

Multifunctional Electronic Media – Traditional Media

The Problem of an Adequate Functional Unit

A case study of a printed newspaper, an internet newspaper and a TV broadcast

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DOI: <http://dx.doi.org/10.1065/lca2003.06.122>

Abstract

Aim and Background. Electronic media are spreading rapidly and some of the services they offer are similar to traditional media. Frequently, credit is given to electronic media for causing less environmental impact, however, looking at it more closely, little is known about the comparability of the environmental impact of both kinds of media. Main reasons for this lack of knowledge are difficulties in defining an adequate functional unit for a comparison of usually multifunctional media, as well as problems in gathering large amounts of inventory data for complex electronic goods.

Objective. Here an LCA case study was conducted for reading or watching the daily news in an online and a printed newspaper as well as on TV. Aim of this study was to find an adequate functional unit as well as to quantify the environmental impact of each of the media, including recommendations for the reduction of their impact.

In order to account for the multifunctionality of the investigated media as well as for ISO 14040ff. guidelines for the definition of the functional unit, several functional units were chosen. The selected functional units cover a spectrum of close functional equivalence to an altogether different approach in comparing entire activities.

Results. Compared on the basis of an average news item, the internet newspaper causes far more environmental impact than a TV news cast, which, in turn, causes more impact than a cutting of a newspaper. Major contributions to the high environmental impact of the internet newspaper are the manufacturing of the computer as well as operation of the necessary infrastructure for running the internet, in particular operation of the telephone network.

Comparing media on the basis of consuming the daily news as a whole leads to less environmental impact for both of the electronic media in relation to a printed newspaper, even if shared amongst several readers. The comparative environmental advantage of the electronic media depends on a set of conditions:

1. No online information is printed.
2. Internet surfing is directed towards specific goals and therefore limited in time.
3. Power consumption is based to a large extent on renewable energy sources. This still holds true for the underlying national electricity mix of Switzerland with a high share of hydropower.

A comparison of the average per capita time of watching TV with surfing in the internet and average paper consumption of free and bought print products also shows that most of the environmental impact results from print products.

Interpretation. Summarising the previously shown results, different perspectives on media and, with it, different functional units lead – not surprisingly – to different results. Relations between the environmental impact of the three media change between approaches. A final conclusion on a qualitative level is drawn.

The first functional unit stands for close functional equivalence, however, it does not resemble options of the consumer in real life. The cuttings of a newspaper cannot be bought as such and the consumer is normally not interested in a single news item. The second functional unit is more of a representation of real life choices and is a typical example of a consumer's choice that frequently has to decide between options which are not exactly functionally equivalent. Finally, the last approach, based on entire activities, supports the result of the previous approach.

Perspective. The case study has shown that a comparison of multifunctional products or services excludes relevant environmental aspects, if functional equivalence is chosen as the unique reference unit. Thus, it is recommended to apply several approaches in order to do justice to the multifunctionality of the investigated products or services. ISO/TR 14049, with its concept of user acceptance, offers such a possibility to compare products or services which are still considered equivalent by the user.

Keywords: Daily news; functional equivalence; functional unit; internet newspaper; multifunctional electronic media; newspaper; television; traditional media

1 Aim and Background

Electronic media are spreading rapidly in numbers and they offer more and more services, some of which are partially replacing conventional media. Analyses of the environmental effects of this substitution are missing considerably. Results of such studies would help to find out whether the current trend is leading to a more or less environmental impact and could contribute to the shaping of a sustainable information society.

To date research in the field of environmental impact of electronic media is mostly focussed on estimates of the energy

demand of the internet (e.g. Romm 1999, Laitner 2000) and on LCA studies of TV-sets, personal computers, mobiles or DfE improvements thereof (Soldera 1995, Behrendt et al. 1998, Johnson 1998, Strubel et al. 1999, Dreier et al. 2000 and Oiva et al. 2000). The wider perspective in comparing the service of electronic media with similar conventional services has hardly been taken. Exceptions are comparisons between e- and surface mail (Zurkirch et al. 2001), electronic versus print telephone directories (Zurkirch et al. 2001), video conference versus real meetings (Rydberg et al. 2001) and a news item in an electronic and printed newspaper (Plätzer 1998).

Problem of the mentioned studies and a general difficulty in comparing electronic and traditional medias, is choosing a meaningful reference or functional unit for multifunctional media.

Here a case study was conducted taking up the mentioned problem. Public opinion polls state that the internet is mainly used for the purpose of information (AG für Werbemedienforschung 2001) and visits to online newspapers and magazines are amongst the most frequent uses of the internet (AG für Werbemedienforschung 2002). Given that, there is good reason to compare reading an online newspaper with reading a printed newspaper and watching news on TV.

At the start of the study the prejudice was prevailing that a 'dematerialised' online newspaper would cause less environmental impact than buying a printed daily newspaper. This was standing against results of Plätzer's study, which can be questioned from a methodological point of view. He found out that primary energy demand and resource consumption for reading a 500 word news item online were much higher than for a cutting of a newspaper, but he did not include manufacturing and disposal of the computer in the system boundaries (Plätzer 1998, p.138–145).

Aim of this study was finding an adequate functional unit for reading or watching the daily news in printed and online newspapers, as well as on TV. A further aim was the quantification of the environmental impact of each of the media including recommendations for the reduction of their impact.

2 Functional Unit

2.1 Defining the functional unit according to ISO 14040 Series

ISO/TR 14049, together with ISO 14040 and 14041, provide a definition of the functional unit and set a guideline for the steps that have to be taken to arrive at the definition of the functional unit (International Organization for Standardization 1997, International Organization for Standardization 1998, International Organization for Standardization 2000). A functional unit is defined as the quantification of the service delivered by the investigated product system (International Organization for Standardization 2000, p.4). The purpose of the functional unit is to ensure comparability when comparing different systems (International Organization for Standardization 1997, p.8), and in a mathematical sense it serves as a reference for in- and outputs of the compared systems (International Organization for Standardization 1998, p.5).

The starting point of an LCA study can be a specific product, a final need or goal, or a function (International Or-

ganization for Standardization 2000, p.4). As LCA methodology was historically developed from a product perspective the process leading to the definition of the functional unit is also described from that point of view. The first step is the selection of one or more relevant function(s). Obviously, a meaningful selection can only be achieved if all possible functions of the product are known and rated in importance. The selection process itself, i.e. the decision of which functions are regarded as relevant, depends on the goals and scope of the study (International Organization for Standardization 1997, p.8). Once the relevant function(s) are selected, they are quantified – this is the functional unit.

There are two more aspects that have to be kept in mind when defining a functional unit. Firstly, the amount of product which is necessary to fulfil the functional unit needs to be able to be quantified (International Organization for Standardization 1998, p.5), i.e. there have to be reliable and valid ways of measuring the selected function(s) of products. Secondly, equivalence of the chosen function(s) and the functional unit has to be ensured when comparing several products. As an alternative, ISO/TR 14049 states that in some cases equivalence of products can also be determined by user acceptance (International Organization for Standardization 2000, p.4).

ISO/TR 14049 does not clearly describe the process of how to arrive at the definition of the functional unit should the starting point already be a service, as in this case. Therefore, necessary steps to do so were deduced from the norm.

2.2 Functions of the printed daily newspaper, internet newspaper and TV broadcast

The starting point of this study was a service, although not a precisely defined one: 'Reading or watching the daily news' provided by the products printed daily newspaper, internet newspaper and TV broadcast. Radio was not included, because it does not offer visual information in the same manner as other media. Instead of directly defining a functional unit, it seemed appropriate to take a step back in order to list up and rate functions of the media according to their importance.

To begin with, the investigated media serve functions on the level of society. They get values across or they construct a social reality. To a large extent, passing on of different values depends on different political opinions or levels of sophistication. Such differences predominantly exist within media, for example between different TV channels or between different newspapers. It is possible to control these differences by choosing media with a similar political opinion and a similar level of sophistication.

The investigated media also serve functions on the level of the individual. Some of these functions are daily routines (TV, printed newspaper), a way to relax (TV), offering the possibility to be stored (newspaper) or burnt in the oven (printed newspaper), etc. These functions are differences between media. In the context of this study they were, as a matter of simplification, regarded as irrelevant functions and therefore ignored. Beyond that, the internet newspaper is the only medium offering links to endless information. This was regarded as an important function, because the internet is typically used by switching from one site to the next. Fur-

ther differences exist within as well as between media in the sense that they are regarded as either informative or entertaining or even both. The way media are perceived depends on the subject discussed as well as on the method of communication, i.e. the amount of text or spoken language, the amount of still pictures or moving sequences, colour or black-and-white presentation etc.

The last two aspects – inseparability of information and entertainment and the open-end character of information on the internet – led to the decision to choose several different functions and functional units.

As a first function, reading or watching a typical news item was chosen, like in Plätzer's study (Plätzer 1998). Nationally available media with an average political opinion and level of sophistication presenting a particular news item were investigated. Thereby similar information content was compared. A drawback of this comparison is that only a cutting of a newspaper was investigated, which, like in Plätzer's study, does not depict reality very well, since newspapers can only be bought as a whole.

The second function chosen was reading or watching the daily news as a whole, because 'being up-to-date' is considered important for many people. Watching the daily news as a whole on the main TV newscast in the evening was compared to reading an online newspaper and a printed newspaper. Nationally available media of different levels of sophistication were taken into account – at least for printed newspapers, since they vary a lot in size. For the online newspaper such distinction was impossible as estimates were only available for an average length of time in staying at distinct homepages of newspapers. Advantage of this comparison is that printed newspapers were looked at as an entity in the way they occur. A drawback lies in the differences in the information content between the various media. Job adverts, automobile markets as well as local news are elements of newspapers, while the TV broadcast does not offer the same variety of information and a self-selection on the same channel is not possible. Besides these differences, each of the three media lead to the initial goal of 'being up-to-date'.

Media use in general was chosen as a third approach, because news consumption is tightly linked with entertainment and media consumption as a whole – at least for TV and internet. Media were no longer compared by the same function, but by the entire activity of watching TV versus surfing in the internet versus per capita paper consumption for bought or free newspapers, magazines, advertisement supplements or books.

2.3 Functional units and reference flows

2.3.1 News item

As mentioned before, 'Reading or watching a news item' was selected as a first function. The functional unit is reading or watching an average news item about the same event:

- On the main evening news broadcast 'Tagesschau' on the Swiss-German TV channel 'SF 1'
- In an average daily internet newspaper
- In an average printed daily newspaper.

The consumer is a Swiss-German adult with an average reading speed, using media at home. News items which occur in all sorts of newspapers and on the evening news on TV are typically restricted to the weather forecast and (inter-)national news with emotional components. Therefore, the average news item chosen was a generic one in the middle of both mentioned kind of news items. Reading of the internet news item also included opening the page, starting from the homepage of the online newspaper. The average news item in the internet or printed newspaper was defined as being in between a tabloid ('Blick') and a sophisticated newspaper ('Neue Zürcher Zeitung').

Over a period of two days, reference flows were determined by measuring the length of time for the specific part of the TV broadcast and by the length of time to open and read the news item online by employees at EMPA. In the case of the newspaper article, only a cutting was considered including text and pictures. The margin of the newspaper was included, but only half its size was eventually accounted for, as newspapers are printed on both sides (Table 1). Minimum and maximum empirical values are indicated as range.

2.3.2 Daily news

'Reading or watching the daily news' was selected as a second function. Here the functional unit is being informed about the daily news as a whole by reading or watching (Table 2):

- The main evening news broadcast 'Tagesschau' on the Swiss-German TV channel 'SF 1', including the weather forecast and a short slot of adverts in between
- The average daily internet newspaper
- A thin, tabloid ('Blick')
- A voluminous, sophisticated newspaper ('Neue Zürcher Zeitung').

The consumer is again a Swiss-German adult with an average reading speed, using media at home.

Reference flows were determined by finding out the usual length of time for the TV newscast including weather fore-

Table 1: Reference flows of 'A news item'

	TV broadcast	Online newspaper	Printed daily newspaper
Average value	180 s	90 s	250 cm ²
Range	142–238 s	33–273 s	133–520 cm ²

Table 2: Reference flows of 'Daily news'

	TV broadcast	Online newspaper	Thin boulevard newspaper ('Blick')	Voluminous sophisticated newspaper ('Neue Zürcher Zeitung')
Length of time or amount	25 min	10 min	43% of 'Blick'	43% of 'Neue Zürcher Zeitung'

Table 3: 'Reference flows' of 'Daily media consumption'

	TV	Internet	Print media
Length of time or amount	110 min	74 min	136 g Newsprint 156 g Coated, graphical paper 44 g Woodfree, uncoated graphical paper

cast. The average length of time to read a daily internet newspaper was difficult to find out. Therefore, available estimates on the duration of single sessions at online newspapers or magazines were taken as an approximation. In the case of the printed newspapers, not the part that is actually read was relevant, but its entity – the way it is bought. As newspapers vary a lot in size, a distinction was made between a thin tabloid and a voluminous sophisticated newspaper. An average sized 'Blick' and 'Neue Zürcher Zeitung' based on the annual issues was assumed. An average of 2.3 readers per 'Blick', 'Neue Zürcher Zeitung' or Swiss newspaper in general was taken into account. Only the reciprocal proportion of either newspaper was allocated to the single reader.

A sensitivity analysis was conducted for the length of time for news consumption as the reference flow for both of the electronic media was based on estimates.

2.3.3 Daily consumption as a whole

Average media consumption was investigated in a third approach. Here the following activities were compared (Table 3):

- Average length of time watching TV per day and per TV spectator at home
- Average length of time surfing in the internet per day and per internet user at home
- Average amount of print media per day and adult – irrespective of the fact is free or paid for, read or simply thrown away.

The length of time watching TV was determined by an average daily turn-on time of the TV, being 238 minutes in 1998 (Jedele 1999). This was divided by the average number of household occupants over 6 years, being 2.2 occupants (Bundesamt für Statistik 1990). This led to 110 minutes of watching TV per household occupant. In contrast, the average actual TV consumption of over 3 year-olds was 144 minutes per day in 1999 (Schweizerische Radio- und Fernsehgesellschaft 2000).

The length of time surfing in the internet was based on available data on average internet use of adult users at home in the German-speaking part of Switzerland. This was 74 minutes in summer 2000 (AG für Werbemedienforschung 2000). Apart from privately motivated internet use, it also included a little time linked to professional purposes.

In the case of print media, the average paper consumption (newsprint and coated, graphical paper) was taken from Verband der Schweizerischen Zellstoff-, Papier- und Kartonindustrie (2000, p.9). Consumption of woodfree, uncoated graphical paper, mostly used for books, was based on imports and estimations. The attained values are approximations for the average daily amount of free and bought newspapers, magazines, books and adverts for over 6-year-olds in Switzerland.

The idea behind this comparison was to get a rough estimate of the overall environmental impact caused by media consumption, therefore it was regarded as acceptable that

print media consumption not only includes private but also business consumption of paper.

3 Product Systems, System Boundary and Allocation Methods

As the user was assumed to be the average Swiss adult consumer, media were specified accordingly. The used computer and TV-sets were modern, middle class appliances, which were supposed to be used in an average way for private purposes. They were defined as follows:

- TV: Colour TV, 72 cm diagonal cathode ray tube, 8 years of life, switched on for 4.2 hours per day (94 W) and 90% of the rest of the time on stand-by (5 W), which is equivalent to switching the TV off only during holidays.
- Computer: Desktop computer, 4 years of life, switched on for 2 hours per day (145 W) and off for the rest of the time.

In contrast to that, specification of the newspaper changes between the functional units was as follows:

- A cutting of a newspaper of average paper quality and printing process reflected by the middle of the two newspapers ('Blick' and 'Neue Zürcher Zeitung') for the first functional unit.
- Two particular newspapers for the second functional unit: 'Blick' as a thin tabloid and 'Neue Zürcher Zeitung' as a voluminous sophisticated newspaper.
- Total print product consumption (newspapers, magazines, adverts, books etc.) in the last approach.

All of the mentioned media were investigated throughout their entire product life, including transportation processes. Operation of necessary infrastructure was also taken into account, such as data transfer via internet, operation of the telephone network, production of TV-shows and operation of a satellite receiver. For reasons of simplification, journalism and the transportation processes linked to it were not included in the system boundaries.

In each of the approaches only a very short time of use of electronic media was looked at, therefore only a small proportion of the production and disposal phase of those appliances was taken into account. This proportion was determined by setting the short use phase looked at in relationship to the overall use phase of the appliance.

Disposal of electronic goods was modelled by waste incineration of plastic parts and application of the cut-off method for metal and glass fraction of electronic appliances.

In the case of newspapers (first and second approach), paper recycling was accounted for by applying the allocation method based on the number of subsequent uses of wood fibre. The average number of cycles of wood fibre in newspaper and magazines were calculated to be 2.3 in Switzerland. For the remaining part of the newspaper, which is disposed of together with household waste, a credit was given for regained heat and power through waste incineration. For reasons of simplification, the cut-off allocation method was applied to print products in the third approach.

Table 4: Important data sources for the inventory

	Source
Manufacturing of TV	(Strubel, Gensch et al. 1999)
Manufacturing of computer: Manufacturing of monitor, printed wiring board incl. components and cabinet	Transfer of data from (Strubel, Gensch et al. 1999)
Manufacturing of computer: Remaining parts	Various data from (APME 1993–2000) and (Frischknecht, Bollens et al. 1996)
Manufacturing of newsprint paper	Paper manufacturers from Scandinavia, Germany and Switzerland. Upstream processes for fossil fuels from various sources
Electricity mix for Norway, Sweden, Germany, Switzerland and UCPTE	(Habersatter, Fecker et al. 1998) and accounting for power imports in Switzerland according to model M2 of (Ménard, Dones et al. 1998, p. 8ff.)
Disposal of part of the newspaper: waste incineration	Data bank of (ifu and ifeu 2000)
Disposal of electronic waste: Shredding	Average power consumption (Behrendt, Kreibich et al. 1998, p. 133)
Waste incineration for plastic fraction of shredding	Data bank of (ifu and ifeu 2000)

4 Data Sources and Methods of Impact Assessment

Main data sources for the inventory are summarised in Table 4. The electricity mix associated with power consumption needs further mentioning. The relevant national electricity mix, depending on the location of power consumption, was assumed. In the case of the production of print media this was the Scandinavian, German, or Swiss electricity mix. In the case of the production of electronic media it was the average European electricity mix. For use phase the Swiss electricity mix was assumed, as use of media was supposed to take place in Switzerland. A sensitivity analysis was conducted for the last assumption by replacing the Swiss electricity mix by the average European electricity mix (UCPTE).

In this study, two internationally recognised assessment methods were applied, the Swiss method of environmental scarcity (Brand et al. 1998) and the European Eco-Indicator 99 method (hierarchist perspective) (Goodkoop et al. 2000). Results are only shown for the first method, as the second method led to very similar results.

5 Results

5.1 News item

Fig. 1 shows the environmental impact of watching or reading a news item. The various life cycle stages are marked. Reading a news item in the internet newspaper causes more environmental impact than watching a news item on TV or reading a cutting of a newspaper (Fig. 1). The relationship of the impact between online and printed newspaper is similar to that in Plätzer’s study, considering that a different electricity mix for use phase was assumed and that manufacturing and disposal of the computer were not included (Plätzer 1998, p.143ff).

Here, the life cycle stages leading to most of the environmental impact are manufacturing of the computer, as well as use phase with power consumption to run the internet. Eighty percent of the environmental impact of use phase is due to operation of the telephone network and internet data transfer. Running of the computer only accounts for the remaining 20%. Manufacturing of the computer leads to more environmental impact in contrast to the TV-set, as overall

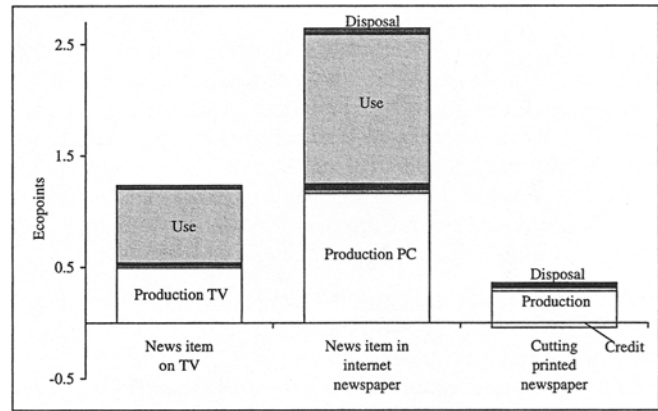


Fig. 1: Environmental impact of reading or listening to a news item. The impact is expressed in ecopoints of the Environmental Scarcity method (Brand et al. 1998)

use of the computer is assumed to be shorter than that of the TV. This, in return, leads to a higher percentage of the impact of manufacturing (and disposal) allocated to a time unit the computer is used.

5.2 Daily news

Seen from the perspective of consuming the daily news as a whole and also from the point of regarding a newspaper as an indivisible entity, both newspapers are causing more environmental impact than reading an online paper or watching the news broadcast on TV (Fig. 2). Irrespective of their size, newspapers largely lead to more environmental impact than both of the electronic media. The environmental impact of the newspaper would rise even higher if only one reader per newspaper would be assumed. The reason behind the high environmental impact of the newspaper is the energy intensive production of pulp and paper.

In the case of printing online information on office paper, merely three pages are enough to double the environmental impact of 10 minutes of internet surfing. The environmental impact is then in the same range of a thin newspaper (Fig. 2). The shown increase for printing three pages is again due to the production of pulp and paper and not the printing process itself.

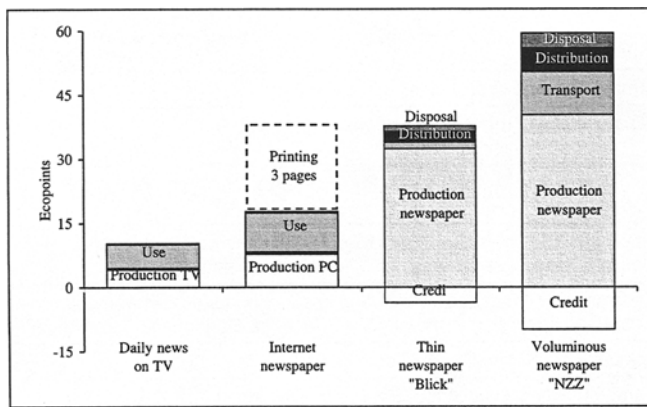


Fig. 2: Environmental impact of reading or listening the daily news including the option of printing online information. The impact is expressed in ecopoints of the Environmental Scarcity method (Brand et al. 1998)

As the length of time to consume the daily news on TV and in the internet was based on estimates, a sensitivity analysis was conducted. By varying the length of time for news consumption it was accounted for that further sources of news information are consumed. Fig. 3 shows the environmental impact dependent on the length of time for news consumption. The environmental impact of either newspaper is invariant of time as only physical existence matters.

The horizontal bar indicates the range of the environmental impact of newspapers – still under the assumption that there are 2.3 readers per newspaper. As long as watching television does not take more than 80 minutes the environmental burden is less than reading a thin newspaper. In contrast to that, 20 minutes of internet surfing are sufficient to be in the same range of the environmental impact of a thin newspaper. As mentioned before, printing three pages of online information during 10 minutes of internet surfing also causes an environmental impact equivalent to a thin newspaper.

Overall, 10 to 20 minutes of internet surfing for information purposes seem like an underestimation when set in relation to the daily average of 74 minutes of surfing by the Swiss internet user at home. This is confirmed even more by occasional long downloading times and easy distraction from the goal in the internet.

Sensitivity of the results was also tested for location of media use, i.e. the assumed electricity mix during use phase. The Swiss electricity mix for use phase was replaced by the average European electricity mix. This replacement represents the use of media in many European countries. The exchange of the electricity mix results in a tripling of the environmental burden of electronic media in relation to the reference setting (Table 5). Even watching television causes nearly the same environmental impact as reading a thin paper.

5.3 Daily consumption as a whole

Seen from the perspective of activities instead of equivalent functional units, average consumption of print media is by far causing more environmental impact than average internet surfing at home or watching TV (Fig. 4). The shown environmental impact of print media has to be interpreted as an upper limit, as per capita print media consumption could not be separated from private and business use, however, includes both. Further, the change in the applied allocation method to cut-off allocation, leads to a comparatively high environmental impact of virgin paper relevant for the consumption of magazines. Even if the environmental impact of print media is overrated by as much as a factor of two, print products would still cause more impact than watching TV or surfing in the internet. On the other hand, it can be questioned whether it is just to allocate the environmental burden of unwanted paper products like adverts, free newspapers or catalogues to the consumer.

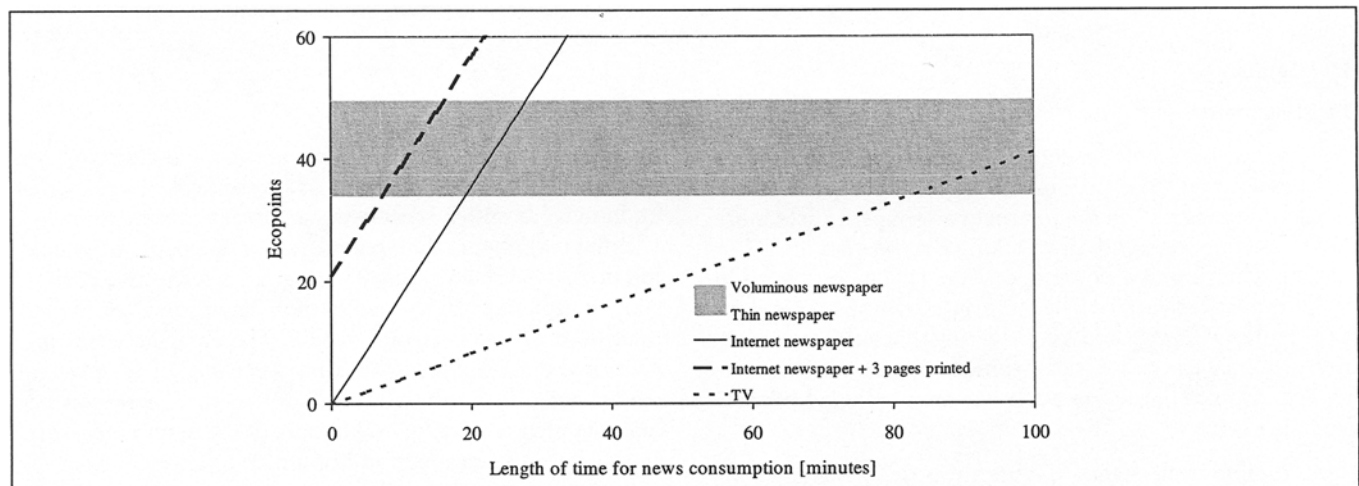


Fig. 3: Influence of length of time for news consumption on the environmental impact (assessment with Environmental Scarcity Method)

Table 5: Influence of the electricity mix on the environmental impact

	Daily news on TV	Daily news in Internet newspaper	Thin newspaper	Voluminous newspaper
CH electricity mix	10	18	34	50
European electricity mix	31	52	same	same

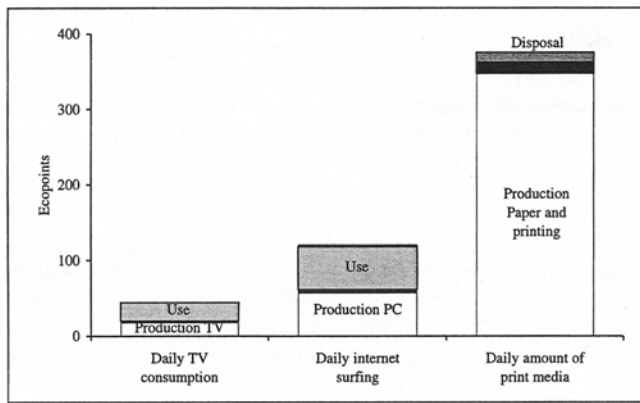


Fig. 4: Environmental impact of daily media consumption

6 Interpretation

Summarising the previously shown results, different perspectives on media and with it different functional units lead – not surprisingly – to different results. Relations between the environmental impact of the three media change between approaches. A final conclusion on a qualitative level is drawn.

The first functional unit stands for close functional equivalence, as in Plätzer's study (Plätzer 1998, p.143ff). However, it does not resemble options of the consumer in real life, as cuttings of a newspaper cannot be bought as such and the consumer is normally not interested in a single news item. Nevertheless, results indicate that short documents containing a lot of information, such as graphs, maps or very compact abstracts which are read completely, are preferably distributed on paper. Results also indicate that future 'printing on demand', i.e. printing of parts of a newspaper, may provide an environmental sensible solution, as long as newsprint paper is used for the printing process.

The second functional unit is more a representation of real life choices and a typical example of a consumer's choice who frequently has to decide between options which are not exactly functionally equivalent, such as going somewhere by car or using public transport. Results of this approach show that for selectively used information, i.e. where the consumer can pick out whatever he likes, TV and internet lead to less environmental impact in relation to print media. However, the environmental advantage of the electronic media depends on a set of conditions:

1. Online information is not printed.
2. Internet surfing is directed towards specific goals and therefore limited in time.
3. To a large extent, power consumption is based on renewable energy sources. This still holds true for the underlying national electricity mix of Switzerland with a high share of hydropower.

Watching TV typically leads to far less environmental impact than surfing in the internet. One of the reasons being the way the impact of manufacturing of the electronic appliance was allocated to its use. The much lower impact per time unit of watching TV compared to surfing in the internet is the result of the longer overall use of the TV-set in relation to a privately used computer. The other reason is the lower power consumption per time unit of watching TV in

relation to surfing in the internet, if the operation of the infrastructure is also included.

The last approach, based on entire activities, supports the result of the previous approach.

7 Perspective

The case study has shown that comparisons of multifunctional products or services shut out relevant environmental aspects, if only reference unit functional equivalence is chosen. Results of the second and third approach show that such a single-minded approach would lead to the wrong conclusions with respect to reducing the global environmental impact. The author votes for application of several approaches in order to do justice to the multifunctionality of the investigated products or services. The concept of user acceptance promoted in ISO/TR 14049 (International Organization for Standardization 2000, p.9) offers such a possibility to compare products or services which are no longer functionally equivalent, however, are still considered equivalent by the user. Together with comparing entire activities, which may be based on average behaviour or specific lifestyles, it can be ascertained where relevant environmental impact should be tackled.

LCA practitioners in the agricultural sector have also been aware of the problem that there is no true and only functional unit (Udo de Haes 1996, Wegener Sleeswijk et al. 1996, Haas et al. 2000). Examples of such parallel functional units are unit area, yield per year or amount of protein per year, which are used aside. Obviously this does anything but resolve the problem to finally draw a conclusion taking the results of all the various approaches into account. The advantage of such a procedure is avoidance of recommendations leading in the wrong direction.

Acknowledgements. This study was funded by the Commission of Technology and Innovation (CH), the association for the promotion of research in graphic arts industry/ugra (CH), Swisscom (CH), Neue Zürcher Zeitung (CH) and Ringier (CH). The authors also thank Mr. M. Zurkirch (Swisscom, Bern) and Mr. H. Schefer (EMPA, St. Gallen) for their excellent work in the project team.

References

- AG für Werbemedienforschung (2000): MA Comis 2000, online report from: www.wemf.ch/de/produkte/comis.html
- AG für Werbemedienforschung (2001): Report Special 10. MA Comis, online report from: www.wemf.ch/pdf/d/Comis01%20Special.pdf
- AG für Werbemedienforschung (2002): MA NET, online report from: www.wemf.ch/d/studien/manet.shtml
- Behrendt S, Kreibich R, Lundie S, Pfitzner R, Scharp M (1998): Ökobilanzierung komplexer Elektronikprodukte. Springer, Berlin
- Brand G, Braunschweig A, Scheidegger A, Schwank O (1998): Bewertung in Ökobilanzen mit der Methode der ökologischen Knappheit – Ökofaktoren 1997. Schriftenreihe Umwelt Nr. 297. Bundesamt für Umwelt, Wald und Landschaft (BUWAL), Bern
- Bundesamt für Statistik (1990): Personal communications with BFS about household inhabitants and age groups based on the census in Switzerland in the year 1990.

- Dreier T, Wagner U (2000): Life Cycle Analysis of a Personal Computer and Peripheral Equipment. International Conference Electronic goes Green 2000+, VDE, Berlin
- Goedkoop M, Spriensma R (2000): Eco-indicator 99. A damage orientated method for Life Cycle Impact Assessment. Methodology Report. PRÉ Consultants B. V., Amersfoort
- Haas G, Wetterich F, Geier U (2000): Life Cycle Assessment Framework in Agriculture on the Farm Level. *Int J LCA* 5 (6) 345–348
- International Organization for Standardization (1997): ISO 14040: Environmental Management – Life Cycle Assessment – Principles and Framework. Geneva
- International Organization for Standardization (1998): ISO 14041: Environmental management – Life cycle assessment – Goal and scope definition and inventory analysis. Geneva
- International Organization for Standardization (2000): ISO/TR 14049: Environmental management – Life cycle assessment – Examples of application of ISO 14041 to goal and scope definition and inventory analysis. Geneva
- Jedele M (1999): Personal communication on measurements of tv user behaviour (telecontrol). SRG, Zürich
- Johnson E (1998): LCA Study of the Product Group Personal Computers in the EU Ecolabel Scheme, March 1998. Atlantic Consulting and IPU, London
- Laitner JA (2000): The Information and Communication Technology Revolution: Can It Be Good for Both the Economy and the Climate? EPA, Office of Atmospheric Programs, Washington DC
- Oiva L, Oppermann W, Middendorf A, Zuber H, Stobbe I (2000): Case study on the environmental impacts of a mobile phone. International Conference Electronic goes Green 2000+, VDE, Berlin
- Plätzer ET (1998): Papier versus Neue Medien: Eine Analyse der Umweltverträglichkeit von Presseinformationen im Licht des technologischen Wandels. Dissertation, Fachbereich Rechts- und Wirtschaftswissenschaften. Technische Universität, Darmstadt
- Romm J (1999): The internet economy and global warming. The Center for Energy and Climate Solutions, Annandale, VI
- Rydberg T, Östermark U, Eriksson E (2001): Life Cycle Assessment of a Videoconference – A comparative study of different ways of communication. 13th Discussion Forum of Life Cycle Assessment. Environmental Impact of Telecommunication Systems and Services, EPFL, Lausanne
- Soldera M (1995): Öko-Computer. LIS, Vaduz/Chur
- Schweizerische Radio und Fernsehgesellschaft (2000): Presseunterlagen des Mediengesprächs des SRG SSR Forschungsdienstes und der Publica Data AG vom 4. April 2000. Bern
- Strubel V, Gensch CO, Buchert M, Bunke D, Ebinger F, Heber E, Hochfeld C, Griesshammer R, Quack D, Reichart I, Viereck HG (1999): Verbundvorhaben: Beiträge zur Entwicklung einer Kreislaufwirtschaft am Beispiel des komplexen Massenkonsumproduktes TV-Gerät. Teilvorhaben 1: Ökologische und ökonomische Begleitforschung. Im Auftrag des Bundesministerium für Bildung und Forschung (BMBF). Öko-Institut, Freiburg/Darmstadt
- Udo de Haes H (1996): LCA: approaches and bottlenecks when applied to agriculture, food and forestry. International Conference on Application of Life Cycle Assessment in Agriculture, Food and Non-Food Agro-Industry and Forestry: Achievements and Prospects. Vlaamse Instelling voor Technologisch Onderzoek, Brussels
- Verband der Schweizerischen Zellstoff-, Papier- und Kartonindustrie (2000): Personal communications of ZPK about Swiss paper consumption in 1999 differentiated according to different paper types, Zürich
- Wegener Sleswijk A, Kleijn R, van Zeijts H, Reus JA, Meussen van Onna MJ, Leneman H, Sengers HH (1996): Application of LCA to agricultural products: 1. Core methodological issues; 2. Supplement to the 'LCA Guide'; 3. Methodological background. Centre of environmental Science Leiden University (CML), Centre of Agriculture and Environment (CLM), Agricultural-Economic Institute (LEI-DLO), Leiden
- Zurkirch M, Reichart I (2001): Environmental Impacts of Telecommunication Services. Two Life-Cycle Analysis Studies. *Greener Management Journal* (32) 70–88

Received: February 11th, 2003

Accepted: June 19th, 2003

OnlineFirst: June 30th, 2003

See the reference Haas G, Wetterich F, Geier U (2000): *Int J LCA* 5 (6) 345–348

Life Cycle Assessment Framework in Agriculture on the Farm Level

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DOI: <http://dx.doi.org/10.1065/lca2000.11.038>

Abstract. Life Cycle Assessment (LCA) is a method that can be used to assess the environmental impact of agriculture, but impact categories and the functional unit of classical LCAs must be adapted to the specific agricultural production process. Serving as an example, the framework of a LCA of 18 grassland dairy farms covering three farming intensity levels and carried out in the Allgäu region in southern Germany is presented. By focusing on the chosen impact categories and the respective, suitable functional units, the specific needs and backgrounds of conducting an agricultural LCA are discussed in general.

Introduction. In this paper, the framework of the Allgäu-LCA is emphasised, especially the selection of appropriate impact categories and functional units to fit specific agricultural and regional requirements in order to compare the impact of farms as well as farming intensity levels.

Conclusion. LCA in agriculture must cover all central environmental impacts. Suggested impact categories for classical LCA's either must be adapted or cannot be applied. Particularly the term 'land use' must be specially defined. In the Allgäu-LCA, 'land use' was converted to 'landscape image', 'soil function/strain' and 'biodiversity' as separate impact categories. The selection of appropriate functional units is essential when assessing impacts and interpreting the results, because in certain impact categories several functional units can be used. In general, in the Allgäu-LCA, the functional unit 'area' and 'farm' were used. The product-related functional unit served only in some abiotic impact categories as an additional figure when often used in the agri-environmental discussion or if international and global impacts are focussed from a national point of view. However, the functional unit product in agricultural LCAs should solely be used if a reasonable cause exists and allocation problems are satisfactorily solved, which will rarely be the case.