

**Nordic Methods for documentation of  
packaging optimisation**

## **Opti-pack**


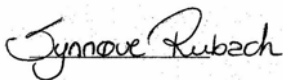

**Key figures for packaging–  
A tool for evaluation and  
documentation of packaging  
optimisation.**

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OR 16.04  
December 2004

[www.sto.no](http://www.sto.no)

## REPORT OVERVIEW

<b>Report number:</b> OR 16.04	<b>ISBN nr:</b> 82-7520-527-1 <b>ISSN nr:</b> 0803-6659	<b>Report:</b>
<b>Report heading:</b> Nordic Methods for documentation of packaging optimisation Opti-pack. <b>Key figures for packaging– A tool for evaluation and documentation of packaging optimisation.</b>		<b>Author(s):</b> Synnøve Rubach and Ole Jørgen Hanssen
<b>Project number:</b> 233943	<b>Project heading:</b> Opti-pack	
<b>Report employer:</b> 		
<b>Abstract:</b>  <p>This report documents the final suggestion for a key figure system (part B) of the Opti-pack project. The main objective for the part B of the Opti-pack project has been to adapt the Norwegian national key figure system and the Swedish and the Norwegian shopping basket to common Nordic systems of key figure. The Norwegian systems have been developed by STØ on behalf of the Norwegian industry, which has financed these projects through the organisation NOK (Næringslivets Emballasjeoptimeringskomité). The key figure system in this report has been be discussed, reviewed and tested by the project members.</p>		
<b>Keywords:</b> *Packaging optimisation *Material efficiency indicators *Waste minimization *EU Packaging Directive	<b>Officially:</b> Open <b>This side:</b> Open <b>This report:</b> Open	<b>Total number of pages:</b> 18
<b>Date:</b>		
 <b>Main author</b> (sign)	 <b>Research Manager</b> (sign)	

## **PREFACE**

Packaging waste has for a long time been one of the most focused problems in environmental politics, both nationally and internationally. On the European arena, the EU Packaging Directive from 1994 (62/ 94) has been an important basis, both for promoting increased recycling and recovery rates of packaging materials, as well as waste reduction related to packaging. Nationally, several countries have established agreements between environmental authorities and the packaging sector to follow up the requirements set in the Packaging Directive.

The Opti-pack project is a synergy project between the Nordic countries; Denmark, Finland, Iceland, Norway and Sweden, financed by the Nordic Innovation Centre. The main objective in the project is to provide instruments for the industry for documentation of the requirements for packaging optimization set in the Packaging Directive. The project finishes their work 31.12.2004.

This report documents the final suggestion for a key figure system (part B) of the Opti-pack project. The main objective for the part B of the Opti-pack project has been to adapt the Norwegian national key figure system and the Swedish and the Norwegian shopping basket to common Nordic systems of key figure. The Norwegian systems have been developed by STØ on behalf of the Norwegian industry, which has financed these projects through the organisation NOK (Næringslivets Emballasjeoptimeringskomité). The key figure system in this report has been discussed, reviewed and tested by the project members.

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# 1 PURPOSE OF THE GUIDELINE

This guideline has been developed to assist companies in their internal processes with packaging optimisation, and if desired, in their communication with customers.

The guideline has also been developed to make evaluations between different packaging systems in a systematic way and with a common methodological basis.

The guideline focus on the whole packaging system, which means that it includes the primary, secondary and tertiary packaging.

## 2 WHY KEY FIGURES FOR PACKAGING OPTIMISATION?

Key figures are important elements in all management systems, as it is in principle impossible to manage activities or processes that are not characterised by some measurable properties (Økstad et al. 2002). Key figures can be used as part of a system for packaging optimisation both for internal decision-making and for external communication. They can thus be of great help for companies in the actual optimisation work.

Does one use more packaging material per packed item? Some key figures can be calculated per product, others can be calculated for the organisation as a whole, for instance the packaging material use in relation to turnover and packaging material cost and logistic cost.

**You can't manage what you can't measure.**

Specific key figures can for instance be used to:

- Document a company's own packaging efficiency/ optimisation performance over time.
- Document impact or effect of new solutions in packaging design projects as result of an optimisation process, and compare them with existing solutions in the same company, or with similar solutions from other companies.
- Identify which part of the packaging system that are contributing most to loss of packaging efficiency, and which are most relevant for improvement actions
- Communicate with customers, e.g. document and communicate improvement of new product solutions compared to existing solutions

The basis for the developed key figures is that packaging optimisation should focus on the following five strategies for resource efficiency (Hanssen et al., 2002):

- A. Optimise packaging to minimise all types of product loss in the value chain, from production to consumption.
- B. Optimise packaging to maximise amount of materials that are recycled after use, and the amount of recycled materials in the packaging (within restrictions defined in health and safety standards and regulations).
- C. Optimise the whole packaging to minimise the loss of efficient volume in transport and storage, i.e. gas, air, utility materials etc.
- D. Optimise packaging to minimise the total mass of packaging materials in the packaging system.
- E. Optimise packaging through minimisation of resource consumption and emissions from the manufacturing of packaging.

***Strategy A will in almost all cases be of first priority, whereas strategy B-E will vary in their importance from case to case.***

To optimise and choose among packaging solutions is a complex job, where a holistic view is required in order to find the alternatives that can fulfil all the purposes of the packaging. It is for instance important to take into consideration elements like:

- Product protection
- Packaging manufacturing process
- Packing/filling process
- Logistics
- Product presentation and marketing
- User/consumer acceptance
- Information
- Safety
- Legislation
- Other issues

In the process of evaluating different packaging solutions, key figures can be a helpful tool.

### 3 WHICH TYPE OF KEY FIGURES?

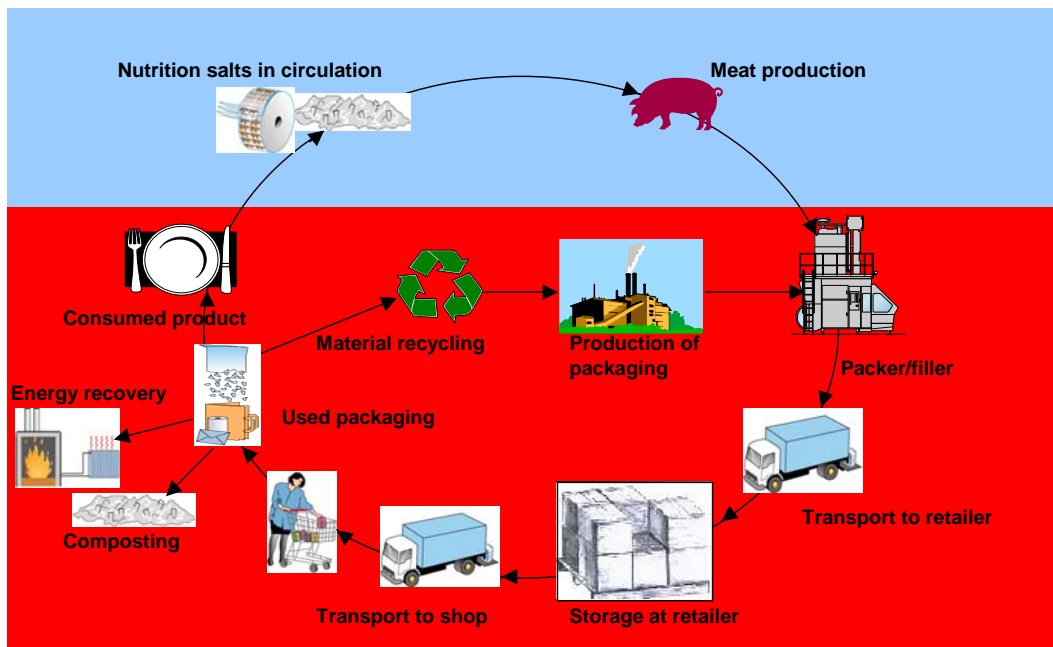
Incorporate key figures in the work with self-declaration according to EN 13427?

Examples of key figures

A systematic use of the self-declaration of packaging in accordance with EN 13427 can give a good overview of a company's situation regarding packaging optimisation. It can also give valuable input to further optimisation activities.

A systematic focus on packaging optimisation requires specific goals for this work and a system for regular internal audits. If a key figure system is integrated in the work according to EN 13427, this can be a helpful tool in order to follow up such an objective.

In a value chain perspective (see Figure 1), optimisation of one part of the packaging system might lead to new problems in another part of the system. For instance: reduction in packaging material for the consumer package can result in more waste of product or a need for more packaging material in the retail package. Packaging key figures can be a helpful tool to measure the effects of changes on the whole packaging system.



**Figure 1** An example of a value chain. The red part is focused in the EU Packaging and Packaging Waste Directive.

Examples of relevant key figures for packaged products are:

#### **Minimise the use of material:**

Mass of packaging materials should be minimised, as long as product waste is not increased.

- Total material consumption [for instance: gram packaging/kg product]. This key figure can be calculated for the packaging system as total, and/or divided into key figures for primary packaging (inner and outer packaging), secondary and tertiary packaging.
- Weight of each specific packaging material [for instance: kg fibre, plastic, glass and metal/kg product]
- Total loss of product (kg)/1000 kg consumed or used product. Can be divided between the most important actors through the value chain:
  - Loss at consumer stage
  - Loss at retailer stage
  - Loss in production stage

#### **Maximise the material recovery:**

Material recycling should be as high as possible to minimise net material use.

- The amount of material that is not material recovered (net<sup>1</sup> material consumption) [for instance: kg packaging/kg product]

#### **Minimise the use of energy:**

Total energy use along the distribution chain should be minimised.

- Total use of energy in MJ per kg packaged product
- Net<sup>2</sup> use of energy in MJ per kg packaged product

Use of energy is only possible to calculate if energy analyse of the actual packaging chain has been performed.

#### **Minimise transport work and inefficient use of space:**

Degree of filling for the total packaging system should be as high as possible to minimise transport work.

- Total filling degree for all three packaging systems (primary package/secondary package/tertiary package) in percentage of theoretical volume
- The mass or volume of additives (for instance gas, air, additives) /kg product

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<sup>1</sup> Net material consumption is calculated as the total material consumption minus the amount of the specific material that has been material recovered after use(national statistics).

<sup>2</sup> Net use of energy is the Total use of energy minus the amount of energy recovered by combustion or the energy that remains in the recovered material if the used packaging is material recovered.

- Transport work (tonnes km)/ kg or volume of product

These proposed key performance figures are related to the CEN-standards on packaging as shown in Table 1.

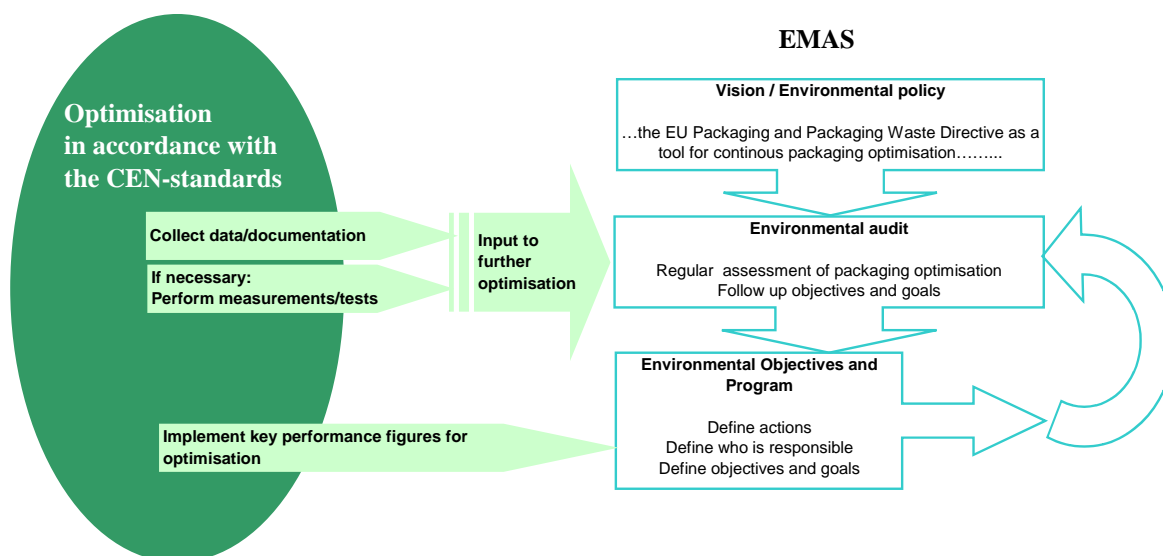
**Table 1 Relationship between the CEN-standards and the proposed key performance figures.**

<b>CEN-standard</b>	<b>Key figure</b>
<b>EN 13428</b> Prevention by source reduction <ul style="list-style-type: none"> <li>• Minimise use of material</li> <li>• Minimisation of heavy metals</li> <li>• Minimisation of noxious and other dangerous substances</li> </ul>	<ul style="list-style-type: none"> <li>• Gross/net material consumption/kg consumed or used product.</li> <li>• <b>Total loss of product (kg)/ kg consumed or used product.</b></li> <li>• Filling degree in % of theoretical available space in the consumer package/retailer package/pallet</li> </ul>
<b>EN 13429</b> Reuse	Gross/net material consumption/kg product
<b>EN 13430</b> Recoverable by material recycling	Gross/net material consumption/kg product
<b>EN 13431</b> Recoverable in the form of energy recovery	Gross/net use of energy <sup>3</sup> /kg product
<b>EN 13432</b> Recoverable through composting and biodegradation	Gross/net material for composting

This work with key figures can be implemented in the work with the CEN standards and it can also be used as input to the Environmental Program to the company. A proposed procedure is illustrated in Figure 2.

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<sup>3</sup> Requires LCA data or data from energy analysis.



**Figure 2** Experience from the CEN-evaluation can be used in the Environmental Program.

## 4 HOW TO CALCULATE KEY FIGURES IN PRACTISE.

What kind of information is needed to calculate key figures?  
And how can the key figures be calculated?

Most of the necessary information needed to calculate the key figures would be available through the work with the self-declaration in accordance with EN 13427.

In this chapter an example of how to calculate the key figures will be given. Figure 3 shows the packaging system for a product called "Good to eat". The consumer packaging is a plastic bag, the retail packaging is a corrugated paper box transported on a Euro pallet with plastic wrapping.

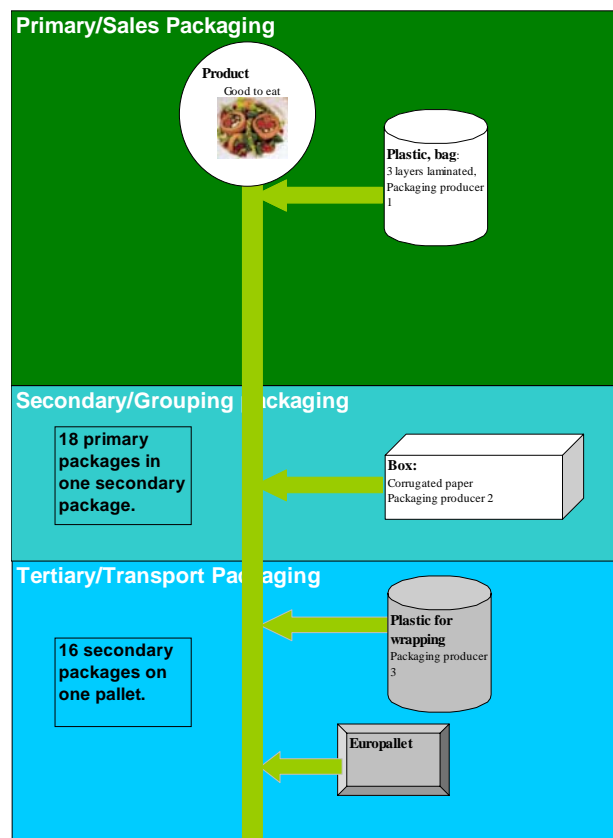


Figure 3 Packaging system for the product "Good to eat".

**In addition to the information, which can be gathered from the data sheet from EN13427-13432, it would be useful to collect the following data:**

- The weight of the product
- The width, height and depth of the packaging
- The number of primary packages in the secondary package
- The number of secondary packages on the pallet

The formulas for the material intensity key figures are as follows:

<b>Expressions</b>	<b>Short form:</b>
Material intensity	MI
Primary packaging	P
Secondary packaging	S
Tertiary packaging	T
Weight of product (kg)	$W_{Prod}$
Weight of primary packaging (kg)	$W_P$
Weight of secondary packaging (kg)	$W_S$
Weight of tertiary packaging (kg)	$W_T$
Number of primary packages in the secondary package	P/S
Number of secondary packages in the tertiary package	S/T

**Material intensity for the primary packaging [kg packaging/kg product]:**

$$I) \quad MI_P = \frac{W_P}{W_{Prod}}$$

**Material intensity for the secondary packaging [kg packaging/kg product]:**

$$II) \quad MI_S = \frac{W_S}{W_{Prod} * P / S}$$

**Material intensity for the tertiary packaging [kg packaging/kg product]:**

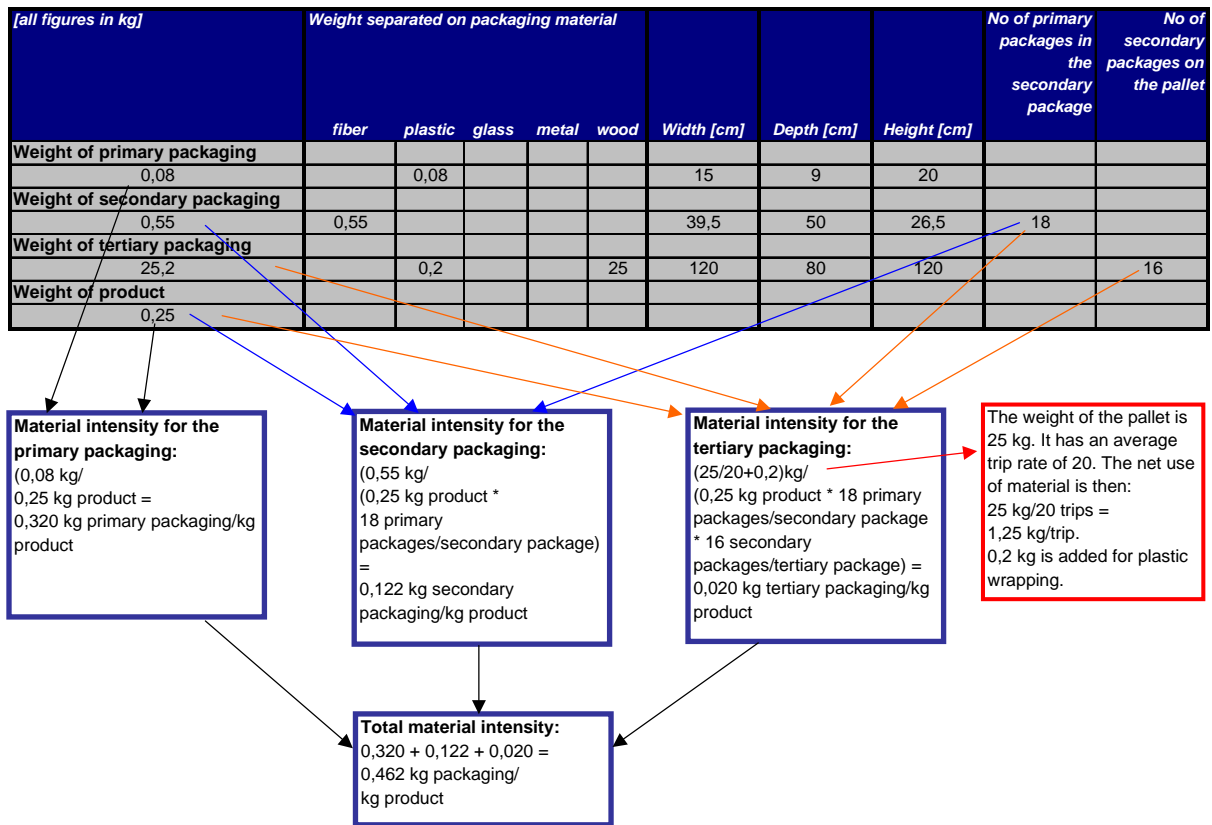
$$III) \quad MI_T = \frac{W_T}{W_{Prod} * P / S * S / T}$$

**Total material intensity for the packaging system [kg packaging/kg product]:**

$$IV) \quad MI_{TOT} = MI_P + MI_S + MI_T$$

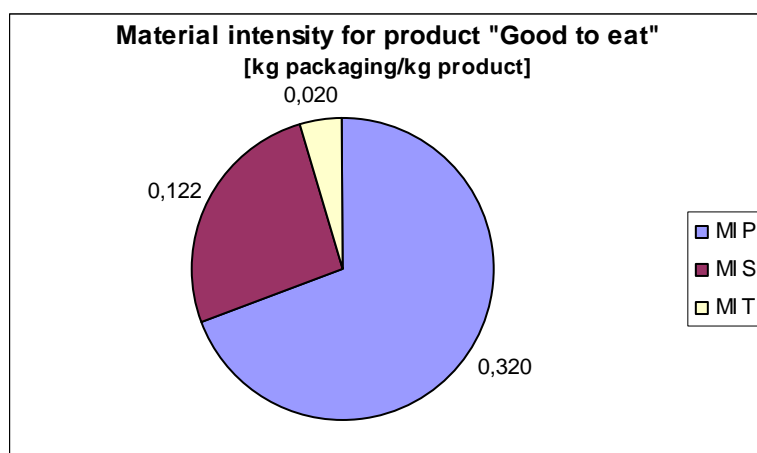
**REUSABLE PACKAGING:**  
 Be aware that reusable packaging is a special case when calculating material intensity. It is important to divide the amount of material with the average trip rate for the packaging in order to find the use of material. For instance Euro-pallet: Average trip rate is 20. The weight of a pallet is 25 kg (varies between 20-25 kg). The material used for each packaging system is:  
 $25 \text{ kg}/20 \text{ trips} = 1,25 \text{ kg/trip}$ .

The formulas I) to IV) are illustrated in the example in Figure 4.



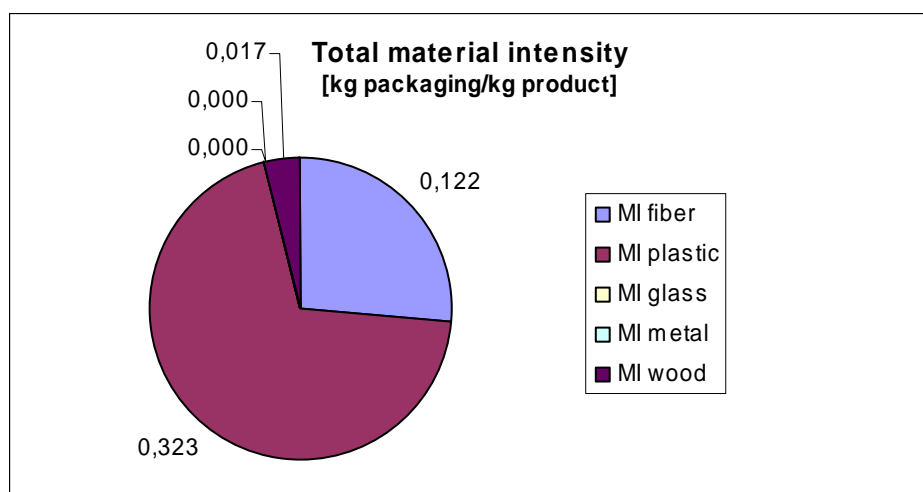
**Figure 4 Calculation of key figures for material intensity.**

The key figures can be presented in a sector diagram to make information more easily understood, see Figure 5.



**Figure 5 Illustration of the material intensity for the primary, secondary and tertiary packaging.**

The formulas I) to IV) can also be used to calculate the material intensity for each packaging material. See Table 3 for the calculated figures and Figure 6 for an example of illustration.



**Figure 6 Total material intensity divided on type of packaging material.**

In addition the net material intensity (which is the amount of material which is not material recovered after use) can be calculated based on data from national statistics on material recovery rates and an evaluation of the possibility to recycle each part of the packaging system. The rates from Norway in 2003 are shown in Table 2 as an example.

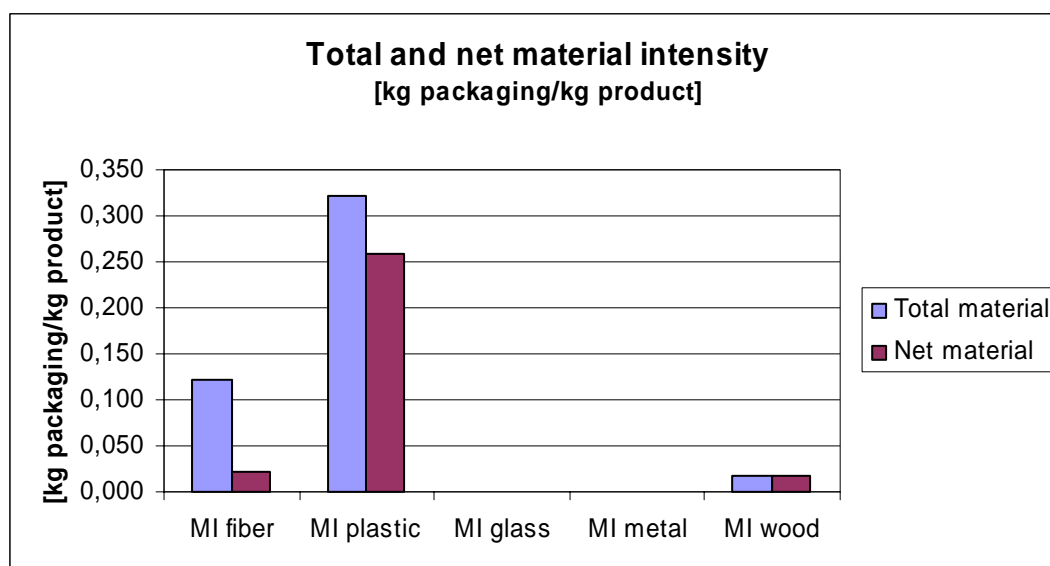
**Table 2** Material recovery rates for Norway, 2003.

<i>Packaging Material</i>	<i>Material Recovery rate 2003</i>
Corrugated paper	83,0 %
Plastic	20,0 %
Metal	61,8 %
Carton	50,3 %
Beverage carton	44,4 %
Glass	91,3 %

In order to calculate the net material intensity, the total material intensity for the primary packaging should be multiplied by the national material recovery rate for each packaging material. Table 3 and Figure 7 shows an example of a total and net material intensity calculation (see Figure 4 for the actual calculation procedure).

**Table 3** Total and net material intensity divided on packaging material.

<i>[kg/kg prod.]</i>	<i>Primary Packaging</i>	<i>Secondary Packaging</i>	<i>Tertiary Packaging</i>	<i>Total material intensity</i>	<i>Net material intensity</i>
<i>MI fiber</i>	0,000	0,122	0,000	0,122	0,021
<i>MI plastic</i>	0,320	0,000	0,003	0,323	0,258
<i>MI glass</i>	0,000	0,000	0,000	0,000	0,000
<i>MI metal</i>	0,000	0,000	0,000	0,000	0,000
<i>MI wood</i>	0,000	0,000	0,017	0,017	0,017
<b>Total</b>	0,320	0,122	0,020	0,462	0,296

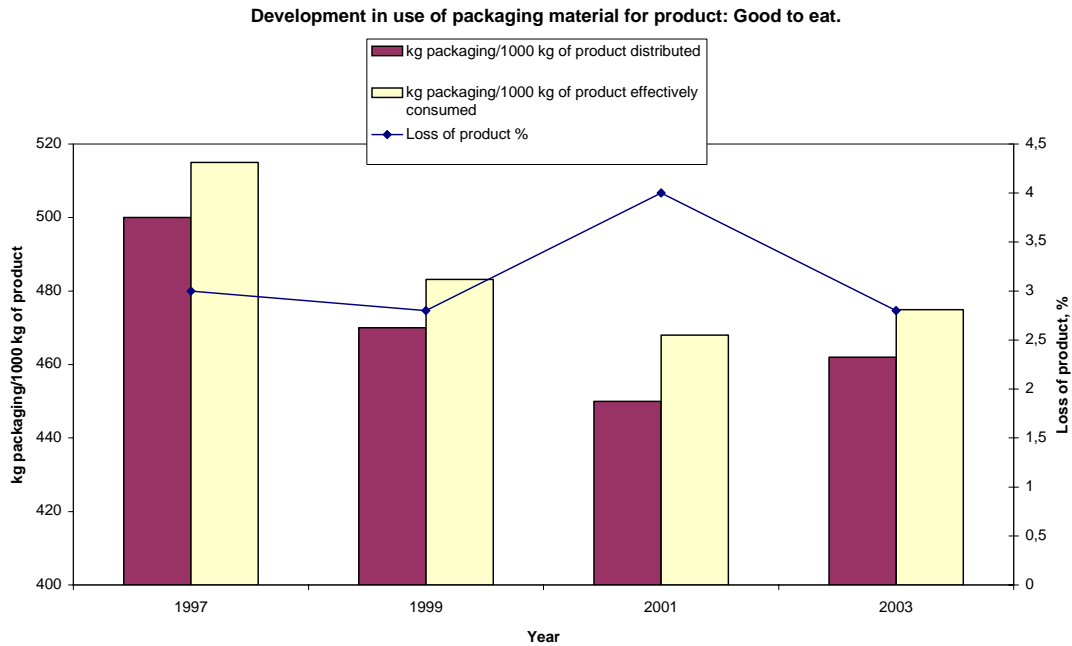


**Figure 7 Total and net material intensity divided by the different types of packaging material.**

#### **COMPARE DIFFERENT SOLUTIONS:**

Key figures can be used to follow changes in use of packaging material for a product from year to year, or to compare new solutions with old solutions in design projects. If there exist data on product loss, this can be valuable in the evaluation of the design changes.

An example is shown in Figure 8. The most important task of the packaging is to protect the product. An increase in loss of product is not environmental beneficial in a value chain perspective.



**Figure 8 Example of development in use of packaging material compared with measurements of product loss.**

#### **DEGREE OF FILLING:**

Calculations of the degree of filling can document how efficient the packaging functions in transport and storing. The theoretical available space in the transport unit should be utilised as much as possible to keep the environmental impact per unit as low as possible. Empty space cost money to transport.

The degree of filling of the primary packaging can be calculated in different ways:

1. The volume of the primary packaging:  $V_{Pr od} = lenght_p * width_p * height_p$  or the specific formula for the shape of the primary packaging (this gives a degree of filling of 100%)
2. If the density is known:  $V_{Pr od} = \frac{mass_{Pr od}}{density_{Pr od}}$
3. The given mass/volume of the product.

The real degree of filling will however often vary from these calculations. The real degree of filling of the primary packaging can be measured by dipping the product in water and measure the volume of water replaced.

The formulas used is as follows:

**Volume of product (e.g. biscuits),  $V_{\text{prod}}$ :**

*Calculated or measured*

**Volume of the primary packaging,  $V_p$ :**

$$V_p = \text{lenght}_p * \text{width}_p * \text{height}_p$$

or the formula for the given shape of the packaging.

**Volume of secondary packaging,  $V_s$ :**

$$V_s = \text{lenght}_s * \text{width}_s * \text{height}_s$$

or the formula for the given shape of the packaging.

**The theoretical available volume of a Euro-pallet (tertiary packaging),  $V_T$ :**

$$V_T = (120\text{cm} * 80\text{cm} * (120\text{cm} - 15\text{cm}))$$

or the formula for the pallet or load carrier used.

**The degree of filling of the primary packaging is calculated as follows,  $DF_P$  [%]:**

$$DF_P = \left( \frac{V_{\text{Prod}}}{V_P} \right) * 100$$

**The degree of filling of the secondary packaging is calculated as follows,  $DF_S$  [%]:**

$$DF_S = \left( \frac{V_P * P/S}{V_S} \right) * 100$$

**The degree of filling of the tertiary packaging is calculated as follows,  $DF_T$  [%]:**

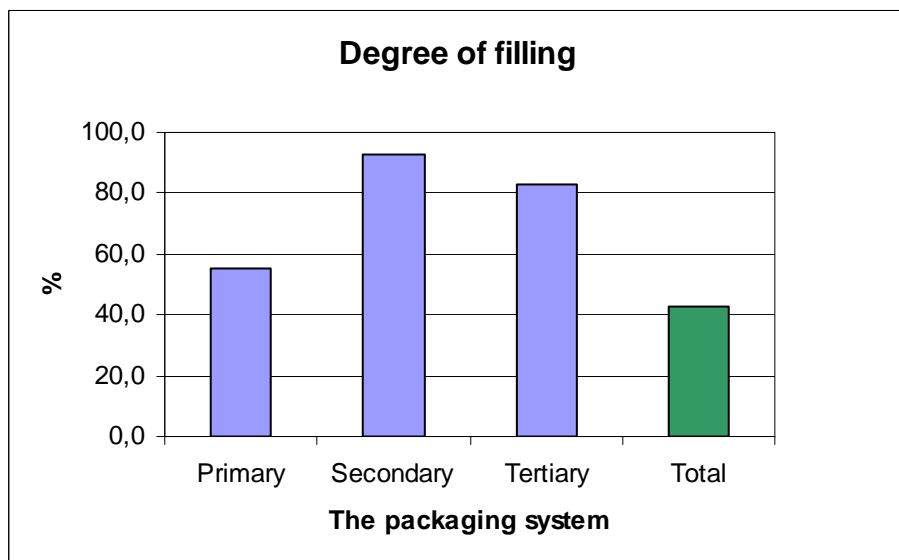
$$DF_T = \left( \frac{V_S * S/T}{V_T} \right) * 100$$

**The total degree of filling for the packaging system is calculated as follows,  $DF_{\text{TOT}}$  [%]:**

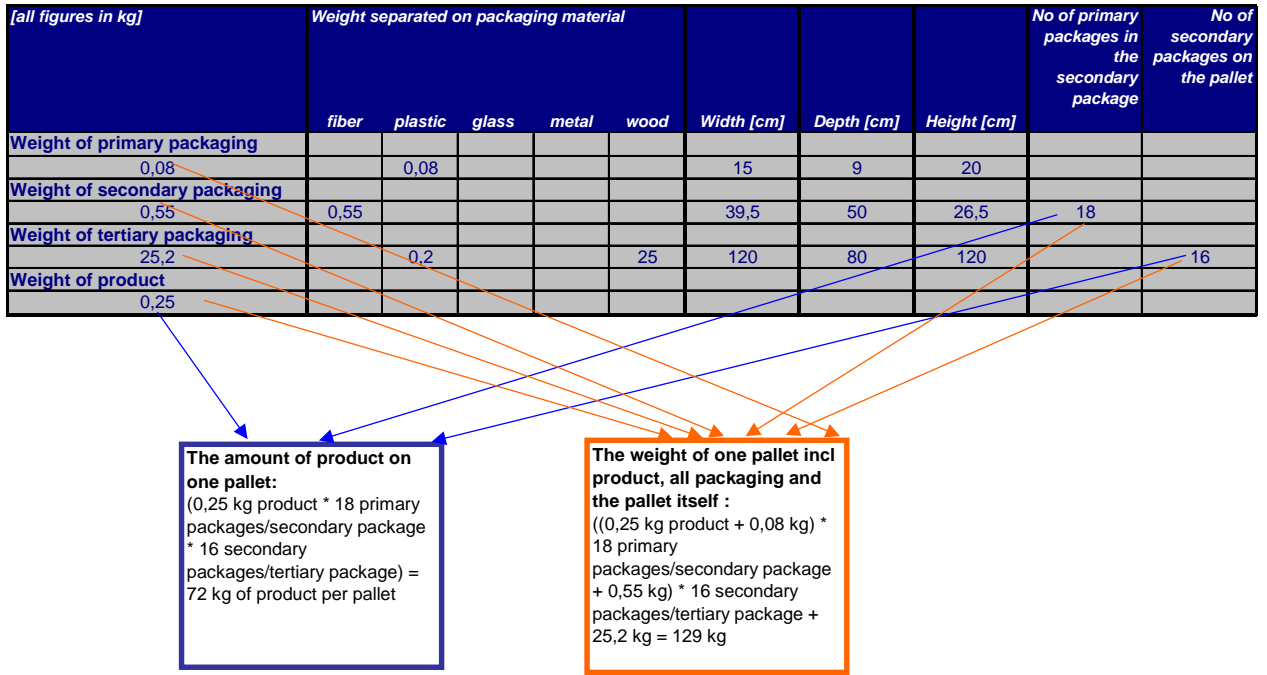
$$DF_{\text{TOT}} = \left( \frac{DF_P}{100} * \frac{DF_S}{100} * \frac{DF_T}{100} \right) * 100$$

**Table 4 Example of a calculation of the degrees of filling.**

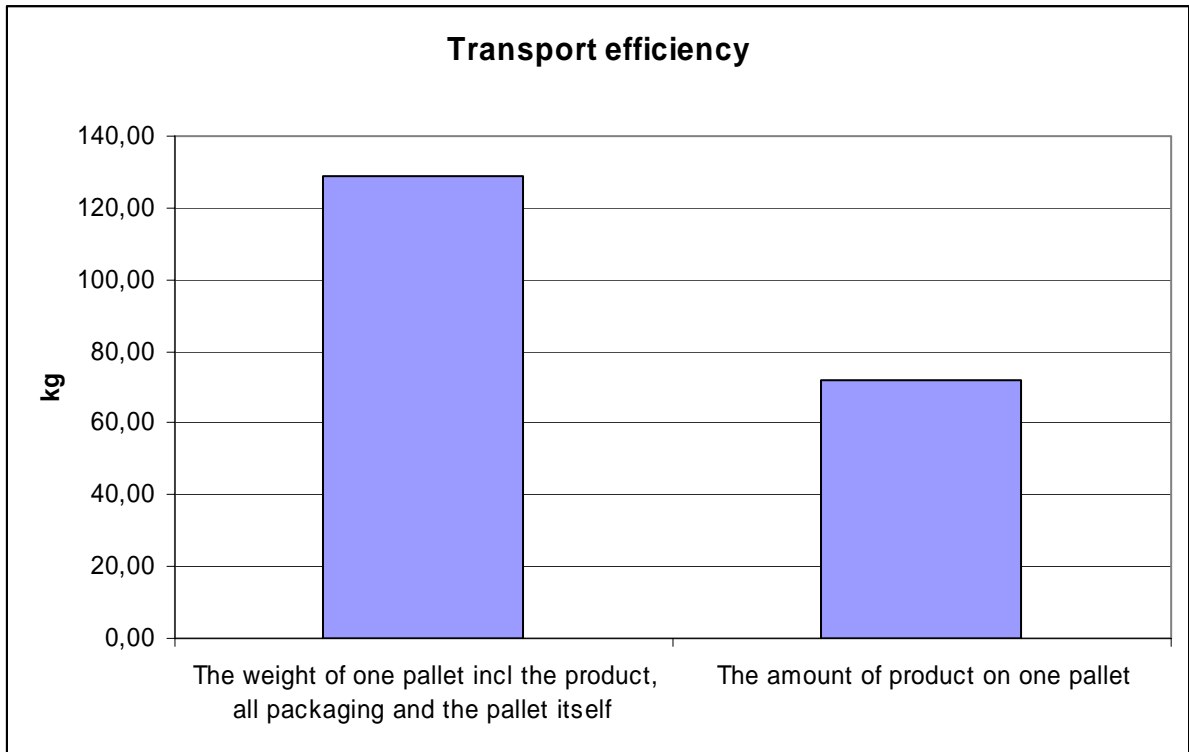
Volume of product	$V_{Prod}$	1500,0	cm <sup>3</sup>
Volume primary packaging	$V_P$	2700	cm <sup>3</sup>
<b>Degree of filling primary packaging</b>	<b><math>DF_P</math></b>	55,6	%
No of primary packaging in secondary packaging	P/S	18	units
Volume secondary packaging	$V_S$	52 338	cm <sup>3</sup>
<b>Degree of filling secondary packaging</b>	<b><math>DF_S</math></b>	92,9	%
Theoretical volume tertiary packaging	$V_T$	1 008 000	cm <sup>3</sup>
No of secondary packaging in tertiary packaging	S/T	16	units
<b>Degree of filling tertiary packaging</b>	<b><math>DF_T</math></b>	83,1	%
<b>Total degree of filling</b>	<b><math>DF_{TOT}</math></b>	42,9	%

**Figure 9 Degree of filling – illustration.****TRANSPORT EFFICIENCY:**

The suggested key figure for transport efficiency can be used to check how much product the different solutions will give on one pallet, and then it can be multiplied with the number of pallets the normal transportation medium can take. This can then be an easy check of the transport efficiency for the selected solution.



**Figure 10 Calculation of transport efficiency**



**Figure 11 Transport efficiency**

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