

PROMOTING INDUSTRIAL ECOLOGY BY EXTENDED PRODUCER RESPONSIBILITY - PRINCIPLES AND PRACTICES

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Abstract

An important part of the concept of Industrial ecology aims at understanding and improving the metabolic pathways of materials in society. Extended producer responsibility is one of the recent, and indeed important, obligations towards industry and recycling structures. Until now this responsibility has mainly been implemented in the sector of packaging, but there are initiatives to expand to more sectors such as electronic and electrical products as well. What we see when examining the present practices of producer responsibility is that there is developing a complex and comprehensive infrastructure for materials separation and recycling. These efforts are much needed, however, they are to some extent reactive oriented if the manufacturing industries are not also focusing on preventative options related to product design, product environmental quality, product recyclability and product function in the use phase. This paper gives an introduction to the principles of producer responsibility and describes how this is implemented in Norway in terms of recycling efforts and material companies.

Introduction

The aim of this first part of the paper is to give an overview of extended producer responsibility (EPR) as a promising strategy for dealing with environmental problems. Shortly, it is an environmental strategy that, either voluntarily or regulatory, gives the producers, who have most influence on the environmental performance of a product, an environmental responsibility for their products. Several questions emerge from this statement: What is included in this responsibility? How far does this notion go? Who are the producers? Does EPR change their way of doing business? Does EPR produce sustainable systems? These questions will not be answered in this paper, but hopefully, the reasons why asking such questions will be outlined in this first part, by giving a short overview of EPR.

Sustainable development, industrial ecology and extended producer responsibility

The relation between sustainable development, industrial ecology and extended producer responsibility is shown in Figure 1 below. In our opinion, sustainable development may describe, unlike the traditional Western modern thinking and activity, a goal of achieving a state of development that takes into account the needs of the future generations. In this context industrial ecology has emerged as *a new way of thinking* to meet this goal (Ehrenfeld 1994). Industrial ecology may be regarded as a metaphor on how to organise our industrial system, and the most perfectly interrelated system we know of, the natural ecosystem, is used to explain this. This metaphor also emphasis that the industrial ecosystems are subsystems to the natural ecosystems (Hanssen 1997). Industrial ecology tries to move the social activities towards the reality and limits of the natural system we live within.

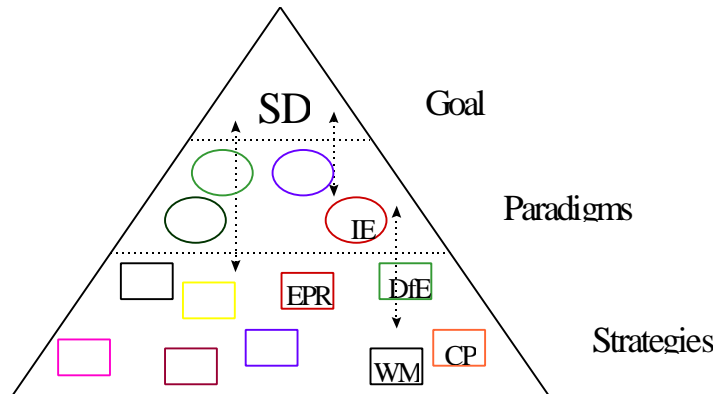


Figure 1: The relation between sustainable development (SD), industrial ecology (IE) and extended producer responsibility (EPR). (DfE - Design for Environment, CP - Cleaner Production and WM - Waste Minimisation)

In this context EPR is one promising strategy that may be consistent with the principles of industrial ecology to reach the goal of sustainable development. The objective of EPR is discussible, however, depending on the standing point. Is the objective of EPR to improve the economic efficiency of a company? Or is it to gain a sustainable use of natural resources or perhaps just to avoid appearing environmental problems? The answers to these questions may be deciding for whether EPR produce sustainable systems or not.

Definitions of EPR

Lindhqvist (1992) has given a mostly used definition of EPR:

"Extended producer responsibility is an environmental protection strategy to reach an environmental objective of a decreased total environmental impact from a product, by making the manufacturer of the product responsible for the entire life-cycle of the product and especially for the take-back, recycling and final disposal of the product. The extended producer responsibility is implemented through administrative, economic and informative instruments. The composition of these instruments determines the precise form of the extended producer responsibility"

Figure 2 below shows the life cycle perspective as reflected in this definition.

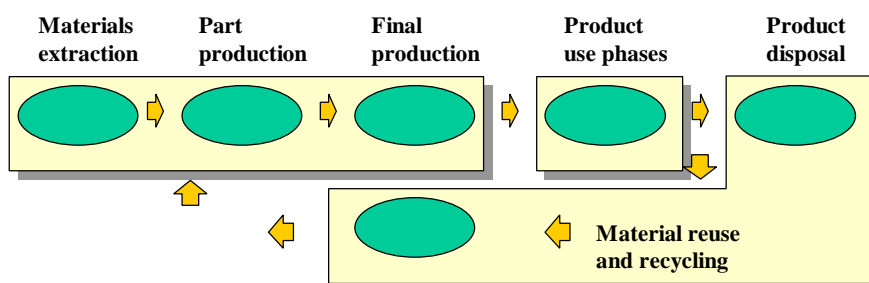


Figure 2: The life cycle perspective and the three phases of production, use and waste disposal/recycling

So far the main focus seems to have been on creating proper take-back systems. This approach does not question to what extend take-back and recycling really is the best strategy

in an environmental and thermodynamic context. It also represents an end-of-pipe oriented approach. Given the fact that a product has environmental impact all through the life span, and in some cases particularly in the user-phase, one interesting question is to what extent EPR has the potential to focus on the design/production and the user phase. Creating sustainable systems has to include a deliberate environmental focus in the design phase (Ehrenfeld 1994).

Some keywords

Some keywords that may describe EPR are:

- ◇ *Life cycle thinking.* This approach is based on the understanding of the earth as a closed system with limited resources and limited waste sinks and that raw materials must be extracted from these limited resources and that waste must be deposited to these limited waste sinks. Secondly, the environmental impact from a product occurs throughout all the phases of a product's life and, thus, all these phases must be regarded as potential sources of pollution and environmental degradation and not only the production part, as shown in Figure 2. This is about closing the product and material loop.
- ◇ *Producer responsibility and participation.* Why are the producers appropriate for being given and bearing a significant environmental responsibility? Firstly, the companies have lots of expertise in their fields which no one else, for instance the government, has. Secondly, the authority and responsibility to carry out environmental improvements are given to the most central part and contributor to this development. Thirdly, the companies have experience in rapid organisational change for adjusting to new challenges they are facing, and a change from hierarchical environmental strategies to participating and horizontal environmental strategies, like EPR, can, because of this, be worked out well in the companies. Finally, some proactive companies are now striving to make environmental work competitive showing that they really are interested in taking this responsibility.
- ◇ *Internalise environmental costs.* Internalising the externalities is an economic concept with traditional neo-classical economic thinking as the starting point. This thinking is based on the notion that the optimal market situation occurs when the price of a product is right. Market failure in environmental policy indicates that the price is not right. The literal meaning of "internalising the externalities" indicates that something is traditionally included in the price and something else is held outside, and the reason for including some new factors in the price is thus the market failure. The internal factors have traditionally been the cost of extracting raw materials, transportation to manufacturing, the manufacturing and distribution to the retailer, all included in the price, and thus, all are factors that increase the value of the product throughout the refining due to the work and capital invested to create the final product. The externalities, however, are implicit, or third party, factors that are affected by the production of the product, resulting in reduced value of these factors or increased costs to re-establish the former condition, but not reflected in the price of the product. These externalities could for instance be common goods, like environmental quality, or human health. Of these two, the latter is by far the most easy to decide the value of. Economists argue that environmental problems will be solved if the environmental cost due to the production is included in the price of the product. This is about getting the price right.
- ◇ *Product design.* The producer has as product designer by far the most influence on the environmental performance of the product demanded by the customer. The designers must include sustainability factors in addition to the traditional designer factors, and to be able to include this, the designers will need to reorganise, to rethink their values and criterias, and they need tools that are adjusted to the new challenges. Being able to find new solutions, the designers must be able, through new visions or breakdown, to think in new directions. In a sustainable context, producers must meet the requirements of environmental

regulations at each stage of the life cycle, but are free to choose the means to do so. As a consequence of the this, one further question is if EPR focuses the function of the product and not the product itself. Does the producer sell functionality, not products? This understanding can give freedom for innovation of new concepts and solutions, fulfilling the demands of the consumers.

A governmental or business strategy?

EPR may be regarded as both a governmental environmental strategy and a business strategy. In most European countries it seems to be a governmental strategy where the governments are either regulatory giving the producers an environmental responsibility or the producers are voluntarily accepting this principle. Being realistic, this voluntarism is mostly due to fear of losing market shares. The governmental strategy is to leave the detailed production-regulated practise of the 70`s and 80`s and to enter a producer and market-driven environmental policy. This is shown in Figure 3 below.

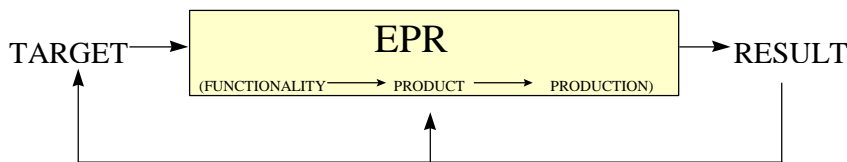


Figure 3: EPR as a governmental strategy

Since the producer is very important in EPR, and interesting question is how does EPR affect the organisational culture in the company? Is it only causing incremental changes in the technologies used, or is it really affecting the heart of the company. Figure 4 below illustrates this difference

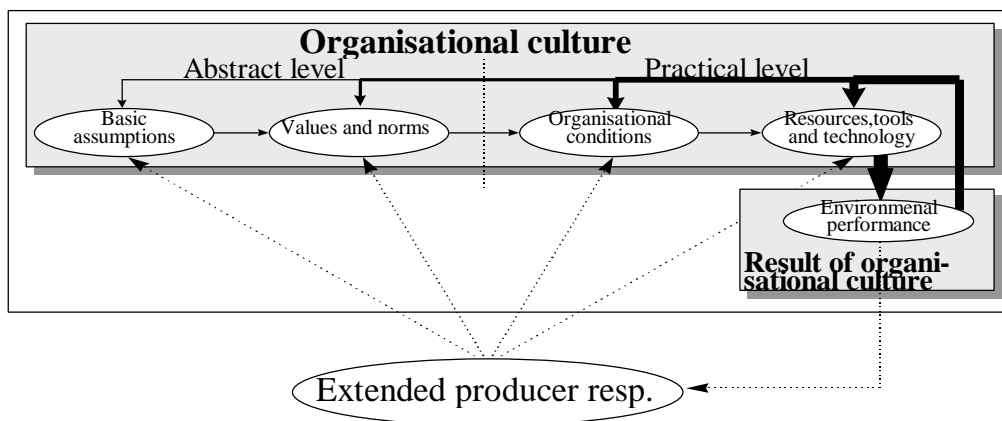


Figure 4: Organisational culture of a company

The intention of Figure 4 is to show how and where in this organisational culture the responsibility is affecting. We shall here divide this into an abstract level and a practical level. The first mentioned is the theoretical part, with basic assumptions (consciousness) and values and norms. The sentence “...the company is responsible for...” indicates something about the being of the company, something about the ontologically meaning of the company, its “raison d’etre”. Telling a company that it is responsible for something, for instance the environmental

performance of its product, tells about why the company should exist, in the same way that the company is a provider of social functions. This theoretical level consisting of normative functions like goals, loyalty, common sense, understanding and responsibility is shown to the left in Figure 4.

On the other, practical and right part, is the organisational and technological part. These elements are more evident to both the company itself and to the outsiders. This part is concerned about how to internally organise itself to deal with the new responsibility. In Norway, for instance, this is realised through the establishment of "material companies" that have the mandate to achieve the goals of recycling and waste management. The question is then to what extent the left part of Figure 4 is affected by this new company. An interesting subject for research is to discover the relation to the practical life. Is there any inconsistency between the theoretical approach and the practical reality.

The potential of EPR

We will end this overview section with some thoughts about the potential of EPR. Figure 5 below describes some aspects of this potential, by showing the relation between demand and supply. Traditionally in environmental work, the focus has been on the production phase, at the lower part of the figure. Introducing life-cycle thinking, the focus is now changing to the product itself. The product is carrier of environmental properties.

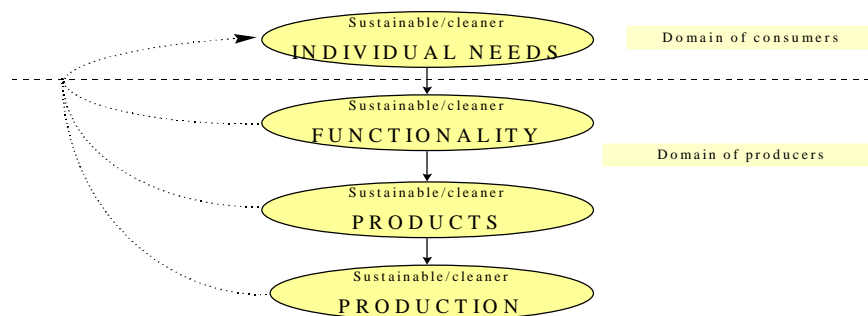


Figure 5: The potential of EPR

As can be seen of Figure 5, the producers are not supplying the real demand of the consumers by focusing on the products. The consumers are in reality demanding a function, not necessarily the product itself. By focusing on the functionality, the producers have more options to choose from, but this requires *collaboration* between companies and sectors.

There is a feedback-loop from the domain of producers to the consumers, indicating that the producers are not only satisfying a demand among consumers, but also *creating* a demand. In this context the notion of responsibility is important.

The legal basis and structure of EPR implementation for packaging in Norway

The systems for extended producer responsibility (EPR) in Norway are organised through the material companies ("materialselskaper"). In Norway there are established material companies for packaging, tyres and batteries in addition to the material companies for electronic and electronic products, which will be started during the spring 1998.

Packaging and organisation of the different material companies for these waste fractions will be the main focus in this text.

The background for the organisation of the material companies for packaging is the "branch agreement" of collection and recycling between the Ministry of Environment and the producers and importers of packaging. This "branch agreement" was established as a follow-up of the central EU directive on packaging take-back, and because the national government was threatening to introduce an environmental tax on all packaging units. In this way the government would push the producers and importers to change their use of packaging to stop the growth in generated amount of packaging wastes. The industry was not interested in this taxes, and made out an alternative proposal where the industry by themselves organise the collection and recycling of the used packaging. This ended in agreements where defined goals for recycling for different packaging wastes are given.

The Agreements and establishing of material companies for the packaging

The Agreements between the Ministry of Environment and the different branches that are responsible for reduction, collection and recycling of packaging waste, were signed on the 14th of September 1995 and have the aim to:

"reduce the environmental problems caused by packaging waste by reducing such waste and by organise increased collection and recycling of these wastes, where it is justified and balanced from an environmental, resource based and economical point of view"

As a result of this agreement, the material companies which are shown in Table 1 were established (Norsas,1997). In the table, recycling goals and the prices the producers and users of the packaging should pay to be part of the system are also given. This payment is based on the "polluter pays" principle.

Even though payment of compensation is voluntary, the industry that deals with the packaging is strongly recommended to join the system to help finance the obligations of the material companies. All companies that use packaging, and that is quite a lot, are embraced of the agreement and should pay the compensation. It is established a control system within each packaging material group to avoid "free riders" who do not wish to be members of the material companies.

Material company	Packaging	Recycling Goals	Compensation
Norsk Returkartong	Drink carton(milk, juice etc)	60 % within 31.12.97	3 øre/unit
Kartonggjenvinning	low weight carton (eggs, shoe boxes etc.)	60 % within 31.12.99	1.50 kr/kg
Plastretur	Plastics	80 % within 31.12.99	1 kr/kg
Norsk Resy	Cardboard, brown paper, paper bags	80 % within 31.12.99	10 øre/kg
Norsk Metallgjenvinning	Aluminium, steel, sheet metal	60 % within 31.12.99	1 kr/kg
Norsk Glassgjenvinning	Glass	no formal goals	4-12 øre/unit

1 kr = Norwegian krone = 100 øre = 0.08 £

Table 1: *Material companies for packaging in Norway*

The material company shall, by motivating everyone who keeps packaging- and foil waste, help to organise collection and recycling of different types of packaging waste according to the goals which are set in the agreements with the Ministry of Environment. As mentioned previously all material companies are demanding compensation from the users of the different packaging materials. This compensation helps the market to organise the collection- and recycling system. For some material companies the abutment is the main income, for others these incomes are small compared to the value of the packaging material.

The ownership are about the same in all material companies and are divided by the producers of packaging, “packer and filler” and the trade's organisation. The material companies have different roles in the market; Norsk Returkartong is both buyer and seller of drinking carton. Norsk Glassgjenvinning is buying glass to their own recycling company, while Plastretur and Norsk Resy are neither buyer nor seller in the market. The owners of the material companies can not take out possible profit.

The material companies have to report the recycling figures compared to the recycling goals once or twice a year to the government. The government are threatening to introduce packaging taxes if the system with the material companies does not work according to the directions.

However, as we will see in the next section, remarkable recycling figures have already been obtained for some of the material companies, and the others are also prepared to manage their recycling goals.

Materialretur is the material companies' fellowship who organise the compensation system for packaging. In addition, Materialretur coordinates information, and collects and reports for all types of packaging materials. Below some more data is given on the organising of the recycling activities.

Non-packaging materials in Norway

This chapter gives some data on how non-packaging recycling is organised in Norway:

Norsk Dekkretur Ltd

Norsk Dekkretur is a material company which was established by producers and importers of car tyres. According to *Forskrift om deponering, innsamling og gjenvinning for kasserte dekk* ("directive for deposal, collection and recycling of discarded tyres") established by the Ministry of Environment on the 25.03.1994, with changes on the 02.09.1994, producers and importers of tyres organise the system in such a way that the tyres are collected without involving the distributors, mainly at the petrol stations. The producers and importers must also ensure that the tires are recycled (reuse, material recycling or energy recycling).

Blybatterier Ltd

This material company was established by producers and importers of car batteries as a result of the agreement between Batteriretur and the Ministry of Environment dated 22.12.1993.

Forskrift om miljøskadelige batterier og akkumulatorer ("Direction of environmental harmfully batteries and accumulators") established by the Ministry of Environment 17.07.1990 and changed 08.02.1995 gives all producers and importers the responsibility for collection and recycling of used lead batteries.

According to the agreement between the Ministry of Environment and Batteriretur are 95 %, around 13.000 tons, going to be collected and recycled each year. In 1997 12.350 tons, almost 95 %, were collected (Norsas 1998). This is not as much as 1996 when 12.650 tons were collected. Batteriretur are expecting problems in 1998, mainly as a result of the extraordinary low lead prices.

Material companies for Electronic and Electric waste (EE-waste)

Material companies for EE-waste are not established yet but a proposal for organisation has been made and the material companies will be established during this spring

In this proposal, it is assumed that producers and importers of electronic and electrical products will be responsible for running a separate collection and recycling system for such wastes.

It is estimated that 144.000 tons EE-waste are generated each year (Miljøverndepartementet 1996) This number is expected to increase rapidly in the next years. Of the total EE-waste, around 10.000 are exported for reuse or recycling. Of the EE-waste that is taken care of in Norway, 38.000 tons are material recycled, 20.000 tons are incinerated and around 76.000 tons are deposited at landfills. The wastes from electronic and electrical articles contain amounts of plastic and metal which can be recycled in addition to amounts of dangerous substances as lead and mercury, which must be treated as special waste.

Newspaper and magazines

In Norway there has been a lot of discussion of what to do with the newspaper- and magazine waste. The main producer of this kind of paper, Norske Skog, has made an agreement with the Ministry of Environment of building a recycling plant for used newspaper and magazines. Norske Skog is planning to build a recycling plant for 144.000 tons of these wastes. In 1997 300.000 tons used newspapers and magazines were collected (Norsas). Today a great part of this paper is sent to East-Asia where it is used in production of new paper!

The Norwegian Pollution Control Authority will have the recycling plant established as soon as possible, and recommends that the Ministry of Environment re-negotiate the agreement

with Norske Skog in such a way that Norske Skog covers a larger part of the expenses. In addition they recommend the Ministry of Environment to evaluate the possibility of introducing extended producer responsibility for newspaper and magazines in the same way as it has done for the packaging waste. By introducing this extended producer responsibility, the users of printable papers, newspapers and publishers have to pay compensation, and then the collection and recycling expenses will be less for the municipalities and Norske Skog.

Amounts, recycling and material companies for paper packaging

Around 1 million tons of paper waste are generated each year in Norway. In the tables below, first the waste source for the paper is given, and then in the second table the treatment of the paper waste is shown, while the third tables gives the amounts of cardboard, paper and carton to material recycling. The figures are from the years between 1990 and 1995 and the information is gathered and estimated by Statistics Norway (Skogedal 1997).

Type of product	1990	1991	1992	1993	1994	1995
In total	918.037	938.739	952.148	943.933	919.601	930.019
Printed matter	444.337	439.246	443.324	442.428	420.017	373.666
Packaging	281.244	272.059	275.859	288.819	282.750	334.747
Buildings	1.791	1.955	1.747	1.783	1.966	2.222
Sanitary and household products.	101.999	99.751	96.688	93.002	100.102	101.927
Other products	88.666	125.729	134.550	97.901	114.765	117.458

Table 2: Estimated amounts of paper waste in Norway [Tons]

As we can see packaging contributes for almost 35 % of the wastes from all paper products.

	1990	1991	1992	1993	1994	1995
Estimated amounts of paper waste	918.037	938.739	952.148	943.333	919.601	930.019
To material recycling.	181.568	210.567	242.170	271.248	319.952	346.159
Incineration	131.008	135.832	137.522	131.011	117.457	114.942
Rest	6.550	6.792	6.876	6.551	5.873	5.747
Spreading/incineration	124.457	129.040	130.645	124.460	111.584	109.195
Landfill	579.707	567.045	643.023	511.299	453.595	439.663
Other treatment.	32.305	32.087	36.310	36.296	34.470	35.003

Table 3: Treatment of paper waste [tons]

Around 35 % of all paper waste are recycled, while around 45 % are deposited at landfills. Incineration is also a quite popular treatment methods, with around 15 % of the paper waste incinerated.

In the next table different types of paper amounts in the public waste sent to material recycling are given:

Material	In total 1996	Househ. 1996	Industry 1996	In total 1995	Househ. 1995	Industry 1995	Househ. 1994	Househ. 1993	Househ. 1992
Cardboard, paper, carton in total	194.900	139.400	55.600	169.608	131.356	38.252	124.200	112.400	60.080
Cardboard	97.500	97.200	300	71.717	61.801	9.916	-	-	58.902
Cardboard, carton	52.100	14.000	38.100	24.720	5.548	19.172	-	-	1.959
Drinking carton	2.300	2300	-	816	816	-	-	-	-
Paper, cardboard mixed	43.000	25.800	17.200	72.355	63.191	9.164	-	-	-

Table 4: Paper, cardboard and carton to material recycling [tons]

There has been a significant increase in the amounts of paper to recycling between 1992 and 1996. This figure has probably increased in 1997 compared to 1996 because of the further development of the material companies.

Now we are going to look into each of the material companies that deals with collection and recycling of paper packaging. Norsk Resy are responsible for cardboard and brown paper, Norsk Returkartong are dealing with drinking carton, while Kartonggjenvinning are responsible for the collection- and recycling system for low weight carton.

Norsk Resy Ltd

Norsk Resy are responsible for collection and recycling of cardboard and brown paper in Norway, see the table below.

The ownership of Norsk Resy is divided between the four corrugated cardboard factories in Norway (Glomma Papp, Petterson Ranheim, Norpapp Industri, Petterson Sarpsborg), trade and distribution, users of corrugated cardboard and the paper factories. Most of the paper, about 95 %, comes from industry and services, who deliver it to the recycled paper wholesale merchant. The other 5 % comes from the households who deliver the corrugated cardboard and brown paper together with other papers. Afterwards the cardboard paper are taken out from the other paper fraction. Corrugated cardboard is quality paper and can be recycled four or five times.

Material:	(corrugated) cardboard, brown paper
Compensation	10 øre/kg
Collection potential:	Around 170.000 tons
Collected and recycled:	130.000 tons in 1997
Goals for recycling:	80 % within 31.12.1999, included at least 65 % material recycling

Table 5: Data for the material company Norsk Resy

Normally, Norsk Resy does not act as buyer or seller in the market, but act as a coordinator between producers and users. The trade occurs between the recycled paper trade and the paper factories.

According to a regulation from Norwegian Pollution Control Authority, anyone who keeps more than 250 kg brown paper, is obliged to deliver this to recycling and not to landfill which is prohibited.

The market for cardboard and brown paper is stable and in balance. The sales price is around 30 £/ton and the four cardboard factories receive the cardboard and brown paper for production of brown wrapping paper. The real expenses for transport and treatment are more than 30£ and the compensation covers this difference.

The demand for brown paper fibre is large and the paper industry is interested to buy far more than the 130.000 tons which were collected in 1997.

Norsk Returkartong Ltd

Norsk Returkartong is the material company for drinking carton (juice, milk etc). See more details in the table below.

Material:	drinking carton
Compensation:	2.5 øre/unit
Collection potential:	Around 20.000 tons (2.5 weight % of the household waste)
Collected and recycled:	12.000 tons in 1997
Goals for recycling:	60 % material recycling within 31.12.1997

Table 6: Data for the material company Norsk Returkartong

Norsk Returkartong is responsible for start up and administration of recycling systems in the municipalities in Norway. Included in this are organisation to secure that the marked for the collected materials are working well, and also responsibility for information to and motivation of the users.

The material company is financed by the compensation importers and "fillers and packers", in total 20 companies, have to pay. The branch is clear set out and there is no "free riders" who do not pay. Tine Norske Meierier (Tine Norwegian Diaries) is the main actor in the system. Agreements with 325 municipalities, covering about 95 % of the population, have been made. The municipalities, intermunicipal companies and private actors are collecting the cartons, and deliver them to different sorting plants, who are packing the drinking cartons together and deliver them to the paper factories Norske Skog Hurum and Keynes Norway. The paper factories will make new products like coloured envelops and cartons. It is signed a long term contract with these paper factories, and Norsk Returkartong receive market price, which is within a fixed maximum and minimum price, for the cartons.

Norsk Returkartong pays 25£-60£ per ton drinking carton for the municipal collection and transportation, with highest price for the collection systems that gives highest user deliverance like source collection at the households. Collection of drinking carton beside the households is not yet organised in Norway.

Norsk Returkartong managed to reach the recycling goals on 60 % material recycling of drinking cartons within 1998.

Kartonggjenvinning Ltd

Kartonggjenvinning is organised together with Norsk Returkartong. The company is supposed to organise the collection and recycling system for low weight cartons, like boxes and egg cartons.

Material:	low weight carton (boxes, egg cartons)
Abutment	1.5 kr/kg
Collection potential:	Around 20.000 tons
Collected and recycled:	Just started
Goals for recycling:	60 % material recycling within 31.12.1999

Table 7: Data for the material company Kartonggjenvinning

Much effort has been put on the system for drinking carton and this has given lower priority to the organisation of the system for low weight cartons. However the work has started and it is still possible to reach the recycling goals within year 2000.

Amounts, recycling and material companies for glass packaging

Statistics Norway's estimation shows that 130.689 tons glass waste were generated in 1995 (Skogesal 1997). Around 44 % of this is estimated to be glass packaging. In the table below the calculation of the packaging waste figures are given. As we can see there has been a major increase in glass packaging production and thereby the waste generation in the two years from 1993 to 1995. The data for recycling of glass packaging are not given in this table.

	1990	1991	1992	1993	1994	1995
a Import	4.781	5.201	5.819	4.945	5.206	3.364
b Export	15.420	29.950	33.449	34.458	46.327	34.034
c Import surplus (a-b)	-10.639	-24.748	-27.630	-29.513	-41.120	-30.670
d Production (statistic from Statistic Norway)	198.316	237.035	209.287	170.470		
e Production (data from Moss Glassverk)				56.384	73.679	76.315
f Import surplus filled packaging	11.938	11.938	11.938	11.938	11.938	11.938
g Goods supply (c+e+f)				38.809	44.497	57.583
h Glass packaging waste				38.809	44.497	57.583

Table 8: Amounts of glass packaging [tons]

After giving some information of the amounts of glass packaging waste it is time to focus on the extended producer responsibility for glass packaging. This is organised through the material company Norsk Glassgjenvinning.

Norsk Glassgjenvinning Ltd

Norsk Glassgjenvinning (NGG) is coordinating the collection and recycling of glass packaging in Norway.

Material:	glass packaging
Compensation:	4-12 øre per unit depending on size
Collection potential:	ca 60.000 tons
Collected and recycled:	ca 40.000 in 1996
Goals for recycling:	not in the agreement

Table 9: Data for the material company Norsk Glassgjenvinning

Norsk Glassgjenvinning has a broad ownership structure where the branch organisation for trade and industry has the share majority. In addition NGG is owned by PLM Moss Glassverk and the recycling branch. NGG stands out from the other material company by running their own recycling plant and by not having made a specified agreement on the recycling goals.

The municipalities, or private transport companies on the behalf of the municipality, are responsible for the collection and transportation of the glasses to Moss Glassverk, close to Oslo in the south of Norway. Almost all of the collected glass is taken care of by Moss Glassverk who can use up to 90 % recycled glass in their new glass production. In addition to production of glass, recycled glass are used in production of glass concrete and insulation.

NGG is financed through help by the compensation and by the sale of glasses. The compensation brought in 1.3 million £ in 1996. It is not very difficult to receive this payment from the producers of glass but it is worse to get the importers to pay. Sale of glass brought in around 1 million £ in 1996. The municipality or other actors who deliver the glasses to Moss Glassverk receive 18 £/ton for non-coloured glass and 12 £/ton for coloured glass.

It is neither environmental friendly nor economical feasible to transport packaging from the north of Norway to Moss in south. This is why NGG is trying to get glass as packing material in road and building materials etc. valid as material recycling. Included the reuse of bottles, 75 % of the used glass packaging was collected in 1997. Without including the reuse of the bottles the recycling figure was 66 % in 1996.

Amounts, recycling and material companies for metal packaging

Used metals are valuable as a resource, and should be collected and recycled. In the data from Statistics Norway it is calculated that iron and metal packaging make 4 % (4600 tons) of the total packaging waste in the industry. The household waste in Norway consists of about 12.000 tons steel- and aluminium packaging waste each year. The collection in the same public containers as are used for glass, or for source separation in the households, has just started.

Norsk Metallgjenvinning Ltd

The material company for metals, Norsk Metallgjenvinning, who is operated by Norsk Glassgjenvinning, is established even though the collection and recycling of metal packaging has not really yet started. The table below gives recycling goals and other main data for Norsk Metallgjenvinning.

Material:	Metal packaging
Compensation:	1 kr/kg
Collection potential:	ca 12.000 tons
Collected and recycled:	starting spring 1998
Goals for recycling:	60 % material recycling within 31.12.1999

Table 10: Data for the material company Norsk Metallgjenvinning

From 01.04.1998 Norsk Metallgjenvinning expect that 250 municipalities in Norway are organised in the collection system for the metal packaging. It is also expected and that around 50 % of the 12.000 tons metal packaging are recycled within year 2000. The metal is collected from the same containers that are in use for glass packaging, transported and sorted in Fredrikstad in the south of Norway.

Norsk Metallgjenvinning guarantees further sale of the waste at a price of 100£/ton, where aluminium represent the most valuable material.

The compensation which the users of the metal packaging should pay will bring in around 1.6 million £ per year.

Amounts, recycling and material companies for plastic packaging

According to the statistic from Statistics Norway plastic contributes to 10 % of the packaging waste in the industry in Norway. The material company Plastretur is responsible for recycling and collection from this and other plastic packaging.

Plastretur Ltd

Plastretur is responsible for organisation of the collection- and recycling system for plastic from households, industry and commerce, trade, aquaculture and agriculture, see Table 11.

Material:	Plastic packaging
Compensation:	1 kr/kg
Collection potential:	ca 95.000 tons (50.000 from households)
Collected and recycled:	1996: 33.250 tons (35 %) to energy recovery, 5.850 (6 %) to material recycling
Goals for recycling:	80 % (where min 30 % material recycling) within 31.12.1999

Table 11: Data for the material company Plastretur

The ownership in Plastretur is divided between the food industry (1/3), industry for trade in goods (1/3) and the plastic industry (1/3).

The municipalities are working with collection, transport and deliverance to the 15 sorting plants in Norway. They get paid for the deliverance in addition to the advantage of not paying landfill tax to the national government. According to the manager of Plastretur the goals for 80% recycling can not be reached if the municipalities do not introduce source separation of plastic at the household.

Sorting of different types of plastic packaging is very important since there are so many types, and the right type must be used when recycling into the specified product. To make this sorting easier, international standards, divided into 7 categories, have been made. It is

therefore important that the producers label the packaging, and also that they produce plastic packaging which is easy to recycle.

For the *aquaculture industry*, a new collection system is established, and with this system all feed packaging, 3.000 tons in total, will be treated and recycled. In the *agriculture industry*, the goal is to establish a system so that all 5.000 tons of plastic packaging can be recycled, not only the 70 % which is recycled today. Plastretur is also cooperating with collection actors and sorting plant in the development of recycle systems for plastic packaging from industry and commerce. Plastretur guarantees that collected plastics will be recycled, and a well-functioning market for the new products. The municipalities and local renovation actors will be the ones that organise the collection system.

Everyone that keeps plastic packaging waste can choose what reception plant they want to deliver the waste to. The same competition situation is established between the reception plant and the plant that recycles the plastic. Today around half of the 110 reception plants for waste are included in the system for plastic packaging. All the 13 recycling companies in Norway, in addition to some in Denmark and Sweden, are organised in the system for recycling of plastic. The bottleneck in the system is often the access to plastic for recycling. At the recycling plant, the plastic material is crushed, washed and re-granulated into pellets. Some of the recycling companies use this material to own production of new products, while others sell the pellets to plastic producers in Norway and other countries, who use it in their new plastic production.

Priority has been given to increase the amounts of recycling of plastic waste from the households. More than 30 % the plastic packaging waste from the household are bags and other plastic products with good recycling qualities. PEHD, mainly plastic bottles, are also suitable products for recycling, and contribute for 14 % of the plastic in the household waste. However, more than 40 % are mixed plastic with a low recycling suitability. On the other hand, this waste fraction is preferable for energy recovery.

During the last six months of 1996, Plastretur received 2 million £ from 1200 payers in abutment. It should probably have been 3000 payers, and especially among the importers many did not pay. All the 15 importers and producers of plastic bags paid the compensation. For some products, such as garbage bags, the compensation is up to 15 % of the value of the product, and not paying gives a significant advantage in the competition among the actors.

The developing of a market for collected plastic meets problems. There is still no standard for what collected plastic packaging is, there are few buyers, and the prices for virgin materials are changing very much, almost as for papers.

Anyhow, through Plastretur's price and market guarantee on plastic packaging, an agreement on a price of 80 £/ton for foil with quality 3 delivered at the recycling plant has been made. Those reception plants who want to be a part of this price system, must also sign an agreement with Plastretur, where they bind themselves to take care of unsorted plastic without taking any charges. Similar systems will also be established for other plastic materials like bottles, cans and others.

Final remarks

The introduction of extended producer responsibility through the material companies seems to be a successful way of decreasing the waste amounts, increasing the recycling rates, and

thereby minimising the utilisation of natural resources such as oil and metals. Until now much effort in Norway has been put on organisation of the material companies for packaging, which of course is an important waste fraction that should be utilised. Most of the branch-owned material companies for packaging have made remarkable progress in the recycling of waste, and it seems like they will reach their recycling goals for year 2000. The material company for drinking carton has already reached its goal, which was 60 % material recycling by 1997. It will be very interesting to follow the process for the other material companies in Norway, and what instruments the government will use if some of the material companies do not manage to reach the goals one has agreed upon. Introduction of material companies for tyres and batteries are also functioning well in Norway.

Even if packaging, tyres and batteries are important waste fractions, waste minimisation and recycling of other fractions must also be worked with to stop the growth of waste to landfill in Norway. The recently started work with material companies for electronic and electric waste will show whether or not the material companies also can be a suitable way of decreasing "more important" waste fraction.

In contrast to the successful development of recycling infrastructure, in which the material companies play a key role, and high recycling targets for selected waste fractions are to be met during the next few years, we have also observed some disadvantages of the producer responsibility implementation system. The first one is the fact that very little effort so far has been done on products with long life-times, except tyres and batteries. Essentially waste recycling by materials recovery has only been developed for packaging and paper, plastic and some metals, including demolished cars, as well as some types of organic wastes in fish and food industry.

The use of producer responsibility as a principle has mainly to date affected the packaging producers. However, as formal structures for electric and electronic wastes are now being launched, this will help strongly to expand to new types of products. An open question is to what extent there will develop recycling structures for building materials.

A second observation is that there is very much debate in society to what extent transportation and energy demand in systems with high recycling rates actually is environmental friendly. There is obviously a need to document positive and negative aspects of cost, energy and other environmental impacts in recycling systems at macroscale, in order to produce a stronger basis for making the right decisions in the future.

A third observation is that very little seems to be done on the developing of long-term, robust and attractive markets for recycled materials. This is an area which obviously will be of the highest importance in future, if and when more ambitious recycling levels are to be met. This is also an example of a type of question in which the process and manufacturing industry should engage much more than today. Facilitating the developing of such markets should be one of the highest priorities of industry as part of their true obligations in relation to "extended producer responsibility".

A fourth observation is the fact that extended producer responsibility today seems to be very much reactive (end-of-pipe) oriented, in the way that most efforts are concerned about building recycling structures in society, often far away from the operative responsibilities of the producing industry. All they do is pay compensation fees as members of a given system. There should of course be a more close link between these structures and the local product design work in companies. Particularly when products with longer life times are to be included, product design will have to play a more significant role than today. We are thinking

of Design for recyclability, disassembly, repairability, longer life-times, etc. Only then will it be possible to say that there is a direct link, and even a close interdependence, between the waste recycling efforts being enforced by the extended producer responsibility principle on the one side and industrial ecology product design responsibility principles on the other side.

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