Nordic Life Cycle Assessment
Wine Package Study

Systembolaget – Vinmonopolet

Performance BIB
Bordeaux – 29th November 2010
1. Context and objectives
2. Methodology
3. Results – Reference scenario
4. Results – Comparative assessment
5. Conclusion
Systembolaget and Vinmonopolet are the Swedish and the Norwegian alcohol retail monopolies
- They sell alcohol in a responsible way, without profit motive
- This includes the environmental impact of the products they sell

Systembolaget and Vinmonopolet decided to assess various wine packaging solutions in order to identify their main impacts on the environment

In addition to Systembolaget and Vinmonopolet, 3 package manufacturers and 1 wine importer participated in the study:
- Package manufacturers: Elopak, Smurfit Kappa Bag-in-Box/Vitop and Tetra Pak
- Wine importer: Oenoforos
The goals of this study are:

- to identify and quantify the environmental impacts of alternative wine packaging solutions
- to identify which stages of the life cycle give rise to the impacts
- to understand the drivers determining the life cycle impacts
- to identify and investigate potential improvement opportunities for each solution
- to carry out a comparative assessment of the packaging systems

In the context of the Nordic market and to the transportation conditions between the winery locations and the packaging locations

The comparative assessment is performed through Life Cycle Assessment (LCA) methodology according to ISO 14040 and ISO 14044

In order to allow communication based on the results of this study, a critical review has been performed by independent experts B Decavael (RDC), JF Patingre (LCA expert), Ann Laurentzon (Innventia AB)
1. Context and objectives
2. Methodology
3. Results – Reference scenario
4. Results – Comparative assessment
5. Conclusion
Five different types of wine packages and sixteen volumes commercialised in Sweden and Norway are considered.

<table>
<thead>
<tr>
<th>PET Bottle 75 cL</th>
<th>Glass bottle 75 cL</th>
<th>Bag in Box 3L</th>
<th>Stand up Pouch 1,5 L</th>
<th>Beverage carton 1 L</th>
</tr>
</thead>
</table>

The most current volumes have been considered as reference scenarios (marked in bold):

- PET bottle: **75 cL** and 37.5 cL
- Glass bottle: **75 cL** and 37.5 cL
- Bag in Box (BiB): 10 L, 5 L, **3 L**, 2 L and 1.5 L
- Stand up Pouch (SuP): 3 L, **1.5 L** and 1 L
- Beverage carton: **1 L**, 75 cL, 50 cL and 25 cL
## Presentation of the Reference Scenarios

<table>
<thead>
<tr>
<th>System</th>
<th>General description</th>
<th>Closure type studied</th>
<th>Tot. Weight including closure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PET bottle 75 cL</strong></td>
<td>The package is blown PET (Polyethylene terephthalate — a thermoplastic polymer resin of the polyester family) with a plastic screw cap closure and paper labels. Various oxygen barrier enhancements can be used to extend product shelf life.</td>
<td>LDPE screw cap</td>
<td>54.4 g</td>
</tr>
<tr>
<td><strong>GLass bottle 75 cL</strong></td>
<td>Raw materials (primarily silica) are melted and formed into glass wine bottles. Paper labels are glued on the bottle or are self-adhesive. A closure (made out of natural cork, plastic or aluminum) is added to the package.</td>
<td>Aluminium screw cap</td>
<td>479.5 g</td>
</tr>
<tr>
<td><strong>Bag in Box 3 L</strong></td>
<td>A flexible plastic bag (composed of an outer barrier film and an inner polyethylene film, equipped with a tap for pouring) placed in a cardboard box. The outer barrier film contains either a thin layer of EVOH or aluminum to protect the wine against oxygen.</td>
<td>Tap and gland</td>
<td>179 g</td>
</tr>
<tr>
<td><strong>Stand up Pouch 1.5 L</strong></td>
<td>A sealed plastic bag that is designed to stand upright and made of a multilayer laminate film with a layer of aluminium foil to protect against oxygen. A tap is fitted to the pouch.</td>
<td>Tap and gland</td>
<td>34.8 g</td>
</tr>
<tr>
<td><strong>Beverage carton 1 L</strong></td>
<td>The beverage cartons analyzed in this study are primarily made of paperboard laminated with a thin aluminum foil and polymer layers. The aluminum foil functions as an oxygen barrier. There are different shapes of beverage cartons and various closures can be applied to the carton.</td>
<td>Top: a base with neck and separable lid</td>
<td>38.1 g</td>
</tr>
</tbody>
</table>
General overview of the LCA methodology

- Life Cycle Assessment (LCA) methodology is standardised at the international level through ISO 14 044 to quantify the environmental impacts of a service or product throughout its life.

- LCA is:
  - A multi–step approach: Each step of the life cycle is taken into account.
  - A multi–criterion approach: The results of the study are presented through several environmental impacts (global warming, air acidification, water eutrophication, ...)

- LCA provides an exhaustive assessment of the environmental issues of a service or a product.

![Diagram of Life Cycle Assessment](image-url)
The Functional Unit must allow quantifying the service given by the packaging, which is its practical value.

The functional unit chosen is:

“Packaging and distribution of 1000 litres of wine”
The life cycle includes the following steps:

- Extraction of raw materials and manufacturing of materials used in the composition of each packaging level: primary (body & closure), secondary, tertiary

- Filling and packaging of beverages

- End-of-life of the various types of packaging (primary, secondary, tertiary) by retailer and consumer including benefits from recycling and energy recovery

- Transportations between each of these life-cycle steps
The study of the environmental impacts has been carried out using the CML life cycle impact assessment method (Institute of Environmental Sciences, Leiden University, NL).

<table>
<thead>
<tr>
<th>Impact category</th>
<th>Unit</th>
<th>Reliability</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abiotic resources depletion potential</td>
<td>kg Sb eq</td>
<td>++</td>
<td>CML 2001 (ADP)</td>
</tr>
<tr>
<td>Global warming potential</td>
<td>kg CO₂ eq</td>
<td>+++</td>
<td>IPCC 2007</td>
</tr>
<tr>
<td>Ozone layer depletion potential</td>
<td>kg CFC-11 eq</td>
<td>+</td>
<td>CML 2001 (ODP)</td>
</tr>
<tr>
<td>Photochemical oxidation potential</td>
<td>kg C₂H₄ eq</td>
<td>+</td>
<td>CML 2001 (POCP)</td>
</tr>
<tr>
<td>Air acidification potential</td>
<td>kg SO₂ eq</td>
<td>++</td>
<td>CML 2001 (AP)</td>
</tr>
<tr>
<td>Eutrophication potential</td>
<td>kg PO₄³⁻ eq</td>
<td>++</td>
<td>CML 2001 (EP)</td>
</tr>
<tr>
<td>Human toxicity potential</td>
<td>kg 1,4-DB eq</td>
<td>???</td>
<td>CML 2001 (EP)</td>
</tr>
<tr>
<td>Freshwater aquatic ecotoxicity potential</td>
<td>kg 1,4-DB eq</td>
<td>???</td>
<td>CML 2001 (USES-LCA-100 years)</td>
</tr>
<tr>
<td>Sedimental ecotoxicity potential</td>
<td>kg 1,4-DB eq</td>
<td>???</td>
<td></td>
</tr>
<tr>
<td>Terrestrial ecotoxicity potential</td>
<td>kg 1,4-DB eq</td>
<td>???</td>
<td></td>
</tr>
<tr>
<td>Water consumption*</td>
<td>m³</td>
<td>+</td>
<td>Ecoinvent, Cumulative water consumption</td>
</tr>
<tr>
<td>Primary energy*</td>
<td>MJ primary</td>
<td>++</td>
<td>Ecoinvent, Cumulative Energy demand</td>
</tr>
</tbody>
</table>

*Inventory indicators
Sources of data

- Package weights were selected to represent the Nordic situation
- Glass system mostly based on secondary data: glass manufacturers solicited chose not to participate

<table>
<thead>
<tr>
<th>Primary packages</th>
<th>Country</th>
<th>Filling stage, 2ndary and 3ary packaging</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass bottle</td>
<td>EU</td>
<td>Jeanjean</td>
<td>Fr</td>
</tr>
<tr>
<td>Systembolaget (bottle weight) Bibliographic data</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PET Bottle</td>
<td>Fr</td>
<td>Manufacturers of equipment for PET bottles production</td>
<td>Fr</td>
</tr>
<tr>
<td>Bag in Box</td>
<td>Fr</td>
<td>Jeanjean</td>
<td>Fr</td>
</tr>
<tr>
<td>Smurfit Kappa Bag in Box, Vitop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stand up pouch</td>
<td>Fr</td>
<td>Jeanjean</td>
<td>Fr</td>
</tr>
<tr>
<td>Smurfit Kappa Bag in Box, Vitop</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beverage carton</td>
<td>Norway</td>
<td>Elopak</td>
<td>Norway</td>
</tr>
<tr>
<td>Tetra Pak</td>
<td>Sweden</td>
<td>Tetra Pak</td>
<td>Sweden</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sources of data

Distribution and end-of-life routes

- All systems have been considered to be transported from the producer factory to the South of France to be filled
- A common distribution hub hypothetically located in Arvika (Värmland County, Sweden) was considered
- End-of-life routes for packages after consumer use in Sweden and Norway have been taken from national statistics and adapted when necessary
- Systembolaget and Vinmonopolet have provided data about end-of-life of secondary and tertiary packaging for their respective retailers network

Data from life cycle inventories

- Specific life cycle inventories from international federations have been used (EAA, PlasticsEurope)
- For other data, the inventory of flows was mainly carried out with the Ecoinvent v2.0 database
- WISARD 4.2 has been used to complete missing LCI
Recycling provides two environmental benefits:
1. Recycling avoids a conventional disposal route such as landfilling or incineration;
2. Recycling avoids the need to extract virgin materials.

These benefits occur at the interface of an upstream system — the one providing recycled materials — and a downstream system — the one using recycled material —. Both systems are essential and some rules are therefore needed to allocate these benefits.

Allocation procedures factors have been chosen considering the recycling market in order to stimulate it:
- For aluminium, glass, cardboard/paper and bottle grade PET for which the demand of recycled material is high, it is important to stimulate the recycling rate, hence the benefits are given to the orientation to recycling.
- For other plastics and non bottle PET, both the use of recycling material and the orientation to recycling needs to be encouraged.

This set of rules is consistent with latest recommendations from the French ADEME/AFNOR platform on environmental labelling.
Limitations for glass system

- The bottle formation process from fusion glass is not included

Other limitations – steps neglected

- Operations of research and development that have permitted the creation of the current wine packages
- Transport of finished goods between the retail outlet and the consumption place
- Consumption of energy to store the finished goods in the outlet or at the consumer’s place
- Cleaning products used at production sites
- Glues used to stick labels, inks used for advertising on labels and packaging systems,
- 2ndary and 3rdary packaging systems used to transport raw materials

The production of the wine has been excluded

- It does not offer differentiation between the different systems due to a lack of reliable data.
- For the end-of-life of the systems, no remnants have been considered inside the packages
1. Context and objectives

2. Methodology

3. Results – Reference scenario

4. Results – Comparative assessment

5. Conclusion
Most of the environmental impacts of the PET system are explained by the impacts associated with the production of the raw materials, be it for primary or secondary packaging.

- The production of the packaging itself is the main contributor for all environmental indicators considered except water consumption.
- Filling is the largest contributor for water consumption and other indicators (the impacts of this stage are mostly due to secondary packaging and not to the filling and conditioning processes themselves).
- Recycling and energy recovery provide environmental benefits on all indicators.
Most of the environmental impacts of the glass system are explained by the impacts associated with the production of the raw materials, be it for primary or secondary packaging.

- The production of the packaging itself is the main contributor for all indicators. Filling has a moderate impact (all indicators under 27%) for both systems. (most of the impacts of this phase are due to secondary packaging or primary packaging supply and not the filling and conditioning processes)
- Distribution appears as a moderate contributor (all indicators under 29%) for both systems
- Important benefits are observed in the end-of-life phase thanks to recycling (post consumer waste)
Most of the environmental impacts of the BiB system itself are explained by the impacts associated with the production of the raw materials, and particularly from the production of cardboard, be it for primary or secondary packaging.

- Packaging production is always the most impacting life cycle stage for all environmental indicators.
- Filling has a significant impact (more than 35%) in terms of water consumption and primary energy for both systems (most of the impacts of this phase are due to secondary packaging).
- Overall, distribution appears as a moderate contributor with all indicators having a contribution below 21%.
Most of the environmental impacts of the pouch system itself are explained by the impacts associated with the production of the raw materials, be it for primary or secondary packaging.

The distribution of the environmental impacts over the life cycle of the SuP shows a balanced profile between each life cycle stage and the most contributing stage depends on the environmental indicator considered.

The production of the raw materials entering in the composition of the SuP is the most impacting stage for several indicators.

Filling and more specifically the production and supply of secondary packaging is the most impacting stage for terrestrial ecotoxicity and eutrophication indicators.
Most of the environmental impacts of the carton system itself are explained by the impacts associated with the production of the raw materials, be it for primary or secondary packaging.

- Packaging production is the most impacting life cycle stage for all environmental indicators apart from terrestrial ecotoxicity where the filling stage is more impacting due to secondary packaging.
- Filling has a significant impact for several indicators. It is the most impacting stage in terms of terrestrial ecotoxicity. Most of the impacts of this phase are due to secondary packaging production.
- Distribution appears as a moderate contributor with all indicators having a contribution below 23%.
1. Context and objectives
2. Methodology
3. Results – Reference scenario
4. Results – Comparative assessment
5. Conclusion
Comparative assessment

 Formats being compared

<table>
<thead>
<tr>
<th>Volume (CL)</th>
<th>Total weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PET Bottle 75 cl</td>
<td>75</td>
</tr>
<tr>
<td>PET Bottle 37.5 cl</td>
<td>37.5</td>
</tr>
<tr>
<td>Glass bottle 75 cl</td>
<td>75</td>
</tr>
<tr>
<td>Glass bottle 37.5 cl</td>
<td>37.5</td>
</tr>
<tr>
<td>BiB 1.5 L</td>
<td>150</td>
</tr>
<tr>
<td>BiB 2 L</td>
<td>200</td>
</tr>
<tr>
<td>BiB 3 L</td>
<td>300</td>
</tr>
<tr>
<td>BiB 5 L</td>
<td>500</td>
</tr>
<tr>
<td>BiB 10 L</td>
<td>1000</td>
</tr>
<tr>
<td>SuP 3 L</td>
<td>300</td>
</tr>
<tr>
<td>SuP 1.5 L</td>
<td>150</td>
</tr>
<tr>
<td>SuP 1 L</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>System</th>
<th>Bev. carton 1 L</th>
<th>Bev. carton 75 cl</th>
<th>Bev. carton 50 cl</th>
<th>Bev. carton 25 cl*</th>
</tr>
</thead>
<tbody>
<tr>
<td>System 1</td>
<td>100</td>
<td>39.6</td>
<td>36.6</td>
<td>38.1</td>
</tr>
<tr>
<td>System 2</td>
<td>75</td>
<td>33.2</td>
<td>31.5</td>
<td>32.3</td>
</tr>
<tr>
<td>Averaged total</td>
<td>50</td>
<td>22.7</td>
<td>23.8</td>
<td>23.2</td>
</tr>
</tbody>
</table>

*25 cl beverage carton has no closure in system 1 and has one in system 2.
Comparative assessment

Preamble

- The comparative analysis of the five packaging systems is focused on three impact assessment and two life cycle inventory indicators:
  - Global warming potential; Abiotic depletion; Air acidification
  - Water consumption; Primary energy

- These indicators have been selected for the following reasons:
  - Apart for water consumption, they are among the most robust and consensual indicators in LCA;
  - These indicators are the most significant for all packaging following the normalisation procedure
Comparative assessment

Results presentation
- The baseline results are presented hereafter in several bar diagrams
- The reference scenarios are identified with black frames
- Each bar shows an uncertainty

Uncertainty analysis
- The uncertainty that is presented focuses on:
  - Uncertainty associated with the raw data
  - Uncertainty associated with transportation scenario

- For each packaging systems, the uncertainty intervals presented in the graphs are based on theoretical best case / worst case scenarios
Within a same packaging system, products with larger capacity have a tendency to show lesser impacts.

The 25 cl beverage carton without cap is an exception. Indeed, since most of the impacts are due to primary material production, the beverage carton without cap performs better as it is lighter.

The packaging systems in Norway and Sweden show similar trends.
Note that for this indicator, results show less variability across the different capacity of a similar packaging system.

General trend observed for global warming is still valid but the relative differences are particularly low and conclusions should be made with caution.
In terms of water consumption, the relative performance across the different packaging systems is identical in Norway and in Sweden.

A general comment regarding this indicator is that the relative performances of the packaging systems are tightly linked with the water requirements of cardboard production.

---

**Comparison of packaging systems in terms of water consumption (m3/FU)**

**FU: 1000l, Sweden**

- **Glass:**
  - 37.5cl: 10.1
  - 75cl: 7.7

- **BiB:**
  - 25d no cap: 2.8
  - 25d cap: 2.6

- **SuP:**
  - 50cl: 1.5
  - 75cl: 1.3

- **PET:**
  - 2l: 2.2
  - 3l: 1.5

- **Beverage Carton:**
  - 3l: 2.3
  - 5l: 1.5

- **November 2010**

---

Nordic LCA
In terms of abiotic depletion, the relative performance of the packaging systems is identical in Sweden and in Norway.

The Bag in Box and the SuP systems have close performance as it can be seen on the 3 L format where the uncertainties are overlapping.

PET bottles are more impacting than the beverage carton as it can be observed for the 75 cl format where the difference of respective performances is higher than the uncertainty.

### Comparison of packaging systems in terms of abiotic depletion (kg Sb/FU)

**FU: 1000l, Sweden**
In both countries, the energy consumption of the 1 L beverage carton is lower than the 1.5 L BiB and the 1 L SuP, reduced primary and secondary packaging materials for the beverage carton explains this performance.

![Comparison of packaging systems in terms of primary energy (MJ/FU)](chart)

While in Sweden, the 3 L BiB is more impacting than the 3 L SuP by 11%, the difference in Norway is only 3%. The difference in waste management explains this difference, indeed SuP tend to be more incinerated with energy recovery in Sweden whereas landfilling is a more common practice in Norway.
Normalisation of LCA results by main stages

- To facilitate the understanding, the environmental impacts are compared to the contribution of an “average” inhabitant to the environmental impact indicator over one year.

- This value (inhabitant-equivalent) is obtained by dividing the total quantity generated for a given indicator by the European Union-25+3 during 1 year by the number of inhabitants of the EU-25+3 (for the year under review).

- The next charts are normalised results for the reference volumes of the partners’ systems.

- Packaging production and waste management stages have been combined for readability reasons (waste management stage can be negative because of environmental credits).
Normalisation of LCA results by main stages

How to interpret these figures?
If one takes the example of the impact of abiotic depletion: the impacts of 100 functional units (i.e. packaging and distribution of 100 000 litres of wine) with beverage cartons of 1l are equivalent to the total impacts on abiotic depletion of about 2.5 European inhabitants over 1 year.
1. Context and objectives

2. Methodology

3. Results – Reference scenario

4. Results – Comparative assessment

5. Conclusion
As a general rule, when comparing a set of different capacities of the same packaging, larger volumes are associated with smaller environmental impacts.

- This rule can however be challenged if a specific format comes with different characteristics (no closure for instance) or if secondary packaging and palletisation vary significantly among the different formats.

- Wine lost during distribution or because of incomplete consumption by consumers should be taken into consideration when optimising the environmental performance of the package.
  - For instance, in terms of global warming potential, wine may possibly represent 30 to 80% of the impact of the “wine + package” system.
  - Wine could also have important impacts on other indicators.

As a conclusion:

Maximising packaging capacity (with respect to demand and consumer practices) is a key target, provided that other parameters do not vary.
Reducing material consumption is among the most effective ways.
Minimizing wine losses should be a key objective.
The distribution phase from the filling station to the distribution hub is a key step of the environmental profile of all packaging systems.

- **Optimising supply and distribution** routes and truck loads are efficient ways to improve the environmental profile of packaging.

- Optimising palletisation can have significant impacts on the performance of packaging.
  - This should however not compete with increasing break rates during transportation.
  - Additional studies on loss rates and wine impacts would however be needed in order to determine break-even points.
Optimising waste management

- **Encouraging consumers to properly dispose of their packaging** is the most powerful leverage point in terms of waste management
  - For plastics and glass, increasing recycling rate is an effective option to reduce the environmental footprint of packaging.
  - Incineration with energy recovery can also be an effective disposal route for some materials, particularly for paper based products.
  - Landfilling is clearly the less desirable option

- Note that the benefits associated with recycling are highly dependent on local conditions, assumptions and methodology
  - This is particularly true for paper based products for which no clear and absolute picture can be drawn

- As a conclusion:
  - **Waste management of post-consumer waste is the most powerful leverage**, hence implying that producers, waste collections services and consumers have an important role to play. Raising consumer awareness is therefore crucial
  - In terms of disposal routes, there are clear environmental benefits for recycling glass, and plastics packaging. For cardboard products, results are highly dependent on LCA methodology and additional studies could cast a different light on the environmental benefits of recycling
Glass in comparative assessment

- The data used for the glass bottle system was the very best available at the time the study was completed.

- As for all of the other package types, newer data could potentially change environmental impact performance.

- Had newer data been used for the glass production process in the Nordic LCA, this would not have changed package weights or filling, distribution and end-of-life stages but only influenced the relative contribution of the primary package production.

- Even allowing for the possibility that newer glass production data would have lowered the environmental impact of the primary production of glass (not yet demonstrated), uncertainty analysis that has been performed on every system and the additional sensitivity analysis on glass potential improvement show that glass seems to be the most impacting system for all the indicators studied in the comparative analysis.
Comparative assessment of packaging systems

Main conclusions of the comparative assessment

- The relative performances of the packaging systems depend on the indicators and formats that are considered. Nevertheless, comparisons made within a same packaging system show as a general rule that larger formats are associated with fewer impacts.

- This rule is not respected by the 25 cL beverage carton without a cap due to reduced materials.

- The important number of packaging formats under study renders difficult a direct comparison across the packaging types but overall it would appear as though BiBs, SuPs and beverage cartons offer lower environmental impact alternatives compared to glass bottles. PET bottles are somehow in between glass and other packaging systems.
Conclusions by format ranges

For very large formats (>1.5 L)
- Considering the 3 L format, the Stand up Pouch and the Bag in Box have very close impacts for all indicators and they cannot be differentiated considering the intrinsic uncertainties of the environmental indicators

For large formats (1 L-1.5 L)
- The 1.5 L SuP is in between the 1.5 L Bag in Box and the 1 L beverage carton for all indicators apart for water consumption where, the SuP tends to perform better than the other packaging materials. For the one litre format, the beverage carton appears as the least impacting system, performing better than the 1.5 L BiB and the 1 L SuP, on most indicators

For medium formats (75 cl)
- The 75 cl beverage carton appears as the least impacting format for all indicators but water consumption where the PET bottle is the least impacting. The 75 cl PET bottle is close to the 1 L SuP in terms of global warming potential, acidification, abiotic depletion and primary energy consumption

For small formats (<75 cl)
- For small format, the 25 cl beverage carton without a cap is the least impacting packaging for all indicators but water consumption, for which the 37.5 cl PET bottle performs better
Comparison of packaging systems in terms of global warming potential (kg CO2 eq/FU)

FU: 1000l, Sweden
Comparison of packaging systems in terms of global warming potential (kg CO2 eq/FU)
FU: 1000l, Norway
Comparison of packaging systems in terms of air acidification (kg SO2 eq/FU)

FU: 1000l, Norway

<table>
<thead>
<tr>
<th>Packaging Type</th>
<th>37.5cl</th>
<th>75cl</th>
<th>1.5L</th>
<th>2l</th>
<th>3L</th>
<th>5L</th>
<th>10l</th>
<th>1L</th>
<th>1.5L</th>
<th>3L</th>
<th>37.5cl</th>
<th>75cl</th>
<th>25cl no cap</th>
<th>25cl cap</th>
<th>50cl</th>
<th>75cl</th>
<th>1L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass</td>
<td>0.79</td>
<td>0.61</td>
<td>0.50</td>
<td>0.35</td>
<td>0.35</td>
<td>0.78</td>
<td>0.55</td>
<td>0.47</td>
<td>1.2</td>
<td>0.96</td>
<td>0.49</td>
<td>0.87</td>
<td>0.68</td>
<td>0.59</td>
<td>0.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BiB</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SuP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PET</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beverage Carton</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Comparison of packaging systems in terms of water consumption (m3/FU)

FU: 1000l, Norway
Comparison of packaging systems in terms of abiotic depletion (kg Sb/FU)

FU: 1000l, Norway

<table>
<thead>
<tr>
<th>Package Type</th>
<th>37.5cl</th>
<th>75cl</th>
<th>1.5L</th>
<th>2L</th>
<th>3L</th>
<th>5L</th>
<th>10L</th>
<th>1L</th>
<th>1.5L</th>
<th>3L</th>
<th>37.5cl</th>
<th>75cl</th>
<th>25cl no cap</th>
<th>25cl cap</th>
<th>50cl</th>
<th>75cl</th>
<th>1L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass</td>
<td>6.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4.55</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BiB</td>
<td>1.8</td>
<td>1.4</td>
<td>1.1</td>
<td>0.78</td>
<td>0.76</td>
<td>1.8</td>
<td>1.2</td>
<td>1.1</td>
<td>2.2</td>
<td>1.8</td>
<td>0.79</td>
<td>1.8</td>
<td>0.93</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SuP</td>
<td>1.8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PET</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beverage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.93</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Nordic LCA November 2010
Comparison of packaging systems in terms of primary energy (MJ/FU)

FU: 1000l, Norway

- **Glass**: 15577, 11646
- **BiB**: 5074, 3892
- **SuP**: 3054, 2146
- **PET**: 4997, 3518
- **Beverage Carton**: 6361, 4885
- **25cl no cap**: 3065
- **25cl cap**: 3940
- **50cl**: 3480
- **75cl**: 2961

**Notes**: The data is presented in MJ/FU for each packaging system. The values indicate the primary energy consumption for various container sizes and types.
Normalisation of LCA results by main stages

Comparison of packaging systems – Normalisation of LCA results by main stages
FU: 1000 l, Norway

How to interpret these figures?
If one takes the example of the impact of abiotic depletion: the impacts of 100 functional units (i.e. packaging and distribution of 100 000 litres of wine) with beverage cartons of 1l are equivalent to the total impacts on abiotic depletion of about 2.5 European inhabitants over 1 year.
Estimation of environmental improvements in the production of glass in terms of global warming potential in Sweden

Comparison of packaging systems in terms of global warming potential (kg CO2 eq/FU)
FU: 1000l, Sweden