NTNU

Norwegian University of
Science and Technology

The communication of environmental impacts through environmental product declarations

Marina Magerøy

Master in Industrial Ecology
Submission date: June 2011
Supervisor: Annik Magerholm Fet, IØT

Norwegian University of Science and Technology
Department of Industrial Economics and Technology Management

Problem Description

Purpose:
The growing interest and increased activity concerning environmental product declarations (EPD) and product category rules (PCR), facilitates the need for a common methodology with respect to the development, understanding and use of these. The purpose of this thesis is to contribute in the harmonisation of standards and guidelines for environmental communication of products and services in Norway.

Main Contents:
1.Literature study concerning the current systems of environmental management and documentation in Norway, and environmental requirements within public procurement
2.Gather information about international EPD and PCR schemes
3.Give an overview of the central requirements in relevant ISO standards (ISO 14025, ISO 14067, 14046) and the similarities and differences between these, establishing the base for an evaluation of how the standards support each other
4.Analyse the current use of EPD's and PCR's on fishery products and furniture
5.Discuss how the use of environmental documentation of products and services contributes to corporate responsibility in the value chain

Assignment given: 17.january 2011
Supervisor: Annik Magerholm Fet

Preface

This thesis is my final piece of work as a student at the Industrial Ecology programme at NTNU, and has been a long and instructive process. The thesis has been prepared under the supervision of Annik Magerholm Fet from the department of the Department of industrial Economics and Technology Management. A thank you goes to her for feedback and support throughout the work.

The main goal of the thesis is to contribute in the ongoing work of harmonising and improving EPDs and PCRs in Norway. I would like to thank the Norwegian EPD Foundation and the technical committee for including me in their workshops and meetings, especially the manager Dagfinn Malnes. Participation in the ongoing discussions has been of importance for the understanding of the area and the progress of my own work.

I would like to thank all students at the Industrial Ecology programme, especially Symbiosis, for making my stay in Trondheim a memorable one and making room for other experiences than just thesis work. Especially Dina, Kristin and David have been of great support when days have become long in front of the screen.

A special thanks goes to Anders, who has bared with me throughout this period. His support, patience and grammar expertise has been invaluable.

Bergen 21.june 2011

Marina Magerøy

Abstract

In 2006 an international standard, ISO 14025, was published on the principles and procedures of environmental product declarations (EPD). The standard gives requirements to the development of EPDs and PCRs and is used as a basis of EPD development within many EPD programmes globally. Despite an international standard, published EPDs today have different contents and format depending on who published the EPD.

The main goal of EPDs is to provide objective, comparable and credible information about the environmental impacts of a product throughout its life cycle. These objectives can be diminished by the variations seen in EPDs and PCRs today.

Through the mapping of six different international EPD programmes and the analysis of published PCRs and EPDs, this thesis shows that there is a need for communication between and harmonisation of EPD programmes at a global level. The main objective of this thesis is to contribute in the harmonisation of standards and guidelines for communication of environmental performance products and services in Norway.

The thesis results in a recommendation to the Norwegian EPD Foundation within five areas;

- format and layout of EPD
- front page of EPD
- environmental impact categories
- user guide
- online database

Abbreviations

B2B	Business-to-business communication
B2C	Business-to-consumer communication
CFP	Carbon Footprint of Products
CPC	Central product Classification
CSR	Corporate social responsibility
EMAS	Environmental Eco-Management and Audit Scheme
EMS	Environmental management system
EPD	Environmental Product Declarations
FEE	Foundation for Environmental Education
GPP	Green Public Procurement
IBU	Institute of Construction and Environment
IEC	International EPD Consortium
ISO	International Organisation for Standardisation
JEMAI	Japan Environmental Management Association for Industry
LCA	Life Cycle Analysis
LCC	Life cycle costs
LCI	Life Cycle Inventory
ME	Ministry of Environment
PCR	Product Category Rules
PCS	Product Specification Criteria
PDS	Product Data Sheet
PEAD	Product Environmental Aspects Declaration
PEIDS	Product Environmental Information Data Sheet
SC	Sub-committee
TC	Technical Committee
WBCSD	World Business Council for Sustainable Development
WG	Working Group

Contents

List of figures

List of tables

1 Introduction

1.1 Background

In today's globalised world, focus on sustainable development and corporate social responsibility in business is crucial for progress and prosperity. Organisations are thriving towards taking responsibility for their actions, and contributing in the fight against climate change. This is especially done through focus on the environmental impacts business causes. Environmental management systems, environmental auditing and reporting, and documentation of impacts are important tools in use. Such tools can be applied at all levels, the products life cycle, corporate site and the global supply chain.

Environmental product declarations (EPD) are used to communicate life cycle based data regarding the environmental profile of products and services, and can be used as a tool in environmental management. The main purpose of EPDs is to provide quantified measure of the environmental impacts of a product or service to professional purchasers, management, government and consumers. Important characteristics of EPDs are objectivity, comparability and validity.

In 2006 ISO 14025 was published, an international standard with principles and procedures for the development of PCRs and EPDs. The development and use of EPDs had been going on for some time prior to the standard, and several national EPD programmes have developed both before and after the standard was published. Even though the standard has existed for five years now, there are still great variances between the development, content and presentation of EPDs both between, and within the programmes. Harmonisation between programmes and its guidelines, and interpretation of the standard is necessary in order for the three characteristics of EPDs to be fulfilled.

The Norwegian EPD Foundation has an ongoing project with the goal of striving for comparability between EPDs. The main areas of focus of their work is on the development of new EPDs, and thereby development of PCR and EPD guidelines, in addition to recommendations on EPD contents and layout. Through more clear and harmonised guidelines the goal is that Norwegian EPDs will be more uniform and thereby increase comparability.

1.2 Objective

The main objective of this thesis is to contribute in the harmonisation of standards and guidelines for communication of environmental performance products and services in Norway.

The thesis should be seen as a contribution to the ongoing work of the Norwegian EPD Foundation in developing a guideline for the development of product declaration, and a standardised format and layout of these. This will be achieved through an analysis of the current content and format of PCRs and EPDs in Norway, as well as other international EPD programmes. Primarily, the focus of the analysis and the discussions will be on the EPDs as this is the area of greatest variance. However, PCRs will be included since EPDs are developed on the basis of these, though not to the same extent as the EPDs. The analysis will focus on how the analysed EPDs and EPD programmes succeed in fulfilling the three main goals of EPDs;

objectivity, comparability and validity. This will result in recommendations for the current work of the Norwegian EPD foundation.

Additionally, the thesis will answer the following questions:

- How can environmental documentation contribute to corporate responsibility in the supply chain?
- How do ISO standards which focus on various environmental impacts of products and services in a life cycle perspective (ISO 14025, ISO 14046, ISO 14067 and ISO 21930) support each other?

1.3 Scope and limitations of the study

The objective of the study is achieved through an analysis of the development and use of EPDs, supported by a literature review and presentations of related theory. This includes current systems of environmental management and documentation in Norway, information about international EPD and PCR schemes, and an introduction to relevant standards.

Initially the aim of the thesis was to analyse the current use of EPDs and PCRs on fishery products and furniture, but during the process this has been changed to include all product categories. This has been deemed necessary in order to include more EPD programmes. The only EPD programmes with EPDs within these two areas are Norway and Sweden, and the analysis would therefore have been greatly limited. By keeping a wider scope, it has been easier to compare how the various programmes develop and present EPDs, and thereby come with more recommendations as to how the Norwegian programme can be improved.

The study includes EPD programmes from six different countries; Norway, Sweden, Finland, Germany, Japan and South Korea. In addition, an overview is given of other programmes which have not been included in the analysis due to limitations of information, and access to published EPDs. Information about programmes and analysed EPDs has been collected during the period from February to May 2011, and since there is a constant development within the area the information may not include the latest developments.

1.4 Structure of the thesis

Initially the thesis gives an introduction to quantitative and qualitative methodology, in addition to a presentation of how the analysis of PCRs and EPDs has been performed. Thereafter, a theoretical background is given along with an introduction to the development of environmental strategies and the definition and understanding of corporate social responsibility. Furthermore, an introduction to life cycle analysis and supply chain management is presented, before a brief introduction to environmental labels and declarations is provided. The theory and understanding of EPDs ends after the third chapter.

The fourth chapter gives an overview of the central requirements in ISO 14025, ISO 14046, ISO 14067 and ISO 21930, pointing out similarities and differences between these.

In chapter five a presentation of current systems of environmental management and documentation in Norway is given. This includes green public procurement, environmental management systems and environmental labels.

A presentation of the history and the organisation of the six international programmes in addition to a description of how PCRs and EPDs are developed, as well as the format and distribution of the EPDs are given in chapter six. Furthermore, a brief presentation of the Danish, French, Dutch and American programmes is given.

The results of the analysis are presented in chapter seven. This includes the compliance of PCRs and EPDs with ISO 14025, and a comparison of the EPDs from the various EPD programmes. The results are further discussed and evaluated with respect to how EPDs fulfil their main objective in chapter eight. The discussion also includes how EPDs can fulfil the requirements of public procurement in Norway, how the four ISO standards support each other, and how environmental documentation contributes to corporate responsibility in the supply chain. Recommendations for the Norwegian EPD programme are given in chapter nine before the conclusion in chapter ten.

2 Methodology

2.1 Introduction

Collection of data for research is usually done through surveys, interviews, observations or literature studies. This can either be done through qualitative or quantitative methods. Both quantitative and qualitative methodology is used to give answers to social research questions, but the aim of the research will decide which methodology should be used. For certain types of research a mix of these two can be used. The method should be chosen to best suit the research question one is working with.

The aim of both qualitative and quantitative methodology is to give a representation of relationships and causes in a social context. They both want to give an understanding of the society we live in, and how individuals, organizations and institutions act and interact within it (Holme 1991). In many research projects a mixture between qualitative and quantitative methods, or between the methods within these two, can be used (Widerberg 2001).

In the following chapter, an introduction will be given to both quantitative and qualitative methods. At the end of the chapter, a description will be given on the methods used in this thesis.

2.2 Quantitative methods

Introduction

Through quantitative methods one tries to explain relationships and causes by converting data to numbers and measurements which are used in statistical analysis (Holme 1991). Quantitative methods are used to say something about characteristics of a group, to give a cross-section image of the phenomenon one is studying in order to make comparisons and to show the strength of relationships in question (Holme 1991).

The methods used in a quantitative analysis are most commonly either a survey interview or a questionnaire. In quantitative research the researcher should not be part of the environment he is investigating, but keep a certain distance and have a me/it-relationship to the subjects (Holme 1991).

Survey interviews

An interview is defined as an exchange of point of views between two people who are talking about a topic that is of importance to both of them, and are sources of primary data in research (Kvale 1997). An interviewer (the researcher) asks questions to an informant/respondent that gives the answers. In a survey interview used for quantitative research the format of the interview is more standardised than for interviews used in qualitative research. In a survey interview every informant is given identical questions in the same way (Ringdal 2001).

The goal of quantitative research is to gain statistical data to investigate a certain case with reliability in the data and eliminate random measurement errors. Therefore the use of survey interviews on a large group of subjects is a good method. In doing so one eliminates the opportunity of improvising in the interview and following up with additional questions if

something interesting comes up in the interview (Ringdal 2001). Through standardised questions the results can easily be aggregated, in addition to reliability of the results (Bryman 2008).

The questions of a survey interview are usually very specific and have in some cases a fixed range of answers (Bryman 2008). Interviews can either be conducted face-to-face or over the telephone. Telephone interviews offer the benefits of being less cost-intensive, easier to supervise and the respondent not being influenced by how he perceives the interviewer. In addition telephone interviews cause certain limitations in regards of availability of people, respondents with hearing impairments, length limitations, screening of calls, not being able to observe the respondent and not being able to use visual aids in explanations (Bryman 2008).

Questionnaire

Through a questionnaire a large range of persons answer the same standardised questions on their own, either through the mail, or handed in at a certain place or over the internet (Bryman 2008). The questionnaire is very similar to the survey interview, but instead of being interviewed the respondent read, interpret and answer the question by themselves. Due to this, the questions must be easy to follow, have few open questions and everything must be self-explanatory in order to achieve reliability in the data (Bryman 2008).

Benefits of using a questionnaire instead of an interview include low costs, quick administration of answers, no effect on the answers from the interviewer and that they are convenient to the respondents. The limitations of a questionnaire are that respondents cannot get help in understanding or clarifying questions, respondents can read the whole questionnaire before answering the first questions, you cannot control who answers, it can be difficult to ask many questions and lower response rates (Bryman 2008), even though some of these limitations can be avoided by the use of internet based questionnaires.

Evaluating data

Measuring of results is more relevant in quantitative research where observations are registered as numbers, than for qualitative research where results are registered as text (Ringdal 2001). Besides measurements, explanations are also important in quantitative methodology. This is done through causality – describing why things are the way they are in addition to explaining how they are (Bryman 2008).

Data collected through quantitative research is evaluated in three different ways; how representative the data is, whether it actually presents what one wants to measure validity and reliability of the data (Holme 1991). Validity can be determined through face validity, concurrent validity, predictive validity, construct validity or convergent validity (Bryman 2008). Three factors are used to determine reliability; stability, internal reliability and inter-observer consistency (Bryman 2008).

Limitations

Sources of uncertainty or error in survey interviews are commonly due to the way a question is worded or asked, how the respondent interprets the question and how the information is recorded and processed (Bryman 2008). Especially for questionnaires, there will not be a possibility of making questions clearer for the respondents until it is too late (Holme 1991). For example is a question is left blank by a majority of the sample you will not notice this until you are plotting the data.

2.3 Qualitative methods

Introduction

Qualitative research method is the second social research method and contrasts from the quantitative methods by being more flexible and not relying on quantifiable measures. A core element of qualitative research is to create a basis for building a theory for explaining a phenomenon's characteristics or qualities (Widerberg 2001). The methods are used in cases where the researchers' aim is to have a holistic understanding, use hypothesis in the research, make nuanced interpretations and try to understand social processes. Through a systems perspective, increased understanding about social processes and relationships is given, and through an actor perspective understanding of the individual is given (Holme 1991).

Since not all causal connections, motives, social processes and relationships can be converted to numerical values, researchers' understanding and interpretation of results are in focus in qualitative research methodology (Holme 1991). Through qualitative research the researcher will try to see the world from the point of view of the subject and try to gain his understanding of the phenomenon one is studying in order to explain it (Holme 1991). This can be done through various approaches of fieldwork, observations, conversation interviews and text and picture analysis (Widerberg 2001).

Fieldwork

Through fieldwork the researcher gets firsthand experience of the issues he is studying. The researcher will take different roles depending on his level of participation. The fieldwork can be organised as fully observation with no participation, participating observation or full participation where the proximity to what is being studied is very close (Ringdal 2001). In order to be a participating observer, the researcher mustn't necessarily participate in the processes he is observing, but should have a close perspective and be in contact with what he is observing. The researcher can also choose to be open or not about his intentions, but most cases of hidden observations are not ethically acceptable (Thagaard 2009).

When conducting fieldwork there is a certain risk for the researchers' presence to influence the way those being studied act and respond, called the Hawthorne-effect (Ringdal 2001). This can be avoided by gaining contact and trust from the subjects over time. Shorter fieldworks will be at the greatest risk of this. The type of behaviour being observed will also influence whether it is likely that people act otherwise than they normally do (Ringdal 2001). For example whether the actions can be considered is legal or ethically responsible, or not.

Conversation interview

The main goal of a conversation interview is to collect more information about the topic you are investigating. The respondent is called an informant, and has a deep knowledge about the topic. The number of informants needed, will depend on how much information is needed and how reliable the sources are. In some cases interviewing 2-4 people will be sufficient to get a general picture, whilst for other cases a higher number will be required (Ringdal 2001).

In a qualitative interview, the researcher tries to understand how the respondent views the world (Kvale 1997). The interview structure is flexible, and thereby allows for a more in-depth understanding of the causalities one set out to explain (Holme 1991) the goal is not to give a measurement of something, but to find more relevant information (Ringdal 2001). The flexibility of the interview makes room for follow-up questions to be asked and to focus on the areas of the respondents' expertise. Even though the conversation interview is flexible and questions can be improvised during the interview, it can be very helpful to have an interview guide whit prepared questions as guidance (Thagaard 2009).

Text analysis

Text analysis is often used as an addition to interviews and fieldwork, and can involve analysis of public documents related to organisations and government, private documents such as letters and diaries and scientific literature (Thagaard 2009). Through text analysis the researcher does not interact directly with the author, and the information is "frozen". Because the material is already prepared, it will not have been influenced by the researcher, but can be interpreted differently depending on the researcher (Widerberg 2001).

Evaluation of results

The reliability and validity of collected data does not have the same importance within qualitative research as for quantitative research since the aim of the research is to gain better understanding, without focusing on statistical values (Holme 1991). Evaluation of the results has more focus on how the research has been conducted, than on the results itself. For example the researchers' influence on a situation should be taken into consideration when analyzing the data (Holme 1991).

For qualitative analysis the terms credibility and confirmability are used instead of reliability and validity, and transferability used instead of generalisability (Ringdal 2001) Credibility reflects whether the research has been done in a trustworthy way, and confirmability relates to the interpretations that are done in the analysis. Transferability on the other hand reflects whether the results are valid in other situations and areas.

Instead of confirming or denying data of qualitative research, its relevance is investigated. This can be divided into two different groups, either research relevance criterion or actor relevance criterion (Holme 1991). The research relevance criterion focuses especially on usefulness, value of deeper understanding or new theoretical insight from the research, whereas the actor relevance criterion focuses on the subjects of the study. Do the subjects recognize the problems and relationships represented, are reactions gained from the subjects through provocation, does the study contribute to better insight amongst the subjects and lastly, does the study either solve a problem for the subjects or give them alternative solutions (Holme 1991).

Limitations
Through qualitative analysis the researchers' understanding of the situation will have a large impact on the results of the study. This can be a weakness of the method as his understanding can be inadequate or even wrong (Holme 1991). As earlier mentioned, a respondent may also act differently due to the proximity of the researcher, and may even act the way he thinks the researcher expects him to act (Holme 1991). Another limitation of quantitative research is that there are no formalised routines or techniques for processing data which is collected (Holme 1991).

2.4 Methods used in this thesis

The research questions for the thesis as presented in chapter 1.2 were established on needs within the current work concerning EPDs in Norway. The analysis is based on a mixture of both quantitative and qualitative research methods, with the main focus being on literature review and text analysis. Participation in workshops with the technical committee of the Norwegian EPD Foundation has also been used as a foundation for the analysis.

A literature study of the development of environmental strategies, corporate social responsibility and environmental management and documentation in Norway, has been carried out in order to understand the context of EPDs, and the requirements which they fulfil within environmental documentation. In addition, a literature study of life cycle analysis and relevant standards has been necessary in order to understand how EPDs are developed, their qualities and technical background.

The presentation of the international EPD programmes is based on programmes' websites and previous reports. The internet and websites have been important sources for access to information about the programmes and published EPDs and PCRs.

The analysis of EPDs and PCRs form the basis for the recommendations given through the thesis. The procedure of the analysis is as follows:

- Collection of PCRs and EPDs
- Selection of PCRs and EPDs to be analysed
- Selection of evaluation criteria
- Analysis of PCRs and EPDs

PCRs and EPDs were collected from six international EPD programmes, a limitation made on the basis of access to information and EPDs. In total 24 PCRs and 87 EPDs were selected to be included in the analysis. In the selection, emphasis was put on representing different product categories, validity of the PCR / EPD, and it being published in English.

The evaluation criteria for the analysis are based on the requirements from ISO 14025 for both PCRs and EPDs. In addition, a more detailed comparison has been performed on a selection of 30 EPDs representing each of the six EPD programmes. In the comparative part of the analysis the following six criteria were selected:

- Length

- Period of validity
- Contents of front page
- Structure of EPD
- Presentation of environmental impacts
- Additional environmental information

The evaluation criteria are of both a qualitative and quantitative character. All criteria used in the analysis will be presented in further detail in chapter 7 prior to each section of the analysis.

3 Theoretical background

3.1 History of environmental strategies

During the past fifty years the perspective on environmental issues and the approach to which it has been dealt with has changed significantly. Figure 1 shows the main strategies used for every decade since the 1960s. This will be further elaborated in the following, mainly focusing on environmental issues and the measures used to solve these issues.

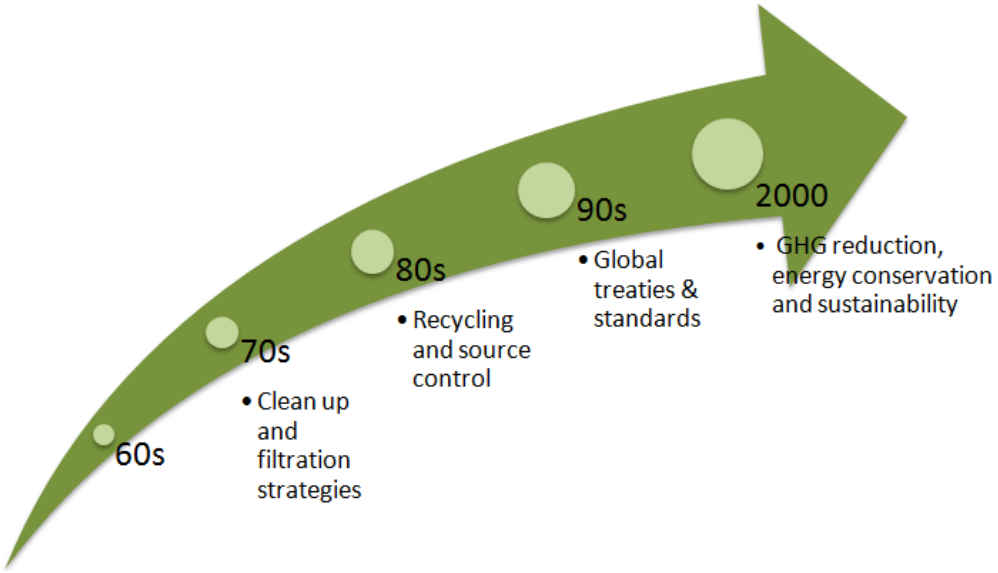

Figure 1: Overview over development of approach towards Environmental issues

Before the 1960s environmental awareness was low, with a main focus on nature conservation and preservation issues (Brattebø, Ehrenfeld, and Røine 2007). The black smoke rising from factories that came with industrialisation was seen as a sign of progress and development, and the environment was seen as a legitimate place to dump wastes. Pollution became more and more visible even though it was not seen as a problem yet.

Pictures of Earth taken during space explorations in the early 1960s opened for environmental consciousness under the realisation among people that we all share one world (Mosley 2010). Slowly, the increasing pollution of the environment started to receive more attention. By addressing the influence the pesticide DDT had on animals and birds, and through the food chain also on humans (Carson 1962), Rachel Carson announced the beginning of a new era with new perspectives (Welford 2007).

Most of the theories that developed during 60s and early 70s were anti-growth theories. A normal perception was that growth and development could not go hand in hand with protection of the environment (Welford 2007), and that population growth was the main reason for the environmental problems seen. Meadows (1972) published his theory about limits to growth, which argued that within a hundred years the earth would reach its bearing capacity if no changes were made. Hardin's theory about the tragedy of the commons also

supported this view, which said that commons would be overexploited if set to free disposition (Hardin 1968).

Initially, end-pipe treatment was seen as the solution to combat pollution, and consisted of technological installations installed to factories, power plants and domestic sources (Brattebø et al. 2007). This set the scene for the beginning of the seventies which was characterised by "local pollution – local solution". Environmental management in this period was regarded by companies with indifference and even hostility (Welford 2007). The Industry felt that environmental initiatives would mean that economic development would have to be sacrificed, and that the gains accrued to the environment were seen as loss to economic growth (Brattebø et al. 2007). During the same period environmental organisations like Greenpeace and Friends of the Earth were established[1].

In the 80s there was a shift of focus from cleaning up the pollution, towards the prevention of it (Brattebø et al. 2007), realised through clean technology initiatives, integrated processes, product responsibility, measurements and management systems. Environmental damages were now a part of everyday life and thereby in the minds of both politicians and the public. A new attitude called Ecological Modernisation developed; environmental protection could in fact live side by side with economic growth (Brattebø et al. 2007). However, problems were merely shifted from on environmental medium to another (Brattebø et al. 2007). A number of international incidents put even more focus on the environment and how one was dealing with the challenges. The gas leakage in Bhopal, India from the sites of Union Carbide Corporation in 1984 (Union Carbide 2011), the chemical spill from Sandoz in Switzerland in 1986 (BBC News 2011) and the Chernobyl accident in 1987.

At the end of the 80s and the beginning of 90s the concept of sustainable development emerged, led by the publication of the Brundtland report in 1987. Sustainable development was defined as development that "meets the needs of the present without comprising the ability for future generations to meet their own needs" (WCED 1987). It builds on three fundamental pillars; economic growth, ecological balance and social progress, known as the triple bottom line (WBCSD 2011). The main challenge of sustainable development is for business to continue its growth and expansion without undermining the environment (Welford and Gouldson 1993).

The second Earth Summit was held in Rio de Janeiro in 1992 (United Nations 1997), and after the summit one could see both governments and corporations taking more strategic actions with respect to environmental issues (Welford 2007). Focus was shifted towards business development, and one saw a rise of global initiatives and standards. Business opened its eyes towards environmental management being a strategic tool for gaining competitive advantage and balancing economic growth and preservation of the environment (Brattebø et al. 2007). Governments developed their policies, affecting business through the polluter pays principle (OECD 2011).

[1] Both Greenpeace and Friends of the Earth were established in 1971 (Greenpeace 2011 and Friends of the Earth 2011)

At the beginning of the 21st century Corporate Social Responsibility (CSR) became a well used business strategy together with a systems approach to environmental problems. CSR comes from the notion that all organisations have an obligation to contribute towards sustainable development. WBCSD defines CSR as "the continuing commitment by business to contribute to economic development while improving the quality of life of the workforce and their families as well as the community and society at large" (Watts, Holme, & Tinto, n d: 3).

A more holistic view and systems oriented approaches on the solution of environmental problems was developed after the turn of the century. This included concepts such as cleaner production, closing material loops, sustainable production and consumption, life-cycle perspective and eco-efficiency (Brattebø et al. 2007). Also the concept of industrial ecology, as defined by Robert White, has been important for the development seen in the last decades;

> "Industrial Ecology is the study of the flows of materials and energy in industrial and consumer activities, of the effect of these flows on the environment, and of the influence of economic, political, regulatory and social factors on the flow, use and transformation of resources. The objective of industrial ecology is to understand better how we can integrate environmental concerns into our economic activities. This integration, an ongoing process, is necessary if we are to address current and future environmental concerns" (White 1994).

Implementing solutions based on the understanding of how to improve the sustainability of production and consumption systems is the main objective of industrial ecology (Brattebø et al. 2007), which can be achieved at three levels; the firm, across firms and at a regional or global level (Fet 2006). The firm level includes environmental accounting, reporting and management systems. Across firms initiatives include symbiosis, life cycle management of products and supply chain management, and at the global level material flow analyses.

3.2 Defining Corporate Social Responsibility

In today's business-world corporations are often expected to deliver more than just the goods, pursue more than just value creation and to help make the world a better place through corporate responsibility (Bakan 2004). CSR has no globally accepted definition, and the definitions and its application will vary according to cultural, economic, religious and legal settings even though many of the definitions used today are formulated in the same way. There is a common perception of CSR as taking responsibilities beyond creating economic value for its shareholders (Fet 2006).

Traditionally, CSR has been perceived as philanthropy, the charity and community work of organisations. Today, this perception has been developed to focus on responsibilities within the operations and supply chain of a company (Fet 2006). This can for example include risk management, extended producer responsibilities, contributions to society through job creation, taxation and economic spillover effects and developing products, services and production methods which promote development (Norwegian Ministry of Foreign Affairs 2009).

According to Dahlsrud (2006) the definition made by the European Commission was found to be the most widely used definition, and therefore considered the most important. Their definition states CSR to be "a concept whereby companies integrate social and environmental concerns in their business operations and their stakeholders on a voluntary basis" (European Commission 2010). The Norwegian Ministry of Foreign Affairs further defines CSR as activities extending beyond complying with national legislation (Norwegian Ministry of Foreign Affairs 2009).

In 2010 an ISO standard covering social responsibility was published as guidance for businesses wishing to focus on the concept. According to ISO 26000, social responsibility is defined as the "responsibility of an organization for the impacts of its decisions and activities on society and the environment, through transparent and ethical behaviour that

- contributes to sustainable development, including health and welfare of society
- takes into account the expectations of stakeholders
- is in compliance with applicable law and consistent with international norms of behaviour and
- is integrated throughout the organization and practised in its relationships" (ISO 2010b).

The definitions of CSR include the three same dimensions as the triple bottom line of sustainability; environment, social and economic in addition to stakeholders and voluntariness. All of which are important contributions towards corporate social responsibility in a business (Fet 2006).

Historically, the responsibilities of business have been well disputed, and one of the main questions has been whether business holds responsibilities besides those of value creation. Friedman was among those that saw the only responsibility of business to be making profits (Friedman 1993), and Joel Bakan described corporate responsibility as illegal when practiced in its right form (Bakan 2004). This was based on the notion that actions based on CSR would be performed in the best interest of the society or the environment, and not in the best interest of the corporation and its stakeholders. The main interest of the corporation and its stakeholders is to increase profitability and should therefore be the first and only priority of a business manager (Bakan 2004).

Corporate responsibility is "more than financial regulatory compliance and tree-hugging" (Hawkins 2006), and a CSR strategy can lead to positive benefits for the business in several ways. CSR initiatives can lead to reduced costs and increased incomes through improved efficiency and quality in production and activities. Improved risk management cultures and working conditions can influence productivity and quality. Additionally, the initiatives can lead to stronger investment profiles and earning potentials to shareholders and enhanced brand management and reputation, thereby affecting market position and sales of the company (Hawkins 2006).

3.3 Life Cycle Analysis

Through Life Cycle Analysis (LCA) the impacts of a product or service is calculated over its entire lifetime, from cradle to grave (ISO 2010a). This includes extraction of raw materials, production/manufacturing, transportation, user face and end-of-life phase (waste handling or recycling). By looking at the entire production system, the LCA can help avoid shifting environmental burdens from one stage to another and sub-optimisation (Baumann and Tillman 2004). Economic and social aspects are not included in LCA. LCA refers to both the results of the analysis and the activity of establishing these results (Heijungs 2007).

Life Cycle Analysis forms the basis of an EPD, and should be performed according to ISO 14040:2006 "Environmental Management Life Cycle Assessment Principles and Framework". In addition LCA can be used in environmental management systems to identify significant environmental aspects of products and services and to integrate environmental aspects into product design and development. Other areas of use include environmental communication, environmental accounting and environmental impact assessments (ISO 2006a). LCA is seen as an impartial analysis and is the basis of environmental policy in the EU, Japan and elsewhere in the world (Schenck 2010).

As shown in Figure 2, a LCA study consists of four phases (ISO 2006a);

1. Goal and scope definition
2. Inventory analysis,
3. Impact assessment and
4. Interpretation

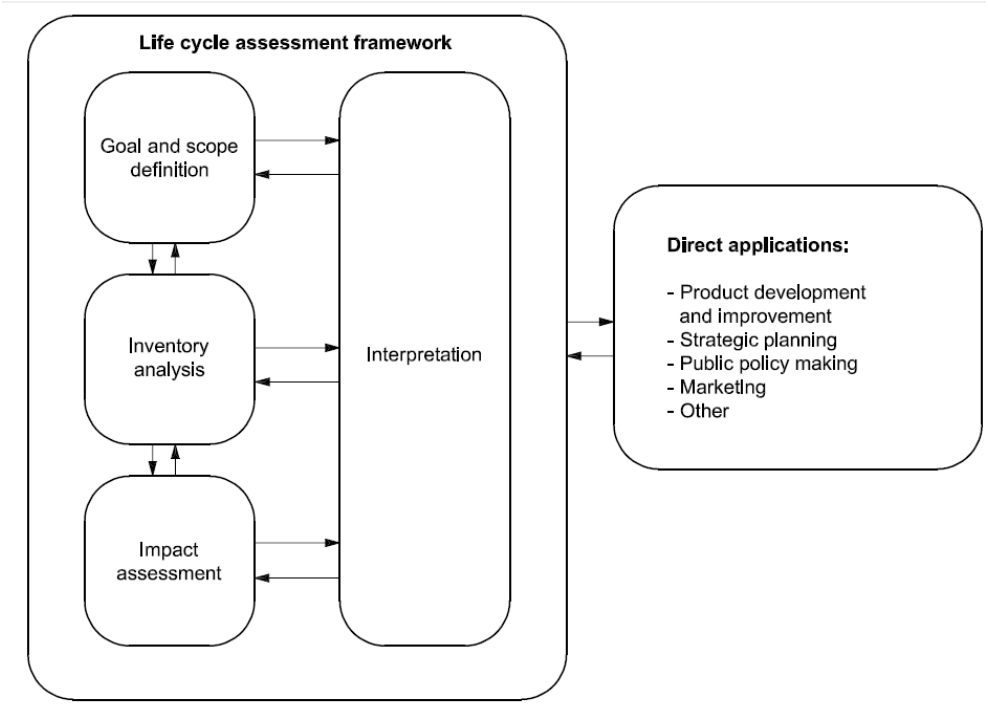

Figure 2: Stages of an LCA (ISO 2006a)

The product of study and the purpose of the LCA are specified through the goal and scope. The inventory analysis (LCI) is the phase where data collection and calculation procedures are defined. The impact assessment relates the emissions and resources to environmental problems through classification and characterization. Finally the interpretation considers the results from the analysis and impact assessment together and in light of the goal and scope of the analysis. The results are then presented, and can in some cases take the form as conclusions or recommendations for decision-makers (ISO 2006a).

Goal and scope definition
Through the goal and scope definition, the aim and main lines of the study are established. A well defined scope ensures that the breadth, depth and detail of the study are compatible with the goals of the study (ISO 2006a). It is important to define the goal and scope at an early stage, as this will influence which data that is to be collected in the preceding phases.

The goal of the study will specify the questions to be addressed, for example geographical area, production system and functional unit (Heijungs 2007). The functional unit is the quantification of the performance characteristics of the product (ISO 2006a). Alternatively a declared unit can be used. Declared unit refers to the quantity of the product, and is especially found in LCA of building products (ISO 2007). Declared unit is usually used when the function and reference for the whole life cycle cannot be stated. By relating the results of the analysis to a functional unit, comparisons can be done between different products which give the same function (Baumann and Tillman 2004). An example of this is the functional unit “seating solution” which is a function which can be fulfilled by both a recliner and a couch. Comparing the impacts of the entire product can be misleading as the couch can be much bigger than the recliner and their life spans different.

The scope defines the methodology, assumptions and limitations of the analysis and sets the conditions for the inventory analysis. Important elements of the scope are definitions of the system boundaries, allocation procedures, impact categories and data requirements. The system boundaries give a description of each unit process and define which unit processes to be included in the analysis (ISO 2006b). Important aspects included in the system boundaries are geography, time dimension, separation from related product systems, life cycle stages, cut-off rules and separation between technical and natural systems (Hanssen et al. 2001). Allocation is necessary in cases where a technical process produces more than one product. The allocation procedure then describes how environmental loads should be partitioned between these products, usually based on weight or economic value of the product (Heijungs 2007). Usually a LCA is based on a standard set of impact categories, but if a limited number or alternative categories are chosen this must be defined in the scope. Description of data requirements includes a description of the level of detail in the study and the quality required for the data to be used (Baumann and Tillman 2004). Data quality requirements are necessary to ensure that data-sets are relevant, up-dated and of good quality (Hanssen et al. 2001). Decisions must also be made regarding the use of specific and generic data.

Inventory analysis

In the inventory analysis the flow model of the product system is built according to the goal and scope of the analysis and the system boundaries. Data is collected and calculated for each unit process before identical releases within the life cycle are aggregated (Heijungs 2007). The result of the inventory analysis is the inventory table which can be grouped under four major headings (ISO 2006a).

1. Energy inputs, raw material inputs, ancillary inputs, other physical inputs
2. Product, co-products, waste
3. Emissions to air, discharges to water and soil
4. Other environmental aspects

Impact assessment

Through the impact assessment the results from the inventory analysis are related to potential environmental impacts through impact categories. Commonly used impact categories, their indicator and abbreviation in addition to the contributing environmental inputs are shown in Table 1.

Table 1: Common impact categories with characterisation factors and contributing emissions and extractions (Heijungs 2007 and Goedkoop et al. 2008)

Impact Category	Indicator	Abbre-viation	Contributing environmental inputs and outputs
Climate change	Global warming potential	GWP	CO2, CH4, CFCs, HCFCs
Ozone layer depletion	Ozone depletion potential	ODP	CFCs, halons, HCFCs
Human toxicity	Human toxicity potential	HTP	Metals, organics, pesticides
Ecotoxicity	Aquatic ecotoxicity potential Terrestrial ecotoxicity potential	AETP TETP	Metals, organics, pesticides
Acidification	Acidification potential	AP	SO2, NOx, NH3
Eutrophication	Nutrification potential	NP	N, P, COD
Photochemical ozone formation	Photochemical ozone creation potential	POCP	NOx, VOC
Depletion of abiotic resources	Abiotic depletion factor	ADF	Metal ores, crude oil, natural gas

The impact assessment consists of three steps. The first two are compulsory, whilst the last step is optional (ISO 2006a). In the first step, classification, the LCI results are assigned to its related impact category. Throughout the second step, characterisation, the total impact for each impact category is calculated based on scientific models. Based on the models, characterisation models are derived which are used to aggregate the contributing inputs and outputs for each impact category (Heijungs 2007). The characterisation factor represents each substance relative importance to the impact category.

The final and optional step of the impact assessment consists of normalisation, grouping and/or weighting of the characterisation results. Through normalisation, world annual emissions and extractions are used to relate the results from characterisation to the total extent of the environmental problem (Heijungs 2007). This is usually performed for error checking and to

add significance to the results. Weighting involves comparing the impacts based on a subjective relative importance of each impact category.

3.4 Supply chain management

The supply chain is defined as "all parties involved, directly or indirectly, in fulfilling a customer request" (Chopra & Meindl 2007: 3). This includes all physical and technical activities performed to create a product, such as suppliers, manufacturers, transporters, warehouses, retailers and customers which are seen as stages in the chain as shown in Figure 3. Within each stage in the chain all functions involved in receiving and fulfilling a customer request is included, such as product development, marketing, operations, distribution, finances and customer service. Between the different stages there is a constant flow of information, products and funds going back and forth. The two main objectives of a supply chain are to fulfil the demands of the customer and at the same time maximise profits.

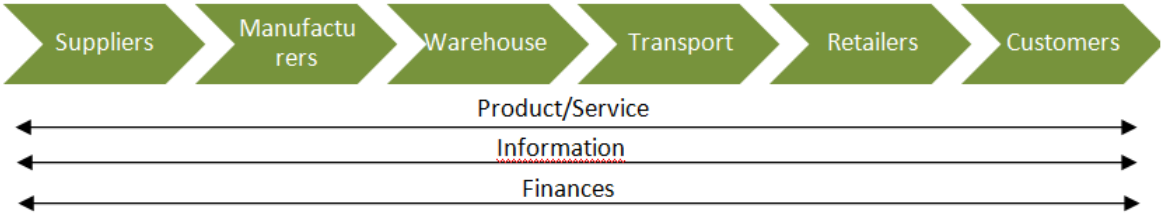

Figure 3: Stages of a supply chain

The presentation of the supply chain in Figure 3 is a simplified one. In reality the supply chain looks more like a web, as each stage of the supply chain will interact with several upstream and downstream actors (Chopra and Meindl 2007). The design of supply chains will also differ widely depending on customer needs and on the activities executed within each stage. Some supply chains may not have retailers; others may need transportation between manufacturers and warehouse in addition to the transportation to the retailers, whilst others again use transportation all the way to the customers. The last example will be evident in the case of online stores, where customers don't have to go to a store to do shopping, but can shop from the comfort of their own homes.

The success of supply chains is measured by supply chain profitability, and not by the profitability of the individual stages (Chopra and Meindl 2007). Supply chain profitability is the difference between the price the customer pays for the product and the sum of all costs across the supply chain in production, storage, transportation etc. Supply chain management involves optimising the flows of information, products and funds between each stage so that supply chain profitability is maximised.

The way of thinking strategically about all activities involved in a business through supply chain analysis was first introduced by Michael Porter (Porter 1985). Through supply chain analysis a firm's core competencies and drivers of competitive advantage are identified and used in the optimisation of the supply chain. The cost structure of an organisation is separated into the five primary activities inbound logistics, operations, outbound logistics, marketing and sales and

service, and four *supporting activities;* firm infrastructure, human resource management, technology development and procurement as shown in Figure 4. Each function plays a separate role in the competitive strategy of a company, and each must have its own strategy aligned with the supply chain strategy (Chopra and Meindl 2007).

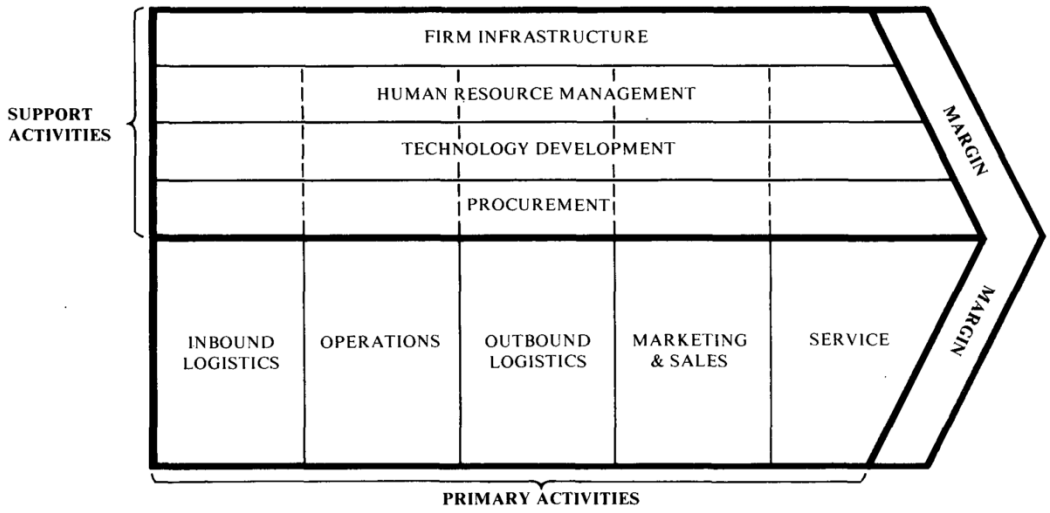

Figure 4: The cost structure of an organisation in supply chain management (Porter 1985)

Important factors of supply chain management include understanding uncertainties, efficiency and responsiveness of the supply chain and how these two affect each other in achieving strategic fit (Chopra and Meindl 2007). Efficiency refers to costs whilst responsiveness describes the time and speed of a certain action. Strategic fit involves a consistency between functions, supply chain stages and customer needs. This is achieved when supply chain responsiveness is consistent with customer needs, supply capabilities and uncertainty.

Supply chain management can be extended to include the environmental aspect in green supply chain management. In doing so, the supply chain can reduce its impact on the environment and at the same time improve business performance (Wilkerson, 2010). A product will induce impacts throughout its life cycle, and it is therefore important to include the entire supply chain from raw material extraction and transportation to final customer use and disposal. When taking the environment into account in supply chain management it is no longer only a trade-off between responsiveness and efficiency, but also the environment (Handfield, Sroufe, and Walton 2005).

Environmental aspects in the supply chain include amongst others the use of energy, fuel, water and other resources, the impact on land areas, discharges to water, emissions to air, pollution to soil and waste. These aspects can be incorporated into supply chain management in a number of ways. Through product design the product can be redesigned to reduce environmental waste, the number and amount of materials that create waste streams can be reduced and polluting materials or processes and chemicals can be substituted with less polluting ones. In the selection of suppliers environment can be a criteria, and by cooperation with suppliers one can have joint development of greener solutions or support suppliers in

improving their processes. When making decisions about plant, warehouse and retail locations one can take social and environmental implications into account, especially in cases of off-shoring. Location will affect the need for transportation which in turn can have great implications for the environment. The choices of materials and amounts for packaging solutions also have implications for the environment and the amount of wastes created.

At the same time as improving the negative impacts of a supply chain on the environment, green supply chain management can have a positive effect on supply chain surplus (Handfield et al. 2005). It is additionally a way of taking a more holistic and systems approach to environmental management and corporate social responsibility.

3.5 Environmental labels and declarations

Environmental labels and declarations are voluntary tools of communicating environmental information and characteristics to consumers, producers and policy-makers. The main goal of environmental labelling is to encourage the demand of products and services which cause lower impacts on the environment (ISO 2000).

Eco-labels are developed by governments, manufacturers and third-company organisations and are given to products that meet certain environmental criteria (Golden 2010). These criteria and the structure of such programmes vary greatly, and according to the global directory of eco-labels, Ecolabel Index, there are currently (per 22.05.2011) 377 eco-labels in 211 countries within 25 industry sectors (Big Room Inc. 2011).

Environmental labelling can be an efficient tool to cope with environmental challenges in two different ways. By encouraging the purchase of environmentally preferred products, labels can stimulate a market-driven environmental improvement (ISO 2000). Secondly, labels give consumers trustable information sources and thereby tools for coping with asymmetric information allocation which can be seen as an obstacle for environmental improvement (Frankl and Rubik 2005). However, a product will not be able to survive in the market place merely because it performs better than other products on the environmental sphere, it will also needs to have a competitive advantage when it comes to price and functionality (Golden 2010).

ISO classifies three types of eco-labels; Type I, Type II and Type III, as shown in Table 2. Type I labels are labels placed on a product to indicate that the product fulfils certain environmental requirements as given by the programme. The label does not indicate how the requirements are fulfilled, and does not allow for comparison between labelled products. Examples of such labels are the EU flower, the Swan and the Blue Angel. The use of type I labels in Norway will be presented in chapter 5.3.

Type II labels do not require third party verification, and are given by the manufacturer itself to indicate certain qualities of the product. A manufacturer can for example show that the product is recyclable, or that it does not include certain substances or chemicals.

Type III labels are detailed declarations of the contents and environmental impacts of products. The declaration allows for comparison between products within the same product category,

but does not grade the performance of the products. Even though a product has an environmental declaration, it does not necessarily mean that it has a better environmental performance than products that do not. It shows transparency in the production processes, and allows for manufacturers and producers to assess which areas of production have the largest impacts and potentially make essential changes for improvement. Type III labels will be explained in greater detail in proceeding section, and will from now on be known as Environmental Product Declarations (EPD) both in singular and plural form.

Table 2: Definition of eco-label programmes according to ISO

Type	Explanation	Example
ISO Type I (ISO 1999b)	Voluntary, multiple-criteria-based third party programme that awards a licence which authorizes the use of environmental labels on products indicating overall environmental preferability of a product within a particular product category based on life cycle considerations	
ISO Type II (ISO 1999a)	Self-declared environmental claim without independent third-party certification	
ISO Type III (ISO 2010b)	Quantified environmental data for a product with pre-set categories of parameters based on life cycle assessments and additional environmental information provided by a programme operator	

3.6 Environmental Product Declarations

Environmental Product Declarations (EPD) provides an impartial and neutral quantified presentation of the environmental impacts of a product or service, based on a life cycle analysis. EPDs are developed on the basis of product category rules (PCR).

PCRs are developed by an EPD-programme operator in cooperation with LCA and industry experts, and in practise they are guiding documents to be used when developing EPDs. In addition to requirements of format and content of the EPD, the PCR states the scope and goal of the LCA to be performed. Important factors of the PCR are life cycle stages to be included, parameters to be covered, and the way in which parameters are collated and reported. Only one PCR is developed for every product category, and the harmonisation of existing PCRs across EPD programmes is encouraged. If an existing PCR can be used, it is to be preferred (ISO 2010a). The requirements for PCRs as specified in ISO 14025 will be further presented in chapter 7.1.

EPD are primarily aimed at being used in business to business communication, but can also be used by interested consumers. The information attained from EPDs can be used for various activities, and EPDs can be said to have five different functions (Hillier, Jonsson, and Ryding 2004);

1. Management tool
2. Communication tool
3. Evaluation/assessment tool
4. Political tool
5. Action tool

In management the information from the EPD can be used in environmental management, product innovation and design (Kristensen et al. 2006) to improve the environmental performance of the product and for purchasers to give the environmental profile of the product. The EPDs offer environmental information which can be communicated throughout the supply chain and to purchasers and other customers, in addition to communicating environmental awareness. EPDs are used by purchasers and customers to evaluate and compare different products through benchmarking. The political aspect of EPDs includes providing government the tool to disseminate environmental consciousness in the business and public sector (Hillier et al. 2004). In addition EPD can be used internally to encourage improvement of the environmental performance of a product (ISO 2010a). Through the information provided in an EPD the company is able to identify hotspots in the production chain where improvements can and should be made. An EPD is not a static document, and can be continuously updated after it is published. In the building and construction sector EPD are used to assess environmental impact of entire buildings.

The development of an EPD is a very comprehensive process of data collection, and difficulties can be faced in achieving quantitative data from suppliers (Kristensen et al. 2006). Additionally this can be a cost intensive process for the developer.

In 2006 an international standard was published on Type III environmental declarations with principles and procedures for developing EPD and PCR. The process towards this standard was long, and the work in ISO had been going on since 1994. The idea of environmental product declarations was first presented to the members of the ISO Technical Committee 207, Sub Committee 3 (TC207/SC3) by an international expert of the American delegation (Bogeskär, Carter, Neven, Nuij, Schmincke, and Stranddorf 2002a). The issue was put on hold till the meeting in 1995 where the Swedish delegation lobbied to put EPD back on the agenda. During the next two years Working Group 1 with the support of a special task group, started working on the creation of an international standard. In 1998 the standardisation work was interrupted to create a Technical Report Type 2 which was published in 1999. The Technical Report summarised the discussions in ISO and presented the state of the art on EPD. After further development the standard was finalised and published in 2006.

One of the main purposes of EPD is to compare the environmental impacts of similar products or services. In order for two EPD to be comparable, it is imperative that the requirements for developing the EPD are identical or equivalent, as given in ISO 14025. If two EPD are based on the same PCR, the EPD will be comparable if all the requirements of the PCR are followed, and the PCR includes all the requirements of the standard.

To ensure credibility of the EPD it is important that the programme operator establishes procedures for the verification of the LCA-data, PCR and EPD. Credibility can also be enhanced through transparency. It is therefore important for interested parties to have access to information through all the stages of development and operation of EPD.

The environmental information provided in an EPD can be difficult to interpret for non-experts (Kristensen et al. 2006). It is therefore important that the declarations are presented in an understandable and recognisable manner. Especially for comparability the presentation of EPD in a uniform manner is important.

Today EPD development is done through national EPD-programmes. Some of the most developed EPD-programmes found globally will be presented in detail in chapter 6. In addition regional and global programmes exist with the goal of harmonising programmes, PCRs and EPDs. One of these initiatives is GEDnet, a global network founded in 1999 for cooperation and information exchange between EPD-programmes (GEDnet 2011). In 2004 a, prior to ISO 14025 being published, an international guide to environmental product declaration was developed and revised in 2005 (Hillier et al. 2004), but the document is still incomplete. On the GEDnet websites published PCRs from member programmes are gathered and made available, so that they can be used by other countries' programmes.

4 Relevant ISO Standards

4.1 Introduction

The International Organisation for Standardisation (ISO), with its 63 national members (ISO 2010a), is the biggest international standardisation body. The main purpose of ISO is to "facilitate the international coordination and unification of industrial standards" (UNIDO 2006). ISO has a special position between public and private sectors, and act mainly as a bridging organisation between requirements of businesses and society (UNIDO 2006). Standards that are developed are of a voluntary character, facilitate international trade, support sustainable and equitable economic growth, promote innovation and protect health, safety and environment (ISO 2010a).

New international standards are developed after the proposal to an ISO technical committee (TC) or subcommittee (SC) which consist of a group of experts within the field in question (ISO 2010a). A published standard is usually the last stage of a time consuming process where consensus is found between all interested parties. Today ISO has a collection of 18 834 standards (ISO 2010a), as well as a number of standards in development.

Technical committee 207 on Environmental Management was established in 1993, and works within standardisation of the field of environmental management tools and systems (ISO 2011).This includes environmental management systems, environmental auditing, environmental labelling, environmental performance evaluation, life cycle assessment and greenhouse gas management and related activities as shown in Figure 5. In total the technical committee has published 28 standards (ISO 2011). In addition to the standards listed in Figure 5 under its corresponding subcommittee, general standards on vocabulary and guidelines have been published directly under the technical committee. The standards shown in parentheses are under development and not yet published.

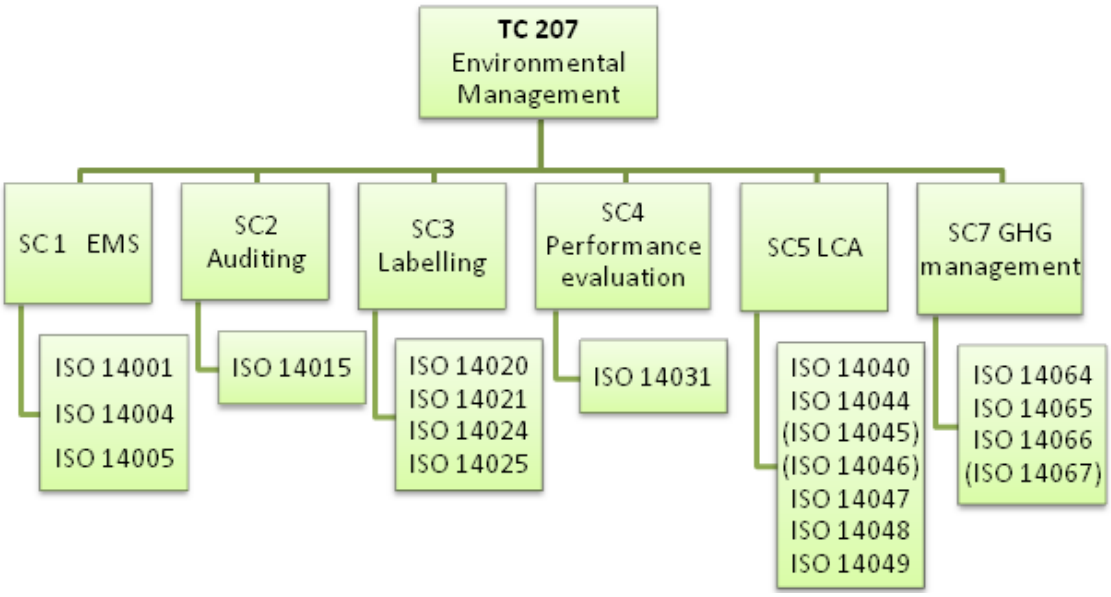

Figure 5: Structure of TC 207

The ISO standards 14001-14005 on environmental management systems, published by subcommittee 1 will be further described in chapter 5.2. The standards on environmental

labelling from subcommittee 3 were briefly mentioned in chapter 3.5 and ISO 14025 Environmental product declarations will be presented in greater detail in the next section. The core elements of the ISO 14040-14049 on life cycle assessment was presented in chapter 3.3. ISO 14031 Environmental Performance Evaluation, ISO 14015 Environmental Assessment of Sites and Organisations and ISO 14064 – 14066 related to greenhouse gases and have not been further mentioned in this thesis.

In the following section an overview of central requirements in standards related to ISO 14025 Environmental Product Declaration will be given. An evaluation of how the standards support each other will be given in the discussion in chapter 8.4. From TC 207 ISO 14045 Eco-efficiency of assessment of product systems, 14046 Water footprint and 14067 Carbon footprint of products will be included, all of which are under development. Information about and access to these standards has been limited, and the comparison made is therefore also limited. In addition a presentation of ISO 21930 Sustainability in building construction – Environmental declaration of building products is given.

4.2 ISO 14025

ISO 14025 (2010), which covers Type III Environmental Declarations, aims at providing LCA-based information on the environmental aspects of products and services. EPDs, as presented in chapter 3.6, can be used as tools for comparing products during a purchase process, improving environmental performance of products, and provide information for assessing the environmental impact of products over their life cycle.

The standard is based on life cycle analysis as described by ISO 14040 and 14044, and EPDs are primarily aimed at business-to-business communication, but can also be used for business-to-consumer communication. ISO 14025 states the general requirements for developing EPD-programmes, PCRs and EPDs.

The development and administration of EPDs and PCRS are done through EPD-programmes. The operation of a programme is described through general programme instructions, which includes guidelines for development of PCRs and EPDs. To ensure relevant and verifiable LCA information in the EPD, the programme operator is required to have procedures for PCR review, independent verification of LCA data, additional environmental information and the declaration.

The main requirements for developing a PCR include determining the goal and scope of the LCA-based information, the rules for producing the additional environmental information, life cycle stages to be included, parameters to be covered and the way in which parameters should be collated and reported (ISO 2010b). The PCR should be based on at least one life cycle assessment. A detailed overview of the requirements of contents in the PCR is given in chapter 7.1.

ISO 14025 requires the quantitative data in the declarations to be reported in appropriate and consistent units, qualitative data to be comparable, and the same methods of producing qualitative information to be used (ISO 2010b). Requirements for inclusion of information are given in more detail in chapter 7.2.

4.3 ISO 14046

The work on a new standard for water footprint, ISO 14046, started in 2009, and is currently under development by TC207/SC5/WG8, and is planned to be completed in 2012/2013 (Humbert 2009). The standard will give the framework and principles for organisations to determine the water footprint of their products, as well as the processes and organisations (Eriksson and Neven 2009). Additionally it will address communication issues. The standard will fill an important gap as the use of freshwater rarely is included as an impact category in present LCA studies and other ISO standards.

The standard is intended to be consistent with standards such as Carbon Footprint (ISO 14067), Life Cycle Assessment (ISO 14040), Greenhouse Gas Quantification (ISO 14064) and Environmental Communication (ISO 14020) in terms of terminology, boundaries and scope (Eriksson and Neven 2009). Due to limited information about and access to drafts of the standard, specific requirements cannot be presented.

4.4 ISO 14067

ISO 14067 covers the carbon footprint of products (CFP) and is currently under development by TC207/SC7/WG2 (ISO 2011). The standard will at the earliest be published in 2012. Per March 2011 the status of the standard is Committee Draft, and there will be a vote for Draft International Standard at the ISO TC 207 meeting in Oslo in June 2011 (Skaar 2011). Information from the current version has been used as a basis for this presentation of the standard. Many issues are still not clarified in the current draft version, and changes will occur in the final document.

ISO 14067 will give guidelines and requirements on quantification and communication of the carbon footprint of a product, based on a life cycle perspective as described by ISO 14040 and 14044. Guidelines for the development of a programme operator will also be given in the standard. The main audience is currently business to business, business to business made publicly available, business to consumer and performance tracking. In the case of business to business communication there is a possibility for a partial footprint on certain process units. Communication of the offsetting of CFP is outside the scope of the standard.

Similar to EPDs, carbon footprint declarations will be made on the basis of PCRs. The development of PCRs follows the same requirements as ISO 14025, and the same PCRs can therefore be used.

Communication of the carbon footprint will done through five different methods; a report, performance tracking report, claim, label and the declaration. Verification of the declaration will be done by an independent third party or through critical review.

4.5 ISO 21930

ISO 21930 (2007) covers “Sustainability in Building Construction – Environmental Declaration of Building Products”. However, the standard focuses only on the environmental impacts, and

does not take the social and economic aspects into account. The overall goal is to encourage the demand for, and the supply of building products with smaller environmental impacts.

ISO 21930 gives guidelines and requirements for the development of PCR and EPD for building products. The development of programme operators is not covered by the standard. The standard is based on life cycle analysis as described by ISO 14040 and 14044, and the EPDs are mainly aimed at business to business communication

The standard has strong similarities to ISO 14025, and complements ISO 14025 by giving additional requirements for developing EPDs and PCRs. This means that products which are certified by ISO 21930 should also fulfil the requirements of ISO 14025. If a product complies with ISO 14025, some additional requirements must be fulfilled in order to be ISO 21930 certified.

The requirements for the PCR are the same as those given in ISO 14025, the same PCRs can therefore be used whether you are making an EPD according to ISO 14025 or ISO 21930. One difference is that according to ISO 21930 a declared unit can be used instead of functional unit.

The requirements for content and format of the declaration made in ISO 21930 are to some extent different from the requirements of ISO 14025. One requirement, which actually requires less information than ISO 14025, is the information about the manufacturer. According to ISO 14025 (2010) “identification and description of the organisation making the declaration” should be included, whereas ISO 21930 (2007) only requires “name and address of the manufacturer(s)”. Requirements which are unique for ISO 21930 are a “simple visual representation of the building product”, information about the sites and manufacturer that the results of the LCA are representative for, and a statement that the declaration represents an average performance, and information about the deviation with respect to the average.

Where ISO 14025 gives examples of environmental impacts to be covered by the declaration, ISO 21930 lists environmental information to be included. Furthermore, the declaration should include scenarios and technical information and information about the use of resources for all stages of the life cycle according to a given list. Verification rules coincide with those given in ISO 14025.

4.6 Summary

A summary of the requirements made in ISO 14025, ISO 14067 and ISO 21930 is given in Table 3. As can be seen there are great similarities between these three declarations.

Table 3: Summary of requirements in the standards

Requirement	ISO 14025	ISO 14067	ISO 21930
Life cycle perspective (ISO 14040 & 14044)	Yes	Yes	Yes
Based on PCR	Yes	Yes	Yes
Use of Unit	Functional Unit	Functional Unit	Functional Unit Declared Unit
Verification	PCR review, Independent verification	Independent 3rd party critical review	PCR review, Independent verification
Req. Dev. Programme operator	Yes	Yes?	No
Communication	B2B (B2C)	B2B B2C	B2B (B2C)

5 Environmental management and documentation in Norway

5.1 Green public procurement

Green public procurement (GPP) is defined by EU as "a process whereby public and semi-public authorities meet their needs for goods, services, works and utilities by seeking and choosing outcomes and solutions that have a reduced impact on the environment throughout their whole life-cycle, as compared to comparable products/solutions" (European Commission 2008).

In the cases of green procurement, environmental information at both the management and product level can be useful. Management related information can be acquired through information about the suppliers' environmental management systems and environmental reporting. At the product level information can be found through eco-labels, LCA-reports, content of chemical or toxic materials, details about end-of-life treatment and environmental product declarations.

Because of the size of their procurement operations, public authorities have the power to make an important contribution towards sustainable development by opting for goods and services that are environmentally preferable (Fet, Michelsen, and de Boer 2011). In Norway public procurement accounts for 330 billion NOK annually (Difi 2011), and in the EU 17 % of GDP (2 trillion euros annually) (European Commission 2011b). As a result, green public procurement has become part of the national strategy for sustainable development in Norway.

Through a number of legislations and initiatives the government aims at contributing to solving national and global environmental challenges. These can be summarised as reducing the emission of greenhouse gases, securing biodiversity, reducing the emission of health and environmental hazardous chemicals and to prevent the overconsumption of resources and the generation of large quantities of waste (NHD 2004).

The legal basis consists of three acts; the *Public Procurement Act* (1999) which states the main principles of procurement rules for all governmental bodies in Norway, the *Environmental Information Act* (2003)which ensures public access to environmental information and the *Freedom of Information Act* (2003)which gives the public the right to demand access to case documents of the public administration. Additional initiatives include the action plan for *Environmental and Social Responsibility in Public Procurement – Sustainable Public Procurement* (2008), *White Paper 14* (2006-2007) on reducing the use of toxins and *White Paper 36* (2008-2009) on public procurement in general. The environmental requirements in public procurement will be seen in light of the Public Procurement Act.

The Public Procurement Act (1999) states the main principles of procurement rules for all governmental bodies in Norway, with the main purpose of ensuring the effective use of resources. It includes consideration of life cycle costs, overall design and environmental impacts. In §6 it states that environmental considerations shall be taken in public procurement; "Central, municipal and county-municipal authorities (...) shall when planning each procurement have regard to the resource implications and environmental consequences of the procurement" (Public Procurement Act 1999).

The Public Procurement Act requires the environmental consequences and life cycle costs to be taken into account in the procurement process. Environmental consequences are understood as the use of raw materials, various emissions and waste generation from production, transportation and operation (NHD 2004). There are no direct requirements as to how this should be done, but at a minimum one should strive to consider various solutions. It is the principal's responsibility to ensure that considerations are made according to the nature of the procurement.

Life cycle costs (LCC) refers to the total costs of the procurement over its entire lifetime. In addition to including repair and operation costs, expenses that occur with respect to the use of resources and energy, emissions and waste management must be included (NHD 2004). The Act states no requirements as to how these costs should be calculated or evaluated.

In public procurement three main steps must be taken in the selection of suppliers; qualification, selection and assignment of suppliers. In the qualification stage, suppliers which do not fulfil certain requirements are eliminated. The selection of suppliers involves weighting of different qualities before the contract with its delivery requirements is assigned to a suppler. This process is shown in Figure 6.

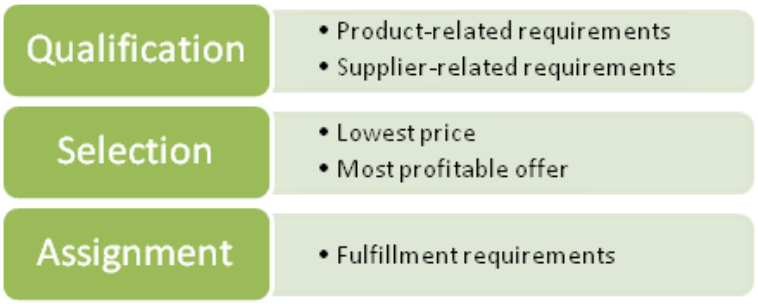

Figure 6: Main steps of selection of supplier in public procurement

As show in Figure 6, a principal evaluating qualified suppliers can set certain product- and supplier-related requirements. These can be set with great freedom, as long as the requirements do not favour certain companies (NHD 2004). The requirements should for example not discriminate against foreign supplier.

Product-related requirements should be based on the needs, or function. An example with respect to the acquisition of a printer, can be that it should be able to print double-sided in order to reduce paper-use. Additionally one can require the product to fulfil the technical requirements made by an eco-label such as the EU Flower or the Swan, but not require that the product is certified a certain label.

Supplier-related requirements are set within economic, financial and technical capacity. In terms of environmental requirements these can only be made if relevant to the contract. The regulations do not open for a general requirement of an environmental management system, or the requirement of specific management systems (NHD 2004). However, the requirement

can state that "The supplier should have X and Y environmental competence, which can be documented through EMAS or ISO 14001 certification or equivalent".

In the choice between more than one qualified suppliers in the assignment process, the principal can either select the supplier with the lowest price or the supplier with the most profitable offer (NHD 2004). In the latter, price, quality, technical, esthetical and functional values in addition to environmental qualities are taken into consideration. The principal has freedom to decide which qualities are important to him. Examples of environmental requirements that can be given weight are percentage of recycled material in the product and the percentage of hazardous chemicals and wastes.

When the contract has been awarded to a supplier, the principal can state environmental requirements as to how the contract should be fulfilled (NHD 2004). These can for example include deliveries to be made without packaging, or the use of recyclable materials in the packaging. Furthermore, the principal could also require that packaging which cannot be recycled, and electrical waste should be collected by the supplier.

Even though environmental issues can be taken into account in the public procurement process, a survey in 2009 on GPP practice in Norwegian municipalities and counties revealed that only 50% actively used information on environmental performance in the final selection of suppliers (Michelsen and de Boer 2009). However, 74.3% of the municipalities stated that they on a regular basis put forward requirements of environmental performance in the qualification of suppliers.

As seen, environmental management systems, eco-labels and EPDs can be used to fulfil documentation of the environmental requirements enforced on suppliers.

EPDs fulfil all requirements of public procurement by documenting the products' environmental qualities throughout the life cycle, and they do not act as a trade barrier whilst performing that function. However, the results of Michelsen and de Boer survey from 2009 showed that EPD was not well-known among the municipalities. Only 10.1 % had received EPDs as product documentation and 43.1% had not heard of the system (Michelsen and de Boer 2009). Today more and more principals are requiring EPDs, and for example Statsbygg, the government's property manager and advisor in construction and property affairs, has started to require EPDs in their projects (Statsbygg 2011).

5.2 Environmental management systems

Environmental Management Systems (EMS) are tools organizations can use to facilitate implementation of environmental policy to deal with the environmental aspects of sustainable development and CSR. By the British Standards Institute, an EMS is defined as the "organizational structure, responsibilities, practices, procedures processes and resources for determining and implementing environmental policy" (British Standards Institute 1994). The biggest certifications of environmental management systems in Norway are ISO 14001, EMAS, Eco-lighthouse and the Blue and Green Flag. The following presentation has therefore been limited to these.

ISO 14001

ISO 14001:2004 is an international standard which provides a set of requirements for establishing and maintaining an environmental management system in all types and sizes of organisations. Implementation of the standard is voluntary and provides organisations with a framework to design and determine its environmental policies. The standard does not determine specific requirements for environmental performance; instead the focus is on documenting environmental aspects and continual improvement of these over time (ISO 2004). This is accomplished through five steps, as shown in Figure 7.

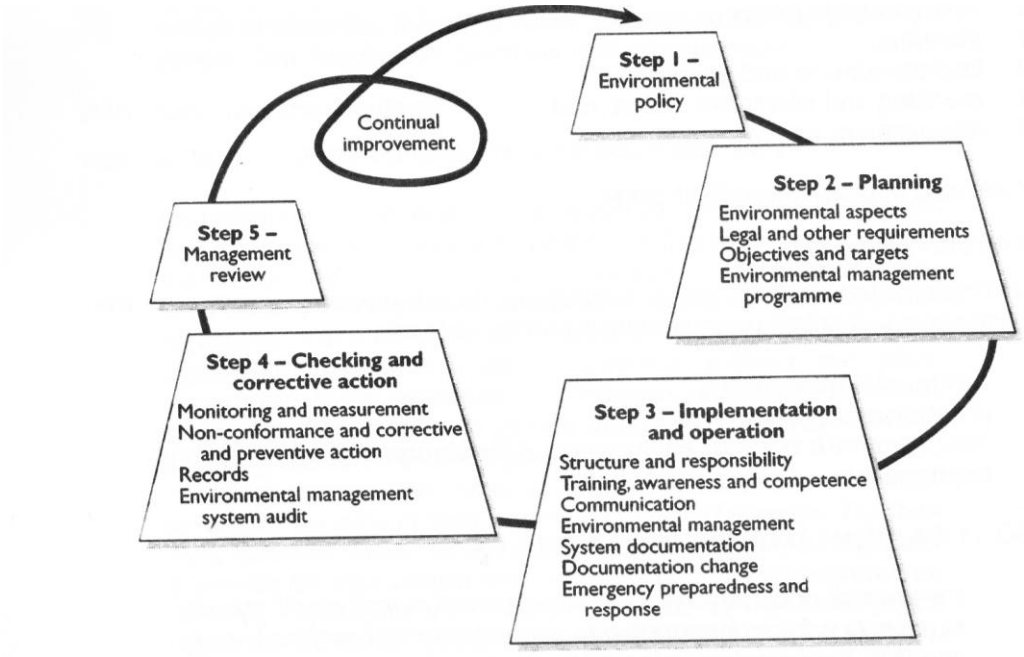

Figure 7: The five steps and elements of ISO 14001 (Starkey 2007)

In the first step of implementing ISO 14001, the organisation has to define its environmental policy. The policy should include a commitment to continual improvement and prevention of pollution, compliance of legal requirements and, provide a framework for setting and reviewing environmental objectives and targets.

Through the second step the organisation identifies environmental aspects of its activities and products, and defines its environmental objectives and targets. Additionally they must plan on how to meet and document these targets.

The goal of the third step, implementation and operation, is to put the plan made in step two into action. In order to do so certain elements must be in place, such as resources, definition of responsibilities, competence, communication procedures, documentation and emergency preparedness and response procedures.

Monitoring, evaluation of compliance and internal audits are performed in the fourth step. Procedures for taking corrective and preventive action must be in place, so that necessary changes are made when needed.

The environmental management system is reviewed by top management at planned intervals in the fifth step, in order to ensure continuing suitability, adequacy and effectiveness. Improvements and changes are then made when necessary in order to be consistent with the commitment to continual improvement.

According to the portal Miljøindex which gathers information about environmentally certified organisations in Norway, there are currently (per 11.06.2011) 781 organisations in Norway that are ISO 14001 certified (Eniro Norge AS 2010).

The Eco-Management and Audit Scheme

The Eco-Management and Audit Scheme (EMAS) is a voluntary scheme for the evaluation and continuous improvement of the environmental performance of companies and other organisations (European Commission 2011a). This is achieved through providing organisations with tools to measure, evaluate, report and improve their environmental performance.

Originally EMAS was restricted to companies performing industrial activities, but has since 2001 been open for all economic sectors (European Commission 2011a). An EMAS certification does not apply to the entire organisation like ISO 14001, but is limited to the sites of the organisation. Additionally EMAS is not a global programme, but is restricted to organisations operating in the European Union and the European Economic Area.

Table 4: Requirements of the company to be certified by EMAS (European Commission 2011a)

1	Adopt an **environmental policy** containing commitment both to comply with all relevant environmental legislation and to achieve continuous improvements in environmental performance
2	Conduct an **environmental review** considering all environmental aspects of the organisation's activities, products and services, methods to assess these, its legal and regulatory framework and existing environmental management practices and procedures
3	In the light of the results of the review, establish an effective **environmental management system** aimed at achieving the organisation's environmental policy defined by the top management. The management system needs to set responsibilities, objectives, means, operational procedures, training needs, monitoring and communication systems
4	Carry out an **environmental audit** assessing in particular the management system in place and conformity with the organisation's policy and programme as well as compliance with relevant environmental regulatory requirements
5	Provide a **statement** of its environmental performance which lays down the results achieved against the environmental objectives and the future steps to be undertaken in order to continuously improve the organisation's environmental performance
6	The environmental review, EMS, audit procedure and the environmental statement must be approved by an accredited EMAS verifier, and the validated statement needs to be sent to the EMAS Competent Body for registration and made publicly available before an organisation can use the **EMAS logo**

The requirements for an organisation wishing to certify their site under the EMAS programme are presented in Table 4. In addition to specifying the requirements for an EMS similar to ISO 14001, EMAS requires the publication of an environmental statement and independent verification of compliance with the requirements of the regulation.

According to Miljøindex 22 organisations in Norway hold an EMAS certification (Eniro Norge AS 2010).

Eco-Lighthouse
The Eco-Lighthouse foundation (Stiftelsen Miljøfrytårn) is a voluntary environmental management system mainly aimed at small and medium sized organizations in Norway, both public and private. Similar to ISO 14001, the Eco-Lighthouse certification includes the entire organisation.

Municipalities are responsible for the certification process of new organisations. Therefore, before an organisation can be certified the municipality in which it has its operations has to have made a commitment to the Eco-Lighthouse Foundation. This involves having an Eco-Lighthouse Officer, a sufficient amount of certifiers, and to pay an annual municipal fee (Stiftelsen Miljøfyrtårn 2011).

The process of being certified as an Eco-Lighthouse organisation involves cooperation with an external consultant. Through an environmental analysis an environmental status and action plan is written in cooperation between the consultant and the organisation. In order to be certified the organisation has to fulfil 45 general requirements in addition to a number of industry specific requirements. The requirements are mainly within the areas energy, waste, working environment, transportation and green procurement. Upon certification the organisation commits to annual reporting within these areas. Furthermore, the report must include a plan of action for the coming year. This encourages continuous improvement in the organisations.

Per June 2011, Eco-Lighthouse has 3039 certified organisations (Stiftelsen Miljøfyrtårn 2011) in Norway. The municipality with the most certificates is Oslo with a total of 637 organisations certified.

The Foundation for Environmental Education
The Foundation for Environmental Education (FEE) has two industry-specific environmental management systems in Norway. Green Flag (Grønt Flagg) is aimed at schools and kindergartens, whilst Blue Flag (Blått Flagg) is aimed at beaches, marina's and boat owners.

The goal of the Green Flag is to ensure sustainable development through environmental education. In order to be certified the school or kindergarten has to follow the seven steps presented in Table 5 (FEE Norway 2011).

Table 5: The seven steps of the Green Flag

1	Establish a kindergarten/school committee
2	Conduct environmental review
3	Develop action plan for the period within a specific topic
4	Monitor and evaluate activities
5	Linking activities to curriculum
6	Inform and involve children/pupils and the wider community
7	Develop an Eco-Code

The steps of the Green Flag focus on low threshold activities that include and motivate the entire kindergarten or school, in addition to the local community it is based in. Close to 800 schools and kindergartens are certified by the green flag in Norway (FEE Norway 2011).

The Blue Flag certification sets 32 requirements for beaches, and 24 requirements for marinas in regards to safety and service, environmental management, water quality, information and training. All environmental information required about the beach or marina should be provided to the public through an information board. In Norway, six beaches and four marinas are currently (per 11.06.2011) certified (FEE International 2011).

5.3 Environmental labels

There are many labels found on products and services in the Norwegian market, both Norwegian, European or global labels. Environmental labels will in this section be understood as Type I environmental labels as defined by ISO. Mandatory labels such as the EU Energy Label or single parameter labels such as Debio and FSC will therefore not be included. An overview of the most common labels is given in Figure 8, and a brief introduction to each programme will be given in this chapter.

Figure 8: Overview of eco-labels in Norway

General principles of Type I labels

Eco-labels can be classified into two categories depending on what it measures, single-attribute or multi-attribute standards (Golden 2010). Single-attribute standards measure only one environmental impact, such as energy efficiency or water usage. Multi-attribute standards take several environmental characteristics into account, thereby making them more complex and data-intensive. A problem often arising with single-attribute labels occurs when comparing labels which cover different impacts.

Important principles are openness and inclusion, in addition to taking the entire life cycle of the product into account. The general principles of environmental labels and declarations as stated in ISO 14020:2000 are given in Table 6.

Table 6: General principles of environmental labels and declarations (ISO 2000)

1	Environmental labels and declarations shall be accurate, verifiable, relevant and not misleading
2	Procedures and requirements for environmental labels and declarations shall not be prepared, adopted or applied with a view to, or with the effect of, creating unnecessary obstacles to international trade
3	Environmental labels and declarations shall be based on scientific methodology that is sufficiently thorough and comprehensive to support the claim and that procedures resultstaht are accurate and reproducible
4	Information concerning the procedure, methodology, and any criteria used to support environmental labels and declarations shall be available and provided upon request to all interested parties
5	The development of environmental labels and declarations shall take into consideration all relevant aspects of the life cycle of the products
6	Environmental labels and declarations shall not inhibit innovation which maintains or has the potential to improve environmental performance
7	All organisations, regardless of size, should have equal opportunity to use environmental labels and declarations. Involvement should not be hindered by extraneous factors or requirements such as procedural complexity or unreasonable information or administrative demands
8	The process of developing environmental labels and declarations should include an open, participatory consultation with interested parties. Reasonable efforts should be made to achieve a consensus throughout the process
9	Information on the environmental aspects of products and services relevant to an environmental label or declaration shall be available to purchasers and potential purchasers from the party making the environmental label or declaration

The Swan

The Nordic Ecolabel, also known as the Swan (Svanen), is the most dominant eco-label in Norway. This is a Nordic label, and the Norwegian programme is managed by the Foundation for Ecolabelling. The Swan was established in 1989 by the Nordic Council of Ministers.

For a product to be labeled with the swan, it has to fulfill a number of requirements. Requirements have been developed within 60 product categories, and several thousand products are certified (Miljømerking 2011). In the evaluation of the product, the entire life cycle of the product is included.

EU flower
The EU-flower was established in 1992 by the EU commission, and is the official eco-label in the European Economic Area. In Norway the flower is also managed by the Foundation for Ecolabelling, and is recognized as an eco-label on equal basis as the Norwegian labels.

The flower and the swan are quite similar labels, and the requirements for the label are developed similarly with similar requirements, and the two labels are equated in situations of comparison (Miljømerking 2011). The biggest difference between latter in Norway is the recognition of the label, the number of product groups labels are developed for, and the number of labeled products.

In Norway only six companies have an EU Flower License, but in total 1152 European companies are certified within 26 categories of products (European Commission 2011c).

Blue Angel
The Blue Angel (Der Blaue Engel), a German eco-label, was established in 1978 and is the oldest environment-related label in the world (The Blue Angel 2011). Around 11500 products and services are certified by the Blue Angel within 90 product categories.

The label shows preferability to products which, compared to conventional products, have less negative impact on the environment. Blue Angel labeled products help conserve resources during production, require less resources in use and disposal and do not contain substances harmful to health or the environment. At the same time they still perform their functions on a high quality level (The Blue Angel 2011).

Similar to other eco-labels, a product has to fulfil certain requirements in order to be awarded the label. One of the most important requirements of the Blue Angel is substantially lower energy consumption than conventional products. Products are labeled within one of four protection goals, health, climate, water and resources. The logo contains a detailed reference to which areas the products performs well in an environmental perspective.

Bra Miljöval
Bra Miljöval (Good Environmental Choice) is a Swedish environmental label, and can be found on some products in Norway. The label was launched in 1992 and is managed by the Swedish Society for Nature Conservation (Naturskyddsföreningen 2010).

Products and services have to meet certain criteria before they can use the label on its packaging. The criteria are developed within a holistic perspective, and put requirements on the raw materials and chemicals which are used in production.

NAAF
NAAF is the Norwegian Asthma and Allergy Association's labelling of products that give minimal health risks. In addition to health criteria, NAAF requires that all products also fulfil the

requirements of either the Swan or the EU Flower. More than 100 products have been certified within 18 product categories (NAAF 2011).

GOTS

Global Organic Textile Standard (GOTS) is the largest international label for ecological textiles. In addition to ecological requirements, the textiles must fulfil certain environmental and health criteria. GOTS certification was started in 2006, and is managed by an International Working Group, consisting of international stakeholder organisations. At the end of 2010 2754 facilities were certified through GOTS (GOTS 2010).

The environmental criteria of GOTS include all chemical inputs to meet certain environmental and toxicological criteria, installation of a functional waste water treatment plant and all processors to comply with social minimum criteria (GOTS 2010).

TCO

TCO is a Swedish environmental label found on IT equipment. The first TCO standard was published in 1992, and since then 1715 certificates have been published within six product categories (TCO 2011).

Environmental criteria include energy efficiency, recyclability of product and packaging, extended product life and implemented environmental management system. In addition TCO certification has criteria related to high performance and usability.

6 EPD & PCR schemes

6.1 Introduction

According to ISO 14025:2010 a Type III environmental declaration programme is a "voluntary programme for the use and development of Type III environmental declarations". The programme operator is the body managing the programme, for example companies, industrial sector, public authorities, independent scientific body or other organisations. Responsibilities of the programme operator include the administration of the programme, preparing general programme instruction and, involvement of interested parties in the programme development.

There are several national and industry specific EPD programmes globally. In the following section some selected programmes will be presented. Focus will be on the history of the programme, organisation, verification and development of EPDs and PCRs, general format of EPDs and PCRs and distribution of EPDs within the programme. An overview of the assessed programmes is given in Table 7 together with the programmes logo. A more detailed presentation of the format and contents of the EPDs from each programme will be given in the analysis section of this thesis, chapter 7.

Table 7: Overview of selected EPD programmes

Country	Programme name	Logo
Norway	Norwegian EPD Programme	
Sweden	International EPD System	
Finland	RT Environmental Declaration	
Germany	IBU	
Japan	Eco-Leaf	
South Korea	Type III Labelling programme	
Denmark	MVD-DK	
France	INIES	
Netherlands	MRPI	
United States	Earthsure, Eco-profile programme, Sustainability consortium	

6.2 Norway

Background and organisation

The Norwegian EPD programme is run by the Norwegian EPD Foundation, established in 2002 by the Confederation of Norwegian Enterprise (NHO) and the Federation of Norwegian Building Industries (BNL) (EPD-Norge 2011). The establishment occurred as a result of a trial EPD scheme

from 1999, also established by NHO (Bogeskär, Carter, Neven, Nuij, Schmincke, and Stranddorf 2002a), and is today still organised under NHO.

The programme is responsible for verifying that Norwegian EPDs and PCRs are developed in accordance with ISO 14025 and that they adhere with ISO 14020, 21930, 14040 and 14044 (EPD-Norge 2011).

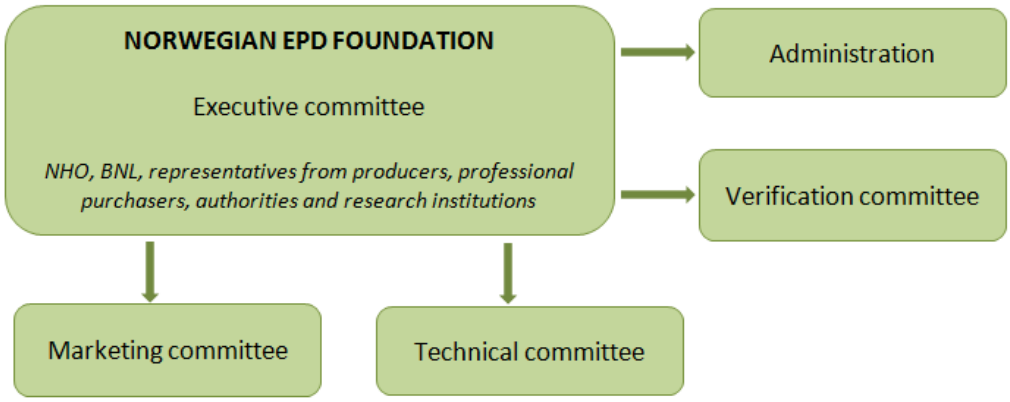

Figure 9: Organisation of the Norwegian EPD Foundation (EPD-Norge 2009)

The organisation of the Norwegian EPD Foundation is seen in Figure 9. Design, operation and monitoring of the programme are the responsibilities of the executive committee. Business on a day to day basis within EPD Norway is handled by an administration consisting of a manager and secretary. The registration and modification of new and old EPDs is the responsibility of the verification committee.

The executive committee consists of members from different interest groups from industry, various research institutions as well as the authorities. It is up to the executive committee to decide which product categories are relevant and approve PCRs for these products. In addition it is their responsibility to approve and verify new declarations. The executive committee appoints the leader of the technical committee and decide how the rest of the committee shall be appointed.

The technical committee assists the executive committee in their work of adopting proposed PCRs, and their statements should be taken into account as far as possible. Another important area of responsibility is to further develop technical LCA questions within the framework of the programme. The marketing committee is responsible for marketing initiatives.

As a non-profit organisation, revenues to the foundation mainly originate from NHO and BNL in addition to annual fees from enterprises and registration fees for EPDs. Prices per 2011 were an annual administration fee for each company of 8 000 NOK, and a registration fee for each EPD of 10 000 NOK for the ten first EPDs. Further additional EPDs costs 1 000 NOK each (EPD-Norge 2011).

Development and verification of PCR and EPD
The development of a new EPD should follow ISO 14020, 14025, 21930 (if building material), 14040 and 14044, a relevant PCR and the programme guidelines (EPD-Norge 2009). The company is responsible for obtaining the relevant data about the product and its production cycle needed for the EPD and the related life cycle assessment. The life cycle assessment can either be performed by internal or external experts.

The LCA report and the proposed EPD are then sent to an independent verificator which has not been involved in the development of these documents. The verificator is responsible for verifying the LCA report and that the EPD complies with the PCR. A verification report is prepared which is sent to the Verification committee together with the proposed EPD. The Verification committee and its leader approve the EPD after going through the verification report, EPD and the relevant standards. An EPD registration number is thereby assigned to the EPD before all approved EPDs are published on the foundations' website (www.epd-norge.no).

General format and distribution
All EPDs of the Norwegian programme are based on valid PCRs, and generally have the same format. According to the programme guidelines the EPDs should include three main parts (EPD-Norge 2009):

1. Description of producer and product, and presentation of contents declaration
2. Presentation of environmental performance
3. Information about verification, and recycling declaration

The guidelines do to this date not give requirements to the layout of the EPDs.

EPD Norway has 12 PCRs published within the product categories furniture and building material. In addition there is a PCR on wild caught fish and one for soccer pitch surface products and soccer pitches. EPDs are published within five product categories as shown in Table 8. Per 25.05.11, in total 92 EPDs have been published through the Norwegian programme (EPD-Norge 2011). Five of the published EPDs within furniture are by an Italian producer.

Table 8: Distribution of Norwegian EPD

Product category	Number of EPD
Building materials	57
Furniture	24
Energy	2
Chemicals	6
Packaging	3

6.3 Sweden

History and organisation
The development of a Swedish EPD scheme started in 1997 as an initiative by Swedish business sector, and was managed by the Swedish Environmental Management Council (Bogeskär, Carter, Neven, Nuij, Schmincke, and Stranddorf 2002a). The Swedish EPD system is voluntary

and can be used by companies and organisations from all over the word. Today, there are 10 other countries in addition to Sweden apart of the programme (IEC 2011b). This includes Italy, Switzerland, Japan, England, Czech, USA, Netherlands, Spain, Taiwan and Poland as shown in Figure 11.

Between 2002 and 2005 Sweden and Italy participated in the Intend Project, funded by the European LIFE Environment 2003 programme (Bogliolo n d). The main goal was to develop an international EPD system, globally applicable. The Italian scheme is developed in cooperation with the Swedish EPD scheme and is therefore virtually the same programme. The main difference between the two countries is the list of characterisation factors, and that the Italian programme refers to a public LCA database, which does not exist in Sweden (Bogeskär, Carter, Neven, Nuij, Schmincke, and Stranddorf 2002a).

Even though it is not an official international EPD system, the Swedish system is a global system and calls itself the International EPD system (IEC 2011b). For this thesis the Swedish programme will be understood as the International EPD system, and EPDs from all countries involved in the system will be included.

The programme instructions are currently under review, and a new version will be published through the websites, www.environdec.com, in November 2011 (IEC 2011b).

The administration of the EPD system consists of the International EPD Consortium (IEC) a steering committee, technical committee and secretariat (IEC 2008) as shown in Figure 10. The International EPD Consortium consists of permanent and associate members, and acts as the programme operator, whilst the secretariat handles routine administrative work.

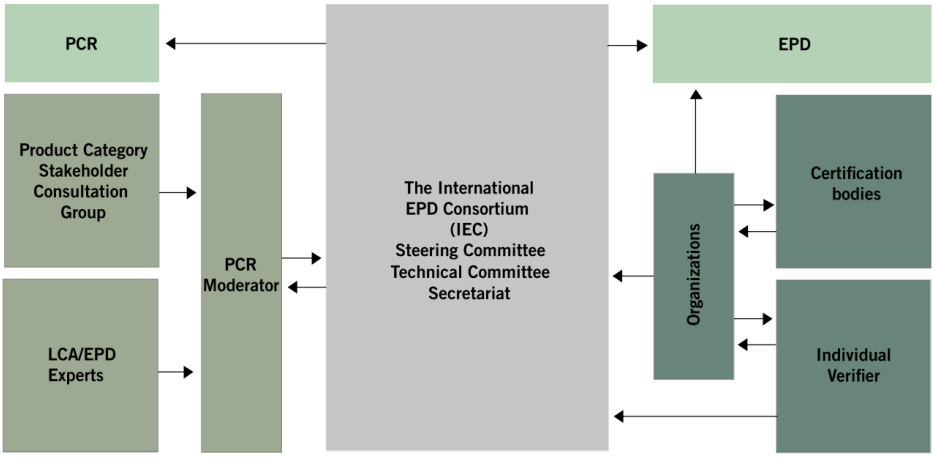

Figure 10: Structure of Swedish EPD system (IEC 2008)

The steering committees main responsibilities is to support the secretariat in the overall management of the system by for example preparing General Programme Instructions, appointing members of the technical committee and considering new potential audience and application of EPD (IEC 2008). The technical committee is a smaller group of 3-5 LCA and EPD experts which act as a PCR review panel, considering and approving new PCRs. In addition they

make suggestions for development of technical and LCA-oriented issues and appoint the LCA/PCR experts who act as external verifiers (IEC 2008).

Development and verification of PCR and EPD
The International EPD system uses the United Nations Central Product Classification (CPC) system to classify its product categories (IEC 2008). The CPC system bases the classification on the physical characteristics of goods and services (UN 2002). Incorporated in the system are numbers that are used to identify and group the products. PCRs are developed on the basis of basic modules which are grouped according to the CPC system. Basic modules are detailed templates which can be used to develop specific product category rules within the given product group.

As seen in Figure 10, the PCR moderator coordinates the work on developing a PCR. LCA/PCR experts are invited to take part in the development process, and together they appoint a Product Category Stakeholder Consultation Group. The PCR proposal is drafted by the PCR moderator and experts before the Product Category Stakeholder Group respond and comment on the proposals.

The organisation requesting an EPD is responsible for the development of the EPD. Information and data needed for the LCA, in addition to other environmental information should be collected according to the PCR. The EPD is thereby verified by independent verifiers whose competence is prescribed by the EPD programme, or internally if the company has an EPD process certification. Underlying data used in LCA calculations, compliance with the PCR, presentation of environmental performance and additional environmental information are all reviewed and documented in a verification report.

General format and distribution
The PCR basic module includes (IEC 2011a);

1. Introduction section which is common for all full PCR regardless of product group
2. Text including requirements which are common for all products which belong to the specified product group
3. Identified specific requirements or information which must be decided upon on a more detailed level

Within the programme there is some flexibility allowed for the format of EPDs, but to ensure some degree of homogeneity the programme guidelines describes certain parts that shall be included (IEC 2008);

1. Programme-related information
2. Product-related information
3. Environmental performance-related information
4. Mandatory statements

The programme gives no requirements or guidelines on the layout of the EPDs.

In addition to publishing EPDs the international EPD system offers an option of single-issue declarations in the form of climate declarations. These are descriptions of GHG emissions

expressed as CO2-equivalents based on a verified life cycle assessment (IEC 2011a). The collection of data and calculations are based on PCR and follow the same requirements as for developing a full EPD. The format of the report should at least include (IEC 2008);

1. Product information
2. Company information
3. Declaration of environmental impact
4. Information about verification procedure

Today the system mainly comprises of EPDs from Sweden and Italy, but also includes other countries as shown in Figure 11.

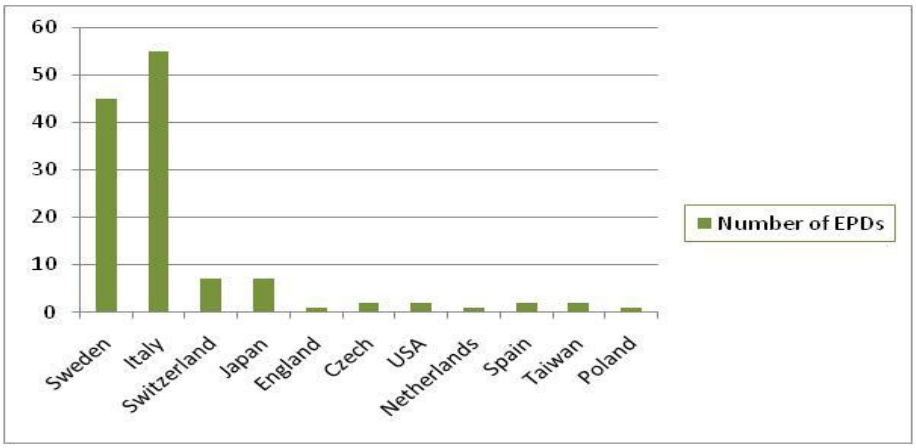

Figure 11: Number of EPD sorted by country

The EPD system has 46 basic modules and 107 published PCRs. 77 of these PCRs are not based on a basic module. This is due to the publication of these prior to the establishment of the basic module system. In addition, 23 PCRs are currently under development. 149 EPD are developed within 9 product categories as shown in Table 9 (IEC 2011a).

Table 9: Number of EPD sorted by product category, Swedish EPD system

Product category	Number of EPD
Energy and water	11
Food and beverages etc.	27
Textile and furniture etc.	14
Wood and paper	6
Rubber, plastics, glass and chemicals	30
Metals	8
Machinery and appliances	34
Transport equipment and services	14
Services	5

6.4 Finland

Background and organisation

In Finland the EPD programme RT Environmental Declaration is run in cooperation between the Confederation of Finnish Construction Industries RT, the Building Information Foundation RTS,

VIT Technical Research Centre of Finland and companies from the construction business. EPDs are developed and published for building products only.

The activity of the Building Information Foundation RTS on EPDs started in 1988 (RT Environmental Declaration 2011) when the European Union adopted the Construction Product Directive. The directive defines the essential requirements concerning safety and health aspects in construction works. According to essential requirement 3 the environmental impact of building products shall be considered in all stages of the life cycle, a requirement the declarations fulfil. The first declarations were compiled in 1988 through a project with the Building Information Foundation RTS and 26 companies.

Development and verification of PCR and EPD
EPDs are today developed according to the "Methodology for Compiling Environmental Declarations for Building Products and Assessing Environmental Impacts of Buildings", published by the programme (RT Environmental Declaration 2011). The methodology is based on the requirements given in ISO 14020, 14040 and 21930.

Declarations are prepared by the company itself or a consultant before an impartial committee of the Building Information Foundation RTS approves the application. Consultants have to be a specialist within construction engineering and assessment of environmental impacts, and the company is responsible for the information being collected and calculated in an expert manner (RT Environmental Declaration 2011). Verification is done by VTT, which is not recognised as a third party as it is one of the format owners (Bogeskär, Carter, Neven, Nuij, Schmincke, and Stranddorf 2002b).

Declarations are given validity for three years at a time, and can be renewed without LCI calculations if the composition and manufacturing of the product has no changed. The declaration fee to Building Information Foundation RTS is 770 Euros for one product or 895 Euros for a product group.

General format and distribution
The declarations consist of a public document and a background document. The public document is two to three pages long and consist of three parts; the product specification, eco-profile of the product and other environmental aspects. The eco-profile includes life stages from cradle to gate and look at various aspects, including use of natural resources, materials, use of energy and emissions into air and water. Aspects not taken into account by the declaration include indoor air emissions, service life, service and maintaining and final disposal and recycling.

RT has 18 published declarations within the building sector on their website (RT Environmental Declaration 2011). In a report by Bögeskar et al (2002) it was however pointed out that since the format of the declarations is publicly available, a lot of companies are publishing EPDs without giving information back to the foundation. The number of EPDs on the foundation website is therefore misleading as to how many EPDs exist in the Finnish market.

6.5 Germany

Background and organisation

The German programme for environmental product declarations is run by the Institute of Construction and Environment (IBU), formerly known as Arbeitsgemeinschaft Umweltvertägliches Bauproduct (AUB). It was created as an initiative from manufacturers for more sustainability in the construction sector in 1998, and is currently the only organisation in Germany that offers an environmental label based on international standards (IBU 2011).

Both manufacturers, independent research experts, the German Ministry of Construction, the German Environmental Agency (UBA), and health and environmental experts are involved in the work of IBU. The programme has 57 members companies in addition to eight associated members and two supporting members (IBU 2011).

A committee of experts, known as the Advisory board, act as an independent and neutral third body of IBU. Its responsibilities include checking results of the product group forum, validating PCRs and intervening with conflicts of interest (IBU 2011).

Development and verification of PCR and EPD

The development of an EPD starts with a request from the producer for the development of such information. As can be seen in
Figure 12, and as is the requirement in ISO 14025, there is a need for a PCR before the compiling of an EPD can start. PCRs are developed by producers and experts through the product forum, which is then verified by the Advisory board and go through an open consultation through an internet based forum.

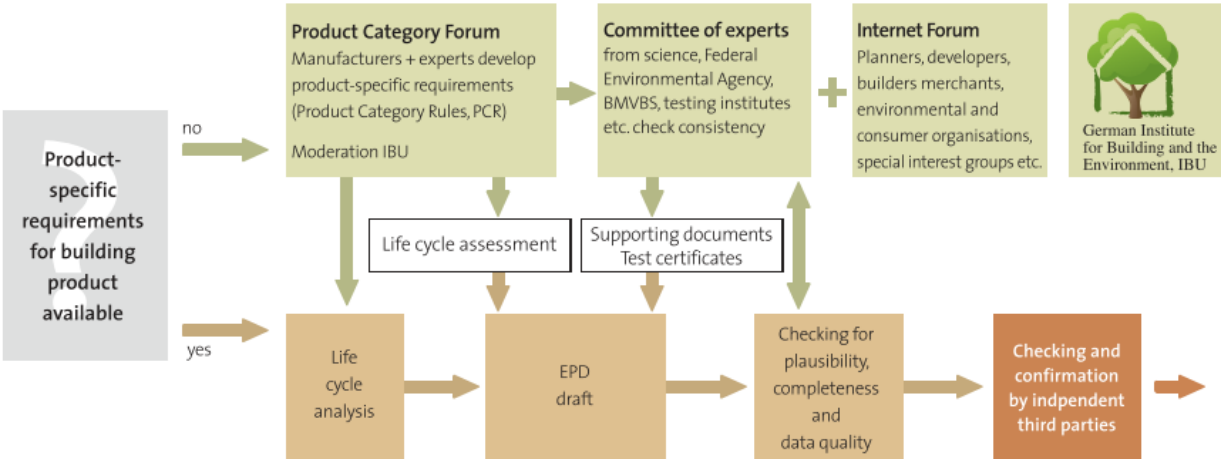

Figure 12: Development of PCR and EPD in IBU (Peters 2009)

When a PCR is in place, the declaration is developed before it is checked and verified by an independent third party, the Advisory board (shown as Committee of experts in
Figure 12). IBU only acts as the programme operator and does not have any influence over the confirmation of the declaration. When the declaration is approved it is published by IBU.

The association is financed through membership, registration and declaration fees (IBU 2011). The membership fee is an annual fee determined by the overall yearly turnover of the company. The general fee for awarding the declaration is 500 Euros. The annual declaration fee starts at 1200 with discounts given according to how many declarations the company has.

General format and distribution
EPD within the German programme is developed on the basis of valid PCRs, in compliance with ISO 14025 and 21930. The declarations include statements on energy and resource use in addition to the environmental impacts of the product throughout the life cycle presented through a number of impact categories. The layout of all EPDs is the same, and includes a short summary of the EPDs in addition to a more detailed version.

IBU has published 144 EPDs within 15 product categories, as shown in Table 10. In addition there are 32 PCRs published on the programme website (www.bau-umwelt.de).

Table 10: Number of EPD sorted by product category (IBU)

Product category	Number of EPD
Bathrooms and sanitary installations	1
Floor coverings	18
Architectural coatings	1
Metals for buildings	12
Roofing and facades	12
Roofing and waterproofing membranes	2
Insulating materials	19
Floor laying substances	7
Glass reinforcement mesh	1
Wooden materials	9
Masonry	13
Plaster and mortar	45
Laminates	1
Lumber	1
Wall and ceiling coverings	2

6.6 Japan

Background and organisation
ECO-LEAF is the programme for Type III environmental declarations, and has been run by JEMAI since 2002. The Japan Environmental Management Association for industry (JEMAI) was established in 1962 and consists of 1100 member companies (JEMAI 2003b). JEMAI serves as the secretariat for three ISO/TC 207 subcommittees, SC3: Environmental labelling, SC4: Environmental performance evaluation and SC5: Life Cycle Assessment.

The ECO-LEAF programme consists of three committees and PSC working groups whose responsibilities are to ensure that new EPDs are prepared, verified and approved accurately and fairly (JEMAI 2002). The relationship between these committees and working groups are shown in Figure 13. Decisions about programme operation and supervision of activities of the PSC and

review committee are taken by the steering committee. The steering committee consists of experts from academia and industry, consumers and public authorities. The PSC committee evaluates PSC proposals developed by the PSC working group and approve the final PSC, and consists of experts from academia and industry in addition to consumers who have a strong knowledge of environment-conscious products and environmental labels. The main responsibility of the review committee is to evaluate certification reviews and the results of verifications. Members of the review committee are LCA experts.

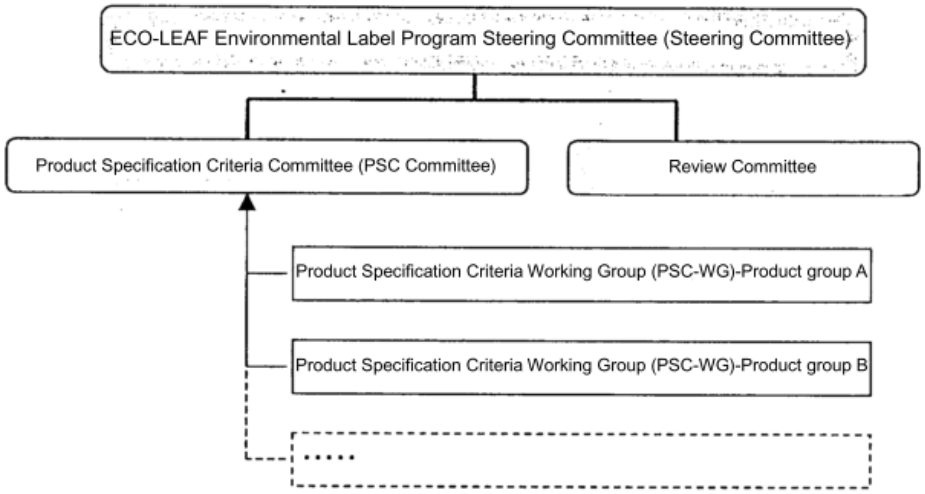

Figure 13: Structure of the ECO-LEAF programme

Development and verification of PCR and EPD

Within the Japanese programme EPDs can be published for industrial products, durable consumer goods and general commodities (JEMAI 2002). EPDs are developed on the basis of product specification criterions (PSC), which are developed by a PSC working group and discussions in the PSC committee. In addition to the PSC the programme guidelines give detailed instructions on data collection and calculation in addition to the content and layout of the EPDs.

In addition to the EPD the company has to prepare supporting documents for verification of the results in the EPD. These are not disclosed to a third party. Verification can be undertaken internally or externally depending on the competence of the company (JEMAI 2002). A company can perform internal validation if they have certification for their data collection system. In the case of an internal verification the verifier must not be involved in the EPD development work.

General format and distribution

The environmental declarations of ECO-LEAF are standardised, and each declaration consists of three different parts. The Product Environmental Aspects Declaration (PEAD) give the basic information about the product and its main environmental impacts. The second part, Product Environmental Information Data Sheet (PEIDS), show the results from the inventory analysis and impact assessments from all life cycled stages. The third and final part, Product Data Sheet

(PDS), show the collected data about the product (JEMAI 2003a). In total all declarations are three pages long.

The ECO-LEAF programme has 131 published EPDs based on 53 published PCRs.

6.7 South Korea

Background and organisation

The programme for EPDs was introduced in Korea in 1996, and implemented in 2001 (ME Korea 2011). The Ministry of Environment (ME) is responsible for the operation of the programme, certification and development of product guidelines. The Korean national type III declaration scheme is privately run, but supported by the Korean government. The Korean Environmental Labelling Association (KELA) has been responsible for the national LCA database since 2002, and functions as the labelling and declaration body (Bogeskär, Carter, Neven, Nuij, Schmincke, and Stranddorf 2002a).

Information about the programme in English is limited, and the EPDs that have been found are not valid anymore. As the information from Bögeskar et al is from 2002, it is hard to say how the programme has developed since then and how much activity there is today.

Development and verification of PCR and EPD

Industry initiates the development of declarations, and companies can request KELA to make declarations for their products. Declarations are made on the basis of product group specific guidelines which are equivalent to the Swedish PCRs (Bogeskär, Carter, Neven, Nuij, Schmincke, and Stranddorf 2002a). These are developed by LCA practitioners upon request of the Ministry of Environment.

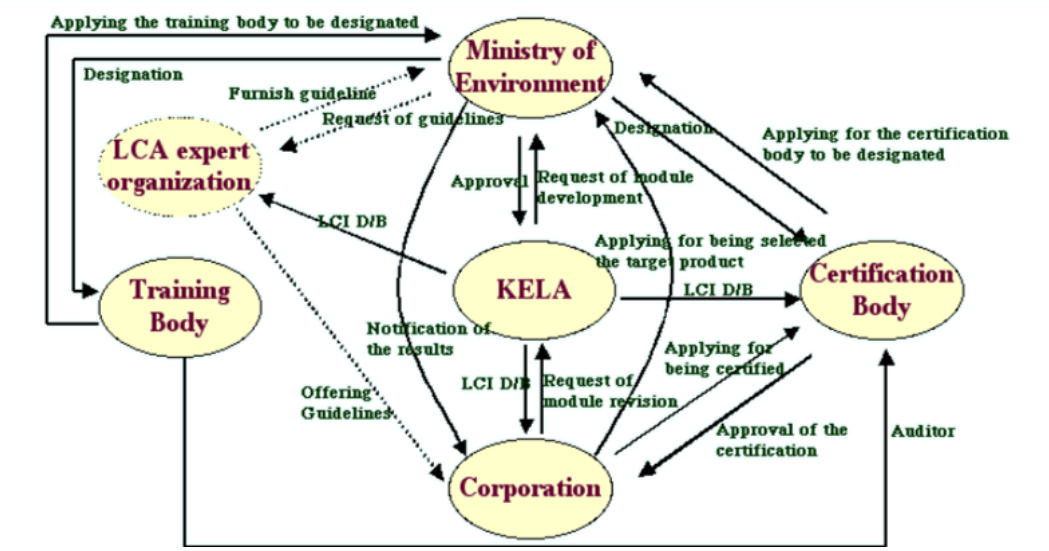

Figure 14: Structure of the Korean Type III Environmental Labelling Programme (Bogeskär, Carter, Neven, Nuij, Schmincke, and Stranddorf 2002a)

Data for development of declarations are provided to companies and LCA practitioners through the national LCA database. All declarations are certified by KAB, and data is checked via audits. This is illustrated in Figure 14.

General format and distribution
The EPDs all have the same layout and format and consists of four parts; front-page, information about the manufacturer, environmental declaration which includes product description, material declaration and environmental information, and an overview of additional certification of the product.

Korea has 22 published EPDs through the programme. These all have the same format, and vary in length from 4 to 7 pages, with the majority of EPDs being 5 pages long.

6.8 Other programmes

The following EPD programmes will not be included in the further analysis, but will be briefly presented to give an overview of other programmes that exist or are under development. These have not been included in the analysis due to lack of information or limited access to EPDs and PCRs. The available information is varying between the programmes, and the presentation will therefore not follow the same structure as above.

6.8.1 Denmark

The Danish EPD programme, 'Miljøvaredeklarationen – MVD-DK', was launched in 2009 (MVD 2011). Currently, PCR of six different product categories have been developed. These categories include electricity and heat, cargo transport, textiles, paper, furniture and windows. Declarations are developed on the basis of ISO 14025 and 14044 and are verified by a third party. The Danish website has scarce information, and have no EPDs published.

6.8.2 France

Contradictory to other countries, the use of EPDs will become mandatory in France for all products and services. Through legislation, the "Grenelle de l'Environment Law"(2007), requires all consumer products sold in France to include an environmental declaration, covering the complete life cycle. Information about the initiative has been difficult to acquire, mainly because most of the information is only available in French or incomplete, as the initiative is still under development.

The initial plan was for all products to at a minimum include a carbon footprint from the beginning of 2011. However, after the adoption of the five-year plan "Grenelle 2: the bill on the national commitment to the environment" in July 2010 (Grenelle environnement 2010), changes were made. A trial of the programme is now planned to start in July 2011 after consultations with stakeholders, and the label should take into account the most significant impacts within each product category in addition to the carbon footprint (MEEDDM 2011b). The sample group is planned to consist of volunteering companies from all sectors and in varying size. 230 groups of companies have volunteered to participate in the trial programme, one third of which are from the food sector (MEEDDM 2011a). The programme will be

managed by the General Commission for Sustainable Development (MEEDDM), and administered by AFNOR, the French standardization organisation.

Guidelines for the development of the declarations are still under development and not yet published.

In addition to the current development of declarations according to Grenelle 2, there already exists a French database for environmental product declarations of building products. The database consists of 612 EPDs (INIES 2009). The distribution of the published EPDs is shown in Table 11. The declarations meet the requirements of the French NF P01-010 standard, which is based on ISO 14025 and 21930.

Table 11: Distribution of French EPD

Product category	Number of EPD
Partitioning / ceiling suspended	187
Cover / sealing	18
Sanitary and bathroom	5
Facades	13
Isolation	190
Interior and exterior joinery and closings	4
Adhesives and glues	81
Floor and wall coverings / paint / decoration products	57
Structure / masonry /structural systems / roof structure	43
Roads / diverse networks	14

INIES consists of a strategic and technical committee. It is the responsibility of the technical committee to take care of gathered data and of updating the contents of the database. Verification of the conformity to NF P01-010 of the EPD is not a compulsory requirement to be admitted to the database, but EPDs which have been verified are distinguished in the database (INIES 2009). The contents of the database are mainly aimed at business to business communication, but can also be of interest to the general public.

6.8.3 Netherlands

The EPD programme in the Netherlands is managed my Milieu Relevante Product Informatie (MRPI) and publish EPDs within the building sector. The project was an initiative of the Dutch Building association (NVTB) and the Ministry of housing started in 1997 (MRPI 2006), and is an industry owned programme (Bogeskär, Carter, Neven, Nuij, Schmincke, and Stranddorf 2002b).

The declarations are based on life cycle analysis from cradle to grave confirming with ISO 14040. The programme does not confirm to ISO 14025 (Bogeskär, Carter, Neven, Nuij, Schmincke, and Stranddorf 2002b). In 2002 the programme included 40 for 40 product categories (Bogeskär, Carter, Neven, Nuij, Schmincke, and Stranddorf 2002b). Information about the programme through the programme website is limited and published in Dutch, no EPDs are available through the programme coordinator.

6.8.4 United States

At date there are no national EPD programmes in the U.S, and the existing programmes have a limited number of published PCRs and EPDs. The Executive Order 13514 (2009) on federal leadership in environmental, energy and economic performance requires Federal Agencies to develop a plan for carbon footprinting of all the goods they purchase, a requirement that an EPD programme would help fulfil. Rita Schenck, executive director of the Institute for Environmental Research and Education (IERE) published in 2010 a roadmap for the establishment of such a programme in the US (Schenck 2010).

In addition to various EPD programme initiatives, the retail store chain Walmart has initiated the Sustainability Consortium, an initiative to document the environmental impacts of all its products through a sustainability index (Walmart 2011). Through the Sustainability Consortium EPDs will be developed in compliance with ISO 14025, but are described as an ISO type III + EPD (TSC 2011). Information is still limited about this programme. The Earth sure and Eco-profile programme will in the following be briefly presented. The information available online is not as extensive as for other programmes, and there are few publicly available EPDs and PCRs, and the programmes are therefore not included in the further analysis.

The Earth sure programme in managed by the Institute for Environmental Research & Education (IERE) and provides EPDs in accordance with ISO 14025 (IERE 2008). The first EPD within the Earth sure programme was developed in 2000 for meat production systems. After this the programme has mainly focused on food and agriculture systems, but is today also developing PCRs within pavement and windows. In the EPD the results of the environmental impacts of the product are compared to US averages for the product.

PCRs are developed in committees consisting of the organisation requesting an EPD, either one upstream vendor or downstream customer and environmental and consumer NGOs. The PCR is reviewed and validated by a third-party panel led by a LCA certified professional. The EPD is developed on basis of the PCR and reviewed internally at IERE and validated by third-party individuals (Earth sure 2009).

The Eco-Profile Programme is managed by Scientific Certification Systems (SCS), an independent, third-party evaluation and certification organisation (Frankl and Rubik 2005). The EPDs within this programme are classified in different categories according to their contents. Basic Environmental Product Declarations give a complete LCA impact profile of the product, and are most similar to other programmes' EPD. Environmentally preferable product declarations identify products that achieve superior environmental performance compared to a standard product baseline. Comparative Product Declarations are based on the American ANSI LCA standard and guarantees fairness and transparency of comparisons between competing products. Other, sector-specific declarations are Comparative Power Declarations and Environmental Building Declarations.

6.8.5 EPD-like programmes

In addition some eco-label programmes have a structure and format similar to those of EPD programmes, and can therefore be mistaken for an EPD programme according to ISO 14025. An

example of this is the Good Environmental Choice Australia (GECA), where each labelled product come with an environmental product declaration (GECA 2011). However, this EPD does not include the elements as required by ISO 14025, rather those of ISO 14024. This is also the case for the British BREEAM system, where certain performance levels within impact categories must be achieved to obtain a certain BREEAM rating (BRE Global 2010). The end product is not a detailed product declaration, but a certification.

6.9 Summary of programmes

Table 12: Summary of EPD programmes

Country	Programme name	Scheme owner	Main focus	From	Standard
Norway	Norwegian EPD Programme	Confederation of Norwegian Enterprise	Building products and furniture	2002	ISO 14025, 21930
Sweden	International EPD System	Swedish Environment Management Council	Various products	1997	ISO 14025, 21930
Finland	RT Environmental Declaration	Building Information Foundation, RTS Confederation of Finnish Construction Industries RT	Building Products	1988	ISO 21930
Germany	IBU	Institute of Construction & Environment	Building Products	1998	ISO 14025, 21930
Japan	Eco-Leaf	Japan Environmental management for Industry	Electronics	2002	ISO 14025
South Korea	Type III Labelling programme	Ministry of Environment	Electronics	2001	ISO 14025
Denmark	Miljøvare-deklarationen	Fonden Dansk Standard		2009	ISO 14025
France	INIES	Département Energie, Santé et Environnement	Building Products		NF P01-010
Netherlands	MRPI	Industry	Building Products	1997	ISO 21930
United States	Earthsure	Institute for Environmental research & education	Food & Agriculture	2000	ISO 14025
United States	Eco-Profile Programme	Scientific Certification Schemes			ANSI LCA standard

Table 12 shows a summary of the main features of each EPD programme. For fields that have been left blank, information has not been available. As can be seen there is a variance between the types of scheme owners. Some programmes are owned by governmental organisations, such as Sweden, South Korea and France. The remaining programmes are owned by various private organisations from the industry, research institutes or foundations which are a mixture of both.

Finland has had initiatives and work on declarations for the longest time, dating back to 1988. The other programmes mainly started developing towards the end of the 20th and beginning of 21st century. Generally all programmes are developed on the basis of ISO 13025 with the exception of the Finnish, Dutch, French and American programmes.

7 Analysis

The main characteristics of EPDs are objectivity, credibility and comparability. In order for these characteristics to be fulfilled, it is important that the basic data included in an EPD are calculated in the same way using the same requirements. In the following analysis three different elements have been analysed. The compliance of PCRs with ISO 14025, the compliance of EPDs with ISO 14025 and a more detailed comparison of EPDs of the various EPD programmes.

7.1 Compliance of international programmes with ISO 14025:2006: PCR

7.1.1 Requirements from ISO 14025

ISO 14025 gives guidance to the development of PCRs through the requirements summarised in Table 13. Most of the criteria for the PCR coincide with the requirements and format of performing a LCA which was explained in chapter 3.3. Similar to the LCA, the contents of the PCR can be divided into three parts; goal & scope, inventory analysis and impact assessment. All parts of the LCA should be performed according to ISO 1440.

From each EPD programme five PCRs have been selected. Since the EPDs of the Finnish programme are not developed on the basis of PCRs, the RT EDP programme has not been included in this part of the analysis. ISO 14025 was not published till 2006, and emphasis has therefore been put on PCRs published after this date with respect to the selection of PCRs. The German programme has only four PCRs published in English, thereby limiting their selection. Details about the PCRs and their corresponding number, given in this analysis, can be found in Appendix I.

Table 13: Requirements of contents of PCR from ISO 14025 shown as criterion for compliance (ISO 2010b)

No.	Criterion
1	Definition and description of product category
2	Functional or declared unit
3	System boundaries
4	Description of data
5	Cut-off rules
6	Data quality requirements
7	Units
8	Inventory analysis
9	Impact category selection & calculation rules
10	Predetermined parameters for reporting LCA data
11	Requirements for additional environmental information
12	Materials and substances to be declared
13	Format and content instructions
14	Period of validity

If there are deviations or special conditions of the requirements in the PCR, this should be specifically stated and explained. If this has been done in the PCR, the criterion will be seen as met in the preceding analysis.

Criterion 1: Definition and description of product category
Areas to be covered by the description and definition can for example include technical performance, function and use of the product category. In order for the criterion to be fully met, both definition and description must be included. For PCRs which only include one or the other, the criterion will be seen as partially met.

Criterion 2: Functional or declared unit
Functional or declared unit must be defined in the PCR so that EPDs based on the same PCR use the same unit. The same functional or declared unit is necessary in comparison of products. The unit should be expressed in SI units (kg, J, meters, etc.).

Criterion 3: System boundaries
System boundaries for LCA should be clearly stated, through for example geography, time dimension, separation from related product systems and life cycle stages. If the LCA is not based on the entire life cycle, information should be given on which stages are not included.

Criterion 4: Description of data
The description of data should include the level of detail of the LCA and the required quality of the data.

Criterion 5: Cut-off rules
The cut-off-rules describe the criteria for the inclusion of inputs and outputs in the analysis.

Criterion 6: *Data quality requirements*
Data quality requirements should include coverage, precision, completeness, representativeness, consistency, reproducibility, sources and uncertainty. The PCR should additionally give guidelines to the use of specific and generic data, and the databases to be used.

Criterion 7: Units
The PCR should determine which units to be used in the life cycle analysis, and in the presentation of results in the EPD.

Criterion 8: Inventory analysis
The inventory analysis must consist of data collection, calculation rules and allocation rules in order for the criterion to be seen as fully met in the analysis. If one or two elements are missing in the PCR, the criterion will be seen as partially met.

Criterion 9: Impact category selection and calculation rules
The PCR should determine which impact categories to be used for the presentation of impacts in the EPD, and the calculation rules to be used when determining impacts. For a PCR which only includes the impact categories without calculation rules, the criterion will be seen as partially met.

Criterion 10: Pre-determined parameters for reporting LCA data

Predetermined parameters for reporting of LCA data should be a part of the PCR; this includes inventory data categories and impact category indicators. The predetermined parameters specify which environmental information regarding a product, which is to be included in the EPD, in addition to the impact categories.

Criterion 11: Requirements for additional environmental impacts
The PCR should define the additional environmental impacts which should be included in the EPD (e.g. documentation of environmental management systems, impacts on biodiversity or preferred waste management). Methodological requirements (e.g. specifications for hazard and risk assessment) should also be included if relevant.

Criterion 12: Materials and substances to be declared
A list of content of materials in the product to be declared in the EPD should be included in the PCR. If relevant, the PCR should give a list of chemicals (toxic & persistent/bio-accumulative or human toxic) that have to be provided in the EPD.

Criterion 13: Format & content instructions
Instructions on the format and content of the EPD should be provided in the PCR. For a PCR which only includes guidelines for contents, or a reference to the programme guidelines, the criterion is seen as partially met.

Criterion 14: Period of validity
The period of validity of the PCR should be clearly stated in the document.

7.1.2 Summary of results
Table 14 shows how the analysed PCRs comply with the requirements of ISO 14025. One can observer that, with a few exceptions, the PCRs generally comply with most of the requirements.

Among the Norwegian PCRs none include data quality requirements. The Swedish PCRs have the greatest variance within the programme. There are no clear trends, and the deviations from the standard includes some requirements only being partially met, one PCR which does not include data quality requirements and another which lacks period of validity. All of the Japanese PCRs lack the functional unit, and most of them do not define data quality requirements or units. Only one of the German PCRs included units to be used in the EPD, and none of the PCRs included calculation rules for the inventory analysis and impact categories.

The South Korean PCRs fulfil the least criteria. Neither requirements for additional environmental information materials and substances to be declared, nor period of validity is included. Additionally only one PCR include units to be used in the EPD. Only two of the South Korean PCRs include both format and content instructions for the EPD.

In total only seven out of all the analysed PCRs fulfil the criterion of format and content instructions for EPDs. Other criteria that many PCRs fail to comply with are the inventory analysis and the impact category selection & calculation rules; in which many PCRs only meet

the criterion partially because calculation rules are not included. None of the analysed PCRs meet all the criteria of the analysis and thereby fully complying with ISO 14025.

Table 14: Compliance of PCR with ISO 14025

Criterion:		Norway					Sweden					Japan				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Definition & description															
2	Functional or declared unit															
3	System boundaries															
4	Description of data															
5	Cut-off rules															
6	Data quality requirements															
7	Units															
8	Inventory analysis															
9	Impact category selection & calculation rules															
10	Predetermined parameters for reporting LCA data															
11	Requirements for additional env. Inf.															
12	Materials & substances to be declared															
14	Format & content instructions															
15	Period of validity															

Criteria met
Criteria partially met
Criteria not met

Criterion:		Germany				South-Korea				
		16	17	18	19	20	21	22	23	24
1	Definition & description									
2	Functional or declared unit									
3	System boundaries									
4	Description of data									
5	Cut-off rules									
6	Data quality requirements									
7	Units									
8	Inventory analysis									
9	Impact category selection & calculation rules									
10	Predetermined parameters for reporting LCA data									
11	Requirements for additional env. Inf.									
12	Materials & substances to be declared									
14	Format & content instructions									
15	Period of validity									

7.2 Compliance with ISO 14025:2010 of international programmes: EPD

7.2.1 Requirements from ISO 14025

An Environmental Product Declaration should follow the requirements of the PCR, where units of measurement, methods of systems and the format are defined. In addition, ISO 14025: 2010 lists a number of elements the EPD should provide in accordance with the PCR it builds upon.

These 15 elements will be utilised as the required criterion by ISO 14025 for the analysis of compliance, as summarized in Table 15.

A range of five or ten EPDs has been selected to check compliance of the programme with ISO 14025. The number of EPDs selected depends on the variations within the programme and how many EPDs are available. For programmes with little variance in the presentation of the EPDs only five EPDs have been included in the analysis. A list identifying the various EPDS which have been selected is presented in Appendix II. The programmes will be presented in the same order as the overview of the programmes given in chapter 6.

Table 15: Criterion for contents of EPD from ISO 14025

No.	Requirement
1	Organisation identification and description
2	Product description
3	Product identification
4	Programme information
5	PCR identification
6	Date of publication and period of validity
7	LCA/LCI data
8	Information about life cycle boundaries
9	Additional environmental information
10	Content declaration
11	Mandatory statement
12	Reference to explanatory material
13	Demonstration of verification

Criterion 1: Organisation identification and description
The organisation making the declaration should be clearly identified and described. For the analysis this has been understood as company specifics such as logo, name, address and website. In addition, a minimum of descriptions regarding the main areas of activity is required. If only the organisation identification is included the criterion is seen as partially met.

Criterion 2 and 3: product description and identification
A description of the product should be given, in addition to product identification. The product identification can for example be the model number.

Criterion 4: Programme information
At a minimum, the names of either the EPD programme or programme operator should be given, in addition to address, logo and website. If only one or the other is included, the criterion will be seen as partially met.

Criterion 5: PCR identification
The PCR the EPD builds upon should be clearly referenced, and details of the PCR should be available for the user upon request. For this criterion to be met the EPD should at a minimum include the PCR name or number.

Criterion 6: Date of publication and period of validity
Both the publication date and period of validity or expiry date is to be included in the EPD. If only one date is included the criterion will be seen as partially met.

Criterion 7: LCI/LCA data
Data from relevant LCA-studies, LCI-studies or information modules should be included. Some categories that can be included are given in the standard, but are not given as requirements. For compliance with the standard, it is therefore only required that such information is included in the EPD. The contents of LCA/LCI data will be further analysed in chapter 7.3.6, as part of the comparison of EPD.

Criterion 8: Information about life cycle boundaries
In cases where the LCA is not based on the entire life cycle, this has to be made clear in the EPD. Information about which stages of the life cycle that are not included should be given. This criterion is seen as met as long as it is clearly stated in the EPD which life cycle stages are included and not.

Criterion 9: Additional environmental information
Additional environmental information is to be included in the EPD where this is relevant, and should only be related to environmental issues. In the analysis, the criterion is seen as met if information is given in a separate part of the EPD than the LCA/LCI results. Only information related to environmental issues will be accepted even though information is given under the chapter heading “Additional information”.

Criterion 10: Content declaration
The EPD should also include a content declaration of the product which covers materials and substances to be declared. This requirement does not apply for “proprietary information relating to materials and substances covered by intellectual property rights or similar legal restrictions” (ISO 2010b). In the analysis, the criterion is seen as met even if the list of materials does not include weight and ranges of the materials.

Criterion 11: Mandatory statement
All EPDs must include a statement saying that environmental declarations from different programmes may not be comparable. For the analysis this has been called the “mandatory statement”.

Criterion 12: Reference to explanatory material
Information about where explanatory material may be obtained should be provided for the user through the EPD. It has not been considered sufficient with a reference to the programme website for this criterion to be seen as met.

Criterion 13: Demonstration of verification
Finally, a demonstration of verification is to be included. The information required is the name and organisation by whom the PCR review was conducted by, and whether the verification of the declaration and data has been conducted internally or externally. For business-to-consumer

communication a name of the third party verifier is required. This is optional for business-to-business communication.

7.2.2 Norway

From the Norwegian EPD programme ten EPDs have been checked for compliance to ISO 14025. EPD are chosen within each of the five product categories of the programme. As shown in Table 16 there are varying results, and no clear pattern of compliance. None of the assessed EPDs fulfil all requirements of ISO 14025.

Table 16: Compliance with ISO 14025 - Norwegian EPD programme

	Criteria:	1	2	3	4	5	6	7	8	9	10
1	Organisation Identification and description										
2	Product description										
3	Product identification										
4	Programme information										
5	PCR identification										
6	Date of publication and period of validity										
7	LCI/LCA Data										
8	Information about Life Cycle boundaries										
9	Additional environmental information										
10	Content declaration										
11	Mandatory statement										
12	Reference to explanatory material										
13	Demonstration of verification										

Criteria met
Criteria partially met
Criteria not met

The EPDs have to some extent the same format and contents, but depending on the organisation producing the EPD, there are variances within formulations, which information that is included and with regards to colour and logo use.

The requirement that most EPDs does not fully meet is the organisation identification and description. All EPD include an organisation identification consisting of name, logo and contact information, but only three of the assessed EPD include a short description of the producer. In addition three EPDs lack a description of the product.

Three EPDs do not have the date of publication included in the EPD, only the date of which it is valid to. Two EPDs do not have a content declaration of the materials, both of these from the product category “Chemicals”. Instead, the EPDs include a more detailed description of the product and its production process.

Three EPDs, all of which are prepared by different organisations, does not include the mandatory statement. One EPD lacks reference to explanatory material.

Three EPDs, all of which are prepared by different organisations, does not include the mandatory statement. One EPD lacks reference to explanatory material.

7.2.3 Sweden

For the international EPD system, 42 EPDs have been checked for compliance to ISO 14025. For Sweden and Italy, which are the two countries with the most EPDs, ten EPDs for each country have been selected; whilst for the remaining countries all EPDs published in English have been used. The results of the analysis are presented in Table 17 and Table 18.

Even though an EPD complies with the criteria of ISO 14025, it does not mean that it is presented in the same way with the same amount of information. The international EPD system is one of the EPD programmes where the variation between layout and contents is the biggest between the EPDs. This will be further presented and discussed in chapter 7.3.

Table 17: Compliance with ISO 14025 - The international EPD system, Sweden and Italy

	Criteria:	Sweden										Italy									
		11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1	Organisation Identification and description																				
2	Product description																				
3	Product identification																				
4	Programme information																				
5	PCR identification																				
6	Date of publication and period of validity																				
7	LCA/LCI data																				
8	Information about Life Cycle boundaries																				
9	Additional environmental information																				
10	Content declaration																				
11	Mandatory statement																				
12	Reference to explanatory material																				
13	Demonstration of verification																				

Criteria met
Criteria partially met
Criteria not met

From Table 17 and 6 one can observe that the criterion that the most EPDs fail to comply with is the mandatory statement, stating that EPDs from other programmes may not be comparable. 19 out of the 42 EPDs lack this statement. Five EPDs lack a demonstration of verification. Especially for the Japanese EPD this can be seen in four out of five of those included.

Many of the EPDs lack parts of the programme identification. According to ISO 14025, the declaration should include “name of programme and the programme operator’s address and, if relevant, logo and website”. Most EPDs have only included the programme logo and/or the website without stating the programme’s name, these are indicated by the grey boxes (criterion partially met). The same programme logo has not been used in all EPDs, which can result in confusion as to who the programme operator actually is. Some EPDs which meet the criterion also include a short description of the programme.

Table 18: Compliance with ISO 14025 - The international EPD system, other countries

	Criteria:	Pol	NL	UK	Taiwan		Spain		U.S		Czech		Japan				Switzerland						
		31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
1	Organisation Identification and description																						
2	Product description																						
3	Product identification																						
4	Programme information																						
5	PCR identification																						
6	Date of publication and period of validity																						
7	LCA/LCI data																						
8	Information about Life Cycle boundaries																						
9	Additional environmental information																						
10	Content declaration																						
11	Mandatory statement																						
12	Reference to explanatory material																						
13	Demonstration of verification																						

Criteria met
Criteria partially met
Criteria not met

The criterion with the most variation is the date of publication and period of validity. Some EPDs present only the publication date, some only the expiry date and others both or one or the other in addition to the length of validity. Two EPDs, both from Taiwan, have no dates in them at all.

7.2.4 Japan

Table 19: Compliance with ISO 14025 - Ecoleaf

	Criteria:	53	54	55	56	57	58	59	60	61	62
1	Organisation Identification and description										
2	Product description										
3	Product identification										
4	Programme information										
5	PCR identification										
6	Date of publication and period of validity										
7	LCA/LCI data										
8	Information about Life Cycle boundaries										
9	Additional environmental information										
10	Content declaration										
11	Mandatory statement										
12	Reference to explanatory material										
13	Demonstration of verification										

Criteria met
Criteria partially met
Criteria not met

Compliance of the Japanese EPD programme Ecoleaf is shown in Table 19. Ten EPDs from different product groups and have been compared with the EPD criteria in ISO 14025. One can

observe that even though Ecoleaf has a standardised format of their EPDs, the content of all EPDs are not the same. In addition the EPDs do not meet all criteria of the standard.

None of the EPDs include the mandatory statement, nor a reference to where one can find additional explanatory material. The criterion of organisation identification and description are only partially met because only organisation logo and name is included in the EPDs, not a description.

Six of the assessed EPDs include the date of publication, but do not state anything with respect to period of validity. The remaining four EPDs include no information about publication and validity. The same four EPDs have not included PCR reference or demonstration of verification.

7.2.5 Finland

The finish EPD programme, RT Environmental Declaration, has EPDs for building materials in a standardised format and layout. As seen in Table 20 they lack quite a few of the requirements stated in ISO 14025. As explained in the information about the programme in chapter 6.4 the Finnish programme does not set out to comply with ISO 14025, but with ISO 21930. However, in chapter 4.5, in the description of ISO 21930 it can be seen that the requirements of ISO21930 build upon ISO 14025. The Finnish EPD programme has therefore been included in the analysis.

The EPDs do not have information about which stages of the life cycle are included and not. In addition the mandatory statement is not included; there is no demonstration of verification or PCR identification.

Table 20: Compliance with ISO 14025 – RT Environmental Declarations

	Criteria:	63	64	65	66	67	68	69	70	71	72
1	Organisation Identification and description										
2	Product description										
3	Product identification										
4	Programme information										
5	PCR identification										
6	Date of publication and period of validity										
7	LCA/LCI data										
8	Information about Life Cycle boundaries										
9	Additional environmental information										
10	Content declaration										
11	Mandatory statement										
12	Reference to explanatory material										
13	Demonstration of verification										

Criteria met
Criteria partially met
Criteria not met

All EPDs have included the organisation name and address, but no further description of it. The same can be seen for the programme operator, where all that is included is the programme logo and name. Four EPDs lack reference to where the user can find more explanatory

materials. For the criterion of content declaration, some of the EPDs mention some of the materials needed in production, but there is no detailed overview as found in other EPD programmes.

7.2.6 Germany

In the German EPD programme of IBU, EPDs are mainly published in German. The format and layout of the EPD are very similar, and in combination with few EPDs available in English the selection of EPD is smaller for this programme.

As can be seen in Table 21, the EPDs assessed all fulfil the same requirements of ISO 14025, and the only criterion not met at all is the mandatory statement. The organisation is identified through logo, name and contact information, but a description of its activities is not included.

Table 21: Compliance with ISO 14025 - IBU

	Criteria:	73	74	75	76	77
1	Organisation Identification and description					
2	Product description					
3	Product identification					
4	Programme information					
5	PCR identification					
6	Date of publication and period of validity					
7	LCA/LCI data					
8	Information about Life Cycle boundaries					
9	Additional environmental information					
10	Content declaration					
11	Mandatory statement					
12	Reference to explanatory material					
13	Demonstration of verification					

Criteria met
Criteria partially met
Criteria not met

7.2.7 South Korea

The validity of the EPDs published on the websites of the South Korean EPD programme has run out, but are nonetheless included in this part of the analysis for comparison to other programmes.

The South Korean EPD Programme is one of the programmes where the layout, format and contents of the EPDs are standardised, and thereby very similar. As seen from the results in Table 22 all EPDs in the programme that have been assessed meet the same criterion.

The EPDs all lack the mandatory statement, as well as references to explanatory material and the demonstration of verification. However, the EPDs have a statement at the end of the EPD confirming that the EPD has been compiled according to “the law 21th environmental technology development and support” in addition to contact information of the certification team. The EPDs only focus on the LCA results, and do not include any additional environmental information.

Table 22: Compliance with ISO 14025 - South Korean EPD programme

	Criteria:	78	79	80	81	82	83	84	85	86	87
1	Organisation Identification and description										
2	Product description										
3	Product identification										
4	Programme information										
5	PCR identification										
6	Date of publication and period of validity										
7	LCA/LCI data										
8	Information about Life Cycle boundaries										
9	Additional environmental information										
10	Content declaration										
11	Mandatory statement										
12	Reference to explanatory material										
13	Demonstration of verification										

Criteria met
Criteria partially met
Criteria not met

7.2.8 Summary of results

Figure 15 shows a summary of the results of the analysis of compliance with the requirements of ISO 14025. Each requirement shows a bar-graph for every country which shows the percentage of EPDs which meet the criteria fully, partially and not met within each programme.

As can be seen in the graphs, requirement 1, 2, 3, 4, 6 and 7 are those that are met fully or partially by the most EPDs from the most programmes. These requirements cover most of the basic information that is found in an EPD. Requirement 11, which refers to the mandatory statement, can be seen the requirement that least EPDs meet throughout the programmes.

The Norwegian programme has the EPDs which meet the most requirements compared to the other programmes included in this analysis. In the German and Finnish programmes all EPD meet the same requirements, and the Swedish programme is where the most variation is seen.

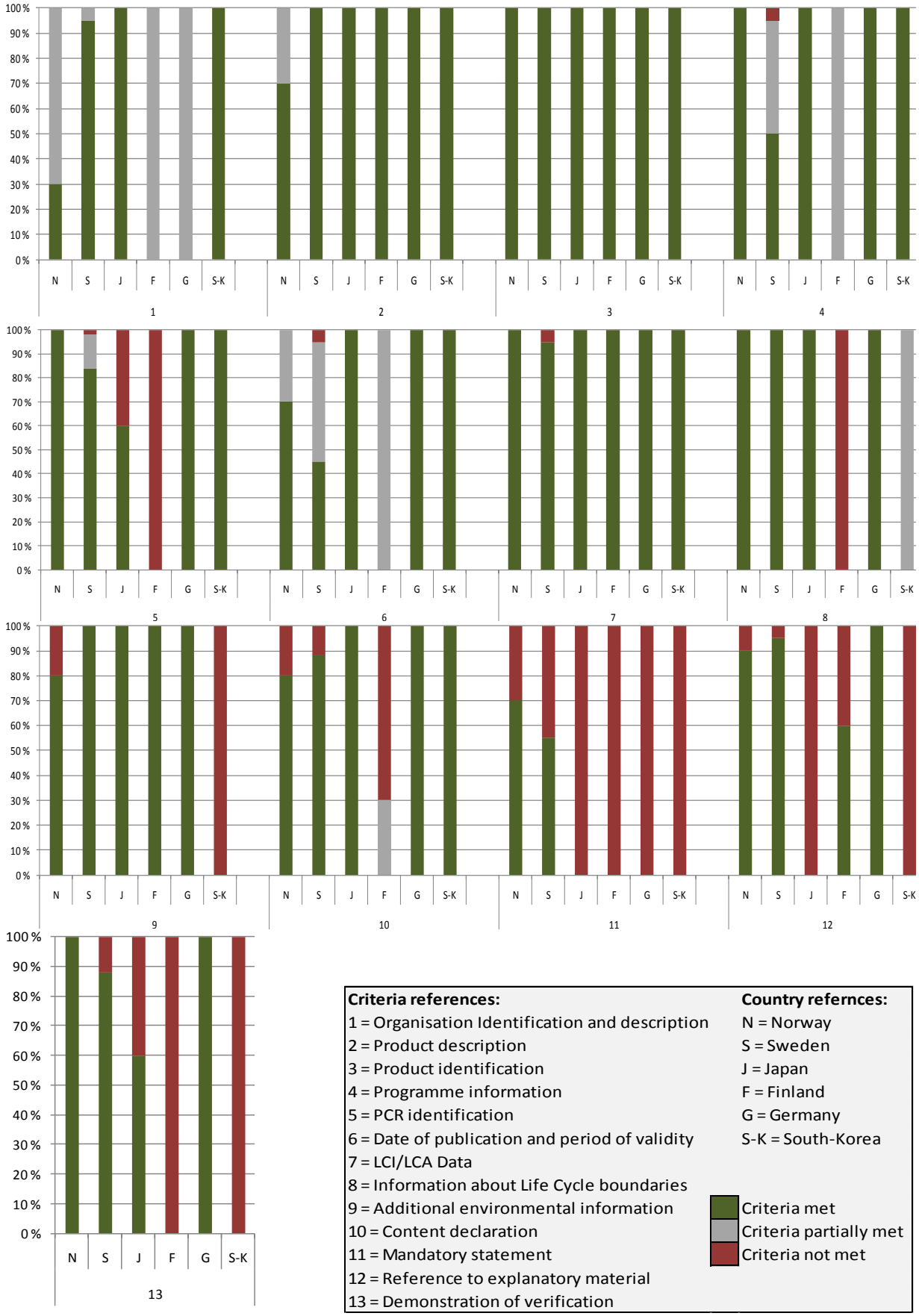

Figure 15: Summary of results of compliance with ISO 14025

7.3 Comparison of EPD

Even though the EPDs in the previous chapter mostly comply with the requirements of ISO 14025, the format and content of the EPDs are quite different. Especially between different programmes, but also within the various programmes differences can be seen. In this part a selection of EPDs will therefore be analysed in greater detail.

From each programme five EPDs have been selected for this part of the analysis, with the exception of the Swedish programme. From the International EPD system ten EPDs have been included, three from Sweden and Italy, which have the most EPDs, in addition to one EPD from Spain, Czech Republic, Japan and Switzerland. This has to be done in order to see if variances can be related to the country of origin of the EPD. In total 30 EPDs have been selected. A detailed overview of these EPDs can be found in Appendix I. The selected EPDs were also part of the analysis of compliance done in chapter 7.2. With respect to the results, the EPD number will refer to the EPD number given in this table.

When selecting EPDs the publishing year has been taken into consideration, and an effort to include newer EPDs has been made. This is due to development within format structure in the various EPD programmes. Furthermore, there have been attempts at harmonisation between and inside the programs. Only EPDs which are still valid have been included. EPDs from South Korea are therefore not included in this part of the analysis.

7.3.1 Comparison criteria

A summary of the criteria used for the comparison of the EPD is given in Table 23.

Table 23: Evaluation criterion for of EPD

No.	Criterion
1	Length
2	Period of validity
3	Contents of the front page
4	Structure of the EPD
5	Presentation of environmental impacts
6	Additional environmental information included in the EPD

Criterion 1: Length

As presented in the programmes' description in chapter 6, there is a large variance in the length of the EPD. Some programmes have a standardised length for their EPD, others do not. Length will be given in number of pages.

Criterion 2: Period of validity

The period of validity of EPD is not defined in ISO 14025. ISO 14025 only requires that the EPD's period of validity is presented through the EPD. This is usually either defined in the programme guidelines or the PCR. The period of validity will be presented as number of years the EPD is valid from its publishing or review date.

Criterion 3: Contents of front page
Some EPDs have a clearly defined front-page with limited information, whilst others present start the presentation of information and results on the first page of the document. The front page will in this part of the analysis be defined as the first page of the EPD regardless of whether it is a front page as such, or the first page of the EPD. A comparison of the contents of this page will be done and commented on. In addition the logo used to identify the EPD programme will be compared within each programme, as this may differ between the EPDs.

Criterion 4: Structure of EPD
The structure of the EPDs will be analysed by looking at the main contents of the EPD and the order in which it is presented. Some programmes will have a standardised structure, whilst others will vary from EPD to EPD. A comparison will be made within the EPD program if differences are observed.

Criterion 5: Presentation of impact indicators
ISO 14025 does not give requirements regarding the life cycle impact assessment in the EPD. These are given individually in the PCR document. For comparability of EPDs, however, it is a requirement that the impact category selection and calculation rules are identical (ISO 2010b). A suggestion of indicators given in ISO 14025 to be used in the LCIA is shown in Table 24.

Due to this, great variance can be seen in the presentation of the environmental impact categories in the EPDs. In this analysis a comparison has been made with regard to selected categories, names of the categories, how the numbers are presented, use of figures and graphs, and the units which the results are presented in.

Table 24: Suggested LCIA indicators from ISO 14025

No.	Name of indicator
1	Climate change
2	Depletion of the stratospheric ozone layer
3	Acidification of land and water sources
4	Eutrophication
5	Formation or photochemical oxidants
6	Depletion of energy resources
7	Depletion of mineral resources
0	Other

Criterion 6: Additional environmental impacts
According to ISO 14025 the EPD should when relevant include “information related to environmental issues, other than the environmental information derived from LCA, LCI or information modules” (ISO 2010b). The information should be separated from the LCA, LCI or information modules. Environmental aspects which should be taken into consideration according to ISO 14025 are given in Table 25.

Table 25: Additional environmental aspects which can be included in an EPD (ISO 2010b)

No.	Environmental aspect
1	Impacts and potential impacts on biodiversity
2	Toxicity related to human health and/or the environment
3	Geographical aspects relating to any stages of the life cycle
4	Data on product performance, if environmentally significant
5	Organisation's adherence to environmental management systems
6	Other environmental certification programme applied to the product
7	Other environmental activities of the organisation
8	LCA information not communicated in LCI or LCA
9	Instructions and limits for efficient use
10	Hazard and risk assessment in human health and the environment
11	Absence/level of presence of materials considered of environmental significance
12	Preferred waste management option for the product
13	Potential incidents that can have impacts on the environment

7.3.2 Length

Table 26: Length of EPD

Country	Norway					International EPD system									
EPD no.	1	3	4	9	10	13	15	18	21	26	27	34	36	40	49
Nr. pgs	4	4	4	4	4	8	12	4	11	10	18	7	25	10	6

Country	Japan					Finland					Germany				
EPD no.	53	54	58	59	62	64	65	67	69	72	73	74	75	76	77
Nr. pgs	3	3	3	3	3	2	2	2	2	2	21	15	20	22	18

In Table 26 the lengths of the analysed EPDs are given. The lengths of the EPDs vary from 2 pages to 25. As can be seen, EPDs within the programmes in Norway, Japan and Finland are of the same length. The biggest variance can be seen in the Swedish programme where the lengths vary between 4 and 25 pages.

7.3.3 Period of validity

Table 27: Validity of EPD

Country	Norway					International EPD system									
EPD no.	1	3	4	9	10	13	15	18	21	26	27	34	36	40	49
Nr. yrs	3	5	5	5	5	3	1	1	3	1	3		4	2	3

Country	Japan					Finland					Germany				
EPD no.	53	54	58	59	62	64	65	67	69	72	73	74	75	76	77
Nr. yrs											3	3	3	3	3

The length of the validity of the EPDs varies greatly, as shown in Table 27. Neither the Japanese nor the Finnish EPDs includes this in their EPDs, and it is therefore uncertain for how long these EPDs are valid. The German EPDs have all a validity of three years from publishing. Most of the Norwegian EPDs have a validity of five years, except from one which is only valid for three years.

The greatest variance within the programme can be seen in the International EPD system where EPDs are valid between one and four years[2].

7.3.4 Contents of front page

The contents of each EPD are shown in Table 28.

Table 28: Contents of front page

Country	Norway					International EPD system										Japan					Finland					Germany				
EPD no	1	3	4	9	10	13	15	18	21	26	27	34	36	40	49	53	54	58	59	62	64	65	67	69	72	73	74	75	76	77
Programme Logo	■	■	■	■	■	■	■	■	■	■	■			■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Producer logo	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■					
EPD id	■	■	■	■	■	■	■	■	■	■	■			■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
Picture of profuct	■	■	■	■	■	■	■	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
"Summary" of LCA results	■	■	■	■	■			■				■			■	■	■	■	■	■										
Validity	■	■	■	■	■	▒	▒		▒	▒	▒		▒	▒		▒	▒	▒	▒		▒	▒	▒	▒	▒					
Reference to ISO 14025	■	■	■	■	■									■		■	■	■	■							■	■	■	■	■
PCR reference	■	■	■	■	■								■	■		■	■	■	■	■										
Verfiication	■	■	■	■	■											■	■	■	■											
Product information	■	■	■	■	■			■				■			■	■	■	■	■	■	■	■	■	■	■					
Producer information	■	■	■	■	■			■				■				■	■	■	■	■	■	■	■	■	■	▒	▒	▒	▒	▒
Graph/Figure of impacts																■	■	■	■	■						▒	▒	▒	▒	▒
Conversion factors																					■	■	■	■	■					
Technical properties																					■	■	■		■	■				

■ Present
▒ Partially present
Not present

Norway

Within the five EPDs in the Norwegian EPD programme, three different logos have been used, as shown in Figure 16. EPD no. 4 uses logo no. 1, EPD no. 3 logo no. 2 and the remaining three EPDs use logo no. 3. EPD no 3 is from 2007, which could explain why a different logo has been used; in addition this EPD is published in Norwegian, which would indicate why the logo is in Norwegian, and not in English like the other two. The use of different logos is the result of development of new logos, and that already published EPDs have not been updates (Malnæs 2011). Logo no. 1 is the newest logo, and then one that will be used in the future.

1. epd-norge.no The Norwegian EPD Foundation
2. EPD Næringslivets Stiftelse for Miljødeklarasjoner
3. epd-norge.no The Norwegian EPD Foundation

Figure 16: Logos used in the Norwegian EPD programme

On the front page of the Norwegian EPDs, a short summary of the LCA results is included. All EPDs include the results of global warming potential and energy consumption. In addition, two of the EPDs include the percentage of recycled materials and the guarantee period.

[2] According to the programme guidelines, validity is generally set to three years in the case of external verification or adjusted to reflect the dynamics of the analysed product system and its industry. In the case of a longer or shorter period of validity this should be defined through the PCR (IEC 2008).

Sweden
Most of the EPDs from the International EPD system have the same structure and content on the front page. There is a picture of the product, a producer logo, the logo of the EPD programme, EPD identification and the publishing date. However, there are some EPDs which differ from this standard, especially among the EPDs which are not from Italy or Sweden. Three EPDs, no. 34, 36 and 40, do not have the programme logo or EPD identification. Another EPD which stands out is no. 18, from Sweden, an EPD of an office chair where the format can remind slightly of the EPD of the Norwegian EPD programme. Out of the EPDs with a programme logo, the same logo has been used. Other logos of the EPD programme can be seen on older EPDs which have not been included in this part of the analysis.

Japan
Within the Japanese EPD programme, Ecoleaf, the front page of the EPD is standardised, and the format and contents are given in the programme instructions as explained in chapter XX. In addition to the same elements as in the Norwegian programme, the Japanese include a graph showing the impacts of global warming impact in each life stage. In the EPDs that have been analysed, the short summary of environmental impacts include the same impact categories; energy consumption, global warming impact and acidification impact. One EPD does not contain the publishing date, nor a reference to ISO 14025 and no verification on the front page. However this EPD is from 2008 and is the oldest EPD included in the analysis, which could explain the limitations.

Finland
Since the Finnish EPDs are only two pages long, they include some more information compared to the other programmes. The product is more extensively described through object definition, conversion factors and technical properties. The layout of all EPDs is the same.

Germany
The German EPDs all have the same layout and they include less information compared to many of the other programmes. This can be related to the fact that the German EPDs generally are longer than the others, and therefore less information is necessary on the front page. The same information which is found on the front page of the Norwegian EPDs can be found in the two page summary of the EPD following the front page.

7.3.5 Structure of EPD

Norway
For the Norwegian EPD programme the structure of each EPDs is quite similar. As seen in Figure 17, there are few differences in the contents and in the order of the various elements. The graph shows the main elements found in the EPD on the y-axis, and the order of the contents in the EPD on the x-axis. Four of the EPDs include 17 elements, whereas the last one has 16.

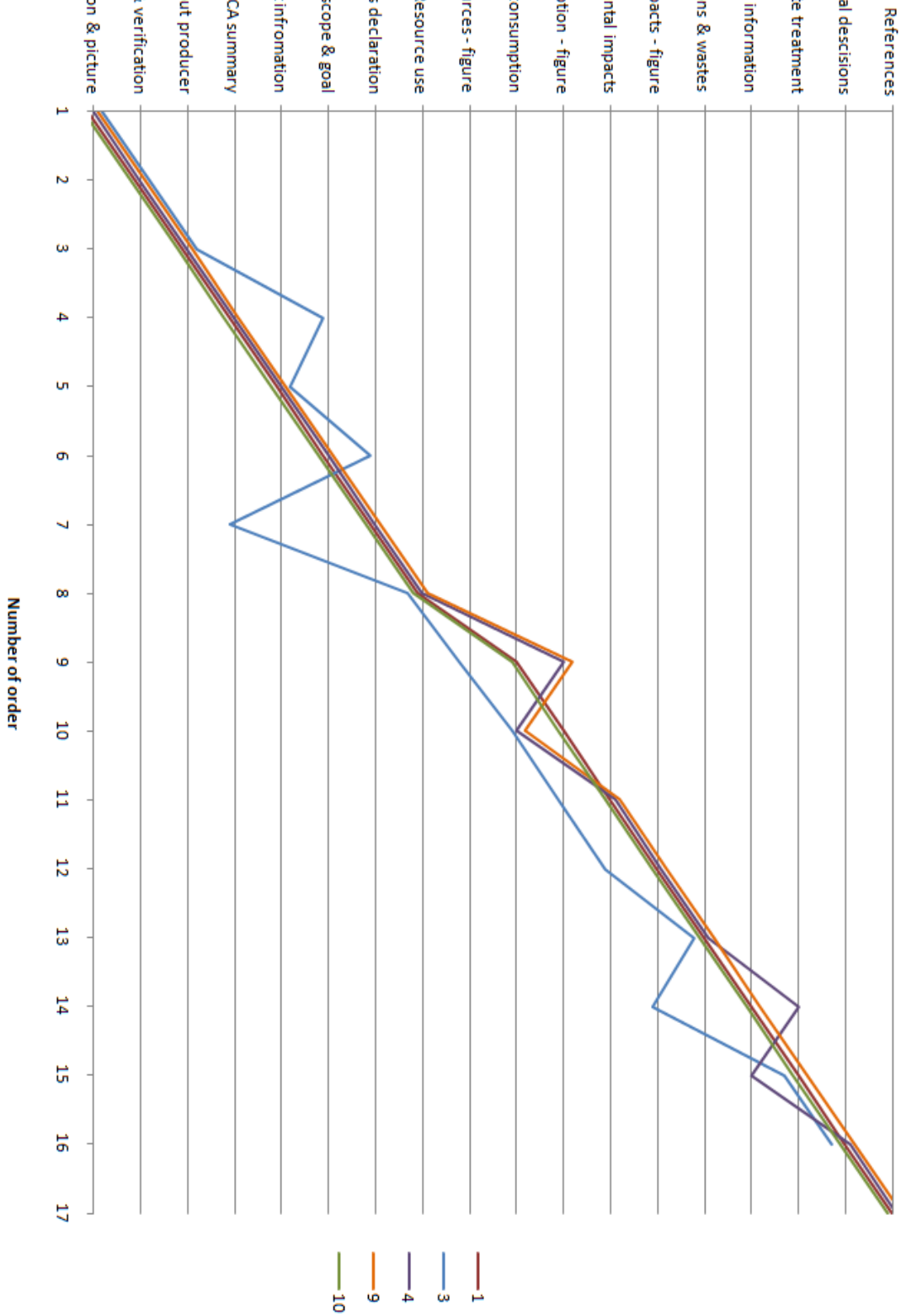

Figure 17: Structure of Norwegian EPD

As can be seen in the graph, the five EPDs mainly follow the same structure with a few variations. The EPD which differ the most is EPD no. 3. The other five mainly follow the same structure. The main differences can be seen in the middle and end of the EPD. The first page of the EPDs has the same content and order, with a few exceptions where some elements are not included.

Sweden
The EPDs from the International EPD system are the EPDs with the greatest variance when it comes to contents and structure. Some EPDs appear to be similar at first glance, but when one studies them more closely great differences appear. Other EPDs are clearly different all along. In Figure 18, a visualisation of these differences is made. One can see that EPD no. 21 and 27 are presented in the same curve, as the structure is identical. In addition EPD 26 follows much of the same structure as these two.

Japan
As explained in chapter **Error! Reference source not found.**, the Japanese EPD programme has a standardised EPD structure consisting of three parts; Product Environmental Aspects Declaration, Product Environmental Information Data Sheet and product data sheet. All EPDs are of this format, and the contents are the same for each of them.

Finland
For all Finnish EPDs the structure is the same as shown in Table 29.

Table 29: Structure of Finnish EPD

1	**Product specification**
	Object definition
	Product description
	Conversion factors
	Technical properties
2	**Eco-profile of the product**
	Use of energy
	Energy in transport
	Process energy
	Feedstock energy of raw materials
	Consumption of raw materials
	Emissions to air
	Emissions to water
	Process waste
	Pie chart of energy in transport and processes
	Pie chart of consumption of raw materials
3	**Other environmental aspects**

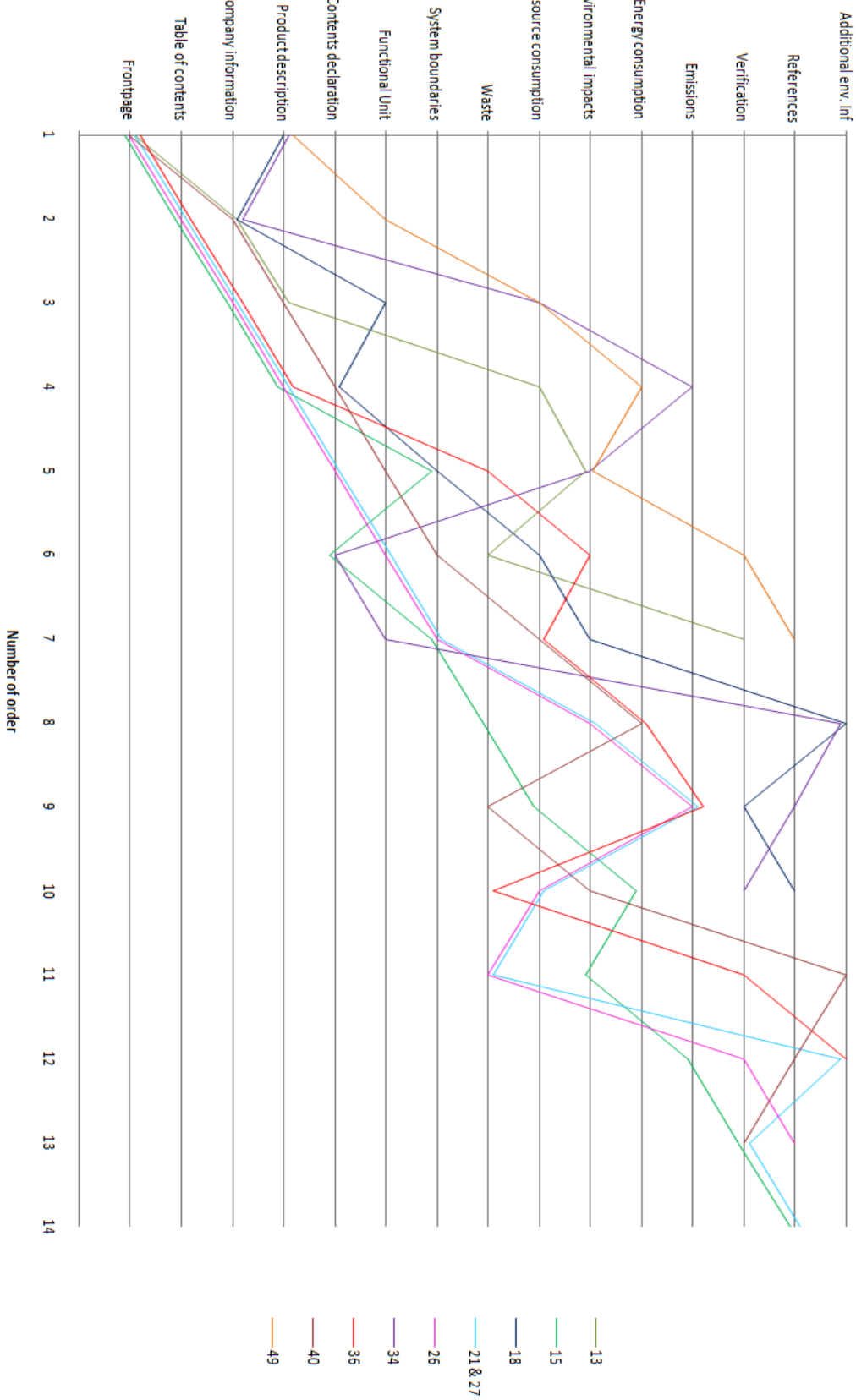

Figure 18: Structure of EPD in International EPD system

Germany

The German EPDs generally follow the structure shown in Table 30. There are however, large variances in the chapter title used for each part, even though the contents are identical. Also, even though the order is the same, there is variance in the numbering of the chapters as some EPDs start at 0 whilst others start at 1.

Table 30: Structure of German EPD

Front page
Summary
Scope of validity
Product definition
Basic material / Material content
Product manufacturing
Product processing
Use stage
End of life phase
Life cycle assessment
Additional information, evidence and test
PCR document and verification
References

7.3.6 Presentation of environmental impacts

Every EPD includes a presentation of the environmental impacts of the product or service. Even though the presentation at a glance can seem similar, there are great differences within and between the EPD programmes as to how the information is presented and what is included in the presentation. The results of the comparison of the EPDs are given in Table 31.

Table 31: Environmental impact categories

Country	Norway					International EPD programme										Japan					Germany				
EPD no.	1	3	4	9	10	13	15	18	21	26	27	34	36	40	49	53	54	58	59	62	73	74	75	76	77
Abiotic depletion																									
Acidification potential																									
Eutrophication potential																									
Global warming potential																									
Ozone depletion potential																									
Photochemical oxidation potential																									
Nutrification																									
Waste																									
Heavy metals																									

Norway

Within the five EPDs in the Norwegian EPD programme there is great variance in the presentation of environmental impacts. As shown in Table 31 the EPDs include different impact categories. In addition the aforementioned categories are given different names in some of the EPDs, and the order in which they are presented in the table differ. This can create difficulties for users with respect to comparison of EPDs where the only reference to the category in the graph is the impact category number given in the table. According to ISO 14025, impact

categories should be presented for the different life cycle stages. This demand has not been included in any of the EPDs. In one of the EPDs the stages have been divided into “to the factory gate” and “user phase”.

How the numbers are presented in the tables differ between the EPDs. In three EPDs decimals are used, where as in the other two the numbers are presented as scientific notation. The number of decimals used also varies. In four EPDs the impact categories have been normalised and specified per life cycle stage in the graph presentation of the results. In the last EPD, the results are presented in kg/g for each impact factor.

Sweden

As can be seen in Table 31, the EPDs of the International EPD System all include the same impact categories; acidification potential, eutrophication potential, global warming potential, ozone depletion potential and photochemical depletion potential. Only two EPDs include a graphical presentation of the impacts. EPD no. 13 includes a graph of the percentage impact of each life cycle stage for each impact category. EPD no. 34 has a graphic presentation of global warming potential only.

The tables and presentation of results vary greatly among the ten EPDs. Three of the EPDs use scientific notation, four of them uses a mixture of notations and the remaining two have three and four decimals in the results. Nine EPDs present the results for every life cycle stage, whereas only one EPD includes the total impact. As seen in Table 32 the units used for the impact categories in the International EPD System vary greatly between the EPDs. The names of the impact categories are however generally the same, with the exception of the name of photochemical oxidant formation.

Table 32: Units used for impact categories in the International EPD system

Impact category:	13	15	18	21	26
Global Warming	kg CO2 eq	kg CO2 eq	kg CO2 eq	kg CO2 eq	kg CO2 eq
Acidification	kg SO2 eq	mol H+ eq	mol H+ eq & kg SO2 eq	mol H+ eq & kg SO2 eq	g SO2 eq
Ozone depletion	kg CFC-11 eq	kg CFC-11 eq	kg CFC-11 eq	kg CFC-11 eq	mg CFC-11 eq
Photochemical oxidant formation	kg ethene eq	kg POCP eq	kg ethene eq	kg C2H4	g PO4 eq
Eutrophication	kg PO4^ 3 eq	kg O2 eq	kg O2 & kg PO43 eq	kg O2 eq & kg PO4 eq	g PO4^-3 eq

Impact category:	27	34	36*	40	49
Global Warming	kg CO2 eq	kg CO2 eq	kg CO2 eq	kg CO2 eq	kg CO2 eq
Acidification	Kmol+ eq	kg SO2 eq	mol H+ eq	mol H+ eq	SOx eq
Ozone depletion	kg CFC-11 eq	kg CFC-11 eq	kg CFC-11 eq	kg CFC-11 eq	kg CFC-11 eq
Photochemical oxidant formation	kg C2H4	kg ethene eq	kg C2H4	kg C2H4	kg ethene eq
Eutrophication	kg O2	P2O5 eq	g O2	kg O2 & kg PO4^3 eq	kg O2 eq

* The units vary between the tables for each life cycle stage

Japan

The Japanese EPDs present the impact categories as part of the product environmental information data sheet. The names of the categories are the same, and are presented in the

same manner for each life cycle stage in scientific notation. In all EPDs four impact categories are found; global warming, acidification, energy resources and mineral resources. In addition one of the analysed EPDs includes photochemical oxidation. No figures or graphs are used to visualise the results, apart from a graph on the front page of global warming potential.

Germany
The German EPDs all include the five impact categories global warming potential, ozone depletion potential, acidification potential, eutrophication potential and photochemical oxidation potential. One of the EPDs includes an additional impact category, as can be seen in Table 31. There is, however, great variance in the presentation of the results and the names used for the impact categories. One of the EPDs only has the abbreviations of the impact categories. The impact categories with the largest variances in name are global warming potential and photochemical oxidation potential. The latter has been called photochemical oxidation formation potential, photochemical ozone creation potential and summer smog potential.

The results of the impact assessment of the German EPDs are not presented in a uniform way. There is a great difference among the use of tables and graphs. Some only present the total impact in the table; some include the impact from each life cycle phase in the table whilst others have separate tables for each life cycle phase. Similar to the Norwegian programme, there is also variance as to whether the numbers are presented as scientific notation or not. The results are shown graphically as relative contribution of effective categories for each life cycle stage for four out of five EPDs.[3] One of the graphs stand out (EPD no. 73), where the graph is made vertical and the colours are different than what is used in the other EPDs.

Finland
In the Finnish programme, the environmental impacts are not aggregated and characterised to impact categories as is done for the other programmes. The eco-profile of the product is presented as usage of resources and emissions. Emissions are further divided into emissions to air and water and process waste. Emissions are not presented for each life cycle stage, only as a total impact and are given in grams or kilos.

7.3.7 Additional Environmental information
In Table 33 the additional environmental information found in the analysed EPDs is presented. All EPDs have included some additional information, although how much information is added varies greatly. Some EPDs only include 1-2 additional elements, whilst others such as EPD no. 13 include 6 additional elements of environmental information in the EPD.

As can be seen, the most commonly additional information provided is the organisation's adherence to environmental managements systems such as ISO 14001, and the preferred waste management option for the product. Japan is the only EPD programme where none of the EPDs include instructions for recycling / waste-handling of the product.

[3] EPD numbers 73, 75, 76 and 77.

Table 33: Additional environmental information found in analysed EPD

		Norway					International EPD system									
no.	Environmental aspect	1	3	4	9	10	13	15	18	21	26	27	34	36	40	49
1	Impacts and potential impacts on biodiversity						■									
3	Geographical aspects relating to any stages of the life cycle						■									
5	Organisation's adherence to to environmental management systems	■	■	■	■	■	■	■	■			■		■	■	■
6	Other environmental certification programme applied to the product								■			■	■			
7	Other environmental activities of the organisation				■	■	■		■	■	■		■	■	■	■
8	LCA information not communicated in LCI or LCIA											■				
9	Instructions and limits for efficient use															
10	Hazard and risk assessment in human health and the environment						■									
11	Absence/level of presence of materials considered of env. significance		■		■				■				■		■	
12	Prefered waste management option for the product	■	■	■	■	■	■		■				■	■	■	

		Japan					Finland					Germany				
no.	Environmental aspect	53	54	58	59	62	64	65	67	69	72	73	74	75	76	77
1	Impacts and potential impacts on biodiversity															
3	Geographical aspects relating to any stages of the life cycle															
5	Organisation's adherence to to environmental management systems	■	■	■	■	■							■			
6	Other environmental certification programme applied to the product	■		■	■			■			■					
7	Other environmental activities of the organisation															
8	LCA information not communicated in LCI or LCIA															
9	Instructions and limits for efficient use											■	■	■	■	■
10	Hazard and risk assessment in human health and the environment															
11	Absence/level of presence of materials considered of env. significance		■		■	■		■			■					
12	Prefered waste management option for the product						■	■	■	■	■	■	■	■	■	■

8 Discussion

The main purpose of this thesis is to contribute to the harmonisation of standards and guidelines for communication of environmental performance of products, and services in Norway. The aim has been to establish recommendations and comments to the ongoing work of EPD-Norway in developing guidelines for the development of PCRs and EPD, and a standardised layout and format of these. In this section the issues raised in the introduction will be discussed and answered. The theory and analysis presented in the thesis will be used as a background for the discussion. The main discussion will evolve around the use and development of PCRs and EPDs. To support this discussion, the following questions which were raised in the beginning of the thesis will also be discussed;

- How can environmental documentation contribute to corporate responsibility in the supply chain?
- How do ISO standards which focus on various environmental impacts of products and services in a life cycle perspective (ISO 14025, ISO 14046, ISO 14067 and ISO 21930) support each other?

8.1 EPD as a tool for CSR in the supply chain

EPDs are, as described throughout this thesis, a communication tool for environmental responsibility, initiatives and awareness. A short discussion will be given as to how the use of environmental documentation of products and services contributes to corporate responsibility in the supply chain.

Corporate social responsibility as described in chapter 3.2 is understood as the integration of social and environmental aspects in a company's business strategy, and making additional efforts towards contributing to sustainable development, in addition to complying with laws and regulations. Incorporating CSR in the supply chain involves taking responsibility upstream as well as downstream in the supply chain and initiating environmental improvements. This can for example be done as requirements to the suppliers with respect to environmental documentation and performance, through implementing environmental initiatives such as management systems in own operations in order to improve own environmental performance, improving the environmental impacts of the product in the use phase or reduce wastes at the products end-of-life.

EPDs provide a neutral and objective source of information about the environmental impacts of a product throughout its life cycle, and can be seen as more than just a tool for meeting requirements of public procurement. Therefore, by introducing EPDs for its products a manufacturer has several opportunities of incorporating CSR into its supply chain management.

The EPD can firstly be used as a data collection tool for inputs needed for documentation in EMS. The EPD contains a lot of information about the impacts of both the direct impacts of the production of the product, but also information about upstream and downstream processes.

By using the information provided in through the EPD the producer can identify which processes has the greatest impacts, and where improvements can be made. This can result in changes having to be made to the production processes at the plant site of the producer. It can

also result in changes made to the material composition of the product or the choice of suppliers. The material composition can have impacts in all stages of the life cycle, depending on the material, and improvements can usually be made by replacing materials with better alternatives. Downstream processes include the use phase and end-of-life, both of these can be improved by the material composition of the product. An example is the use of recyclable materials. A producer which offers an EPD with the product also gives the end-user to make a decision based on knowledge and information about the environmental impacts of the product.

It is clear that a producer who develops EPDs for his products has the possibility of influencing the environmental impact of the product through the supply chain, especially with the regards to choice of production processes and material composition of the product. This does however require that the EPD is understandable to the producer so that the information gathered through the EPD can be used in an efficient manner.

8.2 How relevant ISO standards support each other

Within environmental management and documentation there is an increasing focus on documenting the environmental impacts of a business' activities and productions and the impacts of specific products and services in a life cycle perspective. The focus is both on all impacts which can be met through environmental product declarations or just some specific impacts such as water footprints and carbon footprints. As a response to this several standards exist and are under development as presented in chapter 4. In this section a brief discussion will be given as to how the four standards support each other.

As the presentation in chapter 4.7 describes, ISO 21930 is developed on the basis of ISO 14025. It aims at complementing ISO 14025 in the development of product declarations of building products by giving additional requirements within these product categories. This should in practice mean that a product declaration developed on the basis of ISO 21930 also will fulfil the requirements of ISO 14025. However, there a difference between the information required about the producer between the two standards. As already mentioned ISO 21930 only requires the name and address of the producer. For EPD programmes which focus on building products such as Germany and Finland to not comply with Criterion 1 of the analysis in chapter 7.2. For the Norwegian programme it can seem that the programme guidelines are based on this requirement of ISO 21930 as the guidelines also only require name and address of the producer of the product, and not a description. Therefore all Norwegian EPDs also only partially meet the criterion of ISO 14025.

Since ISO 14046 on water footprint and IOS 14067 on carbon footprint of products still are under development it is difficult to predict how the final documents will relate to ISO 14025. Currently though it seems as though both standards will be based on ISO 14025, meaning that the declarations will be based on the same PCRs and developed in the same way. A water or carbon footprint will in that case require the same steps as an EPD and a full LCA of the product or service. If so, this means that if you already have an EPD of a product it will be easy to produce a carbon footprint or water footprint of the product as you already have the information you need available. This will require that the same calculation rules are described in the standard.

In the case of a carbon and water footprint requiring the same process as an EPD, it could seem like a waste to go through the amount of work and expenses this requires to present only one of the aspects the analysis produces. It will be interesting to see when the final documents are published how these standards support each other and whether the calculation and development rules coincide. A question to be asked is then if one would be better served by incorporating the guidelines for calculation of water and carbon footprint into ISO 14025 and making clearer guidelines on calculation rules rather than developing new standards.

8.3 EPD programmes

General

In the presentation of the various EPD programmes which has been included in the analysis, it is evident that there are differences between the structure and organisation of the programmes, as well as their size and distribution. The development and verification of PCRs and EPDs generally follow the same procedures.

The Norwegian and Swedish EPD programmes are those with the greatest variance when it comes to the product categories within which EPDs are published. Whereas the German and Finnish programmes focus on building products, and the Japanese and South Korean programmes on electronics, the Norwegian and Swedish programmes includes both these categories in addition to several more.

The inclusion of several diverse product categories can lead to certain challenges in the development of programme guidelines, and uniform guidelines for the development of PCRs and EPDs. The guidelines will have to be general and open to be relevant for all product categories. The Swedish programme has solved this challenge by using the CPC system to classify its products, and base the development of PCRs on basic modules as explained in chapter 6.3. In this manner the basic modules can both include the general guideline which apply for all product categories, and the specific requirements which are only relevant for certain product categories. One of the challenges the Norwegian EPD programme will face in the development of guidelines for the development of PCRs and EPDs, is to be general enough so that all product categories are included, whilst at the same time being specific enough in the requirements so that there is room for less interpretation. In practise this will lead to EPDs and PCRs that are more uniform.

It is difficult to say that one EPD programme is better than the other, as special needs and opportunities of the country must be taken into account in the development of such a programme (Hillier et al. 2004). Therefore, one aspect or element which is very important for one programme, may not be necessary in another, and an element that works very well in one programme may not work at all in a different program etc. Aspects which must be taken into consideration in the development of programmes are economic, political, cultural and institutional settings.

Harmonisation
In terms of international trade it is important that EPD programmes are more harmonised. Through harmonisation of EPD programmes, their guidelines, and thereby the development of PCRs and EPDs, this will ensure the comparability and acceptance of EPDs across borders.

In countries where the demand for environmental documentation is growing, and even becoming mandatory, like in France, it is important that the development of EPDs follow the same requirements and structure. It is also important that EPDs are recognisable and easily understandable for the user. In this way EPDs developed under one programme can also be valid in other countries. It is important that EPDs do not become a barrier to international trade. This can easily become the case in for example Norway, where purchasers are used to reading and extracting information from the Norwegian EPDs which compared to, for instance German EPDs, are much shorter. A Norwegian EPD would also be hard to compare against a Japanese EPD, as the information is much more compressed.

Access to information
With respect to many of the current EPD programmes, information is not easy accessible. Information on websites is in many cases limited, not in English, and rarely updated. This reduces the credibility and transparency of programmes. It also limits the opportunities for harmonisation between programmes. If programme operators and EPD developers cannot find information about each other it will cause difficulties with mutual cooperation and learning. It is also important for the user to find information about the programme in order for the EPD to be credible.

There have been few studies about EPDs and EPD programmes since ISO 14025 was published in 2006. There is a need for a greater exchange of information between the programmes, in order to facilitate harmonisation in the future.

Relationship between programme guidelines and ISO 14025
The general relationship between the documents used in development of an EPD is shown in Figure 19. As can be seen, ISO 14025 (in some cases also ISO 21930) is the foundation for all EPD development. On the basis of ISO 14025 each national EPD programme has developed a set of programme guidelines for the development of EPDs within its programme. EPDs are then developed firstly on the basis of programme guidelines, which generally include a high level of detail to the requirements of contents and format of the EPD.

Figure 19: Relationship of documents for developing EPD

In the development of the programme guidelines, there is room for interpretation and adjustment of the requirements as the standard is not always clear. This leads to programme guidelines which will vary between the different countries. In the next step when EPDs are based on the guidelines, there is additional room for interpretation and personal adjustment of

the developer, leading to variations of the EPDs within the programmes. The variations in terms of content, format and layout will be even greater between the programmes. This is especially evident in countries where there are several institutions that develop EPDs, for example Norway and Sweden.

Countries which have clear guidelines and requirements to format and layout in their programme guidelines, are those countries were the variance between EPDs is the lowest. This is especially evident in the German, Finnish and Japanese programmes.

8.4 PCR

The 25 PCRs that were analysed in chapter 7.1 are all developed on the basis of ISO 14025, but are nonetheless different in terms of contents, structure and format. In addition, none of the analysed PCRs fully comply with ISO 14025. When the PCRs which form the basis for development of EPDs differ, it is no surprise that also the EPDs differ greatly.

The fact that PCRs are not developed and presented in a uniform manner, both lead to difficulties when comparing EPDs that are based on different PCRs, and in using PCRs from other programmes when developing EPDs in other countries.

It is the intention of ISO 14025 that if there is a PCR developed within a product category already, this should be utilized instead of developing a new PCR. This will enhance the harmonisation of EPDs and programmes. Furthermore, ISO 14025 states that "justification for differing from existing PCR shall be based on the content of existing PCR documents; and shall not, for example, be based on the origin of any particular PCR" (ISO 2010b). If a PCR does not fulfil all requirements of the standard, this can be a reason for developing a new PCR.

Variations in the presentation and contents of PCRs can raise difficulties for the developer who makes use of the PCR. If the PCRs are developed and presented in a uniform manner, it will be easier for the developer to see necessary requirements and to find the information needed. When using PCRs from other programmes which differ greatly, this can be challenging. An example is the Japanese PCRs which have a very different format than the other programmes. Here information is presented in a table format with limited text and explanations. The structure is also very different, which can make it challenging for someone who is not used to reading these types of documents.

The fact that none of the analysed PCRs fulfil all requirements of ISO 14025, and the way the requirements are met differ, can be an indication that the standard leaves for too much room for interpretations by the programme operators and developers. It is understood that developing standards is a time-consuming and demanding process. Various aspects and interests must be taken into account, and a lot of people need to come to an agreement. Even so, when the standard fails to produce uniform PCRs and EPDs, it could be said to work against its mission. The goal of the standard is to produce PCRs which can be used across programmes, as well as comparable EPDs. At the present time this is not achieved in a successful manner.

8.5 EPD

As presented in chapter 3.6 the main intention of EPDs is to present objective, comparable and credible information about the environmental impacts of products and services. Another important aspect of EPDs is its user friendliness. In the following section it will be discussed how the analysed EPDs fulfil these criteria.

Even though the Norwegian EPDs seemingly have the same format and content, a closer look reveals differences between the EPDs as presented in the analysis in chapter 7. These differences occur as a result of the products belonging to different product categories, and that the EPDs have been developed by different institutions.

Objectivity

Objectivity in the EPD is secured through an LCA-analysis based on ISO 14040-14044 and the presentation of its results. This is fulfilled by the following criteria from ISO 14025:

- PCR identification (criterion 5)
- Data from LCA/LCI (criterion 7)
- Information about life cycle boundaries (criterion 8)
- Content declaration (criterion 10)

The PCR determines the guidelines and procedures of the life cycle analysis, which produces the results to be presented in the EPD. Without a reference to the PCR, it is difficult for the user to know how the LCA has been performed, which assumptions has been made, and which data that has been used, and the quality of this data. In the summary of the analysis results in chapter 7.2.8, one can observe that most EPDs include this reference. Apart from the EPDs from the Finnish program, which is not based on PCRs, only 11 EPDs lack identification of the PCR. The lack of PCR references removes the possibility of comparison of the EPD.

The data from the LCA or LCI, and the presentation of the environmental impacts is maybe the most important information given by an EPD, since this is what facilitates the basis of comparison between two products. It is therefore important that the information is presented in the same way, making it easy for the user to do a comparison. Furthermore, it is imperative that the information is calculated and developed in the same manner and that life cycle boundaries. If not, it will not be directly comparable. The analysis showed that environmental impacts are calculated and presented in numerous ways. This is due to no direct requirements as to the inclusion and presentations of impact categories in ISO 14025. This is a weakness in the standard, and each EPD operator should strive towards determining these issues in their programme guidelines.

Comparability

Comparability is one of the most important properties of EPDs. As explained in chapter 4.2 EPDs must be based on the same PCR, and the requirements of EPDs as stated by ISO 14025 must be either identical or equivalent. Important aspects of the EPDs which should be the same in order to ensure comparability are:

- Information on the front page
- Selection of impact categories (including presentation and calculation rules)

- Functional unit
- Technical performance of the product
- Life cycle information and inventory
- Coherent information about resource consumption

Simultaneously, it is of great importance that the results are presented in a coherent way, so the results are easily comparable for the user. As seen in the analysis, the presentation of results varies greatly between the various programmes. Even within the same programmes great variances are found, especially within the Swedish and the Norwegian programmes. Results are presented within different categories in different units and are not directly comaparable. It is assumed that a more uniform presentation will increase the comparability of EPDs.

Another challenge for the user is to compare two products which have very different impacts, especially if the user is not an expert within the area. The EPD does not present any guidelines to weighting of the impacts, and it can therefore be difficult in situations to make a valid comparison. In the Norwegian EPD programme this has partially been solved by pulling out the impact categories which are the most important for the given product category and presented these within a red frame on the front page of the EPD. This gives an indication to the user which impact categories to give more weight.

Credibility
It is important that the EPD and its information are perceived as reliable sources of data. Through third party verification the end-user can be assured that the data and results of an EPD have been verified. It is therefore important that the verification is confirmed and shown in the EPD and that dates of validity are included.

Additionally to increase credibility the programme operator should be presented in the EPD either by a logo or other reference, identification of the producer should be included, contact persons, references and the mandatory statement should be included in the EPD.

Many of the analysed EPDs do not include the entire period of validity of the EPD and a demonstration of verification. By not including these pieces of information in the EPD, its credibility will be undermined. The user will face difficulties in distinguishing between valid and invalid EPDs.

The Finnish EPD programme is not based on ISO 14025 and PCRs, but instead on ISO 21930. However the requirements of ISO 21930 coincide with and complement the requirements of ISO 14025, so that it should in fact comply with the requirements of ISO 14025. In the analysis it was seen clearly that the published EPDs fail to comply with most of the requirements. Several EPDs from other programmes also fail to comply with several requirements, and it can be discussed the effect of presenting these as valid EPDs. Similarly, EPD-like programmes can reduce credibility of EPDs.

Additionally, several programmes have problems with producers publishing EPDs for their products without them being validated. In Norway a furniture company, Helland, has published an EPD on their website for every product they produce and sell (Helland Møbler AS 2011). Even though the EPDs are developed internally and have not been verified by the Norwegian EPD Foundation they carry their logo. Seemingly they appear to be valid published EPDs. It can lead to diminishing of credibility and confusion among users when producers start publishing EPDs without having them verified, especially when they are presented as other verified and officially published EPDs.

8.6 Recommendations

In this section recommendations will be given to the Norwegian EPD Foundation as to how Norwegian EPDs can be harmonised and improved. The latter will concern the five following areas:

- Format and layout of EPD
- Front page of EPD
- Environmental impact categories
- User guide
- Online database

It should be noted that it is difficult to give concrete recommendations to layout and contents of EPDs, and how information should be presented at best. Such recommendations should be given on the basis of a survey of the users of EPDs, which has not been within the scope of this thesis. It is important that the users' opinion is taken into consideration of further improvements of the programme, as it is they who have the greatest competence on which information they actually use, how they use the information, and which information is of importance. As the main group of users of EPDs are persons within public procurement, and usually not LCA experts, it is important that information is presented in an understandable manner.

Furthermore, it is of great importance that the EPDs at a minimum comply with all the requirements of ISO 14025, and that they are presented in a uniform manner within the same programme. This also relates to EPDs published prior to new guidelines. These EPDs should be updated to reflect the changes in the latter, even if they are only valid for a few more years. If different formats exist in the market, this can lead to confusion among the users, and it can reduce the credibility of the programme.

Format and layout of EPD

As seen in the analysis of the structure of the Norwegian EPDs in chapter 7.3.5, the Norwegian EPDs vary to some degree with respect to the structure and content of the EPDs. It is recommended that a stricter guideline regarding these issues is developed to create more uniform EPDs. EPDs which contain the same elements presented in the same manner will increase the user friendliness of the document.

In the EPD the most important and relevant elements of the document should come first, and the more formal parts can be placed at the end of the EPD. Information such as the compulsory

statement, verification, references and company description is of less importance to the results presented in the EPD.

It is important that the information is presented in the same manner, and that the explanations about life cycle stages follow the same structure. The use of colours and logo in the EPD should be the same in order to increase recognisability.

The best way of presenting information and data should be determined through a user survey with focus on the EPD being understandable and user friendly.

Front page of EPD
The front page should present the key information that the end user needs to compare two products. The user must be able to quickly evaluate whether a comparison is possible before looking at the details of the EPD. This information includes:

- Programme logo
- EPD identification and validity period
- Product specification and picture
- Functional unit
- Key performance characteristics
- A graphical presentation of key impact categories

The programme logo should be included on the front page so that it is clear that the document in fact is an environmental product declaration. Together with the EPD identification, this will confirm that the EPD has been approved by the programme. The validity period is important so that one can see that the EPD is still valid. The functional unit is the key indicator for whether two EPDs can be compared, and should be clearly stated on the front page. Key performance characteristics together with the functional unit, will confirm that two products have the same functions. A graphical presentation of the key impact categories is recommended as this will give a better picture to the user than a number.

Environmental impact categories
Today, some variations are seen as to which environmental impact categories that are included in the EPDs. The greatest variance is however seen in the names of the impact categories, and how they are presented. The programme guidelines should determine a set of basic impact categories which at a minimum should be included in the EPD. These can be expanded for certain product categories. In addition, the calculation rules of the impact categories and how they should be presented should be determined. This will ensure a uniform presentation and comparability of EPDs.

User guide
The main users of EPDs are not necessarily experts in LCA or EPDs. Therefore it is important that the user understands what the document is communicating in order for it to have any value, and to actually be used. The Norwegian EPDs do not include a lot of text and explanations, and it can therefore be difficult to understand the information that is included. It

can therefore be recommended that a user guide is developed with respect to the understanding and use of EPDs. Important issues to be determined in such a guide would be how two EPDs can be compared, what the different impact categories actually mean and consists of, and other emissions. In this way the EPD can keep its short format, which is easy to follow for an experienced user, but still lets new users to read the document without too much effort.

Online database

An online database would make information easy accessible to developers and users of EPDs. By providing the background data of the EPD which can be published in one place, it would be an efficient way for users to check details of the analysis which is not presented in the EPD, and give more information about the assumptions and steps taken in the LCA of the product. This will enhance transparency, and thereby the credibility of the EPDs. It will also make it easier to compare EPDs which are not based on the same PCR, or which come from different programmes. For developers of EPDs this would mean a growing assembly of data which can be used in the development of new EPDs. Such a database would also be of value for professional LCA practitioners. Expanding the database to an international level would strengthen cooperation and harmonisation between EPD programmes.

9 Conclusion

Through the mapping of the different international EPD programmes and the analysis of published PCRs and EPDs it has become obvious that there is a need for communication between and harmonisation of EPD programmes at a global level. Currently PCRs are developed on the basis of ISO 14025 and programme guidelines, which both are open for interpretation. This results in a variety of structures and formats of PCRs from the different programmes. This in turn leads to great variations in the presentation and contents of EPDs.

The analysis shows that both PCRs and EPDs comply with the requirements of ISO 14025 at a varying level, and it is evident that the requirements are not clear enough. The requirements are also met in different manners, indicating that there is a need for harmonisation of the programme guidelines of the EPD programmes. The differences experienced in the EPDs and PCRs can lead to the diminishing of the main objective of EPDs of delivering objective, comparable and credible environmental information about the environmental impacts of a product throughout its life cycle.

In addition to a need for harmonisation between programmes, there is also a need for harmonisation and improvement within some of the programmes. There is currently a process within the Norwegian EPD Foundation covering these issues, and recommendations for their work has been given within five areas; the format and layout of EPD, the front page of EPD, environmental impact categories, a user guide and an online database. It is further strongly recommended that the development should be based on a user survey in order to increase the user friendliness and comparability of EPDs.

References

Bakan, Joel. 2004. *The Corporation, The Pathological pursuit of profit and power*. New York: Free Press.

Baumann, H, and A-M Tillman. 2004. *The Hitch Hiker's Guide to LCA*. Lund: Studentlitteratur.

BBC News. 2011. "1986: Chemical spill turns Rhine red." http://news.bbc.co.uk/onthisday/hi/dates/stories/november/1/newsid_4679000/4679789.stm (Accessed June 12, 2011).

Big Room Inc. 2011. "Ecolabel Index." http://www.ecolabelindex.com/ (Accessed May 22, 2011).

Bogeskär, Malin et al. 2002a. *Evaluation of Environmental Product Declaration Schemes*. European Commission DG Environment.

Bogeskär, Malin et al. 2002b. *Evaluation of Environmental Product Declaration Schemes: Annexes I - IX*. European Commission DG Environment.

Bogliolo, Roberto. n d. "Environmental Product Declaration for concrete." http://www.buzziunicem.it/contentsmulti/instance1/files/document/276Environmental_Product_Declaration_for_concrete.pdf (Accessed April 8, 2011).

Brattebø, Helge, John Ehrenfeld, and Kjetil Røine. 2007. "Framing and defining industrial Ecology."in *Textbook in Industrial Ecology*, edited by H Brattebø, K Røine, H Opoku, and J.R Ehrenfel. Trondheim: NTNU.

BRE Global. 2010. "BREEAM." www.breeam.org (Accessed May 29, 2011).

British Standards Institute. 1994. *British Standard for Envronmental Management Systems: BS7750*. London: BSI.

Bryman, Alan. 2008. *Social research methods*. New York: Oxford University Press.

Carson, Rachel. 1962. *Silent Spring*. New York: First Mariner Books.

Chopra, Sunil, and Peter Meindl. 2007. *Supply Chain Management Strategy, Planning & Operations*. New Jersey: Pearson Education.

Dahlsrud, A. 2006. "How corporate social responsibility is defined - An analysis of 37 definitions." *Journal of Corporate Social Responsibility and Environmental Management*.

Difi. 2011. "Anskaffelser." http://www.difi.no/anskaffelser (Accessed June 15, 2011).

Earth sure. 2009. "Earth sure Environmental Product Declarations Program." 1-8. http://iere.org/Data/Sites/1/SharedFiles/earthsure/Earthsure Agriculture EPD Program.pdf (Accessed April 14, 2011).

Eniro Norge AS. 2010. "Miljøindex." www.miljoindex.no (Accessed June 11, 2011).

Environmental Information Act. 2003. "Act relating to the right to environmental information and participation in decision-making processes relating to the environment 9.May 2003 no.31."

EPD-Norge. 2009. *Retningslinjer for Næringslivets Stiftelse for Miljødeklarasjoner*. Oslo: EPD-Norge.

EPD-Norge. 2011. "The Norwegian EPD foundation." www.epd-norge.no (Accessed March 30, 2011).

Eriksson, Elin, and Carl-Otto Neven. 2009. "Water footprint: Requirements and guidleines ETT preliminary Work Item." http://www.sis.se/pdf/5_Water_Footprint_Carl-Otto_Neven.pdf (Accessed June 17, 2011).

European Commission. 2011a. "EMAS." http://ec.europa.eu/environment/emas/index_en.htm (Accessed June 11, 2011).

European Commission. 2011b. "Environment - Green public procurement." http://ec.europa.eu/environment/gpp/index_en.htm (Accessed June 15, 2011).

European Commission. 2011c. "Facts and figures." http://ec.europa.eu/environment/ecolabel/about_ecolabel/facts_and_figures_en.htm (Accessed May 1, 2011).

European Commission. 2008. *Public procurement for a better environment*. Brussels: European Commission.

European Commission. 2010. "Sustainable and responsible business." http://ec.europa.eu/enterprise/policies/sustainable-business/corporate-social-responsibility/index_en.htm (Accessed December 30, 2010).

FEE International. 2011. "Beaches and Marinas with Blue Flag." http://www.blueflag.org/ (Accessed June 11, 2011).

FEE Norway. 2011. "Foundation for Environmental Education." www.fee.no (Accessed June 11, 2011).

Fet, Annik Magerholm. 2006. "Environmental Management and Corporate Social Responsibility – the challenges in a globalized world." *XII ICIEOM*.

Fet, Annik Magerholm, Ottar Michelsen, and Luitzen de Boer. 2011. "Green public procurement in practice - the case of Norway." *Journal of Economic Litterature* 33.

Frankl, Paolo, and Frieder Rubik. 2005. *The future of eco-labelling: making environmental product information systems effective*. Sheffield: Greenleaf Publications.

Freedom of Information Act. 2003. "Act to public access to documents in the public administration 20.june 2003 No. 45."

Friedman, Milton. 1993. "The social responsibility of business is to increase its profits."in *An introduction to business ethics*, edited by George D. Chryssides and John H. Kaler. Thomson Learning.

Friends of the Earth. 2011. "Friends of the Earth Background." http://www.foe.co.uk/what_we_do/about_us/friends_earth_background.html (Accessed June 12, 2011).

GECA. 2011. "Good Environmental Choice Australia." http://www.geca.org.au/ (Accessed April 14, 2011).

GEDnet. 2011. "GEDnet." www.gednet.org (Accessed May 15, 2011).

Goedkoop, Mark, Michiel Oele, An de Schryver, and Marisa Vieira. 2008. *SimaPro 7 Database Manual, Methods library*. Netherlands: PRe Consultants.

Golden, Jay s. 2010. *An Overview of Ecolabels and Sustainability Certifications in the Global marketplace*. Nicholas Institute for Environmental Policy Solutions Duke University.

GOTS. 2010. "Global Organic Textile Standard, Ecology & social responsibility." http://www.global-standard.org/ (Accessed May 3, 2011).

Greenpeace. 2011. "The history of Greenpeace." http://www.greenpeace.org/international/en/about/history/ (Accessed June 12, 2011).

Grenelle environnement. 2010. "Grenelle 2 law." www.developpement-durable.gouv.fr/IMG/pdf/Grenelle_Loi-2_GB_.pdf.

Handfield, Robert, Robert Sroufe, and Steven Walton. 2005. "Integrating Environmental Management and Supply Chain Strategies." *Business Strategy and the Environment*.

Hanssen, Ole Jørgen, Heidi K Stranddorf, Mie Vold, Lars Gunnar Lindfors, and Leif Hoffmann. 2001. *Systems and methodology for type III environmental product declaration*. Nordic Industrial Fund.

Hardin, Garrett. 1968. "The Tragedy of the Commons." *Science* 162:1243-1248.

Hawkins, David E. 2006. *Corporate Social Responsibility Balancing tomorrow's sustainability and today's profitability*. New York: Palgrave Macmillan http://www.ncbi.nlm.nih.gov/pubmed/21045586.

Heijungs, Reinout. 2007. "Analysis of functional chains: Life cycle assessment (LCA)."in *Introduction to Industrial Ecology - Theory, Methods and Applications2*, edited by Helge Brattebø, Kjetil Røine, H Opoku, and JR Ehrenfeld. Trondheim: NTNU.

Helland Møbler AS. 2011. “Helland.” www.helland.no (Accessed May 20, 2011).

Hillier, Bill, Lars Jonsson, and Svein-Olof Ryding. 2004. *International guide to environmental product declarations*. GEDnet.

Holme. 1991. *Metode valg og metode bruk*. Otta: Tano As.

Humbert, Sebastien. 2009. “ISO standard on Water footprint: Principles, Requirements and Guidance.” http://www.unep.fr/scp/water/documents/Presentations/ISO Activities on Water Accounting (Sebastien Humbert).pdf (Accessed June 17, 2011).

IBU. 2011. “Institute Bauen und Umwelt e.V.” http://bau-umwelt.de/hp2/Home.htm (Accessed February 21, 2011).

IEC. 2008. *General programme instructions*. The International EPD Cooperation.

IEC. 2011a. “The International EPD System.” http://www.environdec.com/ (Accessed April 7, 2011).

IEC. 2011b. “The International EPD System - a communication tool for international markets.” www.environdec.com (Accessed May 27, 2011).

IERE. 2008. “Earthsure.” http://www.iere.org/earthsure.aspx (Accessed February 19, 2011).

INIES. 2009. “The French database of reference on environmental and health characteristics of building products.” http://www.inies.fr/IniesConsultation.aspx (Accessed May 25, 2011).

ISO. 2010a. “International Organization for Standardization.” http://www.iso.org/iso/home.html (Accessed October 10, 2010).

ISO. 2004. *ISO 14001: Environmental management systems - Requirements with guidance for use*. Geneva: ISO.

ISO. 2000. *ISO 14020: Environmental labels and declarations - General principles*. Geneva: ISO.

ISO. 1999a. *ISO 14021: Environmental labels and declarations - Self-declared environmental claims (Type II environmental labelling)*. Geneva: ISO.

ISO. 1999b. *ISO 14024: Environmental labels and declarations - Type I environmental labelling - Principles and procedures*. Geneva: ISO.

ISO. 2010b. *ISO 14025 Environmental labels and declarations type III Principles and procedures*. Geneva: ISO.

ISO. 2006a. *ISO 14040: Environmental management Life cycle assessment Principles and framework*. Geneva: ISO.

ISO. 2006b. *ISO 14044: Environmental management Life cycle assessment Requirements and guidelines*. Geneva: ISO.

ISO. 2007. *ISO 21930: Sustainability in buidling construction - Environmental declaration of building products*. Geneva: ISO.

ISO. 2010c. *ISO 26000: Guidance on social responsibility*. Geneva: ISO.

ISO. 2011. "TC 207." http://www.iso.org/iso/standards_development/technical_committees/list_of_iso_technical_committees/iso_technical_committee.htm?commid=54808 (Accessed June 16, 2011).

JEMAI. 2003a. "Eco-Leaf Environmental declaration." www.jemai.or.jp/english/ecoleaf/outline.cfm (Accessed March 14, 2011).

JEMAI. 2002. *Guidelines for the Introduction of the ECO-LEAF Environmental Label*.

JEMAI. 2003b. "Japan Environmental Management Association for Industry." http://www.jemai.or.jp/english/ecoleaf/index.cfm (Accessed February 16, 2010).

Kristensen, Preben, Lasse Andersen, Birgit Engelund, and Birgitte Nielsen. 2006. *Integrated Supply Chain Information Systems*. Miljøministeriet.

Kvale, Steinar. 1997. *Det kvalitative forskningsintervju*. Oslo: Ad Notam Gyldendal AS.

Malnæs, Dagfinn. 2011. "Personal communication."

ME Korea. 2011. "Environmental Declaration of Products System." http://eng.me.go.kr/content.do?method=moveContent&menuCode=pol_pol_pro_lab_declaration (Accessed February 19, 2011).

MEEDDM. 2011a. "Affichage environmental: 230 enterprises se portent volontaires." http://www.developpement-durable.gouv.fr/Affichage-environnemental-230.html (Accessed May 25, 2011).

MEEDDM. 2011b. *National experimentation on the environmental labelling of consumer products*. http://www.developpement-durable.gouv.fr/IMG/pdf/expaffichage-ang-a.pdf.

Michelsen, Ottar, and Luitzen de Boer. 2009. "Green procurement in Norway: a survey of practices at the municipal and county level." *Journal of environmental management* 91:160-167.

Miljømerking. 2011. "Miljømerking." http://www.ecolabel.no/ (Accessed April 24, 2011).

Mosley, Stephen. 2010. *The Environment in World History*. Abingdon: Routledge.

MRPI. 2006. "Milieu relevante product informatie." www.mrpi.nl (Accessed May 26, 2011).

MVD. 2011. “MVD Miljøvaredeklarationen.” http://www.mvd.dk/da-dk/sider/default.aspx (Accessed May 27, 2011).

NAAF. 2011. “NAAFs merkeordning.” http://www.naaf.no/en/Tjenester/produktguiden/ (Accessed May 2, 2011).

Naturskyddsföreningen. 2010. “Bra Miljöval.” http://www.naturskyddsforeningen.se/bra-miljoval/ (Accessed May 2, 2011).

NHD. 2004. “Veileder: miljø og regelverk for offentlige anskaffelser.” http://www.regjeringen.no/upload/kilde/mod/red/2004/0021/ddd/pdfv/197434-ferdig_miljoveileder.pdf.

Norwegian Ministry of Foreign Affairs. 2009. *Corporate social responsibility in a global economy*. Report No.10 (2008-2009).

OECD. 2011. “Fact Sheet: Extended Producer responsibility.” http://www.oecd.org/document/53/0,3343,en_2649_34395_37284725_1_1_1_1,00.html (Accessed June 12, 2011).

Peters, Hans R. 2009. “It all starts with the building material.” *Greenbuilding* 26-30.

Porter, Michael E. 1985. *Competitive Advantage Creating and sustaining superior performance*. New York: The Free Press.

Public Procurement Act. 1999. “16.July 1999 no. 69.”

Ringdal, Kristen. 2001. *Enhet og mangfold*. Bergen: Fagbokforlaget.

RT Environmental Declaration. 2011. “RT Environmental Declaration.” http://www.rts.fi/ymparistoseloste/index_RTED.htm (Accessed April 12, 2011).

Schenck, Rita. 2010. *A roadmap to environmental product declarations in the United States*. IERE.

Skaar. 2011. “Personal communication.”

Starkey, Richard. 2007. “The Standardization of Environmental Management Systems: ISO 14001, ISO 14004 and EMAS.”in *Corporate Environmental Management 1, Systems and Strategies*, edited by Richard Welford. London: Earthscan.

Statsbygg. 2011. “Statsbygg krev miljødokumentasjon.” http://statsbygg.no/Miljo/Statsbygg-krever-miljodokumentasjon/ (Accessed June 16, 2011).

Stiftelsen Miljøfyrtårn. 2011. “15 på topp-statistikk.” http://miljofyrtarn.no/index.php/hvaermiljofyrtarn/15patopp (Accessed April 24, 2011).

Stortingsmelding 10 (2008-2009). n d. *Corporate lifes' social responsibility in a global economy.* Oslo: Utenriksdepartementet.

Stortingsmelding 14 (2006-2007). n d. *Together for a toxic-free environment - requirements for a safer future*. Oslo: Miljøverndepartementet.

Stortingsmelding 36 (2008-2009). n d. *Det gode innkjøp*. Oslo: Fornyings-, administrasjons- og kyrkjedepartementet.

TCO. 2011. "TCO Certification." http://www.tcodevelopment.com/ (Accessed May 3, 2011).

Thagaard, Tove. 2009. *Systematikk og Innlevelse*. Bergen: Fagbokforlaget.

The Blue Angel. 2011. "The Blue Angel." http://www.blauer-engel.de/en/index.php (Accessed May 2, 2011).

TSC. 2011. "The Sustainability Consortium." www.sustainabilityconsortium.org (Accessed April 14, 2011).

UN. 2002. *Central product Classification (CPC) version 1.1*. New York: United Nations.

UNIDO. 2006. *Role of standards. A guide for small and medium-sized enterprises.* Vienna: United Nations Industrial Development Organization.

Union Carbide. 2011. "Union Carbide Corporation." http://www.unioncarbide.com/bhopal (Accessed June 12, 2011).

United Nations. 1997. "Un Conference on Environment and Development (1992)." http://www.un.org/geninfo/bp/enviro.html (Accessed June 12, 2011).

Walmart. 2011. "Walmart Corporate." www.walmartstores.com (Accessed May 28, 2011).

Watts, Phil, Lord Holme, Rio Tinto, and Shell International. n d. *Corporate Social Responsibility Meeting changing expectations*. WBCSD.

WBCSD. 2011. "Business Role." http://www.wbcsd.org/templates/TemplateWBCSD5/layout.asp?type=p&MenuId=MTE0OQ (Accessed April 23, 2011).

WCED. 1987. *Our Common Future*. Michigan: Oxford University Press.

Welford, Richard. 2007. *Corporate Environmental Management - Systems and strategies*. Earthscan. London.

Welford, Richard, and Andrew Gouldson. 1993. *Environmental Management and Business Strategy*. Lonodn: Financial Times Management.

White, Robert. 1994. “Preface.”in *The greening of industrial ecosystems*, edited by Br Allenby and Dj Richards. Washington: National Academy Press.

Widerberg, Karin. 2001. *Historien om et kvalitativt forskningsprosjekt*. Oslo: Universitetsforlaget.

Appendix I: Details about analysed PCR

No.	Name	Country	PCR id	Year
1	Table	Norway	NPCR 005	2008
2	Seating solution	Norway	NPCR 003	2008
3	Mechanical single ply roof waterproofing membranes	Norway	NPCR 08	
4	Steel as construction material	Norway	NPCR 013	
5	Windows and doors	Norway	NPCR 014	2009
6	Seats	Sweden		2009
7	Office desk	Sweden		2007
8	Table linen for industrial and private users	Sweden		2006
9	Electricity, steam, and hot and cold water generation and distribution	Sweden	CPC 17	2007
10	Finished bovine leather	Sweden	2007:03	2007
11	Intercom	Japan	AX-03	2004
12	Paper beverage cartons	Japan	BD-01	2004
13	Net camera products	Japan	BH-01	2004
14	Optical disc drive	Japan	BB-03	2004
15	Grid electricity	Japan	AT	2003
16	Building metals	Germany		2009
17	Floor covering	Germany		2008
18	Glass reinforcement mesh	Germany		2010
19	Wood materials	Germany		2009
20	Air-conditioners	South Korea	65 (1)	2003
21	Digital camera	South Korea	152 (0)	2004
22	Wafer	South Korea	181 (0)	2007
23	Copper & copper alloy	South Korea	191 (0)	2006
24	Tap water	South Korea	191 (0)	2009

Appendix II: Details about EPD used in comparison of EPD

No.	Country	Product name	id.	Dev. Org.
EPD-Norge				
1	Norway	Signature RFID, Euro	NEPD 116E	NTNU
3	Norway	Protan SE 1,2 takbelegg	NEPD 032	SINTEF Byggforsk
4	Norway	Beverage carton - PE and EvOH coating	NEPD 147E	Østfoldforskning
9	Norway	Håg Sideways 9732	NEPD 121E	Østfoldforskning
10	Norway	Savo Ikon 3 LN	NEPD 143E	NTNU
International EPD system				
13	Sweden	Freight transport on the Bothnia line	S-P 00195	Botniabanen AB
15	Sweden	Matador 8106.180	S-P 00169	Grindex
18	Sweden	RH Ambio	S-EP 00035	IVL
21	Italy	Acqua Minerale Naturale Oligominerale San Benedetto	S-P 00212	San bendetto Spa
26	Italy	Outdoor wall coating	S-EP 00260	Colorificio San Marco SpA
27	Italy	Windows of cormo	S-P 00142	LCA-Lab
33	Spain	Offshore mooring chain R4 & R4S quality steel	S-P 00185	Ingurumenaren Kideak
36	Czech	Concrete blocks	S-P 00211	KB-BLOK system
40	Taiwan	TFT-LCD Module	S-EP 00174	CMO
49	Switzerland	GSG High Pressure Barrel Pump	S-EP 00266	Sulzer Ltd
Ecoleaf				
53	Japan	Multifunction center	AH-09-097	
54	Japan	Data projector	AG-10-066	
58	Japan	EP and IJ printer	AD-10-117	
59	Japan	Facsimile	AH-09-083	
62	Japan	Interphone	AX-08-022	
RT				
64	Finland	Ekovilla thermal insulation materials	No 24.1	RT, RTS, & VTT
65	Finland	Standard Birch Plywood	No. 34	RT, RTS, & VTT
67	Finland	Termex wood fibre insulation	No. 7.1	RT, RTS, & VTT
69	Finland	LION Fibreboard	No. 28.1	RT, RTS, & VTT
72	Finland	Standard conifer plywood	No. 35	RT, RTS, & VTT
IBU				
73	Germany	Direct Pressure Laminate floor covering	ELF-2009111-E	EPLF
74	Germany	Structural steel: Sections and plates	BFS-2010111-E	PE International
75	Germany	Factory-made polyurethane insulating products	IVPU-2010112-D	PE International
76	Germany	Fibre-cement building material product	ÜAC-2010111-E	PE International
77	Germany	Wall and ceiling coverings made of glass yarns	VIT-2010111-E	PE International