Social Aspects for Quantifying Advantages of Renewable Energy Carriers

L.-P. Barthel, M.-A. Wolf, C. Makishi, P. Eyerer
IKP-Dept. LCE, University of Stuttgart
Hauptstrasse 113, 70771 L.-Echterdingen, Germany
Tel.: +49 711 489999-32, Fax: -11
barthel@ikp2.uni-stuttgart.de

Abstract

Until now LCA studies were merely carried out assessing the economical and ecological dimension of products, processes and services. In the last time a third dimension gained more and more attention: the social dimension.

In this part it is attempted to cover a vast field of most different effects on society. Until today a broadly accepted solution is not found. In this paper a method of assessing these effects is presented for the sake of further discussion and development in this new field.

For the use and production of renewable energies the social dimension will play a major role, as the agricultural production is rather labour-intensive and creation of additional jobs – especially in rural areas of developing countries – can be shown using this method.

In this paper the so called social profiles of to energy related feed stocks shall be shown as an example for the expressiveness of the obtained data: the social effects of the production of 1 kg crude oil and the impacts of the production of 1 kg glucose from corn. They can be used to evaluate certain social impacts under a life cycle perspective and demonstrate how the gained knowledge can be used for decision support, by fostering the sustainability approach.

Keywords: Sustainability, social, Life Cycle Assessment (LCA), working environment, Life Cycle Engineering (LCE)

Methodology of Life Cycle Environment (LCWE)

For consideration of social effects related to the production of renewable energy carriers a life cycle based approach is needed for the same reasons as in the ecological field:

- to avoid shifting of social problems from one life cycle phase to another and
- to locate “hot spots” where it is most pressing to change something.

This work shows how the generated data Approach

By assessing detailed statistical data social effects of industry branches are prorated to single processes. These data can be used in an process chain analysis to generate knowledge and statements about the social effects of the produced energy carrier. The method is feasible and was already put to the test. Currently the method is being refined and enhanced.

Data Acquisition for Every Single Process

The social indicators have to be collected for each process in the production chain. This data is not available and initiation of its continuous ascertainment would be cost intensive and time consuming.
On the other hand a meaningful use and comprehensive approach for such indicators was non-existent so one could not know what data to measure and to collect.
To break this vicious circle, for the beginning the second attempt is chosen, but the data acquisition for every single process remains the middle- to long-term goal.

Prorate Aggregate Data to Single Processes

Statistical data concerning social issues is available for most of the highly developed countries, for some of them detailed enough to use them in the LCWE methodology.

To prorate this data down to process level we are acting on the following assumptions:

- The social impacts of a process are related to the amount of human labour of the process
- The amount of human labour of a process is related to the effort made to add value by processing (which is equivalent to the added value itself)

These assumptions are assumed to be valid within the same industry and in the same country only.

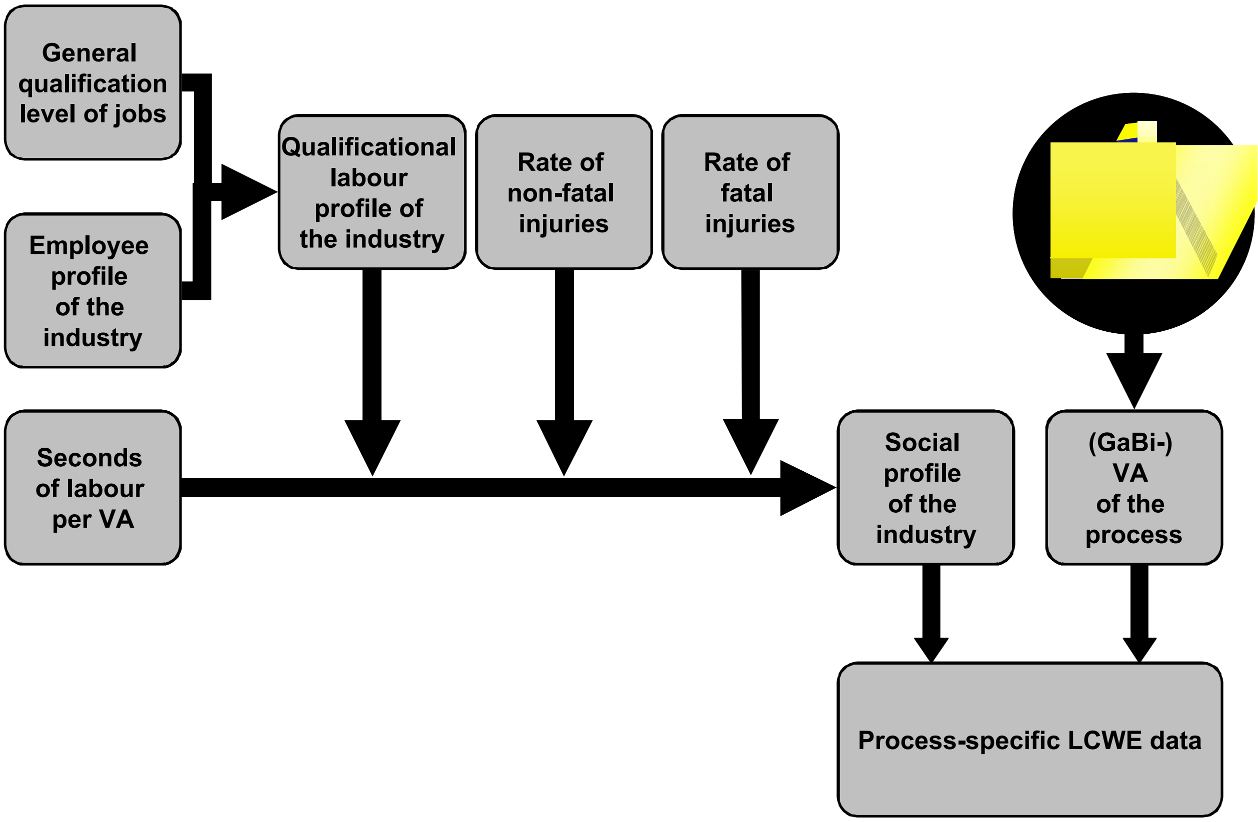

Figure 0.1: Generation of process-specific social Information

General Qualificational Level (GQL) of jobs

The General Qualificational Level corresponds to the International Standard Classification of Education [**ISCED 1997**] which was designed by UNESCO in the early 1970's. In addition qualification on the job and the generally required capability of the jobs is considered.

Employee profile of Industries, Rate of non-fatal Injuries, and Rate of fatal injuries

The "Employee profile of Industries", the "Rate of non-fatal Injuries", and the "Rate of fatal injuries" are all deduced from different statistics and national databases of the industry branches.

Qualificational labour profile of industries

Combination of the Employee profile with the list of qualificational levels leads to the qualificational labour profile for each Industry. This profile shows how much of the worked time in the industry is accomplished on which qualificational level. The following assumptions are therefore applied:

- There are no major differences in the annual working time between employees of different qualificational levels
- The share of employees for which no data was available has the same composition of qualificational levels like the rest

All recorded employees in each industry have been up-scaled to 100 percent (second assumption).

Seconds of labour per VA

The seconds of labour per added value are also derived from different statistics and national databases of the industry branches. They have been calculated from the values for

- Number of employees
- Average number of production workers
- Production worker hours
- Cost of contract work and
- Value added.

To get the total worked hours the "production worker hours" have been multiplied with the ratio of "number of employees" to the "average number of production workers".

Social profile of industries

The social profile of the industries is calculated from the "Seconds of labour per VA", the "Qualificational labour profile of industries", the "Rate of non-fatal Injuries", and the "Rate of fatal injuries". So finally we arrive at an profile for each industry which shows the values of working seconds for each general qualificational level, in total, the non-fatal and the fatal injuries based on one Euro added value in the corresponding industry.

Added value of the processes

The added value of the single process is determined by subtracting the cost of the input flows from the cost of the output flows. Here cost means the value of the flows which is determined by multiplying the price with the quantity of the flow.

Generation of the process-specific LCWE data

The generation of the process-specific LCWE data is then accomplished by multiplying the social profile of the industry with the added value of the process.

Implementation in the Software

The LCWE part of the software displays the three areas Qualified Working Time (QWT), Health and Safety (HSWT), and Humanity of Working Conditions (HWT) in separate tables. They are also separated into INTERNAL and EXTERNAL areas. However, these can also be aggregated into a total value.
To be integrated into the existing LCA-methodology, social measures have to comply with an extended set of criteria, e.g. process-relatedness, quantifiability, additivity, international comparability, data availability etc. Suitable measures and indicators have been identified which meet these criteria and cover an important share of the social safeguard objects.
The data quality is argued to be much better than input/output-matrix based data since it integrates statistical level data with unit process level data. Compliance with a pre-defined set of criteria assures world-wide applicability, comparability and consequent harmonization with LCA methodology and practice.
The indicators listed here are brought in relation to the performed work time within each respectively viewed *process*. Work time has here the function of a basic reference quantity. This context is used when relating the indicators to the functional unit of the *process*. For example, the process of manufacturing 1 kg of tool steel has a basic "paid work time" indicator with the basic measurement quantity of "seconds of paid work per kg of tool steel".
This basic reference quantity is then further specified with the help of other indicators. For example, the indicator "qualification profile of workplace" yields the measurement quantities "seconds of paid work at qualification level A per kg of tool steel" (with total of 5 qualification levels from A = "diploma and higher" to E = "untrained/trainee"). The indicator "occupational accidents not resulting in death" yields the rate of "occupation accidents not resulting in death per kg of tool steel", for example. All other indicators are used the same way. If a reference to the performed work seconds is created, it is initially possible to unambiguously refer to the functional unit of the *process*. Furthermore, the values of the measurement quantities can be quantitatively aggregated across the entire life cycle of the products. Only this quantification (displayed in absolute number values that can be added) makes it possible to summarize the social indicators covering the product life cycle related to the product and thus allows for meaningful comparisons between products and *processes*. Now it is finally also possible to harmoniously embed the social sustainability indicators into the methods and software of the overall balancing and LCWE.
The selection of system limits, cut-off criteria, and allocation methods, as well as characterization, normalization, and (by expansion of the ISO standard possible) weightings of the active categories - as described in the eco-balancing according to ISO 104040 et ssq. – follows the same steps as the selection of social indicators. [GaBi4 2003]

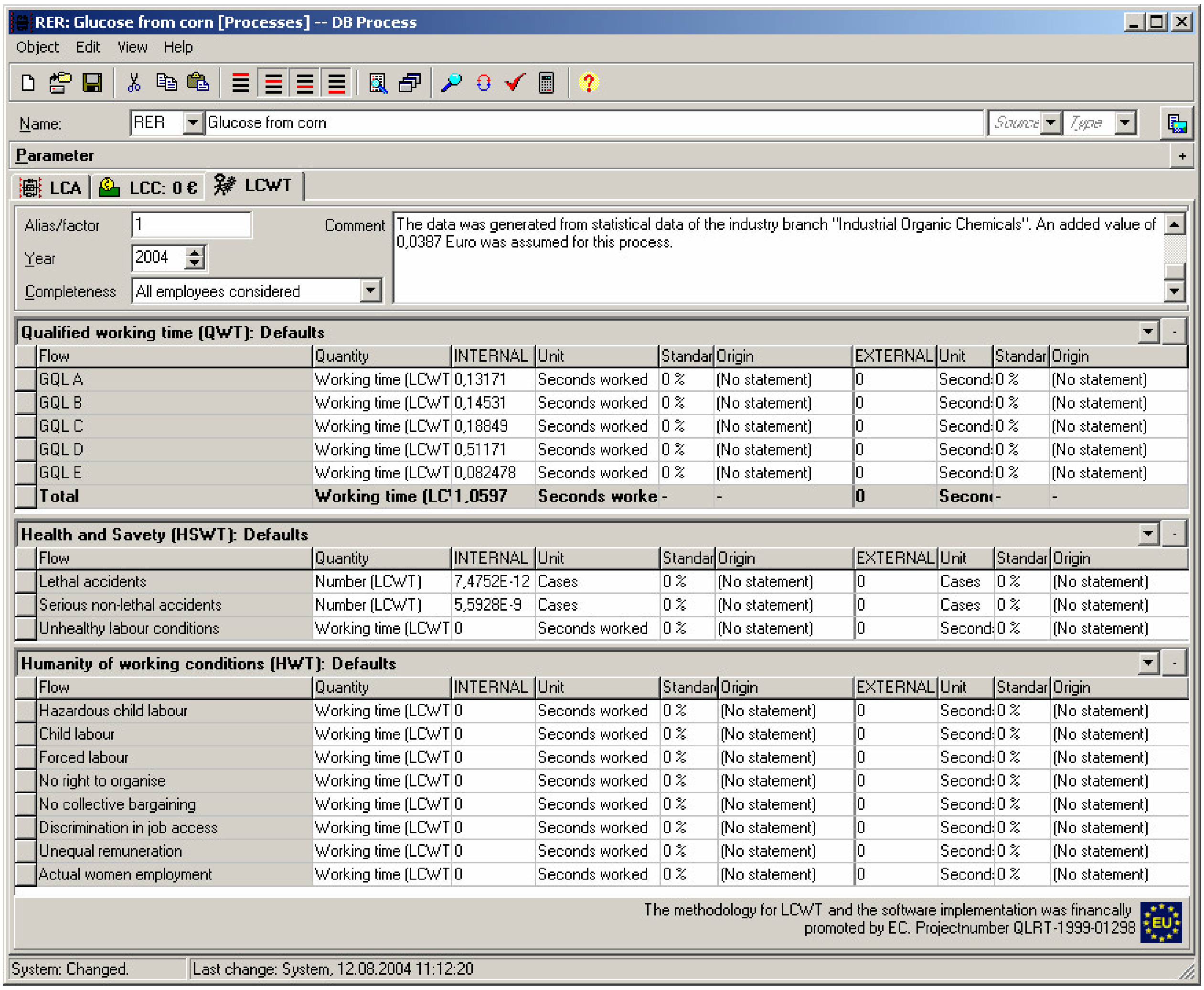

Figure 0.2: Screenshot of the LCWE-Section in GaBi4.

Results

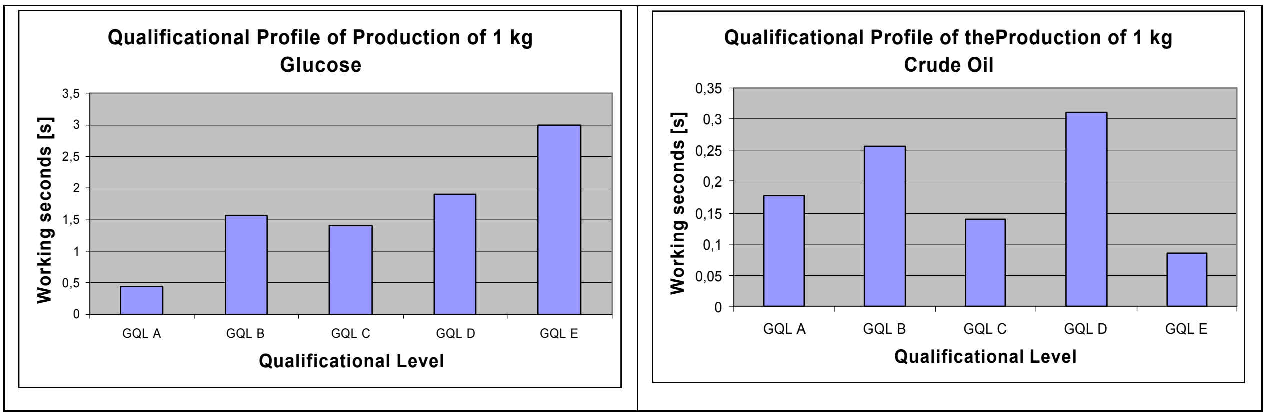

Figure 0.3: Required work for the production of 1 kg glucose from corn respectively of 1 kg crude oil divided into different categories of qualification.

Figure 1 shows the social profiles for the production of 1 kg of glucose from corn respectively of 1 kg crude oil (Please note the different scale of the ordinate). For the production of the glucose the fraction of work on a low qualificational level is high and decreases the higher the regarded qualification.

A different picture results for the crude oil production. Here one has a peak at the qualificational level D, which compromises jobs affording (Upper) secondary education. The lowest share is contributed by the qualificational level E, which comprises all qualifications up to lower secondary or second stage of basic education. But there are a lot of people with a high qualification and education needed.

The results for lethal and non-lethal accidents show an interesting picture, too. The numbers for the two cases are shown in the following table:

Table 0.1: Lethal and non-lethal accidents for the production of 1 kg glucose from corn respectively of 1 kg crude oil

	1 kg Glucose from corn	**1 kg Crude Oil**
Lethal accidents	2,65E-09	3,24E-11
Non-lethal accidents	8,89E-08	2,43E-09

The accidents rates in the agricultural sector are quite high, which leads to the high accidents rates for the glucose from corn.

Conclusions

Energy carriers from renewable resources show slight advantages in certain fields of social relevance. In others potential for improvements could be identified. The social profiles comprising data about the required work and qualificational composition and lethal and non-lethal accidents show remarkably interesting details and are able to quantify possible advantages of renewable energy carriers over fossil resources.

References

ISCED 1997 **UNESCO General Conference:** International Standard Classification of Education ISCED 1997 http://www.unesco.org/education/information/nfsunesco/doc/isced_1997.htm; 22.08.2004

GaBi4 2003 **IKP, PE:** GaBi 4 Software-System and Databases for Life Cycle Engineering, Stuttgart, 1992-2003.