

New LCA Theses

Environmental Consequences of Food Consumption: A Modular Life Cycle Assessment to Evaluate Product Characteristics

Who hasn't been standing once in front of the supermarket shelf and asked herself if the organic carrots from Italy or the cauliflower from her own country is the most ecological choice for the next meal, and then, finally, has decided to buy the delicious asparagus from the USA. The extent of environmental impacts of food consumption depends on various factors. It is not easy for consumers or even for experts to account for these impacts.

The goal of this research work was to assist consumers in considering environmental aspects. Different levels of decision-making for the consumer were distinguished while judging the environmental impacts of consumption patterns. The consumers can recognise the environmental burden by considering certain product characteristics, corresponding to the determinants of environmental impacts. Various combinations of the product characteristics are possible when a consumer looks for food in a shop. A diary survey, conducted in collaboration with a group of psychologists, asked for these characteristics.

The aim of this research work was to support consumer decisions and to highlight the characteristics of a product that are most important with respect to the environmental impacts. The following questions should be answered:

- How can impacts of food purchases be assessed in a scientific way?
- What are the possibilities for an ecological behaviour from the consumers' point of view?
- How far do different consumers realise an environmentally sound behaviour?
- Which restrictions for an ecological behaviour do different consumers face?

Meat and vegetables were chosen as examples in the necessity field of nourishing. These two product groups together account for about 40% of the total energy use due to food consumption. The environmental assessment for food purchases has been simplified by using a modular life cycle assessment (LCA) approach. In this approach the inventory is split into five modules according to the important product characteristics. At the end, the results of the five separate modules can be aggregated, to assess the total environmental burden of a purchased product.

The Eco-indicator 95 and the Swiss method "Ecological Scarcity" have been used as methods for valuation. Both impact assessment methods do not vary much as to the general messages. The overall impact of meat products is dominated by the agricultural production. Differences from the consumers' point of view arise mainly from differences among meat from organic and from integrated production. The import of fresh products from overseas by air adds significant environmental impacts. Other product characteristics,

such as packaging, conservation method and consumption, are of minor importance.

The impacts of animal production vary for the different types of meat. Poultry and pork show the lowest impacts while grazing animals show the highest. This point would merit further investigation (by means of a more detailed, e. g. marginal LCA) because from a top-down perspective it does not seem to make sense to produce more pork instead of meat from grazing animals in Switzerland.

In case of vegetable purchases, all characteristics might have a relevant contribution to the environmental impacts. Production in the greenhouse has much higher impacts than open-air production. The consumption stage adds significant impacts to the inventory. The region of production, and corresponding transports, are important especially if vegetables are flown in from overseas. Packaging, which has gained a lot of public awareness in the past, does not add much to the total environmental scores and thus is not relevant to be considered in consumers' decisions (for this example of vegetables and meat). High differences exist between the products with the lowest and the highest impacts. Purchases of a certain amount of food may differ by a factor of seven or nine in the environmental impacts caused for meat and vegetables respectively. The comparison shows lower scores for organic products, compared to products from integrated production, but this result is unsure and thus needs further research work by LCA.

People do not only differ in their behaviour, but also in their constraints and resources. Acknowledgement of these preconditions has important implications for intervention strategies aimed at fostering environmental behaviour. Therefore, subgroup differences in consumption patterns were investigated. A sample of 134 consumers reported the characteristics of their meat and vegetable purchases in a diary over a period of four weeks. It could be shown that people from different subgroups do differ with regard to the environmental impacts caused.

The ecological relevance of meat and vegetables for the whole purchases was assessed with energy use as an indicator. The expenses for different product groups, reported in the diary study, were used to calculate this energy use. This broad estimation shows some variances between different consumer subgroups. It also highlights the importance of meat consumption. Reducing the amount of meat consumed, might be an option for minimising the environmental impacts due to nutrition that should be investigated in more detail in forthcoming studies.

Consumers will normally not buy only the less polluting product. However, they can adopt their behaviour to buy more environmentally friendly. Starting from the average

purchases investigated in the diary study, different options for these changes were compared. The highest change for a meat or vegetable purchase is caused by a renunciation of fresh products flown in from overseas. A second important option, is a preference for organic products.

The modular LCA, which has been developed in this thesis (JUNGBLUTH et al., 2000), points-up the importance of different product characteristics. The method makes it possible to assess "environmental behaviour" of persons based on information about their consumption patterns. The LCA approach is simplified if a range of similar products is investigated and if knowledge of LCA studies can be used to identify hot spots and main inputs to the life cycle. Some of the results have been made available on www.ulme.uns.umnw.ethz.ch in order to enable consumers to evaluate the environmental impacts of their food purchases.

This book is of interest for all people working on the ecological assessment of food products, those dealing with the environmental impacts of consumption patterns or the decision-making situation of consumers. The thesis and a data annex can be downloaded free of charge at: <http://www.uns.umnw.ethz.ch/~jungblu/dis.html>. A hardcopy of this thesis is available for EUR 25.00 from the author Niels Jungbluth, ESU-services, Zentralstrasse 8, CH - 8610 Uster, T: +41 1 940 61 32, F: +41 1 940 61 94, email: jungbluth@gmx.net.

Niels Jungbluth, Umweltfolgen des Nahrungsmittelkonsums: Beurteilung von Produktmerkmalen auf Grundlage einer modularen Ökobilanz. Februar 2000, 317 Seiten, Dissertation ETH Nr. 13499, Umweltnatur- und Umweltsozialwissenschaften, Eidgenössische Technische Hochschule Zürich, ISBN 3-89825-045-8, dissertation.de, Berlin.

New LCA Theses

Development of a Multicriteria Decision Support System for Integrated Technique Assessment

In recent years environmental policy has changed from focusing on single environmental media towards integrated pollution prevention and control, taking into account all environmental media. For this reason, the necessity to control the relevant mass and energy flows becomes more and more important. Because the implementation of new techniques has effects on the whole process of industrial production, an isolated consideration of single emission reduction techniques is no longer sufficient. Rather an integrated approach should be pursued which also considers possible conflicts between economic, technical and ecological criteria. Appropriate methods for integrated technique assessment, however, are still in their initial stages.

The objective of this research work is therefore to demonstrate the benefits of a multicriteria decision support system for integrated technique assessment, considering technical, economic and ecological criteria, and its application to the iron and steel making industry.

In the first Chapters, a concise survey on the technical and economic preconditions as well as of the environmental legislation for iron and steel production in Germany and Europe is given. Special emphasis is put on the analysis of the latest development in Environmental Policy in the EU towards integrated pollution prevention and control.

A comprehensive analysis of the currently discussed methods for Life Cycle Assessment (LCA) with regard to integrated technique assessments concludes that LCA can only point out mass and energy flows with high ecological priority. Another shortcoming has to be seen in the lack of a systematic consideration of technical and economic criteria.

Therefore, a concept for an integrated approach for technique assessment has been elaborated, based on MCDM methods (MCDM = Multi Criteria Decision Making) for the simultaneous evaluation of the decisive ecological, technical and economic criteria. The preconditions for MCDM and the different approaches are explained with regard to the special requirements for integrated technique assessment.

The methodological core of the research work is the chapter on the enhancement of the outranking-method PROMETHEE which is a specific MCDM method. PROMETHEE proves to be a suitable approach for the integrated technique assessment thanks to its flexible algorithm. This allows tailor-made enhancements to meet specific requirements for an integrated technique assessment. Fuzzy-logic approaches are integrated into the PROMETHEE algorithm for the evaluation of vague scores and weighting factors. This allows a far-reaching utilisation of the limited available information from both an ecological evaluation and a process simulation of innovative techniques for emission reduction. In addition, a graphical sensitivity analysis is introduced for the outranking-method PROMETHEE which shows the limits of the derived results.

The multi criteria decision support system is applied to two case studies from the iron and steel making industry for the determination of Best Available Techniques (BAT), which are to be identified for numerous industrial installations as required by the European Directive on Integrated Pollution Prevention and Control (IPPC-Directive 96/71/EC), and for company internal preparation of investment decisions, where results from process simulations form the base of information. Thus, decision makers in industry and policy are able to analyse innovative emission reduction techniques at an early stage of planning.

The research work gives a broad overview on the current state of technique assessment, on the interrelations between environmental policy, techno-economic and environmental conditions, and on decision theory.

Jutta Geldermann, Entwicklung eines multikriteriellen Entscheidungsunterstützungssystems zur integrierten Technikbewertung. Fortschritt-Berichte VDI, Reihe 16 (Technik und Wirtschaft), Nr. 105, Düsseldorf (1999). ISBN: 3-18-310516-0. 223 pages, numerous Figures and Tables, DM 134;-- (special discount rates)