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Technical report on needs and demands of SMEs

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Abbreviations

LCA	Life Cycle Assessment
PCF	Product Carbon Footprint
ISO	International Organisation for Standardisation
EC	European Commission
UNEP	United Nations Environment Program
RoHS	Restriction of Hazardous Substances
REACH	Registration, Evaluation, Authorisation and Restriction of Chemical substances
IC	Integrated Circuit
LE	Large Enterprise
LCM	Life Cycle Management
PCB	Printed Circuit Boards
UN	United Nations

Executive Summary

The overall goal of the project is to develop LCA webtools customized for SMEs in the sectors bio-based plastics, industrial machines, electronics, semiconductors, printed circuit boards, renewables (stationary and mobile photovoltaic), sensors and smart textiles. To develop tools for each sector the goal in this task was to collect the needs per sector in a broad dialogue with SMEs. The needs assessment have been carried out in form of a questionnaire and with so called green papers, summarising possible needs seeking for feedback from SMEs.

In the needs assessment of the 8 sectors 228 responses were collected and analysed. The survey focused mainly on the status quo about the knowledge and the application of environmental assessment, the drivers and needs regarding environmental assessments and communications and about specific requirements on the targeted webtool.

The status quo is quite similar among all sectors involved. Most of the SMEs have relatively low knowledge about environmental assessments or LCA and also a lack in experiences with assessment tools can be mentioned. Moderately more knowledge can be stated in the bio-based plastic sector, semiconductors and stationary photovoltaics systems. The SMEs also have rather no internal environmental communication channels. Main drivers for carrying out environmental assessment are primarily customer demands and legislation valid for all sectors.

Bio-based plastics use renewable resources for producing plastic materials or products. Therefore the environmental impact is reduced compared to convenient plastic products. The main focus of environmental assessment in this sector will be on the life cycle phases of raw material extraction and manufacturing phases. The companies indicate clearly that the environmental performance should be communicated in form of a Product Carbon Footprint.

In the sector renewables the focus is on stationary and mobile photovoltaics (PV). Companies from the stationary photovoltaics business are interested in calculate energy respectively CO_2 payback times or Net Energy Gain respectively net greenhouse gas emissions reduction. For environmental communication a label is of interest to a couple of enterprises. The sector mobile PV products is rather small in Europe might be appropriate to roadtest the intersectoral synergies from PV and electronics sectors, but not to establish a stand-alone tool for this sector specifically.

Smart textiles companies range from traditional textile industry or electronic producers to high-tech enterprises or design consultancies. As an "emerging sector" there is a chance to implement environmental assessment right from the beginning of the technology innovation process. The tendencies in the preferred communication instruments are EU-Energy Efficiency Label and recycling rates.

Contrarily to smart textiles the sector of industrial Machines is one of the oldest engineering disciplines and a backbone for European economy. In this sector already first development in the ISO or within the ErP directive on environmental assessment exist where the focus is energy efficiency. Therefore it is logic that SMEs wish also a voluntary label focusing on energy efficiency for the environmental communication.

In the sector semiconductor of Taiwan the labeling of carbon footprint is seen as an important future trend especially due to pressure from legislation. To ease up the calculation and to get more realistic results a national database to calculate Carbon Footprint is required.

In the general Electronic sector it has been pointed out that material declarations could serve as starting point to implement LCA because this data are the most requested ones. This is mainly due to environmental regulations (e.g. RoHS directive). One more important demand for the future will be for energy related data. At present SMEs require material declarations and Carbon footprint for communication in the future.

The needs in the printed circuit boards sector are similar to the general Electronic sector. Materials are relevant according to main focus in a life cycle perspective, customer demand for material data and material inventory lists and environmental reports are favored the most for environmental communication. Energy during uses stage is not in focus.

Of specific interest in the sector sensors are the energy savings related to the use phase of sensor systems, which is also of main interest for environmental communication. Besides this aspect, overall equipment effectiveness has also been identified as one potential key indicator for the methodology.

The requirements regarding environmental aspects and communication are quite various across the sectors. Whereas the wish list for the tool shows more conformities. The common needs are the possibility to import and export data, the tool should not be time and cost intensive and easy to use.

In the next step of the project the methodological concept will be developed. This concept will be defined according to the results of the needs assessment, the main aspects from the view of environment and the actual and future legislation. Therefore further research on LCA and similar assessment case studies and on the status regarding environmental legislation and standards is needed. Further all sectors will further foster the integration of SMEs in the project, close cooperation with the manufacturing associations and exchange knowledge with other ongoing research projects in this area.

1 Introduction

"Micro, small and medium-sized enterprises (SMEs) are the engine of the European economy. They are an essential source of jobs, create entrepreneurial spirit and innovation in the EU…" [EC 2005]. These words from Günter Verheugen, a member of the European Commission, point out the significant role of SMEs. But that's not the only reason why the LCA to go project focuses on them. The goal to spread the application of LCAs across European SMEs can contain advantages for the companies themselves.

The methodology of environmental assessments, already established well in ISO 14040, is time and resource intensive for companies especially for SMEs. This method has to follow the paradigm of sustainability. It integrates the ecological, economic and social dimension to a concept which can prepare our economy in a long-term view. Moreover it can be recognized that LCA to go project targets all stakeholders are in touch with LCA issues. Politicians, CEOs, scientists, engineers, marketing staff, NGOs as well as costumers.

There are existing different drivers and causes for spreading life cycle thinking. Main causes are the environmental issues in which policy, economy as well as consumers have to become aware of. In discussion are topics like energy consumption, raw material use, greenhouse gas emissions or water consumption. In the last few years the most popular problematic the global community and media focussed on was climate change. To come up to these future challenges not only the importance of environmental assessments is raising.

In the first stage, implementing environmental assessment, work package 1 comes up get in touch with the SMEs of the target sectors for investigate their needs and demands regarding LCA.

The European Union has to fulfil their emission reduction goals without generating disadvantages for their economic strength. With LCA tools and data this process can be supported. For the consumers this means more transparency in terms of the supply chain, the single materials or the energy efficiency. If the energy prices and the cost for raw materials raise it`s important for the SMEs to react with innovations, adapted to the circumstances. The LCA to go project has the ability to enhance the potential of SMEs through knowledge improvement around environmental management and communication. With the support of a software tool for free, there will be data output and moreover the assessments can directly show possibilities for product innovations.

This report shows the results of task 1.1 in the first work package. The purpose of the needs assessment is to get in contact with the SMEs of the target sectors to find out the status-quo regarding the application of environmental assessments and to figure out their wishes for an environmental assessment tool. The final output is a wish list for the SMEs.

With remote inquiries, guided interviews and workshops, the demands and interests of SMEs are investigated sector wise. A survey and green papers covering topics like requirements regarding a software tool or barriers for acceptance are prepared.

Achieving comparability of the results, each chapter has the same structure. Following this scheme every sector focuses on general information about sectoral specifications, the status quo in the SMEs and as main objective the wish list with the most important needs of the companies. Showing further steps the end of each "sector- chapter" finalizes with an outlook. Moreover it will proceed with an overall sectoral analysis. With that, the differences and similarities between the sectors as well as the discrepancy and consistency within the sectors will be outlined.

2 Methodology

2.1 Definitions

Micro, small and medium-sized enterprises-SME

"The category of micro, small and medium-sized enterprises (SMEs) is made up of enterprises which employ fewer than 250 persons and which have an annual turnover not exceeding 50 million euro, and/or an annual balance sheet total not exceeding 43 million euro." [EC 2005]

Next figure shows an overview about the thresholds of SMEs defined by the European Commission.

Enterprise category	Headcount: Annual Work Unit (AWU)	Annual turnover	or	Annual balance sheet total
Medium-sized	< 250	≤ €50 million (in 1996 € 40 million)	or	≤ €43 million (in 1996 € 27 million)
Small	< 50	≤ €10 million (in 1996 € 7 million)	or	≤ €10 million (in 1996 €5 million)
Micro	< 10	≤ €2 million (previously not defined)	or	≤ €2 million (previously not defined)

Figure 1: Thresholds of SMEs according to European Commission [EC2005]

Additionally has to be mentioned that in the Taiwanese semiconductor study SMEs are limited with 200 maximum numbers of employees. There a differentiation between SMEs and Large enterprises has been made.

Life Cycle Assessment

- General definition

"Life Cycle Assessment is a tool for the systematic evaluation of the environmental aspects of a product or service system through all stages of its life cycle. LCA provides an adequate instrument for environmental decision support. Reliable LCA performance is crucial to achieve a life-cycle economy.

The International Organisation for Standardisation, a world-wide federation of national standards bodies, has standardised this framework within the series ISO 14040 on LCA."[1] [UNEP, s.a]

In ISO 14040 LCA is defined as follows:

"LCA addresses the environmental aspects and potential environmental impact (e.g. use of resources and the environmental consequences of releases) throughout a product´s life cycle from raw material acquisition through production, use, end-of-life treatment, recycling and final disposal (i.e. cradle-to-grave)".[2]

- Streamlined/simplified LCA

The general definition of LCA according to UNEP and ISO both requires a comprehensive assessment of all life cycle phases. This is associated with a high time and data effort. There are already methods developed to compass difficulties like that.

Guinée et al. [2001] defines a simplified LCA more exactly as "a simplified variety of detailed LCA conducted according to guidelines not in full compliance with the ISO 14040 standards and representative of studies typically requiring from 1 to 20 person-days of work". Therefore the goal of the study can still be reached by reducing the amount of data needed.

- Specific in LCA to go project

One goal of LCA to go project is to develop an easy to use software tools especially for SMEs. Therefore a comprehensive assessment according to ISO 14040 is not always leading to the desired results. A simplified approach like streamlined LCA is therefore demanded and lead to the following definition:

LCA within this project LCA to go is meant as an environmental assessment method over the entire product life cycle aiming at the identification of environmental impact categories which are then represented in an easy to use tool for industry

[1] http://www.unep.fr/scp/lifecycle/assessment.htm

[2] EN ISO 14030:2006

Definitions and terms related to LCA

Life cycle	consecutive and interlinked stages of a product system, from raw material acquisition or generation from natural resources to final disposal
Environmental aspect	element of an organization's activities, products or services that can interact with the environment
Environmental impact	any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organization`s environmental aspects
Environmental management system (EMS)	part of an organizations management system used to develop and implement its environmental policy and manage its environmental aspects
Environmental performance	measurable results of an organizations management of its environmental aspects
Raw material	primary or secondary material that is used to produce a product
Impact category	class representing environmental issues of concern to which life cycle inventory analysis results may be assigned

2.2 Subjects and objectives

The overall goal of the project is to develop LCA webtools customized for SMEs in the specific sector. To do so the general recognized needs per sector have to be collected in a broad dialogue with SMEs. To address exactly the needs of SMEs for each sector, the main goal of this task, they are integrated in the project in form of a questionnaire. The survey was targeted at the decision makers or the person who is responsible for environmental issues in the SME. If it was not possible getting answers from companies through the survey, a second approach with green papers has been chosen.

LCA is a tool for enhancing LCM by providing environmental assessement data which are useful in different areas ways. Figure 2 shows how Life Cycle Management and therefore LCA can be useful and beneficial. In which sections LCM can contribute company intern as well as extern is represented in the blue boxes around the circle. The different kind of impacts resulting out of LCM is suggested behind the turquoise arrows.

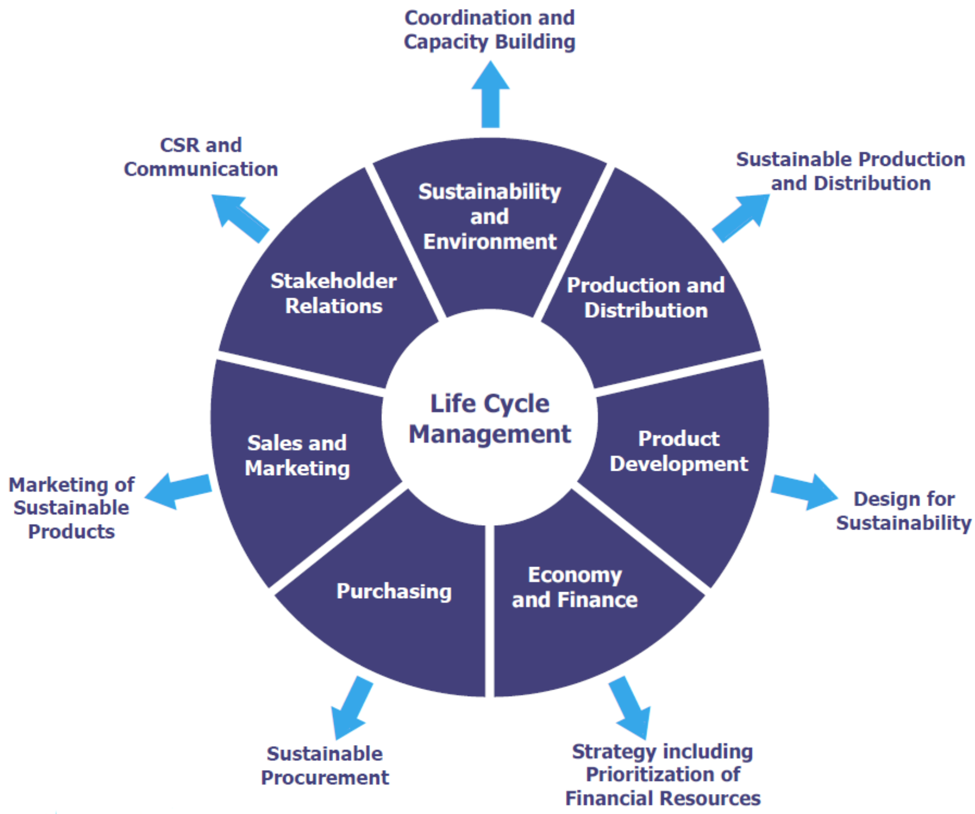


Figure 2: Different functions and contributions of LCM [UNEP 2007]

In the survey most aspects listed in the Figure 2 are investigated on what for is LCA already used and planed in the future in SMEs.

Reaching the overall project objective which is to develop framework conditions for implementing LCA tools, the **main objectives** of the needs assessment survey focus on following key points:

- General information and current status quo about knowledge and expectations regarding LCA and environmental assessments in the SMEs
- Needs and demands for:
  - Environmental assessments and applications
  - Environmental communication
  - LCA tool
- Sectoral cross case analyse
  - Comparing all sectors to find out key differences or similarities

- Contradiction and consistence inside the sectors` needs and demands

For the **European Commission** the results of the survey can be helpful in terms of legislation or as a basis about the innovation potential of SMEs. It gives an overview about the state of the art of the implementation of environmental assessment in the specific sectors. Nevertheless it can support the goal reaching European wide environmental goals according to emission reduction. It can be an economical advantage as well becoming a pioneer in environmental benchmarking for instance.

For the **SMEs** it`s interesting to see the development of the trend in terms of environmental issues. The results of the survey show the actual state in each sector and SMEs can take this as a benchmark by comparing their own experiences regarding environmental assessment. The survey and the project website can also be seen as the first dissemination activities also by raising the awareness on the topic.

For the **LCA to go project partner** the synthesis of all sectors in the end will be helpful for develop the methodology in the next work package. So the cross sectoral view is crucial not only for the scientific point of view but also for the further policy implementation. The partners from the different sectors will learn about environmental assessment and how LCA to go projects differs from the regular way of LCA approaches.

2.3 Survey

The developed questionnaire is available in English, German, Spanish and Polish at http://www.LCA to go.eu/survey. To complete the survey about 20 minutes for 26 questions are needed. For the questionnaire the following formats of questions are used: open questions, multiple choice and single choice.

Oriented on the objectives, the questionnaire is **structured** in three parts:

In **Part 1** the target is to characterise the sector and to get data for survey statistic. It was asked for general company information like name, sector, main products and number of employees, kind of business model and responsibility towards environmental issues. Furthermore it was called for job position of the person, who filled out the questionnaire.

In **Part 2** the goal is to identify present knowledge about LCA and environmental assessment in general. Therefore questions were about experiences in self-assessments on environmental impacts of their products by life cycle phase and by the most important environmental aspect. In detail there are questions about statements persons relate with

LCA and experiences in practice with LCA, assessment tools and familiar approaches. This should help to figure out drivers and obstacles to carry out environmental assessments and to identify the decision context situations (Referring to ILC Handbook).

Part 3 aims at requirements belonging to an environmental assessment tool and environmental communication. In this section of the questionnaire it´s identified which arguments and communication instruments are relevant for SMEs. This should show which kind of information and data they need from an environmental assessment. In the results of this section it should become obvious what kind of environmental information the tool should supply. To some degree it is also asked for specific software expectations. The closing question serves as an expression of interest from SMEs, for follow-up activities within the project.

To run the survey, it was needed to get in touch with the SMEs and find out the appropriate contact person. So they were contacted via email, telephone, in conferences or exposition giving them short information about the project and request them to fill out the questionnaire. If it was not possible getting survey answers from the companies, green papers were used for guided interviews or workshops for further discussions.

The classification of the survey results was undertaken according to the main objectives (see 2.1). This evaluation can be recognized in the structure of the report for all sectors. For each answer the absolute and relative frequencies were appointed related to the number of responding companies. Through the interpretation of the results could be prepared the wish list for sectoral LCA needs.

In the sector semiconductor was developed and used another questionnaire. The survey was conducted before the common LCA to go survey. But nevertheless the content is similar to the common LCA to go questionnaire. The main difference is their focus on carbon footprint and the additional view on larger enterprises. In the chapter semiconductors is more detailed information to the method.

2.4 Green Papers

"Green Papers" were developed to summarize possible needs anticipated among SMEs of a given sector, seeking feedback from SMEs. The "Green Paper" serves as a basis for workshops and to get direct feedback from SMEs, including "LCA to go" partners. These "Green Papers" have been developed for the sectors electronics (including a variant for semiconductors), sensors and photovoltaic as "thought-starters" to provoke comments, either confirming the scenarios laid down in the "Green Papers", or to express an opposing view.

2.5 Cross sectoral analysis

To get a synthesis out of the separately considered sectors in the specific reports a cross sectoral analysis was conducted in the conclusion of the report. The goal was to compare all sectors under different aspects for finding the main differences and similarities. These synergies are then essential for the next task 1.2 development of the methodological sector concepts and also when developing the LCA to go webtool's. If synergies can be identified the structure of the webtool can be used at least partly for more than one sector. The aspects of comparison are:

- General survey topics
- Specific sector characteristic
- Main focus the environmental assessment should consider, depending on what`s the major environmental aspect for each sector
- Knowledge about environmental issues
- Environmental communication preferred
- Requirements for the LCA software tool

3 Sector specific reports

This chapter points out the results of the survey for each sector. It should demonstrate the features and characteristics to get an insight about the requirements of SMEs. For each sector is given general information, the survey statistic and the wish list regarding environmental assessment. Afterwards a short summary about the needs, conclusion and outlook is given.

The following sectors were considered:

- Bio-based plastics
- Industrial machines
- Electronics
- Semiconductors
- Printed Circuit Boards
- Stationary Photovoltaic
- Mobile photovoltaic
- Sensors
- Smart Textiles

3.1 Bio-based plastics

3.1.1 Sector characteristic

According to European Bioplastics', most of the responding companies are members, a plastic product is bio-based, if a significant proportion of the carbon comes from renewable raw materials [European Bioplastics 2011], whether they are virgin materials from nature or vegetal wastes. For the purpose of this project bio-based plastics will be defined as man-made or man-processed organic macromolecules derived from biological resources and for plastics and fibre applications (without paper and board).

The bio-based plastics comprise a wide range of materials: starch plastic, cellulose polymers, PLA (polylactic acid), PA (polyamides), PHA (polyhydroxyalkanoates), PHB (polyhydroybutyrate), PTT (polytrimethylene terephthalate), PVC (polyvynyilchloride) and other polyesters [PRO-BIT 2009]. Due to the bio-based plastics production is still low in comparison with polymers from petroleum, it has been decided not to concentrate our efforts on a specific bio-based plastic, but on all of them. Such decision is based also on the fact that large companies provide most of the production of these materials and they dominate the sector at this stage [PRO-BIP 2009]. Leading European producers are usually large companies and they exceed the target of the LCA to go project: the SMEs. Nevertheless, there are exceptions as SMEs initiated the sector in technology development and production, and constitute the main actors in terms of manufacturing and commercialization of products made by bio-based plastics. This consideration is also presented in the plastic sector in general since plastics converters are mainly SMEs [European Plastic Converters 2010]. Thus, they play an active role in the bio-based plastic sector. Another option is that large biochemical company set up activities in collaboration with SMEs. In addition, contributions between large companies and SMEs are under development since patents are handed over in order to go beyond economical handicaps [PRO-BIP 2009].

Bio-based plastic sector is expected to have a great development in the coming years [Rudge et al. 2005], [Shen 2010]. Indeed, environmental concern has pushed stakeholders to consider important issues, from legislation to preferences when buying, in order to improve the environmental behaviour of the products. As it comes to the environmental concern of the bio-based plastic sector, greenhouse gas emission and energy consumption are expected to have an important contribution [Vink et al. 2003]. Due to the use stage has no contributions in environmental impacts, it is foreseen that the raw material extraction and manufacturing phases were the most important stages in the life cycle of bio-based plastics.

3.1.2 Survey statistic

30 bio-based plastics SMEs have been contacted. Finally 12 companies participated in the survey that represents a 40% of the contacted companies. Most of the companies follow a business to business or product manufacturer model (92%) and only one company work as a logistic or service provider. The geographical distribution of the companies is represented in Figure 3.

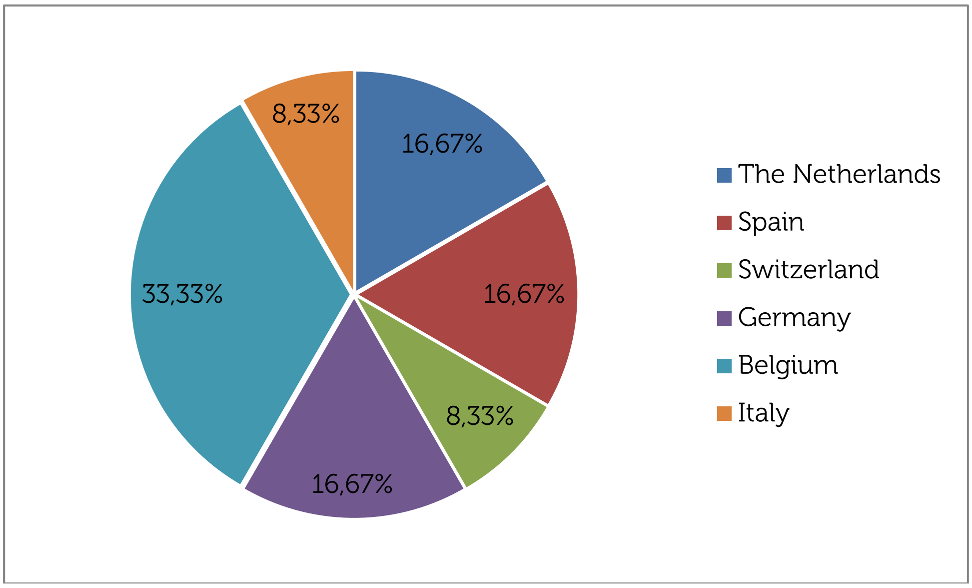


Figure 3: Nationalities of responding countries (Bioplastic)

It should be mentioned that more than 60% of the companies interviewed are from Northern/Central Europe.

Except one large company all of the companies are small and medium enterprises, which is the target of the LCA to go project (Table 1). However, it was considered the additional points of view one big company, since the relevance of this type of companies in bio-based plastic sector is also relevant [PRO-BIP 2009]. Indeed, most of bio-based plastics companies are currently owned or are participated by large enterprises. Furthermore it is usual to find small/medium sized companies in that sector that are spin-offs of research centres/universities as well as large-sized companies [Plastics News 2011]. Therefore the profile of the companies within bio-based plastic sector is heterogeneous.

Table 1: Companies distribution by the number of employees (Bioplastic)

Type of company	Micro enterprise	Small enterprise	Medium-sized enterprise	Large enterprise

Total	1	5	5	1

It is also noteworthy that bio-based plastic sector has a relative high knowledge compared to other sectors, since this market niche is relatively new and require big R&D expenditures for production and manufacturing. In most cases the SMEs were the pioneers in the sector since they made the first steps for production and technology development as well as commercialisation [PRO-BIP 2009].

3.1.3 Survey results

3.1.3.1 Status quo

The job position of the people who filled out the questionnaire ranged from Quality and Environmental Manager to Sales Manager, Product Manager, Product Developer, General Manager, Marketing and staff responsible for Research & Development. However, Marketing & Sales staff were the most abundant respondents. The job positions that are responsible of environmental issues at the interviewed companies were usually related to product managers. However is also very common that Marketing & Sales or Management staff were in charge of this task. Only one company had not a responsible or a person in charge of environmental issues.

It can be recognized that environmental issues are already anchored in SMEs but for the responsible staff it is often involved in one more task in addition to their main function. Indeed 58% of the interviewed companies do not have a job position directly related to the environment.

With regard how the environmental information is managed, 75% of the companies do not have established internal communication channels within product developers and the responsible of environment at the company. This is very important since it reflects the need for a better integration between departments responsible for environment and product engineers and designers.

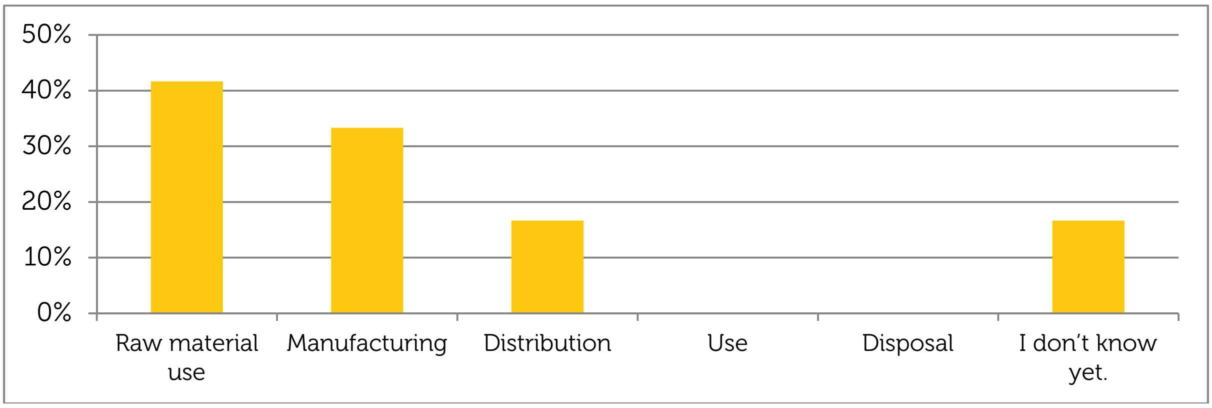


Figure 4: Most problematic life cycle phase of products (Bioplastic)

Figure 4 show that 42% of the companies think that the most problematic stage is the raw material use, as well as manufacturing and distribution stages. Therefore it is clear the awareness of the companies about life cycle impacts at raw material and manufacturing stages. However, 17% of the interviewed companies do not know yet the most problematic life cycle phase for their products. It is also noteworthy that none of the interviewed companies thought about use or disposal stages as the most problematic life cycle stage of their products. It seems that they are thinking more on a cradle-to-gate approach rather than a cradle-to-grave approach.

When companies were asked about the environmental aspects (products or processes that contributes to environmental impacts) energy and water consumption are the main results with 42% and 25% respectively (Figure 5). The energy result is in accordance with literature since PHA and PHB are known to consume more energy in the life cycle cradle-to-grave than polyvinyl alcohol (PVOH) [Bastioli 2005]. On the other hand, the water consumption is explained by the fact that materials which come from an agricultural stage, like starch, need high quantities of water aimed at the correct development of the vegetable. Additionally, water is necessary at industry level in important figures [PRO-BIP 2009].

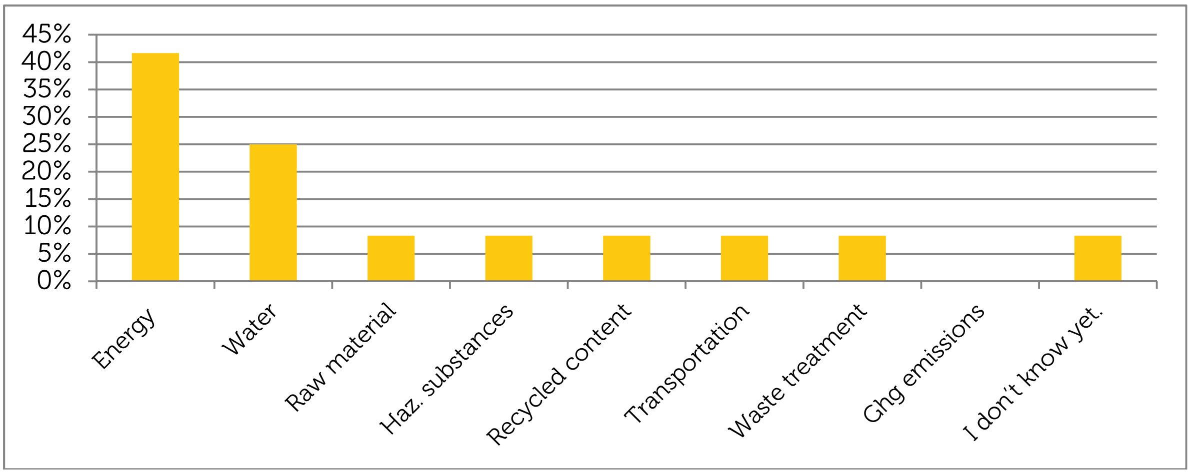


Figure 5: Most problematic environmental aspects of products (Bioplastic)

More results to demonstrate limited experience of SMEs with environmental assessment tools can be mentioned. 42% of the interviewed SMEs never worked with LCA before. Furthermore, 33% of the SMEs are not aware of any environmental assessment tool/methodology, although 33% of respondents are aware of the LCA software tool GaBi (Figure 6).

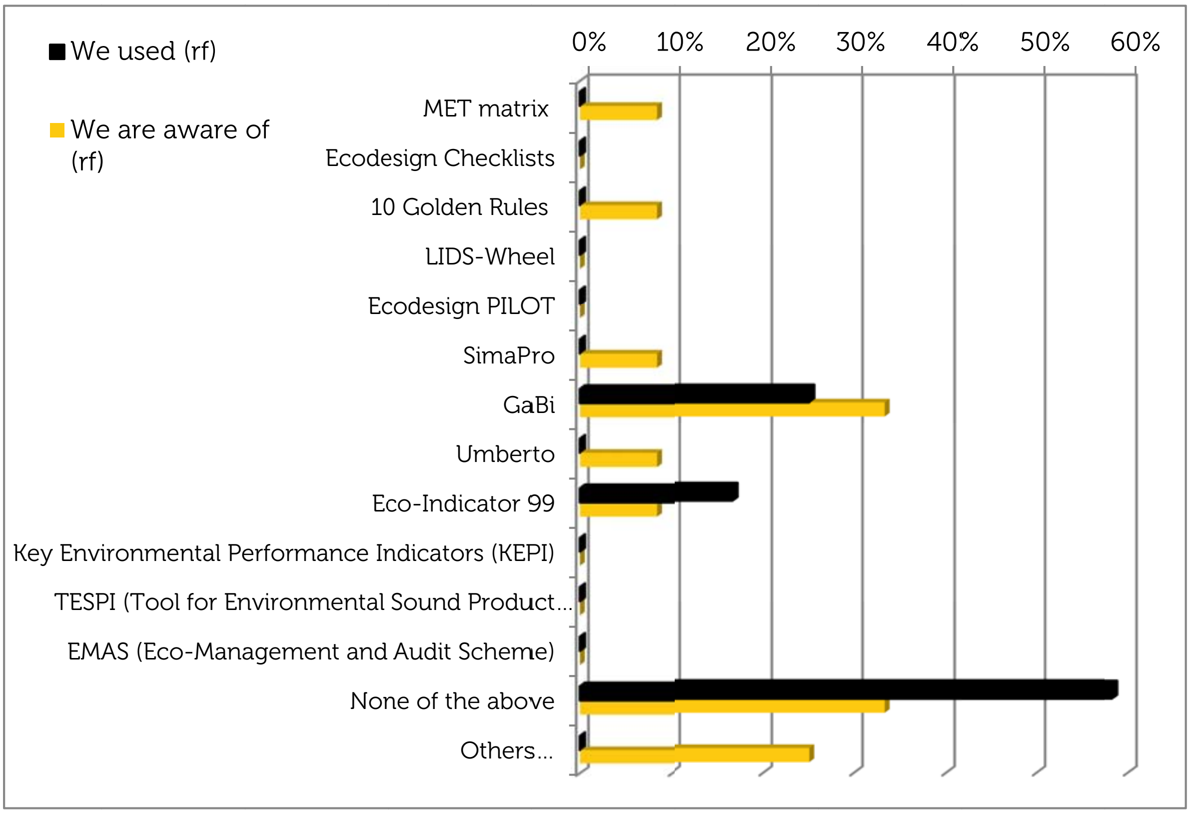


Figure 6: Replies to knowledge on LCA related concepts and experience (Bioplastic)

Furthermore a wide range of replies was obtained when companies were asked for which statement related them with LCA concept (Figure 7) that shows the limited knowledge on LCA of the interviewed companies, although relatively high compared to other sector. The most interesting finding when companies where asked about what the LCA concept is that it seems that companies know what the LCA is aimed for, although sometimes is confused with other concepts not directly related like achieving competitive advantage, reducing costs or optimizing the production.

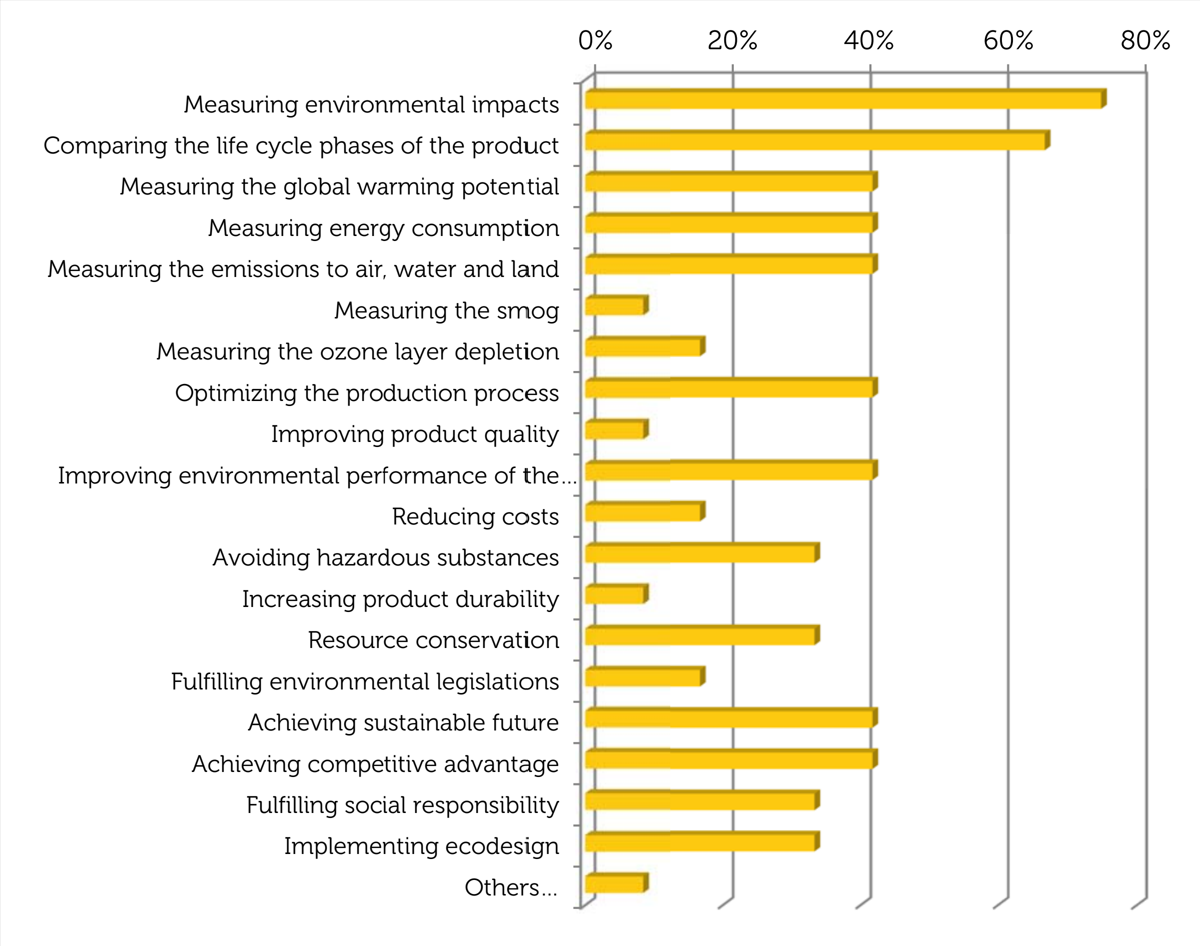


Figure 7: Statements related to LCA concept (Bioplastic)

Interviewed SME's pointed out that their experience with current LCA tools resulted in time and cost intensive task, being also difficult to find suitable databases for the bio-based plastic sector as reflected in Figure 8.

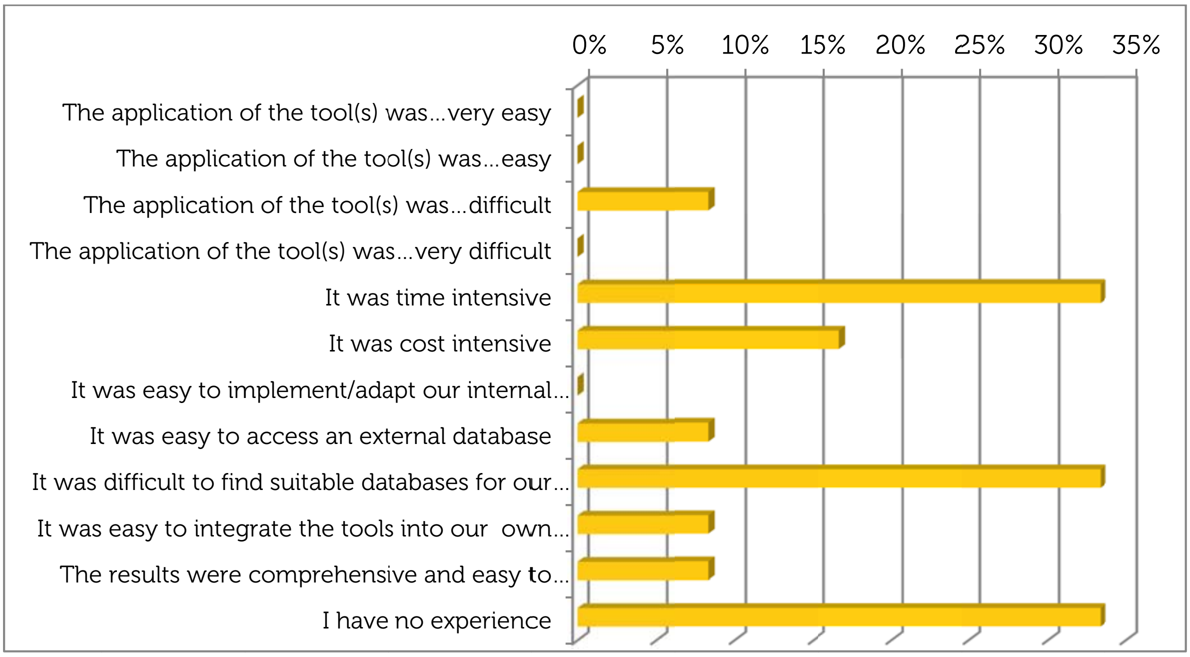


Figure 8: Experiences with environmental assessment tools (Bioplastic)

With regard to the approaches which interviewed companies are familiar with, it can be seen that the selection is quite distributed, but Life Cycle Assessment (58 %), Environmental Management System (42 %), Quality Management Systems (50%) and Legal compliances schemes (42 %) represent the most selected options. Surprisingly, companies are not enough familiar with concepts like Eco-efficiency, Cleaner production, Sustainable Product Development, and Ecodesign (Figure 9).

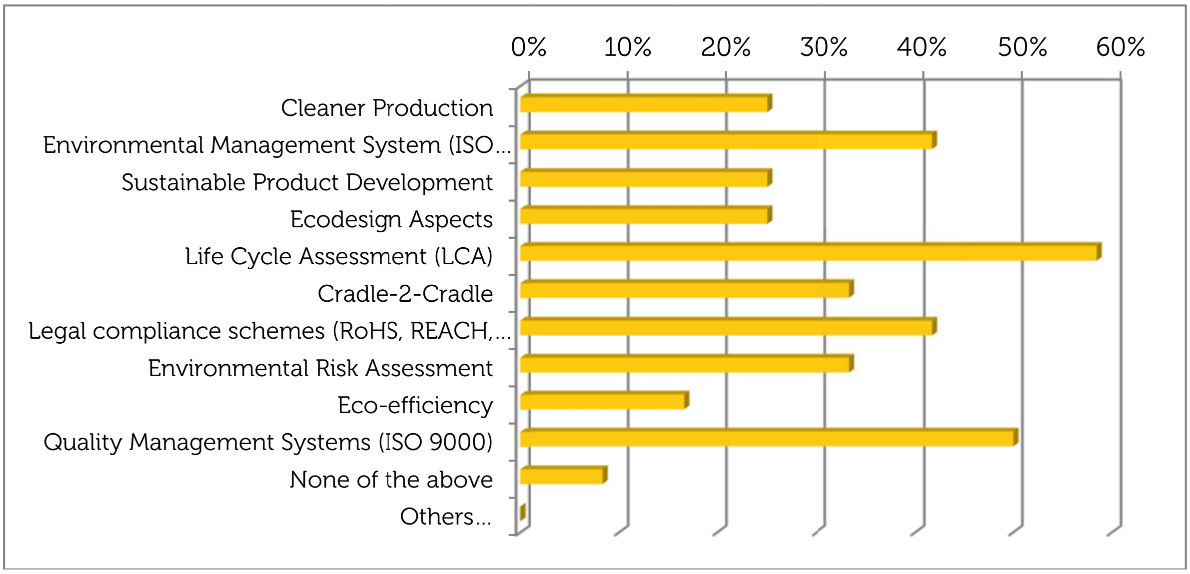


Figure 9: Most common environmental approaches (Bioplastic)

Regarding the characteristics that help to promote bio-based plastic products, reducing the product carbon footprint (92%) and eco-benchmarking (58%) overshadow the remaining the options as is represented in Figure 10.

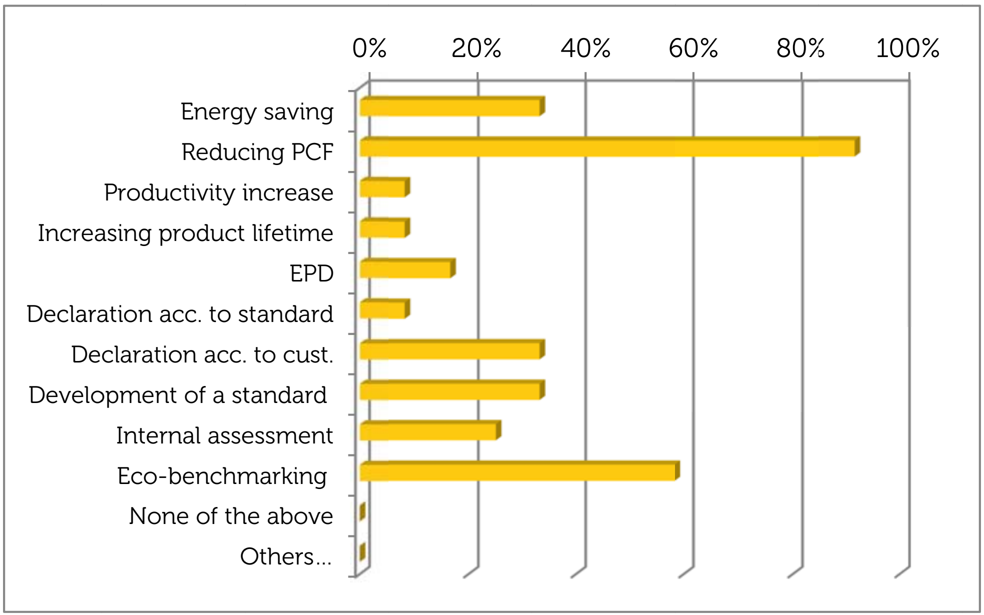


Figure 10: Characteristics that could help for promotion (Bioplastic)

3.1.3.2 Needs and demands

Main target of the needs assessment was to find out the wishes of the SMEs of bio-based plastic sector as a base to develop specific tools. The most important results are presented below. The first results show why companies did not run an environmental assessment yet.

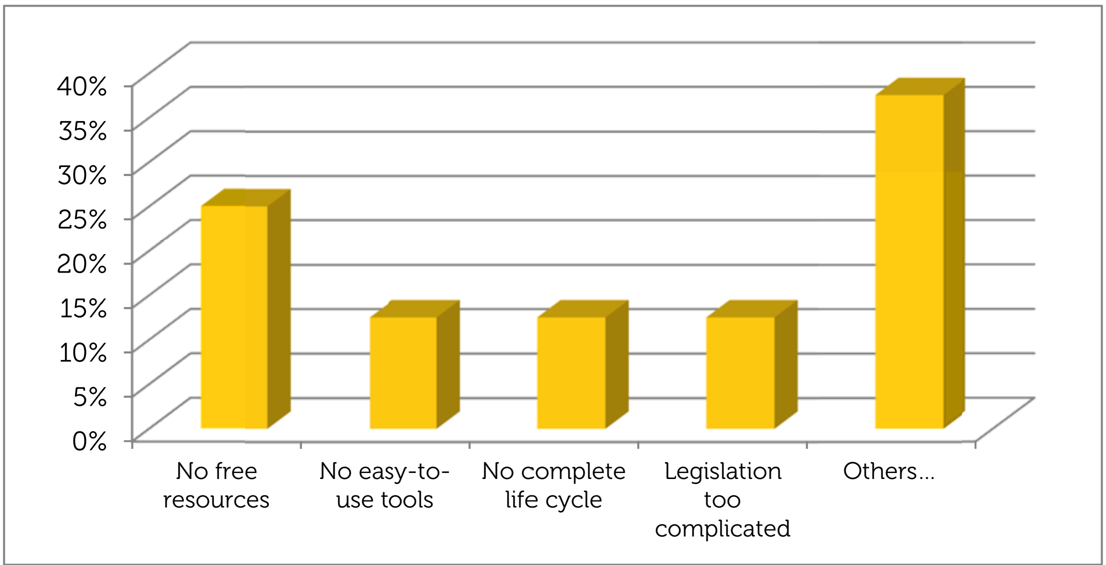


Figure 11: Reasons for not undertaking environmental assessments so far (Bioplastic)

Figure 11 shows that the main reasons for not undertaking environmental assessment were the lack of need to carry it out (included in class "Others..." in Figure 11) as well as free resources (see also Figure 8).

In contrast to these handicaps, the comparison between present and future drivers for doing an environmental assessment from product perspective shown in Figure 12 demonstrates that SMEs in bio-based plastics sectors currently expect to fulfil environmental legislation and EU regulations as well as the environmental improvement of the product. On the contrary they expect that future drivers will be additionally aimed at eco-labelling, reducing the manufacturing costs and improve product quality. Therefore is clear that the drivers in the sector will change in a near future and the new software tool should be aimed at these drivers.

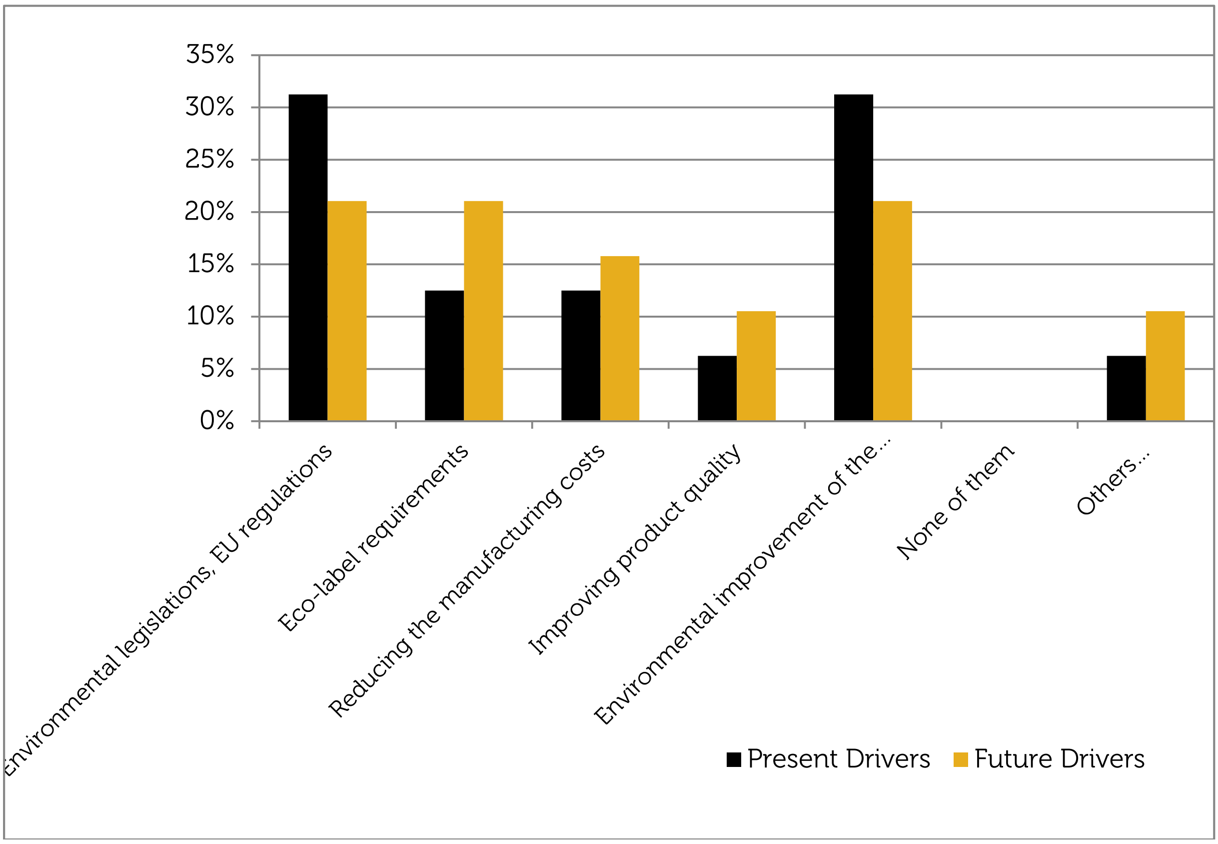


Figure 12: Comparison of present and future drivers from a product perspective (Bioplastic)

From the company perspective the main driver is by far the customer demand (67%), although environmental communication (42%) and competitive advantage (42%) are also important. Therefore companies want to do environmental assessments if their customers´ demand it.

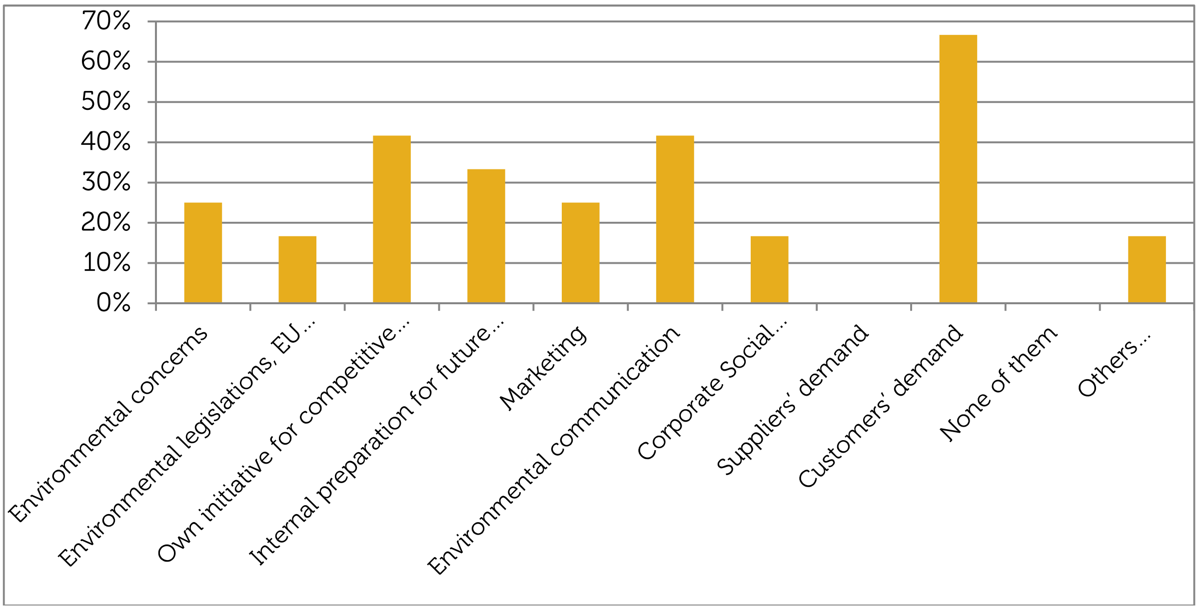


Figure 13: Drivers for environmental assessment – company perspective (Bioplastic)

<u>Environment communication</u>

Figure 14 shows the preferred way of environmental communication identified by the interviewed SMEs of the bio-based plastic sector

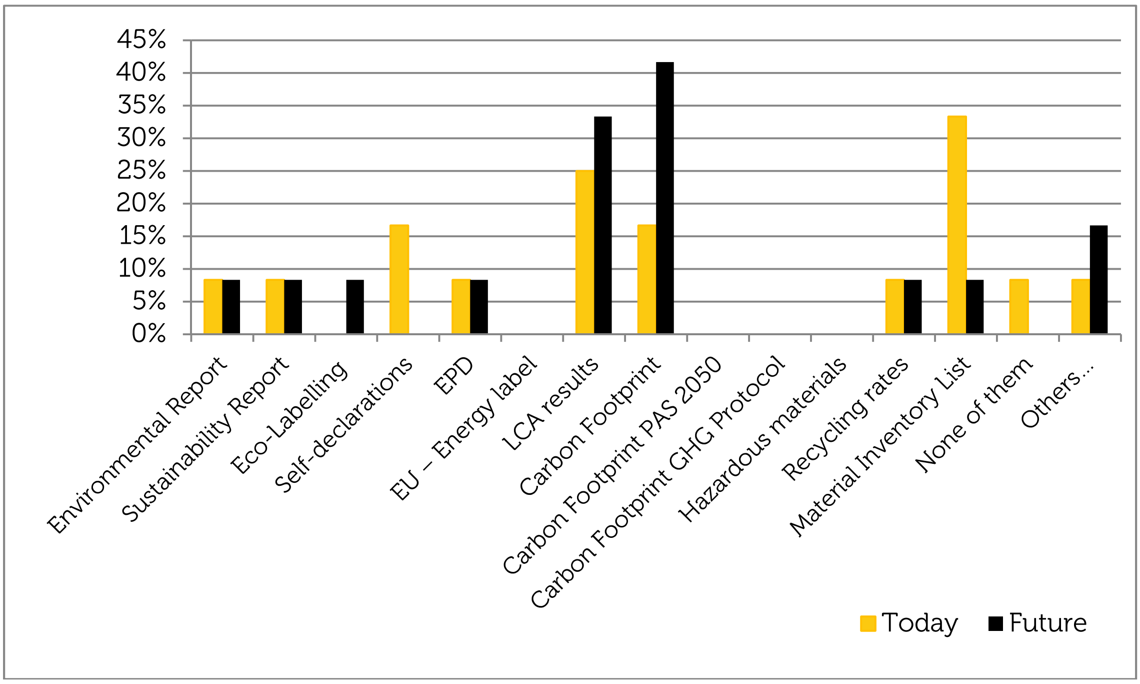


Figure 14: Communication tools used today and planned in the future (Bioplastic)

It has been asked for the currently used of environmental communication tools already in SMEs and the tools which they are planning to use in the future. Currently, the most important communication tool is the Material Inventory List and LCA results. On the other hand, Carbon Footprint and LCA results were the favourite options in a future perspective. Therefore future efforts for the software tool within LCA to go project should be aimed at LCA and Carbon Footprint results instead other communication tools.

<u>LCA tool</u>

The main expectations of different stakeholders regarding the outcome of the tool are LCA and Carbon footprint data as shown in Figure 15.

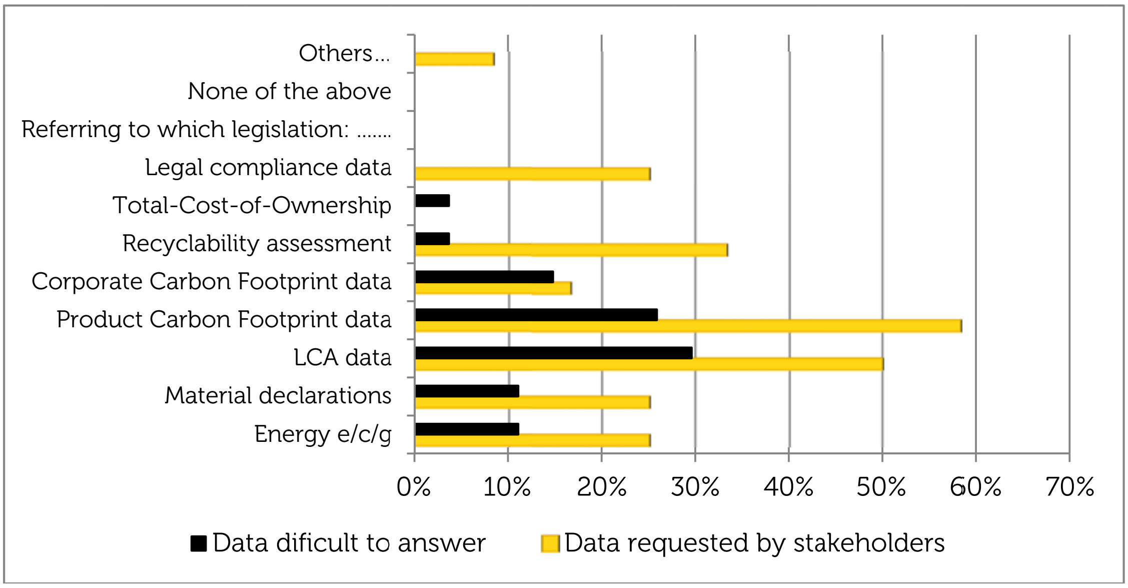


Figure 15: Data requested by stakeholders compared with data hard to answer (Bioplastic)

Stakeholders often request LCA and carbon footprint data as the most demanded data. Paradoxically, these two types of data match up with the hardest ones to answer. Consequently, the tool should help SMEs on an easy-to-use tool aimed at LCA and carbon footprint that fit current demands of stakeholders on these fields. Therefore it seems that results provided by the tool should be easy-to-interpret by the company in a SME-friendly software environment due to the limited knowledge of SMEs on LCA.

Further functionalities expected by the SME's are those related to import and export data (67% of the replies in Figure 16). This fits with the comments that some of the interviewed companies pointed out about the lack of suitable databases for that sector as stated previously in Figure 8. Furthermore one of the SME expressed that there is a need of knowledge sharing on unit operations.

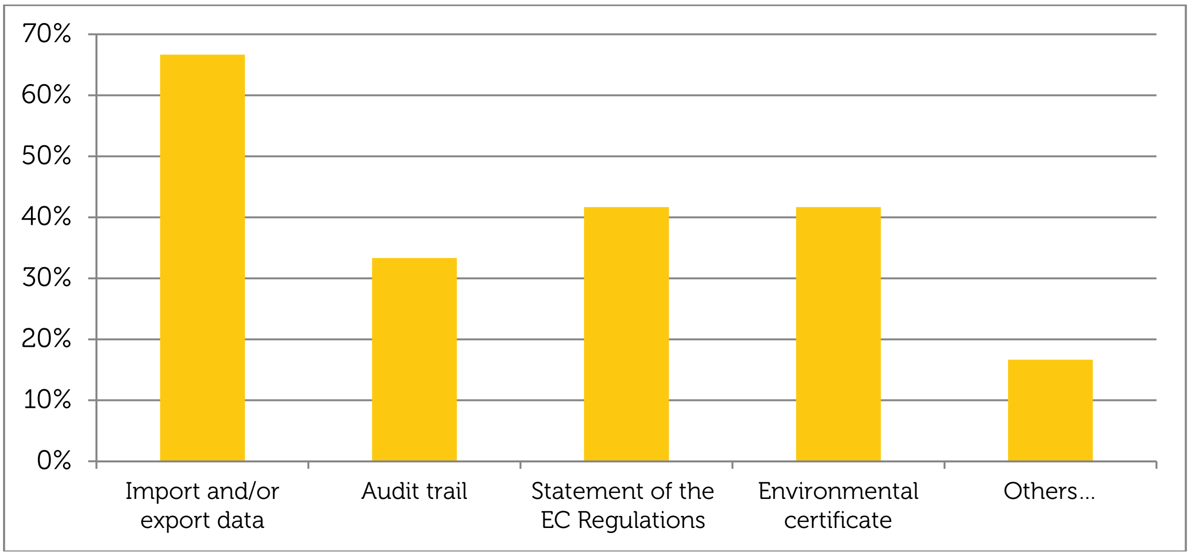


Figure 16: Expectations from a web-based environmental assessment tool (Bioplastic)

Moreover, SMEs prefer the tool will have the ability to provide statements of the EC Regulations binding in the field as well as help in reaching the environmental certificate for their products.

3.1.4 Wish list

In accordance with the results on the bio-based plastic sector, main wishes for the LCA tool are:

- ✓ It is desirable that the new tool avoids excessive time and cost when carrying out the LCAs. In addition, there is a need of a specific database in the bioplastic sector (*see* Figure 8)
- ✓ Since the most selected options in order not to carry out an LCA before by SMEs are the lack of free resources and easy-to-use tools, the software tool provided by this project should face these problems and through a SME-friendly environment that avoid complex LCA terms and jargon (*see* Figure 11)
- ✓ The new tool should be aimed at carbon footprint (*see* Figure 14 and 15) which is the most requested data by stakeholders that are also difficult to answer. LCA data and results are also demanded, although future trends point at an increase of carbon footprint communication (Figure 14)
- ✓ The LCA to go tool should go beyond problems related with import /export data and overcome incompatibilities between filename extensions of archives (*see* Figure 16)

- ✓ There is a need of offering an answer to the lack of specific database for the bio-based plastic sector

3.1.5 Summary

Most of bio-based plastic SMEs do not have a communication channel and 42% have not worked with LCAs before. It has been shown that SMEs require mainly a carbon footprint tool that does not make the analysis a time and resource consuming task. However, bio-based plastics companies are aware about other environmental impacts and need of LCA data and results have also been pointed out. The main driver to develop environmental assessments is the customers´ demand, but legislation issues determine SMEs movement regarding this kind of analyses.

Furthermore, there is a clear need of development a suitable database specifically aimed at the bio-based plastic sector since most of them do not fit the current requirements from the sector. Further actions for widespread LCA knowledge in bio-based plastics SME's are also required since the knowledge in the field is limited, although the knowledge and experience compared to the other sectors is relative high. Therefore the software tool should be easy-to-manage by the companies avoiding also complex LCA terms and jargon.

3.1.6 Conclusion

The main conclusions regarding the LCA to go project in the bio-based plastics sector are presented here. The knowledge of SMEs in the bio-based plastic sector is relatively high in comparison with other sectors, although 42% do not have previous experience with LCAs. This fact can be assumed to lack of customers´ demand for environmental analyses. On the other hand, advances in legislation should help companies to adopt environmental studies from a product perspective. It can be stated that lack of specific database in the bio-based plastic sector, complex LCA terminology, high cost and time intensive are the main handicaps which explain that figure. As a result, the new tool should overcame them and allow the carbon footprint calculation in an easy-to-use software.

3.1.7 Outlook

The next steps will be keeping in touch with SMEs of the bio-based plastic sector in order to discover more specific points to include in the new tool. The development of the bio-based plastic database should be also analyzed. Although the development of these databases is outside the scope of LCA to go project, research team should search/analyze for this kind of databases for a better integration on the software tool.

3.2 Industrial machines

3.2.1 Sector characteristic

This section focusses on machines used for industrial production processes. This very wide field of machines includes machine tools, furnaces, rolling machines, pump compressors, plastic machines and machines for welding, soldering, etc. brazing are included in this sector.

In this sector Germany has the highest production value followed by Italy and United Kingdom. Germany is also the most specialised country followed by Finland and Austria.[3]

Alone 64 thousand enterprises are counted for manufacturers of machine tools and other special purpose machinery[3]. As an important economic sector of the EU, dominated by SMEs, it`s obviously that innovations can generate improvements which can enforce this sector. Main criteria for industrial machines are speed, quality and quantity of products that are produced. So the trend of technological advancement goes in direction of productivity influencing just as well profitability. Industrial machines consume a lot of energy during use phase and provide a huge environmental improvement potential. Due to the general discussion on climate change, the increase of the energy prize and the expected upcoming pressure from legislation the sector has already started first attempts into environmental assessment and environmental improvement of their products.

Generally the sector has to deal with investment goods, means high initial purchase cost and long product lifetime. The main challenge consists in the high diversity of machines and the problems how to generalize and assess them.

3.2.2 Survey statistic

The survey started in May 2011 by sending out emails to the SMEs or contacting directly them via phone in different European countries. The companies from the industry machines sector have been contacted by different LCA to go project partners. FMMI (Association of the Austrian MACHINERY & METALWARE

3 http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=Industrial_processing_machinery_production_statistics&printable=yes

Industries) and the VDW (German Machine Tool Builders` Association) have been contacted and acted as multipliers for the distribution of the survey.

The deadline for the last responses has been at the end of September 2011. As expected it wasn`t easy to get in contact with the enterprises. Moreover it can be supposed that it was too difficult to answer the questions without any knowledge about environmental management or assessment. Finally 20 companies responded the survey.

Table 2: Responding companies distributed according to EC definition (Industrial machines)

Type of company	Micro enterprise	Small enterprise	Medium-sized enterprise	Large enterprise[4]
Total	3	5	12	3
%	15	25	60	-

Table 2 represents the sample of companies participated in the survey. More than a half of the enterprises are medium sized; the other half consists of 5 small and 3 micro scaled enterprises. Also 3 large enterprises with 500 and more employees have attended the survey. These responses have not been taken into account for the survey analysis.

The main products of the responded companies are different kind of furnaces, laser machines or metal machine tools.

Appropriate characteristics for most of the industrial machine SMEs:

- high degree of specialization (evident from the main products)
- Business to Business model (50% of total sample)
- Product manufacturer (55% of total sample)

The 20 responded companies are based in eight different European countries represented in Figure 17.

[4] Responses not accounted in the analysis

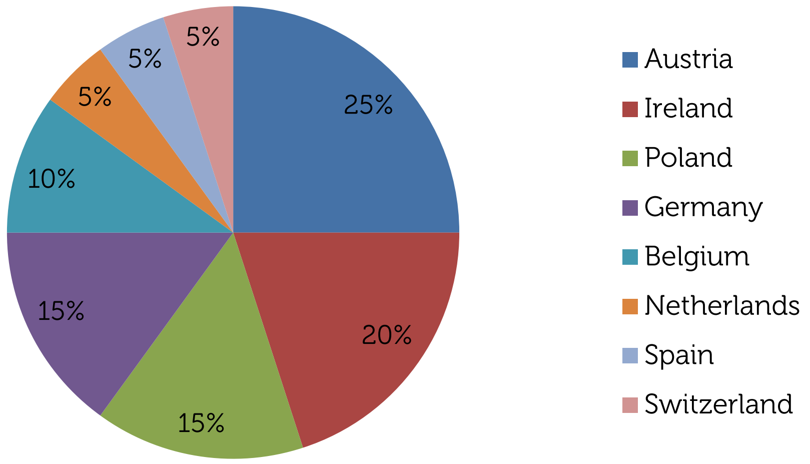


Figure 17: Nationalities of responding countries (Industrial machines)

75% of the responding companies are interested in the survey result and think this could be relevant for them. General project information is wished from 55% and 35% are interested in free training on using the LCA to go tool.

3.2.3 Survey results

3.2.3.1 Status quo

The persons who filled out the questionnaire ranged from Technician/Constructor to CEO, Project Leader, Quality Manager and person responsible for Research & Development. The job positions related with responsibilities for environmental issues are similar various and mostly existent. Results are provided in the next two figures in detail.

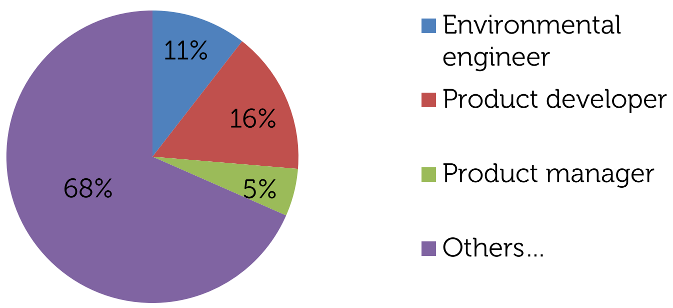


Figure 18: Responsible person for env. ass. (Industrial machines)

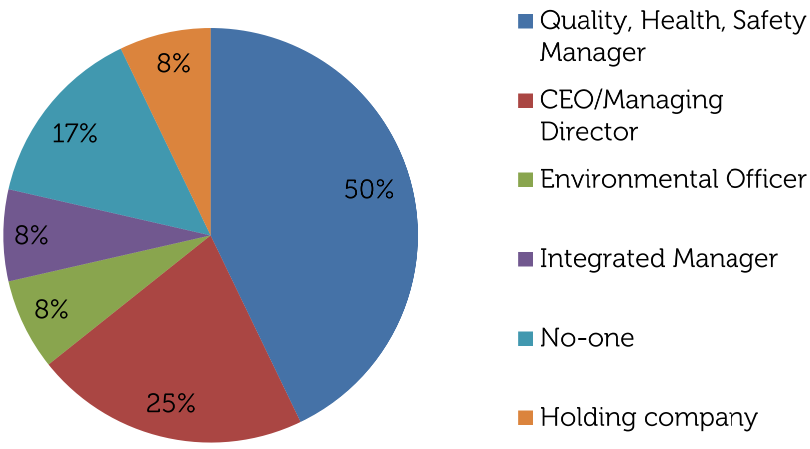


Figure 19: Responsible person for env. ass. - OTHERS (Industrial machines)

Only two companies had no explicit responsible person. Apparently the communication channels within the company seem to be non-existing (94%). But the reason for this can be the circumstance that in SMEs often one person can hold several functions and no communication channel is needed at all.

It can be recognized that environmental issues are already anchored in SMEs but for the responsible persons it is often only one more task in addition to their main function. So it`s not surprising that the results of the questions about prospects and knowledge around LCA show that the respondents don`t know much about it. More clearly this aspect is shown by the next figure, dealing with life cycle phases.

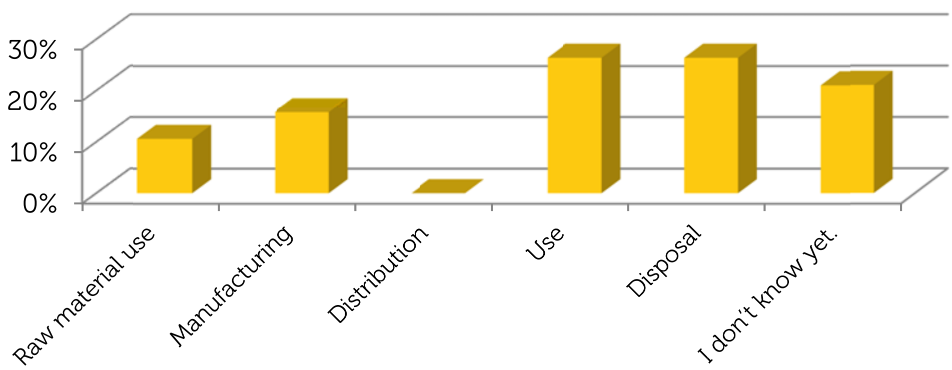


Figure 20: Most problematic life cycle phase (Industrial machines)

Figure 20 is showing that just 26% know that industrial machines are use-intensive products (because of energy consumption). 21% don`t know yet which life cycle phase is the most problematic one. Whereas in another question 45%

indicate, that energy is the most important environmental aspect. So it`s evident, that they know there is environmental impact through energy usage but they are not aware that energy intensive products have the highest environmental impact during the use phase.

More results to demonstrate low experiences with environmental assessments can be mentioned. 85% of the SME`s never worked with LCA before. Furthermore no SMEs used and 87% of the SMEs aren`t aware of any environmental assessment tool. Thus no one of the respondents had experiences with the application of an environmental assessment tool.

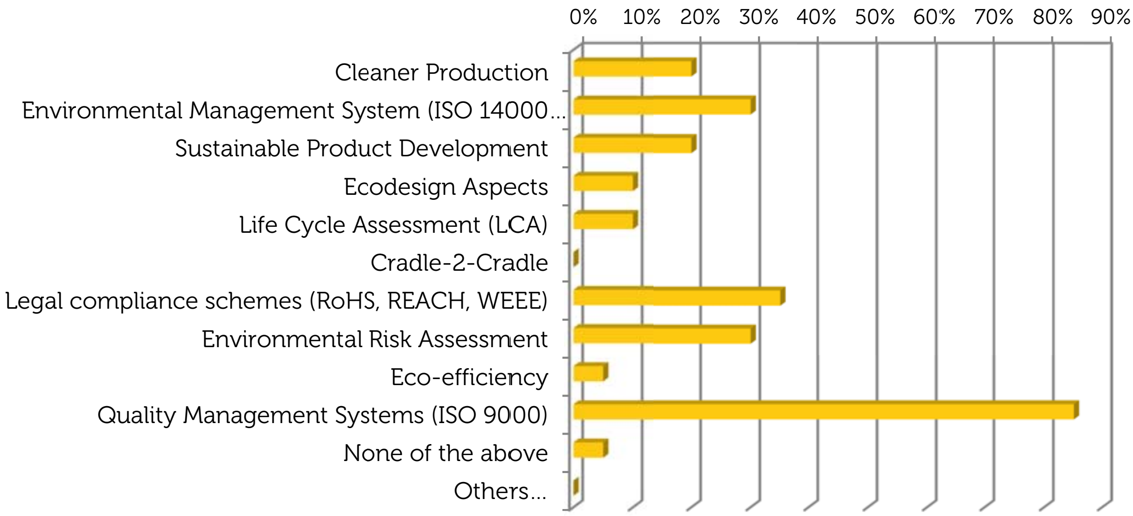


Figure 21: Most familiar environmental approaches (Industrial machines)

In Figure 21 it`s visible, that Quality Management System according to ISO 9000 is the most popular approach. This is due to the highly relevant market requirement in the machine tool industry. There is a low knowledge about Cradle 2 Cradle, LCA and Ecodesign Aspects. Only two SMEs (10%) are familiar with LCA.

3.2.3.2 Needs and demands

Main target of the needs assessment was to find out the wishes of the SMEs as a base to develop the specific tool. The most important results are presented here.

<u>Environmental assessment</u>

The first results show why companies didn`t run an environmental assessment yet.

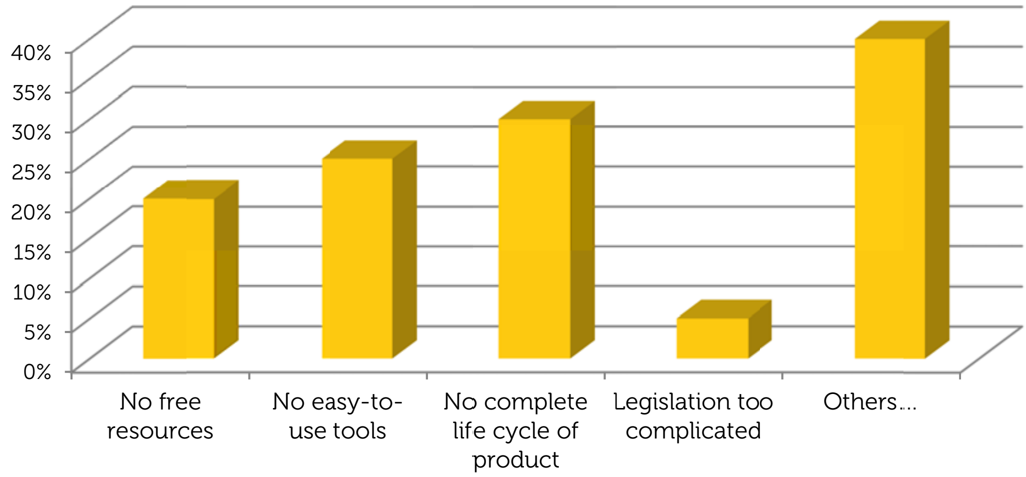


Figure 22: Reasons for not undertaking environmental assessments (Industrial machines)

As Figure 22 illuminates, the main reasons for not undertaking environmental assessment are that products haven`t run the complete life cycle yet and that there aren`t available easy-to-use tools. For the tool it means to find procedures for assessing innovative products, without having complete life cycle data sets available. The second consequence is the importance of an easy–to-use tool.

In contrast to these obstacles, Figure 23 illustrates important present and future drivers for doing an environmental assessment from product perspective.

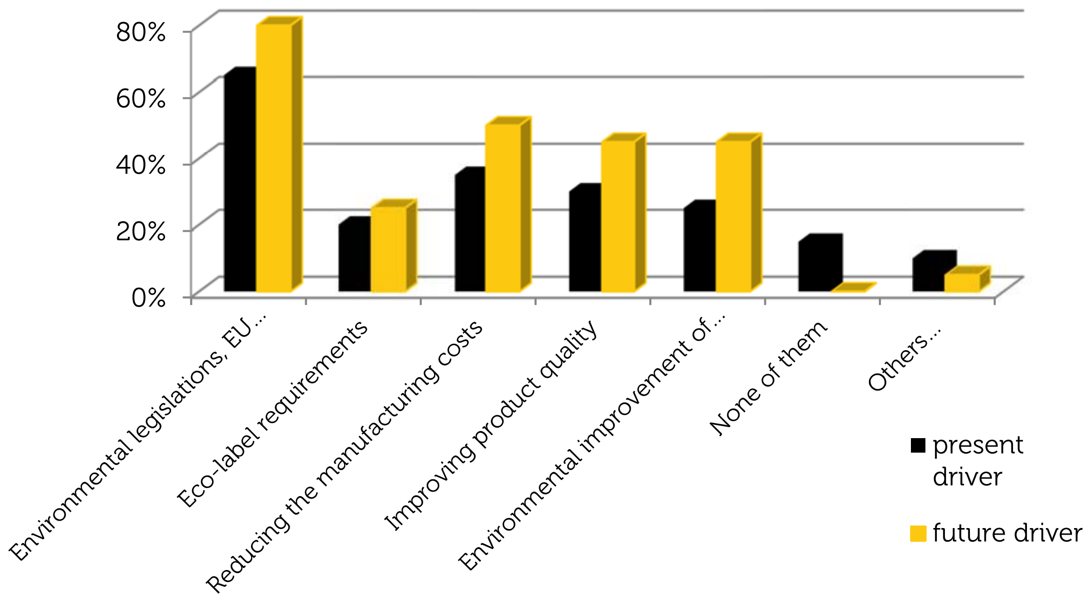


Figure 23: Drivers for environmental assessment – present and future (Industrial machines)

The motivation to perform an environmental assessment depends very much on the legal situation. Moreover it`s required that the tool can help in improve product quality as well as in environmental improvement of the products. Additionally reducing manufacturing costs is seen as a driver.

More drivers are now specified from the company perspective site.

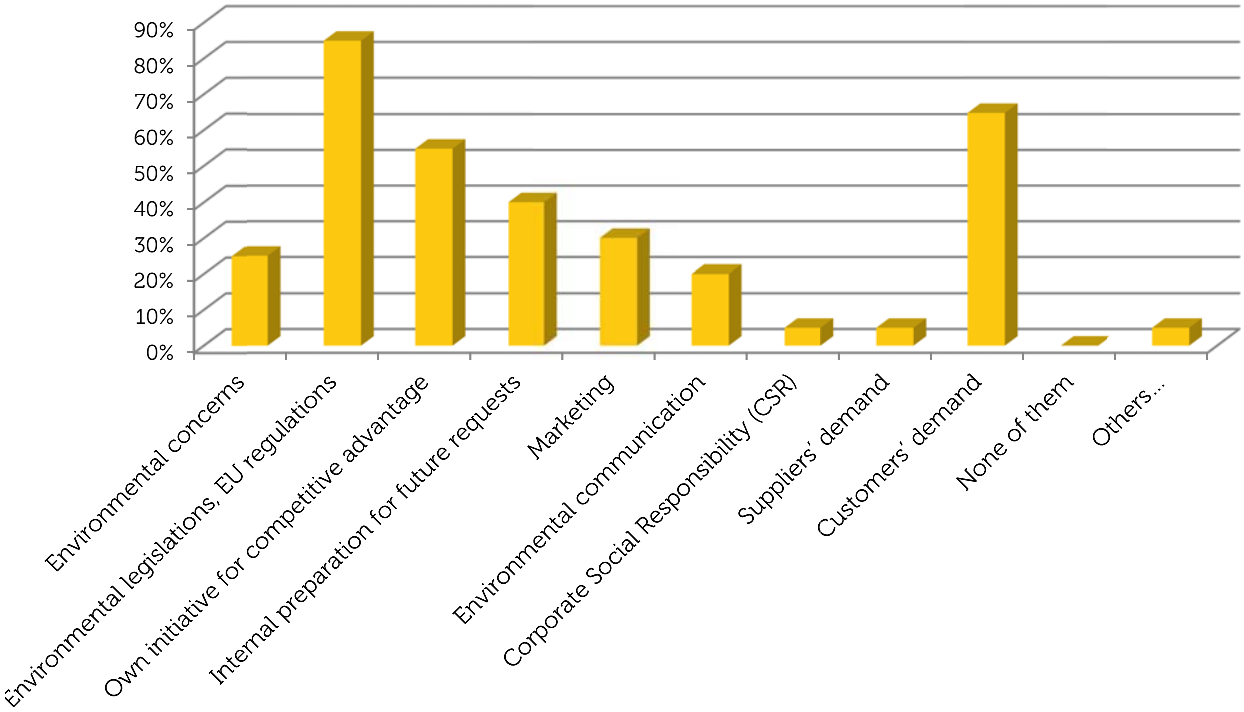


Figure 24: Drivers for environmental assessment – company perspective (Industrial machines)

In Figure 24 once again becomes clear, that the tool has to comply with environmental legislation and EU regulations. Moreover they just wanted to do environmental assessments if their customers' demands for it. The companies could also be motivated for doing environmental assessment if this lead to competitive advantage as well as for internal preparation for future requests.

<u>Environmental communication</u>

Which kind of environmental communication SMEs would prefer, is pointed out in the following Figure 25.

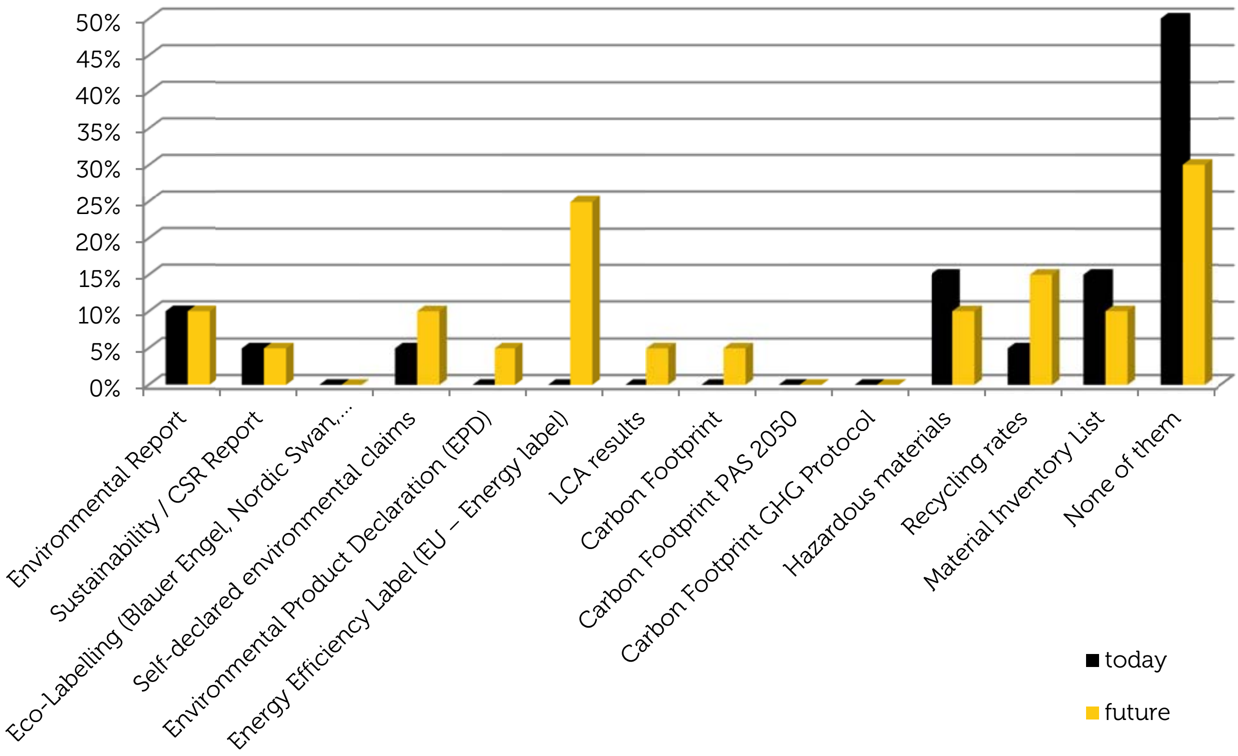


Figure 25: Communication tools used today and planned in the future (Industrial machines)

It`s been asked for the currently used environmental communication tools in the SMEs and the tools which they planning to use in the future. As it can be seen in figure 7 some SMEs aren`t interested in this issue at all, either today or in the future. But it can also be concluded, that the preferred tools should be related to the EU-Energy Efficiency Label and recycling rates. Concerning these issues it can be supposed as a lack of knowledge about environmental issues. An LCA tool should also be used as a kind of information platform to learn more about legislation and directives, explanation of terms or environmental assessments.

As best arguments for promotion are mentioned energy saving, productivity increase, declaration according to customers and increasing product lifetime.

<u>LCA tool</u>

General expectations, which can be seen as wishes of the SMEs are demonstrated by the next Figure.

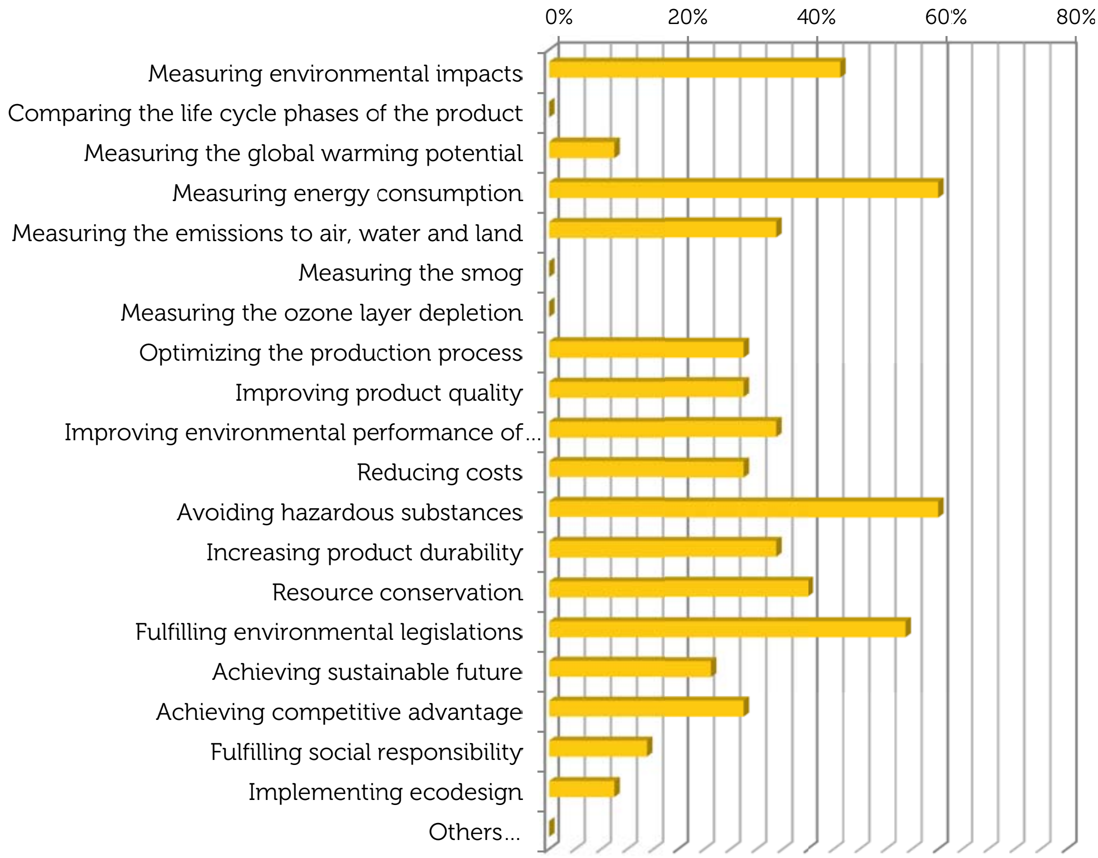


Figure 26: Statements most related to LCA (Industrial machines)

Figure 26 provides information about which aspects are for SMEs most related within LCA. For the questioned companies it`s measuring energy consumption, avoiding hazardous substances and fulfilling environmental legislation. Therefore the tool should focus on energy aspects, hazardous substances and should support in fulfilling legal requirements.

The main expectations of different stakeholders regarding the outcome of the tool range from Energy Efficiency Index to LCA, Eco-profile and environmental certificate. A look to the next figure makes clearer which kind of data SMEs need most of all.

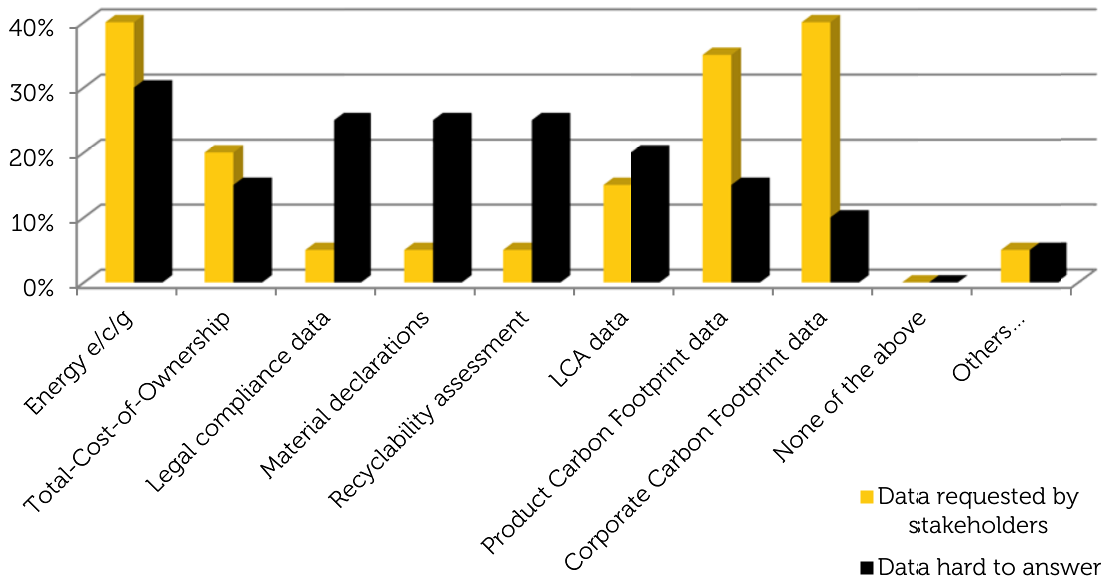


Figure 27: Data requested by stakeholders compared with data hard to answer (Industrial machines)

Stakeholders often request energy data but these are hard to answer. Also LCA data seems to be requested and hard to answer as well. Therefore the tool should help providing this data. In addition to these results it has to be mentioned that 37% of the SMEs didn`t answer the question about which kind of data hard to answer. Maybe they had no experience or knowledge about the data stated here.

Further expectations on the tool were expressed as follows:

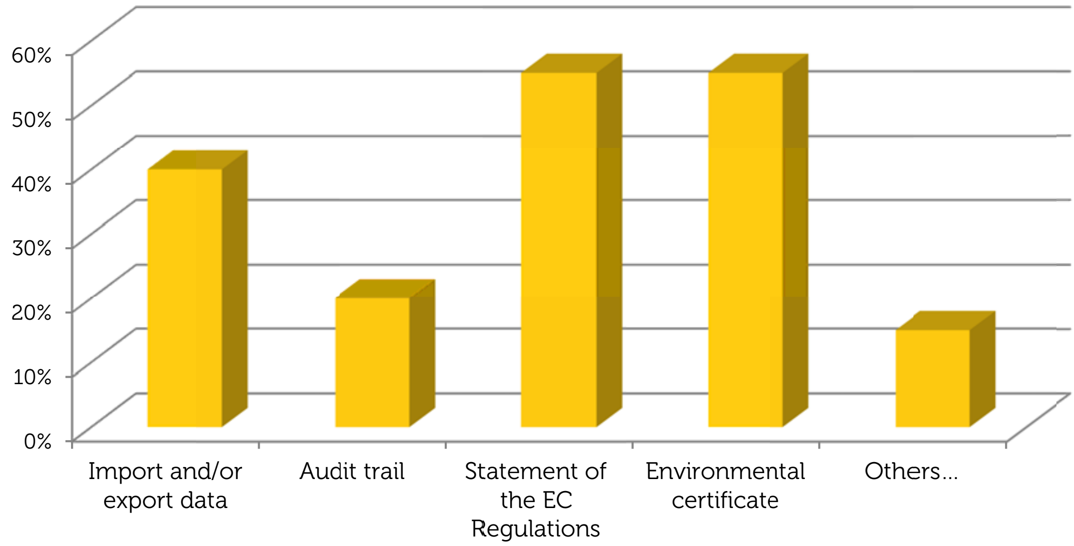


Figure 28: Expectations on the tool (Industrial machines)

According to Figure 28 it seems to be important for the tool development to provide a statement of the EC Regulation or an environmental certificate. Moreover it should be able to import and/or export data in the tool.

3.2.4 Wish list

- ✓ It should be possible to assess innovative products, without complete life cycle data sets *(see Figure 22)*
- ✓ The tool has to be easy–to-use *(see Figure 22)*
- ✓ The tool has to comply with the legal situation – environmental legislation, EU regulation *(see Figure 23, Figure 24)*
- ✓ The tool should help improving product quality as well as giving support in reaching environmental improvement of a product and reducing manufacturing costs *(see Figure 23)*
- ✓ The tool should also be used as a kind of information platform to enhance the knowledge of the SMEs
- ✓ The results of the tool has to be tailored to the customers *(see Figure 24)*
- ✓ Motivation for using the tool is reaching a competitive advantage and preparing for future requests *(see Figure* 24*)*
- ✓ For environmental communication of most interest is an Energy Efficiency Label and a self declared environmental claim, which can also be

interpreted as voluntary environmental label focusing on energy efficieny. Additionally recycling rates should be communicated *(see Figure 25)*

- ✓ The tool has to be aware of following arguments for promotion *(see "Environment communication"):*
  - energy saving
  - productivity increase
  - declaration according to customers
  - increasing product lifetime
- ✓ The tool should focus on energy aspects, hazardous substances and it should support in fulfilling legal requirements *(see Figure 26)*
- ✓ The tool should provide a statement of the EC Regulation or an environmental certificate *(see Figure 28)*
- ✓ The tool should be able to import and/or export data *(see Figure 28)*

3.2.5 Summary

About the <u>conjunction between SMEs and environmental</u> topics in general can be assumed the points below.

- Most of the SMEs don`t have specific environmental communication channels because of their small size
- SMEs have little knowledge with LCA and environmental assessments
- SMEs have no experience in using environmental assessment tools
- SMEs would use an environmental assessment tool if there is customers demand or pressure from legislative

Referring to the <u>wish list</u> it can be said that...

The <u>comparison between the wish list out of the survey and the former case studies</u> points out that there are some matches.

3.2.6 Conclusion

Because of the wide range in the sector industrial machines it is necessary to concentrate on one specific machine group, which is machine tool building.

Machine Tools definition includes a wide variety of machines having as common denominator that they are powered to manufacture metal products or parts. Applied technologies within machine tools are: cutting tools, laser, jet of high pressure water, drilling, milling, electrochemical discharge, bending, stamping etc.

Machine tools have been chosen as it is a core sector within industrial machines in Europe, consuming a lot of energy during use phase and providing a huge environmental improvement potential. Additionally this sector is quite active regarding environmental evaluation and communication of their machines.

The Machine tool sector is already in the focus of the ErP Ecodesign Directive [ErP 2009] where a Product Group Study is just in development. The European association of machine tools CECIMO decided to hand in an SRI (Self-regulation initiative). In this SRI it will be defined on how environmental evaluation of their products can be carried out and how environmental improvements of machine tool can be realized and communicated to the European Commission.

Additionally the ISO 14955 [ISO 14955 2011] is just under development targeting the environmental evaluation of machine tools. This standard consists of the following parts, under the general title Machine tools — Environmental evaluation of machine tools:

Part 1: Design methodology for energy-efficient machine tools

Part 2: Methods of testing of energy efficiency of machine tools and machine components

Part 3: Test pieces/test procedures and parameters for energy efficiency on metal cutting machine tools

Part 4: Test pieces/test procedures and parameters for energy efficiency on metal forming machine tools

3.2.7 Outlook

For the next step in this project and for the goal of this sector developing a tool for the environmental assessment of machine tool it is essential to be somehow involved in all activities going on in this sector. Therefore cooperation with the German association for machine tool VDW has recently been initiated. The Within this cooperation VDW will give his experience as well as product data to foster the development of an environmental assessment tool especially designed for the sector of machine tool. VDW has been chosen as they represent nearly 50% of the European machine tool manufacturer market.

To secure an European approach also CECIMO as the European association of machine tools will be involved after the first methodological concept has been developed. CECIMO represent most of the national associations of machine tool and therefore 1500 European companies (mostly SMEs) are included. This is very important for the dissemination stage of the project.

3.3 Electronics

3.3.1 Sector characteristic

There are more than 170.000 SMEs in the European electrical and electronics sector (a distinct figure for electronics alone cannot be stated), making this sector one of the backbones of the European economy The stated figure comprises a huge variety of companies from electronics manufacturing services to assemblers, system integrators, engineering companies, retailers, electrical installation, repair shops etc. European SMEs are in their majority suppliers to other manufacturers; only very few manufacture, assemble or design end products. The SMEs in this sector serve a multitude of other branches, such as industrial applications (control and automation), the automotive sector, infrastructure / transportation, aviation, medical equipment, and several more. However, the end consumer market (consumer electronics, information and with very few exceptions is the domain of suppliers from Asian countries. This is particularly relevant as in the end consumer market typically environmental arguments count most and serve as a distinction in the market place. In all other sectors typically costs and performance clearly dominate, and a low environmental impact does not add much benefit in customer relations. This also explains, why electronics are subject to environmental considerations, but European SMEs are rarely affected by the related requirements.

The SMEs responding to the survey clearly show the diversity of the sector as they cover inter alia following distinct product segments: power supplies, optical screen accessories, infrared heaters, gas leak detectors, electronic torque equipment, medical equipment, LED lighting, plug connectors, and electronics manufacturing services.

SMEs in the electrical and electronics sector, similarly to the European SME sector as such, employ 20 staff or even less.

3.3.2 Background information

The electronics sector has been subject to similar status quo analyses in past years already, in particular in the European EcoDesign Awareness Raising campaign – EcoDesignARC back in 2005 coordinated by Fraunhofer IZM (contracted by European Commission, DG Industry and Enterprise) and in the CIP-eco-innovation project Life Cycle Innovation & Management for SMEs – LiMaS (coordinated by Simpple), where a survey among SMEs in Spain and Germany took place in 2009/2010.

The Final Report of EcoDesignARC [Schischke 2005] outlined the following findings, which are relevant for LCA to go, and which stem from workshop discussion at 28 events in 20 European countries, and from anecdotal evidence, where Fraunhofer got aware of environmental activities of individual companies:

SMEs tend to favour a very pragmatic approach. Usually legislation has been in the focus of many discussions – as legislation is the key driver to "eco" activities for many companies.

It should be noted, that the EcoDesignARC findings are based on anecdotal evidence, and the LiMaS survey covered particularly those companies, which already had some environmental activities with the project partners. Findings from both projects are in no way representative for the European market and rather reflect the perspective of those companies, who are at least willing to communicate about environmental issues. Similarly, the LCA to go survey should not be considered as being representative.

The final report of the EcoDesignARC campaign concluded that SMEs "[…] undertaking ecodesign activities are very rare […]". The few companies using LCA tools typically do not combine these activities with cost-benefit analyses. Most companies concentrate on a couple of selected eco-design aspects, but rarely base their activities on a full Life Cycle Assessment. Rather a "cherry picking" is observed, pointing out certain environmental aspects (energy efficiency, usage of photovoltaic cells, facilitating ease of disassembly etc.), but without crosschecking, whether these aspects are really the most relevant ones throughout the product life time and whether measures might result in adverse impacts elsewhere in the life cycle.

Moreover the terminology of eco-design tools does not correspond with the technical terms designers used to work with. There is a need to adapt the language of design tools to designers' language. EcoDesignARC revealed that SMEs in the electrical and electronics sector often do not have the capacities to undertake eco-design projects: "In short, the two main drivers for eco-design are legislative requirements and obvious economic benefits – all other potential drivers remain in a "nice-to-have" grey area without immediate urgent need for action."

Findings of the project LiMaS indicate, that "most enterprises acknowledge that environmental aspects are a key factor for competitiveness and business sustainability. However, finding practical solutions to integrate the environmental protection in their activities is a challenge, especially for small and medium-sized enterprises (SMEs)." [Chancerel 2010] The survey in the project LiMaS, which targets at the development of a software tool for eco-innovation, not necessarily a life cycle approach, found out that one-fifth of the companies are already using a dedicated environmental software tool. The remaining 80% do not use currently a software tool for environmental impact assessments, and only one of every three have ever analysed the possibility to do so. 23 out of the 35 answering companies mentioned that a customised software tool could help them to eco-innovate. The survey showed that the manufacturers are looking for a software tool which integrates a wide range of information, i.e. benchmarks with competitors' products, environmental legislation update, Best-Available-Techniques in each sector, legislative requirements compliance monitoring, LCA, innovative technologies, etc. The software should provide clear exportable results, be easy to use, include specific databases for each sector and allow common data entry to cover all the relevant aspects. Consequently, the LiMaS project developments where centered around legal compliance issues.

3.3.3 Methods

In a workshop with the Passive Components industry, which is dominated by large, multi-national companies, the question was discussed, how they currently see the demand among their SME customers regarding environmental data and environmental assessments (other than material declarations, which are common in this sector already for nearly ten years). Unanimously TDK-EPCOS, Kemet, and Vishay reported, that by now no SMEs request such data, and even requests by large companies for LCA or energy consumption data allocated to individual components are rare, but expected to come in future years. Obviously passive components currently are not on the "radar" of the OEMs, and in particular SMEs don't have the pressure or see the need to get hold of primary data throughout their supply chain, which means on the other hand, that any LCA-type assessment undertaken by an SME is not based on primary components data.

The range of respondents to the LCA to go survey covers a spectrum from optical devices like LED-lightning to connector assembly. Some respondents are also manufacturers of renewable energy products and sensors which indicates, that electronics is a horizontal sector serving also some of the other relevant sectors.

28 companies answered the questionnaire, with 2 to 500 employees, thereof 24 companies, which fall under the definition of an SME. These 24 companies in average employ 45 staff, which is above the average for SMEs in the sector. The replies from the 4 other companies are taken into account in the following evaluation as well as they do not significantly deviate from the SMEs' replies. Most of the companies participating in the survey are from Germany, Poland, Ireland and Spain.

3.3.4 Survey results

3.3.4.1 Status quo

Similar to SMEs from other sectors described before, the position of the respondents to the survey is mostly related to product design, product quality or administration of business and occasionally environmental aspects. Only 10% engage dedicated environmental staff, but only one company did not appoint any person at all for environmental issues. Most SMEs are committed to environmental protection.

50% of the SMEs stated not to have any experience with environmental assessment tools.

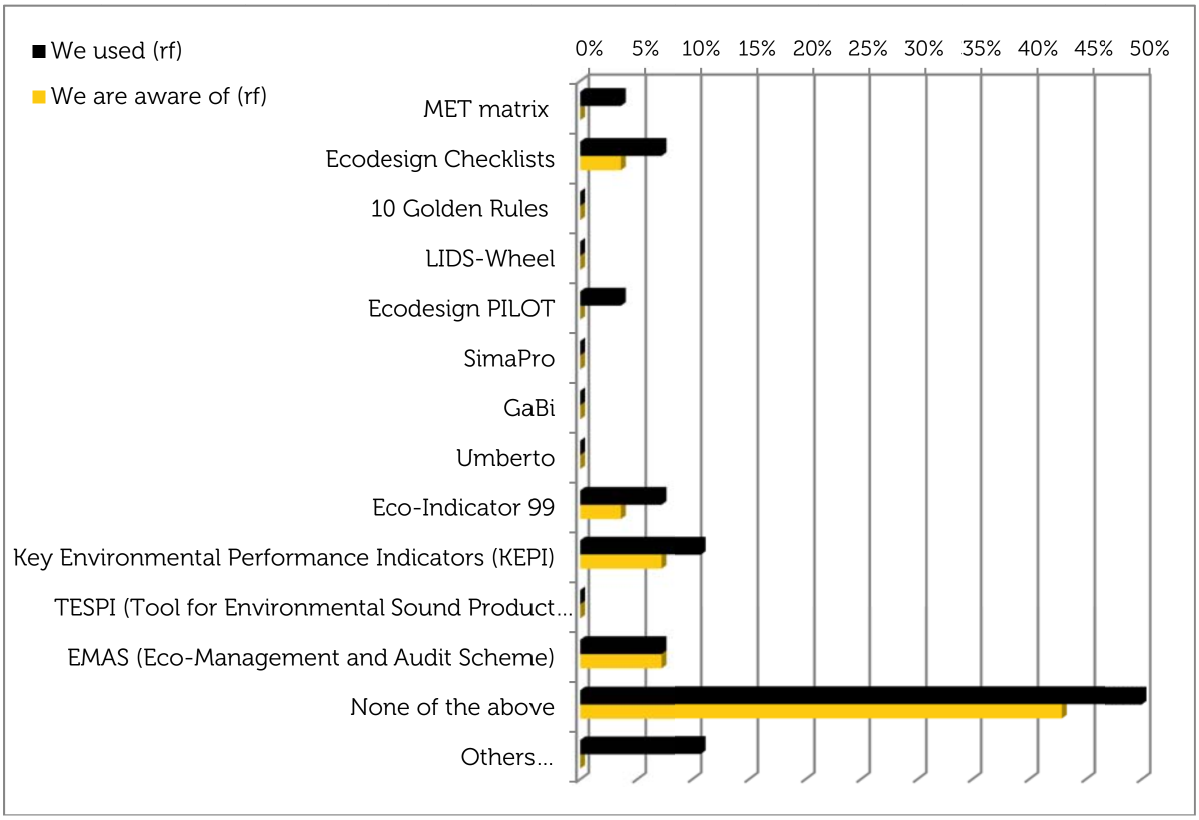


Figure 29: Experiences with environmental assessment tools (Electronics)

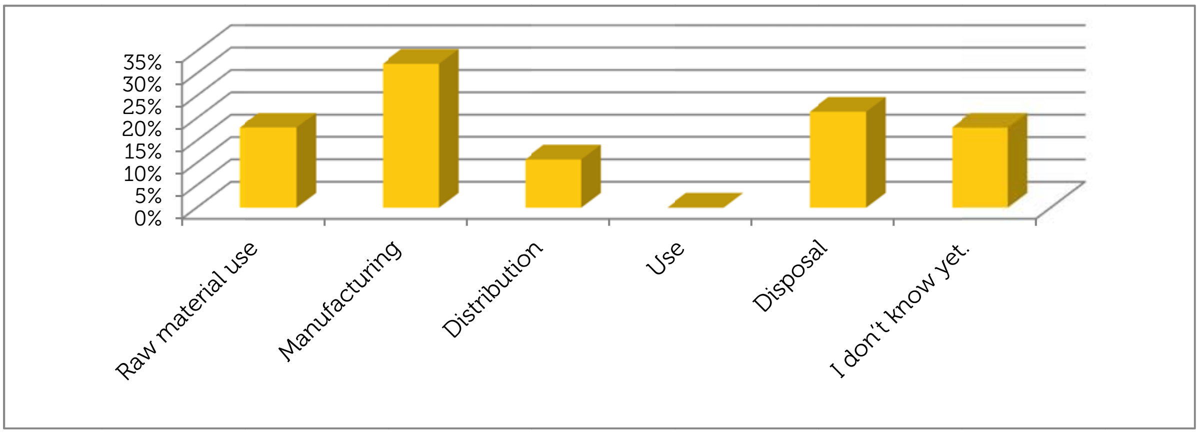


Figure 30: Most problematic life cycle phase (Electronics)

Most respondents see manufacturing, raw material use and disposal as most important life cycle phases of their product (Figure 30). 18% are not sure which phase the most problematic is. None of the respondents from the electronics sector mentioned the use phase, although energy consumption in use is for almost all electronics products a very relevant environmental impact. This judgment by the companies is surprising, given in particular the following response rate: For 38% energy and every fifth water and hazardous substances are the most important environmental aspects. Reducing greenhouse gases are not mentioned. Obviously there is a clear lack of environmental life cycle understanding.

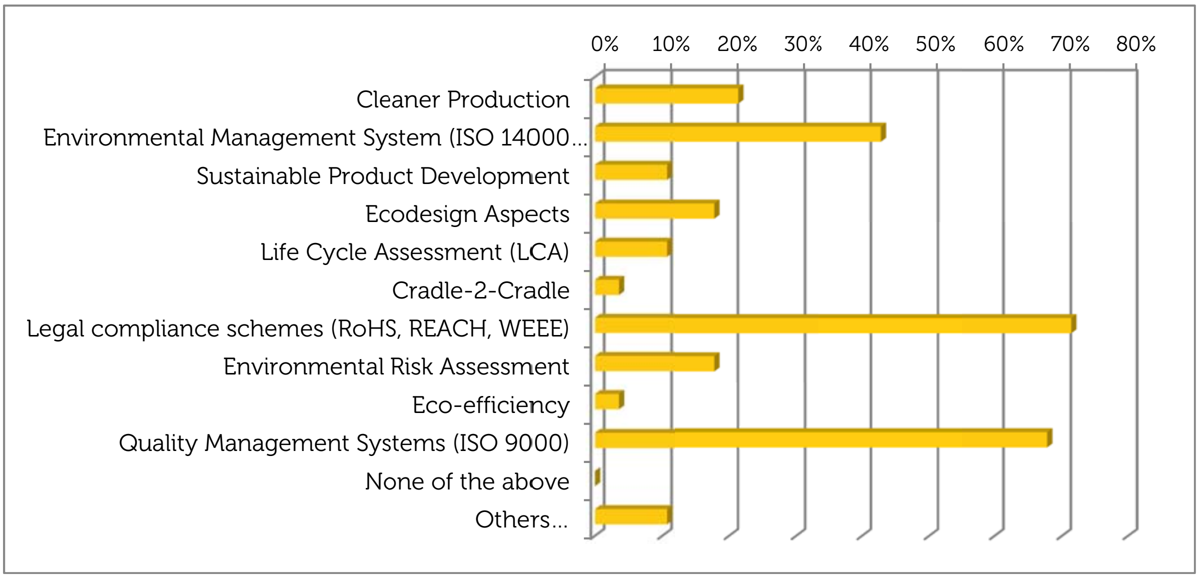


Figure 31: Familiar approaches (Electronics)

Approximately 68% of the companies are familiar with Quality Management System and legal compliance schemes (Figure 31). Another 43% is familiar with Environmental Management Systems. All respondents declared to know at least one approach.

3.3.4.2 Needs and demands

Environmental assessment

Reasons for not using LCA-tools are shown in Figure 32. No free resources in the company to undertake such studies and that the products did not run yet through a complete life cycle (i.e. missing data) were each with 32% the most important reasons.

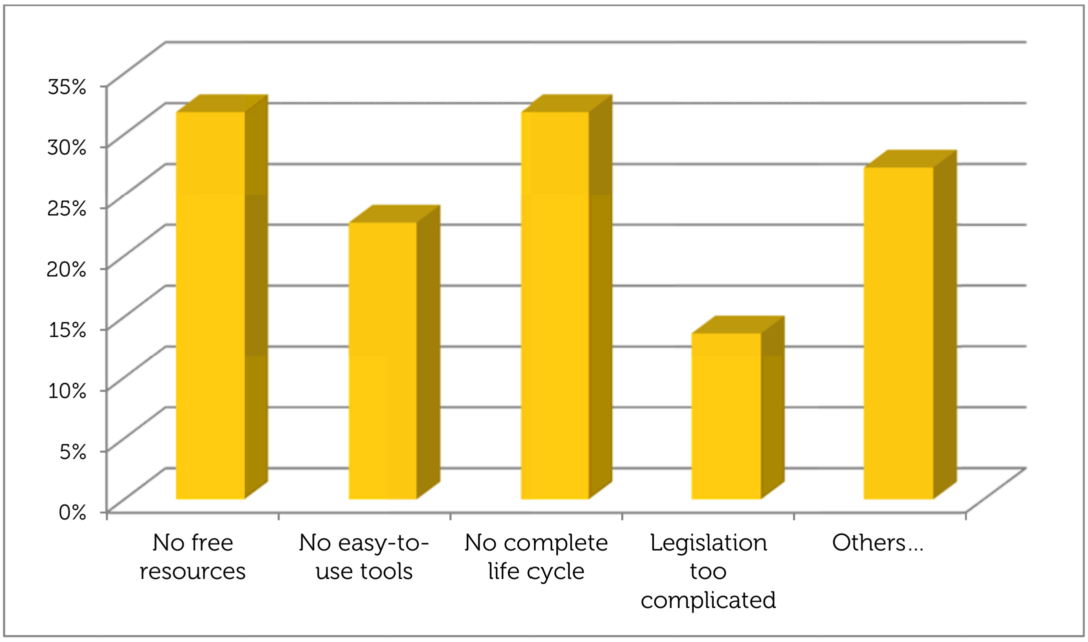


Figure 32: Reasons for not running LCA-tools (Electronics)

In small SMEs free resources will always be a problem. So LCA-tools should be easy to use and understand. A further problem is the knowledge how companies can advance production with these tools.

Further important points are manufacturing costs and product quality. It is interesting that a remarkable number of companies link environmental assessments to improving product quality. Possibly (but this is only speculation without further evidence) "environmentally benign" could be considered a quality attribute of their products.

Figure 33 shows only small differences between present and future drivers. There will be no big change without any pressures by customers or government.

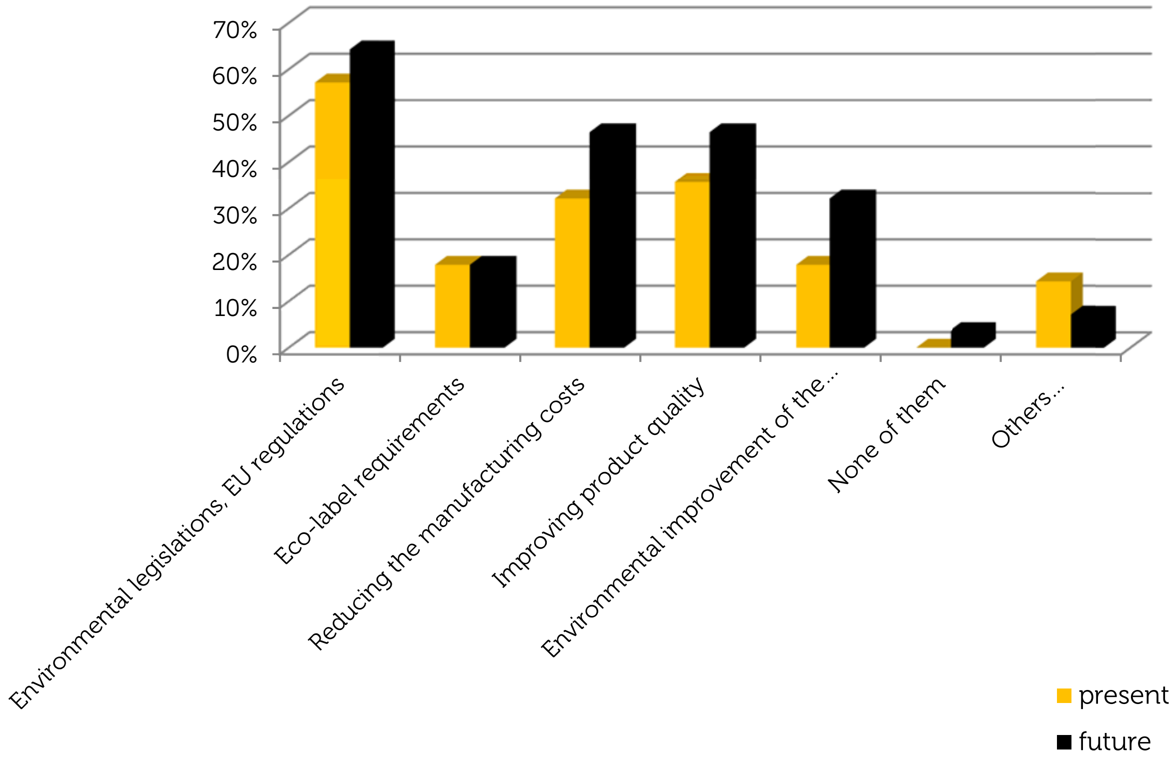


Figure 33: Drivers for environmental assessment – present and future (Electronics)

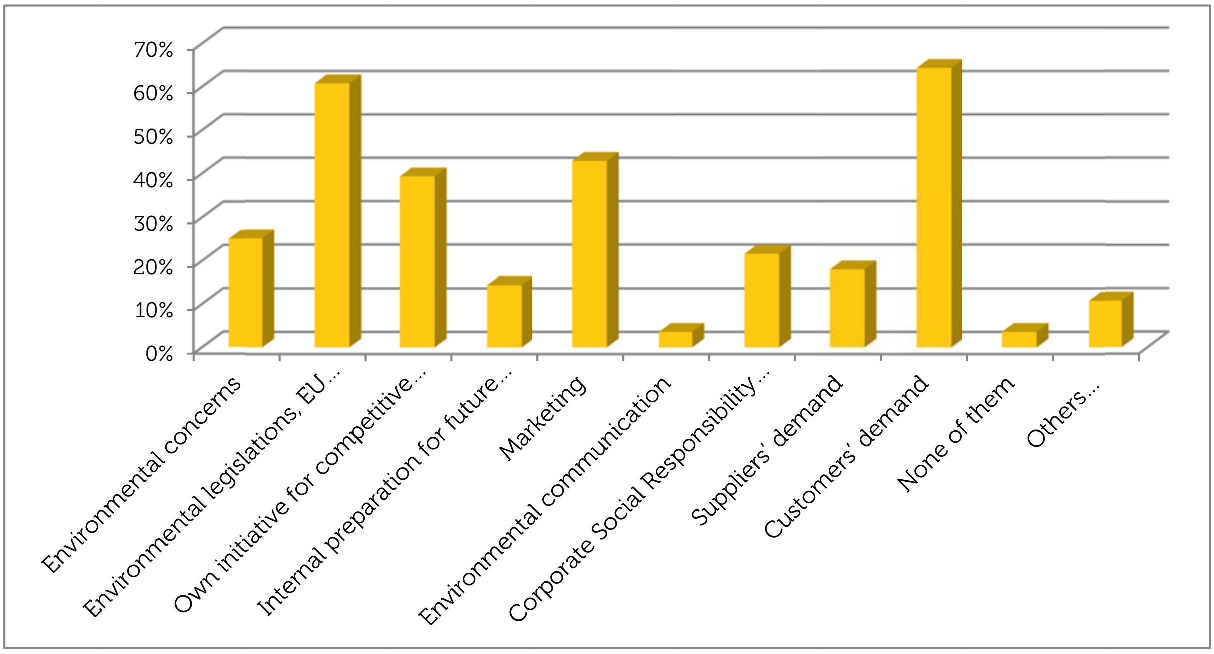


Figure 34: Drivers for environmental assessment – company perspective (Electronics)

Figure 34 shows that customers demand and EU regulation will be the most important drivers to introduce environmental assessments, but also marketing purposes. However, only 13% want perspectively apply environmental assessments.

<u>Environmental communication</u>

The preferred channel for environmental communication is depicted in Figure 35. Close to 30% do not have any environmental communication,. 25% communicate the content (or absence) of hazardous substances, which is presumably related to the fact, that most of the products in this sector are affected by the RoHS directive. Similarly material inventory lists are important, which overlaps also with the high share of self-declarations. Although starting from a very low level, some companies state to plan the use of LCA results for future communication.

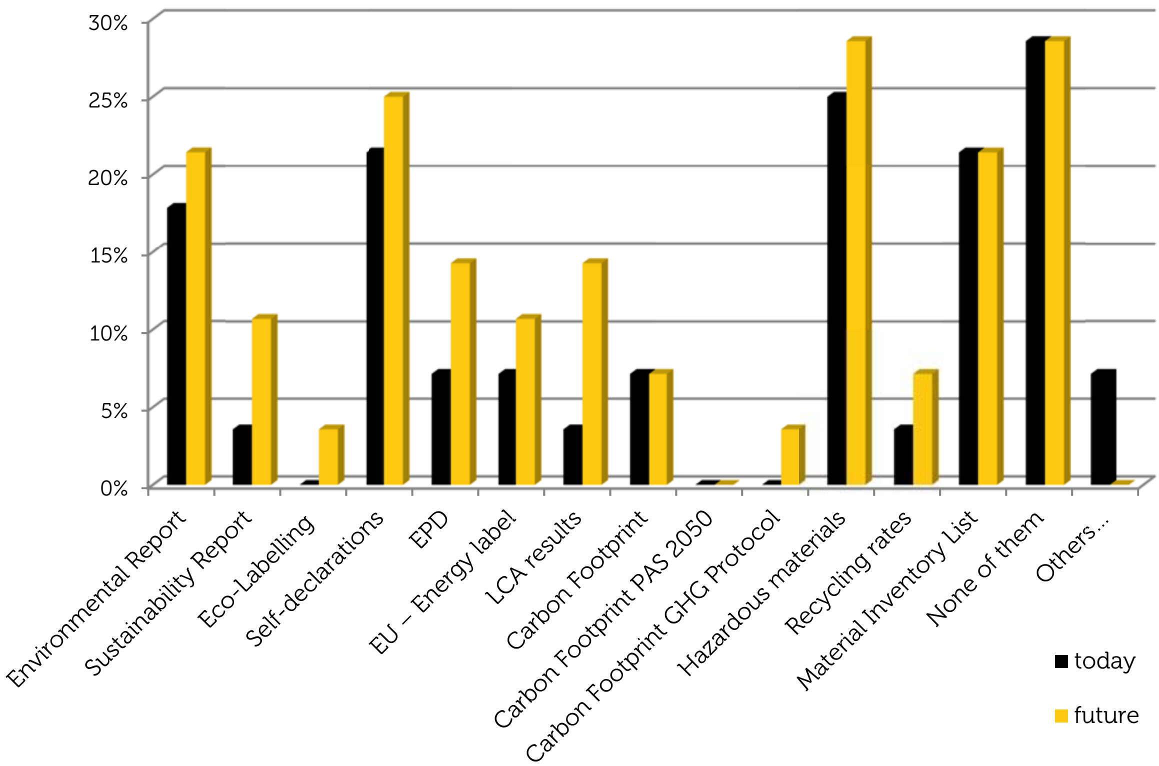


Figure 35: Communication tools used today and planned in the future (Electronics)

Compared to the industrial machinery sector the share of electronics companies actually communicating environmental aspects is much larger.

It is recognized, that the aspect of potential energy savings could be important information to promote own products better (54%). 43% each also state an increased product lifetime and providing declarations according to customer requirements as selling arguments.

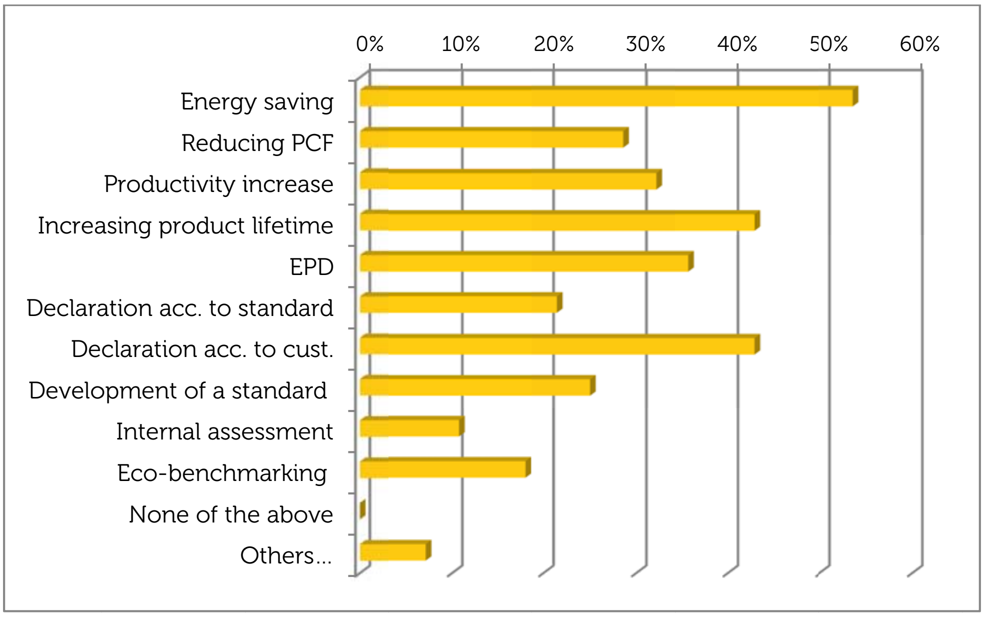


Figure 36: Aspects and arguments potentially useful to promote products (Electronics)

<u>LCA tool</u>

According to the survey results presented in Figure 37 the term "life cycle assessments" is interpreted very differently among the respondents. There is a certain consensus that LCA stands for measuring environmental impacts (64%) and avoiding hazardous substances (60%). One third associates energy consumption, product quality, environmental performance and Eco-design with the term LCA. Global warming potential and ozone layer depletion are not related to LCA, according to the understanding of the respondents.

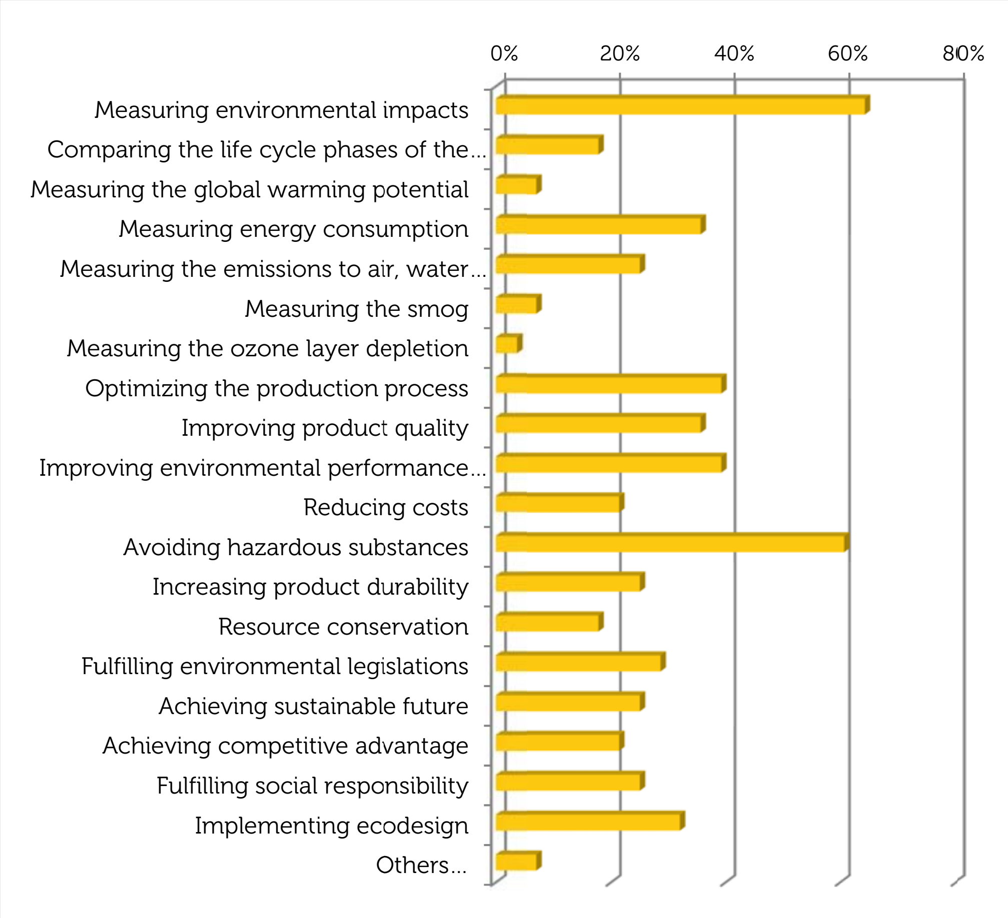


Figure 37: Statements most related to LCA (Electronics)

Material declarations, energy efficiency / consumption and legal compliance data are the most frequently asked for information by customers and other stakeholders. Some problems obviously remain with serving these data request. Life cycle data (LCA or carbon footprint) is rarely requested – and could hardly be served by the SMEs. Also very few SMEs have been approached for recyclability assessments by now,

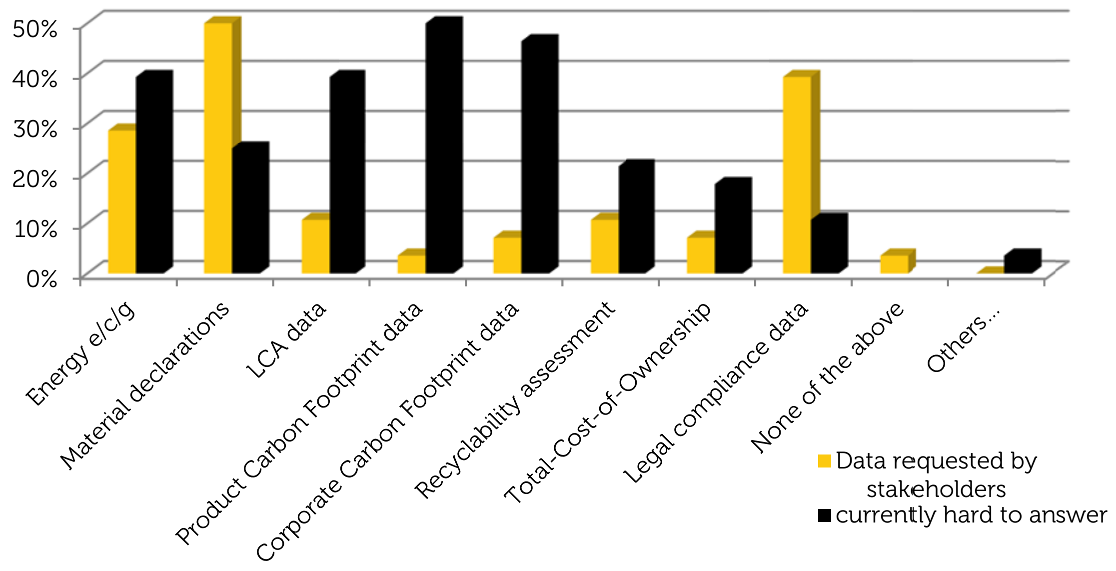


Figure 38: Data requested by stakeholders compared with data hard to answer (Electronics)

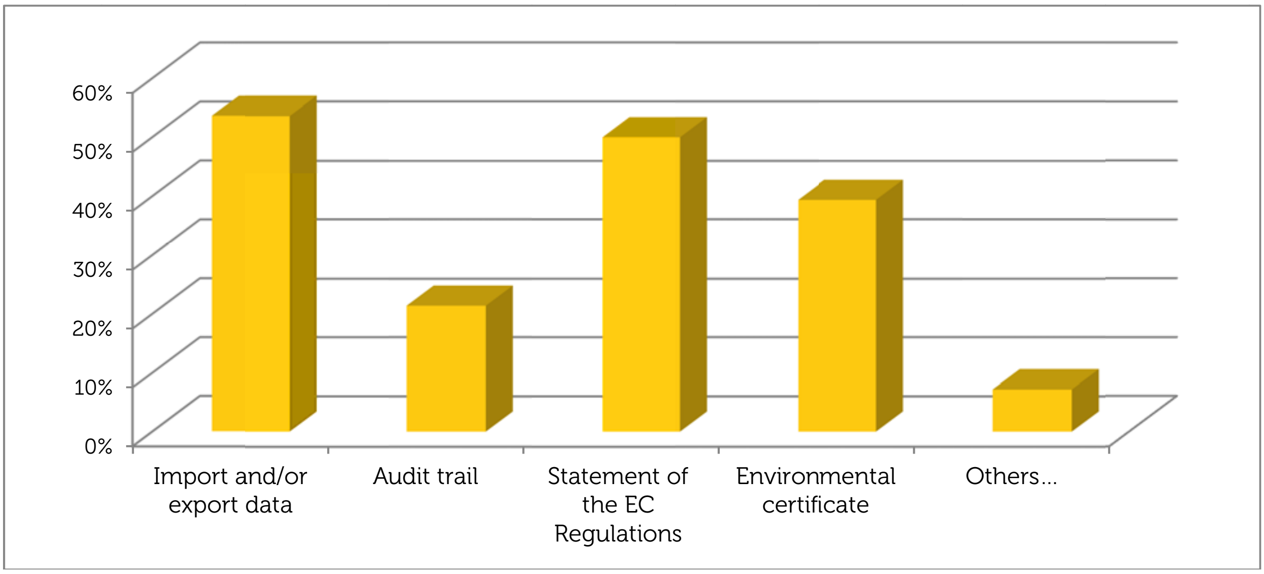


Figure 39: Expectations on the tool (Electronics)

For a web based tool, data import and export and information about EC regulation are preferred. Also environmental certificates are recommended. Other proposed aspects mentioned by SMEs are a feature to select alternative materials.

3.3.5 Green Paper Approach

Complementary to the survey approach in a workshop with MicroPro a Green Paper for the electronics sector was developed (version 1.1), which outlines the specific interests of MicroPro's. Three scenarios have been identified:

<u>Scenario 1: Promote long-living high-quality products through life cycle costs transparency for the customer</u>

A selling argument for "green" ICT products are potential costs savings over the (extended) product life cycle compared to (low-cost) products, which are replaced frequently.

A suitable approach could be a tool, which provides a rough environmental assessment of the total product life cycle compared to a pre-defined "standard" product.

This tool might work as an app for the end-consumer (potentially also used throughout a sales talk and for business-to-business sales) to make individual settings regarding computer configuration, likely use patterns, and electricity price. Based on these parameter settings the tool could calculate (assumed order of consumer interest):

- Life cycle costs
- Total life cycle energy consumption
- Product Carbon Footprint
- Other environmental life cycle aspects

Based on this analysis a customer can chose the optimal configuration and quantify likely savings.

Once a repair or upgrade is due or intended, cost and energy implications can be recalculated versus buying a new unit.

Disadvantages of this approach:

> To limit the complexity of the tool, only well-defined market segments could be covered (e.g. laptops and PCs, but not electronics in general) as the base data for manufacturing the sub-assemblies and – more important – the possible modes and user profiles need to be reflected
>
> A "standard" (competitor's) product and related assessment has to be established and maintained with technical progress. A simplified solution is a webtool which only calculates costs / energy / etc. per use year, but not in comparison with a "standard" product

To be defined: It has to be decided, which environmental parameters should be quantified: Product Carbon Footprint is mainstream (and is compatible with the approaches for semiconductors and passive components)

Scenario no. 2: Green Marketing – Environmental Declaration

As a selling argument, a transparent environmental product declaration meant for publication is developed, based on (simplified) calculations with a web tool.

If recognized by public and private procurement, the declaration based on this web tool can serve as a basis for procurement.

Disadvantages of this approach:

To be applicable for SMEs, the environmental assessment needs to be a simplified one, not a full scale LCA; based on certain pre-defined modules ("grams mainboard"). Simplification undermines credibility of this approach, as even ISO-conform LCAs hardly deliver results suitable for product comparisons (comparison with competitors)

Advantages of this approach:

Approach is feasible, if life cycle impacts are clearly dominated by the use phase, and results depend on certain scenario settings with a limited number of assumptions and parameters, which can be documented briefly. Overall results in this case are less sensitive to production related uncertainties.

Depending on the pre-defined sub-assemblies this approach is feasible for a broader range of electronics products, if above stated simplifications are acceptable

For those products for which such an environmental product declaration is established, this approach is compatible with the first one

To be defined:

It has to be decided, which environmental parameters should be quantified: Product Carbon Footprint is mainstream (and is compatible with the approaches for semiconductors and passive components)

Scenario no. 3: Support reuse strategies with quantification of achievable environmental savings

Longevity / lifetime extension / reusability are core aspects of the business strategy and need to be supported by a reliable methodological approach.

A suitable approach could be a tool, which provides a rough environmental assessment of the major subassemblies to identify those sub-assemblies with the highest environmental impact at production.

Based on this analysis an SME can decide, for which sub-assemblies longevity / repairability / reusability is most important. This analysis enables a manufacturer to judge, for which sub-assemblies lifetime extension is most useful in terms of resource savings (and/or carbon footprint reduction).

Disadvantages of this approach:

> This kind of analysis does not provide any information about the (technical) lifetime of individual components / sub-assemblies; this has to be investigated individually; it is hardly possible to implement in addition a database with reliability data (as this is very specific for a given part / supplier), and is not related to any LCA data directly (although influences the product LCA)
>
> A dedicated "reuse strategy" is not common at all among product manufacturers, hence it might be questionable, whether such approach would be followed by many other SMEs

Advantages of this approach:

> A quantification of "environmental hot-spots" as a target for the reuse strategy could also serve as a cradle-to-gate analysis for any simplified product declaration
>
> If done for all products of a company, this approach is compatible with the first one

To be defined:

> It has to be decided, which environmental parameters should be quantified: Product Carbon Footprint is mainstream (and is compatible with the approaches for semiconductors and passive components), but for quantifying positive effects of lifetime extension, "resource related" analyses might be more useful
>
> A similar discussion about needs among SMEs of the electrical and electronics sector was initiated as a blog at Open Innovation-connect (see

screenshot in the Appendix), the platform of the UK Knowledge Transfer Networks, which yielded in a remarkable number of visits, but no substantial additional input to the discussion.

3.3.6 Wish list

- ✓ It should be possible to assess innovative products, without complete life cycle data sets *(see Figure 32)*
- ✓ The tool has to be easy–to-use *(*see Figure 32*)*
- ✓ The tool has to support compliance with the legal situation – environmental legislation, EU regulation *(see Figure 33, Figure 34)*
- ✓ The tool should help improving product quality as well as reducing manufacturing costs *(see Figure 33)*
- ✓ The results of the tool have to be tailored to the customers *(see Figure 34)*
- ✓ Motivation for using the tool is to follow legal compliance *(see Figure 34)*
- ✓ For environmental communication of highest interest are hazardous materials, material inventory list, company declarations and environmental reports *(see Figure 35)*
- ✓ The tool has to be aware of following arguments for promotion *(see "Environment communication"):*
    - o energy saving
    - o increasing product lifetime
    - o declaration according to customers
    - o Environmental Product Declaration (EPD)
- ✓ The tool should provide information about, material declarations, legal compliance data and carbon footprints *(see Figure 38)*
- ✓ The tool should be able to import and/or export data and to give a statement of EC regulations *(see Figure 39)*

Based on the Green Paper approach the wish list can be extended by the following 3 scenarios:

- ✓ Promote long-living high-quality products through life cycle costs transparency for the customer
- ✓ Green Marketing – Environmental Declaration
- ✓ Support reuse strategies with quantification of achievable environmental savings

3.3.7 Summary

Most of the SMEs are already communicating environmental information, usually related to material data. SMEs have limited knowledge about LCA and environmental assessments. Only very few SMEs have experience in using environmental assessment tools. SMEs recognize pressure from legislation as a main driver for environmental assessments – which actually is the case for at least a decade now -, but also improving the product quality.

The scenarios of interest to MicroPro, which have been identified through the Green Paper discussions, have been partly confirmed by respondents to the survey, indicating lifetime, reuse and service aspects as being of interest.

3.3.8 Conclusion

Legal compliance as one of the main drivers for an interest in environmental aspects hardly can be linked to a life cycle assessment tool as no such life cycle analysis is required yet by any legislation. The ErP Ecodesign Directive for Energy-related Products provides a general framework to implement such requirements, but has failed to do so for electronics products. As a mere compliance tool (many of these are already available anyhow) would fail the objective of boosting LCA use among SMEs, this legal aspect most likely has to be ruled out from further methodology development for the electronics sector.

As material declarations have been mentioned by numerous companies as data being frequently requested, and data being provided to customers, this might be an appropriate starting point to build environmental assessments on. The survey does not unveil, whether material declarations are negative lists (confirmation, that certain substances are not contained) or a positive list (predefined list of materials or 100% declaration). Presumably the negative list approach is the more common one – which is less suitable to build environmental assessments on.

Methodology development jointly with the passive components industry will be centered on the anticipated future need of production related energy consumption and component carbon footprint data. Following the UmbrellaSpec approach is a feasible way forward to limit the complexity of the approach and should be suitable also as an abridged data format for SMEs. At the level of the downstream SMEs carbon footprint data is of interest and energy recognized as an important aspect, and the purpose for using such data is to demonstrate the environmental performance of the end product, but also to support business strategies for lifetime extension.

3.3.9 Outlook

One of the main remaining challenges is the diversity of the sector and interests of the players in the various stages of the supply chain: LCA to go covers not only electronics as such but tackles also the supplier segments of semiconductors, passive components and printed circuit boards (see below). The following methodology development has to consider carefully possibilities to support (environmental) supply chain data management. As this even among the large companies is not yet common business practice a more feasible approach might be, that to a certain extent only aggregated data is provided to the SMEs. Otherwise they will have problems to handle this complexity – without much additional benefit.

In parallel to the needs assessment the methodology development for the passive components industry was kicked-off and data acquisition for some selected component types is underway.

3.4 Electronics - Semiconductors

3.4.1 Sector characteristic

The semiconductor industry is the aggregate collection of companies engaged in the design and fabrication of Integrated Circuit (IC) devices, including upstream and downstream application, such as IC design, IC development, IC manufacturing, IC assembly, IC test, IC application, etc.

3.4.2 Survey methodology and statistic

Development of the questionnaire

The development of the questionnaire comprised two stages. In the first stage, a questionnaire was drafted based on literature review and a copy questionnaire was developed for the FP7 project of the European Union, particularly for investigating SMEs in six industries. In the second stage, seven experts and scholars from the industry, the academia, and research institutes were invited to review the draft questionnaire. The questionnaire was then revised and finalized according to the suggestions from the experts and scholars. The investigation procedure was expected to provide effective and representative results.

This questionnaire contained three parts. The first part discussed general issues of environmental management and life cycle assessment practices of the enterprises in the semiconductor industry. The second part explored how enterprises implement carbon footprint of their products. The third part aimed to know the basic information on the respondents.

Sampling

The questionnaires were distributed to 589 enterprises, of which 448 were members of Taiwan Semiconductor Industry Association (TSIA), while the remaining 141 companies were members of Taiwan Electrical and Electronic Manufacturers Association (TEEMA). The respondents included both upstream and downstream application of semiconductor industry in Taiwan.

The reason for the survey target included large enterprise (LE) is that LEs have much experience of performing LCA and PCF than SMEs, and SMEs can refer to the results of LEs for improving.

Data collection

Copies of the questionnaire for this study were mailed to the target respondents from March 28 to May 26, 2011. Of the questionnaires distributed, 112 were returned (highest return rate within the project survey), resulting in a response rate of 19.0%. Among the samples returned, six were incomplete and thus were excluded from the analysis, thereby trimming the actual number of respondents to 106 and the response rate to 18.0%. Table 3 shows the result.

Table 3: Questionnaire Response (Semiconductors)

Target Group	Total questionnaires distributed	Returned questionnaires	Effective questionnaires	Effective response rate (%)
Semiconductor industry	448	68	65	14.5
Semiconductor downstream application	141	44	41	29.1
Total	589	112	106	18.0

<u>Sample description</u>

Within the semiconductor industry, the sector distribution of the respondents was as follows: IC design (24.6%), IC packaging (13.0%), and photoelectric semiconductor (11.6%). Details can be found in Figure 38. The sector distribution of the respondents from the semiconductor application industry was as follows: notebook (22.2%), desktop (18.5%), and motherboard (12.3%). Details of the results are shown in Figure 40.

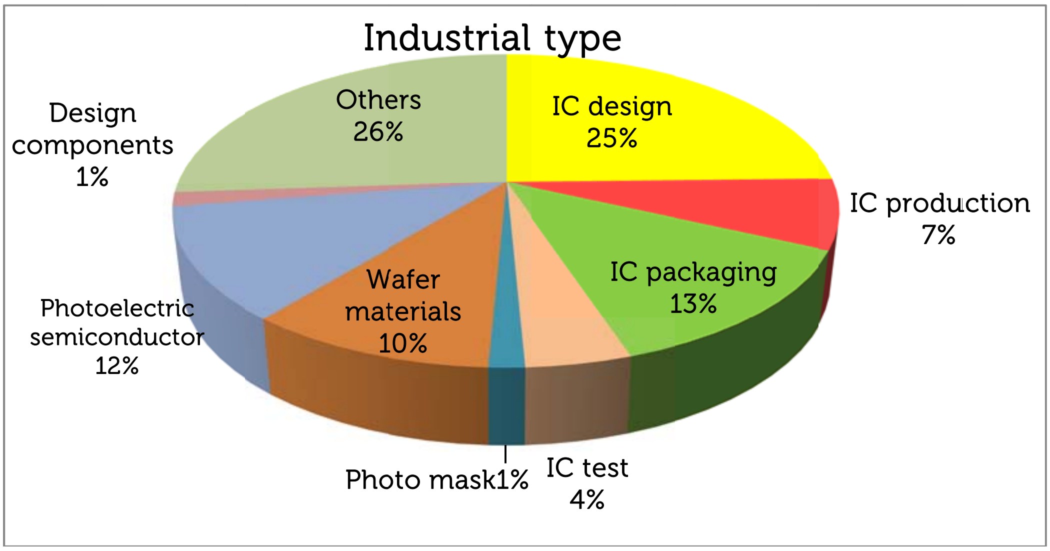


Figure 40: Sector distribution within the semiconductor industry

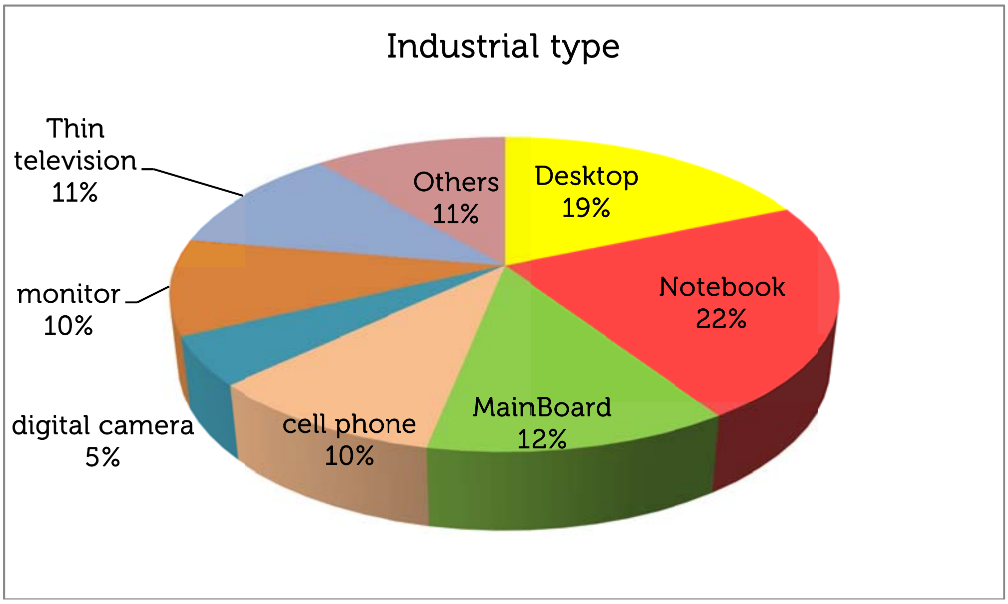


Figure 41: Sector distribution within the semiconductor application industry

According to the latest definition announced in 2009 by Taiwan's Small and Medium Enterprise Administration, Ministry of Economic Affairs, a small- and medium-sized enterprise (SME) is an enterprise with total employees of less than 200. This differs to the European definition of SME with 250 employees. Among the participants to this study, 49 companies (46.23%) were SMEs, while 44 companies (41.51%) had more than 500 employees. Details of the number of employees for all the enterprises are shown in Table 4.

Table 4: Number of Employees of the Enterprises (Semiconductors)

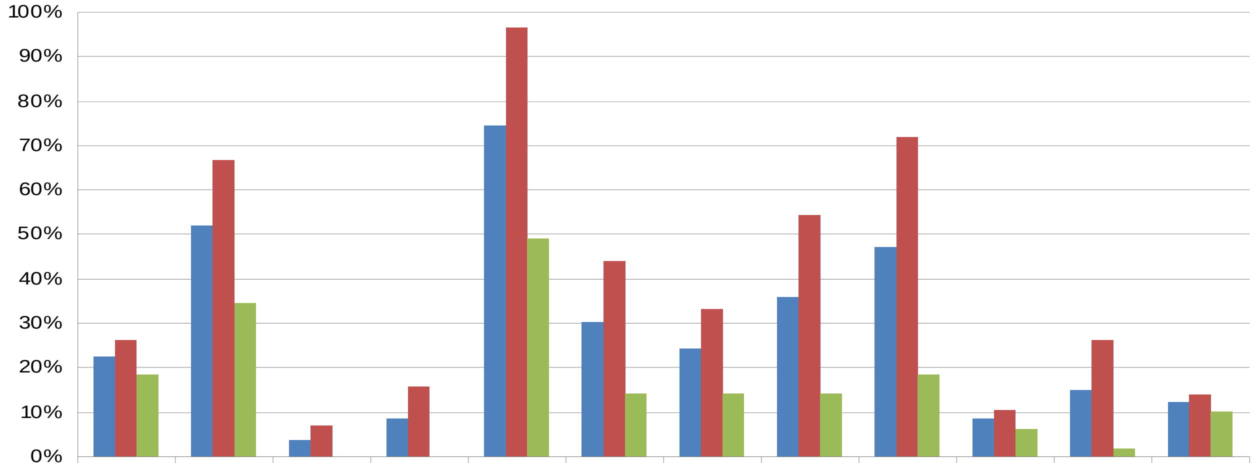
Number of employees	Number of enterprises	percentage
Under 200	49	46.23%
201~300	8	7.54%
Over 301	49	46.23%
Total	106	100%

3.4.3 Survey results

In this section the survey results are described and analyzed. To find out how the size of enterprises, including overall, large enterprises and SMEs, are correlated a cross analysis have been done for all survey results.

Environment managment

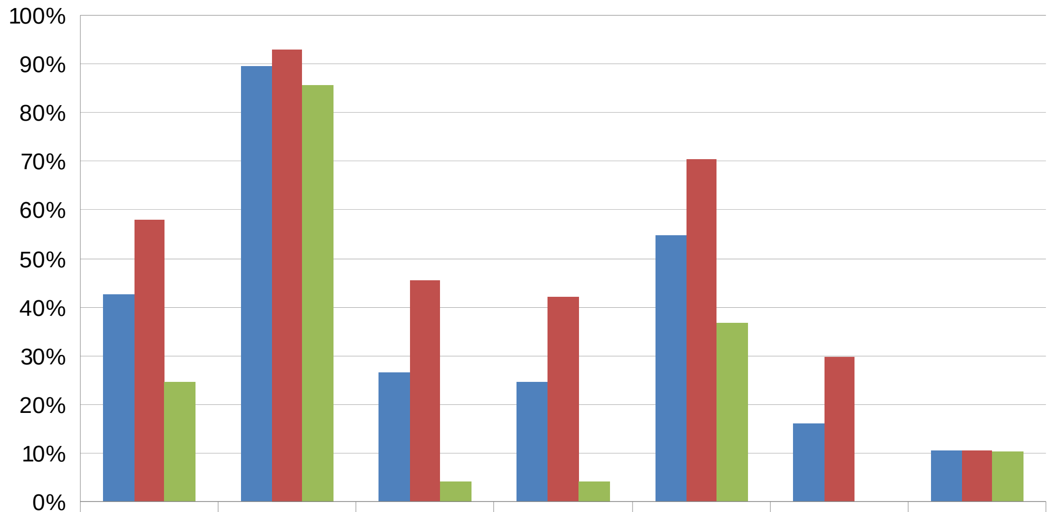
Most large-sized enterprises (96.5%) already had established their own environmental management systems, while nearly half (49.0%) of the SMEs had environmental management systems. Regarding the implementation of other environmental management practices, SMEs were inferior compared with large-sized enterprises. Details of the results are shown in Figure 42.



	Cleaner production	Green supply chain	Eco-efficiency	Carbon labeling	Environmental manageme	Green design	Environmental product	Corporate social responsibil	Hazardous material manageme	Energy menegement system	Environmental labeling	Others
Overall (106)	22.60%	51.90%	3.80%	8.50%	74.50%	30.20%	24.50%	35.80%	47.20%	8.50%	15.10%	12.30%
LEs (57)	26.30%	66.70%	7.00%	15.80%	96.50%	43.90%	33.30%	54.40%	71.90%	10.50%	26.30%	14.00%
SMEs (49)	18.40%	34.70%	0.00%	0.00%	49.00%	14.30%	14.30%	14.30%	18.40%	6.10%	2.00%	10.20%

Figure 42: Enterprises adopting environmental management practices (Semiconductors)

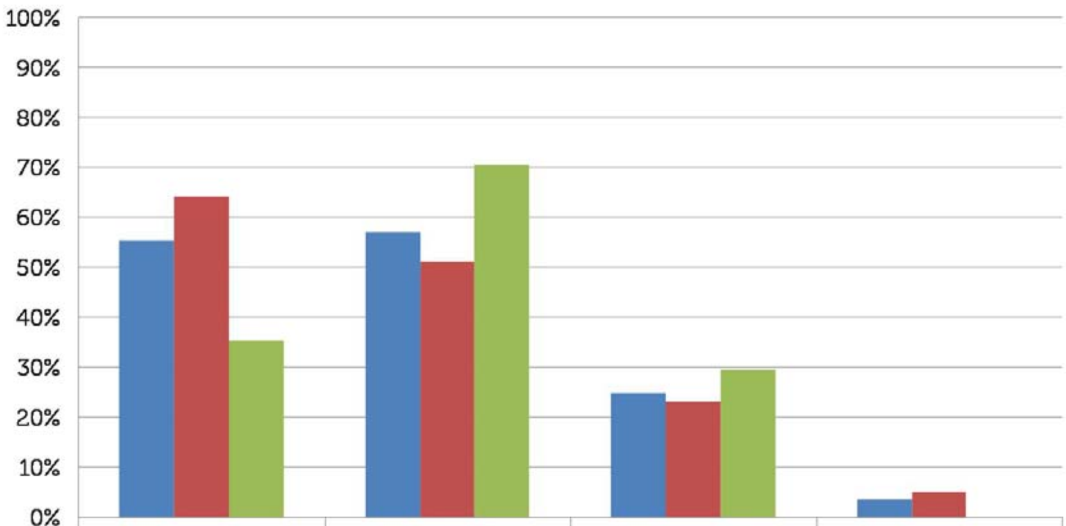
It was found that most of the large-sized enterprises (93.0%) and the SMEs (85.7%) were affected by the Directive of Restriction of Hazardous Substances (RoHS) and other environmental regulations imposed by the EU. Details of the results are shown in Figure 43.



	WEEE	RoHS	PPW	EuP/ErP	REACH	EPEAT	Others
Overall (106)	42.50%	89.60%	26.40%	24.50%	54.70%	16.00%	10.40%
LEs (57)	57.90%	93.00%	45.60%	42.10%	70.20%	29.80%	10.50%
SMEs (49)	24.50%	85.70%	4.10%	4.10%	36.70%	0%	10.20%

Figure 43: Enterprises affected by environmental regulations (Semiconductors)

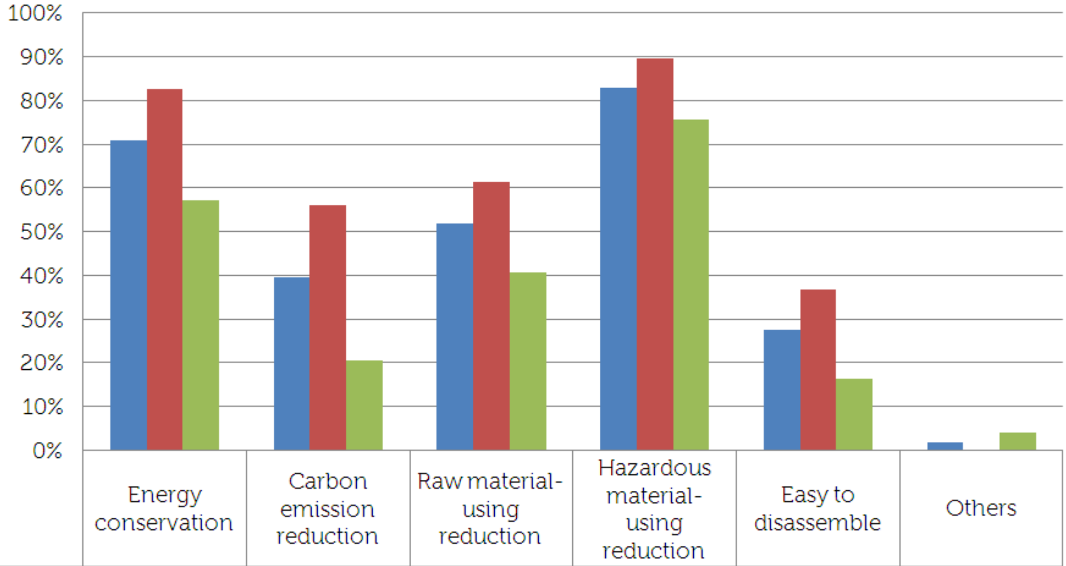
The results suggest that large-sized enterprises use mainly LCA (64.1%) and checklist (51.3%) as tools to evaluate their environmental impact, while SMEs mainly use checklist (70.6%). Details of the results are shown in Figure 44.



	LCA	Checklist	EPI	Others
Overall (56)	55.40%	57.10%	25.00%	3.60%
LEs (39)	64.10%	51.30%	23.10%	5.10%
SMEs (17)	35.30%	70.60%	29.40%	0.00%

Figure 44: Adoption of environmental impact evaluation tools (Semiconductors)

It could be emerged that since almost all semiconductor enterprises would be restricted by the RoHS and Directive of Registration, Evaluation, Authorization and Restriction of Chemicals (REACH) by the EU, 83% of the enterprises were considering reducing their usage of harmful substances during the design stage. Details of the results are shown in Figure 45.

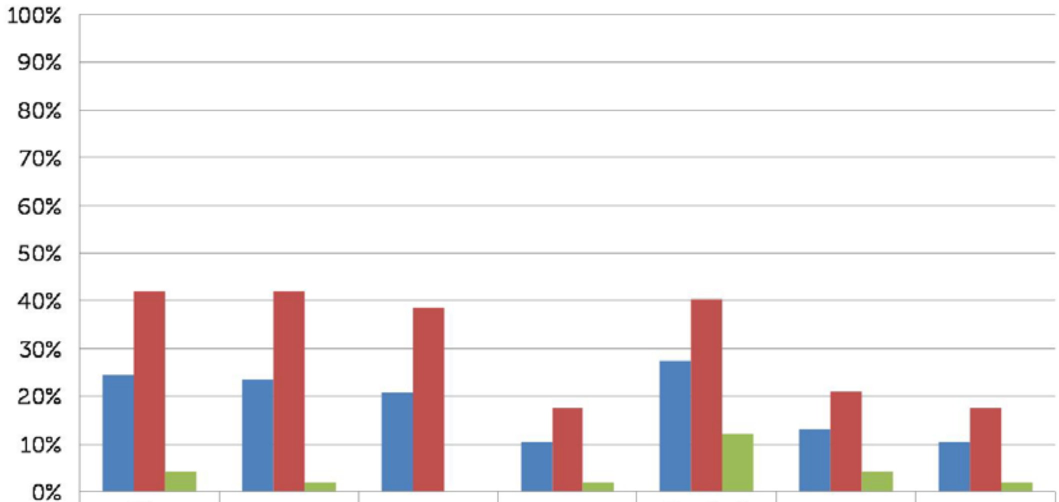


	Energy conservation	Carbon emission reduction	Raw material-using reduction	Hazardous material-using reduction	Easy to disassemble	Others
Overall (106)	70.80%	39.60%	51.90%	83.00%	27.40%	1.90%
LEs (57)	82.50%	56.10%	61.40%	89.50%	36.80%	0.00%
SMEs (49)	57.10%	20.40%	40.80%	75.50%	16.30%	4.10%

Figure 45: Consideration of environmental aspects during design stage (Semiconductors)

Implementation of carbon footprinting

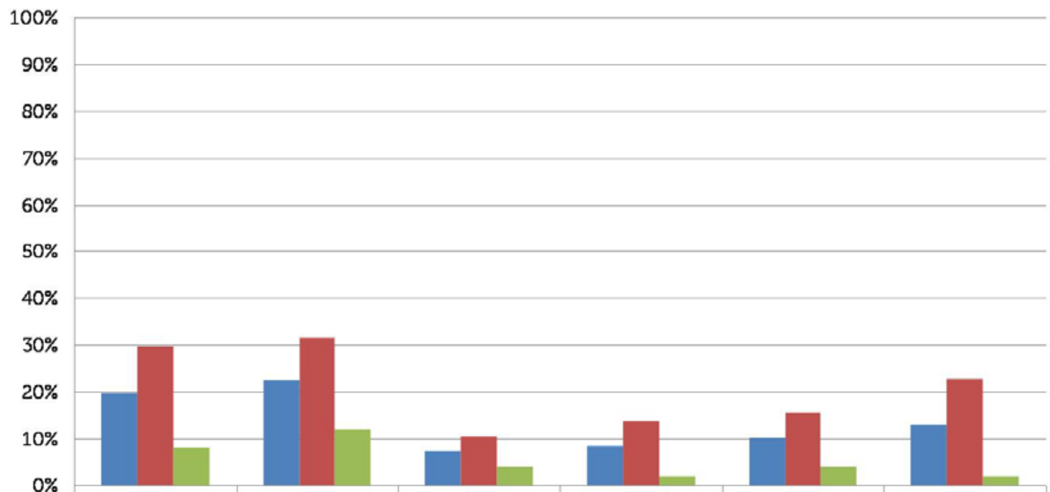
The results of the survey indicate that ratio of enterprises request their suppliers to provide carbon emission data is with 20 % is rather high in comparison with the other European survey results, especially at large companies with up to 40%. Details of the results are shown in Figure 46.



	The organization level	The scope 1 level	The scope 2 level	The scope 3 level	Product carbon footprinting	Different life cycle phases	Different processes
Overall	24.50%	23.60%	20.80%	10.40%	27.40%	13.20%	10.40%
LEs	42.10%	42.10%	38.60%	17.50%	40.40%	21.10%	17.50%

Figure 46: Enterprises requesting suppliers to provide carbon emission data (Semiconductors)

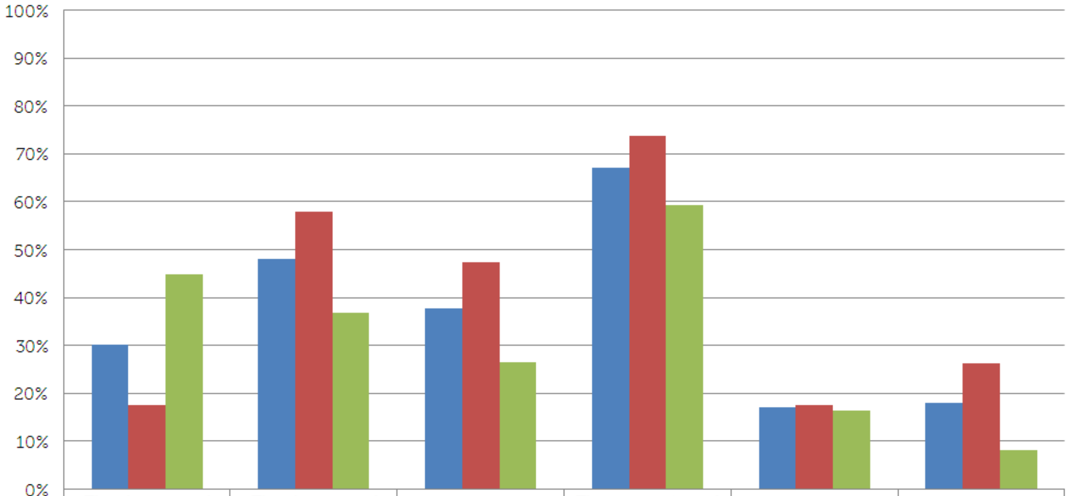
The number of enterprises that require their suppliers to implement carbon management is relatively low. Their main practice is regular auditing. Details of the results are shown in Figure 47.



	Providing carbon emission data regularly	Supplier audit regularly	Incorporating carbon management	Carbon reduction targets	Measures of mitigation of carbon emissions	Disclosure carbon emissions of products
Overall	19.80%	22.60%	7.50%	8.50%	10.40%	13.20%
LEs	29.80%	31.60%	10.50%	14.00%	15.80%	22.80%
SMEs	8.20%	12.20%	4.10%	2.00%	4.10%	2.00%

Figure 47: Carbon-management measures adopted by enterprises and involving their suppliers (Semiconductors)

According to the results two-thirds of the enterprises point out that the major obstacle for carbon management by suppliers is the low proportion of suppliers conducting carbon footprint analysis. This was followed by lack of professional knowledge. Details of the results are shown in Figure 48.

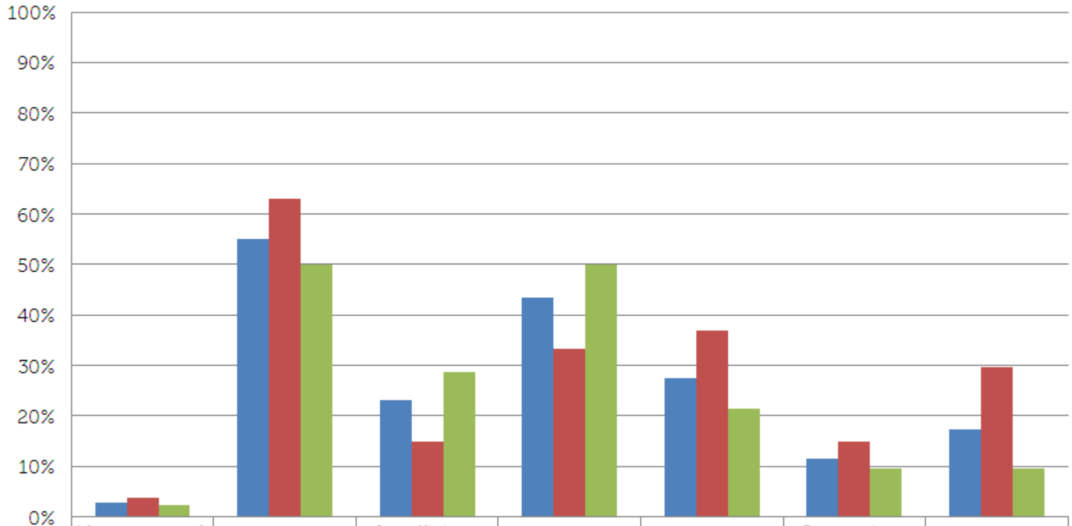


	The shortage of carbon management capability of company	The shortage of carbon management capability of suppliers	Market is monopolized by few suppliers	The proportion of product carbon footprinting implementation for suppliers is low	Suppliers think their carbon emissions are low	Others
Overall (106)	30.20%	48.10%	37.70%	67.00%	17.00%	17.90%
LEs (57)	17.50%	57.90%	47.40%	73.70%	17.50%	26.30%
SMEs (49)	44.90%	36.70%	26.50%	59.20%	16.30%	8.20%

Figure 48: Obstacles to implementation of carbon management for suppliers (Semiconductors)

The results demonstrate that already one-third (34.9%) of the enterprises in the semiconductor industry implemented carbon footprint of their products. Moreover, the larger the enterprises, the higher the proportion of firms that implement carbon footprint (52.6% of the large-size enterprises compared with 14.3% of the SMEs).

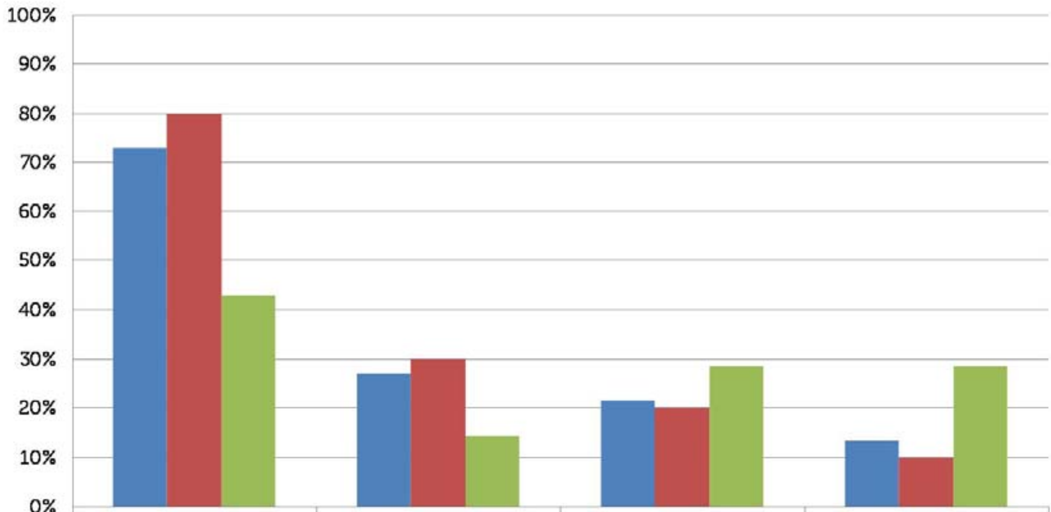
More reasons why enterprises would not implement carbon footprint were the following: such was not requested by their customers (55.1%) and unfamiliarity with the information on carbon footprint (43.5%). Details of the results are shown in Figure 49.



	Not supported by top management	Not required by customers	Insufficient manpower in the company	Unfamiliar with PCF	Cost increase	Competitors haven't done it	Others
Overall (69)	2.90%	55.10%	23.20%	43.50%	27.50%	11.60%	17.40%
LEs (27)	3.70%	63.00%	14.80%	33.30%	37.00%	14.80%	29.60%
SMEs (42)	2.40%	50.00%	28.60%	50.00%	21.40%	9.50%	9.50%

Figure 49: Reasons for non-implementation of PCF (Semiconductors)

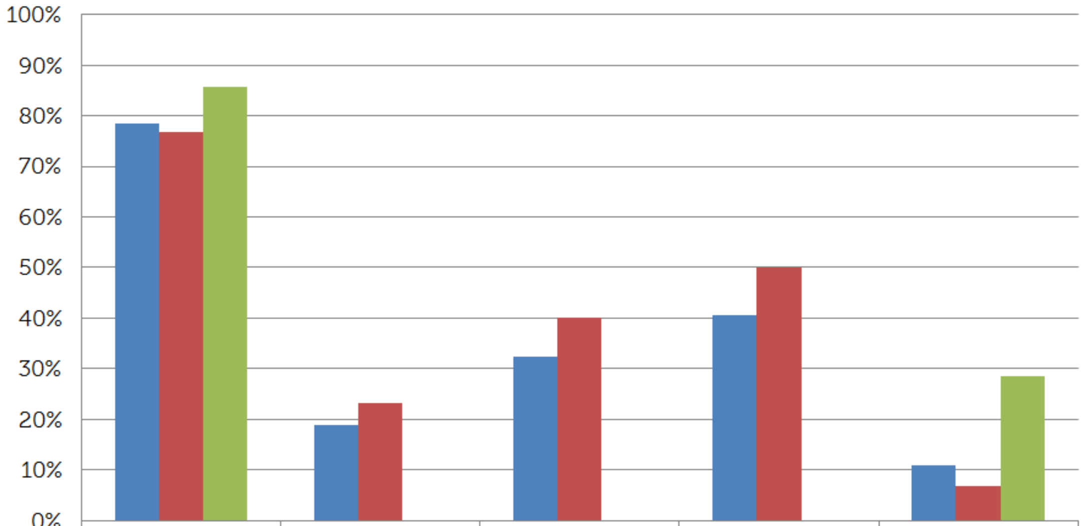
It`s obviously that the major standard for calculating carbon footprint of products was PAS 2050 [PAS2050 2008]. Details of the results are shown in Figure 50.



	PAS 2050	ISO 14067	Taiwan EPA's guideline	Others
Overall (37)	73.00%	27.00%	21.60%	13.50%
LEs (30)	80.00%	30.00%	20.00%	10.00%
SMEs (7)	42.90%	14.30%	28.60%	28.60%

Figure 50: Standards for implementing carbon footprint of products (Semiconductors)

The main reason why enterprises in the semiconductor industry implement carbon footprint was that such offered to their customers. Details of the results are shown in Figure 51.



	Offered to customers	Applying for carbon label	Design low carbon products	Self-reduction plan for PCF	Others
Overall (37)	78.40%	18.90%	32.40%	40.50%	10.80%
LEs (30)	76.70%	23.30%	40.00%	50.00%	6.70%
SMEs (7)	85.70%	0.00%	0.00%	0.00%	28.60%

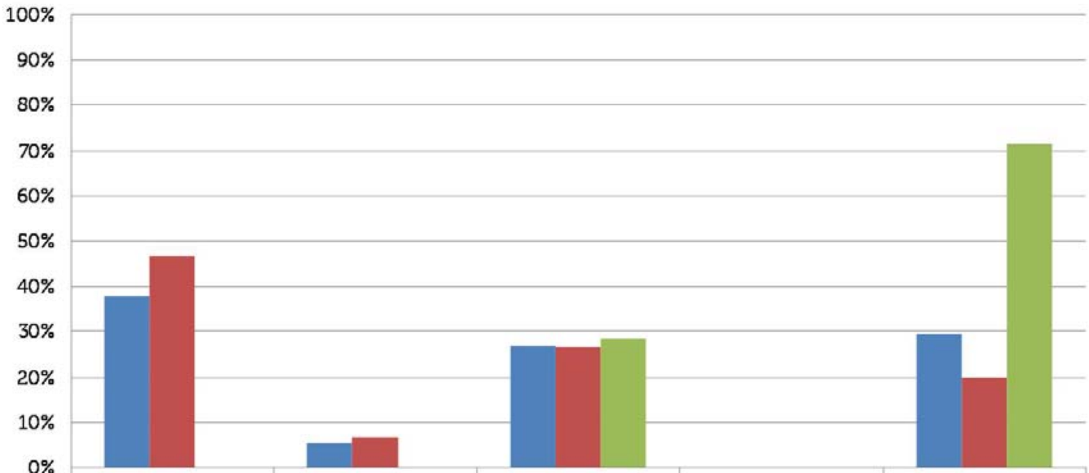
Figure 51: Purposes of implementation of carbon footprint of products (Semiconductors)

The main driving forces for enterprises in the semiconductor industry to implement carbon footprint of products are the desire to fulfil request by customers (4.41 out of the scale of 5.0) and the need to meet environmental regulations (4.09/5.0). Similar results can be found for SMEs. However, for large-sized enterprises, the main driving forces were the desire to satisfy request by customers (4.42/5.0), the desire to improve competitiveness (4.19/5.0), and improved green consumption consciousness (4.19/5.0). Each of the aforementioned scales are 5-point Likert-type scales (1 = strongly disagree/5 = strongly agree).

The findings about the main obstacles for the semiconductor industry to implement carbon footprint of products were the consumption of significant time for data inventory (4.29/5.0) and the high prices of commercial softwares (4.23/5.0). Each of the aforementioned scales are 5-point Likert-type scales (1 = strongly disagree/5 = strongly agree).

Software tool

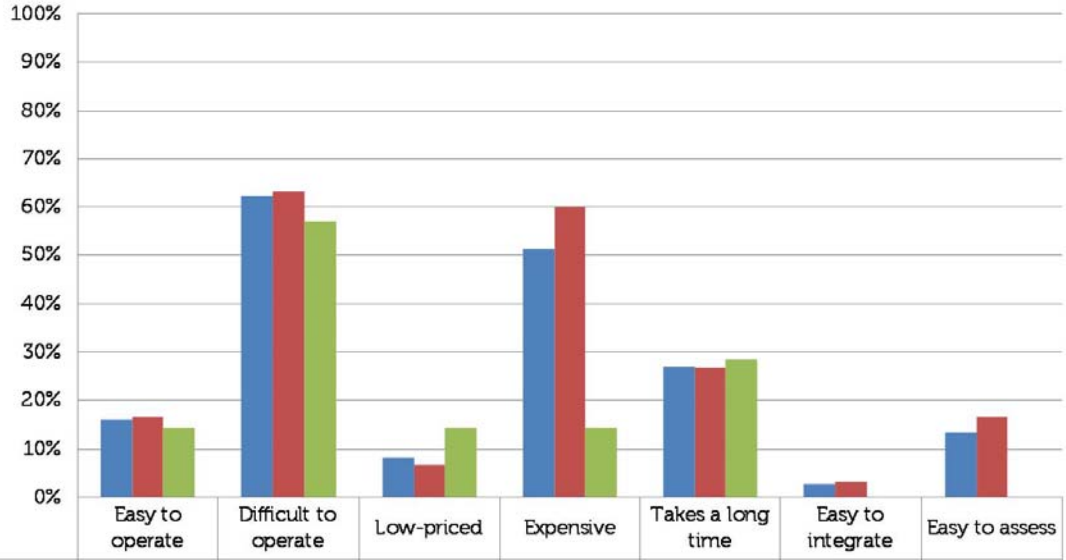
In semiconductor industry, the major software for calculating carbon footprint of products is Dutch's SimaPro [SimaPro 2011] (37.8%), which is followed by Do It Pro (27.0%) developed by ITRI, Taiwan, and others (29.7%), which include Microsoft office excel spreadsheet, Ecoinvent [Ecoinvent 2011], or forms requested by customers. Details of the results are shown in Figure 52.



	SimaPro	Gabi	DoITPro	Umberto	Others
Overall (37)	37.80%	5.40%	27.00%	0%	29.70%
LEs (30)	46.70%	6.70%	26.70%	0%	20.00%
SMEs (7)	0.00%	0.00%	28.60%	0.00%	71.40%

Figure 52: Softwares/tools for calculating carbon footprint (Semiconductors)

Results showed that 62.2% of enterprises in the semiconductor industry considered the existing softwares to be operator unfriendly. They (51.4% of enterprises) also thought that the software was too expensive. Details of the results are shown in Figure 53.



	Easy to operate	Difficult to operate	Low-priced	Expensive	Takes a long time	Easy to integrate	Easy to assess
Overall(37)	16.20%	62.20%	8.10%	51.40%	27.00%	2.70%	13.50%
LEs (30)	16.70%	63.30%	6.70%	60.00%	26.70%	3.30%	16.70%
SMEs(7)	14.30%	57.10%	14.30%	14.30%	28.60%	0%	0%

Figure 53: Impression on the software for calculating carbon footprint (Semiconductors)

3.4.4 Wish list

- ✓ Reduce time and manpower for inventory *(See the results of obstacles to implementation of carbon footprint of products)*
- ✓ Reduction of the cost of the software. *(See the results of obstacles to implementation of carbon footprint of products)*
- ✓ Minimize the uncertainty of the results of the carbon footprint. *(See the results of demands/needs of the software for carbon footprint of products)*
- ✓ Point out the hot spots of carbon emissions in the manufacturing stages. *(See the results of demands/needs of the software for carbon footprint of products)*
- ✓ Be able to be directly input through the format of BOM. *(See the results of demands/needs of the software for carbon footprint of products)*
- ✓ Equipped a carbon footprint database with emission factors of industrial processes. *(See the results of demands/needs of the software for carbon footprint of products)*
- ✓ Language selection. *(See the results of demands/needs of the software for carbon footprint of products)*

- ✓ Output format of the calculation software (*results of carbon footprint of a single product or of the whole factory*)
- ✓ Inventory and input format of the calculation software *(import data directly through the format of BOM (bill of material))*
- ✓ Basic functions of the calculation software *(database with domestic carbon emission factors)*

3.4.5 Summary

About the conjunction between semiconductor industry and environmental topics in general can be assumed the points below.

- It was found that the semiconductor industry in Taiwan has high experience of using LCA as tool to evaluate their environmental impact, but the consumption of significant time for data inventory is the main obstacle to perform PCF.
- SMEs are not as good as environmental management with LEs, including environmental management practices, regulations requested and supplier's carbon management.
- The main driver for enterprises in the semiconductor industry to undertake environmental assessment was the request by their customers. The result indicated that the semiconductor industry in Taiwan was passive for performing LCA and PCF.

3.4.6 Conclusion

About next project step can be assumed the points below.

- It is suggested that the developer improving the tool interface according to the wish list mentioned.
- The results indicated that the high prices of commercial LCA softwares are the main obstacle for the semiconductor industry to implement carbon footprint of products. It suggested to reducing the cost by service in the cloud.
- Establish an industrial carbon footprint database for reducing uncertainty of carbon emission factors and raising the accuracy of calculating PCF.

- To establish a parametric-based tool, and identify key factors from complicated manufacturing processes of semiconductor to reduce the consumption of significant time for data inventory.

3.4.7 Outlook

After completing the investigation of the needs of the semiconductor industry, a Taiwanese research team currently is conducting a detail in-plant carbon inventory for each of the process within United Microelectronics Corporation (UMC) and Siliconware Precision Industries Co., Ltd. (SPIL), and trying to identify the key factors and parameters. Moreover, it is trying to find its relationship with the total carbon footprint of the products to derive a generalized methodology and to simplify the carbon footprint calculation for the semiconductor industry.

3.5 Electronics – Printed Circuit Boards

3.5.1 Sector characteristic

A printed circuit board, or PCB, is a non-conductive material with conductive lines printed or etched. Electronic components are mounted on the board and the traces connect the components together to form a working circuit or assembly.

There are three major types of printed circuit board construction: single-sided, double-sided, and multi-layered. Single-sided boards have the components on one side of the substrate. When the number of components becomes too much for a single-sided board, a double-sided board may be used. Electrical connections between the circuits on each side are made by drilling holes through the substrate in appropriate locations and plating the inside of the holes with a conducting material. The third type, a multi-layered board, has a substrate made up of layers of printed circuits separated by layers of insulation. The components on the surface connect through plated holes drilled down to the appropriate circuit layer. This greatly simplifies the circuit pattern.

Printed Circuit Boards (PCBs) are commonly used in personal computers and also in electronic devices, such as radios, televisions, and other types of electronic products.

Each type of existed PCBs has influence on environment. During their manufacture energy, water and complex chemistries (organic and inorganic compounds; some of them are toxic) are consumed. During the manufacturing process a not unessential amount of trim wastes is generated and aggressive sewage is emitted. The PCBs sector is providing a huge environmental improvement potential. The main challenge consists in the high diversity of PCBs and the problems with lack of data for environmental assessment.

3.5.2 Survey method

The developed questionnaire was presented and discussed with the representatives of the Printed Circuit Board industry during the organized seminar, bilateral meetings and using e-mails. Table 5 shows the result.

Table 5: Questionnaire Response (PCB)

Total inquired PCB companies (Poland, Austria)	Average number of employees	Returned questionnaires	Effective questionnaires	Effective response rate (%)
31	6 -195	14	13	42.0

3.5.3 Survey results

3.5.3.1 Status quo

The persons who filled out the questionnaire ranged from designers, CEO, managers to environmental officers. No majority could be provided. The job positions related with responsibilities for environmental issues are environmental engineers (31%), product managers (15%) and others. 54% of PCB's companies have not answered on this question. Probably no explicit responsible person for environmental issues is defined in their company. No investigated company had special environmental communication channels within company. PCBs companies are usually small and in some cases one person can hold several functions so no communication channel is needed at all.

Similar to SMEs from other sectors described before, it's not surprising that the results of the questions about prospects and knowledge around LCA suggests that the respondents have only partially knowledge about it. More clearly this aspect is shown by the next figures.

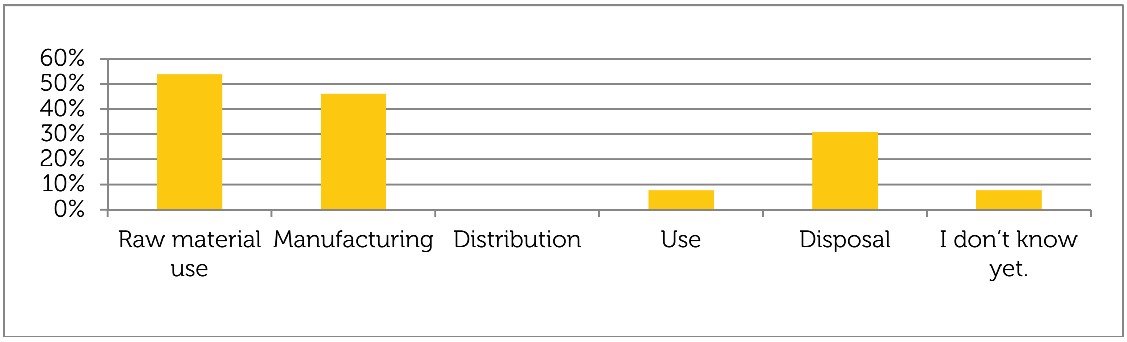


Figure 54: Most problematic life cycle phase (PCB)

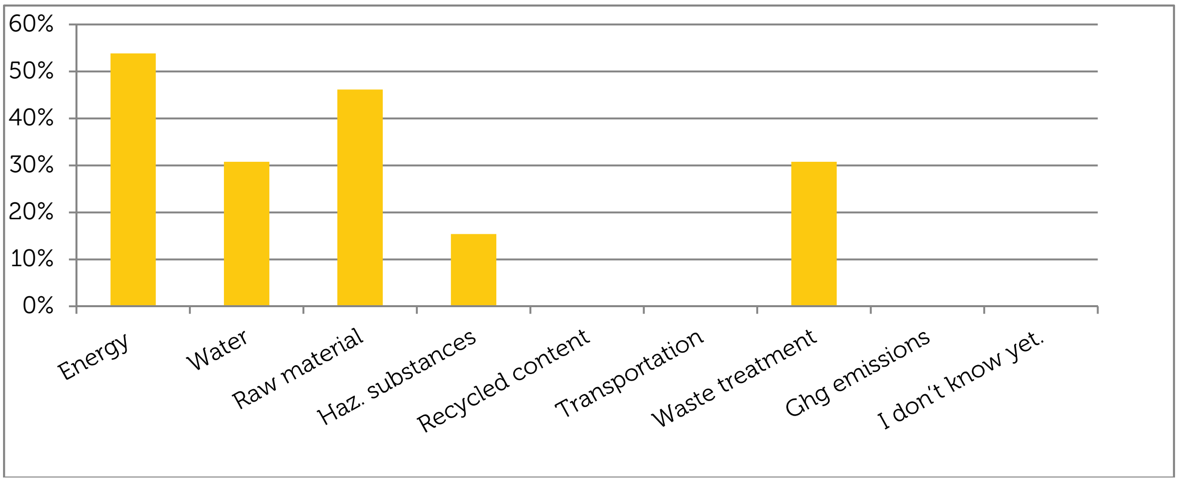


Figure 55: Most important environmental aspect (PCB)

Figure 54 show that most respondents see raw material, manufacturing and disposal as most important life cycle phases of their product. 8% are not sure which phase the most problematic. Only 8% think that it is use phase and none of the respondents from the PCBs sector mentioned the distribution phase, although energy consumption in use is for almost all electronics products a very relevant environmental impact. The PCBs producers see only their part of a product life cycle connected directly with product manufacturing (Figure 55): energy, water and raw materials consumption, hazardous substances and waste treatment (waste treatment during production phase). It is a clear lack of environmental life cycle understanding.

Like in the general Electronic sector (see Chapter 3.3) 77% of the companies are familiar with legal compliance schemes and 62% with Quality Management System (Figure 56). Another 46% is familiar with Cleaner Production and 38% with Environmental Management System (ISO 14000 / EMAS). All respondents declared to know at least one approach. But only one from the respondents had experiences with the application of LCA tool and declared that it was very time intensive. It can be recognized that environmental issues are already anchored in SMEs but for the responsible persons it is often only one more task in addition to their main function.

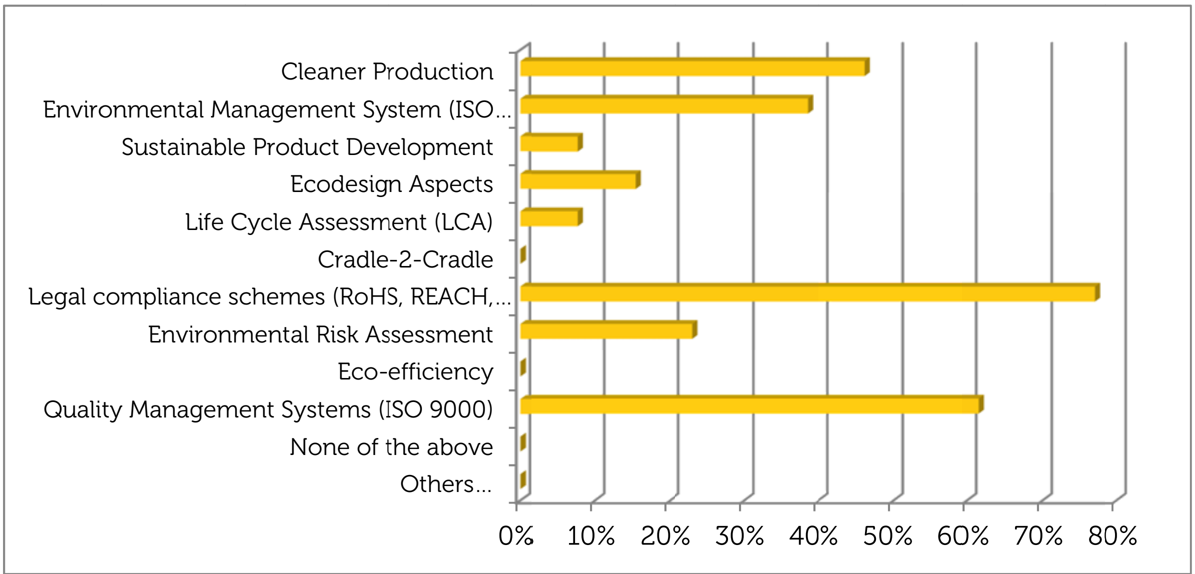


Figure 56: Most familiar environmental approaches (PCB)

3.5.3.2 Needs and demands

<u>Environmental assessment</u>

The first results show why companies didn't run an environmental assessment yet.

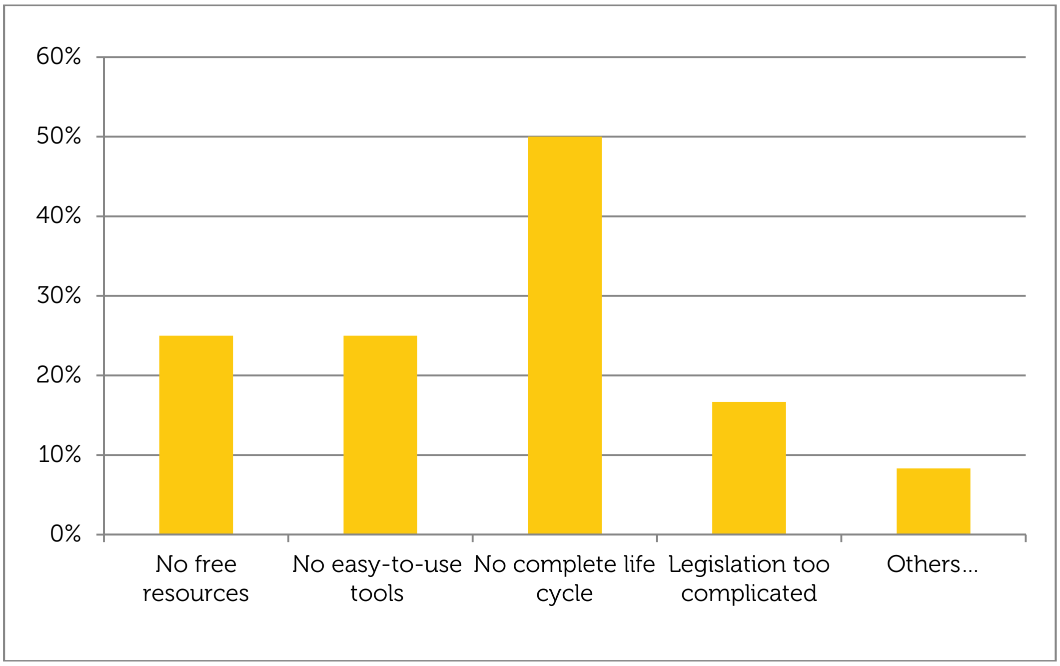


Figure 57: Reasons for not undertaking environmental assessments so far (PCB)

As Figure 57 illuminates, the main reason for not undertaking environmental assessment is that products haven't run the complete life cycle yet (50%). PCBs producers have only data connected with manufacturing process. For 25% of the companies "no easy-to-use tools" and "no free resources" are responsible not to apply an environmental assessment. Legislation and other reasons are less important for PCBs producers.

For the LCA to go tool it means to find procedures for assessing products, without having complete life cycle data sets available as well as LCA-tools should be easy to use, to understand and not time consuming.

Figure 58 illustrates important present and future drivers for doing an environmental assessment from product perspective. At present the motivation to perform an environmental assessment depends very much on the legal regulations and also companies links environmental assessments to improving product quality. Moreover SMEs think that in the future these two main drivers will be less important than present (especially legal regulations) and more important will be environmental improvement of the products as well as eco-label requirements. Also reducing manufacturing costs is seen as a driver. Generally only small differences between present and future drivers are observed.

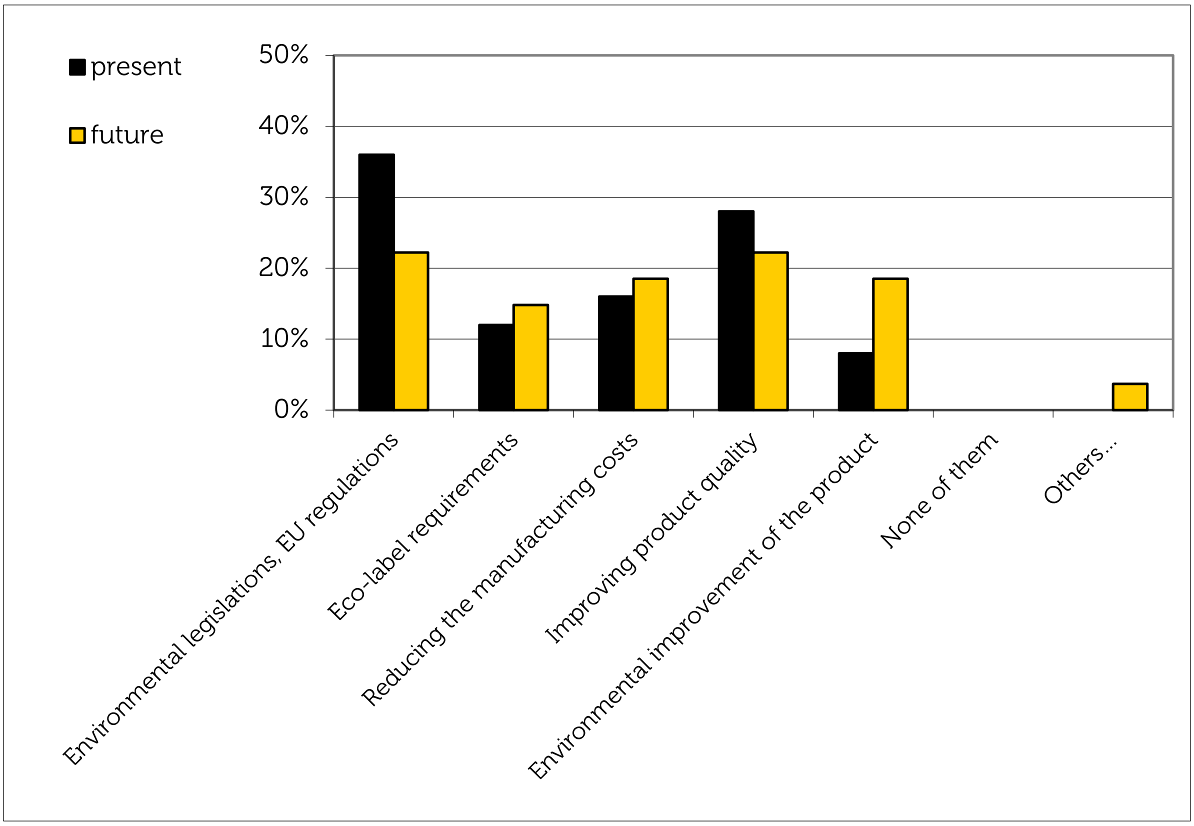


Figure 58: Drivers for environmental assessment – present and future from product perspective (PCB)

Figure 59 specifies drivers for doing an environmental assessment from the company perspective site. It shows that customers demand and EU regulation will be the most important drivers to introduce environmental assessments, but environmental concerns are also on the high, third position. Therefore the LCA to go tool should show compliance of the product with environmental legislation and EU regulations.

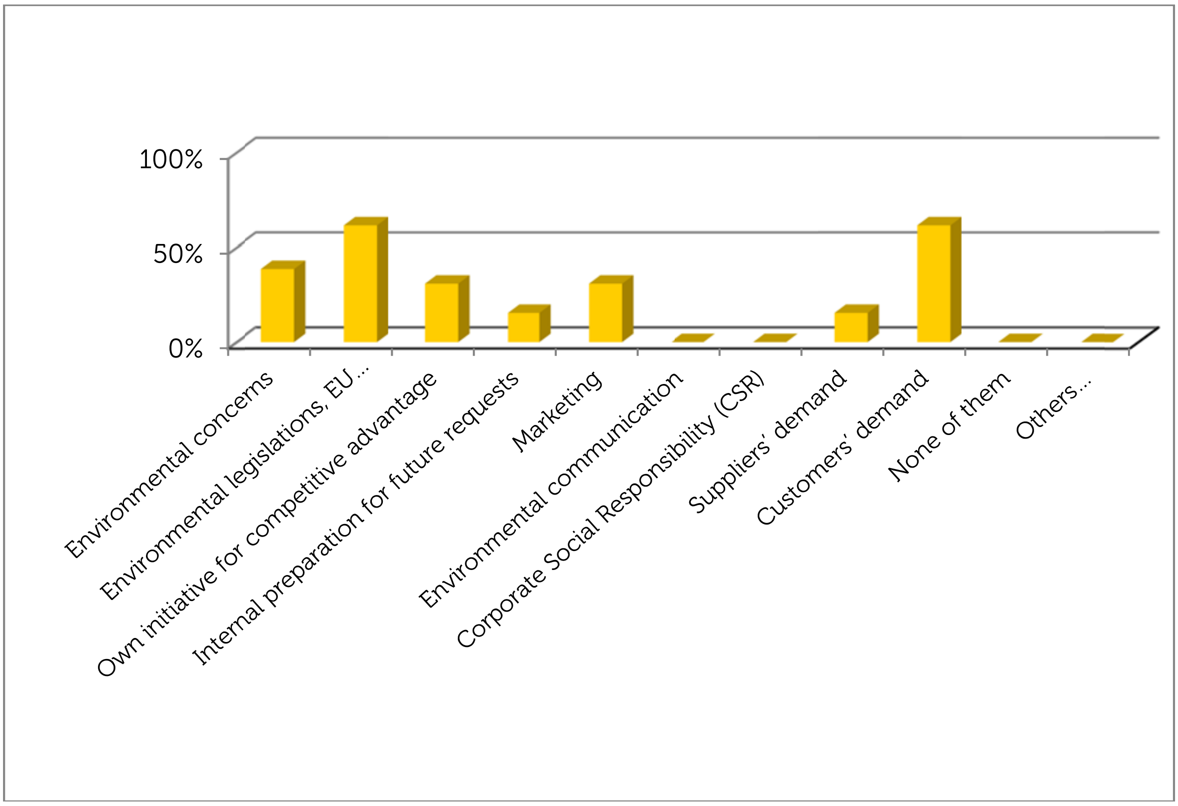


Figure 59: Drivers for environmental assessment – company perspective (PCB)

<u>Environment communication</u>

The preferred channel for environmental communication today and in future is depicted in Figure 60. Today 46% PCBs' companies use material inventory lists and slightly below 40% environmental reports. Popular are also information about the content (or absence) of hazardous substances and self-declared environmental claims (23%, 31% - respectively). Probably, these instruments are used because companies are obliged for this by environmental directives, customers or control institutions. Despite this, as it can be seen in Figure 60 23% SMEs aren't interested today in this issue at all, but in the future this situation has chance to change on plus. The level of self-declarations should decrease in future significantly and increase channels not used at present like "LCA results", "environmental product declaration" or "eco-labelling".

It can be added, that the preferred tools should offer also information platform to learn more about legislation and directives, explanation of terms or environmental assessments.

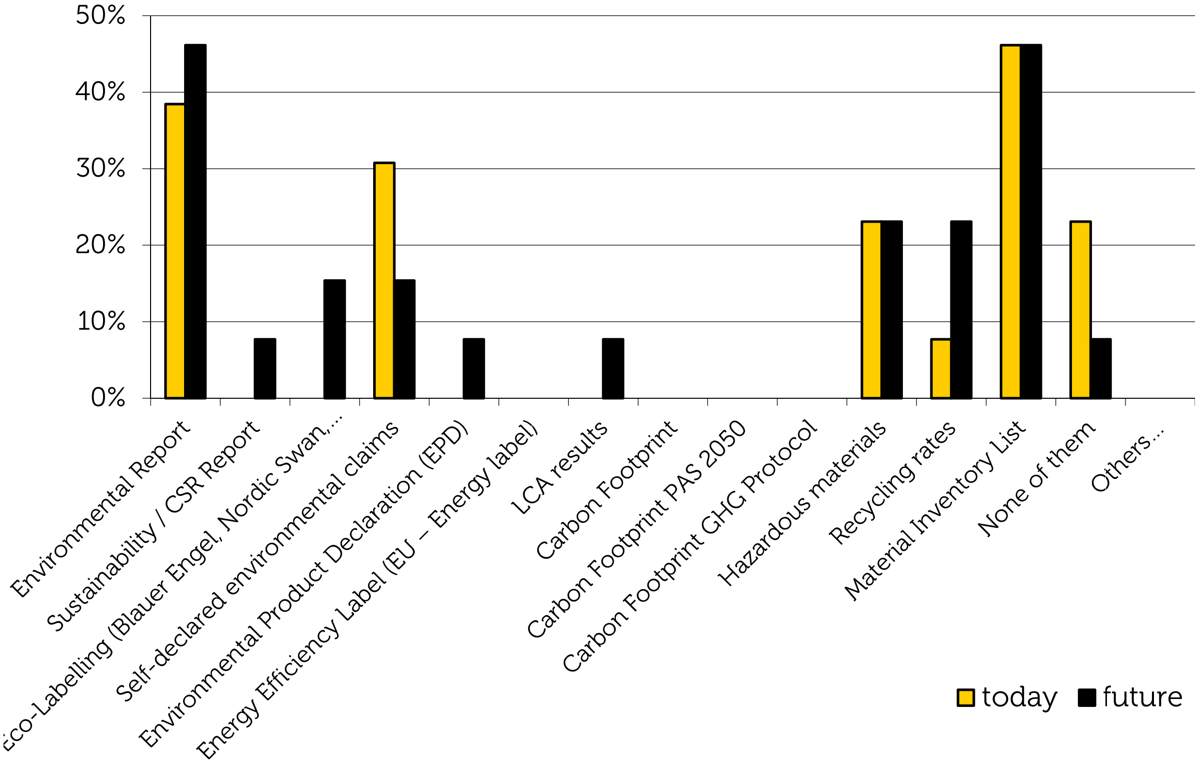


Figure 60: Communication tools used today and planned in the future (PCB)

It is recognized, that the aspect of providing declarations according to customer requirements and standards could be important information to promote own products better for PCBs companies (Figure 61). Other aspects are increasing product lifetime and productivity as well as energy saving.

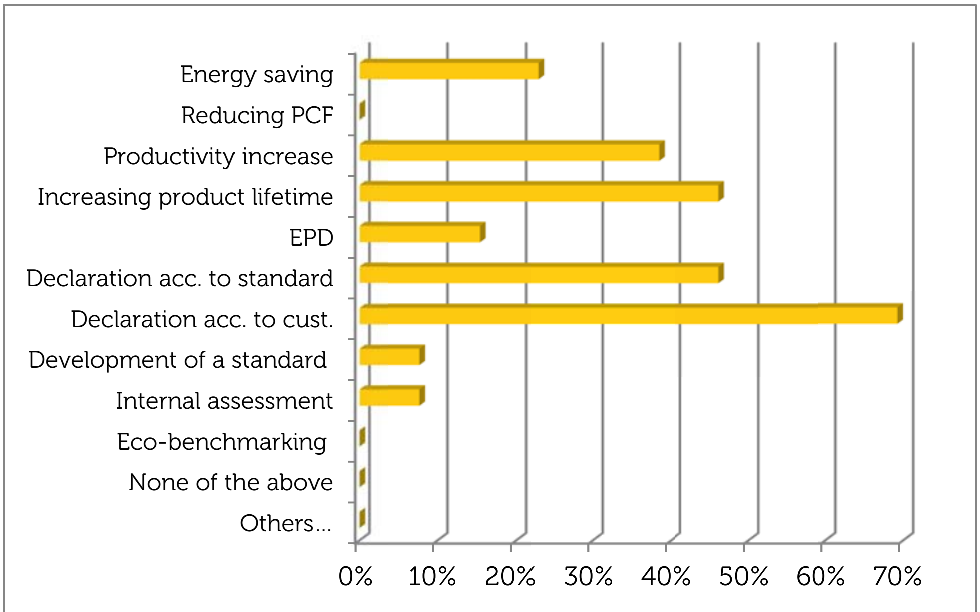


Figure 61: Aspects and arguments potentially useful to promote products (PCB)

LCA tool

General expectations, which can be seen as wishes of the SMEs are demonstrated in Figure 62. According to the survey results the term "life cycle assessments" is interpreted very differently among the respondents from different sectors. For 69% of PCBs producers LCA stands for "measuring environmental impacts". 46% associate with the term LCA "measuring the emissions to air, water and land", "optimizing the production process" and "improving product quality". Also "fulfilling environmental legislation" has high position. Global warming potential and ozone layer depletion, similar to other sectors, are not related to LCA, according to the understanding of the respondents.

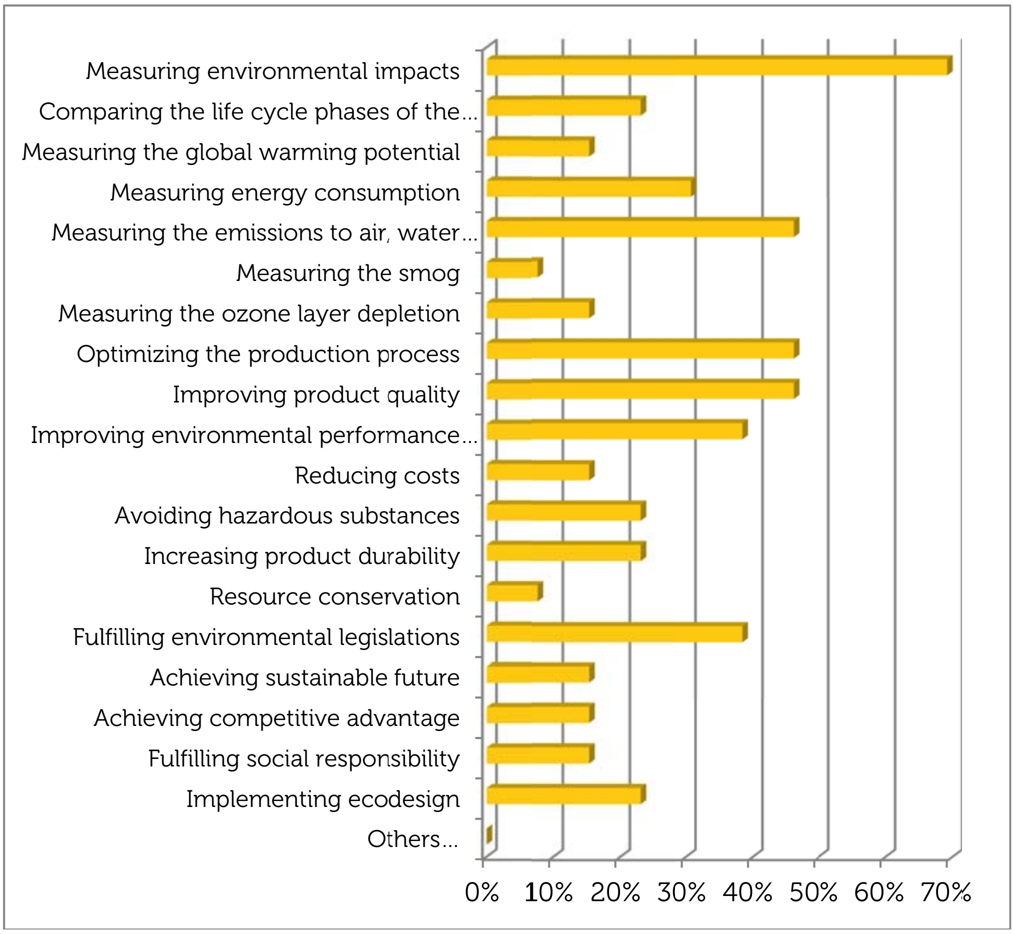


Figure 62: Statements most related to LCA (PCB)

The main expectations of different stakeholders regarding the outcome of the tool are not so wide like for other sectors. It focuses on: "material declarations", "legal compliance data", "energy efficiency" and "recyclability assessment". Stakeholder often request energy data and material declarations but these are also hard to answer. Therefore the tool should help providing this data.

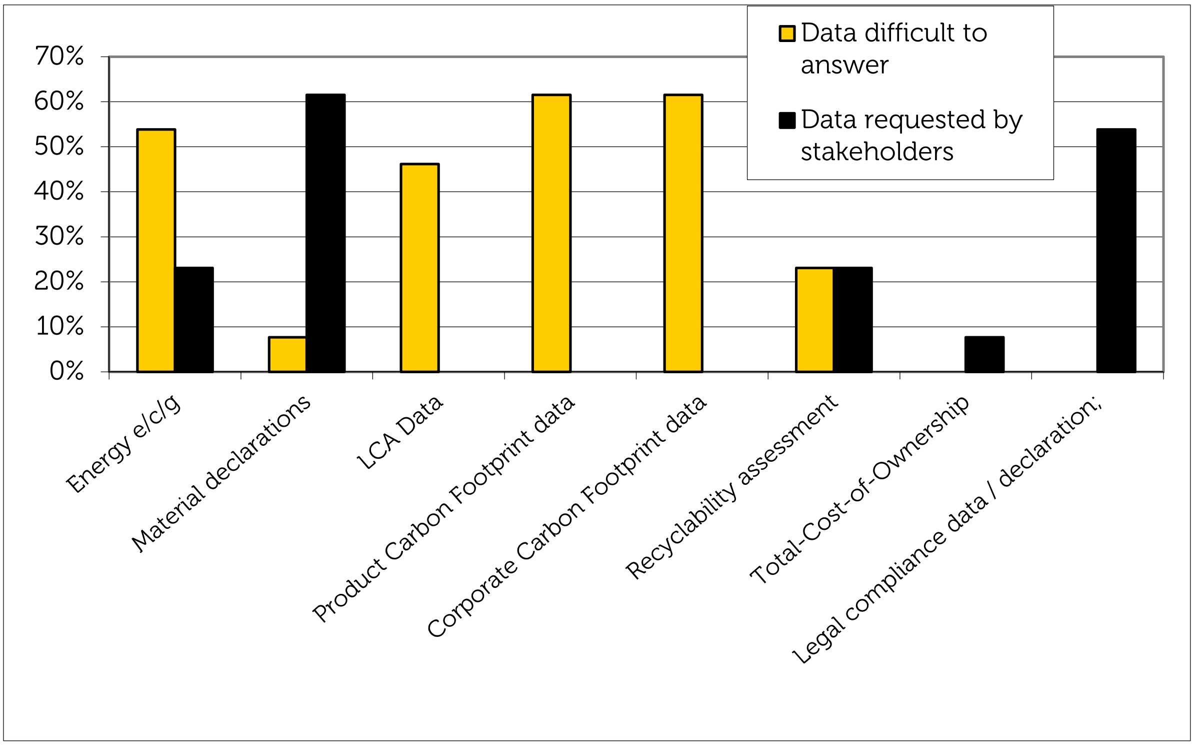


Figure 63: Data requested by stakeholders compared with data hard to answer (PCB)

Further expectations on the tool were expressed as follows:

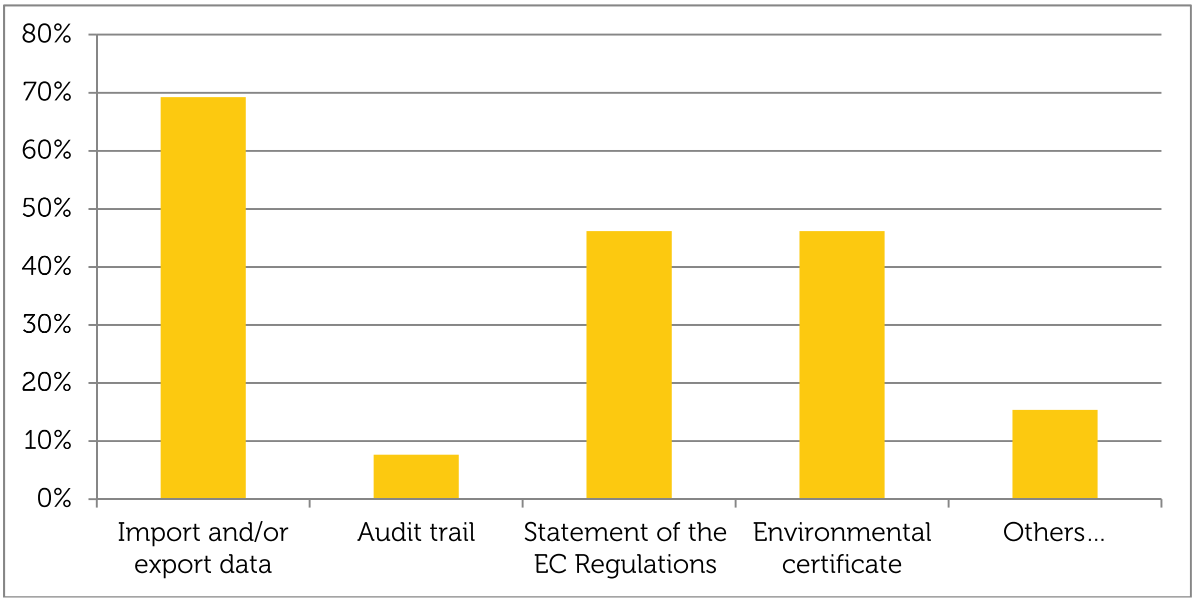


Figure 64: Expectations on the tool

According to Figure 64 the web based LCA to go tool should be able to import and/or export data. Additionally information about EC regulation as well as environmental certificates is preferred.

3.5.4 Wish list

- ✓ It should be possible to assess innovative products, without complete life cycle data sets *(see Figure 57)*
- ✓ The tool has to be easy–to-use *(see Figure 57)*
- ✓ The tool has to comply with the legal situation – environmental legislation, EU regulation and help improving product quality *(see Figure 58 and Figure 59)*
- ✓ The tool should give support in reaching environmental improvement of a product and reducing manufacturing costs *(see Figure 58)*
- ✓ The tool should also offer information platform to learn more about legislation and directives, explanation of terms or environmental assessments.
- ✓ The results of the tool has to be tailored to the costumers demands *(see Figure 59, Figure 60)*
- ✓ A motivation for using the tool would be providing declarations according to customer requirements and standards.
- ✓ The material inventory lists and environmental reports are of most interest for the environmental communication *(see Figure 60)*
- ✓ The tool should provide the following arguments for promotion *(see Figure 61):*
    - declarations according to customer requirements and standards
    - increasing product lifetime
    - productivity increase
    - energy saving
- ✓ The tool should focus on environmental impact aspects, improving product quality and production process as well as it should support in fulfilling legal requirements *(see Figure 62)*
- ✓ The tool should provide a statement of the EC Regulation (material declarations or legal compliance data) and an environmental certificate *(see Figure 63 and Figure 64)*

- ✓ The tool should be able to import and/or export data *(see fig. Figure 64)*

3.5.5 Summary

Most of the SMEs don't have specific internal environmental communication channels because of a small amount of technical staff. Moreover, the environmental information is usually related to material data from production process. It was stated that SMEs have very little knowledge with LCA and environmental assessments and they haven't experience in using environmental assessment tools. Only one of the reviewed SME has experience in using environmental assessment tools. In a future SMEs would use an environmental assessment tool if there is customers demand or pressure from legislative.

<u>Wish list for the LCA to go-tool in the PCBs sector</u>

The LCA to go tool has to be easy–to-use, helpful in improving product quality and reducing manufacturing costs. Very important for implementing of above mentioned tool is complying with the EU legislations, international standards and customer demands. Also, the tool should be able to import and/or export data.

3.5.6 Conclusion

Obtained results from questionnaires analyse will be exploited during the next step of the project. After analysis we know what SMEs staff knows about LCA and other eco-tools and their expectation. The results show that preparation of very clear and simply training material regarding LCA to go-tool is necessary. Several seminars and workshops have to be provided for teaching of the SME's technical staff. Next inquiry activities will permit us to verification of adopted methodology to the specific needs of SMEs.

The LCA to go-tool for the PCB sector should be limited to life cycle phases like: "raw materials use", "manufacturing" as well as "distribution". Next, the results from PCBs sector should be distributed to other sectors for which apply PCBs as a part of products.

3.5.7 Outlook

Info campaign among PCBs producers is planned as well as close cooperation with the companies interested in free training using the LCA to go tool.

3.6 Renewable Energy

3.6.1 Sector characteristic

The renewable energy sector is very diverse as it covers a broad spectrum of energy generation, including wind, water, biomass and solar power. These areas have some aspects in common, in particular the energy generation and the replacement of fossil and nuclear power from the grid, occasionally also to provide regions with power where there was no electricity before. However, as the technological characteristics differ the analysis in WP1 and the core webtool development for the renewable energy sector will focus on the photovoltaics sector, although transferability of the general approach to other renewable energy segments will be addressed in the WP6 activities.

Photovoltaic stationary

The photovoltaics sector covers the manufacturing of the core components, including wafers / solar cells, wafer-based or thin-film PV modules, concentrator modules, development and production of the various balance-of-systems components (mounting and tracking systems, inverters, batteries and charge regulators, cabling and connection material), distributors, integrators and assemblers of PV systems, engineering and consulting companies, project development, electrical installation craftsmen, and in a broader sense also machinery and materials supplier to the PV industry, architects, measurement and control technology providers. Whereas there are only very few large suppliers of wafers, the sector becomes more diverse when it comes to module manufacturing and further downstream the company structure is dominated by SMEs (system integrators, project engineering, installers).

The total work force in the PV sector (Research, development, manufacturing and deployment labour places) in the most important production countries Germany, Spain, Italy and France was 232.000 staff back in 2009 [IEA 2011].

Mobile photovoltaic

Mobile photovoltaic products are a sub-segment of the photovoltaic sector next to grid-connected stationary PV systems. The term “mobile” is here used for non-stationary PV products, which are portable or even wearable – i.e. they can be carried with ease and are therefore small sized and light-weight. Mobile PV is emerging as a major power source for off-grid utilities (such as solar lights, solar traffic signals) and mobile electronic devices (e.g. PV battery chargers, solar charging bags, and solar powered outdoor equipment, cell phones). The range of application for mobile photovoltaics is expanding and the market for such products is growing as the technology becomes more affordable. More and more battery-powered devices use PV to supplement or even replace for grid-connected chargers. Due to recent technological advancements of flexible solar cells, the technology can be integrated in a wide range of products in future (including tents, umbrellas, and even garments). While mobile solar-products with stiff PV-cells are not new (PV pocket calculator for instance) the flexible PV technology is still in a development and design stage. The latter is expected to have enormous growth potential.

The LCA challenges of mobile PV differ from the stationary PV systems. A major difference is the design of mobile products: mobile PV cells can be integrated in consumer products of daily use where they are usually combined with rechargeable batteries that buffer the energy. There are significant differences in the ways of application as compared to stationary PV systems: the latter are hardly dependent on the user behaviour whereas the user must purposefully "sun-bathe" the mobile solar gadgets. The way of usage makes large difference for calculation of the energy-payback time for instance.

3.6.2 Method

For the photovoltaics sector renewable energy a distinction has to be made for installed, large-scale photovoltaics systems and small mobile solar chargers, which are a specific market segment. Mobile solar chargers are covered by a separate chapter.

Photovoltaic stationary

The segment of installed, large-scale photovoltaics systems was tackled with the "Green Paper" approach and an interview-based survey at the 26th European Photovoltaic Solar Energy Conference and Exhibition (26th EU PVSEC), Hamburg. 7 companies where interviewed, 5 of them where from the category distributors/assemblers one from the manufacturing and one from consulting. Among the interviewed companies, actually only 2 of them being European SMEs, where the following: Schüco (energy-efficient buildings), DelSolar (research, development, and production solar cells, modules, and PV systems), Juwi (planning and building photovoltaic systems), Tenesol (design, manufacturing, installing of PV Systems), Powerbright Solar (Manufacturing of PV modules), Solea (Complete systems supplier of photovoltaic Branch), and Etaflorence (consultancy and project development).

The "Green Paper" for PV systems (version 1.1), developed in cooperation with TTA, formulates two different scenarios, which have been developed to guide discussions. This "Green Paper" served as the main input to a focus group meeting of PV sector stakeholders in the Barcelona region on September 26, 2011. Participants at this meeting represented CINERGIA, LAVOLA, SOLARTYS, Temposolar, Catalonia Engineering Solutions, TTA and Simpple.

Mobile photovoltaics

The number of European SME that design and produce mobile PV products is rather small. In total, we were able to identify 25 SME within this sector. 18 companies were contacted and asked for participation in the questionnaire based survey but only three SME (from UK, Austria, NL) found the time to answer our question. Five SME rejected participation for reason of lacking time and hinted that the survey takes place in the prime business season (summer).

3.6.3 Results

3.6.3.1 Status quo

Photovoltaic stationary

In the interviews at the 26th EU PVSEC we could collect different opinions that reached from very interested to totally disinterested. Three of them showed strong interest in the environmental label of PV systems and in the determination of the energy payback time of the PV systems, 2 companies had no interest at all, and another 2 company had a moderate interest. Among the interviewed European SMEs actually one showed a moderate interest in environmental assessments, the other one not. The labelling approach is rather favoured by the large players in the market, according to our interviews. However, LCA to go has to make sure that whatever approach to push, concerns and interests of SMEs need to be addressed properly.

Among the companies interviewed there is only a very moderate level of knowledge about LCAs. Despite the rather high number of LCA studies covering the PV sector, it is not yet business practice to use or perform Life Cycle Assessments. Interviewed companies described the current status quo as follows:

- Two of them used internal and external tools for the evaluation of the CO_2 reduction
- Two companies request supplier data with respect to lead-free, cadmium free components and parts, but also regarding other toxics and heavy metals
- Some mentioned that none of their clients is interested in the CO2 footprint of the production or transportation, so it is not an issue for them either

Mobile photovoltaics

None of the three respondents had experiences with LCA nor have they used environmental assessment tools. None of the three SME has appointed someone to be responsible for environmental assessment. The respondents' conception regarding important environmental aspects and life cycle phase of mobile PV products were rather vague. Aspects mentioned by the SME include Energy, Water, Recycled content, Transportation, Waste treatment, and Water effluents. The SME seem to judge solar cells a-priory an advantageous technology for Sustainable Product Development. However, the evaluation of mobile PV products from a life cycle perspective seems to be derived from stationary PV systems, regardless of the significant differences in the use-phase of such products.

3.6.3.2 Needs & demands

Photovoltaic stationary

Summarized feedback of interviewed companies that were strongly interested:

- 3 of them where convinced that the use of the web tool and the environmental label could be a good marketing argument for their products, because they would be distinguished from other companies, and they could promote their environmental impact reduction of their products.

- It could be also an additive demand from the eco-friendly customers, without influencing the price and keeping the standard quality and efficiency of Photovoltaic Systems

- Supplier data with the lowest environmental impact is important

- It could be important that the Environmental Product Declaration can be generated directly from the web tool, and the third party verification is an important point, because it would be valuable information which would prevent the manipulation of the environmental performance of the company and their products.

- The CO_2 footprint criteria is not considered relevant for purchase decisions (own supply chain), but potentially for marketing purposes

- Supplier Data with worldwide recognized certification is of huge interest, e.g. TÜV, ISO

Summarized feedback of companies that were disinterested

- They are already "green" without the use of any environmental labelling, because renewable energy is sustainable
- Efficiency , Price and Quality are the main aspects that count
- Assessments are anticipated to be costly, lavish with the global recognition
- The companies make good business without environmental data provision
- The approach is of interest only for marketing purposes, if at all
- Too much costly work with the labelling of all parts
- Could be only of interest to very eco-friendly households, but not for e.g. solar parks, big companies
- Quantifying the greenhouse gas emission reduction in absolute terms is not relevant because nobody is interested in
- Moderate interest on other environmental impact

The following paragraph outlines the Green Paper as a result of bilateral discussions with TTA, and complements the variants developed with an assessment by the PV focus group (in *italics*).

Scenario 1: Environmental Label for Photovoltaic systems

A joint environmental label (environmental product declaration) scheme for the PV sector could serve as verified quality label.

The label could enable different levels of information:

- Quick comparative reference (such as LEED certification or energy class colour code, A++ to G, but potentially addressing the full product life cycle, not energy efficiency only)
- Basic benchmark indicators (e.g. CO2 emission per kW inverter)
- More detailed information on specific environmental impacts (Life cycle assessment: various environmental impacts for each of the life cycle stages production / installation / use / disposal)

The participants of the Focus Group Meeting rated these options as follows (one dot per reply):

levels of information:	*strong interest*	*moderate interest*	*not needed*
a) quick comparative reference	●●●●●		●●
b) basic benchmark indicators	●●●●●		●●
c) more detailed information on specific environmental impacts	●●●	●●●●	

Products / systems bearing this label can be clearly distinguished from other, non-label bearing, presumably lower-quality products. Convincing, independently verified and transparent facts about the quality of your products and the lowest environmental impact can be used directly for marketing purposes.

Such an environmental label could cover either

a) Complete PV installation projects (label is granted for each project individually; similarly to the certification of buildings, such as LEED)
b) for newly installed system (label granted at the time of installation)
c) at regular maintenance (label renewed regularly based on technical inspection and maintenance measures undertaken)
d) Complete PV systems (label is granted for a system, label could be displayed e.g. in a product catalogue)
e) Components:
    a. PV module
    b. PV power conditioning assembly (inverter and charge controller)
    c. Batteries
    d. Data logging

The participants of the Focus Group Meeting rated these options as follows (one dot per reply):

Coverage	*strong interest*	*moderate interest*	*not needed*

a) *PV installation projects*			
a. *Newly installed systems*	●●●●●●●		
b. *At regular maintenance*	●●		●●●●●
b) *PV systems*			
a. *Larger systems*	●	●●●●	●●
b. *Smaller turn-key kits*	●●●●●	●●	
c) *Components*	●●●●	●	●●

A new idea was raised at the discussions of comparing a PV system with alternative energy systems. Actually, a payback calculator as outlined as the second scenario below would calculate the effect of replaced conventional electricity from the grid.

A further distinction was deemed necessary and thus included in the above ratings: Whereas for larger PV systems the feasibility of a labeling was questioned as these systems are mostly customized and are rarely offered in a standard configuration, an a priori labeling might not be possible. However for smaller "turn-key kits", i.e. pre-configurated smaller systems a labeling would make much sense, according to the participants of the focus group meeting.

Development of the label criteria needs a joint effort of several manufacturers (type of voluntary agreement), ideally coordinated by an association. Certain level of market coverage is essential for acceptance.

Label criteria should comprise an environmental assessment of your products (manufacturing phase).

Upstream process data (component production) could be based either on

f) real supplier data (up to a certain tier or for most relevant components) and/or
g) generic (parameterised) datasets

The participants of the Focus Group Meeting rated these options as follows (one dot per reply):

Upstream process data	
a) real supplier data strongly favoured	●●●●●●
b) real supplier data nice to have	●
c) generic datasets	-

Although finally a clear interest in real supplier data was stated in the end by most participants the points were raised in the discussion, that data acquisition might be not supported by the suppliers and that for some components (e.g. PV cells) the number of suppliers is very limited, and components largely standardized thus a distinction might not be required. The proposal was made to start with an analysis based on generic data and to complement this generic database with real supplier data as it becomes available.

In analogy to labeling / certification in the building sector an approach was proposed to start the assessment in the planning phase with a simulation and later on to verify the simulation based on real data once the project is realized.

Real supplier data either could be entered

- into the webtool directly by the supplier – which means, data is disclosed publicly, or
- by the downstream company, based on inquiries made among his specific supplier(s) (anonymous data handling in the webtool possible)

Generic or default data should be used preferably only for components / sub-assemblies of minor relevancy.

Generic data could be extracted from the comprehensive literature on PV Life Cycle Assessments and provided as standard database within the webtool.

For the use phase the label should cover

h) output, and efficiency

i) reliability criteria

In case the Environmental Product Declaration (EPD) is intended for components and/or systems, but not a given installation project, for the use phase only some technical parameters (e.g. efficiency, reliability data) or a basic, standardised use scenario will be provided, but not the calculation of a given installation project.

A reference scenario (e.g. time period 20 years, normalised metrics including level of solar radiation, etc) needs to be defined in a broader consensus seeking process.

The environmental assessment will be based on the webtool to be developed.

The Environmental Product Declaration can be generated directly from the webtool.

Third party verification of the Environmental Product Declaration (if required) will not be an integral part of the webtool.

Confronted with the latter statement the participants of the Focus Group Meeting replied as follows (one dot per reply):

"Third party verification will not be an integral part of the webtool"	
a) agreed	-
b) agreed, but webtool should facilitate third party verification	●●●●●
c) certification should be an integral part	●●

Scenario 2: Determination of the energy payback time or Net Energy Gain (NEG) of photovoltaic systems

The energy delivered by a photovoltaic system can be compared with the energy invested in production of the PV system in two ways:

j) energy payback time

k) Greenhouse Gas Emissions (CO2) payback time

l) payback time of other environmental impacts (acidification, waste generation or similar)

m) Net Energy Gain (NEG)

n) Net Greenhouse Gas Emissions (CO2) Reduction

o) Net reduction of other environmental impacts (acidification, waste generation or similar)

The participants of the Focus Group Meeting rated these options as follows (one dot per reply):

Indicator	*strong interest*	*moderate interest*	*not needed*
a) energy payback time	●●●●●●●		
b) Greenhouse Gas Emissions (CO2) payback time	●●●●●●●		
c) payback time of other environmental impacts	●●●	●●●	●
d) Net Energy Gain (NEG)	●●●●●●●		
e) Net Greenhouse Gas Emissions (CO2) Reduction	●●●●●●●		
f) Net reduction of other environmental impacts	●●●	●●●	●

Based on these discussions a clear preference can be given to energy and carbon footprint aspects, other environmental aspects should be covered only if they do not add much to the complexity of the analysis.

These indicators are suitable for:

p) optimised planning of a PV project (user of the webtool: Engineering contractor)
   a. (internal) planning tool only
   b. documentation tool to demonstrate environmental performance of the project (e.g. meeting World Bank tender requirements, qualification for CDM projects)

q) supplier selection, if differences in production efforts are taken into account (user of the webtool: Engineering contractor)

r) pre-screening for e.g. private households, to be guided towards suitable systems (user of the webtool: end-user of the PV system); less accuracy of the data required, as a rough guidance is intended only

The participants of the Focus Group Meeting rated these options as follows (one dot per reply):

Purpose	*strong*	*moderate*	*not*

	interest	interest	needed
a) *optimised planning of a PV project*			
• *(internal) planning tool*	●●●●●●●		
• *(external) documentation tool*	●●●●●●●		
b) *supplier selection*	●●●●●●●		
c) *pre-screening for e.g. private households*	●●●●●●	●	

The fact, that all proposed purposes got a similar high level of interest adds potentially to the complexity of the approach, as a multitude of interests has to be addressed. This involves the risk of developing a comprehensive LCA tool, which is open to guide in several decision support situations. Inevitably, LCA to go has to select appropriate purposes to be served to meet the objective of an easy-to-use tool.

This approach assesses a concrete PV installation project, which could be

s) grid-connected and/or

t) stand-alone

There are numerous commercial and freely available planning tools on the market (such as RETScreen); the “LCA to go” webtool needs to serve a complementary purpose, not duplicate already existing tools.

The webtool needs to consider multiple parameters (tentatively):

- Different cell types (Monocrystalline silicon / Polycrystalline silicon / Amorphous silicon)
- Production of components (inverters, batteries)
- Transportation to the place of installation
- Expected lifetime
- Efficiency of the PV system (cell, power electronics, battery)
- Grid power replaced (Greenhouse Gas Emissions of replaced grid power)
- Degradation of the cell
- Radiation at the place of installation

- Repair / maintenance efforts over lifetime
- Decommissioning at end-of-life

Advantage of the payback calculation is the circumstance, that speculative lifetime statements are not needed as long as it is likely that payback time is shorter than lifetime; the NEG approach incentivises systems with a longer (anticipated) lifetime.

Calculation could include also costs (or be linked to any cost calculation tool), as this increases acceptance of the tool.

Confronted with the latter idea the participants of the Focus Group Meeting replied as follows (one dot per reply):

"Calculation could include also costs"	
a) agreed, should be directly included	●●●
b) agreed, but link / interface to another tool is sufficient	●●●●
c) not needed, as costs are already calculated separately	-

Finally, the participants of the Focus Group Meeting gave their impression whether scenario 1 or 2 or a combination of both is the most appealing approach: As there is a lot of interest in both scenarios, no clear preference was stated and a combination of both is favoured.

<u>Mobile photovoltaics</u>

The needs of mobile PV companies did not become clear due to the low number of responding SME. As a preliminary result, the needs in the mobile PV sector are information support for optimising the production chain and improvements of the product quality. There seems to be a need for marketing, e.g. by use of Eco-benchmarking or Energy Efficiency Index. Also the customers' demand for information on the Product Carbon Footprint could become a driver for LCA in future.

3.6.4 Wish list

<u>Photovoltaic stationary</u>

- ✓ Companies that were convinced of the web tool and the environmental label suggested that this could be really useful to differentiate them from others in their environmental performance, but under one condition, that the products bearing this label should have the same quality and the same price as the competitors with non-labelled products.
- ✓ Label should cover with preference PV installation projects (at new installation), smaller turn-key kits of PV systems (labelling at the shop floor level), and/or components
- ✓ The environmental impact could be minimized with the aid of the reduction of the logistic paths
- ✓ The core area should be Europe
- ✓ Recycling to be considered
- ✓ The web tool and the label should be internationally recognized, only then the use of it can be have a huge relevance
- ✓ The Web tool should include all of the proposed parameters, but additionally the logistics and a calculation of the overall return on investment
- ✓ The web tool should be developed mainly for grid connected PV Systems because they are widespread on the European market
- ✓ Inverters should include less toxic substances and the way of processing should be mentioned in the supplier data
- ✓ The energy payback time of other environmental impacts should include the entire supply chain
- ✓ All intended use cases of an assessment (internal planning, supplier selection, documentation for external stakeholders) are of interest, no purpose is ruled out
- ✓ Assessment should include or at least cross-reference to cost calculations

<u>Mobile photovoltaics</u>

- ✓ The needs of mobile PV companies are mainly marketing support (showing the energy saving potential of solar products). LCA could also support improvements in product design with regard to maximising the energy harvest during the use phase.

3.6.5 Summary

The PV sector is characterized by a certain level of knowledge about and interest in Life Cycle Assessments.

The interviews and discussions unveiled a high interest in environmental assessments of PV systems and components, based on several similarly relevant indicators to calculate energy / CO2 payback times or Net Energy Gain / net greenhouse gas emissions reduction. Hardly any aspect could be ruled out in the discussions, although environmental aspects beyond energy and greenhouse gas emissions are of less interest.

The question, what should be subject of the assessments and labelling clearly can be answered now, that an assessment of PV installations projects and small "turn-key kits" is of highest interest, covering also components, although this latter aspect has been discussed controversially.

For a label third party verification is a requirement and the webtool should facilitate this verification process.

However, a couple of companies are clearly ignorant regarding environmental assessments, having the impression that photovoltaics sells as green technology without any further justification or distinction needed.

3.6.6 Conclusion

Obviously not all raised interest can be fulfilled by the LCA to go approach as there is a trend rather to add new wishes and interests instead of condensing the scenarios to really essential key aspects. The interest in a calculation tool has been confirmed and as complementary activity the development of an environmental label should be initiated. The Green Paper approach turned out to be a suitable approach for the photovoltaics sector as the discussion can be guided towards the key interests of the companies.

Smart solutions have to be found regarding the mentioned shortcomings in sound upstream data.

3.6.7 Outlook

Photovoltaic stationary

Work package 2 will develop the basics of an environmental assessment tool (payback time / NEG calculator), exploring in parallel possibilities for a complementary environmental label. Presumably, as the development of label criteria is usually a lengthy stakeholder process this activity will not end with the Technical Report in WP2, but has to be continued as part of the dissemination and standardization activities of LCA to go.

Mobile photovoltaics

The survey of mobile PV companies may be extended into the winter season in order to increase the response rate.

3.7 Sensors

3.7.1 Sector characteristic

According to estimates of AMA there are close to 1,000 manufacturers of sensors in Europe. Including also distributors, engineering consultants and service providers there might be 3,000 companies in total [AMA 2010]. Sensor technology covers a very broad field of applications, thus characterizing this sector as a very inhomogeneous one:

- Process technology
- Energy technology
- Environmental technology
- Machinery building, industrial automation
- Building automation
- Medical equipment, life science
- Consumer goods

The field of sensors and sensor systems for **process technologies** is characterized by user requirements as follows [AMA 2010]:

- Besides employing sensors in new installations, there is an increasing demand to equip also existing installations with sensors for further optimization of processes
- Besides data logging of process information, also trend information is of increasing interest
- For specific applications there is the demand for further reduced measurement inaccuracies
- Spatial data about process conditions

All these trends are obviously related to the intention to optimize processes, i.e. increase efficiencies and thus also environmental impacts indirectly, which could be a sound starting point for a methodological approach.

3.7.2 Methods

3.7.2.1 Survey

Anticipating that a general survey asking for the status of environmental assessments in the sensors and sensor systems business would mislead the companies to think in particular about the environmental impacts of sensor systems production, and not about the potential benefits sensor based monitoring and control might bring in certain applications, the "Green Paper" approach was followed, and a blog posted at Open Innovation _connect, the UK Knowledge Transfer Network (see Appendix 7.3).

3.7.2.2 Green papers

One company from the sensors sector, producing electronic torque equipment, participated in the questionnaire survey, providing anecdotal evidence of the situation the sector: This company has never undertaken any environmental assessment of their products. By now, they have not had the resources to do so. Their customers by now asked for energy consumption data and material declarations, whereas the latter is difficult to serve.

The "Green Paper" outlined following four scenarios, as a basis for discussions with TAIPRO and interviews led by SIRRIS with local SMEs.

<u>Scenario 1: Quantification of energy savings potential for processes to be controlled by sensors / sensor systems</u>

> Sensor systems are employed in industrial applications for condition monitoring and/or process control with the intention of a more efficient, predictive maintenance and avoidance of non-optimal process conditions.
>
> Such an application is intended to result in savings of energy, resources of various kinds, and reduced costs and higher productivity respectively.
>
> There is a practical need for scientifically robust evidence regarding benefits of applying sensors / sensor networks.
>
> In case of condition monitoring and predictive maintenance cost savings are associated also with e.g. less storage of replacement part, better maintenance management.
>
> The quantification of the savings requires a broader assessment of the intended application.
>
> Two scenarios need to be compared: An industrial installation without and with the sensor system employed.

Relevant indicators to quantify efficiency gains could be:

- Electricity savings in absolute terms (e.g. per year)
- Electricity savings per unit produced, i.e. reflecting productivity increase
- Greenhouse gas emission reductions in absolute terms (e.g. kg CO_2-eq. per year)
- Resource consumption savings of any material, chemical or water in absolute terms (e.g. per year)
- Resource consumption savings of any material, chemical or water Per unit produced, i.e. reflecting efficiency increase
- Production cost savings in absolute terms (e.g. per year)
- Production cost savings per unit produced

Any of these calculations need to include a balance of expected savings and the initial financial or environmental investment, i.e. production and installation of the sensor system itself, plus running (environmental) costs of the sensor system.

Whereas in terms of costs the sensor system most likely is a relevant factor, the environmental investment might be minor compared to the achievable gains. If this holds true, a rather abridged "generic" environmental dataset might be needed only.

Major challenges comprise:

- Assessment of a broader application environment (type of production, production line output, huge variance of products and outputs etc.)
- There is rarely a "standard" application scenario, but rather uniqueness of each application, thus a highly adaptable approach will be required
- Confidential process / production data from the user of the system is or might be required to set up the calculation
- The calculations have to be based on assumptions: Typically there is no statistical data about the failures, which could be avoided by better control, just the general need to reduce unintended down-times etc.

- Link to FMEA / failure analysis is useful, but methodological interface has to be defined

Consequently a methodology / webtool rather would provide a parameterised calculation scheme, but the user has to enter (or adapt default) data and assumptions.

It might be required to focus on a distinct application field, which is highly relevant and poses a significant potential for efficiency gains. Such a priority application for methodology development could be

- Condition monitoring of motors in industrial applications
- In-situ process control for chemical processes
- In-situ process control for bio-chemical processes, such as bio reactors
- In-situ process control for any metallurgic process
- In-line quality control for any kind of production (targeting at reduced rejection rate)

Applications of sensor systems without a clear environmental benefit (e.g. safety control) are not suitable for this approach.

Energy mix is a variable, if the carbon emissions savings are to be quantified (depending on the electricity generation, CO_2 emissions vary broadly across Europe).

Advantages of this approach:

- Delivery of a clear sales argument
- Assessment tool could be used directly in project meetings with the client
- Potentially the assessment tool might allow for an optimal system configuration (how much control is required to realize which effect)

<u>Scenario 2: Quantifying the benefits of a wireless sensor system compared to a conventional, cable-based sensor system in industrial applications</u>

Another aspect of interest could be a quantification of the benefits of a wireless sensor system compared to a conventional, cable-based sensor system in industrial applications: For many applications the main benefit of wireless sensor systems is the avoidance of cables, which are a relevant cost factor in many industrial applications (investment and maintenance).

However, such a scenario requires a comparison wired sensor system vs. wireless sensor system, and not the comparison sensor system vs. no sensor based process monitoring. Such an assessment is therefore not compatible with the methodology formulated under no. 1.

The quantification of the cost and cable savings requires an assessment of the intended system alternatives.

The step from wired to wireless does not result in process efficiency gains, unless additional features are implemented with the change from a (theoretic) wired to a wireless system. For example, being closer with a wireless sensor to a component which is monitored rather would fall under the scenario outlined under no. 1.

Scenario 3: Quantifying the benefits of energy harvesting for wireless sensor system compared to conventionally powered sensor system in industrial applications

Another aspect of interest could be an assessment of energy harvesting options in terms of optimal system design.

This task requires an environmental assessment of various energy harvesting (hardware) options.

The outcome would be a recommendation for the option with the least impact, which might be a less appealing result than the quantification of possible savings to be realized with a sensor system with any power supply technology.

Scenario 4: Ecodesign of wireless sensor system

Limitations in design decisions: An eco-design approach for sensor systems is questionable, as largely “standard” components” are employed and integrated.

3.7.3 Results

The electronic torque equipment manufacturer participating in the questionnaire survey stated as main future drivers for environmental assessments:

- Improving product quality
- Legislation
- Manufacturing costs

Replies to the question "Which of the following could help you to promote your products?" are:

- Energy saving
- Productivity increase for the user of your product
- Increasing product lifetime

The expectation what an assessment should deliver are an Energy Efficiency Index, but also (rather ambitious for an LCA newcomer) a Life Cycle Assessment in compliance with ISO standards. Plans of environmental communication tools in the future target at self-declared environmental claims. Expectations from a web-based environmental assessment tool are an EC regulations statement as a result.

Three companies participated in the "Green Paper" discussion (two were interviewed by SIRRIS, the third one is LCA to go partner TAIPRO). The two external companies are an electronics equipment manufacturer and developer of software solutions, specialized in automation of industrial processes, management of "intelligent" buildings, road traffic management and management of television channels. The second company develops sensor solutions for the automatic door market. The sensor systems are meant to detect movement of people and vehicles to open automatic pedestrian doors and industrial doors.

Findings from the "Green Paper" discussions are:

It is confirmed, that sensors in the automation field are employed "with the intention of a more efficient, predictive maintenance and use of the process in optimal conditions." Better operation and maintenance management is seen as the major benefit by one respondent, whereas another rather stressed the fact, that spare parts storage "freezes" a lot of money.

There is an interest stated to be in the position to **quantify cost savings** of employing a micro sensors platform, and to control how a given equipment is used at the level of a downstream customer, which would allow **a feedback loop to improve the systems design**, to **provide additional services** to their customers and **to check if the equipment is well used**.

It is confirmed, that even large companies, although claiming that they control the global costs of their process, in reality lack detailed knowledge.

Multiple indicators are of interest for industrial automation, but should be related to the process: resource consumption savings as an indicator is related by one respondent to minimizing resource needed to complete a process. Electricity savings are of interest insofar as they are related to keeping costs low. Regarding energy savings in absolute terms one company makes the remark, that it might be difficult to obtain this information, however, the efficiency of a process seems to be well known. Surprisingly, the indicator greenhouse gas emissions reductions was attributed by a respondent with the intention to comply with legislation – although there is none, which directly requires any such indicator. Besides the individual indicators it is recommended to take into account Overall Equipment Effectiveness, which covers availability, performance and quality. With such an overarching indicator, there is potentially a clear overlap with the industrial machinery sector and the approach to be developed for machine tools.

The company developing sensors for the automatic doors market points out the fact, that their "application is intended to result in energy savings and to avoid non-optimal operating conditions", i.e. unintended open / close cycles. This company already developed an application to calculate the energy loss due to door opening. Energy savings are assumed to be two-fold: Electricity for the opening / closing mechanism, and heating / air-conditioning energy losses related to unintended opening of doors. Whereas the first factor seems to be rather easy to handle the latter one is much more complex as the heating / air-con use patterns of any given building has to be reflected.

The company developing sensor systems for doors agrees explicitly, that a methodology / webtool rather would provide a parameterized calculation scheme, but the user has to enter (or adapt default) data and assumptions, adding that accurate data is not required from their perspective. This corresponds also to the statement, that they don't have an interest in differentiating the energy mix per country.

Contrary to the claim made in the Green Paper two of the respondents states, that the cost of sensors is minor compared to the achievable gains. It is pointed out, that the application environment is always specific and an adaptable approach is always required – which confirms the initial statement in the Green Paper, that there is rarely a "standard" application. It is confirmed, that the approach should focus on a distinct application field.

Regarding failures of an industrial application "usually some data are recorded", but the question remains, how much data is accessible to calculate improvements achieved or achievable when employing sensor systems.

Regarding the 2nd scenario "Quantifying the benefits of a wireless sensor system compared to a conventional, cable-based sensor system" the straight-forward statement by one respondent is, that benefits are related to cost savings, which indirectly neglects the importance of environmental considerations. This, plus additional functionality, is confirmed to be the dominating argument, according to the second respondent. The third one adds an additional option, namely not only to compare wired sensor system vs. wireless, but also network of multiple low-cost sensors (with an anticipated higher failure rate and much redundancy) vs. employing a limited number of sensors. One remark is, that in some cases plants are built with cables already installed throughout the facility, leaving limited potential for cable savings thereafter.

Scenario 3 "Quantifying the benefits of energy harvesting for wireless sensor systems compared to conventionally powered sensor systems" is of interest to the company from the doors market, as they see a tendency towards energy harvesting being implemented for their application, and they confirm in interest in environmental assessment of various energy harvesting options, resulting in a recommendation for the option with the least impact.

A reason, why this scenario is more relevant to the doors market than the industrial automation market might be the fact, that the closer an application is to the end-consumer, the more relevant are environmental criteria.

As a respondent from the industrial automation market points out, that energy harvesting is broadly promoted, but rarely implemented in real applications yet, the point is obviously not reached yet, where a comparison of different harvesting options is of broader interest for decision making.

Similarly, scenario 4 "Ecodesign of wireless sensor systems" is of interest for the sensors developer for door applications: By now, they make a trade-off between different technical solutions, making the choice for the least expensive solution, as costs are a major issue in this market. "The impact on the environment could be considered provided that 1) the **method is simple** (one factor globalizing the environmental impact rather than multiple criteria) because it is not known what factor should be favoured, and 2) the **method is understandable**", i.e. calculation is transparent.

For the ecodesign scenario one respondent makes the point, that it could make sense sometimes to think about very low power solutions, i.e. a component redesign, but this essentially requires to tap a very high volume market to save the "grey" energy used to produce the "first run".

3.7.4 Wish list

- ✓ Demonstrate productivity increase for the user of a sensor system

- ✓ Quantify cost savings in combination with environmental impact reduction
- ✓ Indicators of interest: energy savings (of the system to be controlled and broader effects), resource consumption savings, Overall Equipment Effectiveness
- ✓ Adaptable approach to adjust calculations to application specific conditions
- ✓ Quantifying the benefits of a wireless sensor system compared to a conventional, cable-based sensor system is of moderate interest and so is quantifying the benefits of energy harvesting for wireless sensor systems compared to conventionally powered sensor systems
- ✓ Assessment for the purpose to ecodesign a wireless sensor system is of interest
- ✓ Simple and understandable methodology

3.7.5 Summary

Energy savings related to the use phase of sensor systems has been clearly identified as an aspect of high interest. To address the specifics of any customized application has to be acknowledged as a major challenge for the sectoral approach for sensors.

Overall Equipment Effectiveness has been identified as a possible key indicator for the methodology to be developed beyond mere environmental indicators.

The main purpose of an environmental assessment would be customer communication regarding the saving effects the customer might realize. Planning an optimal system (system ecodesign) is less of an issue, and so is the environmental burden of the production of the sensor system itself.

3.7.6 Conclusion

The Green Paper approach turned out to be an efficient methodology for the sensors sector specifically to guide the discussion towards a clear formulation of interests. Obviously the assumption that savings achieved through employing smart sensor systems is of high interest to this sector has been confirmed.

However, this methodological approach only worked well with interviews. Initiating a blog at the Open Innovation _connect forum yielded in a certain visibility of the topic, but not in any substantial feedback. The same experience was made with the call for comments on the AMA website.

With preference industrial applications should be in the focus of the methodology development as this is confirmed to be a field with a high interest. This orientation might lead to major synergy effects with the industrial machinery approach.

According to the analysis so far, data for complex (industrial) systems will be required as an essential input (either as generic data or preferably as provision of data entry possibilities) for any assessment of sensors.

As the interview partners develop systems for applications, where energy consuming processes are relevant, it is logic to focus on energy, but for other types of (industrial) process monitoring and control other environmental indicators still could be relevant – depending on the type of process (wet benches, biotechnology, chemical processes etc.).

3.7.7 Outlook

Given the aspect, that the methodology has to be open for sensor application specific settings, it is essential to push the methodology development not on an abstract level, but to design it around a suitable use case. Jointly with project partner TAIPRO it is planned to set up such a use case in the coming months. Taking into account the specifics of this case study, a flexible framework will be established to allow later adaptations to other applications. In parallel an exchange with ongoing research projects in the field of sensor network based condition monitoring and production technology will be sought to take into account additional specifics.

3.8 Smart textiles

3.8.1 Sector characteristic

Smart textiles can be viewed as a forerunner of 'pervasive computing' a technology vision denoting the integration of electronics into every-day objects to make them smart. The technology cluster of smart textiles cuts across various industrial sectors and therefore exhibits numerous intersectoral synergies on the level of materials, processes and products. For instance, wearable electronics (e-textiles) can contain combinations of textile materials (including bio-based plastics (e.g. viscose)) with electronic components, sensors, flexible PWB, and photovoltaic cells. Furthermore, the emerging technology necessitates innovation in industrial machines of the textile and the electronic industry.

The technology innovation cluster of smart textiles is still in an early stage of its formation as an industrial sector. It was chosen as investigation area of the LCA-to-go project because it exemplifies LCA decision support situations on the micro-level (situation A: future products design support) as well as meso/macro-level decision support (situation B: technology scenarios etc.) [ILCD Handbook 2010].LCA can be used for in the context of SME for making environmentally conscious decisions at an early stage of the technology innovation process of smart textiles.

The assessment of the LCA-needs in the smart textiles sector is taking place in a very heterogeneous spectrum of enterprises, ranging from traditional producers of textile and electronic products to entrepreneurial high-tech SME. The following table displays a rough classification of SME that are active in the smart textiles technology cluster.

Table 5: Heterogeneity of businesses encountered in the smart textiles sector and number of responding SME in each category

• Larger companies and brands of both sectors (textile and electronics) that consider enhancing their product portfolios by smart textiles consumer and business products. The bigger companies often act as system integrators in the higher end of the value chain.	0
• Matured SME from textile sector that want to innovate by taking up new technologies – providing intermediate materials, B2B solutions etc.	6
• Established SME from the electronics sector that act as developers for semi-finished e-textile components. Most of these SME work as contractors for B2B clients (system integrators).	2

• High-tech enterprises: their core business is the development and commercialisation of new technology. Active in mostly in B2B niche-markets (such as health care, safety, work-wear).	8
• Design service providers and artistic fashion designers, adopting the new technology in a playful manner and experiment with new functions and design concepts. Such SMEs have presented numerous prototypes of smart textiles products at industry fairs and conferences, but few of them seem to have been successful placing these products on the high street markets.	6
• Producers of equipment for textile and electronic industry. Some companies in this branch start to develop industrial machines for smart textiles manufacturing.	0

Since the smart textiles sector is still at a nascent stage of formation a common branch-identity has not yet been formed. The sector's agenda seems to be determined a technology-push model but there is no generally agreed innovation strategy. Various publicly founded innovation programmes at European and national scale have been implemented to stimulate innovation. SME have been taken on board of these programmes to foster technological competitiveness of European economy. None of these publicly founded R&D programmes has demanded LCA in the course of technology development and eco-design seems to have not been a subject of attention (aside legal compliance regarding RoHS for instance).

The hot-spots of smart textile innovation are concentrated in a few countries. Next to the number of active SME in this field the innovativeness can be measured by the existence of national innovation programmes addressing this technology. The latter exist in Germany[5] and in Scandinavian countries[6] (Sweden, Denmark) in addition to EU FP6 (completed)[7] and FP7 projects as well as the Interreg IIIC scheme TeTRInno SmarTEX (completed)[8].

[5] MST Smart Textils is a focus sector in the framework of the supporting programme "Microsystems", funded by the Federal Ministry of Education and Research (BMBF). http://www.mstonline.de

[6] http://www.smarttextiles.se; http://www.futuretextiles.dk

[7] e.g. WearIT@work project; http://www.wearitatwork.com

[8] http://www.mateo.ntc.zcu.cz/aboutproject.php

Companies that can be attributed to belong to the smart textiles sector exhibit different attitudes towards technical innovation:

- Pioneers: Entrepreneurial SMEs often emerged as a spin-off from research organisations or were founded by technophile graduates from universities. They are mostly driven by a specific technology development for which they may hold patents. Such firms often participate in publicly funded R&D programs in form of a -push model.

- Early adopters: This group merely comprises existing companies that intend to innovate by developing new products based on novel functions/design concepts. They are motivated by customers / clients requests or aim at competitive advantage. In particular, some European textile manufacturers see the smart textile as an emerging technology niche that offers a competitive advantage in the global textile sector.

- Followers observe the trends in technological and market development rather passively. They may engage in in-house R&D but do not progressively communicate their developments. Companies of this group may jump on the smart textiles bandwagon once those products reach a certain market success. Large companies usually do this by take-over of entrepreneurial SME or licensing in patents.

The majority of SME participating in the LCA-to-go WP1 survey belong to the categories of pioneers and early adopters. The low response rate from companies of the third group may be interpreted as a lack of awareness among these businesses regarding LCA rather than a sign for lack of business interest in smart textile technology.

<u>The current state of affairs in the smart textiles sector</u>

Since the innovation system of smart textiles is still very young and rather small, there are a limited number of SME active in this sector (perhaps less than 100 within the EU). These SME occupy a large variety of highly specialised market niches. There seems so be little intra-sectoral competition on the market place because most companies act in knowledge intensive niches. The critical competition takes place above all in terms of technological progress (enabling technologies) and patent claims (however, not all developers pursue patents). Moreover, competitive advantage emanated from design and realisation of meaningful products that provide added value for their users. While technological advancements have repeatedly been advertised and exhibited at industry fairs and conferences the creation of marketable smart textile products is still confined to special market niches (mostly B2B and health care applications).

While several companies, large sport equipment producers as well as specialised SME, started commercialising first smart textiles products the technology has not made break through on the mass markets yet. This fact contrasts to the fulsome expectations on market growth in the past. Until a few years ago, the smart textiles sector was expected to grow rapidly, in particular in the market segments of sports and outdoor clothes, health care, and workwear [9]. A market research report estimated the Annual Growth Rates (CAGR) of smart textile market segments between 2007 and 2012 as follows: 204.9% biomedical application; 83.5% computing; 20.5% consumer products [10].

Since the economic crisis in 2009, the innovation system has obviously entered a critical phase where the initial hype around the technology is hampered by unfavourable economic circumstances. Smart textiles seem to have experienced a temporary decline in business attention. Figure 65 shows a generic chart of the visibility attributed to e-textiles from the business perspective [11].

[9] Stork, W. (2008). Intelligente Kleidung für mehr Komfort und Sicherheit. Karlsruher Wirtschaftsspiegel 2007/2008.

[10] McWilliams, A. 2007. Smart and Interactive Textiles. Report AVM050B, Wellesley, MA: BCC Research.

[11] Dalsgaard, C., ohmatex (2010): Commercial investment in High-tech textiles smart textile technology. TITV Conference on Smart Textiles, February 2010.

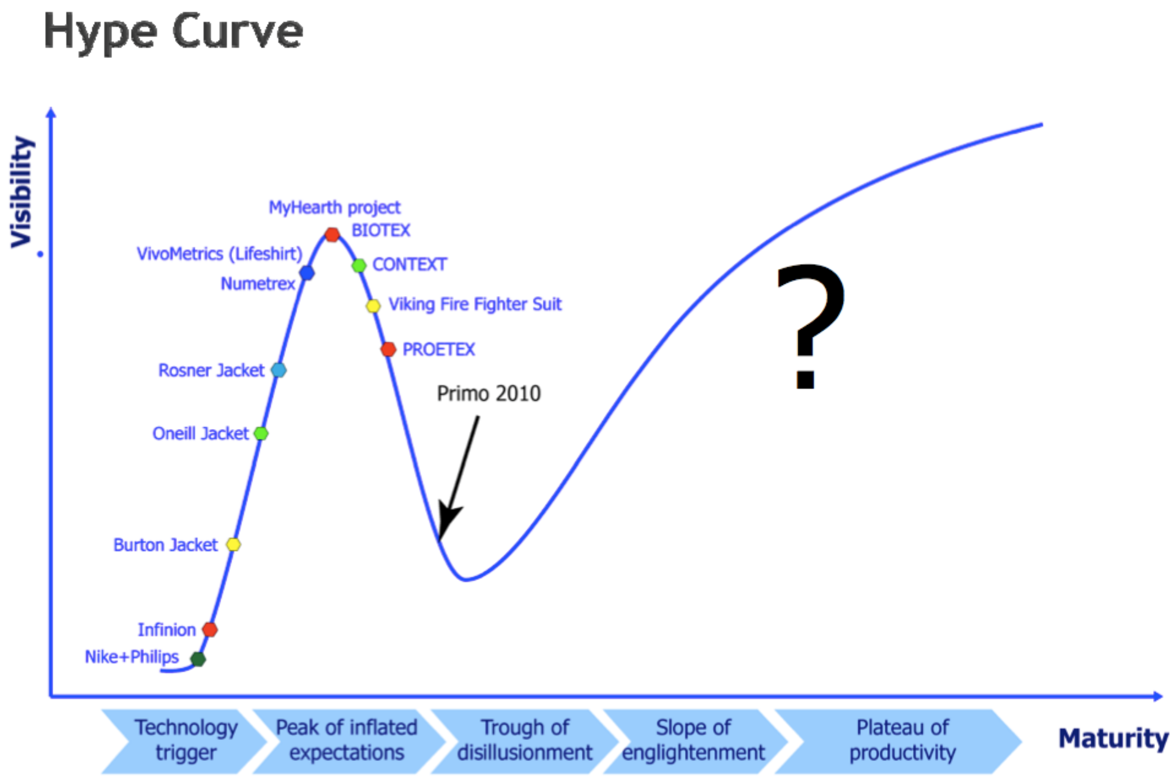


Figure 65: The hype curve of smart textiles: the relative business attention paid to various e-textiles prototypes and product launched on the market. Source: (Dalsgaard 2010)

The chart, known as the "Gartner Hype Curve", represents the attention that a technology attracts by technophile observers such as media, tech-blogs and research reports[12]. The generic shape of the curve reflects the typical fate of any emerging technology at the early innovation phase of the technology life cycle (Figure 66). The chart suggests that any upcoming technology undergoes an initial hype phase where it attracts much entrepreneurial attention. The subsequent 'Trough of Disillusionment' seems to be a typical phenomenon associated with the innovation process of emerging technologies. Reasons for a decline in visibility are usually unfulfilled expectations towards technological performance of prototypal products as well as underestimated difficulties to overcome them. Similar patterns of technology hype cycles have been observed

[12] The hype curve is a proprietary method of a business consultancy (Gartner). The results of the annual ranking, provided by Gartner, are often recited in the business world in spite of lacking methodological transparency. The chart can be interpreted as a indicator of the prevailing attitudes, which decision makers in business exhibit towards an innovative technology. Linden and Fenn 2003: Understanding Gartner's Hype Cycles, Gartner, Inc.

in numerous emerging technologies, for example fuel cell technology [13]. The fate of a more matured technology can imply large-scale commercialization as exemplified by mobile communication technology.

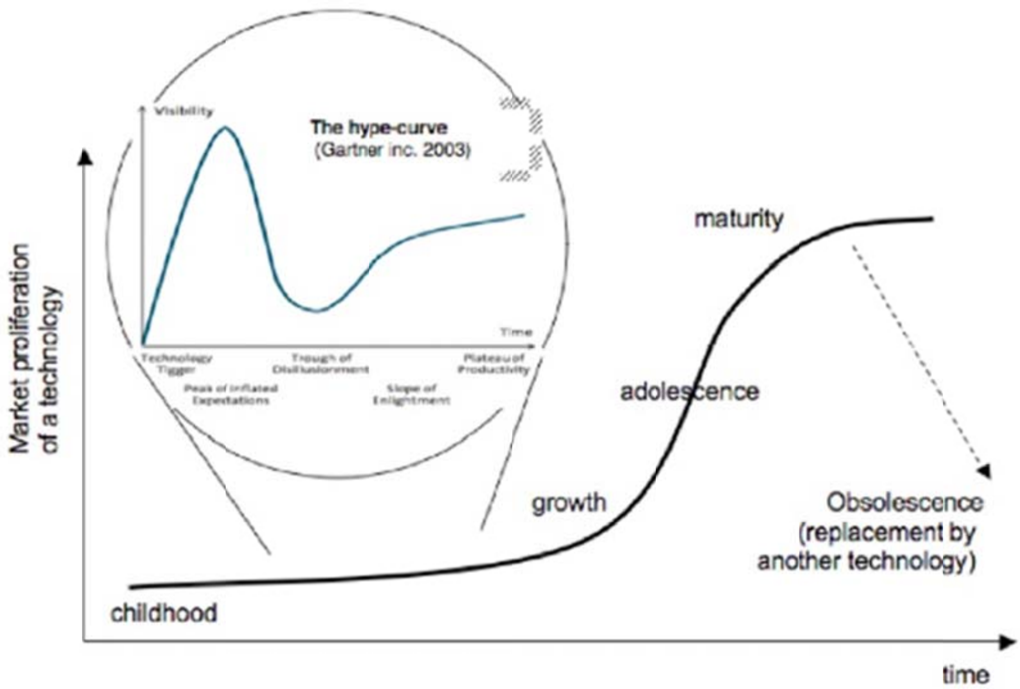


Figure 66: The situation of the hype-curve in the stylized technology life cycle model. Source: adopted from (Grübler 2003) and (Gartner 2003)

The hype curve of the converging smart textiles innovation system appears to have an initial peak in 2008. Since then, the sector seems to undergo a decline in momentum due to the coincidence of the 'Trough of Disillusionment' and the economic crisis in 2009. Smart textile enterprises have higher-than-expected difficulties to launch new products at the market successfully. Apparently, a number of SME went out of business during the past two to three years, or they were taken over by other companies. As of 2011, the entrepreneur's seem to have more conservative business expectations regarding their medium-term market success as compared to 2008. The commercialisation strategies of innovative businesses seem to be hampered by two problems: fist a lack of fresh venture capital and second, the difficult market situation.

This affects the innovation dynamics of the whole technology cluster of high-performance textiles. The future fate of the smart textiles sector depends on the

[13] Hellman, H., 2007. Probing Applications. How Firms Manage the Commercialisation of Fuel Cell Technology. TU Delft, DfS

overall economic situation as much as the sector's ability to overcome prevailing shortcomings in the technical performance of contemporary smart textile prototypes [Stylios 2007]. Entrepreneurs in the smart textile sector see good opportunities to overcome the current problems by progress of technological innovation. At the moment, "Technologies are just not mature enough for textile companies to consider them as standard components" [Dalsgaard 2010]. In future, smart textile may enter the next stage of the technology life cycle (the so called 'Slope of Enlightenment') if technology matures and industry adopts them [14]. In the case of fuel cell technology, the commercial activities of FC-industry has picked up new momentum in the aftermath of a 'Trough of Disillusionment' in 2003 [Hellman 2007]. However, there is also the possibility that the concept of smart textiles becomes obsolete before real products enter the mass market.

3.8.2 Survey methodology

We started with a broad mapping of European businesses in the smart textiles technology cluster to compile a list of SMEs for the survey. This was undertaken by a review of literature and online sources, including company communications, press coverage, technology blogs and proceedings from conferences and industry fairs. Outreach materials and databases of European and national innovation programs related to smart textiles were screened to identify SME that participate in these programmes. Moreover, expert networks in the smart textiles research community were consulted and conferences and industry fairs were attended to get in contact with firms.

In total, 53 firms were found to fit our screening criteria:

- Small or medium sized company or SME-like subsidiary of a larger firm,
- located in an European country (EU + Switzerland),
- having commercialised smart textile products or intermediate materials,
- or demonstrated prototypes, design concepts or services related to smart textiles,
- or are involved in smart textile innovation funding schemes,

[14] For comparison: the famous hook-and-loop fastener (brandname: Velcro) might be considered as a precedent of a smart textile. Today, it is widespreadly applied in a multitude of products. But in 1941 - when George de Mestral invented the fastener - nobody believed in the technology. It took a decade to develop an industrial scale manufacturing process and yet another decade to make a break-trough on the mass market. http://en.wikipedia.org/wiki/Velcro

- or are part of the smart textile value chain (e.g. system integrator).

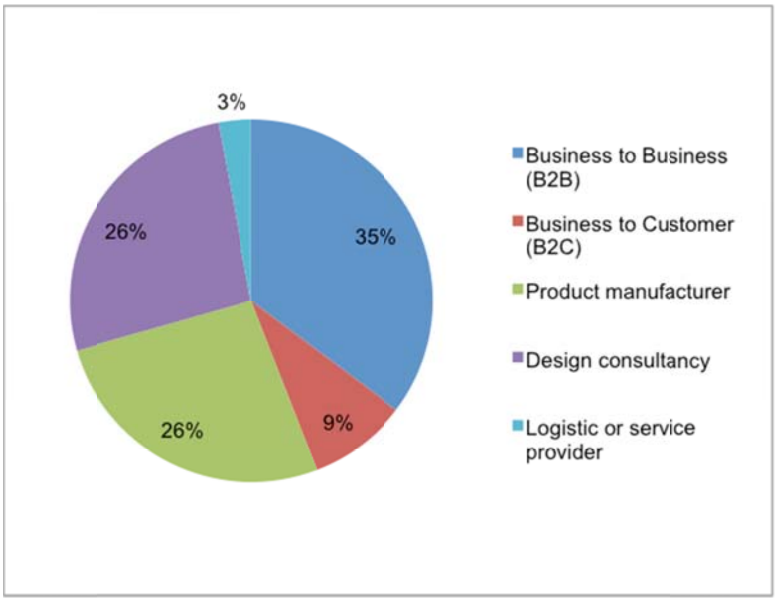


Figure 67: Business models of the responding SME (Smart textiles)

The questionnaire-based survey was conducted between April and July 2011. The SME were contacted by email and/or phone calls. They were asked to respond to the LCA-to-go online questionnaire. A few participants answered the questionnaire at the occasion of face-to-face meetings or phone interviews. In total, 25 SME responded to the questionnaire based survey or answered questions by phone (response rate = 47%). 22 SME did not answer at all and 7 SME (13%) refused participation explicitly. Most of the latter explained their refusal by saying that LCA was not relevant for their business.

The geographical origin of SME participating in the LCA-to-go survey is displayed in Figure 68. It should be noted that Figure 68 represents only a snapshot of the European innovation system in the smart textiles field (only the SME responding to our survey).

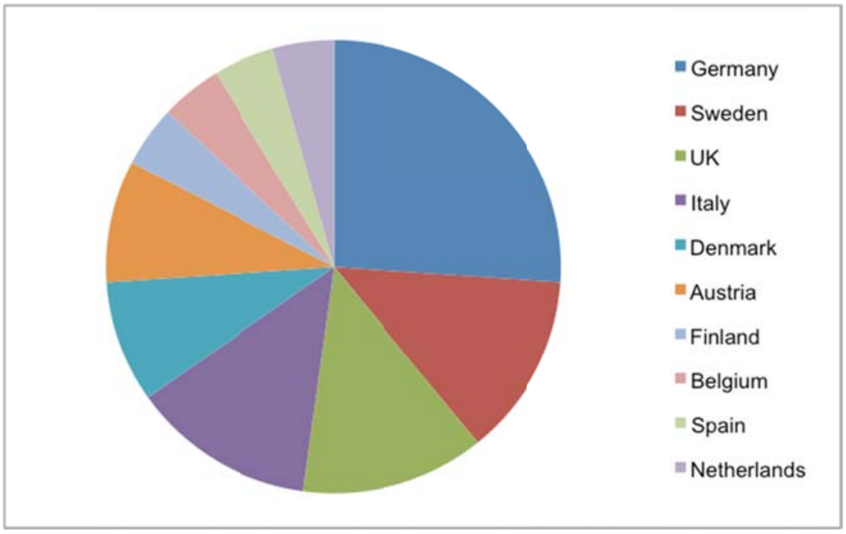


Figure 68: Country wise distribution of responding SMEs (Smart textiles)

Subsequent to the questionnaire-based survey, seven phone interviews were conducted among those SMEs that had expressed their interest in the topic. The purpose of the interviews was to validate and complement the findings from the questionnaire-based survey. The interviewees were asked open-ended questions based on an interview guideline, which was customized in terminology depending on the interviewee's area of expertise. All interviewees were asked to respond on questions in three thematic areas:

- Purpose of LCA application (eco-design, environmental monitoring, external communication)

- How should the LCA be represented to provide useful business support?

- How can LCA be implemented in the business processes of the SME (e.g. product development process, EMS, controlling, business strategy support).

The phone interviews did not aim at empirical robustness; instead they provided more detailed information regarding the actual needs of these companies regarding use and implementation of LCA in their business operations.

3.8.3 Results

Various LCA studies have been published within the mature technology sectors of electronics (see sections 3.3 – 3.5) and textiles.

Textile and apparel sector

In the mature textile sector, publicly funded research projects dedicated to LCA were implemented in the past (COST Action 628)[15] and the present (PROSUITE). Recently, various LCA studies on synthetic fibres[16] cotton fibres[17] and modified cellulose fibres[18] were commissioned by different large textile companies and carried out at public research bodies and consultancies[19].

These gate-to-gate LCA studies tend to focus at the production steps within the textile value chain since textile corporations are increasingly interested in implementing cleaner production mechanism and reduction of carbon footprint / process water usage. LCAs that include the use phase of the textile life cycle (including laundry, drying, ironing) were conducted with focus at the environmental performance of detergents and washing machines[20].

Several cradle-to-gate LCA studies on clothing have been undertaken by fashion retailers (e.g. M&S) or branch organisations of the textile industry (Defra in UK)[21]. Patagonia assessed the fibre-to-fibre recycling of old polyester textiles by means of LCA[22]. While not all of these studies have been made available to the public in detail, these initiatives demonstrate the growing sense of responsibility for environmental impacts among corporations in the textile sector. For the most part, bigger players on the apparel market (fashion brands and large textile

[15] COST Action 628 on of Textile Products, Eco-efficiency and Definition of Best Available Technology (BAT) of Textile Processing, 2001 – 2005.

[16] Advansa (2011) Independent Life Cycle Analysis Confirms CO2 Footprint Reduction Of ADVANSA's ECO2Technology For Thermo°Cool; http://www.advansa.com/news-en/february-2011

17 Levi Strauss & Co. (2008): Life Cycle Approach to Examine the Environmental Performance of its Products. http://www.levistrauss.com/sustainability/product/life-cycle-jean

[18] Shen, L. and M.K. Patel (2010): Life Cycle Assessment of. Man-made cellulose fibres. Lenzinger Berichte 88 (2010) 1-59.

[19] EMSC: http://www.emsc.ch/Publikationen/Textilindustrie%20und%20Landwirtschaft/

[20] http://www.scienceinthebox.com/en_UK/programs/laundrydetergent_en.html

[21] Collins, M. and Aumônier, S. (2002) Streamlined Life Cycle Assessment of Two Marks & Spencers plc Apparel Products. Oxford: Environmental Sources management.

Allwood et al, 2006, Well dressed? The present and future sustainability of clothing and textiles in the United Kingdom, University of Cambridge Institute for Manufacturing, ISBN 1-902546052-0

[22] http://www.treehugger.com/files/2007/02/patagonia_expan.php - Patagonia: Patagonia's Common Threads Garment Recycling Program: A Detailed Analysis. www.patagonia.com/pdf/en_US/common_threads_whitepaper.pdf

producers) have undertaken efforts in LCA. The outdoor fashion industry has teamed up and launched a beta-version of the "The Eco Index" [23], an LCA-based environmental assessment tool designed to provide companies with intelligence on the improvement potential of their products.

SME seem to be less proactive in communicating results of LCA studies they may undertake for their internal purposes[24]. National branch associations of textile industry sector offer LCA support to their members, including development and dissemination of customized LCA tools for textile SME. MODINT, for instance, the Dutch trade association for fashion, interior design, carpets and textiles[25] has commissioned the development of such a tool. It is now offered to textile companies in the Netherlands.

In conclusion, it can be said that for the textile and apparel sector there are some branch specific LCA tools available– some of these are online tools accessible for members or subscribers. These tools differ in the level of sophistication and not all of them are strictly compliant to ISO 14040 (serving rather as quick-check tools). Made-by.org for instance, offers a scorecard approach for social and environmental aspects of fashion products[26].

Smart textiles sector

In contrast to the situation of the classical industry sectors described above, the emerging Smart textiles sector has hardly implemented LCA in practice. Thus far, only few LCA studies on smart textiles or electronic textiles have been published[27] and no information could be gathered during the LCA-to-go survey that companies or research institutes currently undertake LCA on Smart textiles. Previous investigation on end-of-life implications of electronic textiles has

[23] http://www.ecoindexbeta.org/

[24] No LCAs, created or published by textile SME could be found in the public domain but this does not evidence that SME are disinterested in environmental assessment. Rather, this might be caused due to SME's having a pragmatic approach to implement case-by-case assessments. They use findings for internal decision support or client communication rather than for external communication.

[25] http://www.modint.nl Modint Ecotool project see: http://www.ce.nl

[26] http://www.made-by.org/scorecards

[27] LCAs have been conducted on functional nano-textiles in the framework of the EU FP7 project PROSUITE (Project no. 227078): Walser, T., Demou, E.; Lang, D.J.; Hellweg, S. (2011): Prospective Environmental Life Cycle Assessment of Nanosilver T-Shirts. Environmental Science&Technology 2011, 45, 4570-4578. Moreover, LCA on textile-based toys: Muñoz, I., Gazulla. C.,Bala A., Puig, R. & Fullana, P. (2009): LCA and ecodesign in the toy industry: case study of a teddy bear incorporating electric and electronic components. Int J Life Cycle Assess.14:64–72.

shown that environmental aspects are not regularly assessed during the development process of smart textiles at research labs and science organisations.

Most SMEs, and in particular the small enterprises (less than 10 employees) seem to handle environmental tasks (e.g. assuring legal compliance) as normal business assignment in the hands of the managing director or the product manager. The simultaneous responsibility of managing staff explains our survey finding that one-third or the SMEs have internal environmental communication channels (mostly the same person having various duties in the company). However, two-third of the SMEs have not established communication procedures between responsible persons for core business tasks and environmental tasks (because the later task is often not actively managed).

Formal management systems seem to be not state of the art among SMEs. Only 9% of the responding SME have assigned engineers for environmental management tasks (such as ISO 14001) whereas 48% of the SMEs have implemented quality management systems (ISO 9001). Informal environmental improvement practices seem to be established by a minority of SME whose leaders exhibit personal interest and attitudes towards environmental stewardship. A third of the SMEs indicated that eco-design principles are implemented in the product development process but in practice none of the respondents have used tools/checklists for eco-design and environmental assessment[28]. SME seem to embrace the Cradle-2-Cradle approach as a guiding principle, least for external environmental communication.

[28] One survey SME uses KEPI. The same SME is aware of LCA tools but hasn't used them as yet.

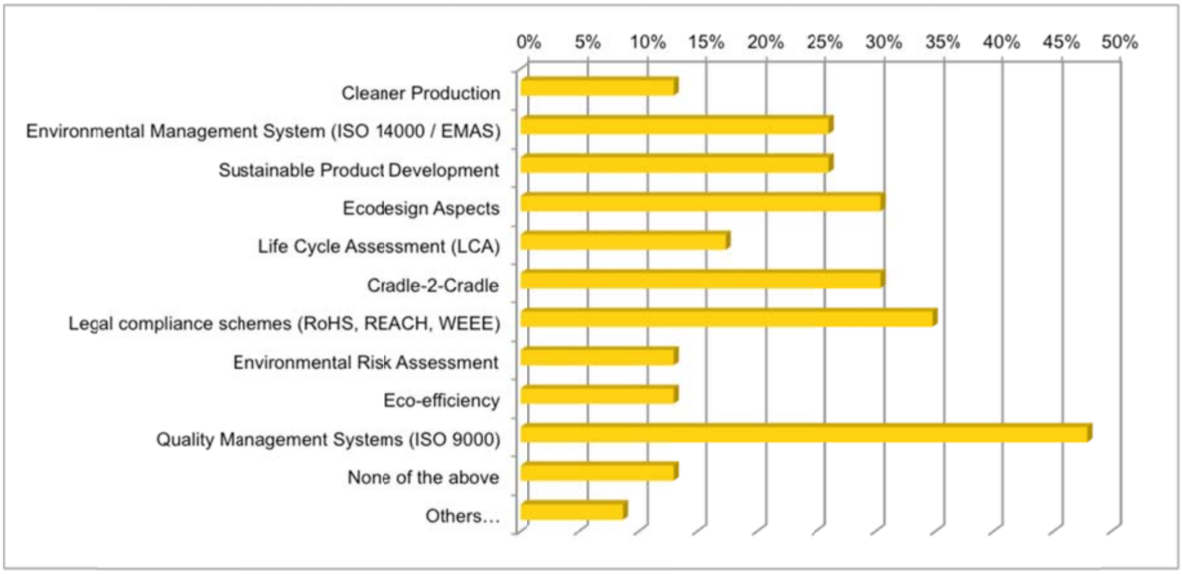


Figure 69: Most familiar environmental approaches (Smart textiles)

81% of the respondents were aware that their job position in the company is related to environmental aspects: Product developer (36%) and product manager (8%) can influence the environmental performance of products. 48% of the respondents hold a managing position (CEO, managing director) where they can influence company environmental policies. In general terms the survey and the subsequent interviews lead to the impression that SMEs are generally positive towards environmental improvement of smart textiles but they are lacking incentives to strive proactively towards sustainable technology innovation.

The results of the survey show that none but one of the respondents have ever worked with LCA at their company (Figure 70). Only one SME indicated that they have undertaken a full LCA once and have used other tools as well. One larger textile company reported that they commissioned a full LCA study[29] on textile materials (not smart textiles however).

[29] Lenzinger Berichte 88 (2010) 1-59.

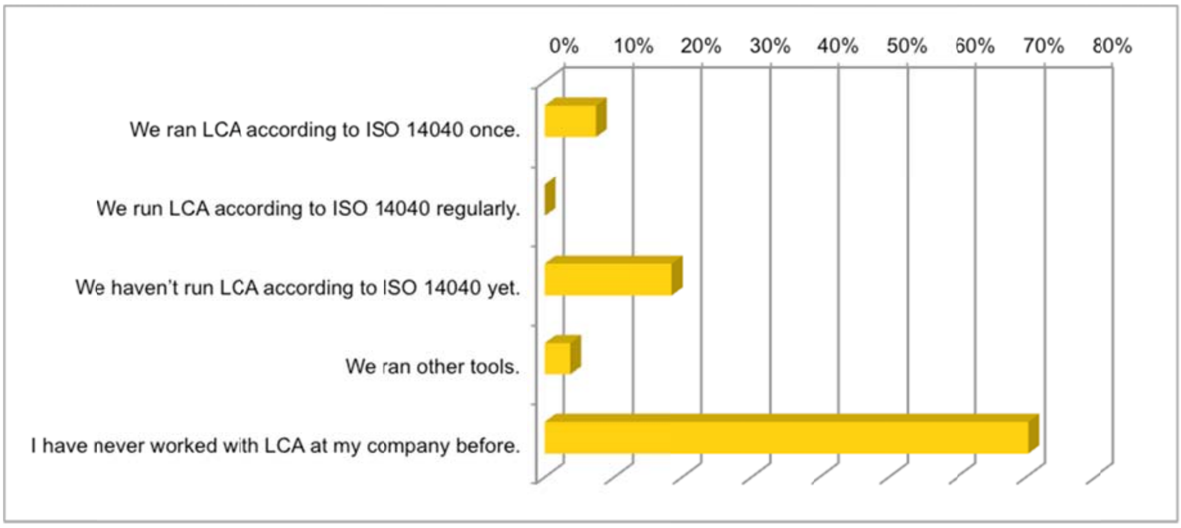


Figure 70: State of LCA implementation (Smart textiles)

The reasons for non-application remained unclear from the survey (

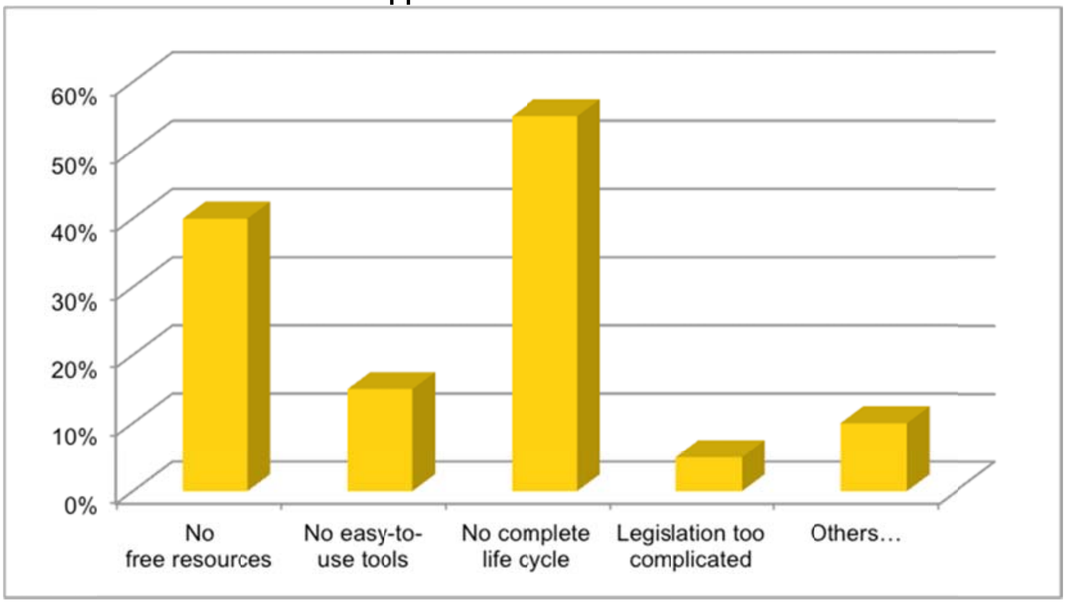


Figure 71). It seems that most SME have no experiences because they have no free resources to exert environmental assessment[30]. Moreover, there seems a prevailing believe that these matters are not important for SME at an early stage of innovation. Various entrepreneurs interviewed pointed out that their business priority is with the technical sophistication of smart textiles. They expressed the opinion that other actors in the smart textiles innovation system (such as

[30] SME from the more traditional textile sector stressed that environmental aspects are becoming more and more important for business success and that their B2B customers demand environmental declarations and/or ask for ecolabels.

research institutes, authorities) should take care for environmental assessment and eco-innovation of smart textiles.

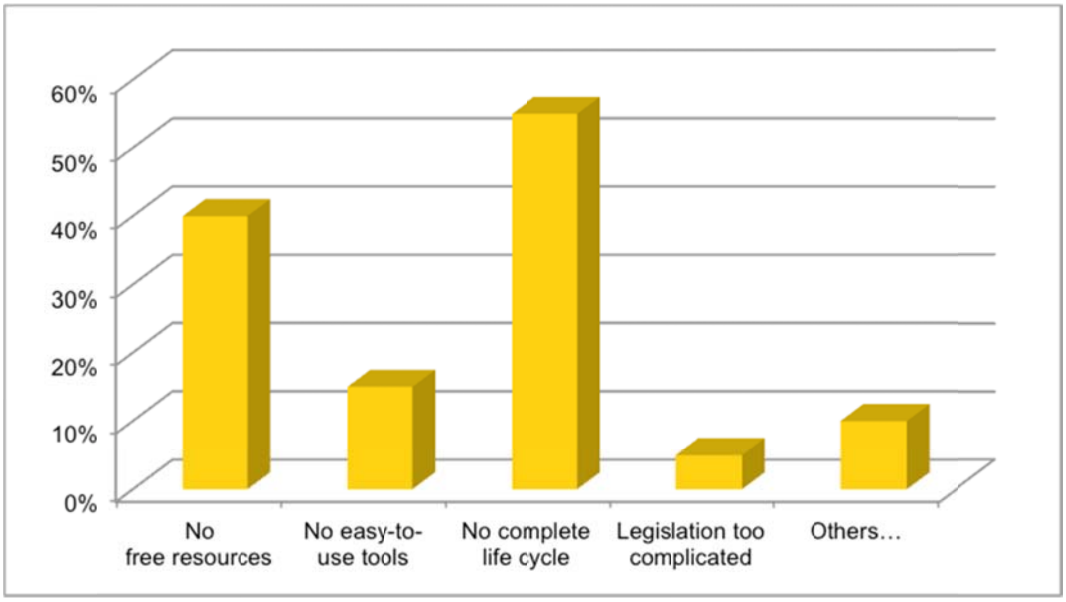


Figure 71: Reasons for not running LCA-tools (Smart textiles)

From this background it is no surprise that the majority of interviewees indicated to have no knowledge regarding the relevant environmental aspects of their businesses (Figure 72) and the environmentally relevant life cycle stages of their products (

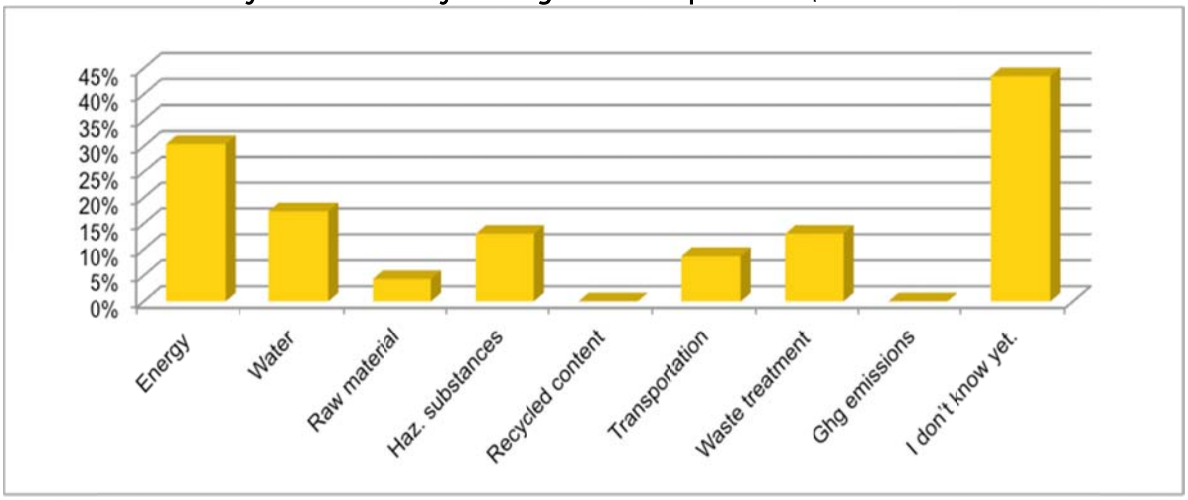


Figure 73). The presumptions on environmental priorities have to be interpreted from this background: the respondents seem to base their decisions on common sense rather than on the results of formal assessment methods.

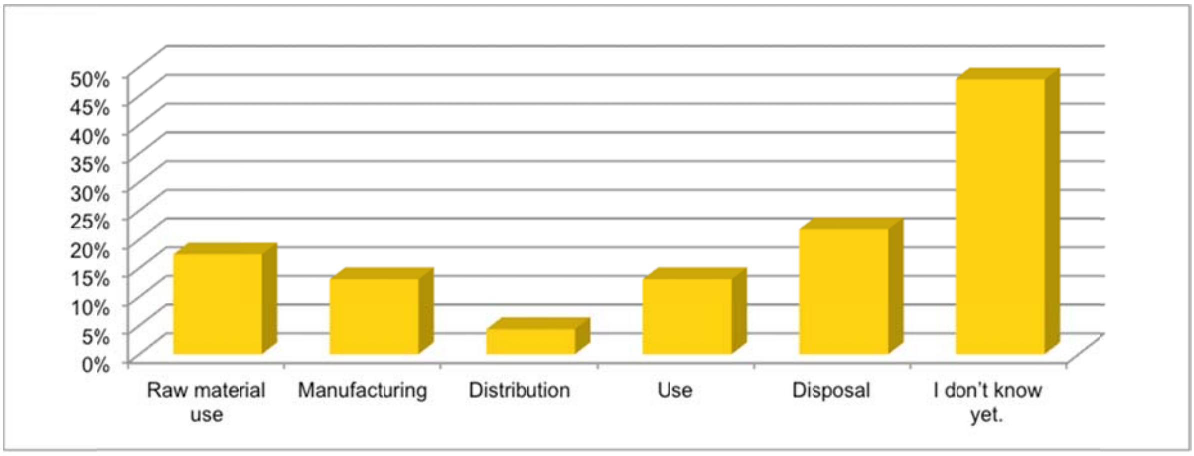


Figure 72: Most environmentally problematic life cycle phase according to the interviewees' guesses (Smart textiles)

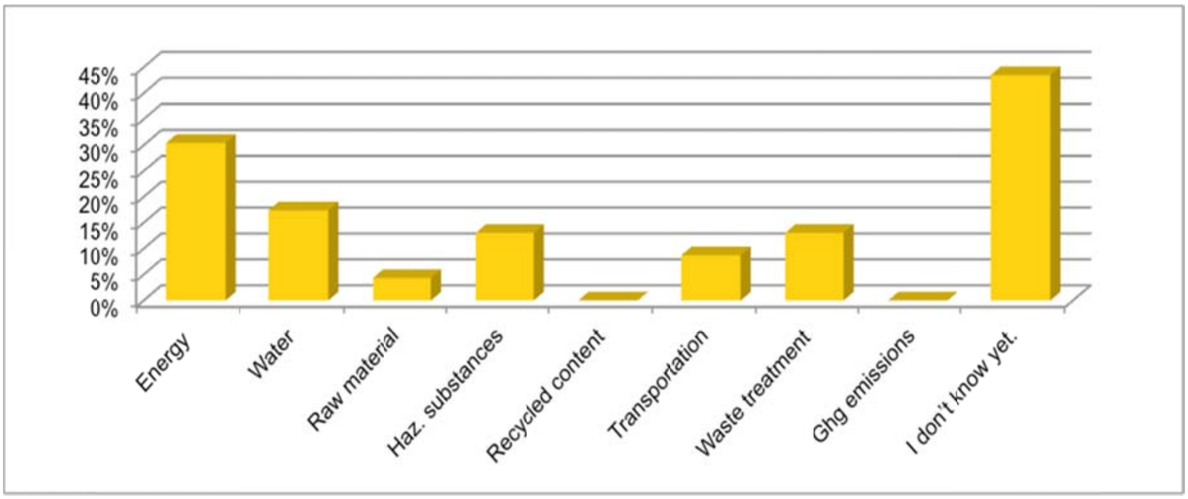


Figure 73: Most important environmental aspect according to the interviewees' guesses (Smart textiles)

The respondents' estimates seem to be influenced by experiences with regulation (e.g. RoHS directive: hazardous substances; WEEE directive: recycling) and environmental aspects frequently addressed by public media (energy saving). Additionally, textile businesses are markedly concerned about fresh water saving and pollution control.

3.8.3.1 Needs and demands

Environmental assessment

In spite of the findings reported above, the smart textiles SME seems to have a latent interest to undertake environmental assessment of their products. At present, only a third of the SME indicated that improvements of the environmental performance of products can be seen as

a driver for innovations in the smart textiles area (

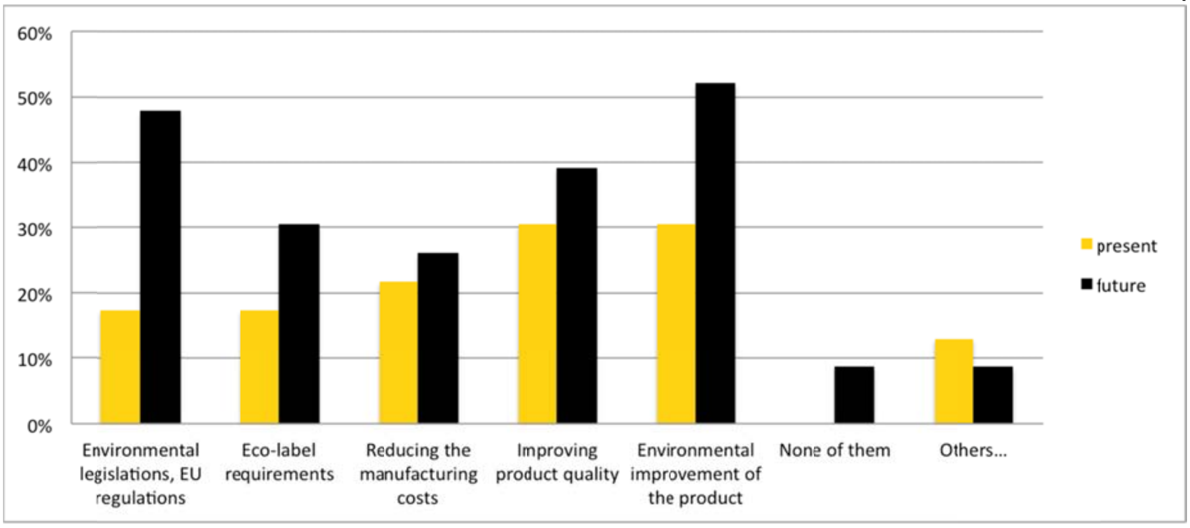


Figure 74). While environmental aspects were presently regarded to have inferior importance as compared to product functionality these aspects were expected to become more relevant in future. 52% of the respondents thought the product quality can benefit from improved environmental performance (Figure 72). The interest in environmental assessment is still not very high among the young SME in the smart textile sector. While they are still busy to solve technological problems related to production processes and product functionality they have little incentive to look into environmental life cycle aspects of products.

The situation differs in the more mature textile sector. SME in this category are increasingly concerned with improving the social and environmental attributes of their products because their customers (e.g. global fashion brands) are exposed to stakeholder scrutiny and public awareness. Sustainability was regarded an important success factor for future textile business. It may signal the future trend for the smart textile businesses: environmental performance of smart textiles is likely to gain importance as the new sector matures and exposes its products on bigger markets in future.

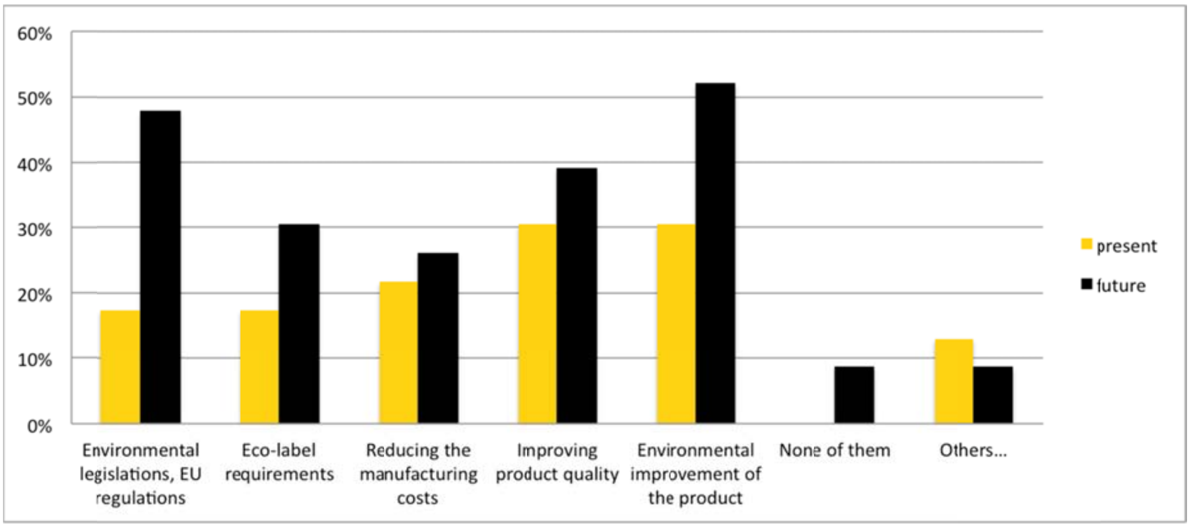


Figure 74: Drivers for environmental assessment – present and future product perspective (Smart textiles)

From the perspective of the businesses, environmental assessment was regarded to become necessary in medium term future due to regulatory requirements. In particular the anticipation of stricter environmental regulation in future seems to fuel concerns of the entrepreneurs. Some interviewees remarked that more demanding regulation could hamper the commercial success of the young smart textiles sector. On the other hand some agreed to the idea that legislation can stimulate sustainable innovation, which helps preserving global competitive advantage of European businesses. They stressed, that – most importantly – the legislature must define and communicate clear environmental performance targets early enough in the innovation process.

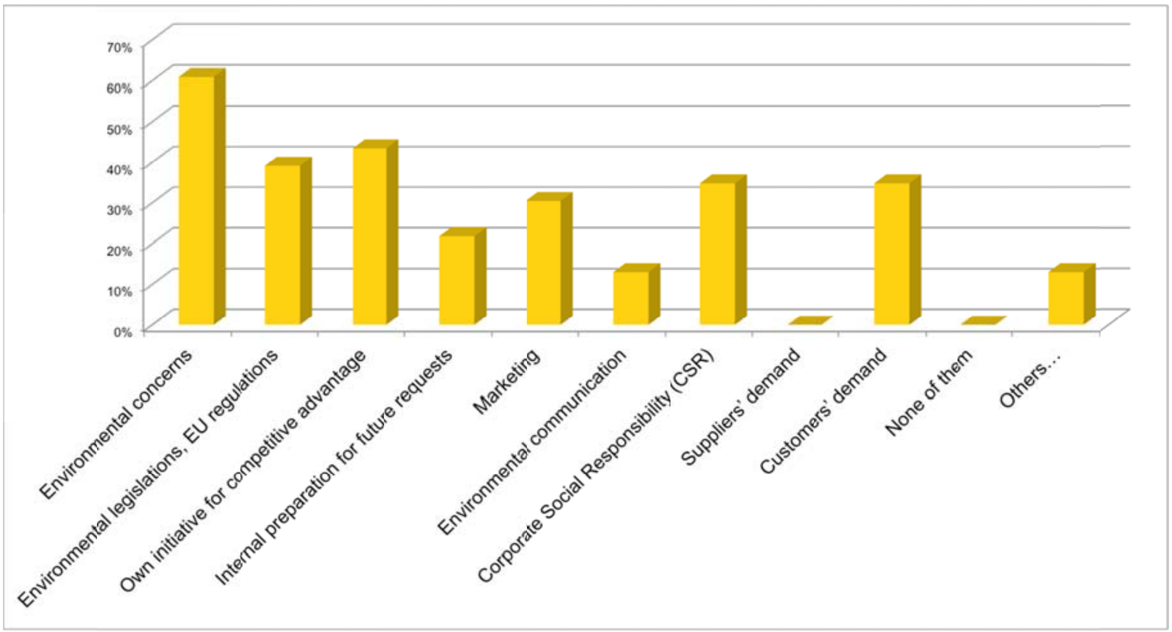


Figure 75: Drivers for environmental assessment – company perspective (Smart textiles)

Figure 75 suggests that the personal stance of the interviewed persons towards environmental issues and social responsibility can have a large influence within the emerging smart textiles sector. Whereas more than 60% of the respondents seem to be aware of environmental concerns there was no evidence that SME implement concrete measures to optimise the environmental performance of future smart textiles products. However, a number of interviewees explicitly emphasised the strategic relevance of sustainable technology development for the future success of smart textiles.

Environmental communication

The majority of respondents did not see any advantage of LCA to support external communication (marketing) nor did they see a need to assess and communicate environmental aspects for internal decision support (

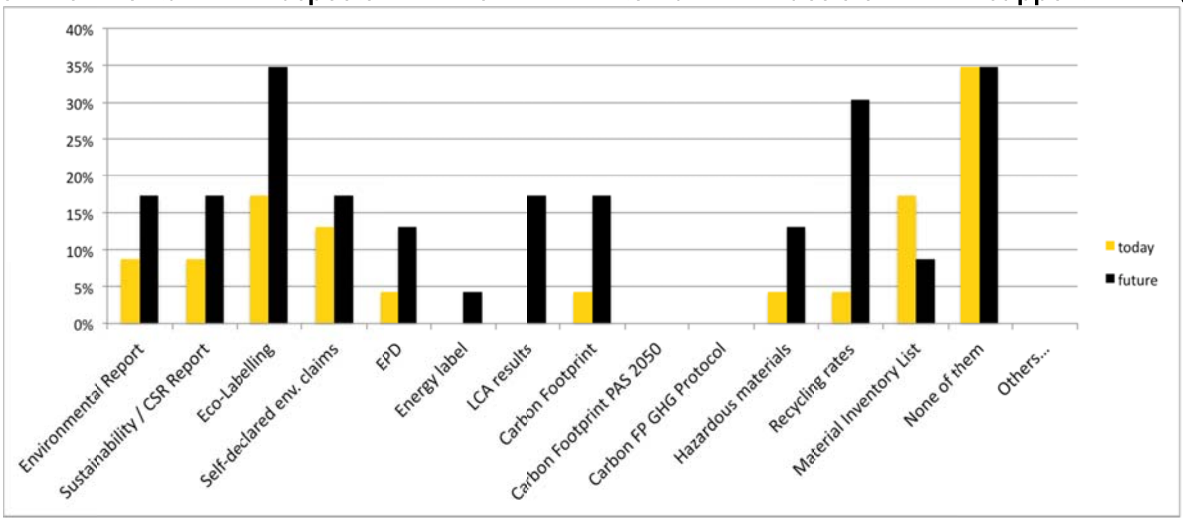


Figure 76). A minority of interviewees however, mostly occupying managerial positions in the respective SMEs, exhibited positive attitudes towards LCA as a support instrument for external communication and environmental improvement (eco-design). As mentioned above, the young smart textiles companies seem to be unaware of environmental aspects being a driver for business development as contrasted to more mature textile companies. Among the latter, there were some that considered eco-labelling as a key important

marketing tool in future (

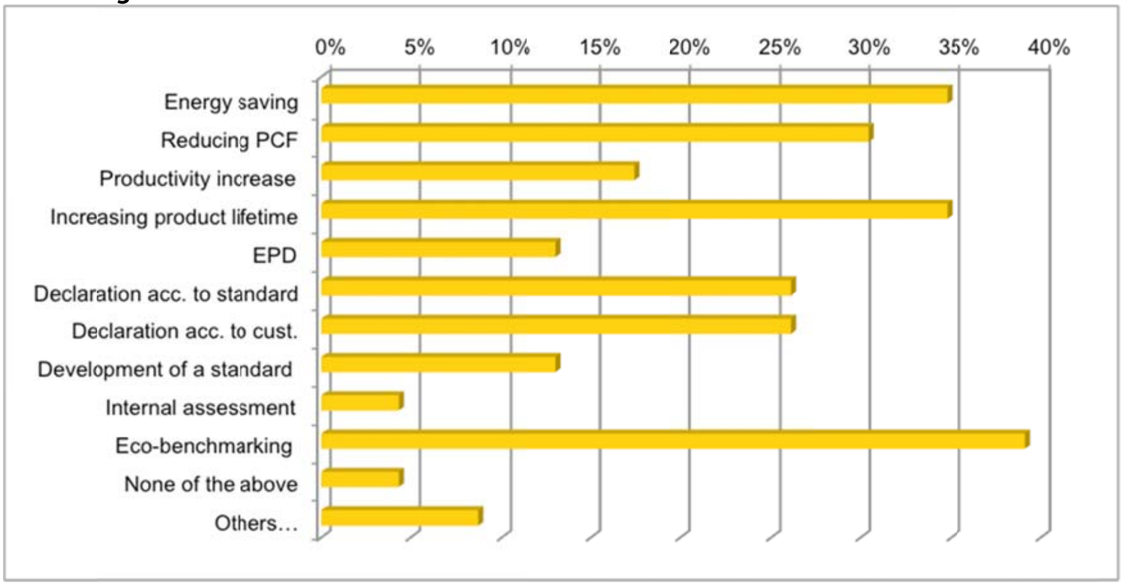


Figure 77). They were concerned about compliance of technologically enhanced smart textiles with current eco-labelling schemes.

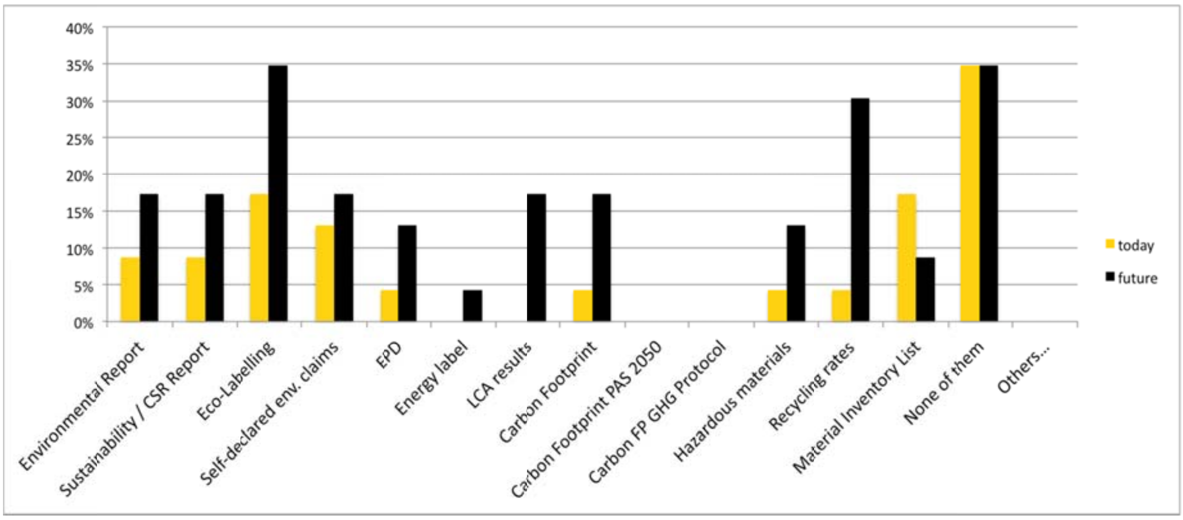


Figure 76: Communication tools used today and planned in the future (Smart textiles)

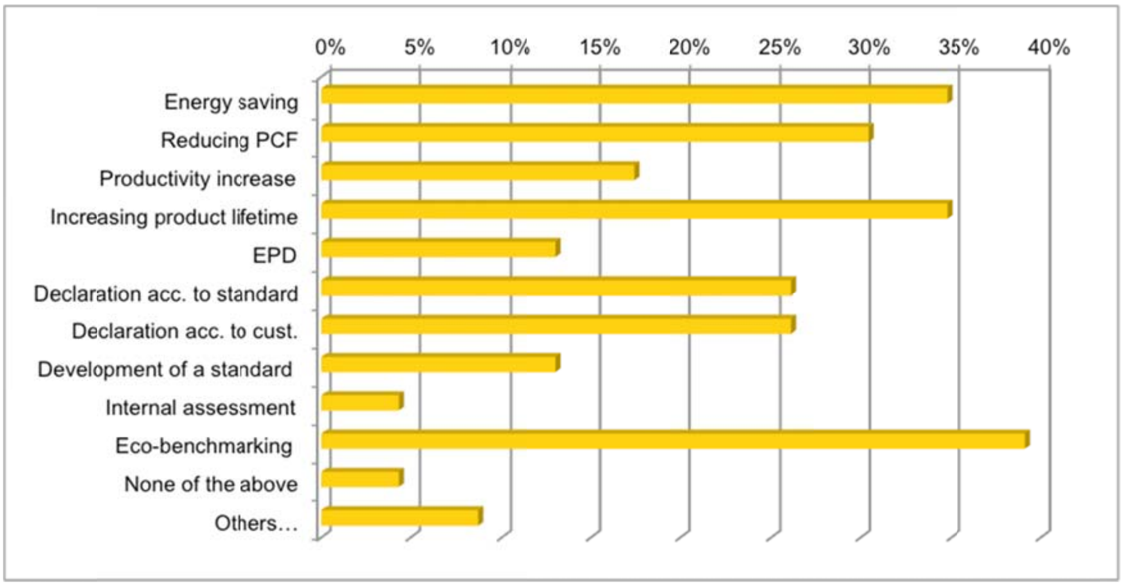


Figure 77: Aspects and arguments potentially useful to promote products (Smart textiles)

<u>LCA tool</u>

In general, there were low expectations regarding any LCA tools and most respondents were indifferent in this question. They were obviously lacking experiences in LCA (neither positive nor negative ones) and thus they could not indicate their wishes clearly. Figure 78 shows the wide range of criteria that were subsumed under the term LCA. Although not all optional key-words presented in the questionnaire were directly linked to LCA the responses indicate the variety of interests. Energy consumption of products (relevant in the case of electronic textiles) and avoidance of hazardous substances peak out, reflecting some of the key environmental problem areas of high-tech products, alongside with the end-of-life aspects (recycling, resource conservation). During the telephone interviews some SME indicated their specific interest in expressing the environmental benefit of their product in the context of the application. Some expect their product to save for example an substantial amount of green house gas emissions compared to the situation without their product and/or with 'conventional' products.

External demand on environmental information is not (yet) a business task for most of the smart textiles SME. Electronic companies are used to material declarations in the context of RoHS compliance and textile producers are sometimes confronted with questions regarding the origin of natural fibre (cotton). There is uncertainty regarding future requirements. In particular in regard to REACH declaration of novel materials such as nano-materials used for advanced textiles.

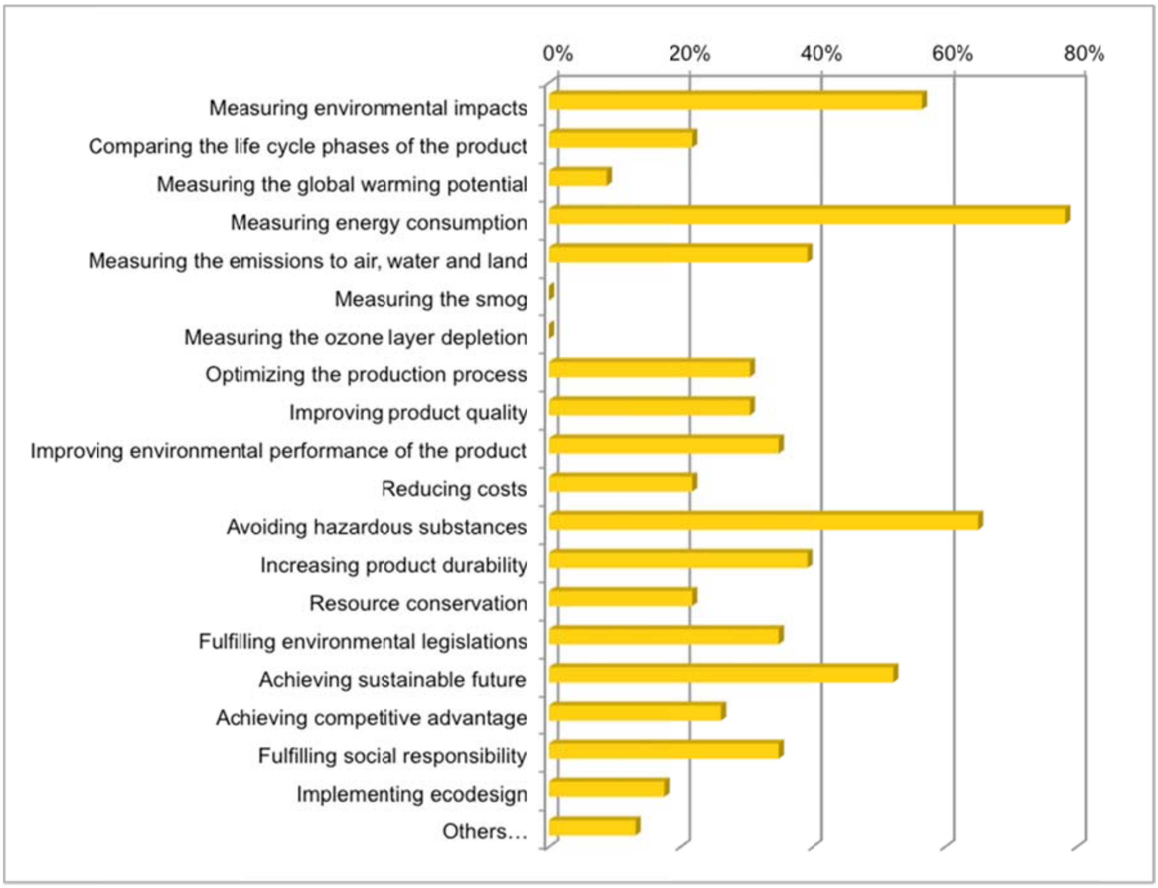


Figure 78: Statements most related to LCA (Smart textiles)

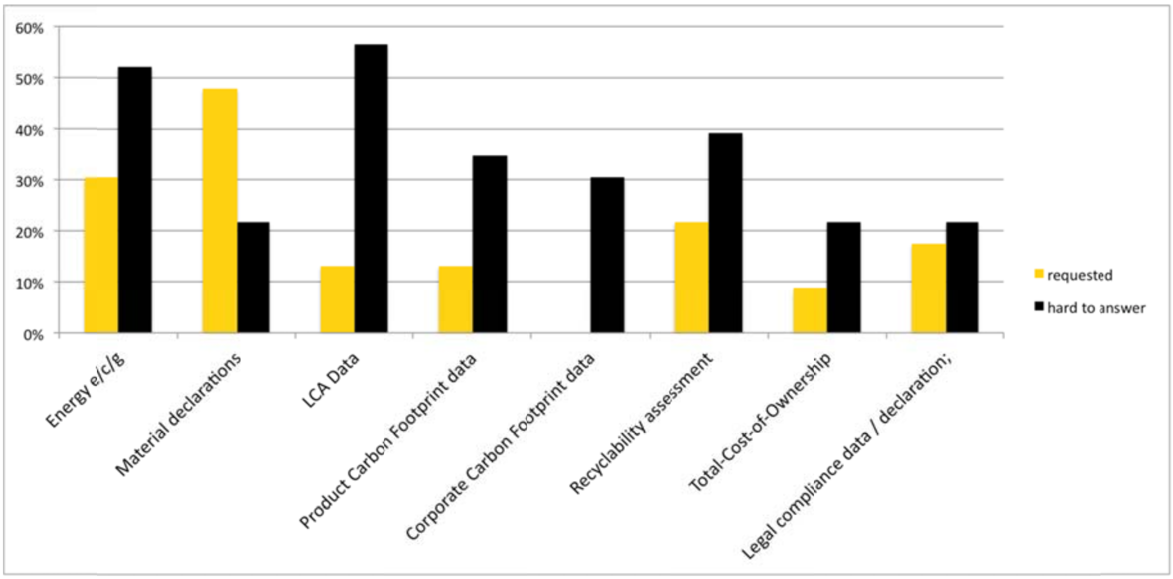


Figure 79: Data requested by stakeholders compared with data hard to answer (Smart textiles)

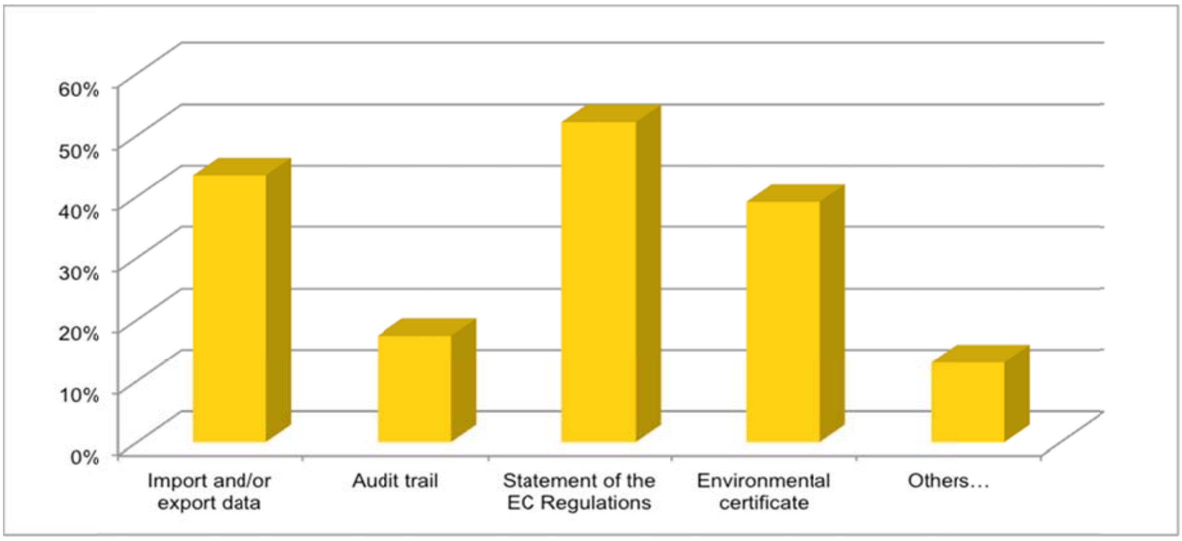


Figure 80: Expectations on the tool (Smart textiles)

The expectations (wish list) on a simplified LCA-to-go tool were rather diffuse because the responding SME were lacking experiences with existing LCA methods. Hence, they were unable to formulate wishes for improvement. A couple of respondents emphasized that any new method or tool must not result in new bureaucratic hurdles to small businesses. For the majority, it appears most useful if results of environmental assessment can provide them with any sort of legal compliance statement or certificate for customer communication. One interesting comment addressed the usefulness of LCA result sheet for SME biding on a call for tenders uttered by governmental bodies.

3.8.4 Wish list

- ✓ It should be possible to assess novel products that contain a large variety of exotic components for which no life cycle data sets exist.
- ✓ The tool will have to be applicable at an early stage of the product development process where uncertainty prevails regarding product specifications, use-scenarios and end-of-life treatment.
- ✓ The tool will be applied in a sector that covers an enormously heterogeneous spectrum of technologies and products.
- ✓ The results of the tool should be represented in an understandable (key-executive) manner, depending on the application purpose (design support or marketing).
- ✓ For environmental communication of most interest is the EU-Energy Efficiency Label and recycling rates

- ✓ The tool should preferably yield information on legal compliance regarding environmental regulation, EU regulation.

3.8.5 Summary

The specific needs of smart textiles SME regarding a simplified LCA tool remain vague since the responding SME lack experiences with existing LCA approaches at all. Most SMEs have little knowledge in and experiences with using environmental assessment tools in general and LCA in particular. It can be anticipated that SME will become increasingly interested in LCA as the sector matures and products are commercialized in larger market segments. In future, the LCA needs of smart textiles SME may be similar to those of the contemporary textile sector.

Taking into account the fondness of designers for appealing visual representation, the LCA2go software tool should match the habits and customs of the textile/fashion sector. That is, the graphical user interface (GUI) of the tool should be designed in an appealing way and the results should be visualized in such a way that is easy to interpret for design practitioners (which have little expertise in LCA).

3.8.6 Conclusion

Smart textiles SME are still in a very early stage of technology innovation and product commercialization. They have little incentives to exert environmental assessments apart from the anticipation of future regulation. In future, SMEs may be more interested to use an environmental assessment tool if regulatory requirements and customers demand become eminent.

The consequences for the LCA2go tool development are twofold: First – it requires a case specific approach to the implementation of a decision-support tool in the operation context of a SME in practice. The case-specification should be as generic as possible but detailed enough to represent the different decision support situations (according to ILCD handbook). Second – it appears useful to adopt an iterative approach of user guidance for the to-be-developed LCA2go tool. That may include a pre-selection step for narrowing the application purpose of LCA (e.g. design support, monitoring, bechmarking, reporting) and a detailing step were users can select a calculation output (ecocosts, ecoindicator, CFP etc…). Usability of the software tool (appealing GUI) for non-LCA experts appears to be a key success factor for LCA application in SME.

3.8.7 Outlook

The WP1 survey will be complemented by further in-depth interviews with a few more SME, which are planned for the autumn 2011 (depending on availability of the interviewees). Remaining questions to address thereby:

- What are the specific needs for decision support at the fuzzy front end of product development?
- How would SME use a LCA tool in daily practice?

Furthermore, a case specific study is planned to be implemented in cooperation with Futureshape, probably in the framework of an assignment for a MSc-Graduation project for a design engineering student of TU Delft. This learning-by-doing approach facilitates a design inclusive research method. Moreover, collection of LCI datasets will be the expected outcome of the project.

4 Conclusion

All together 228 companies have been included in the LCA to go needs assessment via survey or green paper discussion. Per sector 3 to 49 SMEs could be reached. As also other multipliers have distributed the survey within their contacts also larger enterprises were asked and responded to the questionnaire. Distinctions between companies of different sizes have been made in the survey evaluation for the semiconductor sector only as they got 57 responses from large companies. The green paper approach has been used in the sectors Sensors, PV-Systems and Electronics (here additionally to the survey). Thus 7 out of 9 sectors have used the survey.

To give an overview about the data base of the study the methods and quantity of respondents are listed in the following table

Table 6: Survey statistics – Overview (all sectors)

	Survey	Green Paper	
Bio-based plastic	11 (SM), 1 (L)		5%
Industrial machines	20 (SM), 3 (L)		10%
Electronics	24 (SM), 4 (L)	x	12%
Electronics Semiconductors	49 (SM), 57 (L)		46%
Electronics PCB	14 (SM)		6%
Sensors		3 (SM)	1%
Photovoltaics – Systems		2 (SM), 5 (L)	3%
Photovoltaics – mobile	3 (SM)		1%
Smart Textiles	25 (SM)	7 (SM)	14%
SUM	146 SM 65 L	12 (SM), 5(L)	TOTAL 228 companies

SM: Small & Medium enterprises (-250 employees)
L: Large enterprises (> 250 employees)

Across all sectors it was very difficult to get responses from SMEs. Especially in the European countries the response rate was very low compared to Semiconductor sector (Taiwan) where they managed to get 112 responses, nearly the same of all other sectors together.

One main reason for the low response rate was that the contact details of an appropriate contact person could not be identified – as actually in most SMEs there is none working full-time on environmental issues. In the case of the semiconductor sector it worked well where they cooperated with two manufacturer associations: the Taiwan Semiconductor Industry Association (TSIA) and the Taiwan Electrical and Electronic Manufacturers Association (TEEMA) and got all the contact details from them. Also the higher knowledge and experiences of the companies in Taiwan could be an indicator for a higher response rate. Also a reason for the low response rate is that employees in SMEs often have more functions in the company and environmental assessment is not seen as that important. In the green paper approach fewer companies have been involved in the needs assessment for sectors Photovoltaics mobile, Photovoltaics systems and Sensors. This was due to the fact that for these sectors the project team gave preference to in-depth discussions (which usually took 2-3 hours) with some selected companies instead of a broad survey.

To get more European companies involved during the development of the tool and the dissemination phase some sectors are aiming to intensify (Industrial machines) and close new (e.g. Bio-based plastics) cooperations with European manufacturer associations. In addition the PCB sector planning an info campaign to integrate more SMEs in the LCA to go project.

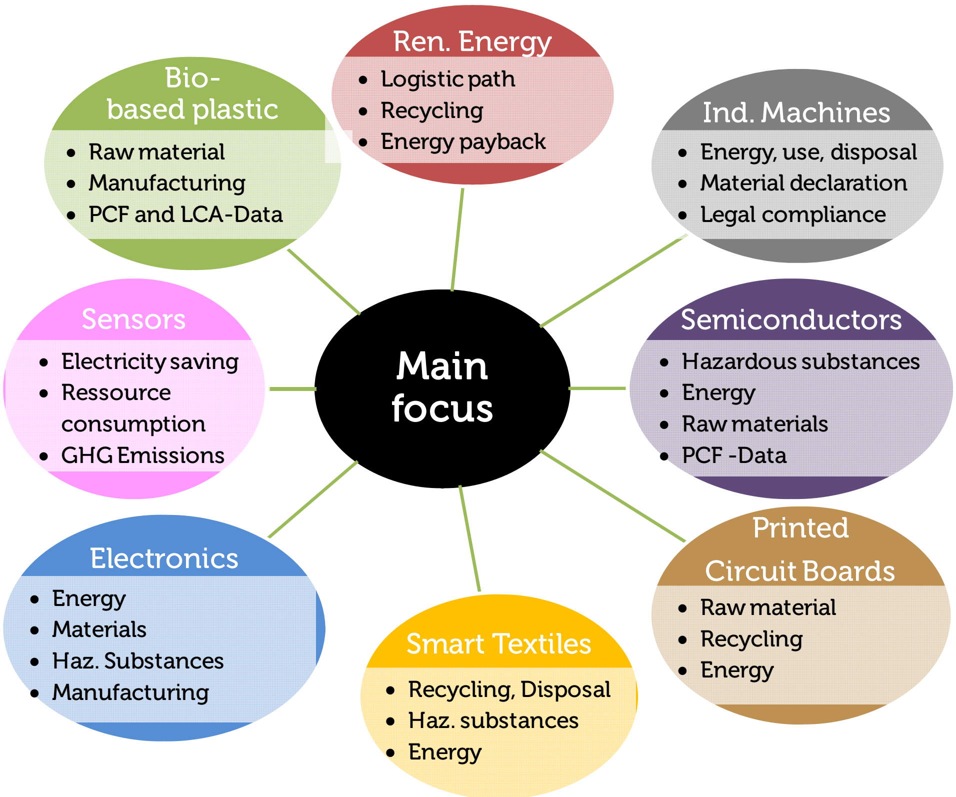
4.1 Cross sectoral analysis

In this chapter a cross sectoral analysis was conducted. The goal was to compare all sectors under different aspects for finding the main differences and similarities. These synergies are then used in the next task 1.2 Development of the methodological sector concepts. In the following the cross sectoral synergies are discussed for the main focus of the environmental assessment the companies think of, the preferred environmental communication and the synergies on the tool requirements.

<u>Main focus of the environmental assessment per sector</u>

In the first cross sectoral analysis the main product life cycle phases and the respective environmental aspects are considered. It has to be mentioned that both aspects in focus are assumptions of the respondents and therefore not always correct.

Figure 81: Main focus of environmental Assessment supposed by respondents (all sectors)



In Figure 81 it is displayed where the companies think the environmental assessment should focus on for each sector. These key issues are on the one hand the most important environmental aspects of the respective sector. On the other hand additional focus is given to the requested environmental data by the customers and other stakeholders.

One common aspect all companies estimate as environmentally important (raw materials, hazardous substances) and also requested by their customers (resource consumption, material declarations) are the **materials used** in the product. Only in the sector Renewable Energy materials are not seen as a major environmental aspect.

Recycling is an issue for the sectors renewable energy (photovoltaics), PCB, smart textiles but not for the other electronic affine sectors like rlectronics, sensors and semiconductors.

It also can be mentioned that in the sectors semiconductors and bio-based plastics data to carry out an **LCA or a PCF** are already requested by the customers. This is mainly due to the fact that the Semiconductors and bio-based plastics are the most advanced sectors where already 35% or 23% have conducted an LCA according to ISO 14040.

Surprisingly the **use phase** is not considered as the phase with the most environmental impact for PCB. According to the companies the use phase has less environmental impact than the raw material, the production and the distribution phase.

<u>Environmental communication</u>

In the second figure the kind of environmental communication intended to be used in the future is displayed for each sector. Additionally communication instruments which could help to promote the specific products are considered.

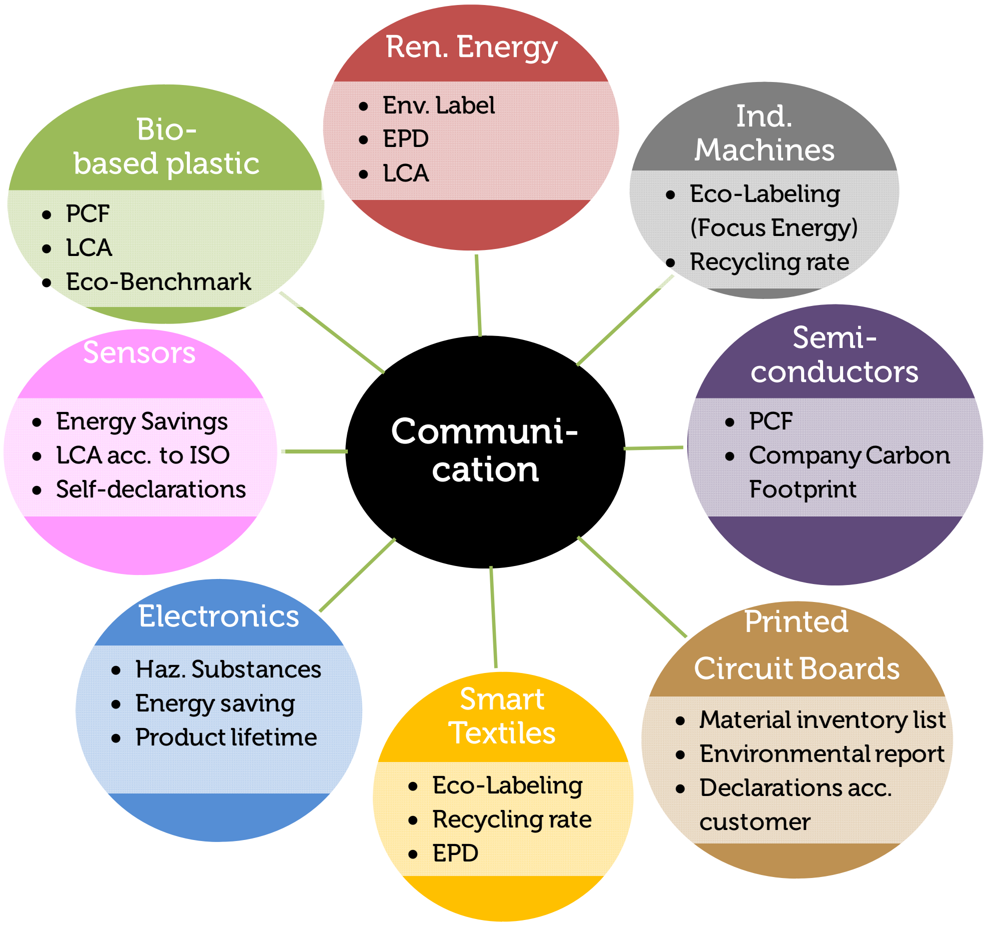


Figure 82: Communication instrument most wanted and needed (all sectors)

The communication tools the companies are planning in the future diver very much between the sectors. In the first place a PCF, an environmental report or an environmental label are indicated for the future communication. The most common instrument is the communication via an environmental label which is favoured by 3 sectors. For the sectors renewable energy and smart textiles a general environmental label has been indicated whereas for the sectors industry machines an eco-label focusing on energy efficiency was selected.

Clear results are coming from the sectors bio-based plastics and semiconductors where both specify the PCF for their future communication. The sectors are already aware of the environmental impacts of their products, have already experience in conducting LCA and PCF data are already required by the customers.

The survey results of the sector Electronics and PCB do not show clear indication which communication instrument should be chosen. On the one hand the materials (incl. hazardous substances) should be declared in first place on the other hand also a general environmental report or a declaration to costumers demand could be a possible way for communicating the environmental performance of the products.

Carrying out a full LCA according to ISO 14040 and communication the results e.g. via EPD is for none of the sectors looked at of high relevance. Just for the sectors Renewable Energy and Bio-based Plastics this would be of interest next to the other mentioned instruments.

The main focus from lifecycle perspective and from customer demands (Figure 81) has to fit to the strategic expectation of the future environmental communication instruments (Figure 82). For example the main aspect in the sector sensors are electricity savings achievable on a systems level (industrial system monitored and controlled by sensors). On the other hand the aspect of hazardous substances is not really taken into account when communication a PCF as it is suggested for the semiconductor sector. Therefore these contradictions have to be solved in the next task 1.2.

<u>Tool</u>

The requirements on the webtool are very similar for all selected sectors. In Figure 80 the most common requirements are listed in the mid circle. In the brackets the number of sectors requested this need is given. Additionally to the general requirement sector specific ones are named in the outer circles.

It is evident, that the wishes regarding features of the webtool are numerous, which is likely to be in conflict with some other objectives, such as an easy-to-use tool of limited complexity. Hence, the following summarises the identified interests, but inevitably in the coming steps of the project decisions have to be made, which of these features should be realised.

Of main interest for the companies is the import and export function of the tool so data of other data bases can be also imported in the tool and the results can be exported for further use in other software tools or producing nice graphics.

The tool should quickly lead to a result, is cheap and easy to use. The tool should provide suitable databases adapted to the respective sectors and work also without having complete life cycle data at hand (alternative: generic scenarios). After performing an environmental assessment the tool should give an Environmental certificate or a Statement of some EC regulations.

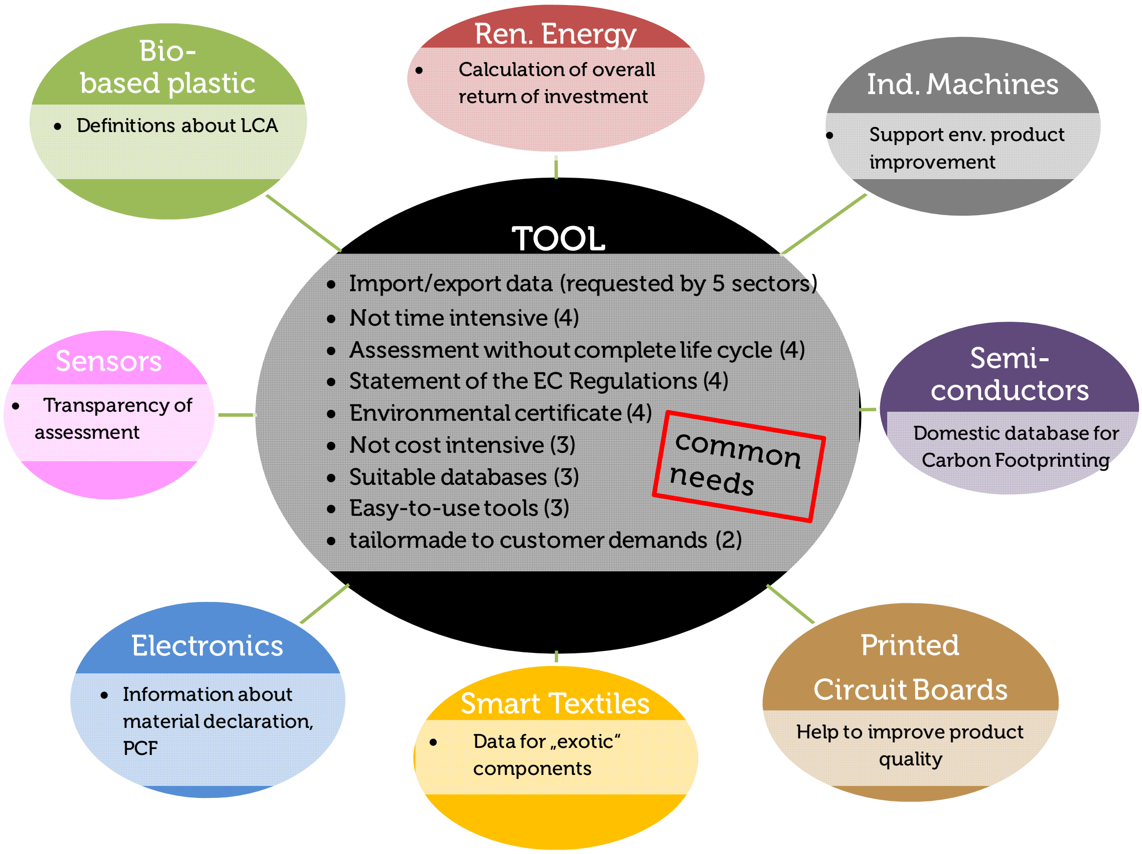


Figure 83: Webtool requirements (all sectors)

Additionally to the general requirements on the tool a few sector specific ones can be named. The companies in the renewable sector like to have a calculation of the overall return of the investment of a photovoltaic system.

The electronics sector demanding information about the material declaration and the tool should also give a PCF which is a bit conflicting with their future environmental communication instruments (Figure 82) where self declarations and environmental reports are named. PCB and industrial machines point out the tool should help to environmental and quality wise improve the product.

More concrete than easy to use is the requirement to avoid complex LCA terms and give definitions for all used ones. Therefore the tool should also be a kind of information platform to understand what environmental assessment is, how the tool can be used, what is the result and what can I do with it.

5 Outlook

In the next step of the project the methodological concept will be developed. It was intended to define this concept according to the results of the present needs assessment. As the environmental profile of the sector products is not clear, especially from company point of view and the main environmental aspects are not always in line with the chosen environmental communication method further investigations have to be done.

Therefore in the first step LCA and similar assessment case studies for each sector will be researched. This will give the environmental profile and all environmental impacts of the product. Out of this study the most relevant environmental indicator can be identified form an environmental point of view.

Additionally the developed tool should be also in line with environmental legislation and policy. Therefore a landscape of already existing and upcoming policy, EC regulations and standards will be generated for each sector (Tasks 7.1, 7.2).

Finally the methodological concept can be defined according to the main environmental aspects from the view of environment, the legislation and the needs assessment from company perspective. When defining the methodological concept it is essential that the environmental indicator, environmental assessment method, environmental communication fits together.

Further the sectors will foster the contacts to the SMEs e.g. in form of info campaigns (PCB) or via close cooperation with the manufacturing associations (Industrial machines). Due to an exchange with ongoing research projects additional aspects should be taken into account (sensors). Also first attempts are made in conducting a carbon inventory (semiconductors), carbon inventory and energy profiles (Passive Components) and in the development of databases (bio-based plastics).

6 Summary

The overall goal of the project is to develop LCA webtools customized for SMEs in the sectors bio-based plastics, industrial machines, electronics, semiconductors, printed circuit boards, renewables (stationary and mobile photovoltaic), sensors and smart textiles. To develop customized tools for each sector the goal for this task was to collect the needs per sector in a broad dialogue with SMEs. The needs assessment have been carried out in form of a questionnaire and with so called green papers.

In the needs assessment of the LCA to go project companies of 8 different sectors were asked via survey or green paper about environment assessment related issues. 228 responses were collected and analysed with the goal to define the status quo about the needs regarding environmental assessments, the data or about the software tool.

The status quo is quite similar among most of the sectors. One of a common result is the fact that most of the SMEs have relatively low knowledge about environmental assessments or LCA. Moderately more knowledge can be stated in the bio-based plastics sector, semiconductors and stationary photovoltaics systems. Another similarity is the lack of experiences with assessment tools in all sectors. Most SMEs also have no internal environmental communication channels. Conspicuous as well is the consensus on the main drivers for undertaking an environmental assessment. Most prominent aspects are primarily customers demand and legislation prevailing for all sectors.

Bio-based plastics is a “green sector” using renewable resources for producing plastic materials or products. Therefore the environmental impact is reduced compared to convenient plastics production out of synthetic or semi-synthetic organic solids, which are extracted out of fossil raw materials. Increasing growth is expected in this sector in the next years. The main focus of environmental assessment in this sector LCA will be on the life cycle phases of raw material extraction and manufacturing phases. The companies indicate clearly that the environmental performance should be communicated in form of a Product Carbon Footprint. Therefore a base a database for bio-based plastics has to be created.

One more “green sector” has been investigated: stationary and mobile photovoltaics. In this sector it`s obvious that high attention is given to the energy aspect. Thus a certain interest in LCA and environmental issues can be explained.

Companies from the stationary photovoltaics business are interested in calculate energy respectively CO_2 payback times or Net Energy Gain respectively net greenhouse gas emissions reduction. For environmental communication a label is of interest to a couple of enterprises, either for PV installation projects, smaller turn-key kits, and possibly covering also components individually. The sector mobile PV products is rather small in Europe with a very limited number of companies and limited interest in environmental assessments. Consequently, this sector might be appropriate to roadtest the intersectoral synergies from PV and electronics sectors, but not to establish a stand-alone tool for this sector specifically.

Another impression is given by the sector **smart textiles**. This sector has to deal with different kind of companies: from traditional textile industry or electronic producers as well as high-tech enterprises or design consultancies. As an "emerging sector" there is a chance to implement environmental assessment right from the beginning of the technology innovation process. Special needs for Smart Textiles are the availability of data for their "exotic components". The tendencies in the preferred communication instruments are EU-Energy Efficiency Label and recycling rates.

Contrary to Smart Textiles the sector of **industrial machines** is regarded as one of the oldest engineering disciplines. Therefore the sector can be seen as traditional and is for the European economy also very important. As a consequence many stakeholders (mainly manufacturer associations) are influencing the developments regarding environmental assessments in different ways. It can be supposed that companies are not that open or flexible for implementations of environmental approaches unless they have to do because of legislation, increasing energy prices or customers demand. Regarding LCA to go project the environmental assessment should principally deal with the energy efficiency. Therefore SMEs wish an Energy efficiency label or a selfdeclared environmental claim is targeted for future environmental communication, which can also be interpreted as voluntary environmental label focusing on energy efficieny.

The impacts of policy driven effort of environmental assessment can already be observed in the sector **semiconductor** of Taiwan, including downstream users of integrated circuits components. In this case the labeling of carbon footprint is seen as an important future trend. The companies should be prepared for the raising demand on environmental labeling. Thus more enterprises are already aware of these issues and have more motivation to get engaged in environmental assessments. To ease up the calculation and to get more realistic results a national database to calculate Carbon Footprint, their preferred way of environmental communication, has to be developed.

The whole **electronic** sector in Europe is already affected by different regulations or legislations (e.g. RoHS directive). That is the main reason why most of the SMEs communicate environmental information, usually related to material data so far. In the survey it was recognized that the energy needed during use phase is for most SMEs not seen as relevant impact on environment.

It demonstrates that companies just focus on materials because they are forced to. Once more can be seen the influences of legislation regarding environmental issues.

In the **general electronic** sector it has been pointed out that Material declarations could serve as starting point to implement LCA because this data are the most requested ones. One more important demand for the future will be for energy related data. At present SMEs require material declarations and Carbon footprint for communication in the future.

The second electronic sector is **printed circuit boards.** The needs are similar to the general Electronic sector. The SMEs demand for material data from production process. Environmental assessment should focus on phases "raw materials use", "manufacturing" as well as ""distribution". Material inventory lists and environmental reports are favored the most for environmental communication.

Of specific interest in the sector **sensors** are the energy savings related to the use phase of sensor systems, which is also of main interest for environmental communication. Besides this aspect, Overall Equipment Effectiveness has also been identified as one potential key indicator for the methodology.

The requirements regarding environmental aspects and communication are quite various across the sectors. Whereas the wish list for the tool shows more conformities. The common needs are the possibility to import and export data, the tool should not be time and cost intensive and easy to use.

In the next step of the project the methodological concept will be developed. This concept will be defined according to the results of the needs assessment, the main aspects from the view of environment and the actual and future legislation. Therefore further research on LCA and similar assessment case studies and on the status regarding environmental legislation and standards is needed. Further all sectors will further foster the integration of SMEs in the project, close cooperation with the manufacturing associations and exchange knowledge with other ongoing research projects in this area.

7 References

[AMA 2010] AMA Fachverband für Sensorik e.V.: Trends in zukunftsorientierten Sensortechnologien, Sensor-Trends 2014, April 2010

[Bastioli 2005] Bastioli, C. Handbook of biodegradable polymers. RAPRA, 2005. ISBN: 978-1859573891

[Chancerel 2010] Chancerel, P.; Schischke, K.; Alonso, J. C.; Rodrigo, J.; Cañellas, N.; Campo, F. J.: Helping SMEs to care for eco-innovation beyond legal compliance, Going Green CARE INNOVATION 2010, Vienna, Austria, November 8-11, 2010

[Dalsgaard, C., ohmatex 2010] Commercial investment in High-tech textiles smart textile technology. TITV Conference on Smart Textiles, February 2010.

[DoItPro 2011] The Life cycle assessment software, Taiwan.

[EC 2005] European Commission: The new SME definition- User guide and model declaration, 2005. http://ec.europa.eu/enterprise/policies/sme/files/sme_definition/sme_user_guide_en.pdf

[Ecoinvent 2011] The Life cycle inventory database, Switzerland.

[ErP 2009] Directive 2009/125/EC of the European Parliament and of the Council of 21 October 2009 establishing a framework for the setting of ecodesign requirements for energy-related products (recast)

[European Bioplastics 2011] Bioplastics 2011, http://en.european-bioplastics.org/

[European Plastic Converters 2010] Plastic Converting in Europe. Understanding the plastic industry. Available in: http://www.plasticsconverters.eu/docs/The_plastics_processing_industry_in_Europe.pdf

[Guinée et al. 2001] Guinée, J.B.; Gorée, M; Heijungs, R. et al.: Handbook on Life Cycle Assessment. Operational Guide to the ISO Standards. Volume 7, Klumer Academic Publishers, 2001

[Hellman, H. 2007] Probing Applications. How Firms Manage the Commercialisation of Fuel Cell Technology. TU Delft, DfS

[IEA 2011] International Energy Agency: Trends in Photovoltaic Applications - Survey report of selected IEA countries between 1992 and 2010, Preliminary Statistical Data, Report IEA-PVPS T1-20:2011

[ILCD Handbook 2010]

[ISO 14955 2011] Machine tools — Environmental evaluation of machine tools — Part 1: Design methodology for energy-efficient machine tools, 2011

[McWilliams, A. 2007] Smart and Interactive Textiles. Report AVM050B, Wellesley, MA: BCC Research.

[PAS2050 2008] British Standards Institution: PAS 2050 Specification for the assessment of the life cycle greenhouse gas emissions of goods and services, 2008- http://www.bsigroup.com/en/Standardsand-Publications/Industry-Sectors/Energy/PAS-2050/

[Plastics News 2011] http://plasticsnews.com/headlines2.html?id=20527

[PRO-BIP 2009] Shen L., Haufe J., Patel M.K. Product overview and market projection of emerging bio-based plastics. Utrecht University, 2009

[Rudge 2005] Rudge, T. J., Hobbs, J. E. and Kerr, W. A. Infant industries accessing global markets: Strategic risks and potential trade barriers in bioplastics. Innovative Marketing, Volume 1, Issue 2, 22-31

[Schischke 2005] Schischke, K.: Promoting Eco-design Activities in the SMEs of the Electrical/Electronics Sector, Final Report ENTR/04/04, Berlin, Germany, December 12, 2005

[Shen 2010] Shen, L.; Worrell, E.; Patel M.: Present and future development in plastics from biomass. Biobuels, Bioproducts and Biorefining. Volume 4, Issue 1, 25-40, 2010

[SimaPro 2011] The Life cycle assessment software, the Netherlands

[Stork, W. 2008]. Intelligente Kleidung für mehr Komfort und Sicherheit. Karlsruher Wirtschaftsspiegel 2007/2008.

[UNEP 2007] Life Cycle Management. A Business Guide to Sustainability

[Vink et al. 2003] Vink, E. T. H., Rábano, K. R., Glassner, D. A. and Gruber P. R. Applications of life cycle assessment to Nature Works™ polylactide (PLA) production. Polymer Degradation and Stability, 80, 403-419

[Wimmer 2004] Wimmer, W.; Züst, R.; Lee, K.-M.: ECODESIGN Implementation - A Systematic Guidance on Integrating Environmental Considerations into Product Development; Springer-Verlag, 2004

8 Appendix

Appendix:

- Authors and contributors
- Blogs
- Questionnaire general
- Questionnaire semiconductor

8.1 Authors and contributors

Name	Institution	Function	Sector
R. Pamminger	Vienna University of Technology	Task Leader T1.1	Industrial machines
S. Gottschall	Vienna University of Technology	Researcher	Industrial machines
W. Wimmer	Vienna University of Technology	Task Leader, Methodology discussions	Industrial machines
Antonio Dobon	ITENE	Sectoral leader	Bioplastics
Javier Monedero	ITENE	Researcher	Bioplastics
Irene Carbonell	ITENE	Researcher	Bioplastics
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Allen H. Hu	United Microelectronic Corporation	RTD semiconductors(manufacturer)	Electronics - Semiconductors
K. Schischke	Fraunhofer IZM	Project Leader, Green Paper development and discussions	Sensors, PV, Electronics
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M. Saint-Mard	TAIPRO	Green Paper discussions	Sensors

P. Arranz	TTA	Green Paper discussions, Focus Group Meeting	PV
M. Anzizu	TTA	Green Paper discussions, Focus Group Meeting	PV
J. Ospina	MicroPro	Green Paper discussions	Electronics
P. Maher	MicroPro	Green Paper discussions	Electronics
D. Mirus	Fraunhofer IZM	Interviews	PV
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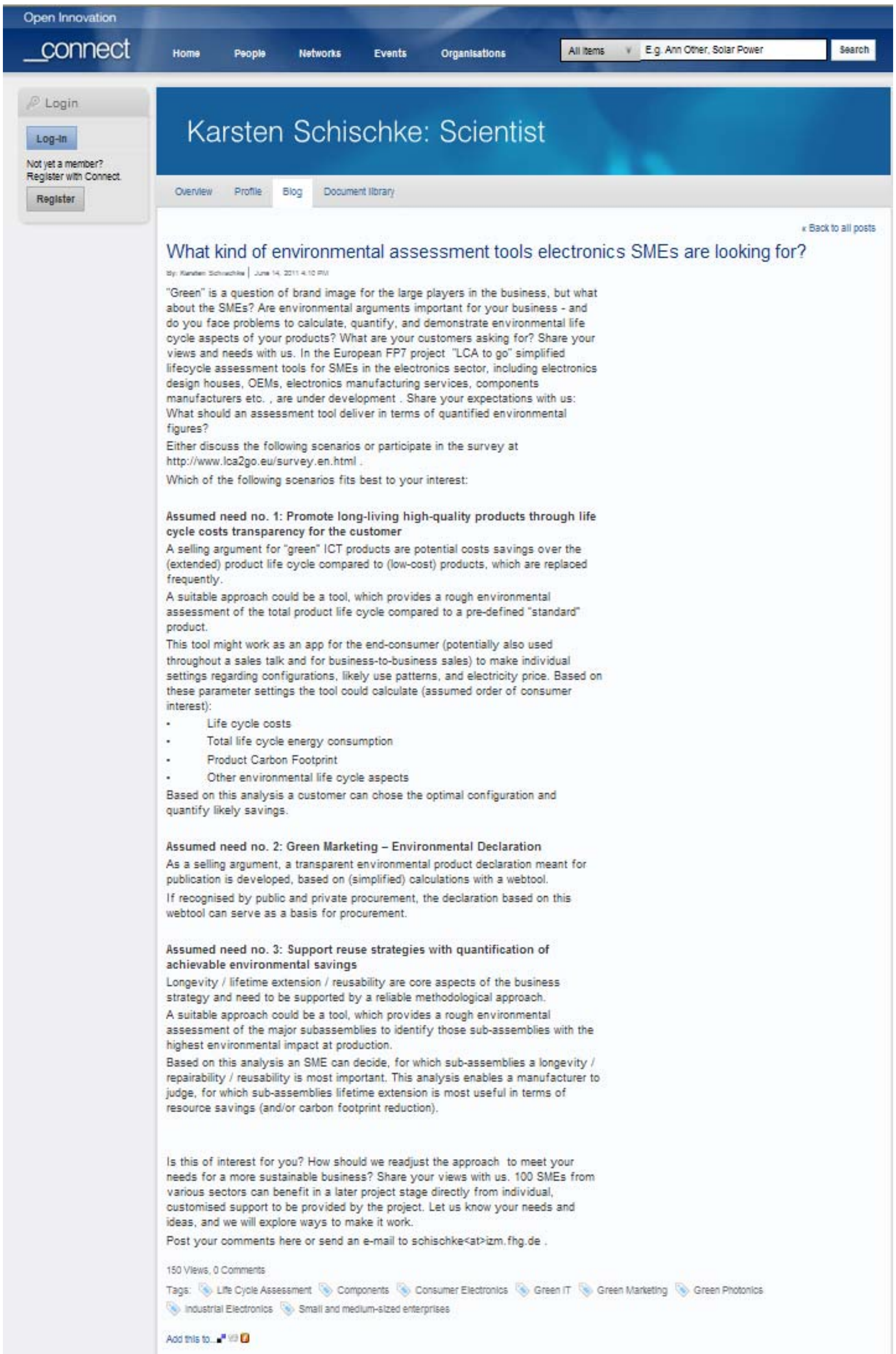
M. Koscielski	ITR	Researcher	Electronics/PCBs
C.Bakker	TU Delft	Task Leader	Smart textiles
Köhler	TU Delft	Researcher	Smart textiles

8.2 Blogs at Open Innovation _connect

8.2.1 Electronics



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What kind of environmental assessment tools electronics SMEs are looking for?

By: Karsten Schischke | June 14, 2011 4:10 PM

"Green" is a question of brand image for the large players in the business, but what about the SMEs? Are environmental arguments important for your business - and do you face problems to calculate, quantify, and demonstrate environmental life cycle aspects of your products? What are your customers asking for? Share your views and needs with us. In the European FP7 project "LCA to go" simplified lifecycle assessment tools for SMEs in the electronics sector, including electronics design houses, OEMs, electronics manufacturing services, components manufacturers etc. , are under development . Share your expectations with us: What should an assessment tool deliver in terms of quantified environmental figures?

Either discuss the following scenarios or participate in the survey at http://www.lca2go.eu/survey.en.html .

Which of the following scenarios fits best to your interest:

Assumed need no. 1: Promote long-living high-quality products through life cycle costs transparency for the customer

A selling argument for "green" ICT products are potential costs savings over the (extended) product life cycle compared to (low-cost) products, which are replaced frequently.

A suitable approach could be a tool, which provides a rough environmental assessment of the total product life cycle compared to a pre-defined "standard" product.

This tool might work as an app for the end-consumer (potentially also used throughout a sales talk and for business-to-business sales) to make individual settings regarding configurations, likely use patterns, and electricity price. Based on these parameter settings the tool could calculate (assumed order of consumer interest):

- Life cycle costs
- Total life cycle energy consumption
- Product Carbon Footprint
- Other environmental life cycle aspects

Based on this analysis a customer can chose the optimal configuration and quantify likely savings.

Assumed need no. 2: Green Marketing – Environmental Declaration

As a selling argument, a transparent environmental product declaration meant for publication is developed, based on (simplified) calculations with a webtool.

If recognised by public and private procurement, the declaration based on this webtool can serve as a basis for procurement.

Assumed need no. 3: Support reuse strategies with quantification of achievable environmental savings

Longevity / lifetime extension / reusability are core aspects of the business strategy and need to be supported by a reliable methodological approach.

A suitable approach could be a tool, which provides a rough environmental assessment of the major subassemblies to identify those sub-assemblies with the highest environmental impact at production.

Based on this analysis an SME can decide, for which sub-assemblies a longevity / repairability / reusability is most important. This analysis enables a manufacturer to judge, for which sub-assemblies lifetime extension is most useful in terms of resource savings (and/or carbon footprint reduction).

Is this of interest for you? How should we readjust the approach to meet your needs for a more sustainable business? Share your views with us. 100 SMEs from various sectors can benefit in a later project stage directly from individual, customised support to be provided by the project. Let us know your needs and ideas, and we will explore ways to make it work.

Post your comments here or send an e-mail to schischke<at>izm.fhg.de .

150 Views, 0 Comments

Tags: Life Cycle Assessment, Components, Consumer Electronics, Green IT, Green Marketing, Green Photonics, Industrial Electronics, Small and medium-sized enterprises

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8.2.2 Sensors

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Quantifying Environmental Benefits, Energy Savings of Condition Monitoring and Other Smart Sensor Applications
What is the benefit of applying sensor networks for environmental monitoring or for condition monitoring of industrial equipment? Although the need for such systems is quite clear, it is hardly possible to quantify the expected effect in detail. In the European FP7 project "LCA to go" simplified lifecycle assessment tools for SMEs in the sensors sector, including component / sensors developers, system integrator, and users of the sensing technology, are under development . Share your expectations with us: What should an assessment tool deliver in terms of quantified environmental benefits? Lifetime energy savings? Total Costs of Ownership, covering also increased productivity and reduced stock piling of spare parts? Achievable emission reductions?
What is the concrete application scenario for such an assessment tool? Transparent, public quantification as a marketing instrument? Parameterised calculation tool to calculate various projects? Internal calculations? Scenario calculations with customers?
Share your views with us. 100 SMEs from various sectors can benefit in a later project stage directly from individual, customised support to be provided by the project. Let us know your needs and ideas, and we will explore ways to make it work.
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