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# Life Cycle Assessment and its Role in Marketing

Business Economics and Tourism

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## **PREFACE**

This thesis is a bachelor's thesis for Vaasa University of Applied Sciences, and has been conducted for the use of Metso Paper. The thesis was done in conjunction with a life cycle assessment study, and was therefore written in Jyväskylä.

I would like to thank my advisor at Metso Paper, M.Sc. Jussi Jääskeläinen, who encouraged and helped me in various ways throughout the process. I would also like to thank the whole LCA-team, and especially M.Sc. Tuula Laitinen, for the support she gave me in understanding the standards.

Finally I would like to thank my supervisor, Dr. Satu Lautamäki, who gave me valuable feedback on the work. The help of everyone involved is greatly appreciated.

## **EVALUATION OF THE WORK**

The work done for this thesis was a challenge; it meant stepping beyond my comfort zone. Coming into a workplace that focuses on the technical aspects rather than the business side of the product, as I am used to, means I had to continuously and rapidly learn new things. This combined with a topic I was unfamiliar with resulted in a very demanding job, but as a result I learned a great deal from working on this thesis.

The way in which time was managed could have been improved. The original schedule for the LCA study (which was used as research material for this thesis) did not hold, therefore the original schedule for this thesis did not hold either. Making a schedule for any pilot study is a difficult task, the task is made even more difficult if the team members are all relatively inexperienced with the subject, as was the case here.

When creating a new system, you should know the fundamentals inside out before starting. In this case it is highly important to know the requirements that ISO sets for LCAs, the job cannot be completed without this knowledge. I spent quite a bit of time familiarizing myself with the topic, and found this time well spent. Overall I am satisfied with this thesis, I feel it is current and responds to the research question. It also creates great value for the company, based on the feedback from my instructor.

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## **ABSTRACT**

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Environmental issues are a growing concern among the general population as well as with governments, non-governmental organizations and as a result with companies. Communicating responsibility in this area is an additional task for companies. Life cycle assessment (LCA) is one method of doing so. In this thesis the aim was to investigate the use of LCAs in marketing without compromising the structure of the report. The research problem is to find a procedure to produce the documentation of a LCA study that supports marketing.

The theoretical framework is based around marketing concepts and the framework for LCAs. The empirical material for this thesis was collected through interviews and a workshop as well as through observations gathered from working on the project.

The results found were quite encouraging as there is a clear need for this type of marketing material. LCAs are quite malleable for marketing material because they contain a lot of information based on facts. The marketing department needs fact-based information, especially when dealing in a business-to-business environment. In marketing paper machines costs are a significant factor in selling the product. LCA information can be used to show how decreased energy use creates savings. For a paper machine the largest environmental load is incurred during the use stage, and thus the focal point for green marketing professionals should be on the use of the machine, this is also where savings potential exists.

In addition to utilizing LCAs as a basis for marketing material it also gives the company a competitive edge in sales situations, while at the same time improving the reliability, responsibility, and transparency of the company, both to customers and shareholders alike.

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Keywords    CSR, Green Marketing, LCA, Product Based Environmental Management

## VAASAN AMMATTIKORKEAKOULU

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### TIIVISTELMÄ

Tekijä	Riitta Talja
Opinnäytetyön nimi	Elinkaariarviointi ja sen rooli markkinoinnissa
Vuosi	2011
Kieli	englanti
Sivumäärä	71
Ohjaaja	Satu Lautamäki

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Yhä useampi on huolestunut ympäristöasioista, niin yksityiset ihmiset, kansalaisjärjestöt, valtiot kuin yrityksetkin. Pelkkä vastuunkanto ei kuitenkaan riitä, vaan se täytyy viestiä myös eteenpäin, tämä tuo lisähaastetta yrityksille. Elinkaariarviointi (LCA) on yksi tapa viestiä tätä vastuuta. Tämän opinnäytetyön aiheena onkin LCA:n käyttäminen markkinoinnissa tinkimättä LCA:n raportointivaatimuksista. Tutkimusongelmana on löytää tapa tehdä LCA:n raportointi, niin että se tukee markkinointia.

Kirjallisuuskatsaus pohjautuu markkinointikonsepteihin ja LCA:n raportointistandardeihin. Empiirisen osan materiaali on kerätty haastattelemalla ja työpajojen avulla, työssä on myös käytetty hyödyksi projektin aikana tehtyjä havainnoiteja.

Tulokset olivat kannustavia; on olemassa selkeä tarve tämän tyyppiselle markkinointimateriaalille. LCA on suhteellisen muovailtava markkinointimateriaalina, koska se sisältää paljon faktapohjaista tietoa. Markkinointiosasto tarvitsee faktoihin perustuvaa materiaalia, etenkin kun kauppaa tehdään yritysten välillä. Paperikoneen markkinoinnissa kustannukset ovat merkittävässä osassa paperikoneen myyntiä. LCA-dataa voidaan käyttää osoittamaan energiankäytön vähenemisestä syntyviä säästöjä. Paperikoneen ympäristövaikutuksista suurin osa syntyy käytön aikana, siksi vihreän markkinoinnin ammattilaisten tulisi keskittyä koneen käyttövaiheeseen, sillä säästöpotentiaali on nimenomaan käyttövaiheessa.

Markkinointimateriaalin lisäksi LCA:han pohjautuvaa tietoa antaa yhtiölle etuja kilpailutilanteissa, parantaen samalla yhtiön luotettavuutta, vastuullisuutta ja läpinäkyvyyttä sekä asiakkaiden että osakkeenomistajien suuntaan.

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Avainsanat	LCA, tuotelähtöinen ympäristöjohtaminen, ympäristömarkkinointi, yritysvastuu,
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## **ABBREVIATIONS**

EPD – Environmental product declaration

ISO – International organization for standardization

LCA – Life cycle assessment

LCC – Life cycle cost

LCI – Life cycle inventory analysis

LCIA – Life cycle impact assessment

LCWT – Life cycle working time

NABC – Framework for value proposition (comes from: Need, Approach, Benefits, Costs)

NGO – Non-governmental organization

PFT – Metso's Paper and Fiber Technology segment

## 1. INTRODUCTION

Sustainability is one of the megatrends in the world today. People are changing their consuming habits, and as a result are creating pressure for suppliers to reduce their use of natural resources. Companies are changing their production processes to respond to the demand and to assure the consumers by acquiring internationally accepted eco-labeling for their products. There is variety of non-governmental interest groups (NGO) working for a “greener” world. Also, governments have become active in this area. In the following paragraphs the current situation is described; the examples have been divided into action taken by governments, NGOs, and companies.

Governments all over the world are taking action to combat environmental issues, such as climate change. The following examples demonstrate a small portion of the change taking place. In Finland, the topic of the Presidential forum on March 22, 2011 was sustainable development. Participants from different areas of society, including Members of Parliament, researchers and representatives of various organizations, were invited to join the forum. (Office of the President 2011)

In the beginning of the year 2011, a new variety of gasoline, E10, was introduced in Finland. In minimum it contains 6% of renewable fuel, which is mainly ethanol. The share of renewable fuel will be gradually increasing in the future. This is a practical measure to reduce CO<sub>2</sub> emissions, due to an EU wide agreement. (Motiva 2010)

The Finnish Funding Agency for Technology and Innovation (TEKES) has recently launched a “Green Growth programme: Less natural resources, improved energy and material efficiency”. The aim of the Green Growth programme is to identify potential new growth areas for the sustainable economy business, which are essentially based on lower energy consumption and sustainable use of natural resources. The programme aims at a leap forward in energy and material

efficiency of production and service chains over the entire life span of products. (Karvonen 2011)

In U.S., President Obama's Administration has announced a \$12 million initiative "i6 Green Challenge for Clean Energy Innovation and Economic Growth". The funding will support awards for six teams around the country with the most innovative ideas to drive technology commercialization and entrepreneurship in support of a green innovation economy, increased U.S. competitiveness and new jobs. (U.S. Department of Energy 2010)

NGOs have a considerable amount of impact on the change taking place, many powerful individuals are investing time and effort into NGOs to make the change towards a more sustainable world possible. The following examples express this.

UN Secretary-General Ban Ki-moon established a High-level Panel on Global Sustainability in August 2010. The panel is co-chaired by President Halonen with Jakob Zuma, the President of the Republic of South Africa. The work is guided by the questions: "How to eradicate poverty and reduce inequality, make growth inclusive, and production and consumption more sustainable while combating climate change and respecting the range of other planetary boundaries?" (Office of the President 2011)

The World Wide Fund for Nature (WWF) has launched a tool box on their website to help individuals and businesses to save paper and reduce their environmental impact. (WWF 2011) Individuals are encouraged, among other things, to think before printing, to use both sides on a sheet of paper, to use technology such as email, and the internet, etc. instead of printing. Companies are encouraged to build up a policy for paper buying and use including measures to

- reduce excessive paper consumption
- use paper with post-consumer recycled fiber
- use FSC-certified paper
- avoid potentially illegal and other unacceptable sources
- choose transparent suppliers with Environmental Management Systems
- avoid contributing to climate change

- use unbleached or totally chlorine free paper
- buy your paper from mills with low COD emissions
- avoid contributing to landfill waste.

Companies develop practices that will give them a competitive edge, or that are required from international organizations, or governments. Environmental issues are something that consumers are paying more and more attention to, in fact environmental practices are expected. Individuals want to do their share for the environment and consuming environmentally friendly products is an easy way to do this. The market exists for green products, and companies are doing what they can to tap into it. (Ottoman 2011, 9) The following examples demonstrate some cases where companies have taken action.

Some retailers have introduced carbon labels. A well-known example is English-based Tesco. “We’ve introduced carbon labels on some of our products to make it much easier for you to compare the environmental impact of what you buy, just like you can do with nutritional information. There are already 120 products with carbon labels including milk, orange juice, washing detergents, potatoes, light bulbs and toilet tissue – and that number is climbing all the time.” (Tesco 2010). In the US, Wal-Mart, the country's largest retailer, announced on July 15, 2009 that it will institute a new policy requiring all of its product suppliers to calculate the environmental costs of their products. These costs will then be tabulated into an easy-to-understand green rating. Wal-Mart plans to post these ratings next to the price tags on products. (Salkever 2009)

A Finish forest company UPM announced reassembly that “UPM applies for FSC (Forest Stewardship Council) certification for its forests in Finland. At the same time UPM also extends its forest service portfolio to cover FSC-certification services to Finnish forest owners. UPM's forests and most of the privately owned forests in Finland are already certified under PEFC (Programme for the Endorsement of Forest Certification Schemes). The FSC certification of company forests increases UPM's possibilities to supply products produced from wood that are certified according to customers' request.” (UPM 2011)

The examples above show a wide global as well as a Finnish national interest towards environmental issues and sustainability. A concern for the environment is common. One of the key aspects is what we leave as inheritance to the next generations.

Within Metso Corporation, the Environmental Team made a decision to further improve environmental performance by creating a capability to produce life cycle assessment (LCA) studies in-house. Life cycle assessment is an ISO standardized procedure to produce information about environmental impacts of a product and it will serve as a basis for product's environmental declaration. This study is a part of Metso's activities.

### **1.1. Research Problem**

The main research problem is to find a procedure to produce a transparent, reliable and internally consistent documentation of a LCA study that supports marketing. As a target was a LCA exercise made for a part of papermaking line of Metso Corporation. The author was a member of the team executing the LCA study for a part of a papermaking line with the responsibility of drawing up the documentation and clarifying the ISO standards for rest of the group. This study contains observations and suggestions concerning the target work and deriving marketing aspects from the results achieved.

In order to solve the research problem the following questions will be focused on: What issues should be considered when doing an LCA study? What are the regulations from ISO standards, and what restrictions or additions do marketing needs have for the report? How should an LCA report be written so that it complies with ISO standards and supports marketing at the same time?

The aim of this thesis is to shed light on what are the most important aspects to consider when doing an LCA report, especially when examined from a marketing perspective. When conducting an LCA report it must be done in accordance with standards, in this case ISO 14040 and 14044. Doing a life cycle assessment means doing a scientific study, using ISO standards to validate the study and to show that

the study has been made according to strict guidelines. This thesis aims to point out ways of utilizing LCAs outside their traditional scope, in this case marketing. LCA can be considered to be a form of product based environmental management, which is briefly explained and discussed in this thesis.

## **1.2. Thesis Structure**

The structure of this thesis is divided into four main sections, which includes the introduction, the theoretical framework, the empirical study, and finally the conclusions.

The introduction familiarizes the reader with the topic and, it discusses why this thesis is relevant. The environmental change taking place is discussed from the point of view of three interest groups; governments, NGOs, and companies.

The theoretical framework is further divided into three parts, each of them a core area for this thesis, namely papermaking, life cycle assessment and green marketing. The papermaking section consists of a brief explanation as to how paper is made. The life cycle assessment section covers the definition of life cycle assessment, describes the thinking process behind the method, describes the stages of a life cycle assessment, as well as presents one method using LCA as a management tool. The final section of the theoretical framework is about green marketing. The history of green marketing is covered, along with some green marketing concepts. The section finishes with the explanation of a value proposition tool (NABC) that will be used in the empirical section of this thesis.

The empirical section of this thesis covers the case company description, the used research methodology, an assessment of reliability and validity, the processes of conducting the study, both from a LCA and marketing perspective, and the results of the study.

The conclusions chapter contains four parts; a discussion, the summarized results, suggestions for the company and an evaluation of the work done.

## **2. THEORETICAL FRAMEWORK**

The principles for conducting a LCA study are the same for all products, the same standards apply no matter what the product or service is. In this work the objective for the LCA study is to study some processes from a papermaking line. This section of the thesis is divided into three main parts.

The first part of this section gives a short introduction to paper grades and the processes of a papermaking line. The second section introduces the phases of a life cycle assessment. Finally, the third section gives background information on green marketing. For the third section, the history of green marketing is briefly explained, and then some techniques to position and market oneself are discussed. Marketing a product is one aspect of product-based environmental management.

### **2.1. Papermaking Process**

The history of paper is a long one; paper has been produced for over 2000 years. Paper can be defined as the bonding of cellulose fibers into a uniform quality sheet by felting them together. 2000 years ago paper was produced by hand, each sheet had to be made individually, it was not until the late 1790s that machine production began. (Nykänen and Paulapuro 2005, 19)

The papermaking process is in principle simple: the fibers from either virgin wood or recycled material are disintegrated and diluted, from a diluted consistency of about 1% the paper web is formed and the water is removed. The final stage is to finish the web surface. Disintegrating and diluting take place at a pulp mill while the web is built up at a paper mill. (KnowPap 2005)

The choice of raw material is decided with the desired end product in mind. Recycled material is used especially when making newspaper and cardboards. The recycling process starts with the collection of recycled paper. The paper is then re-pulped in a container with water and chemicals that is then heated to break the paper into fibers. The recycled paper needs to be screened and cleaned before

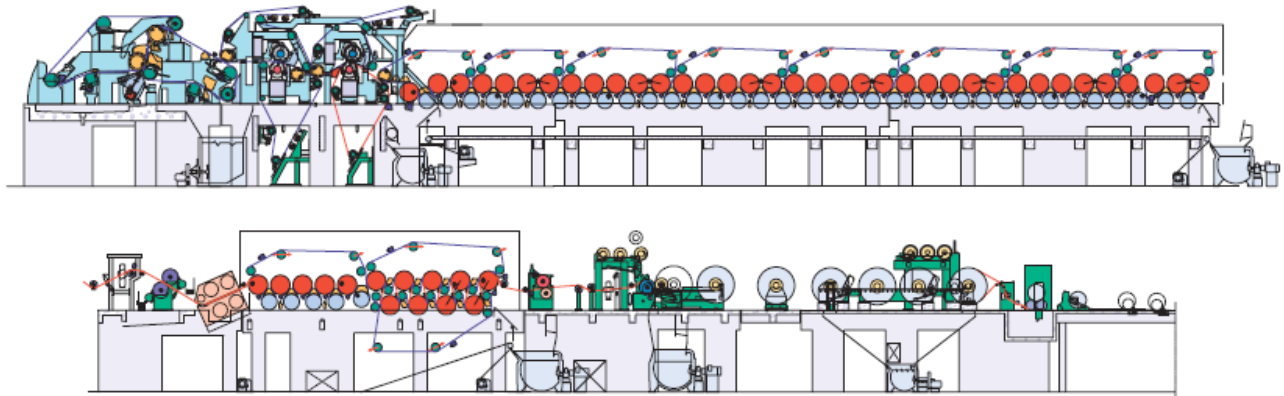
it can go any further. Screening and cleaning is a process where contaminants, such as plastic and staples, are removed from the pulp. The next step is to deink the pulp, a process where old ink and possibly glue are removed from the fibers. The final step before producing new paper from the recycled material is to refine, bleach and color strip the pulp. Refining the pulp means that any fiber bundles are separated to get a more consistent pulp. Color striping is done when the recycled paper has been colored, to remove the dyes from the pulp. The need for bleaching is determined by the end product. In a situation where the recycled paper should be white then bleaching is necessary, however in the case that brown paper is made, bleaching is not done. (KnowPap 2005)

There are two types of pulping processes for virgin fibers, chemical pulping and mechanical pulping. In chemical pulping the wood chips are cooked with chemicals. Fibers are disintegrated and lignin is removed. Lignin is one of three components in wood, the other two are cellulose and hemicellulose. In chemical pulping about 50% of the mass put into the process is recovered as pulp. The rest is usually burned to fuel the process, and exhaust heat can be used outside the pulp mill. In mechanical pulping the wood is disintegrated mechanically by grinding or refining. Sometimes the wood is treated with chemicals to ease the process. Mechanical pulping requires an extensive amount of electricity, but the yield is close to 100%. Only the bark cannot be used as material in mechanical pulping. (KnowPap 2005)

The paper mill converts a flowing fiber suspension into parcels. The products of a paper mill are either cut into paper rolls for printing houses or the paper web is cut into sheets, like A4s. Containerboard grades are delivered from the mill as rolls to be converted as corrugated board and boxes. In the following, the term paper is used to cover both paper and board. (KnowPap 2005)



A paper machine consists of hundreds of parts; in general it can be divided into roughly ten sections these are further explained below. In Figure 1 a drawing of a paper machine can be seen in full.



**Figure 1.** A paper machine (Metso 2011).

The first section of a paper mill is stock preparation and approach flow system. Different fiber fractions, fillers and chemicals are mixed together, cleaned and prepared for the paper machine. Basically there are two different types of fibers: short fibers are from hard wood, like birch, and long fibers from soft wood, like spruce. The filler is inorganic material, like calcium carbonate. Depending on the paper grade, different chemicals are used. The stock is pumped through the headbox to the wire section. (KnowPap 2005)

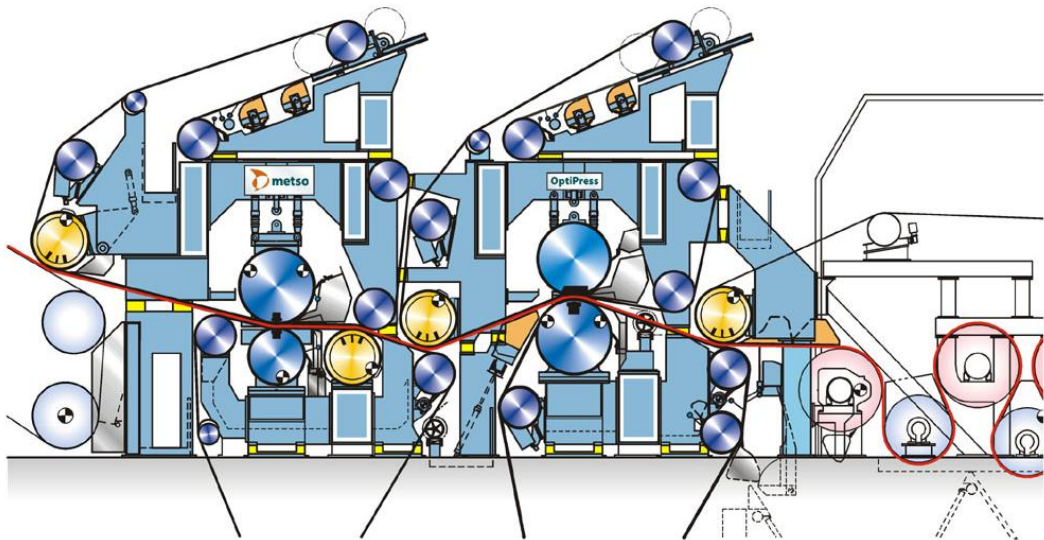
The headbox (example in Figure 2) can be thought as a nozzle spreading the stock in a uniform layer on the wire. It also creates a flow condition, which disintegrates the fiber flocks built in the stock and orientates the flow and fibers properly. The stock consistency in the headbox is about 1% depending on the paper grade. (KnowPap 2005)



**Figure 2.** Headbox (Metso 2011)

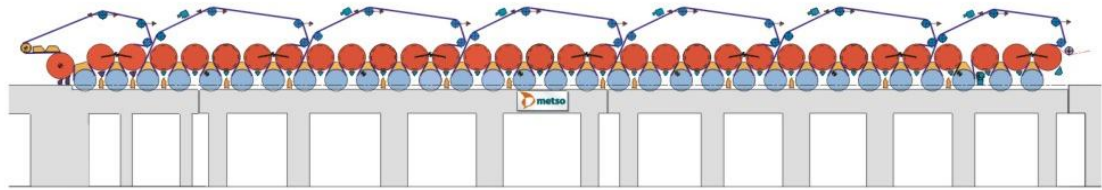
On the wire section the web structure is formed and most of the water is removed. The consistency after the wire section, sometimes called the former as well, is about 20%. Water removal is assisted with vacuum and centrifugal forces. (KnowPap 2005)

Water removal continues on the press section (see example in Figure 3). The volume of the web is reduced mechanically in the press nips. The roll nip consists of two rolls, which are compressed against each other. The felt carries the web through the nip and receives the water squeezed out from the web. The shoe nip consists of a press shoe and a counter roll. The length of the shoe nip is longer, water removal is smoother and the produced solids content is higher. The number of the nips on the press section varies from one to four. The solids content after the press section is about 50%, i.e. half of the web is solid material, and the other half is water. (KnowPap 2005)



**Figure 3.** Press section (Metso 2011).

On the drying section (see example in Figure 4) the web is dried via evaporation. Depending on paper grades, a few techniques are available. The most common option is cylinder drying. Evaporation takes place, when the web travels from a steam heated cylinder to the next one. In the 1990's impingement drying was commercially introduced for printing and writing grades. Gas heated hot air is impinged against the web and evaporated moisture is carried out with the returning hot air. The impingement unit is like a hair dryer, except the hot out-blown air is re-circulated and the air properties differ. The temperature is between 350 and 400 C and air speed 90 m/s. In the installations so far, the impingement unit is in the beginning of the dryer section followed by cylinder drying, except in those used for correcting paper properties like the web curl. (KnowPap 2005)



**Figure 4.** Drying Section (Metso 2011).

In the simplest machine, the drying section is followed by the reel, which reels the web on a jumbo roll. The weight of a jumbo roll might be as high as 50 tons corresponding one hour's production. The jumbo rolls are cut on a winder into smaller ones according to the orders and are then sent to printing houses and other processing. Copy paper, A4's for example, is cut on the mill. The largest sheet cutting installation is in Germany on UPM's mill in Nordland Papier. It is capable to produce over a 1 000 000 tons of copy paper annually. (KnowPap 2005)

Commonly web finishing operations follow the drying section. These include calendering, sizing and coating. Calendering is used to even out the web thickness for printing nips or improve glossiness and smoothness of the web surface. In sizing, a uniform layer of sizing agent is spread on the web surface. Usually the sizing agents are starch based and they do not contain solid material. The purpose of sizing is to improve the surface strength of the web. In coating, a layer of coating color is spread on the surface with a blade. It leaves a smooth surface, where the uneven structure of the base paper is filled with coating color, which may contain solid material like clay. (KnowPap 2005)

The dryer section is covered with a hood. The purpose of the hood is to collect the moisture evaporated on the dryer section. The amount of water evaporated on the dryer section can be over than 50 tons per hour. Air is used to carry the evaporated water out from the paper machine. Typically the exhausted air in the

paper machine's air systems contain up to 170 grams of water per one kilogram of dry air. This leads up to a few hundreds of tons of air to be exhausted per hour. Besides exhausting moist air, the air system brings in fresh supply air and takes care of ventilation on other sections of the paper machine. The heat recovery system (see example in Figure 5) is used to recover the heat from exhausted air and transfer it to fresh air and waters. The recovery rate is good on a paper machine being about 85% on the best. Compared to other industrial drying processes with an extensive energy use, metal, chemical and food industries for example, the achieved recovery rate is high. (KnowPap 2005)



**Figure 5.** Heat recovery system (Metso 2011).

## **2.2. Life Cycle Assessment**

Life cycle assessment belongs to the family of thinking with a life cycle approach. It is one technique that considers the entire life cycle of a product or service. Life cycle approach is a very holistic method of looking at a product; it encompasses everything that happens during the lifetime of that product. Life cycle assessment strives to consider the environmental burden caused by the product, understanding the changes that take place in the environment as a result of that product being produced, used and finally disposed. Other areas of life cycle approach can include working time, the costs incurred at each phase of the life cycle, or even the use of diminishing resources.

All of these variations can be carried out with more or less the same format. The input data just changes, but the method of organizing the data and processing it stay the same. The LCA approach can be used for anything really as long as the input data can be quantified and collected according to life cycle stages.

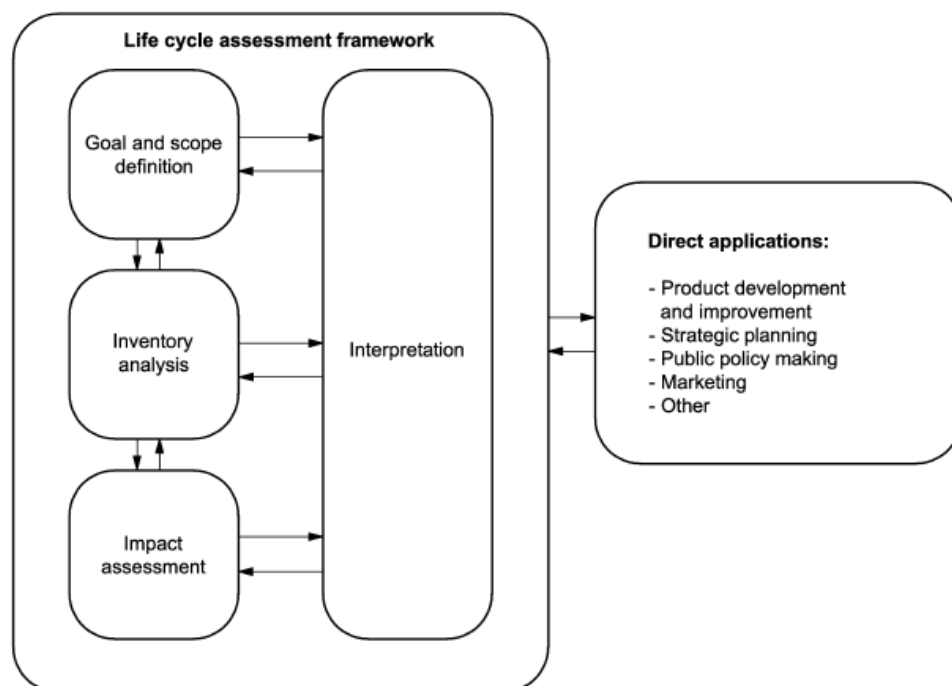
The adaptability of the LCA tool has two sides, a positive and a negative side. The positive aspects are that usability increases, the LCA can be used by all industries and by any size company, or association. The negative aspects are that because of the wide possibility of adaption, it is not uniform, and therefore LCAs cannot be directly compared with one another.

Life cycle assessment is an environmental management technique. It is regulated by two ISO standards from the 1400-series: 14040 and 14044. ISO standard 14040 has the principles and framework and the standard 14044 has the requirements and guidelines. One could say that the 14040 acts as an introduction to LCA as well as the ISO standards on it, whilst 14044 has specific requirements needed to comprehend and carry out a LCA. ISO standard 14050 contains the vocabulary for the 1400-series.

When conducting a life cycle assessment the whole life cycle is taken into consideration, examining the product (here products may refer to physical products, services, or a combination of the two) from cradle to grave. This means

that every stage throughout the product's life cycle must be assessed, starting from raw material extraction, all the way to the disposal of the product. (SFS-EN-ISO14040 2006, 9,11)

In the following picture (Figure 6) the stages of a LCA are shown. The picture depicts the interrelationship of the different stages quite well, showing that iteration is a natural and expected tool in the method for conducting a LCA study. All the stages are interlinked with one another, if you make a mistake in one stage it will cumulate on in the following stages.



**Figure 6.** The Stages of an LCA (ISO 14040 2006, 24).

Life cycle assessment has been developed over decades, and measures have been taken to make it more scientific and representative of the studied product system. Great emphasis has been placed on making LCA a reliable tool to assess the environmental impacts of a given product. Life cycle assessment allows the quantification of the impacts on the environment, making it possible to measure, and therefore compare and contrast the environmental impacts of a given product with for example a global norm or another product. (Baumann and Tillmann 2004, 19)

Life cycle assessment has four distinct stages; definition of goal and scope, life cycle inventory analysis (LCI), life cycle impact assessment (LCIA), and life cycle interpretation (SFS-EN-ISO14040 2006, 9). The goal and scope as well as the interpretation phase set the borders for the study and tie it into a cohesive package. The bulk of the LCA consists of the remaining two phases: the inventory analysis and the impact assessment.

The goal and scope phase of the study is extremely important, as LCAs are done with an iterative approach the goal and scope are scrutinized throughout the study. In the goal and scope phase the study is defined. Definitions on product system, the boundaries set and the nature of the study are all examples of issues that need to be thought out during this phase. (SFS-EN-ISO14040 2006, 23)

For the goal the ISO standard requires the intended application, the reasons for carrying out the study, the intended audience and whether the results are to be used in comparative assertions to be disclosed to the public. (SFS-EN-ISO14044 2006, 23)

The scope part requires a number of different definitions and parameters to be set. First off the product system that is to be studied must be defined and explained, the function(s) of the product system, as well as the functional unit and reference flow that the function is examined in. Then the system boundaries that are set, i.e. the boarder lines within which the product system is studied in, must be explained. For the inventory analysis the allocation procedures must be stated and the requirements for the data collected, including the quality requirements. For the impact assessment phase the selected impact categories, the methodology and interpretation that are to be used for the impact assessment must be stated. Finally any assumptions and limitations that are made, whether a critical review is to be done and if so the type of critical review, as well as the type and format of the LCA study. (SFS-EN-ISO14040 2006, 31)

The inventory analysis is the phase where the data is actually collected. In the inventory analysis phase input and output data with regard to the system is studied. The inventory analysis includes data collection, data validation, relating



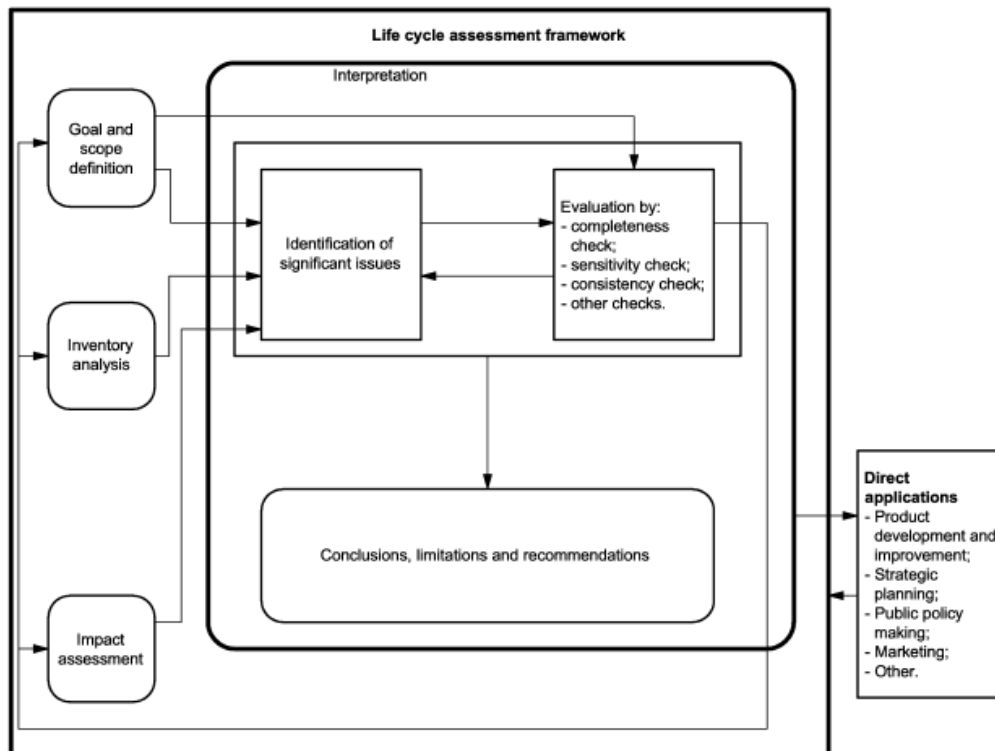
the data to the unit process and functional unit defined in the scope of the study, finally the data is aggregated to produce the life cycle inventory. (SFS-EN-ISO14044 2006, 9, 35)

The impact assessment is a phase where the data is processed and transformed into a form that is easier to understand. The purpose is to provide additional information, to better bring forth the environmental impacts of the studied product system. The impact assessment complements the inventory analysis phase. The impact assessment consists of a mandatory part and an optional part. The mandatory part includes a selection of impact categories, category indicators and characterization models, the classification phase and the characterization phase. The optional elements include normalization, grouping, weighing, and an additional data quality analysis can be made. (SFS-EN-ISO14044 2006, 9, 43,51)

The first question to answer in the mandatory part of the LCIA is the selection, this sets the guidelines for the rest of the LCIA, what is studied, how, and to what extent are explained in the selection. There ought not to be much new information in this part, as the essential information should already be in the scope of the study, but the details, explanations and justifications should be disclosed along with the selected impact categories, category indicators and characterization models. Secondly, the classification has to be done. This means sorting the emissions under the selected impact categories, which can be for example climate change, acidification or eutrophication. The third phase is the characterization, which is unifying the emissions under one impact category to obtain a single figure for that impact category. For climate change that figure is usually expressed as tons of CO<sub>2</sub>-equivalents.

The final phase of the LCA study is the interpretation phase, this is where the conclusions and recommendations are made based on the information that has been gathered in the inventory analysis phase and the impact assessment phase. The interpretation phase has some elements that need to be conducted, these are; the identification of significant issues, an evaluation (in which a completeness, sensitivity and consistency check are completed), and making conclusions and recommendations and noting the limitations of the study. In Figure 7 the different

stages of the interpretation phase can be seen along with the relationships with the other phases of a LCA study. (SFS-EN-ISO14044 2006, 9, 55, 57)



**Figure 7.** Relationship of interpretation phase with other LCA phases (SFS-EN-ISO 14044 2006, 57)

Once the LCA has been conducted, it can, and in some cases has to undergo a critical review. The critical review is either conducted by an expert independent of the LCA or by a panel of experts. Basically there are three different types of critical reviewers; internal expert independent of the LCA, external expert independent of the LCA, or a panel of experts independent of the LCA. For the critical review to actually fulfill its purpose the expert(s) needs to be independent of the LCA study, meaning that they have not been involved in conducting the LCA in any way. One or two critical reviewers are usually enough, the only instance when a panel is required is if comparative assertions intended for the public are to be made with the LCA.

### 2.2.1. LCA Types

There are different types of LCAs. Baumann and Tillman identify four most typical types of LCAs. The most typical LCA is the quantitative LCA study, the remaining LCA types are, accounting LCA, change-oriented LCA, and the stand-alone LCA. (Baumann & Tillman 2004, 63)

The quantitative LCA is one where the environmental impacts are quantified, the impacts are described with numbers and are calculated. The quantitative LCA can then be placed in one of the three remaining categories. The accounting LCA and the change-oriented LCA are both LCAs used for comparisons, while the stand-alone LCA is used for describing one product. (Bauman & Tillman 2004, 63)

The stand-alone LCA is probably the most common of all the LCAs, it can be used for a rough LCA to gain more information on one's own product and the methods of conducting a LCA study. The stand-alone LCA is ideal for identifying the critical points, environmentally speaking, of the product life-cycle. (Baumann & Tillman 2004, 63)

The accounting LCA studies are comparative and retrospective, this means that existing products are studied, and the data is just gathered from the processes used to create that product. The accounting LCA is well suited as a basis for different types of eco-labeling, it can also be useful in purchasing and procurement situations, because it studies products currently on the market. (Baumann & Tillman 2004, 63)

The last of the LCA types is the change-oriented LCA, which are comparative and prospective in nature. This means that the change-oriented LCA aims to seek for new products and new solutions for the product or for creating the product. This type of LCA looks at different options for the future. The change-oriented LCA can be used for deciding on the options for waste management, and for possible recycling schemes. (Baumann & Tillman 2004, 64)

### **2.2.2. LCA as a Tool for Product Based Environmental Management**

These days customers expect a company to take corporate social responsibility actions, including, but not limited to, environmental actions. At the very least it is expected that you control, monitor and try to minimize your own emissions. LCA is good tool of doing this, especially for a company that works project to project. LCA gives the environmental impacts of a product, and when producing a large product, like a paper machine, having product based environmental management system can be more useful, than just having a general environmental management system. When the environmental management system is gathered from the environmental management of products, it not only reflects the products created and the economic situation at the time, but it also allows the possibility to give customers information on the solution created for them, so that they in turn can work on their environmental management system.

#### **2.2.2.1. Corporate Environmental Management**

The corporate environmental management sets up policies and the management system, as well as summarizes and reports the corporate environmental performance. Besides the internal reports to management, the corporate environmental management produces the sustainability report. As an example is Metso's sustainability report 2009. It is divided into the following sections:

- **METSO AND SUSTAINABILITY** describes sustainability as a part of Metso's strategy, Words from CEO, Key figures, Metso in sustainability indexes, Reporting principles, Management systems and stakeholders, R&D supports strategy and sustainability, Internal development projects and Environmental impacts of our own production
- **FINANCE AND OPERATIONS** contains the chapters: We are continuing our investments in emerging markets and Prosperity for our stakeholders.
- **PERSONNEL AND WORK ENVIRONMENT** contains: Personnel and work environment development

- ENVIRONMENTAL SOLUTIONS contains the chapters: Sustainable results with environmental solutions and Cleaner energy production and more energy efficiency
- ADDITIONAL INFORMATION contains GRI content index and Contact and additional information.

LCA is a useful tool in several of these sections. A traditional LCA, that is when you focus on a product and the materials used throughout the life cycle, can be directly applied in a few of these sections. LCA modifications, such as life cycle cost (LCC) and life cycle working time (LCWT) can be used for some of the remaining sections.

The traditional LCA can be applied in the first section, Metso and sustainability, which includes environmental impacts of the company's own production. Conducting a LCA provides a method for arranging this data. Another place where the traditional LCA can be used, or actually the results of a traditional LCA, is the section on environmental solutions. With the help of a LCA it is possible to pinpoint the currently existing energy efficient solutions, as well as find places where energy efficiency can be further improved.

The modifications work much in the same way as the traditional LCA, the input data is just different. For Life cycle cost, the cost of the product is considered throughout the different stages of the life cycle. For life cycle working time, the hours of work are used as input data. When the life cycle cost and life cycle working time are known, the process can be tweaked to be more cost effective, thus bringing prosperity to the stakeholders.

The section personnel and work environment, is more a social aspect than an environmental one. Due to this LCA is not the most suitable tool to assess the issues brought forth in that section. Also the final section, additional information, does not contain any matters that would be reasonable to use LCA on.

The environmental manager of a business unit applies the corporate policies and managements systems in their unit, does reporting, applies environmental permits from authorities, deals with everyday problems faced by the unit and keeps in

contact with stakeholders. In Metso Paper Inc. case, where the installation and start-up on the customer's mill site can take up to 18 months, the business unit's environmental manager sets up the guidelines and principles on how to take care of the environment at the customer's mill site concerning Metso's operations.

The product based environmental management starts from the technology and product development phase and continues throughout the life cycle of the product. During the development phase, the guidelines come from the environmental management and R&D management.

In Metso, the R&D process is managed with a state-gate process. The first stage is the permit to start a technology or a product development project and the process continues via product launching to the end of the development phase. The progress of the project is quarterly reported to the management system and additionally the product is checked at the gate to ensure that the product meets the targets set, including environmental targets. The marketing plan of the product is a part of the development project and it will be linked with environmental issues as well. The environmental performance of a product is built during the development process and the marketing is using the data achieved from testing in their work.

#### **2.2.2.2. Product Design and Development**

During the product design and development process targets for some or all of the following environmental aspects are set within Metso's R&D process:

- Resource use
  - Energy
    - Power (Drives, vacuum, pumps, pressurized air, hydraulics, infrared dryers, etc.)
    - Heat
      - Steam (Primary steam)
      - Gas (Impingement drying, infrared dryers, etc.)
      - Recovered heat (Air heating, water heating, etc.)
      - Other heat

- Water
  - Fresh water
  - Circulated water
- Construction materials
- Operational materials (Oils, other lubricants, spare parts, fabrics and the like, chemicals (e.g. cleaning), etc.)
- Raw materials (Fibers, fillers, chemicals to improve retention and strength, for example)
- Emissions
  - To air (Vapor, heat, other)
  - To water
  - To land
    - Recyclable materials
    - Non-recyclable materials
      - Hazardous waste
      - Landfill waste
- Noise
  - Noise outside the paper machine hall
  - Noise in working environment
  - Noise due to sub-process

The targets are set in measurable units, like kWh per ton of produced paper or m<sup>3</sup> of water per ton of produced paper. The target is compared with the present value. It is also described, what will be the new ideas or modifications to achieve the target. (Jääskeläinen 2010)

When developing papermaking processes, energy use is one of the most important environmental drivers. The low energy use achieved during the product development and design phases, determines largely the environment load of the paper machine during its life time. Rebuilds and change of components made during the life time has the potential to improve energy efficiency to some extent.

Energy efficiency is defined as the ratio between a certain product and service and the amount of energy used to produce it. Favorable energy efficiency can come from small, continuous improvements as well as from radical technological innovations. As energy efficiency evolves over time, the energy efficiency of solutions is measured in relation to a general benchmark level. (Metso 2010)

Energy efficiency improvement action in process industry can be categorized into four groups (Punnonen, et al. 2007). The list can be extended to other areas as well.

- The way to operate
  - The good housekeeping has the top priority. The operators should take care that any resources are not used, if not needed. Heat exchangers are kept clean, etc.
  - In engineering phase, eliminating of over-dimensioning and taking energy efficiency one of the guiding principle in designing.
  - Even though measures are operational, there is a lot room for new innovations and possibilities to utilize information and communication technology.
- Components
  - Development and replacement of the most energy consuming components. In papermaking for example, the conventionally used uhlebox covers can be replaced with a new ones consuming remarkable less energy. The uhlebox's function is to maintain the press felt in a good condition.
- Sub-processes
  - On the sub-process level the whole sub-process is re-thought and re-designed. In papermaking a good example is the press section: Traditionally three or four nip press sections are used. The modern constructions include two or even one nip. The nip is the unit, where the web is compressed and water removed. The installations with one nip consume less energy and construction materials, and



produce the same result as the other press sections; however the range for applications is narrower.

- New technology
  - A good example of subject, where new knowledge and inventions are needed, is minimizing friction. Most of the energy used in processes is to overcome friction. It appears between the fluid and the wall in piping, in bearing, etc.

The product based environmental management takes care of the environmental performance of a product. In the development phase the responsibility lies within the R&D department, the responsibility is then transferred to the product owner, who usually is the product manager. Their duty is to follow the product's position in competition and make initiatives to R&D to improve it, if needed.

LCA is one way of handling product based environmental management. If LCAs are done on a regular basis, any anomalies will be caught early on, where they can still be corrected. This not only helps the R&D department, it will also mean more satisfied customers, thus having an impact on the bottom line. When the product is delivered to the customer, they can use LCA in their product based environmental management as well. Regularly updating energy consumption figures for example will help them manage their expenses and immediately notice if there are any problems with the machine, for example leaks.

### **2.3. Green Marketing**

In order to understand how LCAs can be used as a tool in marketing, it is important to understand the concept of green marketing Armstrong and Kotler define marketing as “the process by which companies create value for customers and build strong customer relationships in order to capture value from customers in return” (Armstrong and Kotler 2009). Hesz and Neophytou (2009, 18) note that marketing is based on the needs of people to express something about themselves through what they wear, use, do, say, believe, buy or even vote for. In other words marketing is called meeting the needs of customers.

Peattie (1992) notes that the term green has been used widely and loosely, therefore it is difficult to give an accurate description of the term. However, he states that usually some of the following traits are fulfilled

- there can be a concern for life on earth, for future generations, or for other countries and their peoples,
  - a desire to develop sustainability, protect the environment whilst improving the quality of human life, for a fairer world,
  - to move away from consumption to conservation,
  - an emphasis on the quality of life over material standards of living.
- (Peattie 1992, 25-26)

Peattie defines green marketing as “the management process responsible for identifying, anticipating and satisfying the requirements of customers and society, in a profitable and sustainable way” (Peattie 1992, 11). Green marketing could also be defined very simply as: using environmental claims in marketing.

While Peattie’s definition implies that the products marketed are actually green, or at least more environmentally friendly than their counterparts, the alternative definition focuses on the arguments used to sell the product. However it is important to note that there is a significant difference between actually green products and products that are merely made to look green. Marketing non-green products as green is generally referred to as green washing (Hesz and Neophytou 2009, 178).

Sustainability is a term that keeps on appearing in definitions concerning anything green, whether it is green marketing, green values or green business practices for instance. Sustainability can be defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs. (WCED 1987, 4)

### **2.3.1. History of Green Marketing**

There have been waves of green values in the past, one of the issues that scholars have tried to figure out is how to ensure that this time it will not just be a passing wave, but will change the way we look at the world and more importantly how we act and use the resources around us. The history of green can perhaps help us notice where we went wrong before.

The first wave of green was experienced as early as the early 1970s. Studies that were made about the exponential growth and the finite resources available sparked off a concern for our surroundings. However, concerns mellowed due to the forecasts never taking place, the increased cost of resources (thus leading to the profitable extraction of previously unprofitable reserves, resulting in “more” reserves), the anti-growth attitude, economic recession, and tougher controls. (Peattie 1992, 20-21)

The second wave came along at the end of the 1980s. We had experienced environmental disasters like never before, the poison gas leak in Bhopal, the Chernobyl nuclear accident, the Exxon-Valdez oil spill in Prince William Sound, and the torching of the Kuwait oilfields, with all of these man-made events publicized the need for environmental consideration grew. The environmental disasters were just one aspect from many that brought around the second wave. Among others, the increased public awareness, the media attention given to environmental issues, the increased power of environmental agencies and pressure groups, the personal interventions by famous people, as well as gaining the ability to prove that environmental problems do exist all contributed to the environmental consciousness. (Peattie 1992, 21-22)

“Earth day 1990 marked a spiritual kickoff of the Environmental Decade.” (Wasik 1996, 8) One can only hope that this time environmental concerns are not a passing wave, that said there is reason to be positive, 1990 is now two decades away and environmental concern has been on the increase. Individuals, companies and governments are all investing more in environmental products and practices.

The first wave of green concerns was more a matter for companies to handle; after all they are the largest consumer of natural resources and the largest emitter of greenhouse gases for example.

The stumbling stones of green values have been the conscious ignorance we have adopted to keep our economies growing, the down-playing of impacts caused by environmental problems (and therefore the dilemma of whom to believe, expert A or expert B), and the belief we have lulled ourselves to that we actually are making a difference big enough by taking measures such as recycling, and thus nothing else needs to be done. The actual scenario is quite different, we can witness the impacts of our detrimental actions on our environment all over the globe (Hesz and Neophytou 2009)

### 2.3.2. Green Marketing Concepts

Several green marketing concepts have been created, in Figure 8 is one concept by John Grant, called the green marketing grid.

	A. Green	B. Greener	C. Greenest
1. Public Company & Markets	Set an Example	Develop the Market	New Business Concepts
2. Social Brands & Belonging	Credible Partners	Tribal Brands	Trojan Horse Ideas
3. Personal Products & Habits	Market a Benefit	Change Usage	Challenge Consuming
	Set new Standards Communicate	Share responsibility Collaborate	Support Innovation Culture Reshaped

**Figure 8.** The green marketing grid (Grant 2007, 1)

In the green marketing grid the focus is on the first row and on the first two boxes more precisely. By doing an LCA and expecting suppliers to have the information needed readily available for Metso to do an LCA, Metso is setting a standard for the industry and sharing the responsibility with suppliers.

Ottoman (2011) has defined “The 20 New Rules of Green Marketing”, the four most relevant ones for this thesis are mentioned below. As rule number six she has stated that “a life-cycle approach is necessary”, the reasoning behind this is that in order to know if a product is green, you must know the overall impacts it causes to the environment. Rule number seven states that “manufacturer and retailer reputation count now more than ever”. This means that it’s not enough that the product or brand is trusted, the company/companies that manufacture and sell the product must also be trusted to make environmentally friendly choices. Rule number eight is called “save me”, it emphasizes that customers will not buy products just because they are green, they will buy the product to personally benefit from it. The benefit can be helping to protect their health or money, it can also be just that the product is better than the competitors product. “Green consumers trust brands that tell all”, this is rule number 15. It advocates for radical transparency, meaning that companies that disclose the good as well as the bad, are gaining more trust than their non-radical competitors. (Ottoman 2011, xviii-xx)

### **2.3.3. NABC – A Framework for Value Propositions**

In marketing it is important to be able to communicate with people of various backgrounds. In order to communicate the value of the product or service the interests of the customer must be known. The NABC framework provides a tool to address a variety of people of different educational fields. Once the questions presented in the NABC framework have been answered the result is a well-rounded sales pitch. With the need for green marketing increasing all the time, companies are looking for methods to communicate their environmental actions. Using the NABC framework is a relatively quick and simple way to look at the benefits of these approaches, in the case of this thesis LCA methodology.

SRI International (the former Stanford Research Institute, originally part of the Stanford University in California, US) has created a methodology to develop a quantitative value proposition. It is used to present the essential information when a new product or service will be developed. Because an NABC is brief, it can be iterated rapidly to gather new market and solution details. Multi-disciplinary, collaborative, iterative work is the keyword to produce a solid proposition, i.e. people with different background will give their contribution to the proposal. Number of iterations should be high, usually more than 10. (SRI International 2006)

Although the NABC framework is not strictly a green marketing concept, it is a marketing concept and can be applied for green marketing as well. Successful green products are very seldom marketed on their green values alone, in fact several scholars feel that greenness should add value to a product, not be the only value creator.

The NABC framework has four questions to answer. (SRI International 2006)

- **NEED:** What are the client's needs? A need should relate to an important and specific client or market opportunity, with market size and end customers clearly stated.
- **APPROACH:** What compelling solution does the company have that is specific to the client need? The vision can be conveyed for example by drawing it, simulating it or by making a mockup of the vision. As the approach develops through iterations, it becomes a full proposal or business plan, which can include market positioning, cost, staffing, partnering, deliverables, a timetable and intellectual property (IP) protection. If a product is being developed, it must also include product specifications, manufacturing, distribution and sales
- **BENEFITS:** How does the client benefit from offered approach? Each approach to a client's need results in unique client benefits, such as low cost, high performance or quick response.
- **COMPETITION / ALTERNATIVES:** Why are the benefits of the offered solution significantly better than those of the competition? Everyone has

alternatives. It is important to be able to tell the client or partner why the offered solution represents the best value. To do this, the competition and the client's alternatives must be clearly understood.

The NABC framework is one of the options to produce value propositions to be used in marketing and especially in R&D when presenting new product initiatives. It can also be used as a tool by which LCA studies and marketing perspectives become combined, as it is used in this study.

### **3. EMPIRICAL WORK**

The empirical part has been conducted for Metso Corporation's Paper and Fiber Technology business segment at paper machine factory's research and product development department in Jyväskylä.

The first part of the empirical chapter includes a description of the company, and the method for conducting the empirical research. The second part of the section describes the findings from the research, including both the LCA reporting process as well as the results for the marketing aspects of the study. The final part gives an overview of the results achieved.

#### **3.1. Case Company Description**

Metso is a global supplier of technology and services for the mining, construction, power generation, oil and gas, recycling, and pulp and paper industries. In 2009 Metso Corporation's net sales were EUR 5 016 million and in 2010 EUR 5 552 million. (Metso Corporation 2010)

Metso is a truly global company; they have engineering, production, procurements, services business, sales and other operations in over 300 units in more than 50 countries. Worldwide Metso employ about 27,000 professionals serving customers in more than 100 countries. Over 40 percent of Metso's net sales come from the services business. (Metso Corporation 2010)

Metso has three reporting segments: Mining and Construction Technology (consisting of Services business line and Equipment and Systems business line), Energy and Environmental Technology (consisting of Power, Automation and Recycling business lines), and Paper and Fiber Technology (consisting of Paper, Fiber and Tissue business lines). (Metso Corporation 2010)

Paper business line has activities in Finland in Valkeakoski (Stock preparation), Jyväskylä (Paper and Board Machines), Järvenpää (Finishing) and Raisio (Air Systems). The paper and board machine factory in Jyväskylä develops and produces processes and machinery from approach system to dryer section. The



number of the employees in Jyväskylä is about 1700 and in research and development about 110. (Metso Corporation 2010)

Metso's mission released in 2010 states: "We contribute to a more sustainable world by helping our customers to process natural resources and recycle materials into valuable products." One of the three strategic themes is strong development of environmental solutions. The two others are strong development of services business and strengthening Metso's global presence. In 2009 it was estimated that 60% of all operations in Metso are linked to environmental business. (Metso Corporation 2010).

### **3.2. Methodology for Empirical Study**

This study was conducted using several methods. The author was deeply involved in the project and was able to observe the process throughout the project. The methods of data collection were, semi-structured interviews, a workshop and participatory action research.

Participatory action research is a research method where the respondents are actively a part of the planning and implementation of the research outcomes. When bringing about social change the participation of the affected community is vital, the researcher is dependent on it. (Welman, Krauger & Mitchell 2005, 205)

In a company participatory action research means that employees are involved in bringing forth change, in fact employees might be the instigators of the change. For participatory action research a distinguishing feature is that it uses versatile design that may be changed and adapted as the research progresses. The research design is not finalized in advance but changes based on the information available. Participatory action research allows the participants to influence, or even determine the course of action. (Welman et al. 2005, 205-206)

In a semi-structured interview the interviewer has a list of themes and questions to be covered. The interviewer will raise these questions if the interviewee does not do so themselves. The order of the questions may vary according to the

progression of the interview. Despite covering the same questions, the formulation and terminology of the questions might change between interviewees. (Welman et al. 2005, 166-167)

### **3.3. Reliability and Validity**

According to Sekaran and Bougie (2010, 161) reliability is an indication of stability and consistency. Kirk and Miller (1986, 19) state that loosely speaking reliability is “the extent to which a measurement procedure yields the same answer however and whenever it is carried out”. Kirk and Miller (1986, 19) define validity as the extent to which the research method in question gives the correct answer to the question asked. Sekaran and Bougie (2010, 157) state that validity is concerned with whether the right concept is measured. From these definitions it can be gathered that reliability measures the accuracy of the research methods used, if the results are consistent then the reliability is high. Validity on the other hand examines how close we get to the set target, if the research answers the questions it is supposed to answer.

The study is reliable, the examined case has been fully used for this study. The delimitations of the case have been done so as to include all the major flows in the system, and therefore minimizing the possible incurring errors. The interviewees and the respondents for the workshop are all professionals in their own fields, the interviewees are all marketing professionals and the workshop respondents come from a variety of different backgrounds, some are in R&D, others in sales etc.

From Metso professionals were involved in every phase of the LCA that has been studied for this paper. The interviewees chosen from the marketing team were professionals that were thought to have the best expertise on the matter. In-depth and semi-structured interviews were chosen so that the respondents could answer as truthfully and broadly as possible, including all the aspects they feel are important. Using this method really plays on the strengths of the experts and lets their visions and ideas come forth. The workshop was done to accumulate ideas on using LCA, it was done in small groups of four so that respondents could

piggyback off others ideas, therefore generating more ideas than would have been the case individually. The event that the workshop was held in was quite tight time-wise, this also demanded the use of groups.

The replies of the experts coincided with each others, therefore increasing the reliability of the answers. In all, the issues described above support the reliability and validity of the study. However, the study is limited to a single-case company, and therefore the results cannot be generalized to other companies.

### **3.4. Conducting a LCA Study**

The LCA study conducted was a part of a Metso wide pilot LCA project. The purpose was besides the LCA results to make notices of execution of a LCA study in different business segments. The project manager from the head office and the LCA project leaders in the business segments formed the project steering group. In each business segment the project was organized in a way best suiting their purposes. This study is based on the LCA study conducted at PFT (Metso's Paper and Fiber Technology segment). The research method for the LCA study was participatory action research.

The participatory action research was conducted during the LCA project, and lasted for seven months, from 07/2010 to 01/2011. As the author was working on the LCA project, alongside the writing of this thesis, more time was invested in the participatory action research than in the other research methods. The participatory action research took place during the team meetings, as members were located in two different offices. In total about 20 hours were used for the meetings. The record of the team meetings was kept in Metso's Notes database.

#### **3.4.1. Team and Guidelines for the Project Execution**

In the paper and fiber business segment the LCA project covers only part of the paper machine and functions in the air systems area. The project team consisted of R&D experts in Jyväskylä and Raisio units. The environmental manager from

Jyväskylä unit was member of the team, as well. In total the LCA team had nine members. Some of the team members had a specialized function, while others were involved in the collecting of the data. Specialized functions in the team were: the project leader, the expert on ISO standards, the expert on carrying out the LCIA calculations with the GaBi 4 program and the person performing the documentation. The author's contribution consisted of two functions: clarifying the ISO standards for the rest of the team with help from the environmental manager and doing the documentation.

Project team meetings were held regularly either by face-to-face meetings or via net conferencing. The team went through the phases of a LCA study step by step. The persons involved had little or no experience of a LCA study with the exception of the environmental manager. The first task was to build a mutual understanding about the process and results achievable.

### **3.4.2. Goal & Scope**

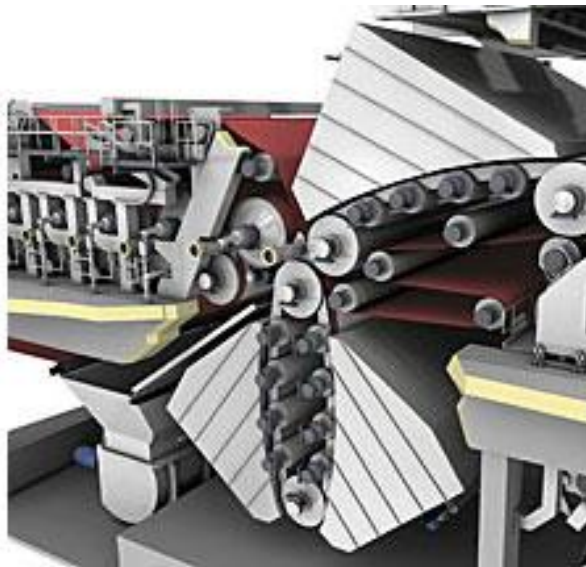
The goals of the project are to:

- Gain the capability to produce LCA information and to find shortages of input data
- Produce fact-based information for marketing material
- Produce information for R&D and to identify the sources causing the largest environmental impacts
- Compare concept C against concept M1

The scope includes the following paper machine sections: Press section, dryer section, hood, air systems and heat recovery. The paper machine used in the study is a fine paper machine delivered to China in 2009. The annual capacity is 240 000 tons of 80 g/m<sup>2</sup> paper. With the selected scope, all major flows (material, energy, etc.) are included and the amount of the manual work is minimized. The delivered papermaking line described in the scope is called the concept C.

In order to find out the effect of impingement drying, an impingement unit called OptiDry Twin was added replacing some of the drying cylinders. This concept is called the concept M1. The modification is based on dimensioning rules used for OptiDry Twin and fitted to the line in question. There is an intention to extend the LCA study to cover the whole papermaking line, and then there will be need for other comparisons as well. This is the reason for naming the concept M1 instead of M.

The OptiDry Twin (Figure 9) is able to dry the paper more effectively than the cylinder dryer, the dry contents of the paper increases by several percentage units during the OptiDry Twin. OptiDry Twin uses both vertical elements and horizontal elements, as a result of this and of the better drying efficiency the machine can be shortened. A shorter machine means that the building can be smaller and therefore less energy will be needed for the heating of the building. (Metso 2010)



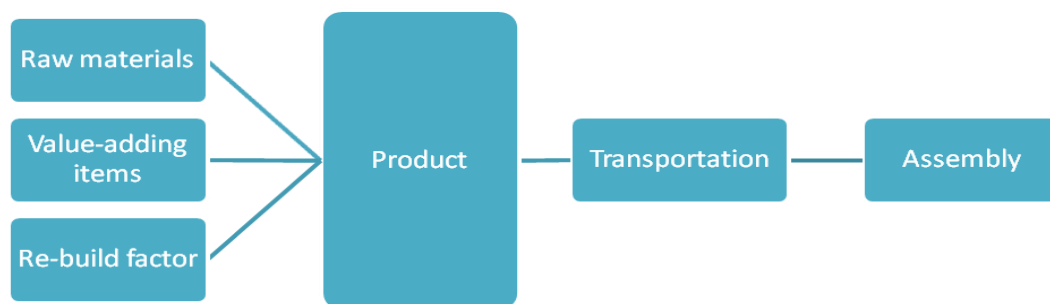
**Figure 9.** OptiDry Twin (Metso 2011)

The team found the defining of the goal easy, however defining the scope in details took quite a long time. The major reason for this was the difficulty of drawing borders between different equipment in the air system and the heat recovery, and especially when the air impingement was used in a clear and logical

way. It was essential that the goal and scope definitions were well thought out. By taking time in making the borders between the sections clear and logical, problems could be avoided later on, thus saving time in the long run. The goal and scope also have a huge impact on the rest of the study; therefore it is important that the definitions made are reasonable, understandable and obtainable. If the goal and scope are not done properly it will be extremely difficult to complete the rest of the study properly.

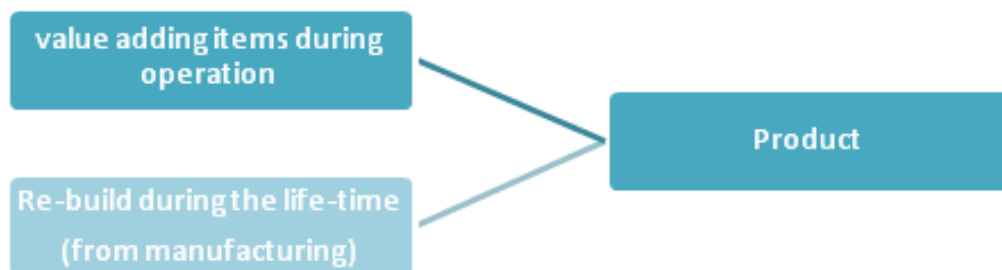
### 3.4.3. Life Cycle Inventory Analysis Phase (LCI Phase)

In the inventory analysis, all the flows to the product and out of the product should be traced. The life cycle of a product is divided into three phases: manufacturing, use and end-of-life. In the case of the paper machine the definitions are as follows; the manufacturing includes the building, transportation and assembly of the product. Below is a picture of the manufacturing phase (Figure 10). The manufacturing phase includes the building of the machine; this is a combination of the raw materials and value adding items used. A paper machine is such a large machine that it has to be assembled on site, for this reason the machine is manufactured and built into components that can then be assembled later on. After the pieces of the machine are finished they are transported (by truck, rail or boat) to the customer and assembled on site.



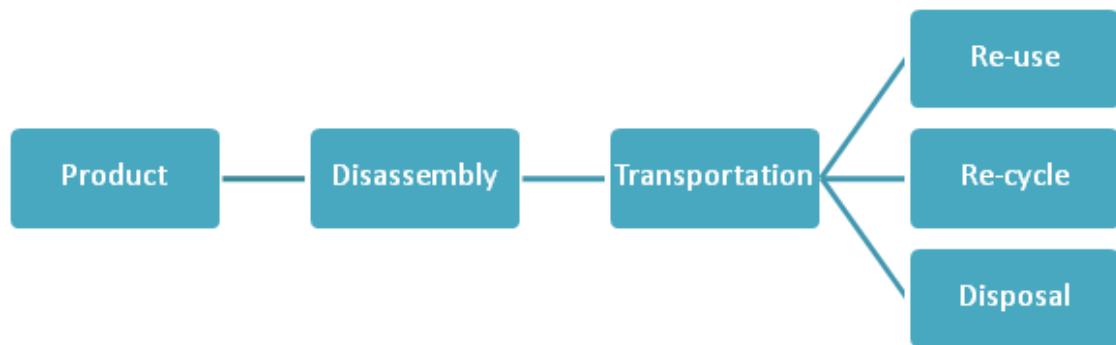
**Figure 10.** Manufacturing phase

The use phase starts when the machine begins paper production for the first time. Figure 11 shows the stages of the use phase. This phase includes the materials needed to run the machine, such as steam, electricity and gas, as well as fabrics and lubricants. The raw materials for the actual paper are not included in this scope. The rebuild factor can be found from both the manufacturing and use phases, this is because the rebuilds are only taken into use sometime during the use phase, but must be manufactured as any other component. Although the rebuild factor is presented two times it is only calculated once for the life time of the machine.



**Figure 11.** Use phase

The end-of-life phase starts, when the paper production line is permanently closed. This phase includes the disassembly, transportation and sorting of the components for recycling or waste treatment. In this case no re-use was calculated into the end-of-life phase, however re-use has been included as a possibility for future LCAs. In the picture below (Figure 12) the included stages for the end-of-life phase are depicted.



**Figure 12.** End-of-life phase

The lifetime of the paper machine was determined to be 30 years. This is actually the time when the machine is expected to produce paper, thus excluding the manufacturing and disposal of the machine, the lifetime here means the time the customer can use the product. 30 years is used for calculations because the main flows can all be expected to occur in this time, therefore not excluding any significant flows during the lifetime of a paper machine. The actual lifetime is hard to estimate, but can be considered longer, as is indicated by the following example. So far, only one paper machine delivered by Metso Jyväskylä has been shut down. That paper machine was the first Metso ever produced, and was in operation for 57 years, before it was shut down in December 2010.

During the use phase, the machine is upgraded several times to keep it competitive. The paper grade produced with the machine will most probably change during the life time, this as well requires rebuilds. A new papermaking line relies on the amount of production and quality in making its profit. Later when there are newer machines on the market producing higher quantities with better quality, the line is converted to produce more value added products. These paper grades are harder to produce and require knowledge of the machine that can only be gathered using the machine over time. To incorporate the rebuilds in LCA, the team ended up with the concept of a rebuild factor. The rebuild factor describes the share of rebuilds made for a given component or a part of the paper machine during its life time. The rebuild factor varies component by component. In this work it was fixed to 15% to keep things simple. The value means that 15% of constructions are changed during the 30 year life time.



A paper machine consists of about 10 000 parts. The most important parts are made by the company, some are made by a sub-contractor and some of the parts are commercially available. Metso's manufacturing includes from the scope the major parts for the press and drying sections including frames, rolls, cylinders and pre-assembly. Parts for hood, heat recovery and air system are mainly sub-contracted. Drives, fans, valves, etc. are commercially available. In this case a part of the manufacturing of frames was made at Metso's factory in China. After contacting with colleagues in China, the group decided to estimate the environmental load of the parts made in China according to Finish manufacturing data. Even though there is a product management system at Metso, at that time it was not completely deployed on that factory. The only option for getting the data was from the drawings made in Chinese, this would have been much too time consuming, considering the nature of the pilot study, so the data was substituted with estimates.

The major purchased part was drives. The environmental load was available per installed kilowatt-hour. The environmental load will vary to some extent with the drive size, however the value given by supplier was reasonably good. It was decided that resources should not be used to gather all the data from suppliers, as this constitutes to such a small fraction of the overall environmental load, but would require a lot of resources. Based on the previous LCA study years earlier, it was known that the major environmental impact is incurred in the use phase.

During the data collection it was noticed that different people presented their findings differently. In the LCIA phase this caused misunderstandings and discussions. To have an unambiguous data collection procedure and presentation format, the group created a data collection sheet. It summarizes up to 13 components in the horizontal direction and in the vertical direction it contains the phases of the life cycle with details. The form enables the collector to start from tiny details and sum them up to entities used in the LCIA phase in a flexible manner. The form was created on a MS Excel sheet allowing macros and the linking of cells. It was also designed for easy printing creating a comprehensive documentation of the LCI phase.

The LCI data collection form includes the following items:

- **PROJECT DATA:** Project name, Section name, Sub-section names (from one to 13 are allowed), Person in charge of data collection, automatically updated date, time and user name from computer.
- **GENERAL PAPER MACHINE PRODUCTION DATA:** Basis weight, speed, web width, production, moisture at sizer, moisture at reel, annual running time, time span used in study. Rest of the data is given in relation to these parameters.
- **MANUFACTURING PHASE**
  - **Production:** Power, heat, lubricants, materials, components. The form contains space, where various material names can be written.
  - **MAINTENANCE AND REBUILDS:** Rebuild factor. The production data is repeated under this section and from each item mentioned above a share pointed out by the rebuild factor is taken into account.
  - **TRANSPORTATION:** Road distance, rail distance and sea distance. The summary line contains the average of distances weighted with the component weight. It is very obvious that the components come to the mill site from different locations.
  - **ASSEMBLY:** Electricity, steam and gas. The amount of supplies when the line is assembled on the site. Also the test use of different sections before the start-up is included in assembly.
- **USE PHASE**
  - **ENERGY:** Power, steam, gas, recovered heat, pressurized air.
  - **CHEMICALS.** Space for various chemicals
  - **FABRICS.** Forming fabrics, press felts, belts, sleeves, drying fabrics. These are the most common.
  - **LUBRICANTS.** Space for various chemicals.
- **END-OF-LIFE PHASE**
  - **DISASSEMBLY:** Power.
  - **TRANSPORTATION:** Road distance, rail distance, sea distance. The calculation is equal to manufacturing phase.
  - **SORTING:** Power and heat

- END OF USE: Recycling factor and amount of net scrap. Based on recycling factor the material is divided either under recycling or under landfill. Under “net scrap” there is space to write in details the materials going for recycling. The credit earned varies material by material.

#### **3.4.4. Life Cycle Impact Assessment Phase (LCIA Phase)**

One member of the team conducted the life cycle impact assessment phase. The reason for only one person carrying out the phase is that it requires a thorough understanding of the software used. As a pilot project everyone was unfamiliar with the software and in order for it to be as easy and fast to use as possible, a framework needed to be created. By creating a well functioning framework that can easily be used or adapted in the future, a lot of time can be saved on future LCAs.

For this study the interest was in green house gases, calculated as CO<sub>2</sub> equivalents, as these were known to be the greatest polluter when building and using a paper machine. The CO<sub>2</sub> equivalents were obtained, for the most part, by using the coefficients from the GaBi database and in a few cases they were taken from literature. The reason for using the coefficients from GaBi database is that they have spent a lot of time and effort in collecting, and ensuring that the figures they produce are reliable and up-to-date. The databases are regularly updated and are derived from a number of different sources such as technical literature and industry sources, for example. (PE International 2011)

#### **3.4.5. Interpretation Phase**

For the interpretation phase the team held a day together to look over the results, and gather conclusions and any discrepancies in the data. The team started off by presenting the gathered data for the different parts of the paper machine. Based on the presentations the members then discussed the relevant points in pairs and

finally as a team. The report was then written based on the discussion and remarks made during the meeting.

Significant issues identified from the LCA study include the massive share the use phase energy consumption plays in the overall figures, therefore the means of producing the aforementioned energy has high significance as well. The heat recovery system saves quite a bit of energy, developing this system could noticeably influence the energy efficiency of the use phase, therefore having a significant impact on the whole environmental burden created by the paper machine.

The materials have a recycling percentage of at least 90%, this means that environmental credit is received, diminishing further the environmental burden of the end-of-life phase.

#### **3.4.6. Results Achieved**

Energy causes the largest environmental load by far. The energy used in the use stage contributes the most to global warming over the life cycle of a paper machine. The results can be explained by the long life time of the machine and amount of paper produced during that life time. The paper machine in question, producing fine paper, produces about 240 000 tons of paper a year. When you compare it with the total mass of a paper machine, the figure is quite large by comparison. Considering that the life time of the paper machine is estimated to be around 30 years, the environmental impacts amounting from the paper produced during this time, far outweigh the impacts of building the machine.

The method of producing energy should be one of the most important aspects to consider when looking at the environmental impact of a paper machine. The designing of the machine is an extremely important phases for the overall environmental burden caused over the life time of the machine. Energy saving solutions must be considered already in the design stage of the machine. The single most important factor in the design stage, environmentally speaking, is to think about the energy efficiency of the paper machine.

### **3.5. Deriving Marketing Aspects**

The empirical study of this thesis was done through observations, interviews and a workshop. This thesis was done for Metso Paper, at their unit in Jyväskylä. All the empirical data was gathered at Metso.

More in depth data was acquired by interviews to the marketing professionals at Metso. Three key marketing professionals were interviewed on the current trends of environmental marketing. Questions included inquiries about the level of knowledge of the customers, the need for this type of material, what sorts of pursuits are already taken in environmental marketing. The interviews were held in a peaceful office setting, during working hours. The interviews lasted for about 45 minutes, during this time the respondents were not working on anything else. Due to time restrictions of the respondents two of the respondents were interviewed at the same time, the third respondent was interviewed individually.

From the interviews it was apparent that environmental issues are a fast growing area that needs to be addressed more prominently than at the moment. In fact one of the interviewees said that environmental issues are one of the core focal points at the moment for Metso. The information is needed especially for the developed markets, in emerging markets the price is the dominating factor when new purchases are made. Although price has a significant impact on the purchase decision in the developed markets as well, other issues, such as environmental factors are also weighed before the final decision is made. In the developing markets the environmental considerations are usually only considered up to the point where they meet with the requirements set by the law. Therefore it is important to be able to foresee the changes happening on the legal front and have the ability to respond to them promptly by creating the necessary changes beforehand.

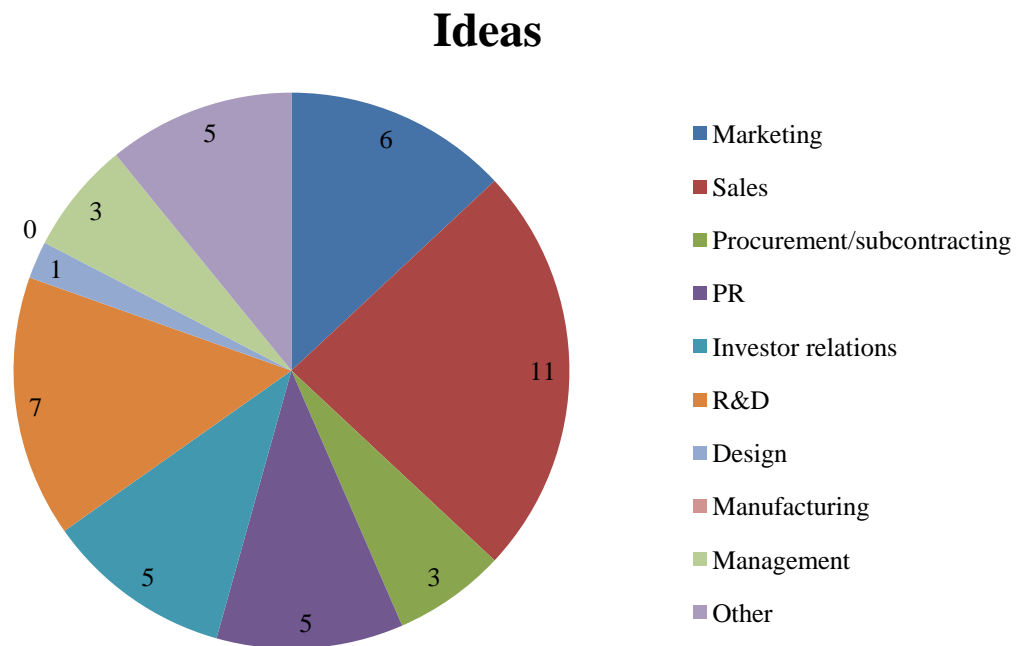
The interviewees stressed that finances are still the most important issues, no matter whom you are dealing with. Environmentally friendlier solutions should still make sense financially speaking, and should not be inferior to other solutions.

The payback period and costs incurred during the use phase are topics that should be addressed. Environmental issues are a “new” dimension to be considered and not something to replace existing dimensions.

Some examples of ways that the interviewees want to present data are graphs, pictures and calculations. Text can also be good, but it should be from the customer’s point of view, highlighting the benefits that that solution brings. An environmental product declaration was seen as a good tool for marketing, since it is regulated by an ISO standard and is formed from a LCA study.

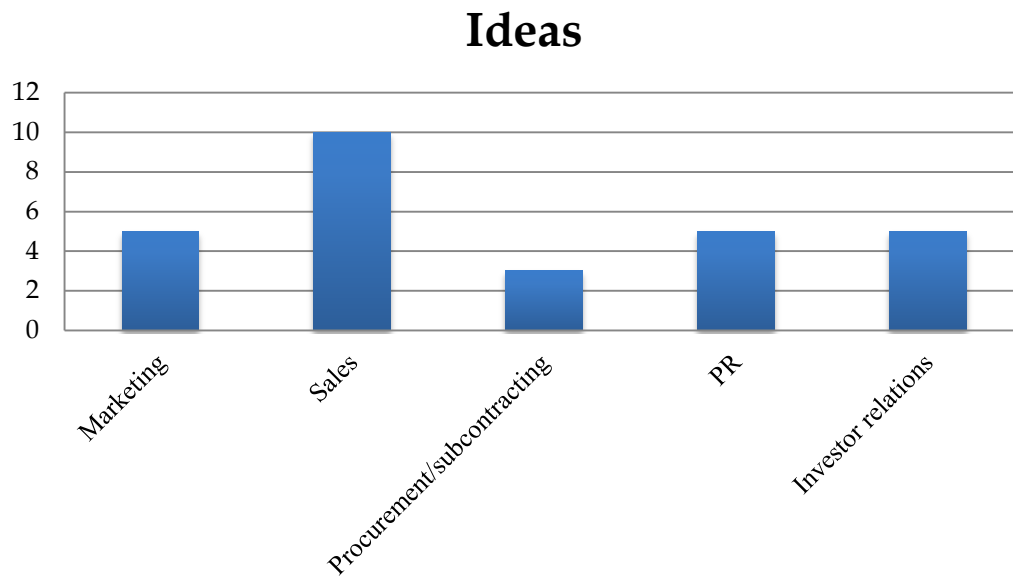
### **3.6. Workshop results**

In addition to the interviews a workshop event was held during a Metso LCA pilot day, where professionals who work with these issues gathered. 31 professionals from the three reporting segments took part in the workshop. The workshop was a part of the LCA pilot day, and was held after presentations about the current state of the pilot studies as well as an introduction to LCA. The duration of the workshop was about two hours. The participants were divided into groups of 4-5 members. For the workshop participants were asked to brainstorm for ideas on how to use LCA in business. First the participants generated ideas by themselves, then in pairs and finally within their group. Once they had an idea it was to be placed in one of ten categories; marketing, sales, design, PR, procurement/subcontracting, R&D, manufacturing, investor relations, management, or other. The distribution of ideas is presented in the chart below (Figure 13). In total there were 40 ideas, some of them fall under several categories.



**Figure 13.** All generated ideas arranged according to category

The ideas that fell into the marketing and sales categories were examined more carefully. Out of 40 ideas generated that day 30 fell into the category of marketing, sales, procurement/subcontracting, PR, or investor relations. Six ideas were categorized as marketing ideas, eleven ideas fell under sales, three ideas were labeled as procurement or subcontracting ideas, five were PR ideas, and the remaining five were ideas relating to investor relations. In the bar chart (Figure 14) below the quantities of the examined ideas are depicted.



**Figure 14.** Examined Ideas

The reason why these five categories are examined more closely is because all of them can be used in marketing at least to some extent. The sales and marketing departments must work very closely with one another and ideas can often be exchanged among the departments. The procurement/subcontracting category was chosen because they deal with the other side of sales, and perhaps the ideas could be reversed and used as marketing or sales ideas. The last two examined categories PR, and investor relations were chosen because they deal with the image of the company, and are therefore connected to marketing.

From the ideas generated, it is evident that the participants feel that taking the lead in LCA matters could have a positive impact on the image of the company, and thereby creating awareness of LCA pursuits can be used as a marketing approach. Another issue that was brought up is using LCA to differentiate from competitors, actively using LCA to bring forth environmental considerations, one example was an idea to create an eco-standard based on a LCA study. What was common for most ideas is that the LCA was considered as a starting point, something to get information from that could then be developed into new materials, or even services.



Two main categories can be seen in the ideas, using LCA as a tool to improve the general views on the company, essentially using it in general marketing. The other category is using it with specific products, generating the LCA on a product and then using it in the marketing and sales of that one product. Both ideas are equally important. Using LCA material in general marketing gets the message across to those who are still unfamiliar with it, as well as those who did not know of the company's efforts to be more environmentally conscious. Having product specific data and using that in marketing allows targeting of those customers that view environmental issues as especially important, customers that could be lost to a competitor providing this information.

Many of the ideas categorized under the marketing header stressed the importance of using LCA as a means of differentiating from the competitors, of showing the way forward in environmental issues, being the first mover. Also diversifying the products in terms of greenness was brought up, this would give the customers options during the transition phase, from turning from a average company to a green company.

The sales category gathered the most ideas from the categories presented. Several ideas dealt with creating new services with the help of LCA, capitalizing on the knowledge that has been acquired, and will be acquired in the future. Another theme was using LCA to gain customers, using LCA figures alongside costs and calculating the benefits for the customer of having a more environmentally friendly machine.

For procurement/subcontracting the ideas dealt with monitoring the environmental impacts of the bought products/commodities, and possibly classifying the suppliers/subcontractors according to their level of commitment towards environmental issues.

For PR the ideas were about increasing environmental awareness, whether within the company, with customers, or within the general public. Increasing knowledge, especially about Metso's environmental operations, but also on the environmental load of paper could potentially lead to more customers.

The final category, investor relations, had quite similar ideas as the PR category, increasing knowledge and improving the environmental image of Metso. It also had some of the same ideas as the marketing category, such as differentiating from competitors could interest new investors.

### **3.7. LCA Marketing**

There isn't really any theory for using LCA in marketing in particular; the same rules apply as with any marketing tool. The thing that makes LCA a good tool for marketing, especially in the business-to-business markets, where decisions are based more on facts than in the consumer market, is that LCA is a fairly reliable method of showing environmental burdens caused by a product. As a result of LCA being so laborious and time consuming it is also a good way to show your environmental awareness.

From the 20 new rules of green marketing by Ottoman (2011), four especially can be used with LCA marketing. The importance of a life cycle approach (rule 6) demonstrates that LCAs are catching on, LCA is a form of communication that more and more customers and consumers will understand in the future. The role of manufacturer and retailer reputation (rule 7) indicates the need for the company to develop their own corporate image as well as that of their products. Conducting LCA studies show a commitment to environmental issues and despite it being a product based technique it enhances the corporate image as well.

Thinking from the customer's perspective is necessary whenever successful marketing is to be achieved, green marketing is no different. Thinking about the customer benefits, over the environmental ones (rule 8) is what really sells the product. For a LCA this means on focusing on the results gained from the study, does it use fewer resources (and therefore less money), is it safer to use and so on.

The fourth rule selected is about transparency, radical transparency (rule 15) to be more precise. Providing your customer with the good and the bad information about your product can actually be a good thing. The more transparent a company is the more trust ensues. One of the cornerstones of LCA studies is transparency,

when conducting a LCA you should not try and hide the negative aspects, in fact if the standards are followed this is nearly impossible to do. However, if radical transparency is employed, there needs to be a plan of tackling the negative issues, a LCA study gives the information on where the problem is and the extent of it, providing an excellent mean of forming a plan to rectify the problem.

LCA can be used to derive marketing material, for example for creating an environmental product declaration (EPD). The declaration can then be given out to customers who ask for it, this sends the message that environmental issues are important for the company and that they are being investigated and tackled. As with the EPD, environmental marketing should be based on tangible facts, customers expect solid evidence to back up marketing claims. The strong suit of a LCA is exactly this, providing facts. During the interviews with the marketing professionals, they stressed the importance of having factual information before planning any marketing material.

LCA data can be used in marketing and sales in a number of ways, however, to start off with it is important to ensure that customers know of the expertise that can be offered to them. Customers need to have the knowledge of the expertise before they can ask for it and before it can be fully capitalized.

One way of presenting the benefits of an LCA could be by using the NABC framework, which was introduced in chapter 2.3.3. Although the theory advises to iterate the process at least ten times, this view has been created based on this research and should work as a starting point for the final value proposition.

**Need** – The increase of environmental concern and a reliable way to communicate it is in heavy demand. Especially in developed countries consumers are paying attention to environmental factors when making a purchase decision. Without this information, it could very well be that a product will be left on the shelf, especially if a competitor has provided this information.

There are three main needs for life cycle assessment information. First off, there is a clear need to have fact-based information to offer to the customer, if and when they ask for it. Secondly, LCA information is highly important for the company

itself. Using LCA information it is possible to identify areas that need further development. Thirdly the marketing department has an increasing need for this information.

**Approach** – ISO standards 14040 and 14044. According to the European council the most reliable way of conducting the LCA is by using ISO standards.

Environmental concern has never before been a concern of the average consumer to this degree, in the past minority groups have paid attention to these issues, thus never creating the demand to widely address the issue. Now that the demand exists, an approach is needed to respond to the demand. LCA is a very flexible method of communicating environmental actions, which makes it a useful tool of communication for wide audiences.

**Benefits** – The information will be ready when it is asked for, therefore when customers are conducting their own LCAs this information will be at their disposal, thereby meeting the demands of their customers. Secondly the products can be made more environmentally friendly when the knowledge of what needs to be improved can be seen from the results. LCA information can be used in product development, keeping ahead of competition by actively searching for areas that can be improved. Finally it allows the use of verified information produced according to standards in marketing material.

In the future it will be required to present information on the environmental impacts of a product, by having LCA information now, a competitive edge can be acquired when the regulations come to existence.

**Competition** – LCA awareness is growing, customers are already asking for LCA information, and without it they will move to the competition.

Environmental issues are something that is constantly being brought up all over the world. Competitors already have LCA-based information, and there is a strong demand for this type of information. Companies, government officials, NGOs and individuals are talking about these issues at an increasing rate, no MNE can disregard the matter, or they will be trampled on by the competition.

To conclude, combining LCA with marketing provides the company with a valuable means to communicate and utilize their environmental actions. Environmental awareness is something that is expected from companies today, integrating that into everyday actions is the method to making it profitable, and committing employees to those values.

## **4. CONCLUSIONS**

The conclusions of this thesis are divided into three categories, the first has a summary of the results found, the second has the discussion, and the third sub-chapter gives some suggestions to the company.

### **4.1. Summary of Results**

Good planning is essential when developing a system for LCA study reporting. The system needs to be flexible so that it can be used in the future for other projects, but structured enough so that the basic structure remains the same. Having a good structure means that time can be saved in the future, as the same problems do not have to be tackled several times. In order to plan the system well it is of utmost importance that the team in doing so communicates with one another. Communication not only brings forth the challenges but it also fosters the development of new ways of handling things and brings about new ways of facing problems and challenges.

The marketing department needs material that is based on facts, especially when in a business-to-business environment dealing with large machines the importance of validated facts is paramount. For marketing purposes the money saved is also crucial, since most customers make their purchase decision based on the cost effectiveness of the machine. The interviews conducted for this thesis support these claims, the respondents emphasized the importance of verified fact-based information, especially in green marketing to avoid greenwashing.

For a paper machine the biggest environmental contributor is the energy used during the use phase of the machine. The mass of the machine is only a fraction of the mass of the produced goods over the life time of the machine. This means that the data for the use phase should be very accurate, the influence of the manufacturing phase is quite small and even if all nuts and bolts are not considered the overall results are not affected very much.

## 4.2. Discussion

“A leader’s job is to organize success.” This statement from Kauppinen (1994, x), a well-known business consultant, describes this thesis to some extent. In the LCA team at Metso’s Paper and Fiber Technology (PFT) business segment, the author contributed in two main ways: by clarifying the ISO standards for the rest of the team and by doing the documentation. The goal was to have a finished LCA study. The ISO standards point the way to that goal, when working on a LCA study the responsibility of the documenter is to ensure that the data corresponds to that of the standards. This was obtained by explaining the various aspects of the LCA study, under the four main headings taken from the standards, to the team. When writing the document it is important to monitor the progress and ensure that the study stays on track so that the final documentation will fulfill the requirements.

Creating the first LCA is a hard task, not only are there likely to be some problems with collecting data, and using it to its full potential, but there are also some challenges with creating the document in itself. In order to create a good document of a LCA, one must be familiar with the ISO standards. This means studying the standards inside out, making sure that all the requirements are met is a time consuming job, not to mention the time it takes to work out what all the requirements mean. In many ways it could be said that the documentation is the most important part of a LCA. The ISO sets a number of requirements on what should be mentioned and where, having the data is not enough, it needs to be presented in the right way, the quality needs to be assessed, and anything short of perfect has to be noted and often explained.

One of the most important phases is the definition of the goal and scope, this is where the requirements are set. Despite the fact that the standards have a long list of issues that need to be considered and addressed, they are also quite flexible. Many hurdles can be overcome with defining the goal and scope in a way that either minimizes the impacts of less than perfect decisions or even completely justifies it. For example in the case of Metso’s PFT pilot study, one major goal was learning from the LCA study, also only a limited product was considered,

therefore the data collection could match this. By explaining that the main goal is to learn as much as possible, it is possible to overlook the fact that the whole machine is not considered, despite this the goal can be reached. The pilot case allowed explaining the limited resources available; this can be used to justify the decision. The learning goal can be used when explaining the discrepancies in data collection, knowing where the discrepancies are shows the company where they have sufficient data and where the processes need to be enhanced.

The most difficult and laborious phase in the project was data collection for the LCI phase. Gathering data can be a real challenge, even more so when dealing with a complex product. Examples of problems with gathering data can be that the data is not being collected in the first place or data storage methods are ineffective, making the retrieval of data extremely laborious.

In the case of this project, data was gathered from within the company, at this stage it was decided that resources should not be used to gather data from suppliers. For a paper machine the major environmental impact are incurred during the use phase, therefore even big changes in the manufacturing phase do not influence the overall results greatly.

Even though the phase was laborious and time consuming, one of the pitfalls was the way in which the data was presented. Only at a very late phase of the project a form was generated to present all the data in a unified format. This unified not only the way the data was presented and discussed, but the way of thinking as well. To get the work done properly, especially if there is a large group in several locations, it is reasonable to use quite a lot of time in planning the work. Since the documentation of a LCA study is quite strictly structured and needs to be internally consistent, the importance of prior planning is further emphasized. If several people are involved in writing the report, the importance of planning becomes all the more important.

The R&D department deals with uncertainties every day. The normal working habit is to collect information, and then draw conclusions from it. This project was no different. One of the major goals was to learn from this project, it was



noted that even better planning would have simplified the work that was done. The importance of good planning is the first major result of the pilot LCA study.

“A leader’s job is to organize success.” This quote can be understood to mean the building of the path for your subordinates, taking the time to build up the system that can then be used time after time to reach the desired goal. Essentially this was the goal of this thesis, to figure out a format that could be used to do LCA studies, the format should be something that the marketing department could utilize as well. The documentation of a LCA study is crucial, not only for the success of the LCA study itself, but also in how well it can be utilized elsewhere in the company. From the company’s point of view the more gain you can derive, the more valuable the work becomes. At this stage when LCAs are still quite new in this area of business, it may be hard to convince management that doing an LCA is time well spent, if it has other uses as well, such as marketing uses, the process of convincing becomes much easier.

Marketing the findings from a LCA study can be done in several ways, there is no right way of doing it. In this case the company in question is a large multinational company working in a business-to-business environment. The products that are sold are large machines, composed from several smaller components and often include a service package along with the tangible product. In this case the way to use these results in marketing could be to have them alongside the other figures, by subjecting the customer to this information, perhaps it could begin to have an influence on buying behavior in the future. For environmentally conscious customers, a package could be sold where the machine would be produced with renewable energy, and the service package would include an energy audit or audits, to find out the energy efficiency of the machine and how it could be further improved.

One method for creating a value proposition is using the NABC framework, as was used in this thesis. It should be noted that the value proposition presented here is a draft and it should be circulated within variable functions within the company in order to have a unified and solid value proposition for LCA.

### **4.3. Suggestions for the Company**

This study could be expanded to cover the whole line, and it would as a result add value for the company by acquiring a complete (self-made) LCA study of an entire machine, for reference purposes. Customers who are in need of LCA data could be provided with this data as fast as possible, it is too late to start the data collection once the request comes in. If no data is prepared, it is very likely that the customer will be lost to a competitor who has already gathered this data.

The importance of having a self-made LCA study really crystalizes when a new LCA is needed within a short amount of time. Having experience of at least one LCA, means that the data collection will be easier, at the very least the sources for data collection will be known; perhaps they have even been developed for easier data collection since the first LCA. The second significant factor is that because the most laborious part of the study, the data collection, has to be done in-house in any case, the remaining parts are reasonable to do in-house as well. Thirdly, having a self-made LCA signals, to any interested party, that this is a long-term commitment, something that will be continued in the future.

When considering the marketing needs for the LCA material, there are several ways of presenting it. It is important to note that customers may have very different needs, and have different knowhow from one another, therefore the marketing material must meet with these conditions. One way of doing this is providing some key figures, this will let customers know that Metso has this information and is interested in providing it for customers. More precise information can then be given to those who have the knowhow and the interest to use this information. One way of communicating some basic data could be by using an environmental product declaration (EPD). Since an EPD is regulated to some extent by ISO standards it also increases the reliability of the document.

Customizing the data for the customer could be an option, however, it requires a lot of work and would perhaps be a feasible method in the future, once the LCA is more familiar for Metso and its customers alike.

To start off with, it would be a good idea to use some of the information from the LCA, and present it along the traditional information. From the interviews with the marketing professionals at Metso, it is clear that price is of high importance to customers. Using the LCA results to explain the price can be extremely valuable, depicting the customers return on investment, the payback time, or annual savings from diminished resource use, can potentially win the deal.

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