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A QUANTITATIVE ASSESSMENT OF THE THEORETICAL QUALITY OF ECOLABELS

WITH SPECIAL ATTENTION TO THE CRADLE TO CRADLE CERTIFIED PROGRAM

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Student name:	Jelle Syswerda
Student nr.:	881122820110
Chair Group:	Management Studies
Supervisor:	Dr. S. Pascucci
Co-reader:	Dr. D. Dentoni
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With special attention to the Cradle to Cradle Certified Program

By: Jelle Syswerda

Msc Thesis in Management Studies Group

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Supervisors:

Dr. Stefano Pascucci
(+31) (0) 3174 82572
stefano.pascucci@wur.nl

Dr. Domenico Dentoni
(+31) (0) 3174 82180
domenico.dentoni@wur.nl

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SUMMARY

This research evolved from an interest in Cradle to Cradle product design. Cradle to Cradle is a philosophy of sustainable development which urges for industries to apply circular material flows (Braungart and McDonough, 2002). The goal is to design products that can be reassembled and of which the small building blocks can be reused for new products an indefinite amount of times. Use only safe resources as materials, power the production process with renewable energy; and wasteful 'Cradle-to-Grave' material flows will be changed in truly sustainable 'Cradle-to-Cradle' material flows. Cradle to Cradle design is also referred to as eco-effective design, as a direct opposition to eco-efficiency – a well-established strategy for sustainable development. Eco-efficiency stands for minimizing the environmental impact by reducing toxic dispersion, reducing energy use and maximizing product output per ton of raw material (DeSimone and Popoff, 2000). According to the developers of the eco-effectiveness strategy eco-efficiency is flawed, because on the long term this strategy is inherently at odds with economic growth and profitability (Braungart and McDonough, 2002).

To motivate manufacturers to start implementing eco-effectiveness principles and create Cradle-to-Cradle products, an ecolabel has been developed: the Cradle to Cradle Certified Program. In general, ecolabels contain a set of criteria a product has to comply with in return for certification. A certified product may carry a logo which offers competitive advantage because environmentally aware consumers will feel more affinity with the product than with non-certified products (Van Amstel, 2008; Lavallée, 2004). The C2C Certified program contains 4 tiers: Basic, Silver, Gold and Platinum. Each tier demands more challenging environmental requirements of a product.

This research focuses on the contradictions between eco-effectiveness and eco-efficiency, and looks into how the principles of these two sustainability strategies have been translated into ecolabel standards. The objective of this research was to determine whether the Cradle to Cradle Certified Program is addressing the eco-effectiveness concept more than 'traditional' eco-labels. The Cradle-to-Cradle ecolabel is expected to represent eco-effectiveness, while many (or all) other ecolabels are expected to follow the eco-efficiency principles. If the criticism of Braungart and McDonough is assumed as appropriate, these ecolabels will only marginally contribute to environmental protection. However, it is also possible that the Cradle to Cradle eco-label does not result in truly eco-effective products, because the principles of eco-effectiveness have not been properly translated. A third outcome could be that many other ecolabels show characteristics of eco-effectiveness as well, which would mean Cradle-to-Cradle is not unique.

It should be noted that eco-efficiency and eco-effectiveness are not pure opposites, but can be complementary strategies as well. However, as Braungart and McDonough (2007) describe, eco-efficiency is only of value when eco-effectiveness has been achieved: "*the slimming down of material flows per product or service unit (eco-efficiency) is only beneficial in the long-term if the goal of closing material flows (eco-effectiveness) has first been achieved."* This is an important issue, from which follows that an ecolabel performs better when it contains principles from both strategies.

To find the answer to the problem statement, an assessment tool was developed during this research with which ecolabels can be rated and compared in a quantitative way. This Scoring System assessed ecolabels on a number of attributes of environmental protection (e.g. material safety, environmental

impact, resource utilization, energy use), and per attribute a distinction was made between the eco-efficiency and eco-effective approach.

The results showed that the non-C2C ecolabels displayed a large variance of characteristics. So the hypothesis that the C2C ecolabel is eco-effective and all others are eco-efficient was quickly rejected. A reclassification was made based on high or low affinity of ecolabels to eco-efficiency or eco-effectiveness. (Eco-efficiency will be abbreviated as EY and eco-effectiveness as ES from here on.) Ecolabels that achieved a low score on both ES and EY had very low standards, and offered 'one-sided' environmental protection. A high EY and low ES affinity was related to 'traditional' ecolabels, ecolabels that do not require closing of material cycles. A high ES and low EY was only found for very new types of products, like renewable energy and biodegradable plastics. These were called 'pioneering' ecolabels. A high EY and ES was only achieved by ecolabels with very 'encompassing' standards, that included high material safety standards, closed loop material cycles and efficient resource and energy use.

The C2C Certified program tiers (Basic, Silver, Gold and Platinum) were all assessed individually. The Platinum tier scored best of all assessed ecolabels on eco-effectiveness, and therefore it can be concluded that the principles of eco-effectiveness have been properly translated. However, no product has up until now been awarded the Platinum tier, which means meeting these standards is either technically impossible or not economically feasible. The Gold tier was rated as an 'encompassing' ecolabel in the assessment, but there are others that perform similarly. The C2C Basic and Silver certification achieved very low scores and are perceived as 'one-sided' ecolabel standards that offer limited environmental protection. The Silver and Basic standards are in no way close to representing the principles of eco-effectiveness. Products carrying C2C Basic or Silver Certification could misinform the green consumer, because products are not as environmentally friendly as the message of Cradle to Cradle makes it appear.

The answer to the main research question is: no, the Cradle to Cradle certified program does not address the eco-effectiveness principles more than traditional ecolabels; with the notification that the word 'traditional' is not correct, since the ecolabel assessment showed that ecolabels display very diverse behavior. The developed Scoring System is a useful assessment tool for ecolabel certifiers that wish to identify shortcomings of their ecolabel standards. The mission of Cradle to Cradle is probably not best represented by an ecolabel, because the goal of eco-effectiveness is not reached while consumers are given that image by the name 'Cradle to Cradle' on a product.

CHAPTER 1. INTRODUCTION

1.1.1 BACKGROUND AND JUSTIFICATION

Sustainability has been a booming subject over the past few years. An increasing amount of initiatives can be found concerning sustainable housing or complete sustainable cities (Knudstrup et al., 2009; Cao and Li, 2011), green energy supply to households in the Netherlands has risen each year the past decade (CBS, 2011), and a company that wants to compete for market leadership in any market has to incorporate sustainability policies in its company strategy to stand a chance (DeSimone and Popoff, 2000).

The issue of sustainable development was first addressed in 1798, by Thomas Robert Malthus. He was a demographer, political economist and country pastor in England, and he wrote *An Essay on the Principle of Population.* In this essay he predicted that uncontrollable growth of the human population would lead to eventual starvation because the food production could not keep pace with the growth of the population. In the end, he was proved wrong because technological improvements made food production methods much more efficient (Paul, 2008; Braungart, 2002). Since then the Club of Rome published a worrying report in 1972 called '*The limits to growth'*, in which they predict that the depletion of non-renewable sources will eventually lead to collapse of the current growth model. This report gained considerable public attention. In 1987, the United Nations Brundtland Commission coined the term sustainable development. In the commission's report 'Our Common Future', they defined sustainable development as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs". This definition includes both the needs of the worlds' poor, as well as the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs (Paul, 2008).

In 1992 the UN Conference on the Environment and Development in Rio de Janeiro was the largest gathering of world heads of state yet, 114 in total. It was an international attempt to develop strategies for a more sustainable pattern of development. It was also at this conference that the term 'eco-efficiency' was coined. A few years later, in Kyoto, developed countries agreed on specific targets for cutting their emissions of greenhouse gases, resulting in a general framework, which became known as the Kyoto Protocol. However, the United States refused to ratify the Protocol, which made the effect of the treaty on a worldwide scale rather limited (Paul, 2008).

Despite the fact that attempts to unify the nations of the world in preventing environmental pollution and depletion of the world's resources have not resulted in a radical change of direction up to now, there are many entities that try to influence humanity's environmental impact on a smaller scale. One such initiative is the introduction of ecolabels.

Ecolabels are a means for a company to show that they are making efforts to reduce their environmental impact. This is shown to the customer by the presence of a small logo of the ecolabel on a product, as a proof of compliance of the product manufacturer to the ecolabel criteria. Certification can be granted to products, processes, buildings, supply chains, or people. They are proof that a certain environmental performance level has been achieved which is higher than in competitive products (Salzman, 1997). Ecolabels were created as a response to increasing

environmental awareness of the public, so besides being supportive of the environment, they offer competitive advantage to businesses that focus on conquering the new 'green product market' (Van Amstel, 2008).

Ecolabels are not all exchangeable; they can pursue very different achievements in environmental performance. Three types of ecolabels have been distinguished by the International Standards Organization (ISO).

The goal of Type I environmental labelling is to identify overall, environmental performance of a product or service within a particular product/service category based on life cycle considerations. It focuses on multiple attributes of environmental performance. Two steps can be distinguished in type I labelling. The first is standardization, the development of a set of criteria. The second phase – certification – allows companies to use the ecolabel on products or services that fulfil the label's criteria. Standardization and certification can either be done by the same company, or by two independent companies (Lavallée, 2004).

Type II labelling, Self-Declared environmental labelling is described in the ISO 14021 standard. It involves an environmental declaration made without certification from an independent third party. Manufacturers or any other entity are able to gain benefit from this declaration. The main requirement of this label is that it must be accurate, and must not be misleading (ISO 14021; Lavallée, 2004).

Type III product declarations must be based on procedures and results from a quantified life cycle assessment compliant with ISO 14040 standards. This type of labelling does not state that the product is superior to another, but gives the ingredient list and the product's nutritional information. Although this type of labelling provides a high standard of environmental impact measurement, it is difficult from a consumer's perspective to identify the product with the lowest environmental impact, and for SME's the complete life cycle assessment is often too expensive (Lavallée, 2004). Type III product declarations are a very suitable measurement to compare two similar products on their environmental performance (Ecospecifier Global, 2012).

Although ecolabels appear to have admirable intentions, concerns have been raised over the years regarding their commercial interests and their effectiveness in practice. Van Amstel *et al*. (2008) express concern over the occurrence of 'green-washing', which is selling a product that seems more environmentally friendly than it really is. Lavallée *et al.* (2004) state that even though ecolabels are meant to protect the consumer from greenwashing practices, in reality eco-logos are handed out via a non-transparent process and it still happens that ecolabels are granted to a product while only certain aspects of its environmental impact are better than competitive products, and an incomplete or one-sided assessment has been made. Because of this non-transparency around ecolabels, they can be seen as credence goods. Credence goods are goods and services where an expert knows more about the quality a consumer needs than the consumer himself (Dulleck, 2006). Furthermore Van Amstel *et al.* have conducted interviews amongst ecolabel certified farmers regarding verification methods by certifiers, and the farmers pointed out that it was fairly easy to fool auditors during audits in case of non-compliance. The extent of compliance is a rather important aspect of the contribution of ecolabels to environmental performance improvement. My research will however not focus on the practical implementation of ecolabels, but on the quality of the ecolabel standards.

A high quality of the standards of an ecolabel is crucial if the ecolabel is going to contribute to environmental protection. Therefore question marks will be placed in this research as to whether the bulk of ecolabels out there on the market are actually making a significant contribution to environmental protection and sustainable development.

In 2002, Michael Braungart and William McDonough published a book called 'Cradle to Cradle design', in which they criticize the way 'mainstream environmentalists' are approaching sustainable development. They unify this approach under the term 'eco-efficiency', and point out the flaws of this environmental strategy which is widely accepted in industry. For clear understanding of their arguments, I will briefly describe eco-efficiency:

Several slightly different definitions exist, but the World Business Council for Sustainable Development originally defined eco-efficiency in 1992 as "being achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle to a level at least in line with the earth's carrying capacity" (WBCSD, 2012). Rather simply put, eco-efficiency can be described as 'to get more from less': more product or service value, with less waste, less resource use and less toxicity (Braungart, 2007). DeSimone and Popoff (2000) frame the essence of eco-efficiency in 7 core guidelines:

- Reduce the material intensity of goods and services
- Reduce the energy intensity of goods and services
- Reduce toxic dispersion
- Enhance material recyclability
- Maximize sustainable use of renewable resources
- Extend product durability
- Increase the service intensity of products

These guidelines are outstandingly applicable on the business model, because corporations that adopt the eco-efficiency principles can express their environmental and social responsibility while at the same time they can be profitable, by saving considerably on resource and energy costs (DeSimone, 2000).

According to Braungart and McDonough, the eco-efficiency concept is flawed because each of the above-mentioned strategies starts with the assumption of a linear, cradle-to-grave flow of materials through industrial systems. "These strategies presuppose a system of production and consumption that inevitably transforms resources into waste and the Earth into a graveyard. Strategies of dematerialization and increased resource productivity seek to achieve a similar or greater level of product or service value with less material input" (Braungart, 2007). With cradle-to-grave material flows as background, strategies are applied to achieve recyclability and prolonged product lifespans. With recycling, the goal is to prolong the period before resources acquire the status of waste, by reusing a material during several life cycles. However, in many cases recycling is actually 'downcycling', because the recycling process reduces the quality of the materials. After recycling, a material is often used in a lower quality application, for example food packaging plastic is recycled into a park bench. The material life span has been prolonged, but its status as a resource has not been maintained. After its life as a park bench it will either become waste or be recycled into a park

bench, but it cannot be used as food packaging anymore. Braungart and McDonough state that the mode of action of eco-efficiency strategies – reductions in the quantities, velocities and toxicity of the waste streams – are not adequate solutions. "Less bad is no good" is their message. They state that eco-efficiency presents appealing solutions for the short term, as they present the potential for tangible reductions in environmental impact and reduced costs. In the long run however, they are insufficient for achieving economic and environmental objectives on several accounts:

1. Eco-efficiency is a reactionary approach that does not address the need for fundamental redesign of industrial material flows.
2. Eco-efficiency is inherently at odds with long-term economic growth and innovation
3. Eco-efficiency does not effectively address the issue of toxicity.

The first criticism is that eco-efficiency does not address the source but addresses the problems. It begins with the assumption that industry is 100% bad, and proceeds with attempting to make it less bad. The second criticism is aimed at the fact that the ultimate goal of reduction is reaching zero. And with cradle-to-grave material flows, the goal of zero is inherently unreachable. It is a worthwhile initial step according to Braungart and McDonough, but as the limits of dematerialization have been reached, the opportunities for growth and innovations will decrease. The third point of criticism is aimed at the fact that toxic substances are emitted by everyday objects, like tables, laptops, pencils. However small the toxic amounts per object may be, all together they form a toxic load which is suspected to contribute to allergies, respiratory problems, risk of cancer and other health issues. *Sick building syndrome* is one of the consequences of the allowance of toxic substances in everyday objects. Minimization of this toxic load in products is an insufficient goal, products should be really safe (Braungart, 2002; Braungart, 2007).

So according to the authors of Cradle to Cradle design, eco-efficiency which has been widely accepted as the leading strategy for sustainable development is not a proper solution. What is their solution? Eco-effectiveness. The fundamental aspects of eco-effectiveness are to generate healthy, Cradle to Cradle material flow metabolisms. The word 'metabolism' is consciously used to draw a parallel with living organisms. "Just as the metabolic systems of biological organisms include the synthesis and breaking down of substances for the maintenance of life, the metabolic systems of eco-effective material flow systems include the synthesis and breaking down of products for the maintenance of a healthy economy and provision for human needs" (Braungart, 2007). When implementing this eco-effectiveness strategy, one aims to use solely healthy materials, which can be retrieved at the end of the product life at the same level of quality, for an indefinite amount of life cycles. To achieve this, materials have to be divided into two material cycles, either a biological cycle or a technical cycle. Biological cycle nutrients are fully biodegradable, so they can decompose and be synthesized an indefinite amount of times. Technical nutrients are not decomposable, and therefore a technical product needs to be retrieved by the manufacturer and broken down actively to monomaterials to be reused in a next product life cycle. Prerequisite to a technical nutrient is that the product is designed such that different materials do not become irreversibly mixed, because that would mean a loss of resource quality (Braungart, 2002; Braungart, 2007). The basic principles of eco-effectiveness are:

1. Eliminate the concept of waste. "Waste equals food."
2. Power with renewable energy. "Use current solar income."

3. Respect human & natural systems. " Celebrate diversity." (MBDC, 2012).

The book on Cradle to Cradle received rather positive critique from the larger public and from industry in particular. Several industrial companies were enthusiastic to redesign their products according to the principles of eco-effectiveness. Since companies like to show their solidary efforts to the public, the demand for an ecolabel regarding Cradle to Cradle design quickly arose. The 'Cradle to Cradle Certified Program' was founded in 2005 by McDonough Braungart Design Chemistry (MBDC, 2012). The criteria of this ecolabel are aimed at guiding manufacturers to become eco-effective. The ecolabel consists of four tiers (Basic, Silver, Gold, Platinum), each level setting more demanding standards for product certification. Ultimately, the highest tier, platinum, ought to reflect true eco-effectiveness.

1.1.1 PROBLEM STATEMENT

The publication by Braungart and McDonough is a rather bold criticism on what has been achieved so far regarding sustainable development. In fact, it states that the current path of sustainability that society is pursuing will merely delay the collapse of our way of life. Furthermore they claim that implementation of eco-effectiveness principles in industrial systems is the solution (Braungart, 2002).

Are these statements verifiable? How?

Following the reasoning of Braungart and McDonough that the mainstream ideas on sustainable development are not sufficient, it is probable that any current ecolabel (other than the Cradle to Cradle Certified Program) has been developed according to the same inferior strategy and therefore those 'traditional' ecolabels set standards that only result in marginal environmental protection.

It is assumed during this research that the principles of eco-effectiveness in theory are a perfect solution to achieve a sustainable human society. This assumption is shared by prominent supporters of the Cradle to Cradle philosophy (Agentschap NL (The Dutch Ministry of Infrastructure and Environment) and Philips (a Dutch electronics multinational). This research focuses on the way these principles have been translated into an ecolabel, and on the extent to which eco-effectiveness principles can be found in 'traditional' ecolabels.

Hence, there is a need to understand whether the Cradle to Cradle Certified Program is addressing the principles of eco-effectiveness more than other ecolabels. The aim of this research is to verify whether the Cradle to Cradle Certified Program truly reflects eco-effectiveness, and to verify whether traditional ecolabels contribute only marginally to the environment.

There are several scenarios foreseen, which are presented as hypotheses and a related problem:

- The Cradle to Cradle Certified Program succeeds in actually realizing products that have a *positive* impact on the environment (eco-effectiveness), which means that Cradle to Cradle design theory is applicable in practice and the answer to true sustainability. **Problem: hundreds of other ecolabels contribute only to a very limited extent to the environment.**
- Eco-effectiveness remains a theoretical concept for now, because the standards of the Cradle to Cradle Certified Program do not actually result in eco-effective products. **Problem: The eco-effectiveness principles have not been translated properly into ecolabel standards.**

- The Cradle to Cradle Certified program does result in products that adhere to eco-effectiveness principles, but during this research it becomes clear that other ecolabels result in the same high quality products. **Problem: The Cradle to Cradle 'hype' revolves around ideas that are not nearly as unique as they seem, because there are other equivalent ecolabels. Cradle to Cradle is merely clever marketing.**

Each of these possible outcomes would be an interesting result and a clear signal for required action.

1.1.2 RESEARCH OBJECTIVES

The overall objective of this study is to determine whether the Cradle to Cradle Certification Program is addressing the eco-effectiveness concept more than traditional eco-labels.

More specifically, this study aims to:

- Conceptualize how eco-efficiency and eco-effectiveness relate to each other
- Determine to what extent the four tiers of the Cradle to Cradle Certified program (Basic, Silver, Gold, Platinum) represent the principles of eco-effectiveness
- Determine whether traditional ecolabels contribute only marginally to the environment

1.1.3 RESEARCH QUESTIONS

The main research question is:

Does the Cradle to Cradle Certified Program represent the principles of eco-effectiveness more than traditional ecolabels?

I. RESEARCH SUB-QUESTIONS

- Can eco-efficiency and eco-effectiveness be complementary?
- To what extent do the four levels of the C2C Certified program (Basic, Sliver, Gold, Platinum) follow the eco-effectiveness concept?
- How do 'traditional ecolabels' perform in terms of eco-efficiency and eco-effectiveness compared to the C2C Certified Program?

1.1.4 ORGANIZATION OF THE THESIS

Chapter 1 introduces the problem, defines the research objectives and specifies the research questions. Chapter 2 describes the relation between eco-efficiency and eco-effectiveness, and will continue by describing how these two strategies come to expression in ecolabel standards. Furthermore the limitations to the study are mentioned. In Chapter 3 the Research Methodology is addressed. This chapter presents the Scoring System which will be used to rate the ecolabel performance, plus the selection of ecolabels. Furthermore the data collection methods are given. Chapter 4 presents the results of the thesis and discussion of the results. Chapter 5 contains conclusions and recommendations for future research.

CHAPTER 2. THEORY BUILDING

In this chapter the first research sub-question will be answered: *Can eco-efficiency and eco-effectiveness be complementary?* This sub-question is crucial, because its answer will be key to the decision on what the standards of a good ecolabel must include. To clarify, the outcome could be that eco-effectiveness should totally replace eco-efficiency as a strategy, or that they can be complementary. This chapter will then continue with linking the principles of eco-effectiveness and eco-efficiency to the attributes of type I ecolabels. From now on, eco-efficiency will be abbreviated as EY, eco-effectiveness will be abbreviated as ES.

2.1. THE RELATION BETWEEN ECO-EFFECTIVENESS (ES) AND ECO-EFFICIENCY (EY)

The first important question to be answered is how EY and ES relate to each other. They are both strategies for sustainable development. But can a company that strives for sustainable production methods only use one of these strategies at a time? Or can both strategies be used complementary? And if so, under what conditions?

A problem in answering this question is that very limited literature exists on the matter. There is an abundance of literature available on EY, but very limited literature on ES or on the relation between the two strategies. One of the few articles that addresses ES is from Dyllick and Hockerts (2002). They make a division into 6 criteria which managers aiming for corporate sustainability have to satisfy: eco-efficiency, socio-efficiency, socio-effectiveness, sufficiency and ecological equity. They state that with just eco-efficiency a firm may exceed social and environmental *carrying capacity* and should therefore be concerned with the absolute effectiveness of their sustainability measures, not only their relative efficiency. However, they do not use the term ES in clear opposition of EY. Neither do they allocate an equally major role to ES as Braungart and McDonough do.

Barbirolo (2006) recognizes as well that literature on ES is practically non-existent and tries to come up with a definition for ES. To come to this definition, he draws a link to the 'state of bliss', i.e. the 'highest ideal condition in any choice' (Balducci *et al.*, 2001). Put in the context of resource environment, the state of bliss is according to Barbirolo obtained when, by producing goods, services, value and richness, the amount of utilized material resources and of energy is '0'. Because this is not possible in reality, the distance from the real state to the state of bliss has to be calculated, referred to as the 'loss function'. His (careful) definition of eco-effectiveness is then the following: *'eco-effectiveness is the degree of natural resources rational utilisation in any economy, that can be measured through a loss function that measures the distance between the real state (material and energy intensity to GDP or per-capita) and the ideal state (or state of bliss), i.e. zero amount of resources, even producing increasing and enhanced richness'.* According to Barbirolo, EY can only be pursued within given resource inputs and is therefore limited. ES turns upside down the terms of the problem by setting zero-resources as the ideal target. Barbirolo mentions no possible combination of the two strategies.

Braungart et al. (2007) are the only source which goes into great detail on the concept of eco-effectiveness and write the following about the relation between EY and ES: *"Efficiency and effectiveness can be complementary strategies. If efficiency is defined as ''doing things the right*

way'', effectiveness means ''doing the right things''. The concept of efficiency in itself has no value; it can be either good or bad. If industry is driven by systems that are inherently destructive, making them more efficient will not solve the problem, and may even aggravate it (e.g. the rebound effect[1]). The slimming down of material flows per product or service unit (eco-efficiency) is only beneficial in the long-term if the goal of closing material flows (eco-effectiveness) has first been achieved."

Braungart and McDonough put ES as a clear opposing strategy to EY. However, they do not completely abandon EY as a strategy, but consider it only of value when material cycles have been closed first. Dyllick and Hockerts seem to consider EY still as the primary strategy, but state that ES is a useful aspect to include because EY alone does not pay attention to the carrying capacity of a system. However, Dyllick and Hockerts seem to have a rather different definition of ES, because they consider it as a strategy which helps a manager focus on preventing depletion of natural resources, while Braungart and McDonough regard ES as an encompassing strategy for economic, ecologic and social prosperity. Barbirolo embraces the concept of ES as presented by Braungart and McDonough, and tries to translate it into certain formulas. He makes a solid point by stating that the final goal is zero resources, since the ultimate aim of a system using nutrient cycles is that no new resources have to be added because they circulate. However, the usefulness of his approach seems doubtful since the presented formulas are rather abstract and the quantities of the variables are hard to determine. Barbirolo does not go into a possible combination of EY and ES principles but simply disposes EY as a useful strategy. Since Braungart and McDonough provide the best and most explicit information about the relation between EY and ES, I will continue with their explanation.

A point of critique on Braungart and McDonough's explanation of ES is that they state that the quantity of emissions, waste streams and resources is no longer important, as long as they are healthy and part of a circular system (Braungart, 2007). In reality this cannot work without applying efficiency principles as well, since transportation of large material volumes and energy are costly. Imagine implementation of ES principles in industrial systems: products need to be returned from the consumer to the manufacturer via a take-back system, which requires very complicated logistics operations. Disassembly of products requires additional labour hours. Renewable energy – ideally supplied in unlimited amounts by solar energy – will still be costly as the electricity needs to be transported to the user and solar installations require maintenance. Furthermore, certain technical nutrients like metals (e.g. aluminium) exist only to a limited amount on our planet. Even if aluminium can be maintained in a technical cycle, there is a theoretical limit to the size of such a cycle. Efficiency is of added value in this case because a larger number of consumers can use a product before the theoretical resource limit is reached.

It can be concluded that EY as a strategy cannot be good when it is part of a destructive industrial system. ES if well implemented is a sustainable practice in terms of resource use, nutrient flows and healthy people and environment. However, in terms of logistics, energy and labour an eco-effective industrial system needs to be efficient as well, or it will become too costly and therefore not

[1] Increased resource efficiency per kg of product is often nullified by an increase of total global production in the same period of time, resulting in a greater total rate of resource depletion. For example: cheaper, more efficient cars have caused more people to start using cars and increased the mileage per user, creating more waste and emissions. This is referred to as the rebound effect (Hertwich, 2008; Braungart, 2007).

economically viable. The graphs in figure 1 depict a few scenarios that will occur when these strategies are implemented.

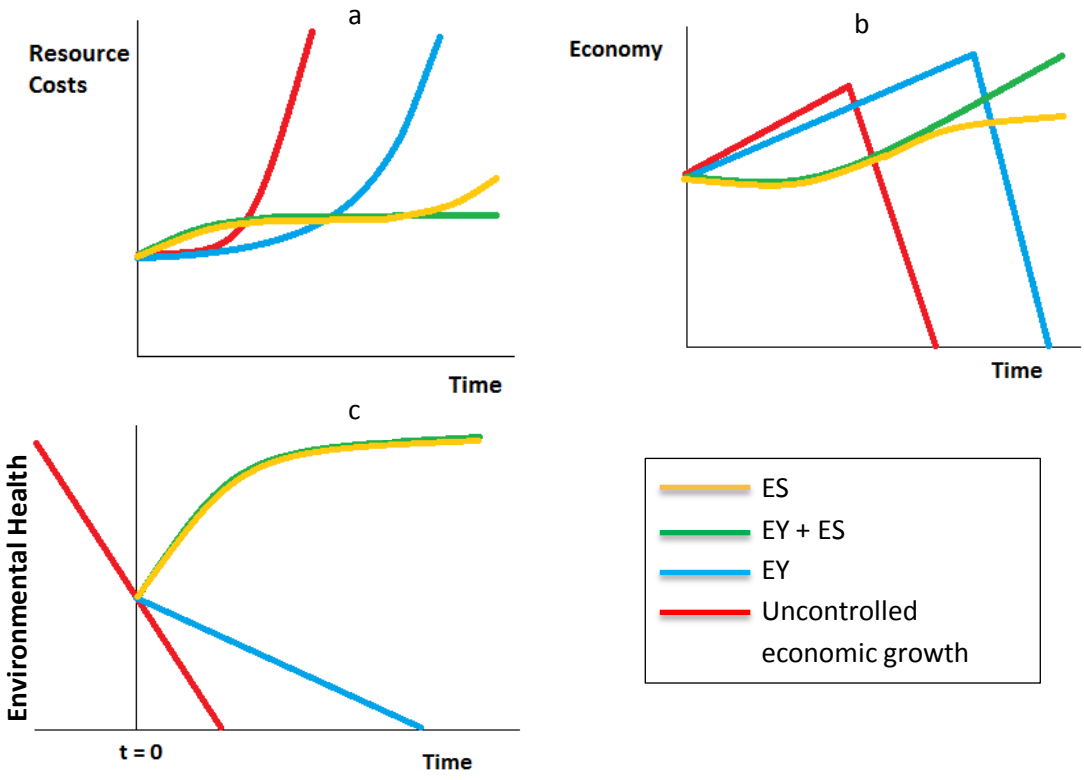

Figure 1. Predictions of what will happen over time when different sustainability strategies are implemented. Graph a represents the cost of resources over time. Graph b represents the economic growth in the future. Graph c represents the environmental health over time (both in the future and past).

It should be noted before discussing these graphs that the reactions of the economy to strategy implementation may be oversimplified, because it is unknown how costly large scale ES implementation would be. The time on the X-axis is not specified, but should be considered in terms of 50 or a 100 years, because e.g. crude oil reserves are estimated at enough for ±40 years. In graph a of figure 1 the consequences are sketched what happens to the cost of resources if a certain strategy is widely implemented. When material cycles are not closed, non-renewable resources will eventually become scarce when the earth's reserves are nearly depleted. The price of resources will soar. ES will be costly at first because radical redesign of our economy is necessary. However, as materials will flow in cycles, the prices will stabilize. However, when efficiency is not implemented, the theoretical limit on the stock of a certain resource may cause the price to go up again.

Graph b represents the prediction of economic growth over time as different strategies are widely implemented. A focus on economic growth and profit maximization will only be possible for a limited time, because when resources run out and clean water becomes scarce this system is not sustainable and will collapse. EY will extend the duration before this collapse occurs. ES will require investments, but will result in a sustainable economy where economic growth is possible. Again, it might stagnate at a certain point if logistics and energy are not applied efficiently. Graph C shows the effect of different strategies on the health of our environment. The environmental health of our planet has been degenerating rapidly since the Industrial Revolution. When nothing is done, this will rapidly continue. EY slows down the damaging process, whereas ES, either in combination with EY or not, will result in maintaining or even improving the environment.

This short analysis of the possible strategies supports the statement of Braungart and McDonough that EY and ES can be complementary, but that EY only has added value when ES is implemented first.

Now that the relation between EY and effectiveness has been determined, it is possible to identify aspects that an ecolabel must have embedded in its standards to be considered a truly holistic/encompassing/overall/environment protecting ecolabel.

So the **next steps** in this research are to identify the key attributes of an ecolabel, and how they should be linked to EY and ES. Secondly a method has to be developed for rating ecolabels on their performance.

2.2. IDENTIFYING KEY ATTRIBUTES OF AN ECOLABEL

The second and third research sub-questions are concerned with the quality of the standards of an ecolabel. To answer these questions, it is necessary to determine which attributes of environmental protection are usually covered by an ecolabel, and how EY and ES come to expression in each of these attributes.

In the previous chapter the three types of ecolabels have been introduced. In this research, the wide range of existing ecolabels will be narrowed down to just type I ecolabels, because the Cradle to Cradle Certified Program can be considered the benchmark ecolabel of this research and this is a type I ecolabel. Furthermore, type II ecolabels are issued by the manufacturer and often one-sided. Type III ecolabels quantify environmental impact of products, but are only suitable when two similar products are compared (Lavallée, 2004).

The goal of Type I environmental labelling is to identify overall, environmental performance of a product or service within a particular product/service category based on life cycle considerations (Lavallée, 2004). The standardization, i.e. the development of the set of criteria is done by a labelling organization. This organization first consults with a committee that consists of representatives from consumer groups, environmental associations, and government representatives. The set of criteria can either be aimed specifically on a certain product or service, or it can be suitable for any kind of product. The standards of the Cradle to Cradle Certified Program are not specified on one product, though it does not certify buildings, people or services. The attributes that together encapsulate 'overall environmental performance' in the Cradle to Cradle Certified Program are:

- Material Safety
- Reutilization of resources
- Energy use
- Water treatment
- Social responsibility

These five attributes can be found in many type I ecolabels, and are also all part the key principles of both EY and ES strategies. Two other attributes are introduced: following the example of Truffer *et*

al. (2001) – who performed a study on electricity ecolabels – **the environmental standard of an ecolabel** will be considered. Furthermore Van Amstel *et al.* (2008) state that ecolabels give standards for the production process, but what they often surpass is to measure the environmental impact beyond the production stage. Therefore **the environmental impact considerations** of ecolabels will be discussed as well. However, besides similarities, there are a number of fundamental differences when looking at this kind of attributes from an EY or ES perspective. In the next section (section 2.2.1 – 2.2.6), the core attributes of an ecolabel will be discussed and linked to the optimal situation of both EY and ES. Sections 2.2.1 to 2.2.6. are leading up to a quantitative analysis of a selection of ecolabels, which will help to answer research sub-questions two and three. This next discussion explains certain choices that were made in developing an assessment tool for rating ecolabel performance: the Scoring System. Following the example of Truffer (2001), the several topics discussed in the next section will be referred to as 'dimensions'; in which dimensions are defined as 'criteria on which ecolabels may differ'.

2.2.1 MATERIAL SAFETY OR TOXICITY OF A PRODUCT

Practically every type I ecolabel devotes part of its standards to material safety. In case of ecolabels focusing on a product this is a rather obvious choice. The goal of ecolabels is to distinguish products that have a better environmental performance than their competitors (Lavallée, 2004) and for that reason their standards are more demanding than material safety requirements set by the law.

The strictness of allowing dubious substances differs per ecolabel. The more demanding the standards are, the more challenging it is for a manufacturer to comply and the higher the costs will be to keep the same functional quality. Therefore not every ecolabel simply states that any harmful or doubtful substance should be banished from a product.

So what do EY and ES strategies say about material safety? EY states as key principle 'reduce toxic dispersion'. This principle does not clearly define to what extent toxic dispersion should be reduced. DeSimone and Popoff (2000) explain this principle as paying attention to avoiding dispersion of toxic substances in the environment, which may otherwise increase costs in the future. Braungart and McDonough mention that eco-efficiency focuses on 'safe limits'. Their point of critique here is that one can never be completely sure of safe amounts, and furthermore that the accumulation of toxic substances from all those little amounts can cause health complaints (Braungart, 2002).

From an EY perspective, a product is satisfying when hazardous substances are emitted or dispersed in the environment in harmless quantities. ES takes this a step further. Braungart and McDonough state their discontent about the fact that sometimes a manufacturer does not know exactly the chemical composition of one of his products. They recommend a system where a products chemical composition is known down to a 100ppm, and every material is assessed for its safety divided in the categories red, yellow, green and grey:

Red: High hazard and risk associated with the use of this substance. Develop strategy for phase out.
Yellow: Low to moderate risk associated with this substance. Acceptable for continued use unless a GREEN alternative is available.
Green: Little to no risk associated with this substance. Preferred for use in its intended application.
Grey: Incomplete data. Cannot be characterized.

Ultimately, a material should consist of merely green assessed substances. Furthermore, a material has to be assigned as either a constituent of the biological or the technical cycle.

Many different sets of hazard classification systems have been developed which are stricter than what is prohibited by law. Examples are the GHS, the IARC or EC (European Commission). Additionally, 'Risk phrases' exist which are certain risks attributed to dangerous substances and preparations (Annex III of European Union Directive 67/548/EEC) . These Risk Phrases or R-phrases are sorted by number, and an ecolabel can choose in its standard to prohibit substances assigned to certain R-numbers. This is considered the highest environmental standard from an eco-efficiency perspective.

In essence, EY and ES do not differ that much in their material safety goals. ES creates a new way of assessing material safety with the colour categories. However, in essence the result is the same as when using the existing hazard classification systems. The final product safety all depends on the strictness of the requirements of an ecolabel in following one of these systems. The best possible result is both for EY and ES a product that contains no hazards whatsoever.

2.2.2 ENVIRONMENTAL STANDARD

According to Truffer (2001), there are large differences in the environmental standards set by an ecolabel. Some ecolabel standards are more demanding than others. Often less demanding standards are a conscious choice made by a labelling organization to more easily gain applicants, however it results in differences in the environmental quality of a labelled product.

For example an ecolabel could focus on the product composition/energy efficiency/recycling. In section 2.2 the five key attributes of an ecolabel have been given. From an EY perspective, a good ecolabel focuses on all of these attributes. Every attribute which is neglected decreases the environmental standard level of the ecolabel. Another aspect of eco-efficiency is that it is relative. A product that performs better than competitors (on environmental aspects) is automatically good from an EY perspective. An ecolabel which states that a product has to be X% better than competitors therefore earns extra credit. Lavallée (2004) gives the Canadian Terra Choice as an example; this ecolabel issues the eco-logo to a product which, at some phase of its life cycle, is 20% more efficient than other products in the same category.

Eco-effectiveness recognizes the same multi-attribute-approach, but it is fundamentally different from EY in the sense that one should not look at the competition but at *what is good* (Braungart, 2002). The environmental standards of an ecolabel only display an acceptable level if it includes material flow metabolisms (material retrieval methods or biodegradable products). In the very best ES scenario a product should offer an actual benefit to the environment in some way.

2.2.3 ENVIRONMENTAL IMPACT MEASUREMENT

Ecolabels are in essence developed to decrease negative environmental impact, but what they often surpass, is to measure the environmental impact beyond the production stage (van Amstel, 2008).

In the WBCSD definition of eco-efficiency we can find the final goal of EY strategy for reducing ecological impact: "being achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively *reducing ecological impacts and resource intensity throughout the life cycle to a level at least in line with the earth's carrying capacity"* (WBCSD, 2012). Braungart and McDonough make a solid point that this goal is inherently at odds with economic growth. In the end, a cradle-to-grave product flow will always lead to resource depletion or a ceiling for the amount of resources that can be harvested.

So how does one measure ecological impact? Admittedly, it is an effect that is very hard to measure or to quantify. Life Cycle Assessment is a method especially developed to quantify the environmental impact of a product throughout its life cycle. That way the stages most urgent for improvement are identified. However, the LCA method is only suitable for Cradle-to-grave (EY) material flows because it aims at reducing the damaging effect of products, whereas Cradle to Cradle principles (ES) look for a beneficial footprint (NL Agency, 2012).

So from an EY perspective, the best possible criterion in an ecolabel is to perform an LCA. Other more simple measurements of environmental impact are considered as reasonable efforts too. From an ES perspective, the burden on the environment will be lifted when materials are safe or simply don't end up in the environment by keeping them in a loop. Furthermore, emissions and effluents that are as clean as the streams that came in are examples of eco-effectiveness (Braungart, 2002).

2.2.4 RESOURCE USE

Resources have a certain value, which is diminished after a product has been discarded as waste. There are several strategies to extend the timespan over which a resource is valuable. Increased product durability is one, reduced resource input per tonne of end product is a second, and reusing resources at their end-of-life stage is a third. These are all strategies which are given as principles of EY (DeSimone, 2000). ES is a strategy which is bio-inspired, and it uses the cherry tree blossoms as an example of a system that is not efficient, but it is effective, as its end-products are all nutrients for other organisms. ES is not against efficient resource use, but it argues that efficiency is only a useful strategy when it is part of a larger material flow metabolism (Braungart, 2002, 2007).

This dimension will be separated in EY criteria focusing on efficient use of resources, and ES criteria aiming at reusing resources. Doing so, the researcher is consciously overlooking the fact that 'design for recycling' is one of the key aspects put forward in EY strategies. My argument is that recycling /reusing resources belongs to the ES strategy, and industries that are recycling products while embracing the EY set of thoughts, are in fact applying a bit of ES strategy.

The ES part of the dimension will also pay attention to the statement of Braungart and McDonough that recycling is in fact often downcycling: recycling resources at a lower value than in their previous life. And finally biodegradable products should be scored according to a secondary set of criteria, since they can return to the environment, unlike technical nutrients.

2.2.5 ENERGY USE

The use of renewable energy sources (energy from natural sources and which are naturally replenished: solar, wind, water, biofuel, etc.) and using energy scarcely are important aspects of both

EY and ES. It should be added that EY sees the use of non-sustainable sources while minimizing energy expenditure as a reasonable compromise, whereas ES does not.

Again, similar to the 'resource use dimension', a clear line will be drawn between EY and ES for the purpose of scoring specific attributes of the ecolabel. EY criteria will focus on ecolabel standards concerning minimization of energy consumption, whereas ES criteria will address renewable energy use.

2.2.6 LIMITATIONS OF THE STUDY

Other aspects contribute to the success of an ecolabel which are not treated in this report, being:

- Consumer perception
- Price of certification
- Verification methods
- Rate of compliance
- Corporate social responsibility

In practice, these aspects form an important contribution to the success or failure of an ecolabel. Ecolabels offer, besides a means to protect the environment, a competitive advantage for companies that wish to enter the market segment of the 'green consumer' (Van Amstel, 2001). Many ecolabels consider the fact that they are a marketing tool and adjust the 'severity' of their standards to a marketable level. Truffer *et al.* (2001) state that simple standards acquire fast market penetration because the standards are easy to comply with for a manufacturer and therefore cheap. These ecolabels will lose credibility in the long term, but consumers often don't look deeper into an ecolabel than the logo on the package.

Ecolabels perform regular audits to check whether applicant firms actually comply with the standards and keep doing so over the following years. The control on compliance is at least equally important as the quality of the ecolabel standards in achieving high environmental performance, because without compliance an ecolabel is useless. Van Amstel *et al.* (2008) have done research on the aspect of (non-)compliance by ecolabel certified farms, and have found that many farmers state that hiding non-compliance to ecolabels from auditors is fairly easy and happens in many cases.

The researcher is aware that the above mentioned aspects are important factors for an ecolabel to be successful. This research however is limited to the extent to which the standards of an ecolabel contribute to environmental health, with the principles of EY and ES as theoretical foundation. The aspects mentioned above are not included in this research because from an eco-efficient of eco-effective perspective they are not perceived differently.

CHAPTER 3. RESEARCH METHODOLOGY AND DATA SOURCES

3.1. THE SCORING SYSTEM

The previous chapter described the main differences between EY and ES perspectives on the environmental attributes which often appear in type I ecolabel standards. These differences are now translated into an assessment tool to rate ecolabels on their overall environmental performance. The aim of this assessment is to achieve a better insight in the 'behaviour' of ecolabels. With behaviour is meant the focus ecolabels put on certain attributes. Most preferably ecolabels will be distinguished that are one-sided in their environmental protection, some that show more affinity to EY principles and more affinity to ES principles. Of course, it should be possible to answer the research questions too after this assessment has been carried out.

In order to compare ecolabels in a qualitative way, each of the 5 dimensions discussed in the previous sections (2.2.1 – 2.2.6) will be divided into 5 ordinal categories [1-5], which range from low to high adherence to the principles of either eco-efficiency or eco-effectiveness.

I. DIMENSION #1 TOXICITY OF THE PRODUCT

EY 1 point: Threshold requirements regarding harmful substances are in compliance with public regulations (no added value of the label)

2 pts: When only a limited number of prohibited harmful substances is mentioned (<5); or when the thresholds concerning harmful substances exceed 500 ppm

3 pts: When only a limited number of prohibited harmful substances is mentioned (<10); or when the thresholds concerning harmful substances exceed 200 ppm

4: All substances that are classified by the IARC, GHS or EC as definitely, probably or possibly carcinogenic to humans are prohibited in the product. Known mutagenic or teratogenic substances are also prohibited. Precise thresholds and verification methods for a large number (>10) of hazardous substances are given (heavy metals, VOC emissions, etc.)

5: All requirements for a score of 4 pts are met, plus standards are provided that prohibit the use of 'doubtful' substances. For example >10 R-phrases are mentioned in the standards and any substance associated with one of them is prohibited.

ES 1: When so called 'grey' substances are present: the complete product content is unknown, and certain undefined materials are present

2: all materials in the product are known down to 100 ppm and assessed on their safety to humans and the environment. Hazardous ('yellow') or dangerous ('red') substances are identified but not yet removed from the product.

3: All criteria for a 2point score are met. Additionally: risky substances are allowed with the guarantee that better alternatives are being searched for and that there is no direct contact for humans. Every product component is marked as a constituent of the technical or biological cycle.

4: All requirements for a score of 3 pts are met, with the difference that 'red' substances are no longer allowed.

5: All requirements for 3 pts are met, with the difference that red and yellow substances are no longer allowed. Only safe ('green') materials may be used in the product.

II. DIMENSION #2 THE ENVIRONMENTAL STANDARD OF LABELLED PRODUCTS

A multi-attribute ecolabel focuses on several issues in its attempt to raise the environmental performance of a product. These issues are identified:

- material safety
- resource use (recycling)
- energy use
- water treatment
- social responsibility

EY 1 point: The relative market performance is not specified, and the label standards address only one of the abovementioned issues, while neglecting other issues: one-sided environmental protection

2: Relative market performance is not specified, which means the product could be just better than average; and the label is neglecting 3 of the above mentioned issues

3: Relative market performance is not specified, and the label is neglecting 1 or 2 of the above mentioned issues

4: Relative market performance is not specified, but the label standards include all of the above mentioned issues

5: The ecolabel is only granted to products that are among the top-20% segment of the market regarding environmental performance, whilst the label standards include all of the above mentioned issues

ES 1: end of life of the product is not considered in the label standards: the product will probably end up as waste in a landfill

2: a linear, cradle-to-grave product life cycle for which a waste management plan is defined in the standards: e.g. incineration, downcycling, safe disposal.

3: the label standards require that the manufacturer is in the development stage of a plan for retrieval of product nutrients (technical cycle products). The plan will be implemented within a defined period of time.

4: absolute environmental benefit is achieved during production of a product by actively retrieving products/nutrients after useful life, but no clear environment supporting process step or product attribute is added

5: *absolute environmental benefit* is achieved during production of a product by (1) actively retrieving nutrients/products after useful life and (2) adding a clear environment supporting process step or attribute in the product cycle (e.g. shoe soles release plant seeds when they are biodegrading)

III. DIMENSION #3 ENVIRONMENTAL IMPACT MEASUREMENT

EY

1point: No attempts to measure the environmental impact, but only product samples are measured; ecolabel only focuses on the product composition

2: For ecolabel standards that only require 4 measuring tests or less of the 6 measurements indicated for a 3 points score below.

3: If an ecolabel demands test results concerning all of the following measurements:

- bioaccumulation
- aquatic life in effluent stream (Fish toxicity, algae toxicity, bio-concentration)
- indoor air quality (VOC emissions)
- biodegradation rate
- greenhouse gas (GHG) emission
- soil samples of factory grounds (soil organism toxicity)

4 points: Complete Life Cycle Assessment performed: quantification of total environmental impact

5: Complete Life Cycle Assessment performed: quantification of total environmental impact, even local criteria are included

ES

1: no attempts made to measure environmental impact or to close the loop

2: measuring the environmental impact in some way: measuring effluent streams of the factory site and setting thresholds for presence of toxic components; or applying guidelines/principles for good water treatment and the use of safe materials for the product (which will inherently result in a low impact on the environment).

3: the factory emissions are clean: effluent streams are as clean as the water that came in; air emissions need to be free from any chemicals or greenhouse gases; there are no waste streams any more

4: effecting a *positive* environmental impact; a beneficial process step or product characteristic is included. Certain measurements to support this positive impact have to be included. (e.g. the aquatic life in an effluent stream is more diverse because of biological nutrients in the effluent)

5: All the requirements for a 4 pt score, and in addition the label requires actively closing the product loop, either by:

- designing a product that is fully biodegradable and contributes to natural ecosystems after its useful life
- recollection of end-of-life-products and making them into new high quality resources (technical cycle). By doing this, measurements of environmental impact become no longer necessary, under the condition that clean energy is used and waste streams from production contain only safe substances.

IV. DIMENSION #4 GOOD RESOURCE USE (EFFICIENCY AND REUTILIZATION)

EY 1point: No standards included in the ecolabel criteria about efficient use of resources.
2: The ecolabel requires a company to supply data on resource volumes used and waste volumes, and requires gradual improvement in resource efficiency over time.
3: The ecolabel standards require that a product is designed in a way that uses resources efficiently.
4: Waste volume during production is less than 5% of the produced product volume (e.g. a waste water stream that is clean enough to use again is not considered waste, a polluted effluent stream is considered waste)
5: Being able to produce a product while creating no waste whatsoever in the process

ES 1: No design for reutilization required by ecolabel, will lead to typical 'cradle-to-grave' products; product is not biodegradable
2: Recollection/Recycling of resources at a lower quality level than during previous life cycle, with therefore limited life cycles possible; product is <50% biodegradable
3: Standards that oblige a manufacturer to be developing a plan for managing nutrient flows and a timeline including milestones for implementation; product is > 50% biodegradable
4: Actively implementing the nutrient management plan. Recollection of 75% of resources, at the same quality level as before production; product is more than 75% biodegradable
5: Actively closing the product loop. Recollection of >95% of resources, at the same quality level as before production; product is completely biodegradable (>90%)

V. DIMENSION #5 ENERGY USE (EY: MINIMIZING EXPENDITURE; ES: RENEWABLE ENERGY SOURCES USED)

N.B.: From an economic perspective, a company often will take initiative to use energy efficiently regardless of any ecolabel. For that reason, it is logical that most ecolabels will not address this issue and it is not useful to assess and score ecolabels on this attribute. A more useful aspect for an ecolabel to focus on is that the end products are efficient when it comes to energy consumption. The EY part of this dimension will therefore focus on the requirements for energy-efficient products. Products which do not consume energy (paints, furniture, etc.) will be given 3 points, as that is the benchmark score. The eco-effectiveness part of this dimension focuses on the use of renewable energy for the production process.

EY 1 point: No standards included in the ecolabel criteria about designing a product which requires less energy than competitors.
2: Standards in the ecolabel which specify a certain amount of energy that may be used by the product and which is >20% lower than similar conventional products.
3: Standards in the ecolabel which specify a certain amount of energy that may be used by the product and which is >50% lower than similar conventional products.
4: Standards in the ecolabel demanding that a product is in the top 20% segment of the market regarding energy efficiency
5: For standards requiring a product which is able to generate its own power supply in a clean way.

ES 1: No obligations in the ecolabel on the use of renewable energy

2: Using a minimum of 50% renewable energy for final product assembly

3: Using a minumum of 50% renewable energy, and obligations for the manufacturer to be developing a plan for 100% renewable energy use, including a timeline and measurable goals.

4**:** Using 100% renewable energy in manufacturing company but less than 100% renewable energy in the entire production chain.

5: Using 100% renewable energy in the entire production chain

3.2. SELECTION OF ECOLABELS

The next step is to select a number of ecolabels that can be compared against the Cradle to Cradle Certified Program. This selection was made making use of the Ecolabel Index, a database on ecolabels. This database currently recognizes 433 ecolabels around the world. Using this databases' search filter, the selection was narrowed down to ecolabels that were PRODUCT-related, which left 248 ecolabels. This was too big a selection to assess due to time constraints. Further narrowing down was done by deciding that only ecolabels active in **The Netherlands** would be assessed. Included in this selection of 38 ecolabels were still a few non-suitable ecolabels. Type III ecolabels were removed, as well as ecolabels focusing on fair trade, food or animal protection, because they are not suitable for measurement against the Scoring System. This left 27 ecolabels. However, some more adjustments in the selection were made. The Blaue Engel and EU ecolabel both provide product specific standards, so for both ecolabels two different product standards were assessed. The 'Naturally Sephora' ecolabel was given by the Ecolabel Index, but no standards could be found on the website. Also it seemed to be a type II ecolabel. A number of ecolabels were structured very similar, especially the Forest certification ecolabels and the Air Emission ecolabels. Because of time constraints and the lack of added value, the researcher decided to only assess one ecolabel out of the Forest Certification ecolabels and the Air Quality ecolabels. Furthermore, each tier of the Cradle to Cradle Certified Program has been rated separately. Table 1 below lists the 21 assessed ecolabels.

Table 1. Table 1 represents a list of the ecolabels that will be assessed using the Scoring System. The columns give (from left to right) the name of the ecolabel, the specific product to which the standards apply, the year of foundation and the version of the ecolabel standard that was assessed.

Name	Product category	Year founded	Version of ecolabel standard
AISE	Liquid Laundry Detergents	2005	Charter 2010 – ASP Substantiation Dossier: "Liquid Laundry Detergents (household)" Ver 1 October 2010
Blaue Engel	Office equipment with printing function	1978	Office Equipment with Printing Function (Printers, Copiers, Multifunction Devices) RAL-UZ 122
Blaue Engel	Low-Pollutant Paints and Varnishes	1978	Low-Pollutant Paints and Varnishes RAL-UZ 12a
Compostability mark of European bioplastics	Compostable products	2000	Certification Scheme Products made of compostable materials (April 2012)
Cradle to Cradle Certified Program	Not specified, any product	2005	Cradle to Cradle® Certification Program Version 2.1.1
Eco-Insitut	Painting and Coatings	2007	http://www.eco-institut.de/en/downloads/certification-eco-institut-label/
EU ecolabel	Community ecolabel for textile products	1992	document number C(2009) 4595
EU ecolabel	Light bulbs	1992	document C(2011) 3749
Flybe Aircraft	Flight emissions	unknow	http://www.flybe.com/corporate/sustainabi

Ecolabel		n	lity/eco_labelling_scheme.htm
(FSC) Forest Stewardship Council	Wood	1994	FSC-STD-01-001 (version 4-0) EN
Global Organic Textile Standard	Textile	2006	Global Organic Textile Standard (GOTS) *Version 3.0*
Greenguard Indoor Air Quality	Building materials, finishes, furnishes	2001	Greenguard Children & Schools Standard © 2010 GREENGUARD Environmental Institute
Milieukeur: the Dutch environmental quality label	Furniture	1992	Milieukeur meubelen (MK.33) 22 december 2010 – 22 december 2012 (MEU.11). link: http://www.smk.nl/nl/s434/SMK/Certificatieschema-s/Milieukeur/c375-K-t-m-O/p462-Meubelen--Milieukeur
Natrue-Label	Cosmetics	2007	NATRUE Label: requirements to be met by natural and organic cosmetics Version 2.5 – 12.06.2012
Natureplus	Construction Materials	2002	Natureplus e.V. Award Guideline RL0000 BASIC CRITERIA Issued: May 2011
RECS International Quality Standard	Electricity from renewable sources	2007	Source: the RECS ecolabel website, from: http://www.recs.org/content.php?IDPAGE=7 N.B: No official standard!
SMaRT Consensus Sustainable Product Standards	Undefined	2002	SMART BUILDING PRODUCT STANDARD© SCORECARD
TCO Certified	IT products: desktops	1992	TCO Certified Desktops 4.0 5 March 2012

3.3. DATA COLLECTION METHODS

During this desk research literature has been studied and a secondary research has been carried out. A list of references of articles and books can be found at the end of the report. A list of the ecolabel manuals that have been used is given in the previous section 3.2.

The following sources of information have been visited during the research:

- Scientific articles from journals
- Academic textbooks and journals
- The Ecolabel Index Database
- Official ecolabel standards
- The ISO 14020 standards series guiding manuals
- Websites

3.4. DATA ANALYSIS METHODS

The secondary research will be performed by going through the official standards of all ecolabels given in table 1. These standards give in most cases detailed requirements which a product has to fulfil to be awarded the particular ecolabel certification. The standards will thus be read and assessed by using the Scoring System that was developed during this research. More extensive standards will result in higher points for an ecolabel.

CHAPTER 4. RESULTS AND DISCUSSION

During the research, 21 official ecolabel standards were closely studied and assessed using the Scoring System explained in section 3.1. Amongst those 21 were the four tiers of the Cradle to Cradle Certified Program, which were derived from the same document. The maximum score an ecolabel could obtain was 25 points in either the EY or ES category, the lowest score was 5 points.

Each ecolabel that was selected for analysis is meant specifically for PRODUCTS, and has been issued to products in the Netherlands (the ecolabel is not necessarily from a Dutch auditing firm, it just has to be issued to Dutch products). This selection was made based on information gathered from the Ecolabel Index database. The Ecolabel Index found 38 ecolabels that complied with these conditions. From those 38, all type III ecolabels and food- and animal-related ecolabels were removed, since they are not compatible with the Scoring System. A number of other ecolabels was also eliminated for various reasons. DIN-Geprüft issued the same standard as 'The compostability mark for European Bioplastics'. Florimark is more of a quality insurance seal than an ecolabel. Naturally Sephora is given as an ecolabel by the Ecolabel Index but on its website there is no mention of any ecolabel standard. Naturtextil Best did not respond to an email request for its ecolabel standard, though it specifically stated that the standard could be obtained by requesting via email. Philips Green Logo is a type II ecolabel, because it accredits its own products. Some ecolabels are very similar in their structure and aim. For example Air Emission Ecolabels are all similar (Greenguard, Indoor Air Comfort, M1 emissions classification). The same goes for Forest Management ecolabels (FSC, PEFC, Rainforest Alliance, SFI). Bound by time constraints the decision was made to assess only one Air Emission ecolabel and one Forest Management ecolabel, being respectively Greenguard and FSC.

Table 2 represents the results of the quantitative analysis of the ecolabels using the Scoring System explained in section 3.1. It can be seen quickly that the C2C platinum tier scores the highest of all ecolabels on eco-effectiveness with 22 points, but that its EY score is just above average. The EU Ecolabel Light Sources and Natureplus (building products) score highest on EY, and while the EU Light Sources ecolabel is far below average on ES, Natureplus does pretty well on ES. Greenguard and RECS are by far the lowest on EY (<10), while quite a lot of ecolabels have a score below 10 on ES.

Table 2. Results of the ecolabel assessment against the Scoring System. EY is eco-efficiency, ES is eco-effectiveness. For each ecolabel the scores per dimension are presented, and the scores have been added up in the last column to give a total sore. At the bot tom the average and the minimum and maximum applied scores per dimension are given. These show possible abnormalities in the Scoring System for dimension 3EY and 4EY, as the maximum applied scores are respectively 4 and 3.

	Dimension #1		Dimension #2		Dimension #3		Dimension #4		Dimension #5			
	Material Safety		**Environmental standard**		**Impact measure-ment**		**Resource use**		**Energy use**		**Total**	
Label name	**EY**	**ES**	**EY**	**ES**	**EY**	**ES**	**EY**	**ES**	**EY**	**ES**	**EY**	**ES**
AISE Cleaning products	4	4	4	2	4	2	3	2	2	1	**17**	**11**
Blaue Engel Varnishes and Paint	4	4	2	1	2	2	2	1	2	1	**12**	**9**
Blaue Engel Office printing equipment	4	1	3	4	1	3	3	4	4	1	**15**	**13**
Compostability mark of european bioplastics	4	3	3	5	2	5	1	5	3	1	**13**	**19**
C2C Basic	3	2	2	1	3	1	1	2	3	1	**12**	**7**
C2C Silver	3	3	4	3	3	2	1	3	3	1	**14**	**12**
C2C Gold	4	4	4	3	3	3	1	3	3	3	**15**	**16**
C2C Platinum	4	4	4	5	3	5	1	4	3	4	**15**	**22**
Eco-institut	4	3	2	1	1	1	1	1	3	1	**11**	**7**
EU ecolabel Textile	3	2	3	2	1	2	2	1	3	1	**12**	**8**
EU ecolabel Light sources	5	2	5	1	1	2	3	2	5	1	**19**	**8**
Flybe Aircraft	1	1	2	1	1	2	3	1	4	1	**11**	**6**
FSC	3	4	4	5	2	5	3	5	3	1	**15**	**20**
GOTS	3	2	4	3	2	2	3	2	3	1	**15**	**10**
Milieukeur Furniture	5	3	3	2	1	1	3	1	3	1	**15**	**8**
Natureplus e.V.	5	4	4	4	4	2	3	4	3	1	**19**	**15**
Natrue label	4	5	3	2	1	4	3	4	3	1	**14**	**16**
GreenGuard Indoor Air Quality	3	1	1	1	1	2	1	1	3	1	**9**	**6**
RECS	1	3	2	3	1	3	1	3	1	5	**6**	**17**
SMaRT	3	3	4	4	4	3	3	4	3	2	**17**	**16**
TCO Certified	4	3	4	3	1	2	3	3	4	1	**16**	**12**
average	3.5	2.9	3.2	2.7	2.0	2.6	2.1	2.7	3.0	1.5	**13.9**	**12.3**
maximum	5	5	5	5	4	5	3	5	5	5	**19**	**22**
minimum	1	1	1	1	1	1	1	1	1	1	**6**	**6**

4.1.1 THE C2C TIERS

One of the research questions was "to what extent do the tiers of the Cradle to Cradle certified program follow the eco-effectiveness concept?" One thing that becomes evident is that there is a near-linear progression to be seen amongst the Cradle to Cradle tiers: $R^2 = 0,795$ (see figure 2). This was expected, because the tiers of the C2C Certified Program are meant to guide a manufacturer towards eco-effectiveness in several steps. The linearity between these tiers is proof that the Scoring System works well as an assessment tool, because the increasing demandingness of the C2C tiers results in a performance score per tier with a linear pattern in the Scoring System.

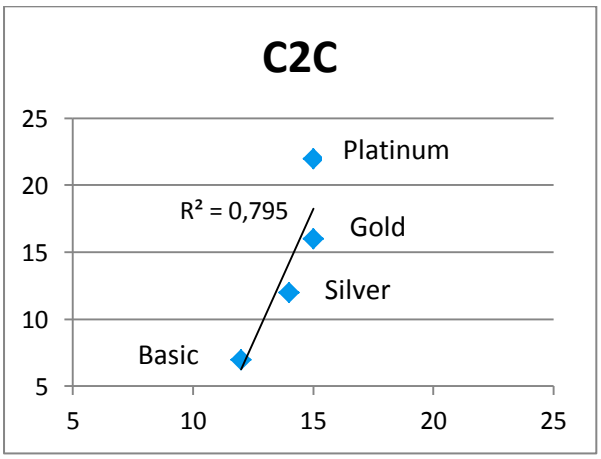

Figure 2 shows the four tiers of the Cradle to Cradle Certified program appropriate to their scores on EY and ES: Basic, Silver, Gold and Platinum. A certain linearity can be seen between the different tiers ($R^2 = 0,795$), which confirms that the Scoring System is working well as an assessment tool.

As becomes clear from table 2, the C2C platinum level indeed sets criteria that are very close to the maximum score for eco-effectiveness (22 out of 25). So let's see where it misses out on points. In Appendix I the reasoning and applied scores of each ecolabel can be found. Comments are made next to the scores that were given per dimension. This is where the C2C Platinum ecolabel misses out on points:

- The ecolabel requires only 50% green assessed components in the product composition; whereas the Scoring System requires 100% Green assessed components for 5pts.
- Ecolabel requiring a reutilization score of 80%, whereas the Scoring System requires 95% for 5pts.
- Ecolabel requiring 50% renewable energy use in the entire production chain, whereas the Scoring system requires 100% renewable energy use in the entire chain for 5pts.

These missed points are probably due to a sense of realism which moved the developers of the C2C Certified Program. True eco-effectiveness is both from a technical and an economic point of view hard to realize and currently the gap between ES and industry in practice is still very big.

The C2C gold tier receives 16 points on ES, which is still well above the average of 12.3. The Silver tier (12) and the Basic Tier (7) are below the average on eco-effectiveness of all assessed labels. This is a remarkable result because most of the other 'traditional' ecolabels were not developed from an eco-effectiveness strategy. The most probable explanation for this result is that the developers of the Cradle to Cradle Certified Program want to guide manufacturers step by step towards real Cradle to

Cradle (eco-effective) products, and they wanted to set a low entry level. However, these results make clear that any product which has been certified C2C Basic or Silver is still far from being Cradle to Cradle.

The distribution of the Cradle to Cradle tiers on eco-efficiency is very small though: ranging from 12 (Basic) to 15 points (Platinum). The scores are close to the overall average of 13.9 pts. The reason for the (big) gap with the maximum of 25 points is probably due to some room for improvement, but mainly to the fact that ES does not agree on certain things with EY. For example, 4 points are missed because an LCA is not considered as a useful tool by ES strategies. The C2C Program could improve on its EY score by paying more attention to efficiency issues in its standards, such as the requirement of 'creating no waste in the production process' (dimension 3) or showing that they want to achieve the best market performance. The low score for the C2C tiers on EY is expected, because efficiency principles are of a lesser priority than the ES principles for Braungart and McDonough (2007): "*The slimming down of material flows per product or service unit (eco-efficiency) is only beneficial in the long-term if the goal of closing material flows (eco-effectiveness) has first been achieved*".

4.1.2 TRADITIONAL ECOLABEL VS THE C2C CERTIFIED PROGRAM

The last sub-question was 'how do 'traditional ecolabels' perform in terms of eco-efficiency and eco-effectiveness compared to the C2C Certified Program?' Figure 3 gives a graphic image of the total scores per ecolabel on EY and ES. It can be seen that the distribution of ecolabels over the grid of figure 3 is much dispersed. Also, the Cradle to Cradle tiers are found amongst the traditional ecolabels, they are 'swamped in the crowd'. Of the four tiers, only the C2C platinum level stands out.

A lot of information can be gathered from figure 3. Certain notable patterns are seen in terms of correlation, the age of the labels, and a possible classification into four groups. These patterns will be described in several steps throughout this chapter.

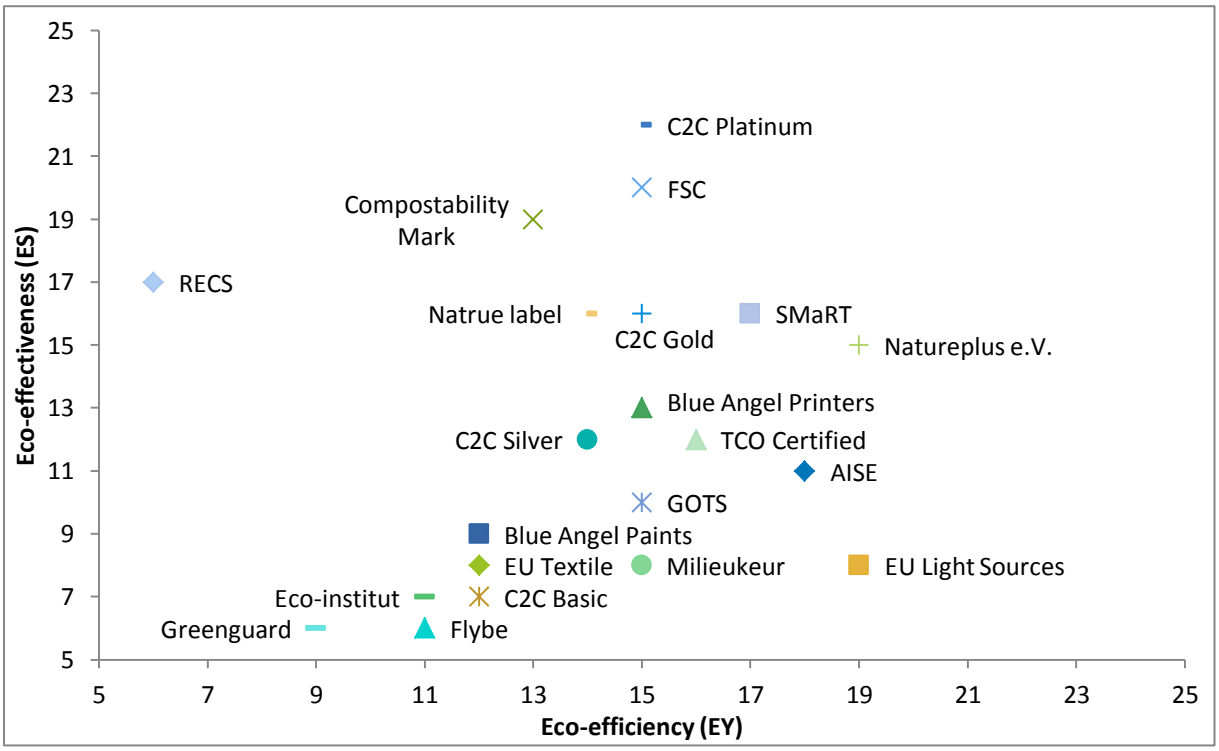

Figure 3 shows a plot of all assessed ecolabels. EY is given on the X-axis; ES is displayed on the Y-axis. The minimum possible score per category is 5 points, the maximum 25. The most interesting results are the wide dispersion of the 'traditional ecolabels' and the interflow of the C2C tiers among the traditional labels.

Figure 3 shows big differences in performance between ecolabels, so some statistical calculations were applied to gain a better insight. Table 3 shows the statistical values for the traditional ecolabels. The scores of the C2C tiers are not included in this calculation. With a mean of 13.94 ± 0.86 for EY and a mean of 11.82 ± 1.12 for ES, the results show that the traditional ecolabels score slightly higher for EY than for ES. This supports the expectation that traditional ecolabels show EY-strategy characteristics. However, the difference is not very big. Furthermore the standard deviation is rather large, which means there is a lot of variation. This variation is also visible in figure 3.

Table 3. Statistical values for the 'traditional ecolabels'. The difference between the mean for EY and ES is pretty small, and the standard deviations of both EY and ES are rather big. These data make clear that there is no real pattern indicating that traditional ecolabels are clearly eco-efficient and that they do not include eco-effectiveness principles.

	N	Mean	Std. Deviation	Std. Error Mean
EY	17	13.94	3.526	.855
ES	17	11.82	4.599	1.116

Figure 3 shows a sort of pattern from the left bottom towards the right top end. This may indicate a correlation between EY and ES strategy. Clear outliers are the RECS ecolabel, The Compostability Mark for European Bioplastics and the EU Ecolabel for Light Sources. RECS was a disputable ecolabel since it represents renewable energy, which is more of a resource than a product and therefore hard to rate. European Bioplastics is scoring very well on ES, and not so much on EY. This is expected, since biodegradable plastics show close adherence to the principles of ES, so a mistake is unlikely. The EU ecolabel on Light Sources scores very well on EY and well below average on ES. This outlier was also expected, it is an ecolabel that does not take in mind a lot of the principles of the ES strategy. However, when these outliers are taken out of the data, a correlation can be seen between a high EY and a high ES score: R^2=0.4315 (see figure 4). This means that either the design of the Scoring System causes this correlation, or it means that any ecolabel that aims for higher quality standards will automatically incorporate a lot of EY ánd ES principles. In fact, these two explanations are most probably complementary. Indeed, an ecolabel that aims for higher standards often incorporates

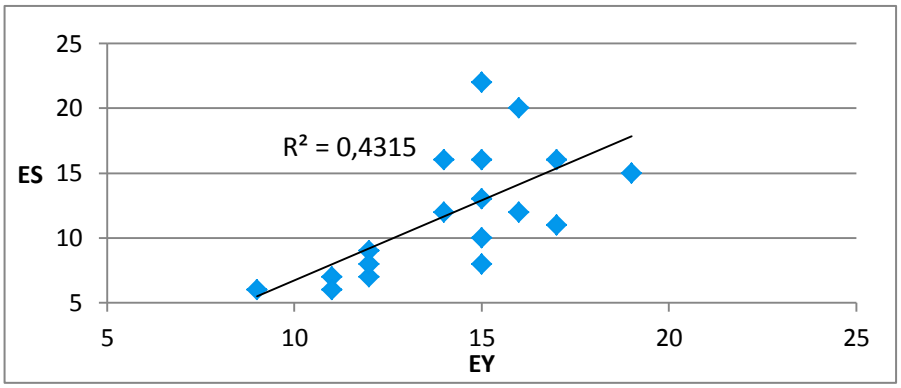

Figure 4. A certain correlation can be seen between the EY and ES values of the ecolabels: R^2=0.4315. This correlation could indicate that in general ecolabels that set more demanding environmental requirements will use both EY and ES principles to set their criteria.

recycling as a requirement, and demands better material safety. Recycling is a strategy that is part of the EY principles, but was strictly put under ES strategy in this Scoring System (see section 3.1.IV.). Furthermore, material safety standards are part of both EY and ES strategy, and high standards on material safety will thus result in more points both for EY and ES. So the conclusion here is that any ecolabel that has good EY characteristics will have gained some points for ES too and therefore will score better on both EY and ES than an ecolabel with more simple standards. So the visible correlation can be explained by an overlap in EY and ES principles, which is also represented in the Scoring System.

4.2. INTERPRETATION OF RESULTS

The age of the ecolabels may be a factor in their distribution over an EY-ES plot. The expectation is that 'traditional', i.e. 'older' ecolabels are based on more old-fashioned thinking, and therefore have less ES principles in their standards, which will result in a lower ES score. Figure 5 depicts a plot of the ecolabels, this time with their associated year of foundation. A dashed line is drawn at 15 points, which is the median between the maximal and minimal possible ES score. From figure 5 it can be seen that 1 out of 8 ecolabels above the line is from before 2000, and 6 out of 12 ecolabels from below the line was founded before the year 2000. That is 12.5% and 50% respectively above and below the line, which is a significant difference. This result confirms the expectation that older ecolabels are less adapted to the newer ES strategy. It should be noted here that all versions of the ecolabel standards that were assessed were very recent, mostly from 2010 or even more recent (see table 1 in section 3.2). So even though older ecolabels keep adjusting their standards, they seem to be stuck in the same old ways of thinking.

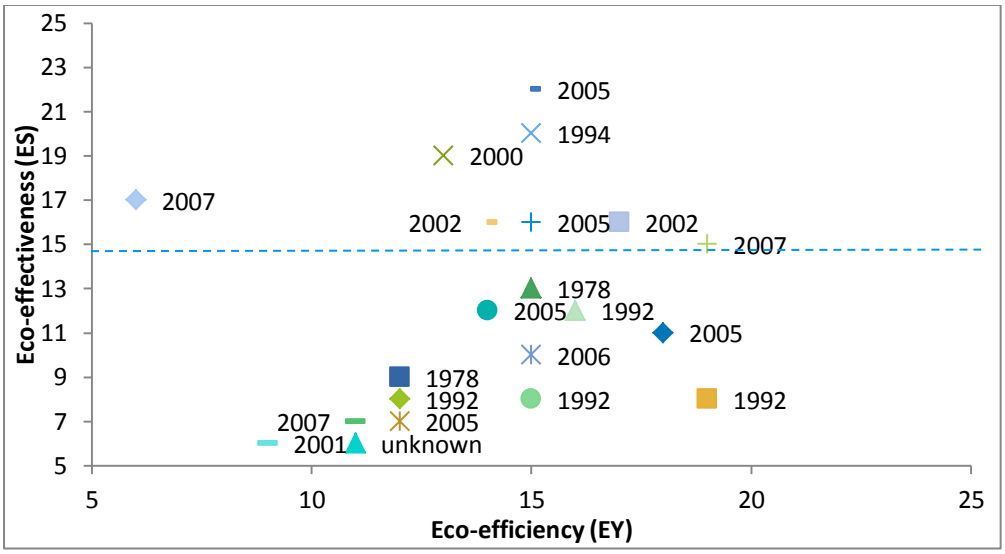

Figure 5. The year of foundation of each ecolabel is given (Source: Ecolabel Index). The name of the ecolabels is not significant for this pattern. When a line is drawn at 15 points for ES (halfway between 5 and 25), in the top half 1 out of 8 labels is from before 2000, in the lower half 6 out of 12 ecolabels was founded before 2000.

The result of figure 5 shows that there are certain 'progressive ecolabels' and certain 'orthodox ecolabels'. That is to say, if one agrees to consider ES strategy as a new environmental streaming and EY as an established one. However, when this distinction is made, one can still observe a large variation in the scores for EY. Above the line, a variance from 6 points for EY (RECS ecolabel) up to 19 points (Natureplus e.V.) is seen. Below the line this variance is 9 points (Greenguard) until 19 points (EU Light Sources). This means that even within the 'old ways of thinking', the EY principles, some ecolabel standards follow these EY principles very closely, whereas other ecolabels present very one-sided standards. This corresponds with the observation made by Van Amstel (2008), that some ecolabels only offer one-sided environmental protection. If again a line is drawn at the 15points point, this time a vertical line dividing the ecolabels on EY performance, 4 sections are created. Figure 6 depicts this overview of ecolabels and the division in 4 sections.

Each of these categories represents certain characteristics of an ecolabel. The left bottom group in figure 6 performs relatively low on eco-effectiveness and eco-efficiency. This means that the ecolabels in this group will represent products that may have some environment protecting characteristics, but they are rather one-sided in their efforts. This group includes ecolabels like Greenguard, Eco-Institut and Flybe. These three all clearly offer one-sided protection, as Greenguard and Eco-Institut focus solely on material safety and surpass everything else, and Flybe pays only attention to carbon emissions. Two other ecolabels that are in there are the EU ecolabel for textiles and the Blue Angel ecolabel on Paints and Varnishes. These both set a lot of material safety standards, but do not pay any attention to the end-of-life of their products, and also surpass aspects as environmental impact and resource efficiency. Strikingly, the Cradle to Cradle Basic and Silver tier also fall into this group. Apparently, the standards for these tiers are set such that encompassing environmental protection is not achieved. Indeed, when looking at the outcomes in Appendix I, C2C Basic and Silver do not set very strict product safety requirements and do not require aspects as a product take-back system, renewable energy use or resource efficiency. This group of environmental labels will be referred to as 'one-sided', since they offer one-sided environmental protection.

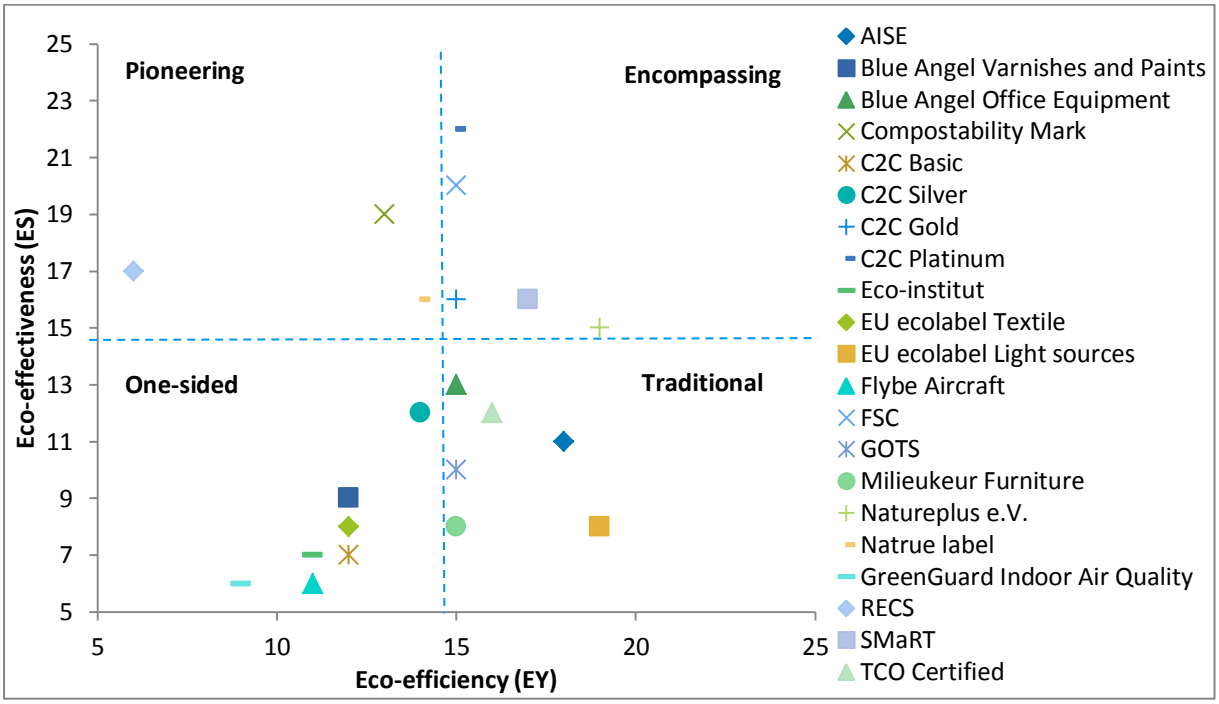

Figure 6. Classification of the ecolabels into 4 categories. The separation is made on the median between the minimum and maximum possible score. A 15 point score is placed just above the separation line. The four groups are named One-sided, Traditional, Encompassing and Pioneering.

The bottom right group in figure 6 contains ecolabels that score relatively high on EY and relatively low on ES. This group contains ecolabels that in general set a lot of requirements on material safety, resource efficiency, that often do measure the environmental impact of products with LCA's or other tests. They are ecolabels that have translated the EY principles well into their standards, but they lack any of the requirements that are necessary to achieve ES: no take-back system or recycling plan, no use of renewable energy, and no closed loop. These ecolabels are typical 'traditional' ecolabels that result in cradle-to-grave product flows, with a bit less environmental damage than conventional products. Mileukeur Furniture, EU Light Sources, GOTS Textile and AISE Cleaning Products are in this group, for the reasons just mentioned. Blue Angel Office Equipment (Printers) and TCO (Desktops)

are surprising ecolabels in this group. They both do contain standards on a take-back system for end-of-life products. Both of them lose points on low material safety requirements and on the fact that they require a take-back system which is meant in the first place for safe disposal or downcycling and not for material reutilization at the same quality level (see table 2 showing the scores and Appendix I).

The top right group contains ecolabels that perform relatively high on both EY and ES. This group contains labels that set challenging environment-protecting requirements for a product. To end up in this group an ecolabel standard has to set challenging requirements on all aspects of environmental protection, it has to be 'encompassing'. This includes strict material safety requirements, requirements for a closed product life cycle, resource efficiency, environmental impact measurement, energy use and in the best case scenario the product has an actual *beneficial* impact on the environment. This group contains the C2C Platinum and Gold tiers, FSC (Forest stewardship), SMaRT and Natureplus e.V. (building products). The FSC label has a slight advantage that it licenses a very environmental friendly product. It gains a lot of points for wood being a biological nutrient and the beneficial impact it has on ecology through good forest management. The C2C Gold and Platinum tiers are expected to be in this group as they are supposed to represent the ES strategy. The SMaRT label was an interesting surprise during this research. It is a very encompassing type of ecolabel that works via a score system. Points can be earned for all kinds of environmental achievements accomplished by a manufacturer. Some are compulsory requirements, most are voluntary. The SMaRT label has several tiers, of which the highest can be earned by achieving 90 out of the max of 157 points. The label has been rated in this research based on a 90 point score. The SMaRT ecolabel includes every aspects of environmental protection as put forward in Braungart and McDonoughs ES strategy. It was founded in 2002, three years before the C2C Certified Program. The Natureplus e.V. label scores very well on EY, and with 15 points for ES it only just makes it into this top right group. It does contain nearly every aspect of the ES strategy, except for the requirement of renewable energy use. Natureplus does very well on its EY score because it contains an LCA assessment and high material safety requirements.

The top left group in figure 6 contains a group of labels which score relatively high on ES and low on EY. These ecolabels find themselves in a rather unconventional field. EY is seen as an economically viable way of environmental protection (DeSimone, 2000). ES is relatively very new and presents challenging problems for those manufacturers trying to achieve an eco-effective product. For that reason, the combination of EY and ES seems challenging yet appealing but ecolabels that solely focus on ES principles must be aiming for pioneering products. In this top left group the Compostability Mark for European Bioplastics is found, along with RECS and Natrue. These ecolabels indeed all aim for certain pioneering products, respectively Biodegradable plastics, renewable energy and environment friendly cosmetics. The Natrue ecolabel is very close to the separating line and could easily be in the top right group when a little bit of attention would be paid to e.g. social responsibility, environmental impact measurement or energy efficiency. Of the three 'pioneering' labels, this is the least extreme one. The biodegradable plastics ecolabel is expected in this group. Biodegradable plastic is a product in its development stage and the production costs are still relatively high, but it would be a real ES product when used on large scale. RECS (renewable energy) was hard to rate against the Scoring System since it is more a resource than a product. However, its position on the plot in figure 5 in the 'pioneering group' is exactly where it would be expected.

4.3. DISCUSSION ON THE SCORING SYSTEM

The Scoring System that was developed for this research was somewhat based on an ecolabel assessment by Truffer *et al.* (2001), but it was mostly developed from combined theory. Although a few ecolabels were tested during its development to take out big mistakes, this group of 21 assessments was the first time a complete assessment has been performed using this Scoring System. This Scoring System can thus be considered completely new and its quality had to become apparent from the results that are gathered from this first assessment. Based on the results, the judgment of the Scoring System ought to be very positive. To support this statement a few observed results stand out: the categorization in four groups of ecolabels is very consistent. Each group contains ecolabels that were expected in that group. Furthermore a convincing linearity is seen for the Cradle to Cradle tiers, which is expected because the compliance difficulty should increase which each tier. The ecolabels in general show a correlation from the left bottom corner to the top right corner of the plot. This correlation is expected because a certain overlap between EY and ES principles exists. If the Scoring System shows the same pattern that is a confirmation of its quality.

So these overall results give a positive image. Some flaws can be detected though when looking at the individual scores per dimension (see table 2): for dimension 3 EY and dimension 4 EY the maximum score of 5 points has not been applied once. For dimension 4 EY even the 4pt score has not been applied. Also, the 2pt score of Dimension 1 EY has never been applied. Apparently the Scoring System sets certain expectations that ecolabels do not live up to. These Scoring System requirements were either so demanding or so detailed that none of the assessed ecolabels contained these criteria in their standards. So, 4 specific requirements of the System out of a total of 50 never corresponded to the requirements set in the standards of the 21 assessed ecolabels. This means that some revising of these dimensions may be required in case of further use of the Scoring System.

Some more details in table 2 require attention: the average score of 3,5 for Dimension 1 EY is rather high. This is probably due to the 'behaviour' of type I ecolabels: nearly every ecolabel pays attention to the product composition and the use of safe materials. Exceptions are the Flybe Aircraft ecolabel and RECS. It is perhaps a shortcoming of the Scoring System that it does not distinguish material safety requirements in more detail, because certain small differences between ecolabels are not included in the rating. The average score of 1,5 for the use of renewable energy (dimension 5 ES) is very low, but again it is probably not a flaw in the Scoring system: it shows that many ecolabels are not keen to make the use of renewable energy compulsory. In this assessment, only 4 out of 21 ecolabels requires the use of renewable energy. Furthermore only 6 ecolabels write specifications about the efficient use of energy for a product (dim 5ES) and only half of the labels (11 out of 21) require efficient use of resources (dim 4EY). Probably efficiency requirements are often surpassed in ecolabel standards because a manufacturer will be efficient anyways for economic reasons.

Concluding, the Scoring System seems to be working well because results correspond to expectations and observed patterns could be easily explained. However, some revising of specific requirements is necessary in case of further use of this assessment tool, and a more detailed evaluation of material safety requirements would be an asset.

4.4. DISCUSSION OF THE HYPOTHESES

In this section, the hypotheses of the research will be discussed.

The overall objective of this study was to determine whether the Cradle to Cradle Certification Program is addressing the eco-effectiveness concept more than traditional eco-labels.

Furthermore, in the problem statement three hypotheses were formulated:

1. The Cradle to Cradle Certified Program succeeds in accomplishing true eco-effective products. **Problem: hundreds of other ecolabels contribute only to a very limited extent to the environment.**
2. Eco-effectiveness remains a theoretical concept for now, because the standards of the Cradle to Cradle Certified Program do not actually result in eco-effective products. **Problem: The eco-effectiveness principles have not been translated properly into ecolabel standards.**
3. The Cradle to Cradle Certified program does result in eco-effective products, but during this research it becomes clear that other ecolabels result in the same high quality products. **Problem: The Cradle to Cradle 'hype' revolves around ideas that are not nearly as unique as they seem, because there are other equivalent ecolabels. Cradle to Cradle is merely clever marketing.**

Based on the results found during this research, it is wrong to state that Cradle to Cradle represents ES, and all other ecolabels represent EY. In the first place, the C2C Basic, Silver and Gold tier of Cradle to Cradle do not supersede many other ecolabels in terms of eco-effectiveness. Only the C2C Platinum tier does supersede the other ecolabels in eco-effectiveness. But we have seen that the ecolabels can be divided into several groups based on distinctive characteristics. This division presents evidence that there are more ecolabels which display ES characteristics, some of which are better than the C2C Basic, Silver and Gold tiers. But let's discuss in more detail what the score of the C2C Platinum tier means. It remains an issue for debate whether the C2C Platinum tier truly represents eco-effectiveness, because it does not reach the maximum score of 25 points. With 22 points it is very close though and it achieves a higher score than any other ecolabel that was assessed. In section 4.1.1. the missing requirements of the C2C Platinum tier for a maximum score were already mentioned. These shortcomings were most probably based on a choice of the developers of the label to make compliance to the standards more feasible. Because the theory on eco-effectiveness clearly explains its ultimate goals: safe products, in closed loop material cycles, powered with renewable energy. Since this goal is still far from the current (industrial) situation, the developers are expected to have made the standards are little less challenging.

However, what's more important, is that *until now no product applying for the Cradle to Cradle Certified Program has been awarded higher than C2C Gold* (MBDC*, 2012). So while we may consider the C2C Platinum tier as very close to true eco-effectiveness, the ecolabel standards have until now not led to true eco-effective products, because manufacturers have not achieved to fulfil the requirements yet. Probably manufacturers are reluctant due to doubtful financial prospects and technical challenges. This is an alarming conclusion, because it means that actual eco-effective products for now remain an unfulfilled goal.

Let's add to the previous paragraph that being in the 'encompassing group' does not mean an ecolabel is really eco-effective. The gap between 15 and 25 points is in terms of requirements still rather big. To illustrate, the SMaRT ecolabel grants Platinum certification to a product which has 90 points out of 157 according to their scorecard system. For 90 points, a product would have to achieve a material reutilization score of about 60%. This is not real eco-effectiveness, while the ecolabel does end up in the 'encompassing' group. So when does an ecolabel become truly eco-effective? The answer is: at 25 points. But since technical possibilities are limited and economic interests cannot be overlooked, a 25 point ES score is not realistic. The question we should be asking is: 'when are we satisfied?' This is not for me alone to answer, though I think that a 20 point score is – with our current technical capabilities – a good result. What about the EY score? As Braungart and McDonough (2007) stated "*The slimming down of material flows per product or service unit (eco-efficiency) is only beneficial in the long-term if the goal of closing material flows (eco-effectiveness) has first been achieved"*. This means that EY is of lower priority than ES. So when are we satisfied? My answer would be: an ecolabel that achieves an EY score of ≥15pts and an ES score of ≥20points on the Scoring System in this research.

In that case, an extra division would be required in the top right group, with a horizontal line at 20 points. The C2C Platinum tier and FSC label would end up above the line, while the SmaRT ecolabel, the C2C Gold tier and the Natureplus ecolabel would end below this line. These two groups could be addressed as the 'encompassing' group (below the line) and 'toplabel' group (above the line). Actually the ecolabels in the 'toplabel' group are disputable: the C2C Platinum label has never been awarded, and the FSC label certifies wood, which is not a human-made product. It is striking that the FSC label ends up as a 'toplabel', because trees are the main source of inspiration for Braungart and McDonoughs ideas of eco-effective design.

Let's discuss the hypotheses. Hypothesis number 1 is **not true.** The Cradle to Cradle ecolabel does not succeed, because its Basic and Silver tier standards are clearly insufficient, the Gold standard is 'encompassing, but not 'toplabel'. And the C2C Platinum tier has not yet been awarded to any product. Furthermore many other ecolabels perform similar or better than the C2C tiers, as could be seen in figure 6.

Hypothesis number 2 is **partly true**. The potential problem that was described is not true, because the requirements set for the C2C Platinum tier are very near to a truly eco-effective product. So one can conclude that the ES principles have been properly translated into ecolabel standards. However, true eco-effectiveness does remain a theoretical concept for now, because realization of a product that complies to the C2C Platinum tier has not yet been achieved. Furthermore the lower tiers of the C2C Certified Program do not represent true eco-effectiveness, so for these tiers hypothesis 2 is true.

Hypothesis number 3 is **for the most part true**. The C2C Platinum tier does stand out from the other ecolabels regarding its standards. But it does not seem fair to conclude from this result that Cradle to Cradle is better than other ecolabels when the C2C Platinum tier has (until now) never been awarded. The Gold tier achieves a pretty good result, but there are ecolabels that perform similarly: the ecolabels in the 'encompassing' group. Furthermore, according to the results, the C2C Basic and Silver tiers perform rather poorly and even end up in the 'one-sided' group. The researcher expects that many consumers of C2C products and customers of C2C Certified manufacturers are not aware that the Basic and Silver tiers are so far removed from eco-effectiveness. Van Amstel (2008) and

Lavallée (2004) wrote already of non-transparency regarding ecolabels and consumer perception. The average consumer is not going to search for the standards of an ecolabel but forms an opinion based on media and information that spontaneously reaches him. In case of the Cradle to Cradle Certified program I believe that some misinformation also occurs. People that know what Cradle to Cradle is are often inspired by the ideas of eco-effectiveness it represents. A Cradle to Cradle Certified logo on a product will thus appeal to a lot of people. However, as this research has shown, the Basic and Silver logo actually provide a rather one-sided environmental protection. In my opinion, companies that are C2C Basic or Silver Certified profit from the inspiring message and the hype around Cradle to Cradle but the actual environmental conservation they achieve is marginal. So hypothesis 3 is not true, but the problem described under hypothesis 3 comes out nonetheless: the eco-effectiveness principles developed by Braungart and McDonough are properly translated into ecolabel standards (being the Cradle to Cradle Certified Program. However, actual eco-effectiveness is not reached because most manufacturers are satisfied with Basic, Silver or Gold Certification, which is less difficult to achieve than the Platinum standards but is still sold as a Cradle to Cradle product. So the Cradle to Cradle certifiers earn money with the illusion of eco-effectiveness, while the certifications that are granted (Basic, Silver, Gold) offer similar or lower environmental protection than many other ecolabels.

I think that this criticism needs to be softened though. The ultimate goal of Cradle to Cradle has to be praised from whatever way you look at it. Many people support the thoughts of C2C and are making efforts to reach the goal. However, this is a difficult and costly process and it will take time before an eco-effective society would be possible. The biggest difficulty of achieving Platinum Certification is that a company will have to move its suppliers all along the chain as well to become Cradle to Cradle, as one of the requirements is that at least 50% renewable energy is used to manufacture the entire product. So the C2C Platinum tier cannot be achieved by a single company, and a lobby throughout an entire supply chain is required to achieve a real eco-effective product. In any pioneering situation it is difficult to move that many people. The conclusion here is that Cradle to Cradle is a difficult but admirable goal which will require a lot of time and effort, and in the meantime the Certifiers and manufacturers are earning money by misleading consumers by showing the Cradle to Cradle logo while setting very average environmental standards.

With this discussion of the hypotheses the main research question has also been answered. The Cradle to Cradle Platinum tier does answer the eco-effectiveness principles best of the assessed ecolabels. However, it has until now never been awarded to any product, and since the C2C Gold tier does not perform good enough to be called eco-effective, in practice the Cradle to Cradle Certification program does not result in eco-effective products. In addition, the C2C Basic and Silver tier performed disappointingly in the Scoring System and can be classified as ecolabels that offer one-sided environmental protection. Because there are a few ecolabels that perform similarly to the C2C Gold ecolabel – classified as 'encompassing' – the answer to the main research question is: **no, the Cradle to Cradle certified program does not address the eco-effectiveness principles more than traditional ecolabels.** With the notification that the word 'traditional' is not correct, since the ecolabel assessment showed that ecolabels display very diverse behaviour.

CHAPTER 5. CONCLUSION AND RECOMMENDATIONS

5.1. CONCLUSION

This research focused on getting a clearer view on the environmental protection that ecolabels offer. A central role in this research was given to the Cradle to Cradle Certified Program and the eco-effectiveness strategy that was first introduced by the developers of the Cradle to Cradle ideas. The principles of eco-effectiveness were compared to the more established eco-efficiency strategy, which is used as a strategy for sustainable development since 1992. The overall objective of this study was to determine whether the Cradle to Cradle Certification Program is addressing the eco-effectiveness concept more than traditional eco-labels.

During this research, an assessment tool was developed, which can be used to assess ecolabel standards on their overall environmental performance. A clear separation is made between eco-effectiveness and eco-efficiency in this assessment tool. The results of the assessment support that this Scoring System is working since little unexpected results were found in the ecolabel distribution. The linearity of the Cradle to Cradle ecolabel tiers is proof of the aptness of the Scoring System. Some minor flaws were detected, but with some revision the Scoring System could be a useful tool for other ecolabel assessments.

The way EY and ES strategies relate to each other has been discussed. The conclusion drawn in this research is that they can be complementary; with the addition that closing material flows (ES) is of priority, but efficient use of resources (EY) is a necessary addition to prevent too high logistics costs and to extend the moment where limited available resources reach this limit.

The age of ecolabels seems to be correlated to the extent of eco-effectiveness in the ecolabel standards. The older an ecolabel, the lower it scored on ES. It is a remarkable result that these ecolabels did not evolve over the years while a lot of younger ecolabels seem to have better incorporated modern insights in their standards.

The assessed ecolabels have been categorized in 4 classes according to their affinity with eco-efficiency and eco-effectiveness. These four classes were ‘encompassing’ (high EY, high ES), ‘pioneering’ (low EY, high ES), ‘traditional’ (high EY, low ES) and ‘one-sided’ (low EY, low ES). This classification makes it able to see at one glance which ecolabels offer good environmental protection and which do not. The ecolabel in the group addressed as encompassing all still have room for improvement, therefore a second division was made at an ES score of 20 points into ‘encompassing’ ecolabels and ‘toplabels’.

The Cradle to Cradle tiers Basic and Silver ended up in the ‘one-sided’ class, which is a striking result. The Gold tier has been classified as encompassing, which makes it one of the better ecolabels but it is not good enough to be called eco-effective. The Platinum tier scores 22 out of the maximum of 25 points and is therefore the closest to real eco-effectiveness of all assessed labels. Eco-effectiveness seems not to be possible yet in practice because this Platinum tier has never been awarded to any product until today. For that reason it can also be concluded that the Cradle to Cradle Certified Program does not succeed in realizing eco-effective products. A risk of the Cradle to Cradle Certified Program may be that consumers are misled by the Cradle to Cradle logo on a product that is certified

Basic or Silver and offers one-sided environmental protection. This product is slightly environmentally better than a non-certified similar product, but it does not represent the high standard it implies.

5.2. RECOMMENDATIONS

The outcome of this research could be of value to ecolabel certifiers to learn what they might be missing in their standards, in particular the Cradle to Cradle Certified Program certifiers. This research contributes to known literature on ecolabels and to the theory of eco-effectiveness. For further research, it is my recommendation that the information gathered in this research is linked to other success factors of ecolabels. A good ecolabel needs to have high quality standards, compliance of licensed manufacturers and a good consumer perception. Other researchers have already disclosed that compliance can be a problem (Van Amstel, 2008) and that ecolabels are often licensed through a non-transparent process which makes consumer trust unpredictable (Lavallée, 2004). This research has identified that a lot of allegedly encompassing ecolabels (type I labels) are not always that encompassing. In conclusion, ecolabels are not a perfect tool to achieve sustainable development, but with some work they can become very effective. However, the influence of ecolabels all depends on how much attention consumers pay to them. So in my opinion, the highest priority for further research on this field is to find out how big the competitive advantage – or say, influence – of a label on a product is. Based on the outcome of that research, it can be decided whether further efforts to improve ecolabels are worthwhile.

The mission of the Cradle to Cradle community to redesign the way we make things and change our society to an eco-effective one is a goal this researcher supports. Whether a C2C ecolabel is the way to do it is doubtful though, because it does not reach the pursued goal as this research has pointed out. However, companies that pursue Cradle to Cradle design should be motivated with certain incentives, and competitive advantage via an ecolabel is a proper incentive. This research cannot answer whether manufacturers are satisfied when they reach a C2C Silver status or whether they continue pursuing compliance to a Gold or Platinum tier. Due time, technological advancements will make a Cradle to Cradle based society possible. To do so, people will have to be motivated to make that radical change. My recommendation is that researchers will think about the best methods to get all stakeholders in a certain material cycle in touch and motivated to implement Cradle to Cradle in their branch. Eco-effectiveness will never be achieved by individuals, but can only be achieved when interdependent links in a chain/cycle team up.

CHAPTER 6. REFERENCES

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CHAPTER 7. APPENDIX I

In this appendix, a reasoning has been given for each applied score, to justify the scores as they have been applied. This link goes directly to the ecolabel Index website with the selection of ecolabels as used in the research. Ecolabel Index link:
http://www.ecolabelindex.com/ecolabels/?st=country=nl;subject=products

Name: ***AISE Cleaning Products***
Product: **Liquid Laundry Detergents**
Source: http://www.sustainable-cleaning.com/en.companyarea_documentation.orb

Dim 1 ***EY: 4pts.*** *A calculation tool is provided to carry out an Environmental Safety Check. This tool includes many components commonly used in washing detergents. For the components a threshold level is given which should assure that concentrations in waste streams are below water toxicity level.*
ES: 4pts. *The tool as just describes rates materials as green, orange or red, depending on their concentration. Red-rated components are not allowed.*

Dim 2 ***EY: 4pts.***
Material safety: *Environmental safety check*
Resource use: *reduction of resources to manufatcure product is an aim*
Energy use: *providing consumers advice about sustainable use (LCA assessment performed which indicates that consumer use provides largest burden)*
Water treatment: *Water streams contain waste after washing, standards are included to minimize the pollution of these streams.*
Social responsibility: *Attempt to support the environment by providing information about sustainable wash methods to consumers*
ES: 2pts. *Recycling of 60% of packaging is required. The water waste streams cannot be recovered. The ecolabel requires that the components in these streams are safe when they end up in open water.*

Dim 3 ***EY: 4pts.*** *The ecolabel criteria are based on a life cycle assessment concerning the environmental impact of laundry detergents.*
ES: 2pts. *The label is focusing requirements on good water treatment by minimizing the concentration of harmful substances. It does not aim for clean emissions or beneficial output.*

Dim 4 ***EY: 3pts.*** *From the ecolabel standards: "The second most important factor to reduce environmental impact is through the reduction in resources used to manufacture the product."*
ES: 2pts. *Resources in water streams are not recoverable, and packaging has to be recovered for at least 60%. According to the life cycle assessment, packaging disposal contributes ~50% to solid waste, and 60% of 50% = 30% of total solid waste which is recycled. This is still a significant loss of resources, but it is better than no recycling at all.*

Dim 5 ***EY: 2pts.*** *The ecolabel indicates that most of the energy use is caused during consumer use. So improvement can be gained by better informing consumers: making sure they wash full loads at <30C. No quantitative predictions about energy efficiency improvements are given, it is assumed that this is >20% (than the current expenditure).*

ES: 1pt. *No obligations in the ecolabel about renewable energy.*

Name: Blaue Engel Office equipment with printing function
Product: printers, copiers, Multifunction Devices
Version: Office Equipment with Printing Function (Printers, Copiers, Multifunction Devices) RAL-UZ 122

Dim 1 ***EY: 4pts.*** *Detailed description of compounds that are not allowed for use. However, certain exceptions are allowed in case of technological necessity, so a product can still contain doubtful substances. Less than 10 risk phrases used.*

ES: 1pt. *A number of substances are forbidden in the product, but for plastic parts weighing under 25 grams the material requirements are less strict. It is not stated in the ecolabel that all materials need to be known down to certain level.*

Dim 2 ***EY: 3pts.*** *There is no relative market performance specified, and the label does not mention social responsibility or water treatment*

ES: 4pts. *The label states as a requirement that the product is designed for recyclability and that the manufacturer makes use of a takeback system to retrieve products.*

Dim 3 ***EY: 1pt.*** *The ecolabel only requires measurement of VOC emissions.*

ES: 3pts. *The environmental objective of the ecolabel is "avoidance of pollutants, emissions and waste, the lowest possible energy consumption of electronic devices during use as well as utilization and recycling of used products". The ecolabel specifications are such that the amounts of materials that come into contact with the environment are minimal, which is regarded as equal to clean emissions.*

Dim 4 ***EY: 3pts.*** *The ecolabel requires that the printer can print double-sided. This is a way to use printing paper efficiently.*

ES: 4pts. *An active takeback system is required of the manufacturer. However, the percentage of recyclable content is not specified in the ecolabel. >75% is assumed in this case.*

Dim 5 ***EY: 4pts.*** *The ecolabel standards give great detail about limits for power consumption of printers in and that they should vary according to the activity level of the printer (ready, stand-by, sleep-mode). No relative market performance is required of the product, but it can be assumed that printers built according to these standards are highly energy-efficient.*

ES: 1pt. *No requirements regarding the use of renewable energy.*

Name: Der Blaue Engel
Product: Paints and Varnishes
Version: Low-Pollutant Paints and Varnishes RAL-UZ 12a

This ecolabel gives very detailed instructions on which substances are and are not allowed in paints and varnishes. It is the ecolabel that is licensed to most applicants by Der Blaue Engel (1091 licenced products). In 1980, it was the first ecolabel for a complex chemical product. The Award Criteria apply to paints and varnishes and comparable coating materials with paint properties for interior and exterior use as house paints as well as for industrial coating. The criteria characterizing the paint properties are: formulation, processing properties and imperviousness of a thoroughly dry paint surface.

Dim 1 ***EY: 4pts.*** *Very detailed instructions and thresholds for (un)suitable substances. However, exceptions for the use of hazardous substances are mentioned too, in terms of allowance of impurities, and for hazardous substances that emit no VOC's. Furthermore, less than 10 risk phrases are mentioned. Therefore, 4 points and not 5.*
ES: 4pts. *The system of 'red', 'yellow' and 'green' substances is a Cradle to Cradle term used in the eco-effectiveness teaching, which is not applied by most other ecolabels. However, the ecolabel prohibits the use of many explicitly named substances which are indicated as toxic, very toxic, carcinogenic, muta-, teratogenic or reprotoxic. Therefore it is assumed that this policy of material use is as strict as the use of only 'green' and 'yellow' materials and prohibition of 'red' substances.*

Dim 2 ***EY: 2pts.*** *The ecolabel is addressing material safety and water treatment, but does not go into energy use, social responsibility or reutilization of the product.*
ES: 1pt. *The end of life of the product is not considered in the ecolabel.*

Dim 3 ***EY: 2pts.*** *Indoor air quality and LC50 for fish are required measurements.*
ES: 2pts. *The ecolabel standards state that the product may contain no substances which "are classified in „Verwaltungsvorschrift wassergefährdender Stoffe" (Administrative Regulation on the Classification of Substances Hazardous to Waters) 6 as amended, in Water Hazard Class 3."*
The water hazard classes (WGK) are defined as:
1: low hazard to waters 2: hazard to waters 3: severe hazard to waters
Since there is a threshold (class 2 substances) for hazardous substances that may enter the water, 2 points.

Dim 4 ***EY: 1pt.*** *No requirements about resource efficiency.*
ES: 1pt. *Paint is non-reusable. Furthermore it is not biodegradable. So resources are lost at end-of-life of the product. The label states that "empty containers may be offered for recycling". However, the ecolabel is not addressing the composition of the container but only the paint, so the container will not be considered in the scoring of the ecolabel.*

Dim 5 ***EY: 3pts.*** *Paint is a non-electric product, so requirements on energy efficiency are not expected.*
ES: 1pt. *No requirements on the use of renewable energy during the production process*

Name: Compostability mark of European bioplastics (DIN Certco)
Product: bioplastic
Source: http://www.dincertco.de/web/media_get.php?mediaid=39263&fileid=93526&sprachid=2

Dim 1 ***N.B.*** *The specific material requirements were not accessible without payment of a 90euro fee and were therefore not seen by the researcher. The values of dimension 1 are based on the limited information supplied in the ecolabel manual.*
EY: 4pts. *The standards require: "Compliance with the threshold values named in Table A.1 in DIN EN 13432". Since this standard requires payment of a fee, it is assumed that the material safety requirements are detailed and extensive.*
ES: 3pts. *It is assumed that the material composition needs to be known. The benchmark value of 3 points is given because of limited information access.*

Dim 2 ***EY: 3pts.*** *The ecolabel addresses material safety, resource use (biodegradability means no waste), and water treatment (biodegradability means safe effluents). Energy use or social responsibility are not addressed.*
ES: 5pts. *The ecolabel states that "the germination rate and plant biomass of both plant types grown on the compost using test substance must be higher than 90% of the corresponding blank compost". Since the product is made of biological resources that return to nature, no loss of resources occurs, and the end of life product can be used as fertilizer.*

Dim 3 ***EY: 2pts.*** *The ecolabel standards do not provide detailed information on which of the mentioned measurements are included. Since the requirement is that materials are biodegradable, it is assumed that materials are assessed not to be: bio accumulative, toxic to aquatic life, toxic to soil micro-organisms, and that they are biodegradable. VOC and GHG emissions are not mentioned.*
ES: 5pts. *The product can be used as fertilizer after its useful life*

Dim 4 ***EY: 1pt.*** *No mention of efficient use of resources in the ecolabel*
ES: 5pts. *The product has to be >90% biodegradable within less than 6 months*

Dim 5 ***EY: 3pts.*** *The product does not consume energy.*
ES: 1pt. *No requirements on the use of renewable energy.*

Name: C2C Basic certification
Product: Unspecified/Any
Version: Cradle to Cradle® Certification Program Version 2.1.1.

Dim 1 ***EY: 3 pts.*** *Although the ecolabel requires that hazardous substances are identified as 'red' materials, the substances are not prohibited. The requirement is that the manufacturer commits to eventual phase-out. Heavy metals are prohibited above 100 ppm, but organohalogens are only prohibited above 1000ppm. More than five hazardous substances are mentioned.*
ES: 2 pts. *Products are required to be optimized as biological or technical nutrient, but for the Basic certification level no plan for end of life product recovery is required. The other requirements for a score of 2 pts are met.*

Dim 2 ***EY: 2pts.*** *The Basic ecolabel requirements do not request from the applicant to pay attention to water treatment or social responsibility. Material safety and energy use are addressed. Resource use is not truly addressed, since a product has to be defined as a technical or biological nutrient, but this is merely a strategic decision which involves no metrics or calculation and no practical efforts.*
ES: 1 pt. *The ecolabel requirements state that for Basic certification the manufacturer has to demonstrate "the intention to optimize the product as a Technical or Biological Nutrient product". An actual plan for recovery of end of life products is not required for the Basic level, which means resources are not recovered.*

Dim 3 EY: 3pts. *The Basic ecolabel standards include a number of environmental health criteria on which substances are evaluated, which adhere to the tests mentioned for a 3pt score. (fish toxicity, daphnia toxicity, algae toxicity, biodegradation rate, bioaccumulation, climatic relevance and other)*
ES: 1 pt. *No guidelines required for Basic level certification concerning clean water effluents or measuring environmental impact. All materials in the product are identified, quantified and assessed on their risk down to 100ppm, so it should be known too how much is flowing away in effluent streams. However, there are no quantities given in the ecolabel standards.*

Dim 4 ***EY: 1 pts.*** *No standards about efficient use of resources.*
ES: 2 pts. *A end of life product recovery plan is not required for this certification level. However, the product is in the process of being optimized as a biological or technical nutrient, so the Basic label scores more than 1 point.*

Dim 5 ***EY: 3pts.*** *The product type is unspecified, so benchmark score is applied.*
ES: 1 pt. *There are no obligations to use renewable energy for the Basic certification level.*

Name: C2C Silver
Product: Unspecified/Any
Source: Cradle to Cradle® Certification Program Version 2.1.1.

Dim 1 ***EY: 3 pts.*** *Every substance needs to be identified and is characterized on its impact for human and environmental health. For hazardous materials a strategy for eventual phase-out is required. However, the Silver certification can be obtained while the product still contains dangerous substances. Three points because thresholds for heavy metals are <100ppm.*

ES: 3pts. *For Silver certification, the applicant must commit to eventual phase-out of harmful substances (with the addition that an annual review will be performed to judge if sufficient progress is made) and the manufacturer has to be "in the process of developing a plan for end of life product recovery".*

Dim 2 ***EY: 4pts.*** *All issues are addressed in the Silver standards, but the relative market performance is not specified*
ES: 3pts. *For Silver certification, the ecolabel states that "the manufacturer is in the process of developing a plan for end of life product recovery"*.

Dim 3 ***EY: 3pts.*** *Life cycle assessment not required. Substances need to be assessed on their human and environmental safety, for which all 6 measurements are required for a 3pt score.*
ES: 2pts. *Good water treatment principles need to be adopted by the manufacturer. And the product is assessed for its safety, with the guarantee that problematic substances will be removed in de future.*

Dim 4 ***EY: 1pt.*** *No standards about resource efficiency.*
ES: 3pts. *Standards oblige a manufacturer to be developing a plan for managing nutrient flows, including a timeline and milestones for implementation*

Dim 5 ***EY: 3pts.*** *The product type is unspecified, so benchmark score is applied.*
ES: 1pt. *The Silver ecolabel standards require a strategy for implementation of renewable energy (or 'current solar income' as the label calls it) including a timeline as well as measurable goals and timelines. However, Silver certification can be obtained without actually using power from renewable sources.*

Name: C2C Gold
Product: Unspecified/Any
Source: Cradle to Cradle® Certification Program Version 2.1.1.

Dim 1 ***EY: 4pts.*** *All substances assessed as 'red' (which stands for high hazard and risk associated with this substance) have to be phased out of the formulation. Compliance to a set of emission standards is also required.*
ES: 4pts. *All product ingredients are known, product is marked as a biological or technical nutrient, and 'red' assessed substances are no longer allowed.*

Dim 2 ***EY: 4pts.*** *All issues are addressed in the Gold level standards, but the relative market performance is not specified*
ES: 3pts. *The manufacturer has to be in the development stage of a end of life product recovery plan. The plan has to be more defined and concrete than for Silver certification, but actual implementation is not yet required.*

Dim 3 ***EY: 3pts.*** *Measurements are similar to the requirements for the Silver level, an LCA is still not required.*
ES: 3pts. *The Gold certification level contains an extensive set of requirements from the manufacturer on preserving water quality.*

Dim 4 ***EY: 1pt.*** *No standards about resource efficiency.*
ES: 3pts. *The manufacturer has to be in the development stage of a end of life product recovery plan. The plan has to be more defined and concrete than for Silver certification, but actual implementation is not yet required.*

Dim 5 ***EY: 3pts.*** *The product type is unspecified, so benchmark score is applied.*
ES: 3pts. *The Gold standards state that 50% of the manufacturers energy use has to be provided from renewable energy sources, while the ultimate goal is to provide with 100% renewable energy sources. The intention to reach this goal is supported by a plan including timeline and milestones.*

Name: C2C Platinum
Product: Unspecified/Any
Source: Cradle to Cradle® Certification Program Version 2.1.1.

Dim 1 ***EY: 4 pts.*** *Substances that are given a high risk mark are not allowed. However, substances with a low to moderate risk are still allowed as long as no better alternative is at hand. (Brainstorm remark: Even though the use of this risky substance is caused by the fact that there are no alternatives technically possible, it means that a product still contains undesired components. In my opinion, the fact that the platinum ecolabel only requires 50% 'Green' assessed components is not truly representing eco-effectiveness. It is a really good achievement, but there should be a higher level that demands 100% green assessed components.)*

ES: 4pts. *The product is required to contain 50% "Green" assessed components, which means yellow substances are still allowed. Red substances are not allowed.*

Dim 2 ***EY: 4pts.*** *All required issues are addressed in the Platinum level standards, but the relative market performance is not specified*

ES: 5pts. *For Platinum certification,* ***t****he manufacturer needs to be actively retrieving end of life products. Furthermore, innovative water discharge measures have to be implemented, e.g. constructed wetlands or green roofs. These kind of projects will contribute to wildlife and biodiversity.*

Dim 3 ***EY: 3pts.*** *No LCA required. All measurements are included.*

ES: 5ps. *Positive impact is created by wetlands formation, or alternative good water discharge measures. Depending on the product, it is required of a company to close the biological or technical cycle and actively recollect end of life products.*

Dim 4 ***EY: 1pt.*** *No requirements about resource efficiency.*

ES: 4pts. *Active recollection of end of life products needs to be implemented. A resource reutilization score is calculated, based on the recyclability and recycled content of the product. For Platinum certification, a reutilization score of 80 is required. It can be safely said that >75% of the product needs to be reused, but not more than 95%: 4 points.*

Dim 5 ***EY: 3pts.*** *The product type is unspecified, so benchmark score is applied.*

ES: 4pts. *The Platinum standards require 100% renewable energy use by the manufacturer, and at least 50% from the entire supply chain.*

Name: Eco- INSTITUT Painting and coatings
Product: Paintings and Coatings
Source: ***http://www.eco-institut.de/en/downloads/certification-eco-institut-label/***

The eco-INSTITUT ecolabel cooperates with the EU-ecolabel, Blaue Engel and Natureplus. It is able to test products against the criteria of one of the three cooperative labels, especially by using its laboratory for sensitive VOC emission measurements. Still, it is an independent institute which has its own quality mark and criteria.

Dim 1 ***EY: 4pts.*** *The ecolabel states that "products suitable for the label must be toxicologically harmless and to a large extent environmentally compatible". However, for harmful substances there are thresholds, but they are not forbidden. Furthermore, Water Hazard Class II (WGK II: water polluting substance) is still allowed.*
ES: 3pts. *Materials are assessed on their safety, but dangerous substances are still allowed in small amounts.*

Dim 2 ***EY: 2pts.*** *Eco-INSTITUT focusses on material safety and to a lesser extent on water treatment: there can be no substances rated as class 3 water hazards in the product. The other aspects are not addressed.*
ES: 1pts. *End of life of the product is not considered by eco-INSTITUT*

Dim 3 ***EY: 1pt.*** *Only VOC air emissions are considered, none of the other aspects.*
ES: 1pt. *The aim of the ecolabel is to create "to a large extent environmentally compatible" products. Their way to accomplish this is by setting high standards for the materials which are allowed in a product and VOC emissions, but actual measurements of the environmental impact are not mentioned.*

Dim 4 ***EY: 1pt.*** *No standards included in the ecolabel criteria about efficient use of resources*
ES:1pt. *No design for reutilization required by ecolabel, will lead to typical 'cradle-to-grave' products; product is not biodegradable*

Dim 5 ***EY: 3pts.*** *The product does not use energy.*
ES: 1pt. *No requirements on the use of renewable energy*

Name: EU ecolabel: Community ecolabel for textile products
Product: textile
Version/source: document number C(2009) 4595, from: *http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:197:0070:0086:EN:PDF*

Dim 1 ***EY: 3pts.*** *A number of R-phrases (risk phrases) are mentioned in the ecolabel. Any substance for which one of those R-numbers is given, is not allowed in the product. However, a lot of other substances such as heavy metals, antimony, formaldehydes are still allowed up to threshold levels above 200ppm.*
ES: 2pts. *The manufacturer is required to provide a safety data sheet of the product. From this it is assumed that all (hazardous) materials in the product have been identified. The materials are not categorized as red, yellow or green materials, which makes assumptions necessary for scoring the ecolabel on this subject. Heavy metals are permitted in colorants to a threshold level, from which it can be concluded that 'red' materials are still present, and they come into close contact with humans.*

Dim 2 ***EY: 3pts.***
Material safety: *the ecolabel goes in great depth*
Resource use: *one remark about sizeing which should be recycled for 85%.*
Energy use: *the manufacturer has to prodide data on energy use during production (wet processes)*
Water treatment: *aim of label is to reduce the water pollution caused in the processing*
Social responsibility: *not addressed in label.*
ES: 2pts. *The label requires that substances ending up in the waste water are to a large extent biodegradable or eliminable by water treatment plants. For the textile products, no end of life management plan is mentioned in the label.*

Dim 3 ***EY: 1pt.*** *bioaccumulation: - , aquatic life in effluents: - , VOC: + , biodegradation rate: + , GHG emissions: - , soil samples: -. 2 out of 6 discussed.*
ES: 2pts. *Substances in waste water streams are assessed on biodegradability. The waste water is sent to treatment plants.*

Dim 4 ***EY: 2pts.*** *Energy and water use data from manufacturing sites involved in wet processing are required.*
ES: 1pt. *It is possible to use recycled fibres within the ecolabel as long as they comply with the criteria, but the ecolabel does not promote the use of recycled fibres.*

Dim 5 ***EY: 3pts.*** *Textiles do not consume energy.*
ES: 1pt. *No obligations on the use of renewable energy*

Name: EU ecolabel for light sources
Product: light bulbs
Version: document C(2011) 3749

N.B.: *The ecolabel standard starts with setting the aim of the criteria, amongst which are 'disposal treatment of a light source' and 'reducing the total emissions of mercury'. However, in the ecolabel criteria (after the introduction) these aspects are not specifically addressed.*

Dim 1 ***EY: 5pts.*** *A large number of substances to which hazard statements or risk phrases have been assigned are prohibited for use. The product still contains mercury, in amounts of 1,5-3,0 mg (assuming a light bulb of 50grams that is 30-60 ppm) Furthermore plastic parts are allowed to contain chlorine. But since more than 10 R-phrases are used, these are considered as safe amounts.*
ES: 2pts. *A large number of risky substances is prohibited, which means the substances in the product will have to be known in detail: no presence of grey substances. Mercury is still present, and there is no plan for retrieval mentioned in the ecolabel standards.*

Dim 2 ***EY: 5pts.***
Material safety: *the ecolabel mentions a large number of prohibited Risk Phrases*
Resource use: *the average lifetime of the lightbulb is increased, which saves resources*
Energy use: *high standards regarding energy efficiency: "10 % better than the lumen per watt value according to Class A".*
Water treatment: *substances which may cause aquatic toxicity are forbidden*
Social responsibility: *production of the light source must follow the ILO conventions, regarding child labour, etc.*
Market performance: *The label requires energy efficiency performance which is 10% better than Class A, so it can be assumed that the product has to be in the top 20% environmental performance segment.*
ES: 1pt. *The end of life is being extended by the standards set in the label, but there is no plan for end of life products.*

Dim 3 ***EY: 1pt.*** *The ecolabel focuses merely on product composition and packaging content. There is no mention of any measurements regarding environmental impact*
ES: 2pts. *The use of safe materials and prohibiting substances that are assigned a Risk phrase will inherently lower the environmental impact.*

Dim 4 ***EY: 3pts.*** *The amount of mercury that may be used is given a maximum. Furthermore consumers are informed via the packaging how to perform proper maintenance on the lamp and that turning of lights saves energy and money.*
ES: 2pt. *The product is not designed for reutilization. However, there are requirements on the recycled content of the packaging (80% for cardboard, 50% for plastics). Therefore, 2 points are given.*

Dim 5 ***EY: 5 pts.*** *Ecolabel requires an energy efficiency that is "10 % better than the lumen per watt value according to Class A".*
ES: 1pt. *No requirements on the use of renewable energy.*

Name: **Flybe Aircraft Ecolabel**

Product: Flight emissions
Source: http://www.flybe.com/corporate/sustainability/eco_labelling_scheme.htm

N.B. *This ecolabel is about informing customers about their ecological footprint when flying on an airplane. It is useful because it compares several planes, and the relative emissions per customer. It falls short in many ways because it doesn't consider e.g. the material re-use of the plane, the product lifetime duration, the VOC emissions inside the aircraft. These shortcomings result in a low score. It is possible though that an LCA would point out that the amount of resources for construction of the plane are negligible in comparison to the fuel use.*

Dim 1 ***EY: 1pt.*** *The materials to be used for the aircraft are not specified in the standards.*
ES: 1pt. *The materials to be used for the aircraft are not specified in the standards.*

Dim 2 ***EY: 2pts.*** *Energy use (fuel) and social responsibility (noise) are addressed.*
ES: 1pt. *End of life not considered.*

Dim 3 ***EY: 1pt.*** *Only greenhouse gas emission*
ES: 2pts. *Measuring the CO2 and NOx emission per air plane*

Dim 4 ***EY: 3pts.*** *Lower amounts of CO2 emission are rewarded.*
ES: 1pt. *No design for reutilization required by label.*

Dim 5 ***EY: 4pts.*** *The ecolabel is designed in a way to inform customers, so they can make a sound choice concerning their own environmental impact when flying. To obtain the highest reward, 'A' ranking, a plane must be in the top 20% segment regarding fuel (energy) efficiency.*
ES: 1pt. *No obligations on renewable energy usage.*

Name: Forest Stewardship Council
Product: Wood
Version: FSC-STD-01-001 (version 4-0) EN

Dim 1 ***EY: 3pt.*** *Label states that all laws need to be abided. Furthermore the use of chemical pesticides is avoided as much as possible. Since this is a natural product (wood), there is no need for specifications down to x ppm on the use of materials. Therefore the benchmark score of 3 points is given.*

ES: 4pts. *Wood is a natural product, so the product itself contains only green components. Pesticides are strived to be environmentally friendly and biological control agents can only be used under strict monitoring. Since there is no explicit information that only green materials are used, 4 points.*

Dim 2 ***EY: 4pts.***
Material safety: *Pesticides are strived to be environmentally friendly and biological control agents can only be used under strict monitoring.*
Resource use: *the amount of trees that are cut has to be in balance with the growth rate.*
Energy use: *not addressed.*
Water treatment: *"forest management operations shall...conserve water resources"; written guidelines about water resource protection required.*
Social responsibility: *The FSC principles include "Indigenous peoples' rights" and "Community relations and worker's rights".*
ES: 5pts. *The product is a nutrient of the biological cycle, and the ecolabel requires that "the rate of harvest of forest products shall not exceed levels which can be permanently sustained", which assures a balanced resource level. The actual benefits stated in the label: "Forest management operations shall recognize, maintain, and, where appropriate, enhance the value of forest services and resources such as watersheds and fisheries". Furthermore: "Ecosystem diversity shall be maintained intact, enhanced or restored."*

Dim 3 ***EY: 3pts.*** *The ecolabel requires monitoring and assessment of certified forest areas. Monitoring includes amongst others the growth rates of the forest, soil fertility, cleanliness of water streams. VOC and GHG emissions are not mentioned, but those two are no risky factors in this case: in the outdoors, VOC's will disperse quickly; and trees of a thriving forest will sequester enough carbon to balance out the carbon emitted by machine labour.*
ES: 5pts. *Wood is a biological substance, so it is fully biodegradable after its useful life. The positive effect on the environment is enhancement of forest conditions during growth of the tree. (See explanation of Dim 2 ES).*

Dim 4 ***EY: 3pts.*** *The ecolabel requires minimization of waste, without giving specifications on amount.*
ES: 5pts. *The product is completely biodegradable.*

Dim 5 ***EY: 3pts.*** *Trees do not consume energy (electricity).*
ES: 1pt. *No obligations on the use of renewable energy.*

Name: Global Organic Textile Standards (GOTS)
Product: Textile
Version: Global Organic Textile Standard (GOTS) Version 3.0

Dim 1 ***EY: 3pts****. Materials with carcinogenic properties are not prohibited in the product, but allowed to low threshold levels (e.g. the limit value for arylamines as residue in GOTS goods is 20 ppm; disperse dyes classified as carcinogenic are allowed up to 30ppm). These are trace-amounts, but many other ecolabels prohibit their presence.*

ES: 2pts. *Dangerous substances are identified because thresholds have been set for trace amounts. However, they can still be present in the final product, and since the final product may be clothing, there is risk of skin contact. Therefore, 2 points.*

Dim 2 ***EY: 4pts.***
Material safety: *The label mentions a large number of thresholds for product residues. The label states that a product may still contain trace amounts of hazardous components due to unavoidable contamination.*
Resource use: *minimization of waste and discharges is part of the ecolabel policy*
Energy use: *data on energy consumption must be provided, , and target goals and procedures to reduce expenditure are required.*
Water treatment: *data on water consumption must be provided, and target goals and procedures to reduce expenditure are required.*
Social responsibility: *extensive attention is paid to social responsibility by the label in the form of social criteria.*
ES: 3pts. *The ecolabel requires that in the future the manufacturer will start recycling materials. The label states that "from 1st January 2014 onwards any polyester used must be made from post-consumer recycled material". It should be noted that only a part of the product consists of polyester, so it is not a 100% recycling plan. It is not clear from the ecolabel to what extent the 'organic fiber' should be biodegradable.*

Dim 3 ***EY: 2pts.*** *The ecolabel does not address any VOC's arising from the textile products or dyes. The other aspects are covered in the standards.*
ES: 2pts. *The Chemical Oxygen Demand of waste water streams is measured after waste water treatment (before it is discharged to surface waters). It has to adhere to certain limits. However, streams are not completely clean.*

Dim 4 ***EY: 3pts.*** *The ecolabel requires as part of environmental management that a manufacturer minimizes waste and discharges, minimize use of chemicals, and minimization of water and energy use.*
ES: 2pts. *The ecolabel requires that in the future the manufacturer will start recycling materials. The label states that "from 1st January 2014 onwards any polyester used must be made from post-consumer recycled material". It should be noted that only a part of the product consists of polyester, so it is not a 100% recycling plan. Therefore, 2 points, not 3.*

Dim 5 ***EY: 3pts.*** *The product does not consume energy.*

ES: 1pt. *No obligations on the use of renewable energy.*

Name: Greenguard Indoor Air Quality Children and Schools Standard
Product: Air Quality in Schools
Source: Greenguard Children & Schools Standard © 2010 GREENGUARD Environmental Institute

N.B. *On its own this ecolabel is far too incomplete to guarantee a good environmental treatment by a product. It addresses only emissions from the product. However, it could be of value in combination with another ecolabel, because this ecolabel uses highly specialized test methods.*

Dim 1 ***EY: 3pts.*** *The label tests product emissions, but does not focus on the product composition. A number of forbidden volatile compounds are mentioned. However, it is not clear from the standards whether certain (possibly) carcinogenic substances are banned or not.*
ES: 1pt. *The standard looks at product emissions, but it is stated nowhere nor can it be assumed that the complete product content must be known. Risky volatile compounds have to remain under a certain threshold, but are not prohibited.*

Dim 2 ***EY: 1pt.*** *Only material safety is treated in the ecolabel. (Social responsibility to a certain extent since the ecolabel aims for children's health protection, but workers ethics are not mentions.*
ES: 1pt. *End of life is not considered.*

Dim 3 ***EY: 1pt.*** *The ecolabel measures VOC emissions, but none of the other environmental impact factors.*
ES: 2pts.*The fact that children are more susceptible to toxic components is taken into account in the label, which is a rare feature of an ecolabel. This calculation factor can be considered as a way of measuring the impact of the product.*

Dim 4 ***EY: 1pt.*** *No mention of efficient use of resources.*
ES: 1pt. *No design for reutilization required*

Dim 5 ***EY: 3pts.*** *The product (construction materials) does not require electricity.*
ES: 1pt. *No mention of the use of renewable energy.*

Name: Milieukeur Furniture Certification Scheme the Dutch environmental quality label
Product: Furniture
Source: ***http://www.smk.nl/nl/s434/SMK/Certificatieschema-s/Milieukeur/c375-K-t-m-O/p462-Meubelen--Milieukeur***

Dim 1 ***EY: 5pts.*** *Several R-phrases are mentioned, any ingredients to which an R-phrase has been assigned need to have disappeared after processing. Mentioned R-phrases include substances linked to cancer, harm to aquatic organisms, genetic damage, etc. (R40, R45-46, R49-53, R60-63, R68). Thresholds are given for heavy metals.*
ES: 3pts. *The standards on material requirements are quite high, although red substances are not banned from the product, but merely allowed to a limited extent. There are requirements that a product needs to be designed for easy disassembly.*

Dim 2 ***EY: 3pts.***
Material safety: *yes*
Resource use: *There are certain elements in the standards which indicate that efficient resource use is an aim: "Any varnish that is painted on a surface larger than 25cm2 needs to be applied with a minimal efficiency of 65%"; Material packaging has to be made of recycled cardboard.*
Energy use: *not mention in standards*
Water treatment: *Ingredients linked to R-phrases regarding aquatic toxicity cannot be in the final product.*
Social responsibility: *not mentioned in the label. (Although the requirements on sustainable forest management reflect principles of social responsibility.)*
ES: 2pts. *The ecolabel requires that a product is designed in such a way that it can be separated for 90% in different fractions at end of life stage. However, this separation is done with the aim of safe waste disposal, not with reutilization in mind.*

Dim 3 ***EY: 1pt.*** *VOC emissions measurement is the only measurement which is required by the standards.*
ES: 1pt. *The ecolabel sets thresholds for the use of hazardous materials. However, most materials are burned at end of life stage, including those trace amounts of hazardous materials. Furthermore, it is not clearly stated by the ecolabels whether metals are retrieved in pure form, so it is assumed they are retrieved after burning as a mixture (of lower quality).*

Dim 4 ***EY: 3pts.*** *The ecolabel requires efficient use of resources, for example, it is stated that "any varnish that is painted on a surface larger than 25cm2 needs to be applied with a minimal efficiency of 65%".*
ES: 1pt. *The product has to be designed for disassembly and easy replacement of parts. However, the ecolabel does not state that the old parts need to be recycled, but merely separated for safe disposal.*

Dim 5 ***EY: 3pts.*** *The product does not use energy.*
ES: 1pt. *No requirements about renewable energy.*

Name: Natureplus e.V.
Product: Building products designed to achieve economic sustainability
Source: Award Guideline RL0000 BASIC CRITERIA Issued: May 2011

Dim 1 ***EY: 5pts.*** *Instead of R-phrases, this ecolabel uses H-statements, which are introduced by the GHS. They serve the same purpose and H-statements are intended to replace the R-phrases. The ecolabel mentions more than 10 H-statements.*

ES: 4pts. *Products should be designed in a recycling-compatible way, which makes them technical nutrients. Furthermore it can be assumed that any 'red' substances are not allowed. Since the addition 'where technically possible' can be found multiple times, it is clear that the use of solely green materials is not a requirement.*

Dim 2 ***EY: 4pts.*** *All environmental issues addressed. Environmental performance should be 'above average'. Since 'above average' stands for 'the top 50%' and not clearly means 'top 20%', 4 points.*
Material safety: *yes.*
Resource use (recycling): yes: *Design for reuse of resources and efficiency are both criteria.*
Energy use: yes: *above average energy performance is an overall aim.*
Water treatment: Yes: "*In the interests of preventive environmental protection, the emissions of organic and inorganic substances into water, soil and the atmosphere must be strictly limited"*
Social responsibility: yes: *Compliance with the minimum standards of the ILO is required.*
ES: 4pts. *The criteria include: A plan for actively retrieving materials is not clearly mentioned in the standards, but this section is quite clear: "Recycling/disposal rules: [….] The building materials should be suitable for processing into recycled products of a comparable value". Based on this requirement, it can be assumed that the product cycle will be actively closed.*

Dim 3 ***EY: 4pts.*** *The main testing procedure includes a Life Cycle Assessment. Details on the LCA method that is used are not given in the basic ecolabel standard.*
ES: 2pts. *Emissions have to be extremely low. Waste should be safely disposable. "the emissions of organic and inorganic substances into water, soil and the atmosphere must be strictly limited". However, they are not actually required to be clean.*

Dim 4 ***EY: 3pts.*** *The ecolabel requires minimal resources spent per product.*
ES: 4pts. *The standard requires design for recycling/disposal of products. Furthermore, only materials of renewable origin or of non-depletable source are eligible for certification and products of petrochemical base are per definition not. The level of recycling should be into products of comparable value. A percentage of recycled products is not given.*

Dim 5 ***EY: 3pts.*** *The product (construction materials) does not consume energy.*
ES: 1pt. *No mention of renewable energy.*

Name: Natrue Label: requirements to be met by natural and organic cosmetics
Product: cosmetics
Version: Version 2.5 – 12.06.2012

Dim 1 ***EY: 4pts.*** *This is an arbitrary decision. The ecolabel allows only the use of natural ingredients, nature-identical ingredients and derived natural substances. Mineral oil is ruled out for use. This means that attention is paid that only environment-compatible substances are used that can go back to nature. The ecolabel does not mention any forbidden substances or R-numbers though. So strictly speaking, the ecolabel requirements are according to the Scoring System just 'in compliance with public regulations'. However, since the ecolabel aims at using ingredients that are all safe to human and environmental health, 4 points are given.*

ES: 5pts. *Ingredients need to be safe. This section describes the only exception: "All necessary auxiliary materials and catalysts, including enzymes and micro-organisms, which are not explicitly defined in the NATRUE Criteria, but are technically unavoidable or are used to have a better adapted energy efficiency in the context of improving sustainability – have to be removed, after use, completely or at least considered as technically unavoidable and technologically ineffective traces in the finished product."*

Dim 2 ***EY: 3pts.*** *Social responsibility and energy use are not addressed. Neither is market performance.*
ES: 2pts. *The aim is to use ingredients that can return to nature without problems, so biological nutrients are used. The packaging is not really well handled. From the standards:*
"1. As far as possible packaging must be kept to a minimum.
2. If at all possible, products should be designed for multiple uses (except for sample packs).
3. If at all technically feasible and available, recyclable packaging materials, if possible made of renewable raw materials, are to be used."
Since there is no obligation for eco-effective packaging, 2 points are given.

Dim 3 ***EY: 1pt****. There are no measurements of ecological impact required.*
ES: 4pts. *The product can return to natural ecosystems, thereby closing the loop. One point is subtracted because the packaging does not have to be eco-effective.*

Dim 4 ***EY: 3pts.*** *"Packaging must be kept to a minimum". "70% of the natural substances of the product must come from controlled organic farming and/or from controlled wild collection."*
ES: 4pts. *The product is completely biodegradable, except for the packaging.*

Dim 5 ***EY: 3pts.*** *The product (cosmetics) does not consume energy.*
ES: 1pt. *The use of renewable energy during production is not required.*

Name: RECS
Product: Renewable energy
Source: http://www.recs.org/content.php?IDPAGE=7

N.B: *Disputable type of ecolabel. Electricity is not really a product and therefore less suitable for this Scoring System.*

Dim 1 ***EY: 1pt.*** *No specifications about product composition and hazardous components*
ES: 3pts. *Benchmark score given because renewable energy is not a cyclical resource but it is non-depletable. It is not compatible with this Scoring System.*

Dim 2 ***EY: 2pts.*** *Energy use is addressed, and when energy is considered as the product, 'resource use' is also considered (from renewable source).*
ES: 3pts. *Electricity is used and not returned in cycles. But renewable energy has an endless source.*

Dim 3 ***EY: 1pt.*** *No attempts to measure environmental impact*
ES: 3pts. *The certification body sees renewable energy as carbon neutral.*

Dim 4 ***EY: 1pt.*** *No standards included in the ecolabel criteria about efficient use of resources*
ES: 3pts. *Electricity is not recollected but supplied from renewable source.*

Dim 5 ***EY: 3pts.*** *Technically, electricity is the product, so it does not consume electricity.*
ES: 5pts. *It is assumed that the company is using 100% renewable energy in the entire production chain.*

Name: SmaRT platinum level (Sustainable Materials Rating Technology)
Product: Any/unspecified
Source: ***http://sustainableproducts.com/mts/SMaRT_Scorecard.pdf***

N.B. *The SmaRT ecolabel deserves some extra explanation: The SMaRT ecolabel is an intelligent system that rates a product via a(nother) scoring system (than used in this research) on social, environmental & economic criteria. Points can be earned based on a certain achievement, and the final score is awarded with a certification 'grade' (silver, gold or platinum). It is constructed differently than most ecolabels, since most requirements are not compulsory, and the final points score of >90 points for platinum (out of 157 maximum) can be achieved by focusing on different aspects. Therefore it is complicated to rate this ecolabel according to the Scoring System used in this research. The score is based on what is necessary for a manufacturer to achieve 90points, while trying to balance the efforts amongst all domains.*
90/157=0.57. So 57% of the points per category need to be earned on average to gain platinum certification.

According to SmaRT's own comparison with other labels, they are they most encompassing program: ***http://mts.sustainableproducts.com/SMaRT_Brochure_MTS_v.3.pdf***

Dim 1 ***EY: 3pts.***
31 Points can be earned for material safety. To gain 57% one needs 18 points. To earn these 18 points, e.g indoor air VOC's and carcinogenic VOC's need to be minimized. Also reduction or removal of toxic chemicals and pollutants is rewarded. Materials in the product need to be known.
Since carcinogens need to be minimized but are not prohibited, 3 points will be given for this EY dimension.
ES: 3pts. *A chemical inventory is required ('Stockholm Chemicals', from the stockholm convention on POP's), so product components need to be known and assessed for safety. An inventory is required of biological and technical content of the product. The data sheet is not very detailed on the allowance of hazardous substances, but since the removal of hazardous substances is not explicitly stated, only three point will be given.*

Dim 2 ***EY: 4pts.***
Material safety: *yes*
Resource use: *yes, biological or recycling content inventory required, plus operational reclamation system.*
Energy use: *yes, efficiency and renewable energy addressed*
Water treatment: *Water pollutants ought to be minimized*
Social Responsibility: *In the form of social indicator reporting.*
ES: 4pts. *Points are awarded for product reclamation, 39 maximum. 57% of 39 points is 23 points. 23 points is equal to 60% reclamation/reuse of products. Since no percentage is specified in the Scoring System of this research, 4 points are given.*

Dim 3 ***EY: 4pts.*** *LCA process required.*
ES: 3pts. *Pollutants are inventorized and minimized, and attempts are made to close the loop. Points can be earned for reclaiming more used products. However,*

completely clean emissions or a beneficial *process step is not part of the label. So an arbitrary decision has to be made: 3 points.*

Dim 4 ***EY: 3pts.*** *The ecolabel gives 5 points for "dematerialization (less material by % weight)". No real waste management plan (besides partial reclamation).*
ES: 4pts. *The higher the material reclamation %, the more points can be earned. For platinum, at least 23 points (or 60%) is needed. 27 points corresponds to 80%. This is sufficient for a 4 pt score in the ecolabel assessment (and it allows the manufacturer to spend less attention on another topic, so it is reasonable).*

Dim 5 ***EY: 3pts.*** *This is one of the only assessed ecolabels where energy efficiency is rewarded. The ecolabel calculates the energy efficiency relative to the starting point (throughout the facility). Points are given though for energy efficiency OR the use of renewable energy, which makes it more complicated. For that reason, I will give 3 points for energy efficiency, and 2 under ES for the use of renewables.*
ES: 2pts. *50% renewable energy use is awarded with a maximum score.*

Name: TCO Certified
Product: desktops
Version: **TCO Certified Desktops 4.0 5 March 2012**

Dim 1 ***EY: 4pts.*** *Most doubtful substances are prohibited, and 14 H-statements (risk phrases) are included concerning hazardous substances. However, PVC is not completely prohibited as a material, which becomes clear from this paragraph: "The magnitude of the environmental problems relating to PVC differs depending on the environmental status of a particular manufacturing facility and the uses of additives. At present there are very limited possibilities to distinguish between harmful and less harmful production facilities for PVC". Therefore 4pts will be given instead of 5.*
ES: 3pts. *A take back system is required, which makes all materials constituents of a technical cycle. Since PVC is not forbidden, a red assessed material is still being used.*

Dim 2 ***EY: 4pts.*** *All 5 environmental aspects are being addressed in the ecolabel standards. Relative market performance is not an issue.*
ES: 3pts. *A take back system is required by the ecolabel, after which the manufacturer is responsible for proper treatment of its own end-of-life products. This could be re-use, recycling, or pollution controlled energy recovery.*

Dim 3 ***EY: 1pt.*** *The ecolabel is not measuring the environmental impact in any way. None of the tests mentioned in dimension 3 are fulfilled.*
ES: 2pts. *The ecolabel requires the use of safe materials, high energy efficiency and the use of materials that do not (seriously) harm the quality of water supplies. A take back system is required, but since emissions are not stated as clean or a positive impact is not mentioned, a 2point score is applicable here.*

Dim 4 ***EY: 3pts.*** *The ecolabel requires a longer product lifetime, thereby using resources more efficiently.*
ES: 3pts. *The ecolabel standards include criteria on the introduction of a product take-back system. However, it is not stated that materials should be reused at the same quality level. Controlled energy recovery is considered as an acceptable recycling method too. Therefore it cannot be said that 75% of resources is reused at the same quality level.*

Dim 5 ***EY: 4pts.*** *The product should fulfil the 'Energy Star Power Management requirements'. Energy Star is a label on its own handed out to products that fulfil their energy efficiency requirements. It is assumed that roughly only the top-20 segment on the market qualifies for the energy star program.*
ES: 1pt. *There is no mention of the use of renewable energy in the TCO ecolabel. Nor is renewable energy part of the energy star program.*