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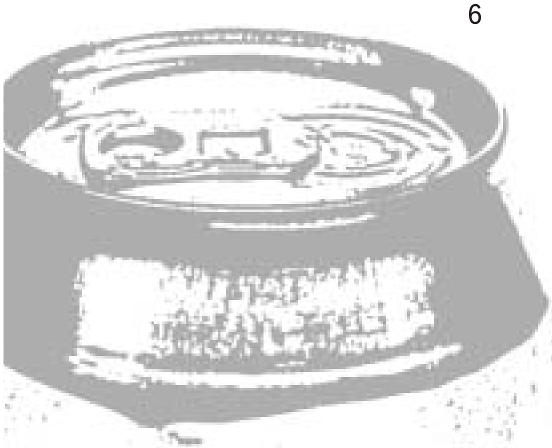
The Aluminium Drinks Can

Results of the EMPA Sustainability Study

Commissioned by IGORA, Zurich

Contents



This brochure is a synopsis of a study produced by the S-E-E.ch® consortium.
The study is available for inspection at IGORA Switzerland.
The S-E-E.ch® consortium, made up of the EMPA (St. Gallen), Carbotech AG (Basle) and IBF AG (St.Gallen), was founded for the purpose of carrying out the study.

The authors would like to thank IGORA for the constructive nature of the collaboration and their willingness to subject the recycling system to an S-E-E.ch® study, thus permitting an examination of its contribution to sustained development in Switzerland. Their decision to make the results a subject of public debate merits particular attention, as with this study it was possible for the first time ever to demonstrate the groundbreaking method of operation of the S-E-E.ch® tool in practice on a larger scale.

In the main the study uses information made available to the authors by IGORA. Where possible, the plausibility of this information was checked in mathematical terms and by independent research.

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Credits

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Summary of the results of the EMPA sustainability study

The study looks at the degree to which the aluminium drinks can contributes to sustainable development (SD) in Switzerland. This is not merely an academic question, as sustainability is considered an essential factor for the long-term market success of the aluminium drinks can. After detailed discussions with independent experts (members of the 'advisory board'), the authors of the study were able to convert the value-oriented Brundtland definition of sustainable development into an operationalised definition. To this end they defined a number of primary and secondary indicators embracing all three dimensions of sustainable development (economic, environmental and social). This framework then supplied answers, in the form of objective facts and figures, to eight key questions. With these answers it is possible to obtain concrete management information from what was formerly an abstract concept of sustainability. The data collected for the previous decade (1990–2000) is factual; the statements made for the present decade are forecasts based on projected trends.

The results of the study provide the aluminium drinks with a good reference. If we look at the reasons for this positive analysis, then the following becomes clear:

- Recycling is the key factor. Actual consumer behaviour corresponds to a large degree to the recommendations that IGORA has been putting forward for many years. The success achieved by 'recycling providers' with their information campaigns is reflected in the recycling rate of 91%, an exceptionally high figure.

- The aluminium industry has recognised its environmental responsibility and as a result has invested huge sums in environmental protection over many years.

- The packaging industry has significantly improved its products in ecological terms; as far as the drinks can is concerned, for example, it has reduced the aluminium requirement by more than 25% (with no associated loss in packaging performance).
  The three aforementioned measures have led to a virtual fourfold reduction in environmental performance.

- Viewed over the entire life cycle, there is balanced participation of all partners in the value-added process, which means that the value chain can be said to exhibit economic fairness.

- Value added is also created in the social dimension; this can be seen most clearly in the remarkably high contribution to the maintenance of education institutions at all levels in Switzerland. This contribution is rendered in the form of substantial fiscal revenues that on a pro-rata basis help to maintain society's learning capability.

Finally, the study also takes a look at the period 2000-2010. It does this with the aid of scenario-bakked hypotheses with respect to economic, environmental and social development trends.

Special software, i.e. the S-E-E.ch® tool (developed by the Basle-based company Carbotech AG and IBF AG of St. Gallen), was employed during the study. The use of this systemic approach permitted the generation and processing of a wealth of new data as well as the transparent and comprehensible representation of the multifarious interactions and a scenario-based assessment.

The main conclusion drawn by IGORA, who commissioned the study, is that we must do everything in our power to ensure that the current recycling rate of 91% is maintained.

1

Method and approach

Sustainable development and sustainability are almost synonymous terms, and in this sense an orientation towards long-term development is the aim of every company and every society. Yet in the modern economy short-term success is often valued more highly than long-term objectives such as these. The best-known definition of sustainable development was provided in 1987 by the Norwegian prime minister Gro Harlem Brundtland in a UN commission report and formed the basis for the international conference in Rio on the subject of sustainability:

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (Brundtland Report, 1987)

1.1 Concept of sustainable development

The objective of long-term market survival pursued by every company demands economic success, minimum environmental impacts, and benefits in the social sphere, be this in respect of the workforce or society itself, which in the form of the national economy is the basis of all economic activity. This view makes allowance for the change in perspective from shareholder value to stakeholder value by taking into account different aspiration groups and their varying needs and requirements.
In practice the three dimensions of sustainable development are said to be economic, environmental and social, an approach adopted in this study.
Systems of indicators are used to quantify the extent of sustainable development. These are variables that describe the effects of the system under consideration with respect to the three dimensions.
To avoid re-inventing the wheel and to make use of existing experience, reference was made to existing systems of evaluation as far as possible. Accounting systems and the financial indicators derived from them were used to measure the wealth of companies. When it comes to evaluating the life cycle of products, life cycle analysis, which thanks to the ISO 14040 series of standards exhibits a clearly structured approach and a high level of acceptance, is the most suitable tool.
The complex interrelationships were identified and analysed using a new method known as S-E-E® analysis, which in terms of approach is based on the ISO 14040 series of standards.
In this project the approach adopted and assumptions made were reviewed by an advisory board.

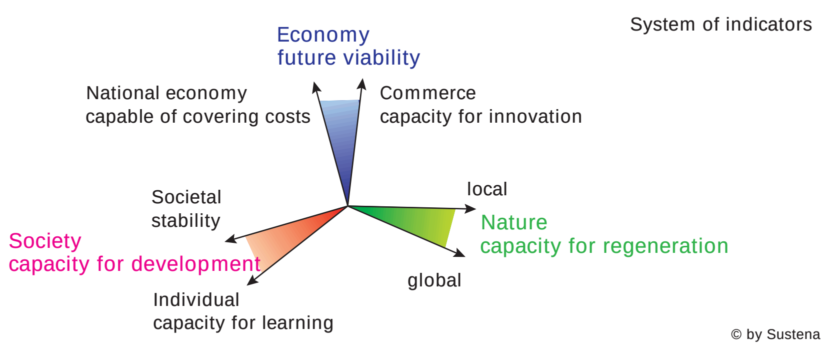
1.2 Study tool (S-E-E.ch®-tool)

Powerful tools were needed to process the large quantities of data involved and the associated links. A number of separately deployable tools already exist for assessing individual aspects of sustainability. But a methodically consistent approach permitting a global assessment and satisfying the above criteria had previously not existed. The S-E-E.ch® tool, which allows the global, operationalised linking of economic, environmental and social aspects, was developed to fill this gap. A particular strength of this instrument is that it permits the dynamic computation of scenarios whose impacts can be quantified by changing the numerous influencing variables and assumptions.

This approach allows the user to analyse existing systems and assess the sustainability of processes that are still at the planning stage. To this end it is necessary in an initial step to ascertain the current position and then effect the requisite changes in course.

Sustainable Development (SD)

Embraces, according to the Brundtland Report (Rio 1987), the dimensions:
society, economy, environment



Objectives and underlying conditions

2.1 Objectives of the study

The study had the following objectives:

- to develop product-related sustainability criteria;
- to examine the extent to which aluminium packaging systems – taking the aluminium drinks can as an example – contribute to sustainable development in Switzerland;
- to ascertain by so doing the strengths and weaknesses of aluminium packaging systems in terms of sustainability and thus identify potential for optimisation.

Data was not to be obtained by comparisons with other packaging systems.

2.2 Eight key questions

With the help of the advisory board, the following eight key questions were selected from the wealth of questions that have been asked with respect to the packaging system under examination:

1
What is the economic scope, expressed in monetary terms, of the aluminium drinks can system under examination?

2
How does recycling influence economic fairness along the process chain?

3
To what extent is investment the driving force behind innovation?

4
How did eco-efficiency change in the period covered by the study?

5
How did environmental performance change in relation to globally ratified climate protection policy (Agenda 21) in the period covered by the study?

6
What interactions exist between the aluminium drinks can system under examination and the Swiss education system?

7
How significant are the efforts undertaken by IGORA to influence the behaviour of consumers with respect to recycling?

8
What are the effects on human health of emissions from the aluminium drinks can system under consideration and how does this compare with everyday activities of the consumer?

2.3 Boundaries

Temporal boundaries

To allow a differentiated statement to be made on sustainable development with regard to aluminium packaging products, we considered the years 1990, 2000 and, in the form of a forecast, 2010. You have to look into the future if you want to assess sustainability and reach agreement on measures, although admittedly there is a danger involved. For this reason all identifiable trends were handled conservatively, and the impacts of the various assumptions were presented in the form of scenario calculations. In addition, the results obtained for 1990 and 2000 were checked for plausibility.

Spatial boundaries

The system under examination relates to the market for aluminium packaging products and the recycling of such products in Switzerland. Owing to the internationality of the system the relevant data was gathered worldwide in the context of life cycle analysis. Production stages were taken into consideration in the following areas:

Global:
Extraction and processing raw materials, extraction and processing of energy resources and raw materials such as bauxite and oil
Rest of Europe:
Aluminium sheet production, can production, filling, distribution and re-melting of recycled cans
Switzerland:
Distribution, retail trade, consumption and reverse logistics

Content-related boundaries

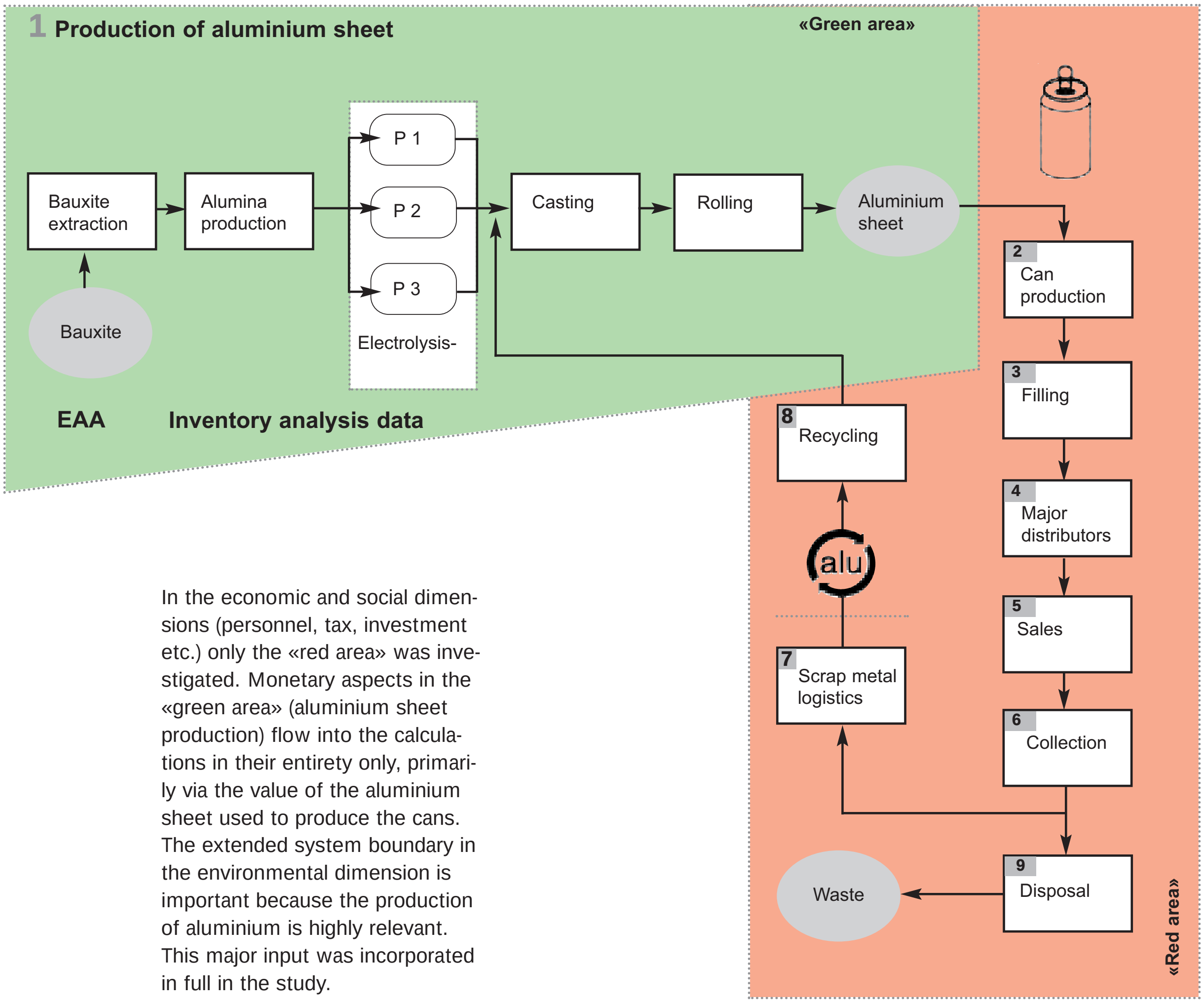
Owing to the boundaries defined by IGORA and in view of the innovative, pilot nature of the study, the most commonly encountered aluminium drinks can, the 33 cl container, was chosen as the subject of the study. Taking the can as an example, the study can be transferred to other aluminium packaging products in terms of its systematic structure.

2.4 Functional unit

The normative reference quantity selected for the study was 1,000 33 cl aluminium drinks cans.

2.5 System under examination

In the environmental dimension the system boundaries were set from «cradle to grave», starting with bauxite extraction, aluminium production, transportation to the rolling mill, can production, transportation to the filling plant, and ending with the retail trade and sale to the consumer, including the subsequent collection and recycling of the used cans. The model takes into account prevailing consumer habits. For the aluminium can this means that both consumption at the point of sale and home consumption flow into the model.



In the economic and social dimensions (personnel, tax, investment etc.) only the «red area» was investigated. Monetary aspects in the «green area» (aluminium sheet production) flow into the calculations in their entirety only, primarily via the value of the aluminium sheet used to produce the cans. The extended system boundary in the environmental dimension is important because the production of aluminium is highly relevant. This major input was incorporated in full in the study.

2.6 Advisory board

A specialist advisory board made up of representatives from the economic, environmental, social and sustainability fields oversaw the project:

- Dr René Buholzer, Schweizerischer Handels- und Industrieverein[1], economiesuisse, Zurich Switzerland
- Dr Peter Gerber, Federal Office for Environment, Forests and Landscape (BUWAL), Berne, Switzerland
- Dr Markus Lehni, World Business Council for Sustainable Development (WBCSD), Geneva, Switzerland; Dr Lehni now works for Deloitte & Touche Experta AG, Director Global Sustainability Services, Zurich, Switzerland
- Mr Alexander Wirtz, Alcan Deutschland GmbH, Eschborn, Germany
- Mr Werner Zbinden, self-employed social scientist, Zurich, Switzerland

1 Translator's note: Swiss Federation of commerce and Industry

Data basis (inventory analysis)

During the inventory analysis the basic data and influencing variables in the three dimensions (economic, environmental and social) were collected across the entire life cycle. The starting point here is the value chain forming the basis of the system under examination:

As well as current data these inventories include data relating to previous and future technologies for many processes. The Ökoinventar Transporte [Transportation Eco-Inventory], for example, contains emissions data from the beginning of the nineties as well as data from current and future exhaust fume standards (e.g. Euro 1 to Euro 3 for heavy-goods vehicles). Using this breakdown and information on specific changes in manufacturing technologies and the processes under examination in this project, we were able to model the data for the relevant years.

	Considered in the economic and social dimensions							
Aluminium-sheet	Can production	Filling	Major distributors	Sales	Consumers	Retro-logistics	Disposal	Recycling
Considered in the environmental dimension								

3.1 Data employed

In the areas can production, filling, detailed logistics and reverse logistics, data was obtained and checked for consistency and plausibility by experts. First and foremost, the following variables were collected:

Economic indicators	Environmental indicators	Social indicators
Cost of materials Energy and disposal costs Staff costs Capital costs	Material flows Energy flows Demand for resources Emissions	Jobs by quality of work Labour costs per quality of work Further education Training costs Fiscal revenues

Data relating to the provision of aluminium sheet, the recycling process, energy provision, transportation and infrastructure etc. was obtained from the literature.

BUWAL (1996)
Ökoinventare für Verpackungen, Schriftenreihe SRU Nr. 250
ESU (1996)
Ökoinventare für Energiesysteme, 3. Auflage, ESU (1997)
INFRAS (1995)
Ökoinventar Transporte
ESU (1997)
Ökoinventare von Entsorgungsprozessen
EAA (2000)
Environmental Profile Report for the European Aluminium Industry

By deploying the S-E-E.ch® tool, which in the environmental dimension is based on the proven EMIS life cycle analysis software, the authors were able to draw upon one of the most comprehensive databases in the LCA field when collecting the data.

Basic social data was obtained from the Swiss Statistical Yearbook published by the Federal Office of Statistics.

Key aluminium drinks can data

	1990	2000	Forecast for 2010
Weight of can	16 g	13 g	11.5 g
Recycling rate	40%	91%	95%

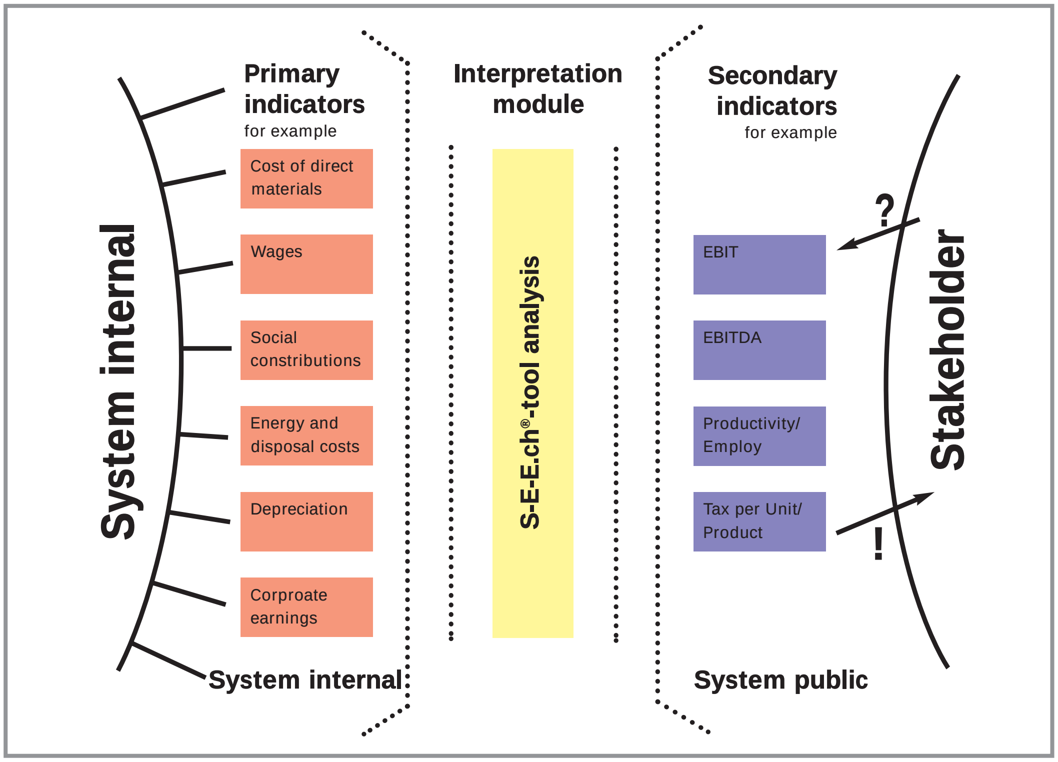
3.2 Allocations

To gain a representative picture of the value chain, all the relevant companies were studied and an analysis was performed of their part in the aluminium drinks can system under consideration. It should be noted that all costs incurred from aluminium sheet production to transportation to the filler plant, as well as for reverse logistics, disposal and recycling, were attributed in full to the aluminium drinks can, whereas the costs from filling to consumption are primarily generated by the drink being filled. This means it is necessary to allocate the costs accordingly. This allocation was performed by weight. A review of other allocations revealed no significant differences.
The allocations up to and including aluminium sheet were taken from the EAA study.

3.3 Method of calculation

Subsequently a dynamic data matrix that permits both plausibility checks and error and confidence limits testing of the results was created. It was then possible to determine the scenarios raised by the questions posed using the data set obtained.

Indicators



An indicator is a measurable variable that characterises the state of a particular aspect by means of a comprehensible numerical value (with unit), thus allowing a verifiable statement to be made with respect to one of the three sustainability dimensions of the system under examination. Using indicator timebars it is possible to track advances (or retrograde developments where applicable) in the orientation towards sustainable development. Future scenarios allow the consequences of decisions to be examined before they are put into practice.

Whilst there are good indicator systems in the economic and environmental dimensions, for the purposes of this study no suitable indicator systems existed for areas describing the social dimension. For this reason a number of indicators were devised for these aspects.

Advantageously, these indicators were devised in two detailing stages. The first stage involved the formulation of so-called primary indicators from which secondary indicators were derived using an appropriate interpretation module in the second stage. The primary indicators are indicators that are directly connected to the three dimensions of sustainable development – economic, environmental and social. They are based on objective and scientific interrelationships. These indicators were calculated using an impact-oriented method[2] developed in the Netherlands. In the assessment virtually every impact was computed and incorporated in the assessment. For reasons of clarity, and due to the fact that the various impacts indicated comparable results, a selection was made from the large number of effects involved. This selection was arrived at on the basis of topicality in public debate.

[2] Heijungs R., Guinée J.B., Huppes G., Landkreijer R.M., Udo de Haes H.A., Wegner Sleeswijk A. (1992): Environmental Life Cycle Assessment of Products, Centre of Environmental Science, Leiden

4.1
Primary indicators

The following indicators were among those used as primary indicators: ➩

Economic indicators[3]	Environmental indicators	Social indicators
Cost of direct materials Cost of indirect materials Wages Social contributions Energy and disposal costs Other operating expenditure Capital costs Depreciation Tax Corporate earnings	Greenhouse potential Energy resources Acid-forming potential Ozone-forming potential Eutrophication Toxicity	Labour hours per quality of work Labour costs Cost to the economy of training

These parameters were used in their entirety to permit the performance of dynamic examinations of the system and the making of consistent statements under changed conditions.

4.2
Secondary indicators

The secondary indicators are indicators that are indirectly connected to the three dimensions of sustainable development (economic, environmental and social) or involve societal evaluations. These indicators were used to obtain system-relevant variables and substantiate the statements made.

The following indicators were among those used as secondary indicators: ➩

	Economic indicators	Environmental indicators	Social indicators
Goal	Secure profitability and innovative capacity	Use resources and exploit nature without compromising their regenerative capacity	Maintain society’s capacity for learning
Measure	EBIT EBITDA approximate variable for operating cash flow	Eco Indicator 99 (EI 99)[4] Eco-efficiency: quotient obtained from EI 99 and value added External health costs	Employee qualifications (education requirement) Contribution to national economy, in particular the education system, through fiscal revenues Education efficiency

3
Thommen Jean-Paul:
Managementorientierte
Betriebswirtschaftslehre,
Versus-Verlag
Zurich 1996

4
Goedkoop M.:
The Eco-Indicator ‘99
Amersfoort 1999

5

Study results

5.1 Value added

When assessing a system you need to know its dimensions if you wish to develop an understanding of the influence the results have on the immediate and wider environment. The turnover generated by the input costs incurred, and the turnover from the individual links in the value chain, is as follows:

	1990	2000	Forecast for 2010
Turnover	CHF 34 m	CHF 41 m	CHF 49 m

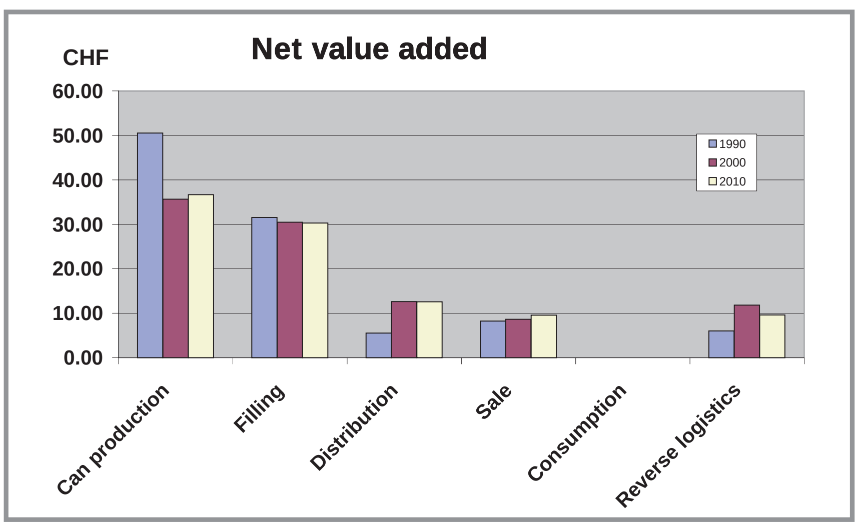
The 17% increase in value added over the first ten years of the period under consideration can primarily be attributed to market growth. In making this statement the study refers only to the system under examination and therefore consciously avoids making a comparison with developments on the drinks container market as a whole. From an economic point of view we can say that all the process steps in the value chain operate at a profit.

Moreover, it is more important for the system under consideration to distribute the potential inherent in the value chain fairly, thus allowing it to grow by way of motivation.

5.2 Distribution of value added (economic fairness)

The ten years between 1990 and 2000 were characterised by strong competition on the drinks packaging market and rising labour and investment costs. What is decisive is whether the industry has managed to be successful, despite these difficult underlying conditions. The analysis shows that net value added has fallen only in the can production sector. This becomes relative, however, when the considerable investments that have been made in this segment of the production chain are taken into consideration. The value added calculation shows that each stage of the production chain operates successfully in commercial terms.

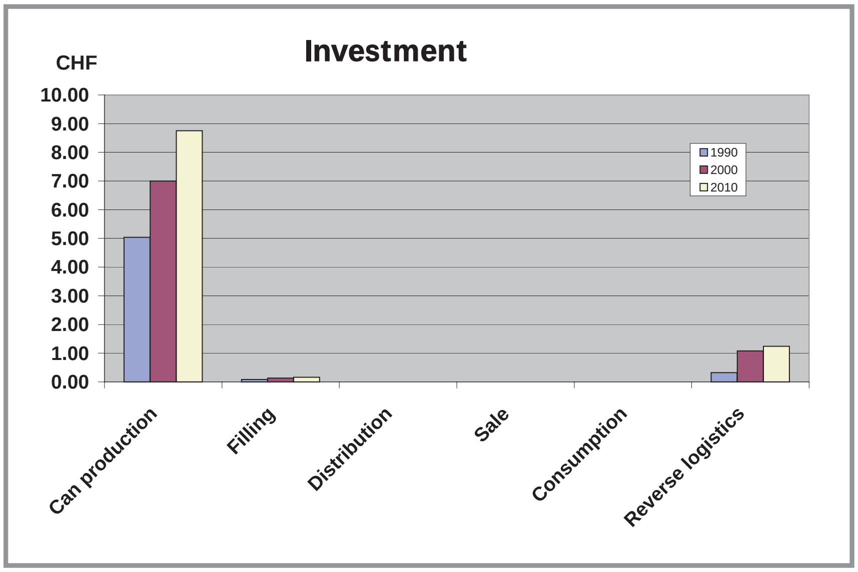
The assumed future scenarios incorporate a further increase in labour costs and take constant market pressure as fact. They demonstrate that the system has a good chance of long-term market survival – provided the recycling rate remains at present levels.



5.3
Investment as a driving force of innovation

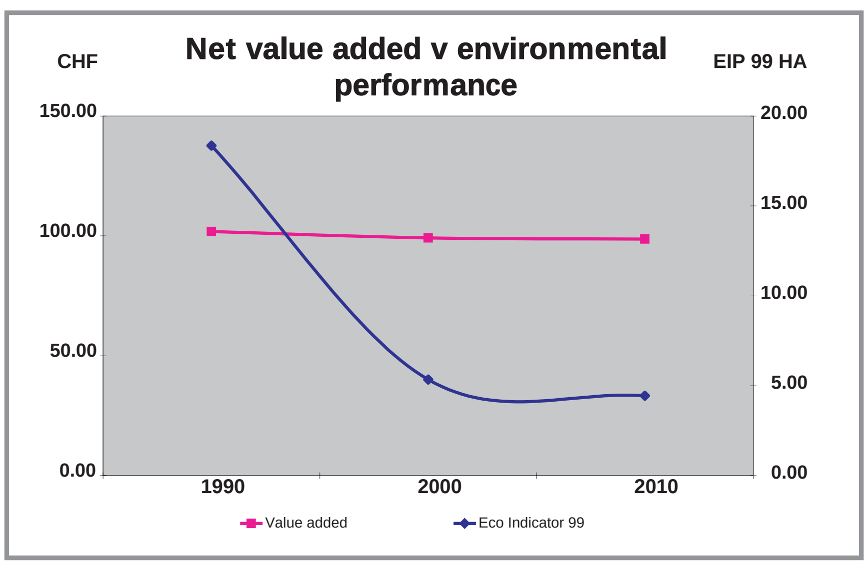
If we look at the investment analysis we will see that large investments have been made in can production, a situation that looks set to continue in the future. The "beneficiaries" of this innovative readiness are, above all, the participants in the process chain under examination, who have been able to maintain their net value added at constant levels thanks to the marked reduction in weight of the aluminium drinks can, and in some cases even improve it slightly.

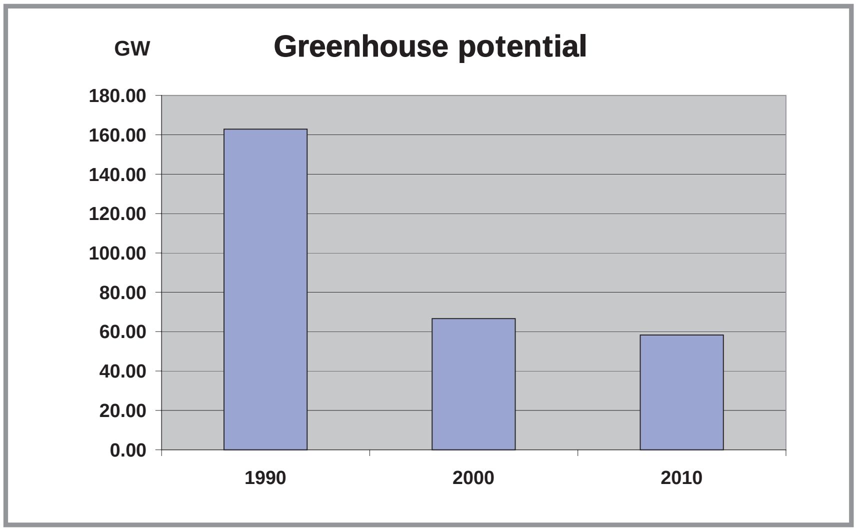
If there had been no or only little willingness to optimise the product, then this form of packaging would hardly have been able to compete in terms of price with alternative systems, in spite of efforts in the area of recycling.
Thanks to the investments made the industry was able to deliver a constant level of functionality whilst using much less material (from 16 grams in 1990 to 13 grams in 2000 and a projected 11.5 grams in 2010). This equates to a weight reduction of 4.5 grams in total per aluminium drinks can or almost 30%.
Furthermore, an additional link in the process chain has been established in the form of reverse logistics, with all its employees and infrastructures. This link in the chain can be termed a necessary addition without which the system as a whole would not be able to function.



5.4
Eco-efficiency

A major requirement for sustainable development is that the reduction of environmental impacts should not be nullified by the increase in production and that in overall terms this should not lead to an increase in the environmental load. In other words, it is necessary to separate the increase in productivity from the environmental impact. To determine whether the system under examination meets these requirements, the value added was contrasted with the environmental impacts using eco indicator points. The graph clearly shows that these requirements were satisfied thanks to a reduction of environmental impacts by a factor of almost four, while net value added remained constant.
This factor of four corresponds approximately to the "Factor Four" demand raised in a new report to





the Club of Rome (Prof. E. U. von Weizsäcker, A. B. Lovins, L. H. Lovins: Factor Four). Halving resource use while doubling wealth (for example by increasing the useful life of products) is defined here as a precondition for sustainable development. The aluminium drinks can system under consideration already meets this requirement as a result of a massive reduction in environmental loads.

5.5 Contribution to climate protection policy

In the current environment policy debate global warming is recognised worldwide as one of the key problems meriting serious attention in the next few years. For this reason we also examined total emissions of greenhouse gases, expressed in terms of global warming potential (GWP), throughout the process chain.

The results make pleasant reading, since these emissions were reduced by more than half in the previous decade. The main reasons for this success are the reduction in can weight, improvements in production conditions and advances in recycling. Further improvements can be expected over the next few years, although these are set to slow in view of the high level of performance already achieved.

In this context the aluminium drinks can system has more than exceeded the international undertaking given by Switzerland of reducing its emissions of greenhouse gases by 10% by 2010 (base level: 1990).
This massive reduction will also pay in economic terms as plans are in place to introduce the regulatory charge set forth in the CO_2 Act with effect from 1.1.2004 if targets are not met. According to current legislation the maximum charge will be CHF 210 per tonne. In 1990 the process chain under examination consisting of 1,000 drinks cans was associated with emissions of 163 kg of CO_2. In 2000 the figure was 67 kg. This 96 kg reduction would have resulted in savings with respect to CO_2 levies of around CHF 22, were such a levy to be imposed worldwide. Since only a very small proportion of such emissions arise in Switzerland, a CO_2 levy would have only marginal influence on the costs of the aluminium can.

5.6 Contribution to the Swiss education system

A major factor for the sustainability of a society is its learning capacity or, put differently, a sound education system. On the one hand companies employ people whose education is funded mainly by the state. On the other hand fiscal revenues from companies and employees provide the finance for this education system. In Switzerland some 16% of the federal budget is spent on education. This raises the following question: "Do the ‘noncommitted’ fiscal revenues (i.e. those not earmarked for a particular purpose) meet the costs of the education services provided?" The calculations made for the system under consideration show that the education costs are more than covered.
The comment that the system under examination is low-tech is not uncommon for this type of production system. Its mass-production process is highly automated and the education enjoyed by

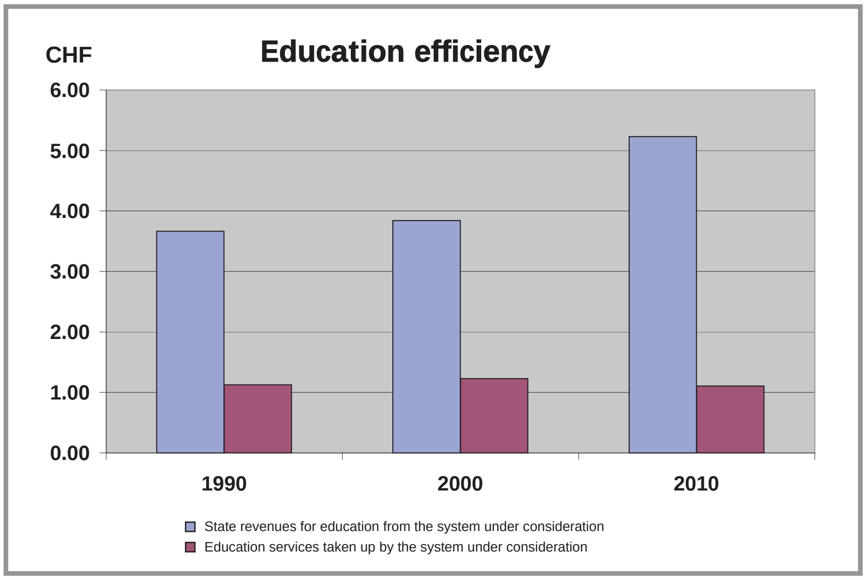
the majority of the workforce is not overly expensive in terms of the national economy. As a result the contribution to the education system is accordingly high (the situation for service companies, in particular those in knowledge-intensive areas, is significantly different).

5.7 Public Education

Improved recycling rates can of course be achieved only if consumers behave in line with the objectives. For this reason one of IGORA's major tasks is to increase the environmental awareness of consumers and motivate them to act accordingly. To this end consumers are provided with extensive, transparent information by means of information bus, videos, exhibitions, PR, brochures, leaflets, lectures and on the Internet. For motivation purposes various events, collection incentives, competitions, awards and prizes etc. have been introduced – with success, as the improvement in recycling rate to 91% demonstrates.

5.8 Comparisons with everyday activities

As with every other activity, drinks can production is automatically associated with emissions. In some cases some of these emissions can damage our health. In the year 2000 the World Health Organisation (WHO) commissioned a broad-based study into the costs of problematic emissions. On the basis of this study we calculated the external health costs associated with 1,000 aluminium drinks cans. The results show that in 1990 costs amounting to some CHF 70 were still being generated. By 2000 this figure had been reduced almost threefold, while planned developments should see a further fall to about a quarter. To permit a comparison of costs, we also ascertained the external health costs associated with rail and road transport operations. This revealed that in 2000 a high-speed train created the same health costs over 4.5 kilometres as 1,000 drinks cans. Over a distance of 240 kilometres a car of average fuel consumption invoked the same external health costs. So an average Swiss citizen would have to consume approx. 62,500 cans of drink per year to generate the same external health costs brought about by travelling.



6 Conclusions

An appraisal of the answers to the eight key questions shows that the aluminium drinks can system has made great strides in various aspects of sustainability. This is especially true:

In the environmental sector – by separating the increase in productivity from the environmental impacts and reducing the latter by a factor of four.
In the social sector – by steadily increasing education efficiency with no loss in work quality and quantity.
In the economic sector –by successfully remaining on the market. A lack of data means that the extent to which the increase in production and the economic indicators show a net success compared to the market as a whole cannot be quantified with any degree of certainty.

The major success factors therefore definitely include the following aspects:

- A dramatic increase in recycling rates within the period covered by the study
- Innovative measures towards a reduction in can weight.

Although further improvements are possible for both criteria, these will automatically be smaller than before. Improvements are much more difficult to achieve when standards are already high than when performance is poor (falling marginal utility).

The interaction of all process parties is of major significance if the very efficient collection and recycling system is to function well. In this connection it also becomes clear just how important it will be to devote the necessary attention to the economic well-being of all process partners and the long-term viability of the system for all stakeholders. Consumer behaviour will also be of decisive importance for the success of recycling.

Yet the above statements must also be seen in the context of a dynamic market. Survival on this market will depend upon the underlying conditions, consumer motivation and the potential for innovation. The underlying conditions include the competitive situation and the associated market price, labour and capital costs, aluminium, indirect material and energy prices, and possible regulatory charges such as CO_2 taxes. These conditions can be influenced only to a certain degree, yet it is necessary to recognise trends and their potential effects early if proactive action is to be taken. The ability to calculate such scenarios extensively and dynamically is one the main strengths of the method applied here. This was done to a certain extent in this study with the 2010 scenario. Owing to the considerable uncertainties involved, data assumptions were made conservatively (same changes in workforce strength and wages as for the period 1990 to 2000, no increase in the cost of energy and materials, interest and product revenues, increase in value-added tax to 10%).

Glossary

Acid forming potential
Contribution to the acidification of soils and watercourses (e.g. by nitrogen oxides or sulphur dioxide).

Allocation
Assignment of the effects of a process (or a service) to the various outputs.

Alumina, alumina production
Bauxite has to be processed to pure aluminium oxide (alumina) before aluminium can be extracted from it by electrolysis.

Aluminium
The third most abundant element (eight percent) in the Earth's crust after oxygen and silicon. Aluminium never occurs in its pure form, only in compounds. Bauxite contains the highest concentrations of aluminium.

Bauxite, bauxite mining
Bauxite is the principal ore in the production of aluminium products. It is mined primarily in surface workings. The most important deposits occur in the Tropics.

BUWAL
Swiss Federal Office for Environment, Forests and Landscape, based in Berne.

Casting
Aluminium obtained in a smelting process called electrolysis is cast into ingots weighing several tonnes.

Disposal
General term for the treatment of goods that have fulfilled their function. Can be practised in different ways:

- Reuse of the good by cleaning
- Recovery by processing (recycling) to give secondary materials.
- Combustion e.g. in a waste incineration plant, exploiting where possible the heat released in the process
- Landfill

EAA
European Aluminium Association, Brussels. An organisation made up of the leading European producers of aluminium. The environmental aluminium production data used in this study were collected and made public by this association.

EBIT
(Earnings Before Interest and Taxes) refers to the operating profit of a company before deduction of interest and tax. Neutral with respect to financing variables.

EBITDA
(Earnings Before Interest, Taxes, Depreciation and Amortisation): can be considered an approximate variable for operating cash flow.

Eco indicator
The eco indicators 95 and 99 are methods used to assess environment impacts based on the principles laid down at ISO 14040. An impact analysis is derived from an inventory analysis and the two are weighted relative to each other to give a score (indicator) referred to as an eco indicator.

Energy resources
Consumption of non-renewable energy resources such as oil, gas, coal and uranium. In contrast to useful energy, which refers only to the amount of energy required during use, energy resources also comprise all the preliminary stages of energy provision.

Environmental impact points
Method of assessing environmental impacts developed in Switzerland. The assessment is based on the relationship between current material and energy streams and streams that are acceptable under Swiss environmental policy.

Eutrophication
Change in the nutrient balance brought about by the introduction of substances containing nitrogen or phosphorous.

Evaluation method
In the evaluation method the relevance for the environment of the various environmental impacts are weighted relative to each other and summarised in the form of an indicator. This is done with reference to a value of measure based on scientific and environmental objectives (aggregation).

External costs
Those costs not directly attributable to the generator of the costs that must be met by society as a whole (general public).

Functional unit
The functional unit provides the useful value (specification) of a product or service to which all data refers. Typical functional units are, for example, the packaging of 1,000 l of beer in drinks containers (e.g. aluminium or tin cans).

Greenhouse potential
Contribution to the warming of the climate due to emissions of gases that influence the greenhouse effect (e.g. CO_2, methane and nitrous oxide).

IGORA
Organisation founded on 1.4.1989 with the aim of optimising the recycling of aluminium drinks cans.

Impact analysis
The environmental impacts of the various material streams are identified in an impact analysis and represented in the form of an impact profile.

ISO 14040 ff.
Standard in force worldwide, part of the ISO 14000 «Environmental Management Systems» series of standards, that deals with the subject of Life Cycle Assessment (LCA).

Indicator
A determinable variable whose plausibly derived numeric value (with unit) permits a verifiable statement with respect to one of the three sustainability dimensions of the system under examination.

Inventory analysis
The inventory analysis records, in the same way as an accounting system, all the major material flows initiated by the activities under consideration.

Major distributors
Regional-based intermediate storage and distribution organisations.

Megajoule (MJ)
Unit of thermal energy: 1 MJ = 3.6 kWh (kWh = unit of electric energy).

Ozone forming potential
Contribution to the formation of ozone (summer smog) caused by the emission of substances such as organic solvents and nitrogen oxides (NOx).

Preimposed disposal charge (VEG)
State-imposed disposal charge in Switzerland.

Preimposed recycling contribution (VRB)
Private-sector organised recycling contribution.

Recycling
Repeated use of old materials or residuals as secondary materials. Closed-loop cycles are the ideal target, the ability of secondary materials to compete with primary materials on the markets is the realistic target.

Recovery
Processing of materials (recycling) to give secondary products. Combustion with heat recovery is sometimes termed thermal recycling.

Scrap metal logistics
Process of collection, processing and transportation prior to recycling or disposal.

Sustainable development
The best-known attempt at a definition was made in 1987 in the UN Commission Report under the stewardship of the Norwegian prime minister Gro Harlem Brundtland. «Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.» (Brundtland Report 1987)

Value added
The value added to a product by a step in a process chain. Also the difference between the activities performed by a producer (value of production) and the costs incurred by the producer (= input costs). To be more precise, the value added obtained from the difference between the value of production and the input costs, is the gross value added since it also includes the depreciation costs that serve to replace the capital equipment consumed during production (gross value added less depreciation equals net value added).

Waste
Movable object disposed of by its owner or one whose disposal is in the public interest.

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