Barriers in the EPR System for plastic packaging, Norway

A case study of policy and technology based obstacles at various policy levels in the recycling system of plastic packaging from Norwegian households – with extensive analysis of Trondheim municipality.

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1. Introduction

In industrial ecology, unit processes are seen as part of interacting systems rather than isolated components. For example, any product at a certain time has a unique ecosystem characterized by raw material suppliers or component, manufactures delivery, consumers, maintenance and collection systems, waste handlers and recyclers (Richards, Allenby and Frosch 1994). Efficient material- and energy flows in these systems helps avoid depletion of natural resources, an important contribution towards industrial ecology (Ehrenfeld 1994) and sustainable development (WCED 1987). From a global perspective, it is possible to think of the earth as made up of numerous interrelated natural ecosubsystems. One such subsystem may be bound by geography, such as an urban area, an industry, as agriculture, or a material, such as plastic (Richardset.al. 1994).

The Norwegian system for plastic recovery is an example of a subsystem. Previous studies undertaken separately by the two authors in the Norwegian substance flow of plastic packaging from households - a subsystem to the general plastic recovery system- have identified several obstacles of hence policy, administrative and technological character. These obstacles can be observed in politics and policies at national, local, and industry level, as well as in the performance of household actors. This is the configuration of actors within the Norwegian Extended Producer Responsibility (EPR) strategy for plastic packaging. The intention of this paper, therefore, is to combine and elaborate on these findings in a political science perspective and a chemistry engineering perspective. We suggest that the position and role of the actors in the system needs to be renegotiated.

Extended producer responsibility in an actor – policy perspective

In order to reduce the amount of waste being generated as at the same time increasing the amount of waste being recycled or reused, the Extended Producer Responsibility (EPR) strategy is suggested. EPR is an incentive-based policy (Lifset 1993), a principle in which producers accept significant financial and/or physical responsibility for the treatment or disposal of post consumer products (OECD 2001, Røine et al. 2000). And in the long term promote more efficient products in term of cost and time efficiency in the take back system – such as reduction of packaging, ultimately environmental efficient improvements.

There are four principal goals for EPR (OECD 2001):

- Source reduction (natural resource conservation/materials conservation)
- Waste prevention
- Design of more environmentally compatible products
- Closure of material use loops to promote sustainable development

EPR policies are enacted in order to facilitate high levels of recycling by tapping the expertise or financial resources from producer groups. It does so by aspire to internalize externalities by changing the behaviour of producers through a tighter link between product design, marketing decisions and waste management- related concerns. Fundamentally for the EPR strategy, or the take back requirement, is a life cycle perspective on environmental management with a stage-by-stage approach (Lifset 1993). All such production consumption cycles consist, however, of *social practices* (Spaargaren 2000), that must be taken into account to fully understand the dynamics in these cycles. This imply in our study, a multi level as well as multi actor approach. Applying policy analysis in a producer- consumer (here referred to as the domestic level) perspective operationalizes this.

2. National policy calls on Industry and municipalities

Over the past ten years the Norwegian model for recycling has developed towards an Extended Producer Responsibility (EPR) strategy. This may bee seen in light of the governmental effort to provide elements that should constitute environmentally sound waste management policy at *all* levels. A comprehensive strategy for this appeared first in Parliamentary Report nr. 44 (1991-1992) *"Initiatives for reduction of waste generated, increased recycling and safe waste treatment"*,[1] and is later repeated and evolved in proceeding reports. The discursive scope for this report is the global reform of sustainable development as presented by the World Commission for Environment and Development (WCED) in *Our Common Future* (1987). The new waste policy may those be regarded as a governmental strategy for concretization of the assignment to the work of the WCED as embodied in White paper no. 46 (1988-89) *Environment and Development*.[2] Though, as we will se, it is more probably part of a general diffusion of new strategies in the era of ecological modernization.

However, within this framework, preventive strategies for waste are given priority, those waste management at all levels should aim at:

1. Preventing waste and reducing the quantity of harmful material in the waste;
2. Encouraging reuse, material recycling and energy utilization.
3. Ensuring an environmentally justifiable final treatment of waste, which is not reused.

These elements are inherently embodied in the more precise EPR, which is only one of many strategies that may help meeting the goals of the national waste policy. In White paper no. 44 (1991-92) two key actors, *industrial representatives* and *municipalities* are identified as crucial in the *"establishment and further development of complete systems for waste management"* (Ibid. p. 30). This new inclusion is justified with market-oriented principals. Increased responsibility to industry and business is regarded a strategy to make the actual costs of the existing waste management system more visible.

The strong emphasis on a market-based framework for the future waste management, the 'new goals for the economical politic' seems to be business-as-usual for the economy, secured by technical solutions to overcome the problems of waste. The domestic level is for example not included specifically in the policy strategy, only indirectly and in an inherently assumed position as instrumental source sorters, in whatever manner required by the actual municipality.

Industry and business were urged by the comprehensive waste management report to rethink product design towards more environmental friendly solutions, and to find ways of securing reuse of sorted material in their production. When the national budget for 1995 was discussed in parliament, there was

[1] The original title is: St.meld.nr 44 (1991-92*), Om tiltak for reduserte avfallsmengder, økt gjenvinning og forsvarlig avfallsbehandling."*

[2] In retrospective it is interesting to note that the White paper on waste (no 44 (1991-92) came, though only one month, before the international signing of the action plan for sustainable development – Agenda 21 – which Norway to day, ten years later, is criticized for *not* haven taken seriously (Langhelle 2001, Opoku 2001); as opposed to the early support for the work of the WCED.

a proposal for a green tax of one *'kroner'* (90 cent) per unit of packaging. In this way, the government wished to pressure producers and importers to consider their use of various packaging materials and stop the growth of waste.

3. Industry and business at the negotiation table- the producer perspective

Business and industry reacted swiftly to the proposed tax, suggesting an alternative solution: If the government put off the tax, the industry would itself make sure that return systems were established. Furthermore, clear objectives were set for the share that was to be recycled by a given deadline. As a result, several waste collection companies were established. Each responsible for developing, organising and controlling return systems for the various waste fractions they represent. This work requires market development, product development, technology development and, above all, attitude development.

Today, we have such systems for plastic packaging, cardboard packaging, beverage cartons, glass, and metals (aluminium, steel, tin). To co-ordinate this new development the company *Materialretur AS* was established by six materials companies to organize their joint market-oriented activities, recruit members and offer services to the members. The agreements are developed individually for each fraction with concrete measures for collection and recycling.

The plastic packaging agreement

Based on the EEC agreement, the Norwegian business association has voluntarily undertaken an obligation towards the Ministry of Environment to recycle 80% of the plastic packaging. 30% of this amount is supposed to be material recycled while the latter 50% energy recovered.
From the annually total consumption of 100.000 ton plastic packaging, 55.000 ton comes from the households.[3] Ultimately then, 55.000 ton plastic packaging should be collected and redistributed, along national guidelines, for further treatment at the municipality level. However, last year only 22% of the national consumed plastic packaging was recycled in Norway

EPR for the plastic packaging in Norway is implemented through a covenant between Ministry of Environment and representatives from the producers, retailers and grocery trades of plastic packaging in Norway. In the agreement text from 1995 it is stated that the plastic packaging industry should: i) work for waste reduction of plastic packaging, and ii) build up a recovery system for plastic packaging that ensures 30 % recycling and 50 % energy recovery of plastic packaging. In order to meet these objectives the "material company" Plastretur was established. The "material company" is, according to the agreement, responsible to co-ordinate, develop, run, manage, monitor and organise collection and recovery of plastic packaging, Plastretur is, however, not owner of or involved in the direct operation of the collection- and recovery activities. Plastretur's activities are financed through a fee that users of plastic packaging (importers and "fillers&packers") are obliged to pay. The fee varies with the amount of plastic packaging used for filling and packing of the main product. A large part of the fee is used to give economical support to actors as municipalities, sorting plants and recyclers, which Plastretur has signed agreements with in order to obtain the recovery goals. However, the support to the recycling companies is reduced since the first agreements were signed in 1996, and a further reduction is planned as the cost-efficiency in the various recycling systems improves. At the moment the fees and the support to the actors are the following (personal communication Schefte 2001):

Fee for use of plastic packaging:

- Use of plastic packaging for importers and "fillers and packers":

[3] Pressemelding fra Plastretur 26.12.00.

1700 NOK/ton imported or used for filling/packing

Support for source separation, collection and recycling:

- Operation of appropriate plastic packaging source separation systems:
  1100 NOK/ton potentially recyclable plastic packaging in households

- Sorting of bottles and cans (sorted into fractions of HDPE, PP and PS):
  3500 NOK/ton accepted for recycling

- Sorting of bottles and cans (not sorted into material fractions):
  2500 NOK/ton accepted for recycling

- Sorting of foil (LDPE):
  1600 NOK/ton accepted for recycling

- Sorting to energy recovery:
  500 NOK/ton accepted for energy recovery (with high energy utilisation)

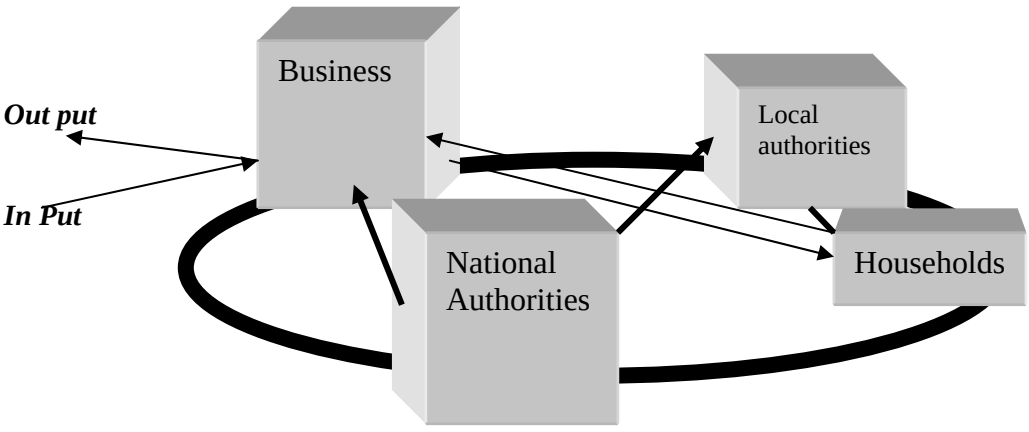
Recycling:

- 1450 NOK/ton for sold product made of foil
- 0 NOK/ton for recycled products from bottles and cans

Even though it may be the case that the actual costs to cover the necessary waste management are more than 1700 NOK/ton, Plastretur have no plans for the moment to increase the fee. There is, however, a potential of increasing the incomes if the so-called free-riders, that do not pay for use of packaging, is caught and obliged to pay. Today it is paid fee for around 65 % of the plastic packaging imported and used by fillers and packers in Norway (Plast). Nevertheless, the challenges for Plastretur is to use the income from the fee as efficient as possible in order to meet the recovery goals. They must therefore decide upon whether they should prioritise the household sector, which have the worst packaging in terms of cleanness and thus are most expensive to recover, at the same extent as packaging from industry, agriculture and aquaculture, which contain packaging that are more available for recovery. On the other hand, it is not possible to reach the recycling goals if the household sector is ignored, since 50 % of the packaging waste is generated here. The question is therefore how Plastretur can support the household sector in a cost-effective manner and thus prioritise whether source separation-, collection- or recycling activities should have the highest priority.

As a result of the effort and economical support from Plastretur the recovery rate have increased from 7,5 % material recovery (recycling) and 36 % energy recovery in 1997 to 19 % recycling and 59 % energy recovery in 2000. The energy recovery goal is more than reached, while a lot of work remains to reach a recycling rate of 30 per cent.

Figure: A preliminary figure of the direct effect of commands in the EPR in the sub flow of plastic packaging (Thin lines indicate the product stream – simplified).



Boundary of the domestic plastic substance flow

4. Increased responsibility to the municipalities' -Vertical diffusion or interaction?

The main argument for increasing the responsibility for the municipalities is: To oversee that the environmental standards are implemented and to keep social economic cost as low as possible , coordination of the waste management within a defined area is necessary. This new obligation required the passing of a new law by the pollution control agency. Waste management plans became the main tool in the coordination process. This would help getting an overview of *all* waste produced locally, included waste from productions that the municipalities are not responsible of. These plans would help localizing possibilities for reuse and its final treatment of other wastes. Important, for this strategy, it is stated, is that municipalities and industry and business works together.

There is no general act stipulating the division of authority between the State, the county and the municipalities in Norway. Municipalities and counties may therefore take on any function that the law does not forbid them to carry out, or which has not been specifically delegated to other institutions. The main functions explicitly delegated to the are in the areas of waste, water and sewage management, mandatory land use planning and pollution control in agriculture (All 1999). The issues at stake and the degree of responsibility may, however, vary over time. It is important to be aware of the changes taking place when analyzing the role of the municipalities as actors in the plastic packaging system, as the role and impetus constantly is evaluated and adjusted.[4]

[4] The development of a national environmental policy in Norway falls into five phases with relevance for local environmental policymaking in general and waste management in particular. It all started to take shape with an increased consciousness towards nature conservation and regional planning in the mid -60's (1965-72), succeeding with an institutionalization period of national environmental policy during the 70's (1972-82) with the establishment of the environmental department in 1972. The introduction of a comprehensive waste management strategy appears first in the third phase in the history of municipal environmental policy in Norway.[4] This phase (1985- 96) is dominated by the reform known as 'Environment in the municipalities' (MIK). The MIK reform was designed to test new administrative and political models for the organization of municipal environmental policies. It was largely a continuation of the trends in previous phases, but now with the local level in focus. Earmarked funding was given to large municipalities for a full time position for an environmental manager.[4] Both a national and a local feature were shaped during this period. A Local bureaucrat characterizes this phase as the "golden age" of local environmental policymaking in Norway.

In 1993(?), internal control regulations based on the Pollution Act were introduced which forced the municipalities to introduce a documented management system for municipal renovation and draining (Aall 1999). In line with this parliament request, municipalities were entitled to presented plans for source sorting, recycling and improved waste management. These plans were meant for use in the local development of practical solutions for improved waste management (St.meld. 44: 30)[4]. It is also clearly stated in the report that industry and business life increasingly will be involved in source reduction and recycling, and that these activities will be in coordination with the development in the municipalities. To meet the above objectives the Parliament, in 1993, adopted *Forurensningsloven* § 33a which transferred waste management policies juridical to the municipalities, statutory on requests for local source sorting. The statutory also opened up for breaking the municipalities' monopoly for household waste collection in order to secure socio-economic profitable recycling systems. With the juridical change, municipalities were now also entitled to request a complete cost absorption in their waste fees, including final treatment of waste. Motivation for doing so was the assumption that the relative lesser costs promoted by recycling would be more visible (White paper 58 (1996-97)).

On the one hand, we can see that the national authorities have clear ambitions to create a national 'management by objectives' regime on issues during this period. On the other hand, there are indications that that the municipalities seek to develop a genuine municipal profile (see Aall 1999 for categorization). The MIK reform

Not at the negotiation table

As coordinators of the waste streams and main actors in the collection system at the local level, local environmental officers complaints that they were not invited to the negotiation table when these strategies were developed. According to the informants in a survey on obstacles at national level for local implementation of sustainable development, this exclusion has resulted in deals that are not necessarily optimal according to local circumstances (Opoku 2001).

Despite general satisfaction with the national waste collection policy, several appeals against the fraction-systems were actually made in the study. One was the centralized recycling plants for the many fractions that often lead to long transport distances. Another appeal was that the treatment priorities among fractions in the system, not necessarily is the best for the environment, and call for greater flexibility in this regard. As example it was argued that it is demoralising to separate out e.g. plastics when considerable portions of this un-renewable resource is used for energy recovery, while cardboard, a product of renewable resources is recycled. It was also emphasized that the most recent white paper on environment (St. meld. nr. 24 /2000-2001/) allows increased use of energy recovery at the expense of materials recycling: Accompanied by a government proposal for 20 new incineration plants, the local incentives to work for the fraction-take-back system and large scale environmental improvements vanishes, informants reported (Opoku 2001).

Energy recovery from plastic is a very controversial issue in Norway. Economic calculations primarily by Statistics Norway (SSB) have formed the basis of the government's policy-making in the sector. Spokespersons for these assessments are for instance described as the 'incineration mafia' by, at the time Head of Department at the Pollution Control Authority, Janne Sollie[5]. A discussion between Bruvoll at the SSB and Hanssen at the Eastern Norway Research Foundation (ENRF) and Programme for Industrial Ecology at the Norwegian University of Science and Technology calumniated in an intricate series of articles in the popular press. Hanssen's findings conflict with those of the SSB: Based on a study from the Drammen region, carried out by ENRF, on behalf of the waste collection company *Plastretur*, in 1999, concludes that *"the right thing to do is to continue developing recycling systems for plastic packaging wastes, and as large a share as possible should go to materials recycling"* (Raadal et al. 1999: 6). If an agreement on deliveries of plastic packaging for incineration energy recovery is chosen, they continue, it must ensure the highest possible environmental efficiency in replacing other sources of energy, e.g. by replacing coal or imported electricity, the report states (*ibid.*).

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ended 1.st January 1997 (Bjørnæs et.al. 2000), from then on we are talking about a Local Agenda 21 (LA 21) phase of the local environmental policy (Aall 2000). Funding for the LA 21 program is stipulated to end with the year 2001. This is, paradoxically, a late follow up of the action plan for sustainable development – Agenda 21-, signed at the UN Conference for Environment and Development in Rio in 1992. As mentioned, Agenda 21 builds on the report from the World Commission on Environment and Development led by the Norwegian Prime minister at the time Gro Harlem Brundtland.

As national governments prepare for Rio+ 10 in Johannesburg in August 2002, pressure from local communities, civil society and research institutions may influence the government to continue these processes. However, a fifth phase has emerged as even more responsibility for environmental issues is to be transferred to local communities as part of a general reform of public sector. The shape and profoundness of this process is still unclear. What is clear is that business and industry will get the responsibility of more waste accumulated in the municipalities than previously. Juridical, the pollution control agency was given extensive authority to impose recycling and other treatments of waste. In the latest White paper on the nations environmental condition report nr. 24 (2000-2001) a new juridical proposition is given. If this motion is carried out, fewer obligations will be in the hands of municipalities while industry and business get more responsibilities. The change will in large be that municipal actors, official or private, only are responsible for waste from households as at now they also collect waste from small businesses activities.

5 This statement was presented by Sollie at a course seminar in Environmental politics at IndEcol, spring 2001.

The expenses of the system on the municipalities represents another appeal against the fraction based recycling program reported in the survey on local implementation of sustainable development. More specifically it concerned the share of responsibility and cost among the actors involved in the fraction based recycling program. As we have seen, the volunteer agreements started out as a response to government proposals for packaging taxes. Despite the government's contribution to the playing field of the industry in this new waste management strategy, municipalities are still left with costs connected to return and transport. While the waste collection companies on the other side is in a unique business position regarding access to raw materials, which do not necessarily contribute to waste reduction or other environmental benefits (Opoku 2001). A similar shortcoming is reported from a study of urban recycling in Chicago. Environmental groups had developed the concept of recycling, but were locked out of the negotiations about recycling operations (Pellow et al. 2000). Here the actual details of recycling programmes tended to be worked out behind closed doors by local municipal leaders and industry representatives, especially those from large waste firms (*Ibid*.). As in Trondheim, waste firms and local governments in Chicago jointly developed large-scale municipal kerbside programmes. Residents would place materials at the curbside, where they would be picked up and transferred to a Materials Recovery Facility (MRF). At the MRF in Chicago another set of workers would sort and bale materials for resale to firms use recyclables for their production Process (Powell et al 2000). While in Trondheim, fractions would be sent to the waste firms. In both cases, however, it seems like the programs were guided mainly by a narrow set of economic goals, more than the concern with environmental improvements. Eik (2001) argues that increased actual costs for source separation, central sorting and recycling have put increased pressure on increasing the support from *Plastretur* to the municipalities.

In the survey on national obstacles for local implementation of sustainable development, the waste got the highest positive score. To get a more detailed understanding of municipal roles and performance in the EPR strategy for plastic packaging, we have applied a case study approach.

4.1. Local response on national policy; the case of Trondheim

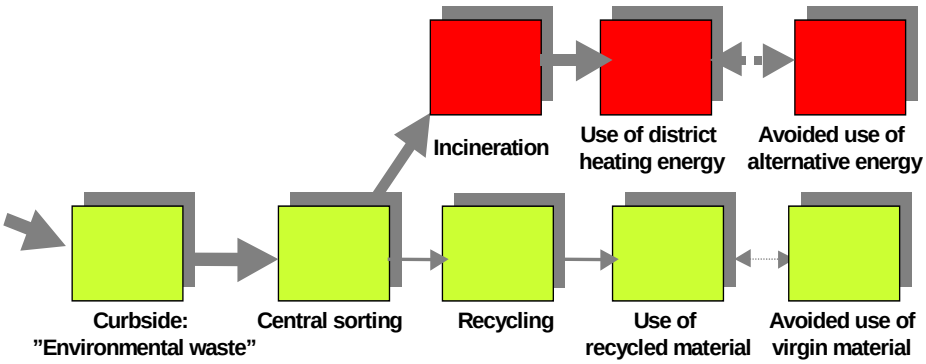
More than half (250) of some four hundred municipalities have introduced recycling systems for plastic packaging in Norway. One of them is Trondheim, the third largest city in Norway, situated by one of the fjords some 500km north of the capital Oslo.

In 1997 Trondheim municipality, introduced a source sorting system based on four separate waste bins at the curbside. The intention was to reduce the amount of waste going to the incinerator and landfill, and to increasing the potential for recycling. The local collection system contains a small container for hazardous waste, such as paint etc, and four normal sized bins for hence: 'Paper and hard paper', 'Environmental waste' and the last one for 'Residuals'. The concern of our study is the bin labeled 'Environmental waste'.

At this point the objective of this bind was to collect and those prevent products anticipated to hold hazardous sources from going into the incinerator and those prevent unwanted emission. Instructions and purpose regarding the interior of this particular bind has varied over time, a source of frustration in the populace. Today material recovering is the main purpose of the bind. Throughout the period, however, 'Environmental waste' has included a various set of sources. Today plastics, metal and drinking beverages (*drikkekartong*) are collected here, often resulting in unclean fractions unsuitable for material recovery (Opoku 1999).

The agreement and the establishment of *Plastretur* were very much decisive for the establishment of source separation and recycling of plastic packaging from households in the municipality in January 1999 (Bakkejord 1999). Before the introduction of the source separation system, the plastic packaging was, together with other wastes, transported directly to the local incineration plant for production of district heating energy. As figure 1 below shows the situation is different today.

Figure 1: The material flow of plastic packaging waste generated in households in the city of Trondheim, Norway (Eik 2001).



The plastic packaging wastes from the 150.000 inhabitants in the city are now to be placed together with other recyclable waste (metals etc.) in the bin still labeled 'environmental waste'. From here the plastic packaging is transported to a central sorting plant, located 15-20 km from the households in the city. At the sorting plant, clean and recyclable foil (Low density polyethylene - LDPE) and bottles and cans (Polypropylene - PP, Polystyrene - PS and High density polyethylene -HDPE) are sorted out. The plastic packaging which is not sorted goes directly to incineration with energy recovery. The foil is transported 120 km to a recycling company which produces pallet bricks. It is assumed that this pallet bricks substitute alternative pallet bricks made of tree (avoided use of virgin material in figure 1). The bottles and cans are transported 600 km to another sorting plant in Sweden. From here the sorted PP and PS in one fraction and HDPE in another fraction are transported around 100 km to recycling companies which produce re-granulate. Use of this re-granualte to make plastic products (see www.plastretur.no/produkter) lead to avoided use of alternative virgin material to make these products (Eik 2001).

An evaluation of the recycling system for the plastic packaging from Trondheim is, however, by no means representative for the efficiency of extended producer responsibility for recycling of all plastic packaging in Norway. Recovery of plastic packaging from industry, agriculture and aquaculture, as well as other source separation- and sorting system for household plastic packaging waste, have been more successful in terms of recycling rate and cost-efficiency (Plastretrur 2001).

Influence of the agreement on the local recycling system [6]

Despite relative low figures the developments of the EPR perspective in the policy design are regarded as positive in a loop closing perspective. Regarding the goal of source reduction it is likely that the Trondheim system have contributed. Increased recycling, which is obtained during the time period, will probably lead to less use of natural resources. 1 kg recycled plastic packaging can substitute 2 kg oil (Plastretur 2001).

The recycling rate has increased considerably during the 2,5 years, however, it should have been higher all the time the source separation and the sorting facility is designed to obtain high recycling rate (Bakkejord 2001). Emissions of CO2-equivalents have decreased considerably as a result of the increase in recycling rate. The total costs, on the other hand, have varied during the period. The incineration option from 1998 is the most reasonable, while the system today is the most expensive. More comprehensive sorting at the central sorting plants explains the considerably increase in the total cost from 2000 to 2001.

[6] This entire section is provided by Eik.

Looking into the goal of waste prevention, figures for waste generated in households in 1999-2001 is not given or analysed. However, we have figures on total municipal waste produced in 1999, 2000 and the first 5 months of 2001 (Eik et al 2001). These figures tell us that waste amounts have increased during the period. It is therefore likely that the plastic packaging waste amounts have increased as well. However, this should be investigated.

Regarding waste reduction, six years after the volunteer agreement, respondents of the Norwegian survey still calls for packaging tax, or reduced taxes on products without unnecessary or environmentally harmful packaging— as measures to *prevent* wastes from being produced (Opoku 2001).

Regarding design of more environmentally compatible products there is nothing that indicates that this have been strongly emphasised. The plastic packaging is still difficult to sort.

One may discuss what is meant by closure of material use loops. It can be argued that energy recovery of plastic packaging is to close the loop since the energy content of the plastic packaging has been utilised. However, if the material is recycled instead, the material can maintain the quality and be used several times before being incinerated for energy production. For this reason we do not regard energy recovery as closure of material loops. In this perspective we can argue that, due to increased recycling rates, the system has to a certain degree successfully moved towards a closing of the material loop.

As we have seen the EPR principals is to some extent implemented in the recycling system for plastic packaging from households in Trondheim. However, it remains to be proved that the national strategy - implementation of EPR, through the covenant and establishment of Plastretur - is the reason for this partial success. To answer this question we have, in addition to carrying out an economical- and environmental analysis, performed qualitative research interviews and had conversations with the actors in the recycling system. This has been carried out among others to examine the influence of extended producer responsibility and the establishment of Plastretur on the system (Personal communications 1999-2001). On the basis of these quantitative economical- and environmental analysis and these qualitative research interview the following can be summarised regarding the role and influence of the covenant and Plastretur:

- The agreement has not influenced the amount of plastic packaging waste generated in households in Norway.
- The agreement has not to a large extent influenced standardisation- and labelling efforts in design and production of packaging used in and imported
- The agreement has contributed in increasing the recycling rates of plastic packaging considerably. However, much of the recycling is down-cycled (feed-stock recycling), i.e. high quality plastic packaging is used to produce low quality plastic product and energy.

- *Plastretur* is highly decisive for spreading information to the actors in the system and for co-ordination of plastic packaging material flow between the actors
- *Plastretur* has to a certain degree succeeded to create an understanding of the life cycle perspective among the actors in the defined recycling system.
- *The identification of actors and the definition of the recycling system is, however, insufficient.*

- *Plastretur* plays a decisive role in creating and maintaining a market for management and recovery of plastic packaging waste
- All actors, except transport companies, are highly dependent of economical support from *Plastretur*.

Regarding the economical support it should be mentioned that even though *Plastretur* have reduced their economical support to the *recycling companies* in Norway during the period, the overall support to the system for recycling of plastic packaging from households in Trondheim has increased. This is a

result of the increased support to the *source separation- and central sorting* of the system. The various actors in the recycling system are dependent on economical support from *Plastretur* to be able to transfer packaging waste into new products. Incineration without source separation is an alternative management option for the plastic packaging from the municipality of Trondheim. For his reasons there is no doubt that the defined recycling system will fall apart or even stop completely if the economical support from *Plastretur* fails to appear in the future.

It should also be mentioned that, even though we have only analysed a small system, our examination on the influence of EPR should be very much representative for household plastic packaging in Norway in general. The reason for this is that the kind of packaging generated and transformed in our system is the same as in Norwegian households in general. Another reason is, as we have seen, that the recycling companies in our system are the central players in the national recycling strategy for plastic packaging.

As we have discussed, improved efficiency is a necessity to justify the recycling of plastic packaging from households in the city of Trondheim. Theoretically it may even be possible to run such a system with profit and thus avoid the economical dependence of *Plastretur*. In this connection it should be mentioned that *Plastretur* have a 5 years plan for decreasing the support to recycling companies into zero (Schefte 2001). The aim of *Plastretur*'s business is rather to sell plastic packaging to the recyclers. However, in some way the extended producer responsibility should be taken care of in order to ensure that users of plastic packaging take their responsibility on bringing plastic packaging waste into new valuable products. In any case support to municipalities (or other actors that organise source separation) and to sorting plants seems to be necessary in the next years and it is obvious that the users of plastic packaging have to cover large parts of these costs.

Unless the fee from importers and "fillers and packers" is raised or the free-riders are caught, Plastretur have the today's limited amount of money to spend on sorting and recycling initiatives. The question is then to what extent *Plastretur* should support a recycling system that does not function perfectly? On the other hand: Can we expect that such a system is environmental- and economical efficient after only a few years? And is it possible to reach the goal of 30 % recycling of plastic packaging in Norway if the big cities are ignored?

After examining the improvements already obtained as well as the improvement potential of the system we suggest that *Plastretur* maintain the economical support to source separation and sorting of plastic packaging from Trondheim. However, instead of source separating plastic packaging in the same container as other "environmental wastes", we suggest that a container or bag only for plastic packaging is introduced. Only this small change will probably increase the recycling rate remarkably without increasing the cost noticeable.

According to Eik et al (2001) it is possible, by changing the design of the packaging, the source separation- and the central sorting facilities, to increase the recycling rate remarkably in the Trondheim system without increasing the costs.

More than four years after the introduction of the source sorting system and three years after the introduction of plastic recycling, only 9% of the total amounts of the plastic packaging waste from the households, in the municipality, are recycled into new plastic products. Our argument is, that these rather disappointing results lies in poor policy design at both national and local level. This is in our analysis partly due to banal factors such as insufficient will and understanding of implications of the system at both political and administrative level. As result we observe inadequate technical solutions and poor communication and dialog with the domestic level.

Table 1: Recycling rate, CO2-equivalents emissions and Total net costs from recovery of 1000 kg plastic packaging generated in Trondheim, Norway. Avoided costs and emission due to substitution of alternative virgin material and energy are included.

Year	Recycling rate	CO2-equivalents (Enhet?)	Total net costs (NOK)
1998	0	473	1073
1999	5,5	456	2266
2000	11,4	365	1626
2001 (01.01-31.05)	15,3	365	3015

5. Household level – consumer perspective

Though there is a will and desire to overcome the gap between the technical and social sciences traditional domain in industrial ecology, it is newer the less there. It is particularly challenging when it comes to include the domestic level into the flow analysis. By taking this substance flow analysis into consideration from a sociological 'life style perspective', as suggested by Spaargaren (2000), the objective is to contribute to the integration of the domestic level in the flow analysis.

A 'lifestyle' is defined by Giddens (1991) to *be "a more or less integrated set of practices which an individual embraces, not only because such practices fulfil utilitarian needs, but because they give material form to a particular narrative of the self*' (cf Spaargaren 2000). Part of this narrative in the context of domestic recycling (source sorting) will be the level of comfort, cleanliness and convenience.[7]

We are still waiting for new data from personal interviews of domestic recyclers in Trondheim. Mean while results from the policy analysis of the introduction of the source sorting system in the period 1996-1998 (Opoku 1999) can give some preliminary indications:[8]

In order to meet the goals of source sorting and waste reduction three sub objectives were identified at the domestic level, these were knowledge, motivation and resources. Though no sharp line can be drawn between the sub-objectives, the following analysis of the results from a 1997 survey will be presented in categories representing knowledge, motivation and resources.

Knowledge

To identify and measure the variables representing the knowledge category, a selection from the questionnaire based on questions requiring information on: source sorting, source reduction, waste reduction, LA 21 and general environmental awareness, in order to give positive answers were made. Though only 18 % of the respondents held that source sorting increases their consciousness towards waste and 13% held that source sorting is important in order to reduce the amount of waste, as many as 1/3 mentioned less packaging as ways of reducing waste (see figures below). While the source sorting system helps in reducing the amount of waste going to the landfill or incinerator, less packaging is waste reduction at source. As consumers the public may exercise pressure on the producers to change the packaging. Important here, however, is that there is an awareness of the components in the waste problem. Our assumption is that this kind of awareness might grow into a more conscious consumer, which in the long term might have a positive effect on the waste issue all together.

When asked to list areas in which the respondent held that she or he could help provide a better environment in their local community, 48% referred to source sorting. Though this is a very positive

[7] Spaargaren uses these three components in the context of domestic *consumption* and reefers to (Shove 1997).
[8] This particular project was a joint implementation of source-sorting and a new coordination and approaching strategy known as LA 21. The latter is the local follow up of Agenda 21, the action plan for sustainable development from the UN-conference on Environment and Development in 1992.

response, it is only an increase of 3% if we make a comparison with the 1995 survey conducted on the whole populace of Trondheim, before the program was introduced.[9]

A logistic regression analysis where the «source sorting» response is the dependent variable shows that among the socio-economic variables only gender has a significant impact on the response. The findings indicate that there is a higher tendency for women to regard source sorting as a way of contributing to a better environment than men do.

Information on the Local Agenda 21 aspect of the project was distributed in the mail to all informants. Despite this, only 17% responded positively when asked if they knew that Strinda district and the Volunteer exchange were involved in a Local Agenda 21 project aimed at making inhabitants reduce the waste generated in their district. When testing for the effect of socio-economic variables on the awareness of the LA 21 initiative, neither of these variables showed any significant effect

A possible explanation to this disappointing result is that information brochures often are regarded as commercial material, and then thrown out when distributed without addressee through the mail. Also important is that when EHG introduced the source-sorting program to the Co-ops, though in a context they thought of as Local Agenda 21, the term itself was not mentioned. And as the respondents in the survey were 18 years or older the target group at the school seminars, where LA 21 were introduced in more detail, were not included in the survey.
A more detailed question regarding the sufficiency of the information provided for recycling of paper, source sorting, environmentally unfriendly waste and the reduction of the waste production was also given. Here the respondents were most satisfied with information regarding source sorting (62%), and less satisfied with information about waste reduction (64%). Regarding the complexity of waste reduction compared to source sorting, and the fact that waste reduction was the main objective of the project more information on waste reduction is required. Again, however, this is an issue that needs to develop at the individual level. A follow up question after a longer time period would therefore be interesting. At this point, the fulfillment of the knowledge sub-objective must be regarded insufficient.

When looking into socio-economic characteristics of the respondents to the more general questions regarding knowledge about the environment, there are only a few significant findings. There are indications that men are more aware of technical installations such as the two return/recycling stations in town than women are; that people informed about these stations are generally older than those who are not; And that families with children have more knowledge about these stations than those without children.
Women on the other hand responded more frequently than men that use of private care and winter tires with studs (*piggdekk*) is the most environmentally unfriendly factors in the municipality. The higher education one possessed the higher likelihood of giving the same negative response concerning use of private care and tires with studs. There was no significant socio-economic pattern among the respondents who held that the garbage problem had the most negative effect on the environment in the municipality. However, women, more frequently than men, held that source sorting is a way for them to help improve the local environment

Motivation
In the motivation category questions identifying attitudes/feelings and willingness towards source sorting, waste reduction or other environmental actions are looked into.
A positive feedback from the survey to the program implementers is that 50% of the respondents listed a positive experience from source sorting when asked to do so. Among the positive categories 18% responded that the program had contributed to a more conscious attitude towards what they throw

[9] Among the 6 alternatives listed as possible ways of improving the environment in the 1995 survey, "Waste treatment" were then the highest ranked alternative, making an equivalent to the «source sorting» figures in the 1997 survey (Norfakta, 1995).

away, which was the highest score among these categories. This, we believe, is a positive trend for the motivation to go a step further and actually throw less or choose more environmental friendly items at the store. The interpretation of the second category in the diagram below is that as for now 9% of the respondents along Route 16 do consume along these inquiries.

Also relevant for motivation is people's judgment of their own possibilities to improve the local environment. As noted above, source sorting got the highest rank before less use of private care and more use of public transport on this question. The high rank for source sorting is regarded positive for the motivation variable. The only socio-economic variable of significance on this question showed a positive correlation between high education and negative attitude towards use of private care, in other words no particular trend for those listing source sorting first
However, when asked to what degree people tend to believe source -sorting will lead them to produce less waste, younger people tend to be more positive than older respondents. Households with children and people with higher education are generally more *positive* towards source sorting than others when that question is asked specifically.
Only few months after the introduction of the program the EHG could report/confirm that residences in the co-ops along subscription route 16 have started to make even further connections to ways of reducing waste. Based on this development executives in the Environmental Section of the municipality were asked if they believed a more positive curve for waste reduction at Strinda will emerge given a longer time frame. On two occasions the rather surprising response was that they had not thought of that possibility.
Finally, when testing for the effect of what was regarded as knowledge variables on motivation no specific trends emerge. There is only a low positive tendency that households with children have a general positive attitude towards source sorting compared to other categories
Though, not over whelming results from the motivation category either, there are positive tendencies for the further development of the program if supported sufficiently.

Resources
The resource category was defined as soft and hard ware material available for the subscribers in order to meet the objectives of the program. These were defined as the pamphlets of information regarding LA 21 and the four waste bins required for the source sorting system. As such it is both required in order providing knowledge and therefore motivation.
Formally the resource category should be regarded as a technical matter. However, the placement of the waste bins was postponed several times due to delays at production, and because of weather conditions. The timing between the distribution of information and placement of the waste bins may therefore not have been the ultimate.
None of the three sub-objectives were met sufficiently according to the expectations; however, as the pilot project's unsuccessful experiences may be adjusted prior to an extension of the program.

6. Summary

In this paper we have presented barriers to an optimal plastic packaging recycling rate in households in the city of Trondheim. The implementation of EPR for users of plastic packaging, through a covenant between the Ministry of Environment and the plastic packaging industry in Norway, have to some extent influenced the recycling system examined. Even though the amount of packaging generated and the appropriateness of the packaging for recycling have remained more or less unchanged, the "material company" *Plastretur* have played an important role to contribute to the increase of the recycling rate from 0 in 1998 to 15,3 % so far in 2001. Co-ordination, information and economical support have been highly decisive for the establishment, maintenance and improvement of the recycling system. However, changes should be carried out in the design of the source separation- and

central sorting stage of the life cycle of plastic packaging, as well as in the national policy goals for the plastic fraction and in the information provided to the users – households – of the system.

In other words, obstacles to optimal plastic recovery are identified at all levels of analysis: In national policymaking and identification of major actors in the system, steering goals for material company, local distribution of information and inclusion of users at household level, and finally actual follow up at household level .

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