Summary of the report:

Life Cycle Assessment
and Socio-economic
Cost Benefit Analyses
of the Treatment of
Plastic Packaging Waste
from Households in Norway.

Hanne Lerche Raadal,
Lars von Krogh,
Cecilia Askham Nyland.
Ole Jørgen Hanssen

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REPORT OVERVIEW

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Life Cycle Assessment and Socio-economic Cost Benefit Analyses of the Treatment of Plastic Packaging Waste from Households in Norway.

Author(s):
Hanne Lerche Raadal, Lars von Krogh, Cecilia Askham Nyland and Ole Jørgen Hanssen

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Resymè:
The study has been carried out for two different regions in Norway (Hamar and Drammen), which have different collection systems for source sorted plastic packaging waste. Before the system for plastic sorting was introduced in the two regions, plastic packaging waste deposited on landfills.

The following conclusions are reached based on the Life Cycle Assessment (LCA) and Socio-economic Cost Benefit Analyses (CBA) of the different systems:

- Material recycling systems are the most environmentally beneficial when compared to systems without recycling (all plastics to landfill). The analyses also show that the higher the collection rate, the greater the environmental benefit.
- Transport contributes very little to the total environmental loads.
- The relatively newly established sorting systems give higher socio-economic costs than the systems without recycling (all plastics to landfill).
- When examining the recycling and energy recovery processes in isolation (transport and sorting not included), recycling is more beneficial than energy recovery for both the LCA and CBA.
- There seems to be potential for optimising the recycling systems to be more socio-economically beneficial. This applies especially to costs for transport, sorting and information.
- Choosing to discount external costs, so that future emissions are worth less than emissions that occur today can affect the conclusions of the CBA.
- It is important to be aware of the assumptions that these analyses are built on. The results must be used carefully as a basis for making decisions about whether one should recycle a waste material or not.

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Ole Jørgen Hanssen	Mie Vold
Projectleader	**Director of Institute**

Contents

Summary of the report:

Life Cycle Assessment and Socio-economic Cost Benefit Analyses of the Treatment of Plastic Packaging Waste from Households in Norway.

1 Background

This project has been carried out for Plastretur AS. It is to be used as the basis for Plastretur's strategy for the development of collection systems for plastic packaging waste from households. The study has been carried out for two different regions in Norway (Hamar and Drammen), which have different collection systems for source sorted plastic packaging waste. Before the system for plastic sorting was introduced in the two regions, plastic packaging waste was collected together with residual waste and deposited on landfills. The analyses also include the landfill systems.

The principle aims of the project have been to compare the environmental and socio-economic costs for the systems analysed, as well as comparing the situations before and after source sorting was introduced in the regions.

2 Methodology

The study has been based upon the life cycle assessment (LCA) methodology, as described in the ISO-standards 14040-43. The LCA methodology has been used for the assessment of environmental impacts of different waste management solutions. The model of material and energy flows from the LCA has also been used as the basis for a socio-economic cost benefit analysis (CBA), thus combining the two methodologies. The LCA has been carried out to assess the environmental profiles for a set of waste management systems, whereas the CBA has been carried out to establish the total cost, or benefit, for the same system.

The CBA was calculated in two steps:

- First, the internal costs were calculated by using Life Cycle Cost (LCC) methodology for the same model that was used in the LCA. LCC methodology makes an inventory of the actual costs (e.g. labour, energy, investment, administration, avoided costs for virgin material or energy) for the system's entire life cycle. The data for these life cycle steps were then calculated on the same basis as for the environmental LCA. All environmental taxes were excluded from the internal costs.
- The second step was then to calculate the external costs for the same systems. This was done by taking the physical results from the environmental life cycle inventory assessment (e.g. kg CO_2) and applying specific emissions costs to these data (ref. Econ, 2000).

The functional unit (the basis for the analysis) was one tonne of plastic packaging waste generated in households. For the sorting systems, a certain amount of this household waste is recycled and replaces an equivalent amount of virgin plastic. Some of the remaining waste is used for energy recovery and replaces an equivalent amount of energy from alternative energy carriers (fuel oil).

The data used has been collected in collaboration with the local authorities and Mepex Consult AS. The central actors in the recycling sector have also been closely involved. The collection rates for the Drammen and Hamar region are approximately 18% and 55%, respectively. These collection rates were calculated based on the actual collection data from the two regions.

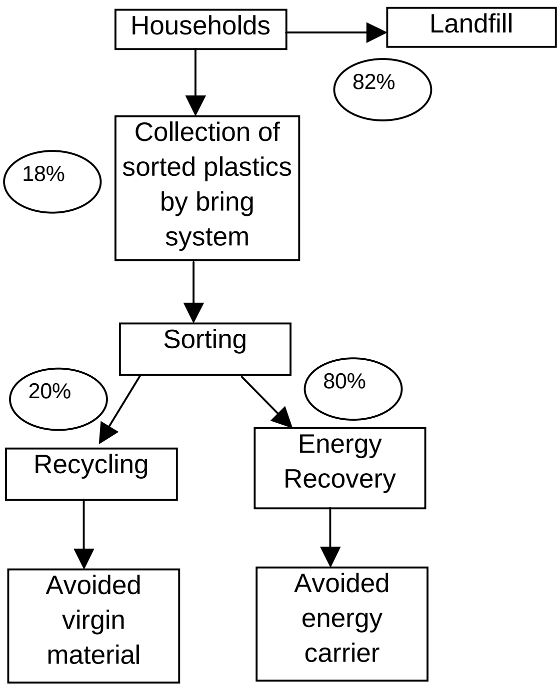
The collection rate is calculated using the following equation:

$$\frac{\text{Amount of collected plastic packaging waste (kg/person.year)}}{\text{Total amount of generated plastic packaging waste (kg/person.year)}} = \mathit{collection\ rate}$$

The total amount of plastic packaging waste generated was 11,3 kg/person.year (ref. Plastretur 2001).

Figure 1 shows simple flow charts for the waste management systems for plastic packaging in the Drammen and Hamar regions after the commencement of the household sorting system. These systems are later referred to as “Drammen / Hamar, collection rate 18% / 55%”, respectively.

The Drammen system:



The Hamar system:

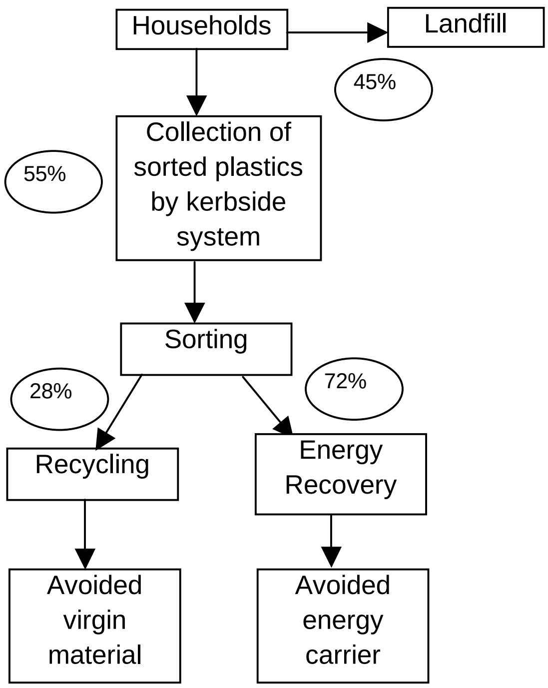


Figure 1: Flow charts for the recycling systems for plastic packaging in the Drammen and Hamar regions.

Before the system for plastic sorting was introduced in the two regions, plastic packaging was collected together with residual waste and deposited on landfills. These landfill systems are later referred to as “Drammen / Hamar, reference scenario”.

3 Environmental Life Cycle Assessment (LCA)

Figure 2 shows the environmental profile for two impact categories for the four systems. The Global Warming Potential and Acidification are presented in kg CO_2-equivalents and g SO_2- equivalents per tonne plastic packaging generated in the households, respectively.

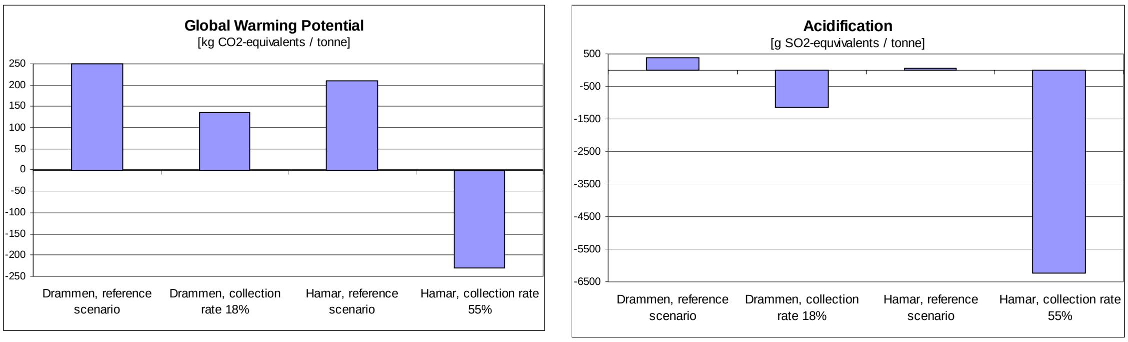


Figure 2: Global Warming Potential and Acidification

The recycling systems give the most beneficial results for both the impact categories. The main reason for this is the benefit gained from avoided energy and avoided virgin material that occurs when the collected plastic is sent to energy recovery and recycling. These benefits are bigger than the burdens from the increased transport in the recycling systems.

Transport contributes very little to the environmental burdens for the systems when compared to the contributions from the waste treatment method, or the substitution of energy carriers and virgin material.

The Hamar recycling system (Hamar, collection rate 55%) is the more beneficial of the recycling systems because the increased collection rate means bigger savings from avoided energy and avoided virgin material use.

4 Socio-economic Cost Benefit Analyses (CBA)

Figure 3 shows the results from the Social Cost Benefit Analyses for the four systems as the total cost split up into external and internal costs. The results are presented in Norwegian Krones (NOK) per tonne plastic packaging generated in the households.

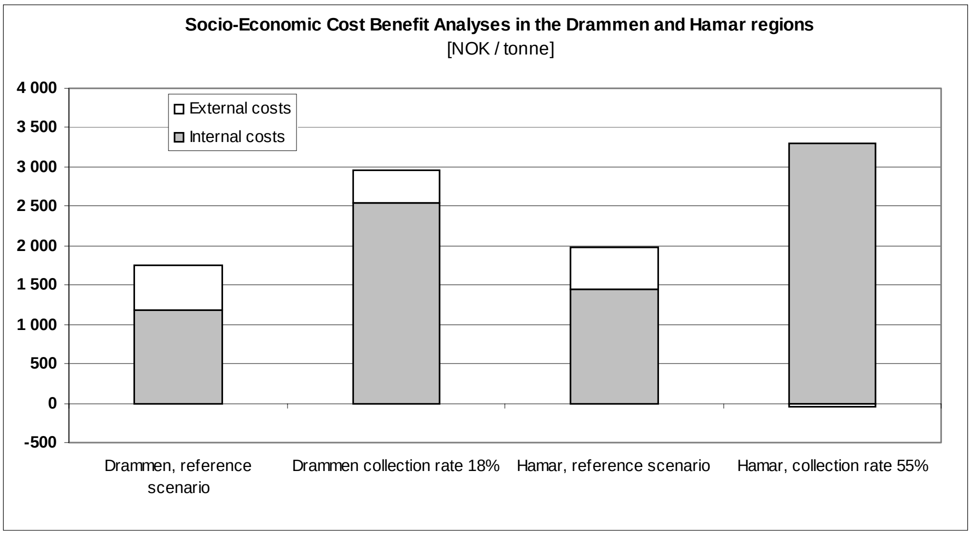


Figure 3: Socio-economic Cost Benefit Analyses

The total CBA results show the opposite of the environmental impact categories, as the reference scenarios give the lowest total cost.

When comparing the external costs only, the results are similar to the LCA results. The “Hamar recycling system” gives an external benefit of about 50 NOK, which shows that the higher collection rate the lower the external costs.

When comparing the recycling systems only, the Hamar system has higher costs than the Drammen system. The main reason for this is the higher transport costs arising from the collection of a larger amount of sorted plastic. The Hamar system is credited for the greatest amount of economic benefit from recycling and energy recovery, but this benefit is smaller than the extra costs for transport, sorting and information.

Discounting is part of the normal methodology for CBA. If costs occur over a given time period one discounts the costs according to a standard formula. Using this methodology means that emissions that occur in the future are valued at less than if they occurred today. This approach has a large impact on the external costs for landfill systems. A sensitivity analysis was performed for the results of the CBA. Analyses were performed without discounting the external costs of emissions occurring in the future. When the external costs are not discounted over time the total costs for the system are 35% higher than if they are discounted. This shows that choosing to discount external costs, so that future emissions are worth less than emissions that occur today can affect the conclusions of the analyses (i.e. material recycling costs about the same or even less than disposing of waste on a landfill site).

5 Conclusions

The following conclusions are reached based on the Life Cycle Assessment (LCA) and Socio-economic Cost Benefit Analyses (CBA) of the different systems:

- Material recycling systems are the most environmentally beneficial when compared to systems without recycling (all plastics to landfill). The analyses also show that the higher the collection rate, the greater the environmental benefit.

- Transport contributes very little to the total environmental loads.

- The relatively newly established sorting systems give higher socio-economic costs than the systems without recycling (all plastics to landfill).

- When examining the recycling and energy recovery processes in isolation (transport and sorting not included), recycling is more beneficial than energy recovery for both the LCA and CBA. This is because the difference between the costs and benefits for energy recovery are smaller than the difference between the costs and benefits for recycling.

- There seems to be potential for optimising the recycling systems to be more socio-economically beneficial. This applies especially to costs for transport, sorting and information.

- This study has not taken into account that when plastic packaging waste is recycled, it is made available for use in several future life cycles and can therefore replace virgin material more than just once. A recycled material is not at the 'end-of-life' phase of the life cycle; it is entering a new life cycle as a raw material. In order to assess the complete picture of the burdens and benefits arising from recycling, the system boundaries must be expanded to allow for recycling many times.

- Choosing to discount external costs, so that future emissions are worth less than emissions that occur today can affect the conclusions of the CBA.

- It is important to be aware of the assumptions that these analyses are built on. The results must be used carefully as a basis for making decisions about whether one should recycle a waste material or not.