.720.111.187**	**28.206.743.378**	**1.842.930**	**av.costs p.company**

DTI - Compliance Cost Assessment for the EC Draft Directive on Marking and the EC Decision on Material Identification[23]

(1) Background

In order to begin the process of developing its position on the Commission's Draft Directive, the UK Department of Trade and Industry conducted a brief study in 1996 to anticipate the Directive's impact on business in the United Kingdom. It was determined that although converters would be responsible for physically marking the packaging, the packer/filler sector would also be affected, being responsible for ensuring correct marking.

(2) Costs Survey

To determine the impact on business, the study consisted of a compliance cost assessment (CCA) which considered all packaging materials (i.e., not just plastic). The CCA was a preliminary effort in the long-term arrangements to provide feedback on the legislation, and was derived through limited consultation with representatives of selected industry federations and individual businesses. No mathematical modelling or other processing of the cost figures obtained was performed. The resulting document was brief (6 pages), intended for further review and comment by business and experts.

Despite heterogeneity in the sectors affected, compliance costs were estimated by extrapolating the financial implications for an individual business to the sector as a whole, based on turnover. With the exception of unlabelled plastic film (accounting for roughly 53% of the film produced), most plastic packaging is marked according to the SPI system, which is similar to that proposed by the Commission. The British Plastics Federation therefore indicated that if the SPI system were left in place, and the sectors affected could rely on adhesive labels for the balance of unmarked plastics (rather than introducing marking in plastic film directly), costs to industry would be negligible. On the other hand, if the same marking requirements were imposed on plastic film (which accounts for more than half of all plastic packaging on the market) the cost significance of a marking requirement on the sector would increase. Cost impacts for film would also have to account for losses in revenue from the reduced recycling potential of marked film.

Conversely, the changing of existing moulds (to adapt from SPI to the proposed marking scheme) was estimated to cost about 11 million GBP for plastic containers alone, rising to 33 million GBP for all plastic packaging products. Note was made that the implications for small firms would vary considerably depending on the amount of packaging they handle and the sector to which they belong. Investment needs to meet identification standards would have to be

[23] Commission Decision of 28/Jan/97 *establishing the identification system for packaging materials pursuant to European Parliament and Council Directive 94/62/EC on packaging and packaging waste* (97/129/EC)

determined on a case by case basis (e.g., capital investments would be necessary for those firms lacking facilities to mark packaging).

Trade issues were only addressed to the extent that they were not judged significant so long as the cost of marking is low for industry.

Gross resin consumption by plastic processors in the United Kingdom in 1997 amounted to 3507 thousand tons (that is, 12.86% of the total EU consumption). Assuming that the same rate is valid for consumption of resins for packaging plastic materials, UK consumption of such resins in 1997 would have reached some 0.66 million tons (EU consumption in the same year was 5.1 million tons). Given the costs estimated noted earlier (33 million GBP, or 51.1 million *EUR*), the cost of marking packaging products would be 77.4 *EUR* per ton.

Questionnaire Survey

The Consultant conducted a questionnaire-based survey among industry representative to gain insights on products manufactured and processes used by the plastic converters sector. In addition, interviewees were also asked to estimate the cost implications of a mandatory marking scheme.

To that end a questionnaire was developed (attached) consisting of four sections:

- identification;
- product(s) description;
- marking process;
- marking costs.

The section on identification records basic contact information and the size of the company in terms of number of employees.

The section on product(s) description summarises the company's product type(s), the sectors in which the products are used, the resins utilised, and the fabrication process.

The section on marking process gives -for those enterprises marking their products- an overview of the methods and reasons for marking, plus a summary of main constraints and difficulties. Information is also collected on the share of products currently being marked and on reasons for not marking, where applicable.

The section on marking costs presents main cost factors (equipment, staffing, etc.) and estimated increases in unit cost of products due to marking.

As illustrated in Table 4.7 below, the questionnaire was finalised in consultation with experts in the field, and guidance was obtained from trade associations at the EU and national levels concerning representative contacts in the plastic converting industry.

Telephone contacts to industry were made to check their willingness to participate in the survey and to verify contact information. Following this the questionnaire was sent with an explanatory cover letter.

It was found that the questionnaire approach was not as effective as had been hoped: response rates were lower than expected and, whenever obtained, the key issue about the costs of marking remained unresolved. Most respondents, especially industries that are not marking their products, were reluctant to provide any estimates. Similarly, data obtained were not always comparable across industry branches and/or Member States. Thus, considerable follow-up was required, often for little gain.

The questionnaires did however serve to identify issues needing further clarification, which were followed up through in-depth interviews with experts in the

field. A selected group of reviewers were also asked to comment on the assumptions made for the cost model developed.

Table 4.7 Questionnaire Development and Processing

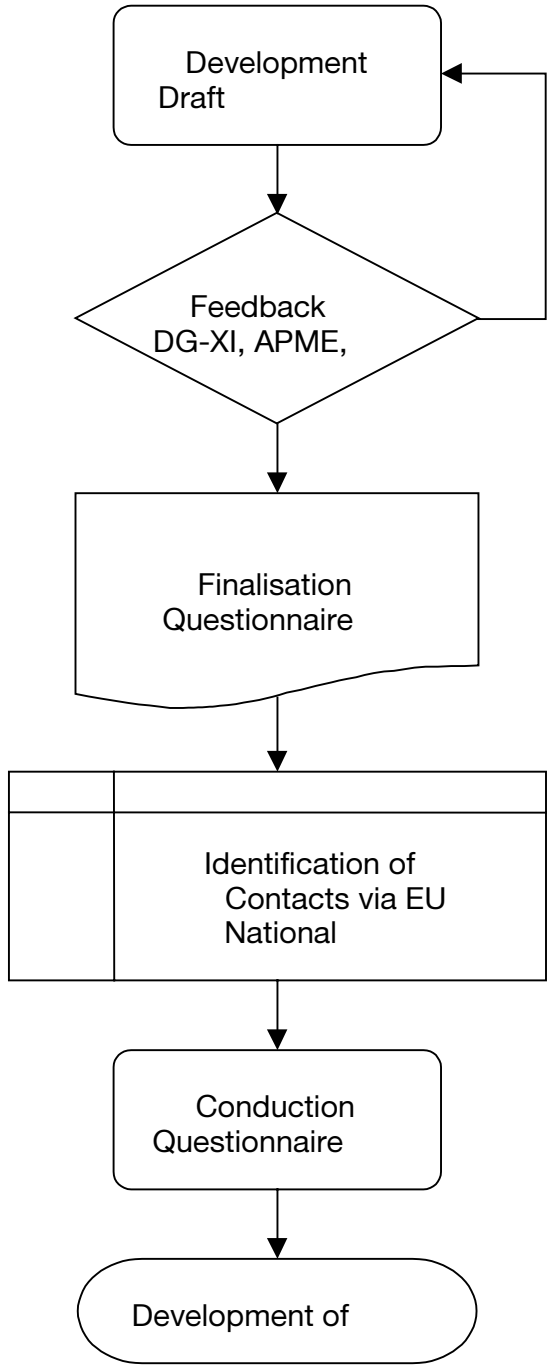

Table 4.8 and Table 4.9 below illustrate the breath of coverage of the survey, by giving per country summaries of product types manufactured and fabrication processes used by the enterprises contacted.

As illustrated below, no companies producing fibres or wires could be identified, and priority was given to producers of moulded products, films and sheets (those deemed to bear a larger burden should a mandatory marking scheme be put forward).

Similarly, only one fabrication process (expansion) fell out the survey, while all other types were represented by no less than 2 industries. Although depending on the variety of products manufactured, a given industry would in general use various production processes, typically from two to four.

Table 4.8 Plastic Processors Surveyed by Product Type and Member State

	Moulded Products	Films and Sheets	Foams	Pipes	Fibres	Profiles	Wires	Coatings
Denmark	✓	✓		✓				
France	✓		✓	✓		✓		✓
Germany	✓	✓						
Italy	✓	✓	✓					
United Kingdom	✓	✓	✓					

Table 4.9 Plastic Processors Surveyed by Fabrication Process and Member State

	Extrusion	Extrusion Coating	Thermoforming	Blow Moulding	Injection Moulding	Calendering	Film Blowing	Expansion
Denmark	✓			✓	✓		✓	
France	✓		✓	✓	✓			
Germany	✓	✓	✓	✓		✓		
Italy	✓		✓		✓		✓	
United Kingdom	✓	✓	✓	✓	✓		✓	

Table 4.10 below gives a distribution of the companies contacted in terms of size (number of employees). Although significant efforts went into ensuring a representative coverage of SMEs, this remained limited because of interviewees uneasiness to reply (indeed, most of the knowledge base of the sector lies in larger business, as otherwise anticipated).

Table 4.10 Companies Surveyed by Size and Member State

	EMPLOYEES	
	below 100	above 100
Denmark	1	5
France		4
Germany	2	4
Italy	1	3
United Kingdom	2	2

Table 4.11 below presents a per Member State distribution of companies surveyed according to mark types used (ISO, SPI, both, none).

The segment 'Other' dominates the total due to the fact that nearly all Danish-based companies use the DIN system (similar to ISO's). The French industry uses the governmental mark "NF Environnment" in some instances, or labels plastics with a code defined by the client (the latter also applies for the only Italian entry under 'Other').

Most German companies are not currently marking their products (on the plastic itself) and only one industry reported to use both ISO and SPI codes, upon the clients' request.

Table 4.11 Plastic Processors Surveyed According to Marking Practices

	MARK TYPE				
	ISO	SPI	ISO/SPI	Other	None
Denmark		1		6	
France	2			2	
Germany	1				5
Italy	2	1		1	1
United Kingdom		2	1		1

Finally, Table 4.12 below presents a range of estimated costs for marking distinguishing between companies that are currently marking all their products, some of them, or none.

It is worth mentioning that among the interviewees that reported not to mark their plastics, a vast majority felt uneasy to provide any cost estimates and anticipated a significant financial burden from introducing a mark. This is especially true for smaller companies.

Table 4.12 Estimated Costs of Marking According to Current Marking Practice

PRODUCTS CURRENTLY MARKED	*INCREASE IN UNIT PRICE*							
	Negligible	0.01%	0.05%	0.10%	0.50%	1%	5%	10%
All								
Some								
None								

Questionnaire for the cost assessment of different plastic identification schemes

Identification

1. Company name:

2. Contact person:

3. Number of employees: ☐0-25 ☐25-50 ☐50-100 ☐more than 100

Product(s) description

4. General description of product type(s): ☐ Moulded products ☐Films & sheets ☐Foams ☐Pipes ☐Fibres ☐ Profiles
   ☐Wires ☐Coatings
   ☐Other_____

5. Sectors in which products are used:

☐ Packaging ☐Building/construction ☐Electrical/electronics

☐Automotive and other transportation ☐Agriculture

☐ Furniture ☐House-wares ☐Mechanical engineering

☐Toys ☐Other_____

6. Plastics used:

a. Thermoplastics: ☐L/LDPE ☐HDPE ☐PP
   ☐PVC ☐PS/EPS ☐PET
   ☐Other_____

b. Thermosets: ☐Polyurethanes ☐Polyesters

   ☐Other_____

7. Fabrication process

   ☐Extrusion ☐Extrusion coating ☐Thermoforming ☐Blow moulding
   ☐Injection moulding ☐Calendering ☐Film blowing ☐ Expansion

   ☐Other_____

Process used to introduce plastic identification marking

8. Do you presently label your products? ☐Yes, using the following standard:

☐ISO ☐SPI ☐Both SPI and ISO
☐Other label than ISO or SPI, specify_____

☐No, do not presently label**,** comment:_____

9. Method used in labelling: ☐Melt imprinting ☐Moulding

☐Embossing ☐Other_____

10. What are the main reasons for labelling products and for choosing a specific standard? ☐ Domestic market ☐ Export to EU ☐ Export beyond EU

☐ Agreements with customers/recyclers
☐Other_____

11. Are all products are labelled? ☐ Yes ☐ No If No, give reasons:

☐ Products are too small (e.g., computer chips)

☐Labelling would damage plastic's function (aesthetics or contamination)

☐Product use results in contamination of the plastic

☐Other_____

12. Are there any constraints/difficulties/limitations with existing labelling?

☐ Yes ☐ No If Yes, give reasons:

☐ Labels become unreadable during product use, making labelling a wasted effort

☐ Plastic cannot be recycled due to contamination during product use

☐ Switching labels for each product group is tedious and resource-demanding

☐ The absence of a recycling market makes labelling a wasted effort

☐Other_____

Cost implications for plastic identification (give best estimate if no identification system is currently used)

13. Main cost factors - if possible, estimate relative importance in percent:

- ☐ New equipment needed for labelling, ____%
- ☐ Increased staff time needed for labelling, ____%
- ☐ Increases in equipment "down-time" due to inserting label, ____%
- ☐ Increased energy and/or water consumption, ____%
- ☐ Materials purchases (e.g., inks, oils, etc.), ____%

14. Unit cost of labelling versus unit cost of the product (order of magnitude):

☐Negligible ☐ 0.01% ☐ 0.05% ☐0. 1%

☐0.5% ☐1% ☐5% ☐10%

Background Information on Plastic Converters

This section describes the main plastic product groups (noting final users and resins utilised in the production process), and the marking techniques suitable to each production process.

Product Groups
The following economic sectors are the largest consumers of plastic products are:

- packaging;
- electronic equipment;
- vehicles;
- construction; and
- agriculture.

Typical product groups within each sector are listed below:

Table 4.13 Plastic Product Groups per Sector

SECTOR	PRODUCT GROUP	RESINS
Packaging	bottles, boxes, films, sheets	PE, PET, PP, PS
Electronic Equipment	TV sets, CD-players, telephones, faxes, computers, etc.	PC, ABS, PUR, PVC
Vehicles	fabrics, instrument panels, wheels, guards, bumpers, insulation	PP, PVC, PUR
Construction	flooring, wall coverings, pipes, cables, profiles (roofing), window frames, insulation	PVC (plasticised/non-plasticised), PUR, XPS, PP, PE
Agriculture	films, sheets	PE, PVC

The most common manufacturing techniques used for packaging material are injection moulding, blow moulding, film blowing and expansion. The production process often imposes the marking method to be used: while the mark can be a part of moulds, printing techniques have to be used for films and sheets.

The electronic equipment sector is dominated by the increasing penetration of personal computers (gross volumes world-wide estimated at around 90 million units per year). The plastic parts of the electronic equipment account for between 25% and 30% of the total weight (Chainet, 1994).

The cases of PC monitors and TV sets are often made of PC and ABS. Other polymers such as PC, PS, PUR and PVC are also used (although PVC accounts for less than 1% of the total).

Moulding is the most common production process used to manufacture plastic for electronic equipment. Marking is therefore not very costly since the label can be placed in the mould.

The plastic content in vehicles amounts to about 3 % by weight (VOLVO, 1994), mostly PP. Moulding is the most common production process for plastic parts in vehicles.

Plastics used in the construction sector are produced in different ways and from different polymers. The sector is the largest consumer of PVC, which can be used both plasticised and non-plasticised.

Floorings, wall coverings, roofing membranes and cables are made of plasticised PVC. Extrusion is the most common production process for plasticised PVC.

Pipes and profiles for roofings, and window frames are made of non-plasticised PVC (window frames can also be produced from other polymers such as PUR). By and large, non-plasticised PVC products are manufactured by moulding.

Insulation materials are typically made of XPS or PUR, both produced through expansion (and using also a blowing agent).

PE is the dominant polymer in films and sheets for agriculture, although PVC is also used. Films and sheets for agriculture are largely produced by extrusion.

Marking Options

The Commission Decision on material identification (97/129/EC) lays down an identification system for packaging made from plastic (and also paper and fibreboard, metal, wood, textiles, glass or composites). The numbers and abbreviations for material identification should appear in the centre of or below the "recyclable" or "reusable" markings (see Table 4.14 below for a listing of materials and codes).

Table 4.14 Marking Codes for Packaging Plastic Products

Material	Abbreviation	Code
Polyethylene Terephthalate	PET	1
High-density Polyethylene	HDPE	2
Polyvinyl Chloride	PVC	3

Material	Abbreviation	Code
Low-density Polyethylene	LDPE	4
Polypropylene	PP	5
Polystyrene	PS	6

Plastic films will have to bear very close markings along all their length to prevent parts of the plastic to be unmarked after the film is split up by end users.

Most electronic equipment is currently being marked. Some of the larger manufacturers use a marking system similar to ISO's or SPI's (which does not require special tools or equipment for marking, since the plastics are moulded). Smaller producers, however, tend to mark the plastics with different (often company-specific) systems.

Marking of construction materials depends on the nature (hard or plasticised) of the product. Most of the hard materials (pipes, roofing panels, and window frames) are moulded and they can be marked either as part of the moulding process or using melt imprinting. In the cost assessment it has been assumed that they will be marked using melt imprinting. Softer (plasticised) materials such as wall coverings and floorings cannot bear visible marks for aesthetic reasons, which compound to the technical difficulties attached to the marking of such products (marks are currently being put on the reverse of plastic).

Strict standards are being discussed in Sweden and Denmark, involving compulsory visible marking of all construction material, indicating the composition of the plastic.

Plastic film and sheet used for covering crops are usually made in large rolls with a defined width. Marks are currently being placed on the borders of films, with a constant distance of about 50 cm., and using an imprinting technique. Such a system is commonplace in all EU Member States.

National Statistics for Estonia, France, Italy, Slovakia, and the United Kingdom

Statistical data for the plastic converters industry in selected EU and Accession Countries are given below. No aggregated data could be obtained for Germany, one of the top four EU producers, while Estonia and the Slovak Republic were the only Accession Countries to supply figures).

In general, the sector shows an upward trend, alongside developments with national GDP (except for the Slovak Republic, the only country were the sector has experienced a recession).

While Slovakia shows a much larger turnover figure when compared with Estonia (roughly 180000 and 55000 *EUR* in 1997, respectively), per capita values are largely comparable (between 33 and 38 *EUR* per inhabitant -not shown in the tables).

No trend on turnover could be obtained for France, nor were disaggregated turnover figures available for the United Kingdom. Nonetheless, the French statistics presented here correlate well with Eurostat's estimates given in Table 2.7 above (slightly below 17 million *EUR*). This is not the case for Italy, however, where comparison of Table 4.20 and Table 2.7 suggests a decrease in the industry's output in Italy, whereas the time series given in Table 4.21 below show a stagnating trend after 1995.

Overall, the trend seems to be of growth in turnover for all countries analysed, with the mentioned exception of Slovakia.

Employment shows an upward trend for Estonia, Italy (this includes both plastic and rubber producers, since disaggregated figures for the plastic sector alone are not recorded -not shown in the tables), and the United Kingdom.

As for the previous indicator no time series were available for France, and Slovakia showed a significant decline in employment (in accordance with the fall in turnover).

Employment by the sector in relation with the total population gives values of around 1 employee per 1000 heads in Estonia and Slovakia, and between 2 and 3 employees per 1000 heads in France and the United Kingdom. This represents a ration between EU and Accession Countries that ranges between 2 and 3.

On the other hand, per capita consumption values given in Table 2.8 above amount to some 23 tons per capita in Estonia and Slovakia, and between 60 and 66 tons per capita in France and the United Kingdom. That is, a much narrower ratio (between 2.4 and 2.9) than the previous one.

In summary, the above indices show that the gap between the EU and the Accession Countries is larger for employees per unit of total population than it is for volume of plastics consumed per unit of total population. That is to say, that

production by plastic processors is significantly more effective in the EU than in the Accession Countries.

Table 4.15 Plastic Transformers in Estonia

	Trade Volumes (1000 EURO)	Turnover (1000 EURO)	Employees	Sites
1997				
Plates, Sheets, Tubes and Profiles	2 312	2 841	25	3
Plastic Packaging Goods	12 010	13 228	534	21
Builders' Ware of Plastic	30 855	32 015	697	26
Other Plastic Products	6 892	7 203	735	70
TOTAL	*52 069*	*55 288*	*1991*	*120*
1996				
TOTAL	*24 387*	*35 060*	*1494*	*105*
1995				
TOTAL	*17 640*	*18 474*	*1472*	*100*

Source: Statistical Office of Estonia

Table 4.16 Number of Sites (France, 1997)

	Number of Employees						
	20 - 49	50 - 99	100 - 249	250 - 499	500 -	other	*TOTAL*
Plates, Sheets, Tubes, Profiles	61	41	25	9	7	1	*144*
Packaging Goods	138	72	61	24	9		*304*
Builders' Ware of Plastic	119	41	29	10	2	1	*202*
Other Plastic Products	365	141	91	23	18	2	*640*
TOTAL	*683*	*295*	*206*	*66*	*36*	*4*	*1 290*

Source: National Institute of Statistics and Economic Studies

The table shows that the share of companies with less than 100 employees is around 75% of all companies. Within the four sub-industries the distribution does not deviate much from the average.

Table 4.17 Total Workforce (France, 1997)

	Number of Employees						
	20 - 49	50 - 99	100 - 249	250 - 499	500 -	other	*TOTAL*
Plates, Sheets, Tubes, Profiles	2 100	2 858	3 832	3 112	4 706	24	*16 632*
Packaging Goods	4 722	5 263	9 001	8 223	7 266		*34 475*
Builders' Ware of Plastic	4 080	2 849	4 676	3 780	1 677	313	*17 375*
Other Plastic Products	12 186	9 830	14 970	7 911	17 527	84	*62 508*
TOTAL	*23 088*	*20 800*	*32 479*	*23 026*	*31 176*	*421*	*130 990*

Source: National Institute of Statistics and Economic Studies

Looking at the distribution according the workforce and to turnover show a different pattern. The share of SME in total workforce and turnover are a bit more than 30%. Although being a much smaller share than measured by their number, the economic importance of the smaller companies is still considerable.

The data for France illustrates that the converter industry has a large share of SMEs and that they constitute a significant part of the production.

Table 4.18 Turnover in million EUR *(France, 1997)*

	Number of Employees						
	20 - 49	50 - 99	100 - 249	250 - 499	500 -	other	*TOTAL*
Plates, Sheets, Tubes, Profiles	361	583	692	558	734		*2 929*
Packaging Goods	631	699	940	903	1 132		*4 304*
Builders' Ware of Plastic	500	355	536	525	511		*2 427*
Other Plastic Products	1 164	961	1 586	951	2 369		*7 031*
TOTAL	*2 656*	*2 598*	*3 754*	*2 937*	*4 746*		*16 691*

Source: National Institute of Statistics and Economic Studies

Table 4.19 Export in million EUR *(France, 1997)*

	Number of Employees						
	20 - 49	50 - 99	100 - 249	250 - 499	500 -	other	*TOTAL*
Plates, Sheets, Tubes, Profiles	531	574	947	966	1 885		*4 903*
Packaging Goods	495	671	1 789	1 639	2 623		*7 217*
Builders' Ware of Plastic	193	227	593	341	1 143		*2 497*
Other Plastic Products	844	780	2 394	921	2 088		*7 027*
TOTAL	*2 064*	*2 253*	*5 723*	*3 867*	*7 739*		*21 644*

Source: National Institute of Statistics and Economic Studies

Table 4.20 Plastics Transformers in Italy (1995)

Plastic Sectors	**Trade Volumes** *(million EURO)*	**Turnover** *(million EURO)*	**Sites**
Plates, Sheets, Tubes and Profiles			
Plastic Packaging Goods	1 061	3 590	284
Builders' Ware of Plastic	198	672	67
Other Plastic Products	2 218	7 602	953
TOTAL	*4 761*	*15 445*	*1 568*

Source: Italian National Statistical Office

Table 4.21 Added Value of Plastic Converters (Italy)

All Plastic Sectors	*Year*			
	1994	*1995*	*1996*	*1997*
Added Value (million EURO)	*1 582*	*2 016*	*1 965*	*2 054*

Source: Italian National Statistical Office

Table 4.22 Plastic Transformers in Slovakia

	Turnover *(1000 EURO)*	**Employees**	**Sites**
1998			
Plates, Sheets, Tubes and Profiles	-	3 407	12
Plastic Packaging Goods	-	540	10
Builders' Ware of Plastic	-	893	16
Other Plastic Products	-	1 070	21
TOTAL	-	*5 910*	*59*
1997			
Plates, Sheets, Tubes and Profiles	130 869	3 609	8
Plastic Packaging Goods	14 847	633	12
Builders' Ware of Plastic	14 942	849	12
Other Plastic Products	18 200	981	17
TOTAL	*178 858*	*6 073*	*49*
1996			
Plates, Sheets, Tubes and Profiles	150 324	4611	6
Plastic Packaging Goods	13 582	464	9
Builders' Ware of Plastic	11 267	726	9
Other Plastic Products	17 257	931	13
TOTAL	*192 430*	*6733*	*37*
1995			
Plates, Sheets, Tubes and Profiles	166 154	5081	5
Plastic Packaging Goods	8 506	467	8
Builders' Ware of Plastic	8 018	674	9
Other Plastic Products	16 118	686	12
TOTAL	*198 797*	*6908*	*34*

Source: Statistical Office of the Slovak Republic

Table 4.23 Plastic Converters in the United Kingdom

	1993	1994	1995	1996
Enterprises	4 927	5 480	6 023	6 273
Total Sales *(million EURO)*	18 170	20 422	21 900	22 996
Employees	184 729	189 177	196 902	197 266

Source: UK National Statistics Information and Library System

Figure Extra Community Import of Plastics in the UK (1996)

Product Type	Net Supply *(million EURO)*	Extra EC Imports *(million EURO)*	*(%)*
Plates, sheets, tubes and profiles	5 385.2	394.3	7%
Packaging goods	4 453.4	405.1	9%
Builders' ware of plastic	4 536.9	48.0	1%
Other plastic products	6 397.2	701.8	11%
TOTAL	*20 772.7*	*1 549.2*	*7%*

Source: UK National Statistics Information and Library System