PILOT STUDY

IMPACTS OF THE CRADLE TO CRADLE CERTIFIED PRODUCTS PROGRAM

Technical report

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CRADLE TO CRADLE PRODUCTS INNOVATION INSTITUTE

FOREWORD

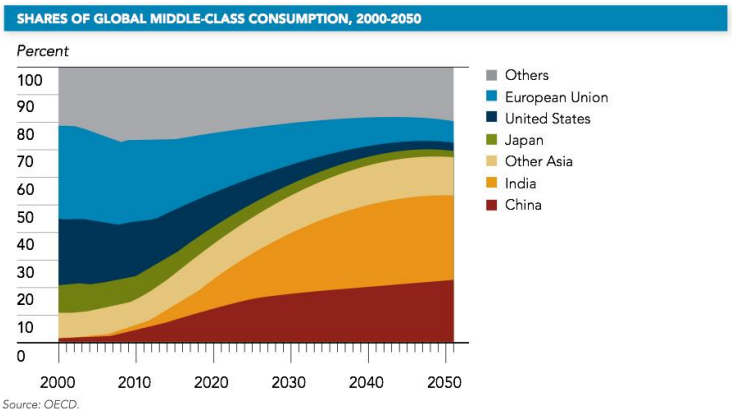
10 Companies Show us the Way Forward

The Cradle to Cradle Case for Good Business

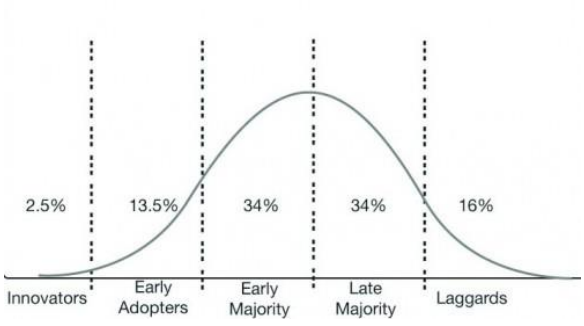
Dear Reader:

Today, the world is at a crossroads. Our planet has 7 billion people and it is not getting smaller. Together, we can achieve a healthy and prosperous future by working to innovate well-designed, healthy products with reusable and safe materials, made without the need to deplete precious resources or energy. Many companies are proving that responsible leadership is the way forward, and consumers need choices—good choices. The research in this report provides valuable insights to that challenge, and draws business insight from these leading companies. The research presented herein is a valuable contribution to this critical conversation.

It has been more than 20 years since Dr. Michael Braungart and William McDonough first laid out their Cradle to Cradle philosophy — a new model for abundance and prosperity in which the making of things is transformed from a destructive event to be a positive force for people, economy, and planet. Their vision is being realized in the *Cradle to Cradle Certified™* Products Program — gifted to the Institute and the public domain by McDonough and Braungart and is showing a new path forward.



Now is a critical moment because billions of people around the world are poised to gain middle class consumer power to change how we design, use and reuse products. If the world is going to flourish, shared prosperity must be realized with a new consumption model free from waste, pollution, and social and environmental expense. The model is Cradle to Cradle and its implementation is the certification program.



So it's time to measure the real impacts of Cradle to Cradle thinking as integrated into the Institute's Certified Product Program. To date, over 200

FOREWORD

companies have had their products assessed for certification. They have much in common. They are values-based companies. They have visionary leaders. They have a commitment to fundamentally changing the way products are made. They are classic "Innovators". Sometimes innovators are cast as "risk-immune". Not here. These companies face plenty of risk, including doing business in the midst and aftermath of a historic economic downturn.

We have selected ten companies — representing different sizes, different geographic locations, and very different product offerings — to help us begin to explore the economic, social, and ecological benefits of certification. This report shares these early findings.

The core question we ask the reader to consider is how do we build on their success? What can we bring to the world that would encourage the "Early Adopters" to take this new way of designed and manufacturing products to the next level and beyond.

We invite you to read the findings here and consider how the certification program can be a bridge to the new circular economy that works to the benefit of all.

Let's stop talking and get started. Pioneering companies have already laid the groundwork worldwide. They've built competencies in new product design, new material innovation, creation of reuse cycles and in increasing their commitment to renewable energy, water stewardship and social fairness.

Trucost helped gather the information and found some great examples. Other examples are self reported but just as impactful. We all can imagine a Cradle to Cradle world but these ***Innovators*** are showing the way. Change can be exciting. Change can be an opportunity for new growth as more and more companies adopt the Cradle to Cradle principles and start their innovation journey.

An exponentially greater number of companies and consumers need to understand the benefits that come with Cradle to Cradle product certification. This report is a start. In order to have real impact, the number of product manufacturers participating in the system must grow.

The innovative companies highlighted here show this can happen. Enjoy reading this report. It is a road map, showing the path towards a world of abundance. Join us on the journey.

Bridgett Luther

President, Cradle to Cradle Products Innovation Institute

ACKNOWLEDGEMENTS

The study represents pilot research designed to contribute an initial evidence base for the *Cradle to Cradle Certified* Products Program and stimulate thought about how the making of things can be transitioned into a positive force for people, planet and profit. While the study is not intended to provide scientific verification or demonstrate causality, it does provide an initial indication of the very significant economic, environmental and social potential of the program. More granular research, considerate of a wider sample of companies, is needed to strengthen the pilot findings. The *Impact Study* report series is available to download at *www.c2ccertified.org/impact:*

Roy Vercoulen led the study on behalf of the Cradle to Cradle Products Innovation Institute. Please direct comments and questions to roy@c2ccertified.org

The Cradle to Cradle Products Innovation Institute is a non-profit organization, created to bring about a new industrial revolution that turns the making of things into a positive force for society, economy, and the planet. The Institute administers the publicly available *Cradle to Cradle Certified* Product Standard, currently in its third version, along with the Products Program to support it. It also issues the product-certificates, and reviews the product analyses of its Accredited Assessment Bodies. The Institute is also responsible for selecting, training and auditing these assessment bodies worldwide.

The *Cradle to Cradle Certified* Product Standard is a continuous improvement quality standard gifted to the Institute by William McDonough and Michael Braungart after eighteen years of development with the world's leading brands. It guides the assessment of a product across five quality categories — material health, material reutilization, renewable energy and carbon management, water stewardship, and social fairness. Qualifying products are awarded one of five levels of achievement — BASIC, BRONZE, SILVER, GOLD, PLATINUM. Learn more.

Trucost Plc, a global environmental data and insight company, conducted the Impact Study research and delivered the report.

ACKNOWLEDGEMENTS

The Cradle to Cradle Products Innovation Institute and Trucost thank the following contributors and partners for their expertise, input and support:

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The Scientific Review Panel: Dr Gijsbert Korevaar of Delft University of Technology, Netherlands, Dr Constance McDermott, of Oxford University, United Kingdom; and Pavan Sukhdev, Visiting Fellow at Yale University, and founder of GIST Advisory.

The Participating Companies: AGC Glass Europe; Aveda; Construction Specialties; Desso; Ecover; Royal Mosa; PUMA, Shaw Industries; Steelcase; and Van Houtum.

GLOSSARY

Benefit	A positive impact associated with a particular process or project (in the context of this report, specifically the improvements to society, the environment and business, associated with the Cradle to Cradle certification of a product).
Biological cycle	The planet's biological metabolism to which a product manufactured as a biological nutrient can safely return.
Burden	Cost associated with a particular process or project. In the context of the recycling burden this includes the associated 'cost' of processing recyclates, including energy requirements and other resources.
CAS Number	Chemical Abstract Service number. This number uniquely identifies each pure chemical compound. This is also designated as Chemical Abstract Service Registry Number (CASRN).
Circular economy	The circular economy refers to an industrial economy that is restorative by intention; aims to rely on renewable energy; minimizes the use of toxic chemicals in the technical cycle and eliminates toxicity altogether in the biological cycle; and eradicates waste through careful design. Circular economy is based upon Cradle to Cradle material cycles. For more information see http://www.ellenmacarthurfoundation.org/circular-economy/circular-economy/the-circular-model-an-overview
Club goods	Subtype of public goods for example, or services provided by social or religious clubs.
Common pool resources	A type of good consisting of natural or man-made resource system such as fishing grounds. Unlike public goods, these resource pools may be overused.
Cradle to Cradle®	The Cradle to Cradle philosophy from which the *Cradle to Cradle Certified* Products Program is derived. Developed by designer William McDonough and chemist Dr. Michael Braungart in their 2002 book, *Cradle to Cradle: Remaking the Way We Make Things* (North Point Press), it encourages the rethink of human design intentions with an emphasis on constant improvement and movement from simply being "less bad" to becoming "more good." Cradle to Cradle® is a registered trademark owned and licensed by McDonough Braungart Design Chemistry, LLC (MBDC). Learn more.
Defined content	Known chemical content of product or material. For *Cradle to Cradle Certified* products, content must be defined to phase out problematic inputs and optimize formula.
Eco-effectiveness	The use of intelligent and healthy materials, designing human industry that is safe, profitable, and regenerative, while producing economic, ecological, and social value. Eco-effective products move a step farther than doing eco-efficient products by ensuring the move from 'more with less' to doing 'the correct thing'.
Eco-efficiency	Doing more with less. Eco-efficiency is good only in the correct scenarios, for example using less resource within products and wasting less – but it is important to ensure the correct processes are in place initially, and eco-efficient design is paramount (see 'Eco-effectiveness above).
End-of-use	The point at which a product is no longer required for its original intention – in circular economy this will involve a second use or recycling/ recovery to ensure the product is retained within the techno- or bio- sphere.

GLOSSARY

EP&L account	A tool to quantify the environmental impacts along the entire value chain of a business, product or other entity, placing a financial value on these impacts. This helps companies combine sustainability metrics with traditional business management, and provides a single metric to allow comparison of a range of impact fields.
Impact	Any result apparent following a change to a particular process – impact may be positive or negative.
The Institute	For the purposes of this report, 'The Institute' refers to the Cradle to Cradle Products Innovation Institute
Net benefit	The benefits associated with a particular project, once costs of the project have been subtracted (in the context of this report, specifically the improvements to society, the environment and business associated with pursuit of a *Cradle to Cradle Certified* Product after costs of optimization and certification have been taken into account).
Optimization	The process of improvement. In reference to this report, continual improvement across the *Cradle to Cradle Certified* Product Standard's quality categories to meet high levels of certified achievement.
Primary data	Data observed directly from the given process – owned by the reporting company. For example, such data includes direct onsite energy use and type, water consumption, product material input, sales data and profit.
PRODCOM	PRODuction COMmunautaire" (Community Production)
Public goods	A good which is available for all, and no one can be excluded from use
Rapidly renewable material	A material which can be regrown within ten years or less.
Recycled content	The proportion of material, by mass, sourced from recycled material, either recovered or diverted from the waste stream.
Recycling	A mechanical, physical or chemical process on a material to transform it into a usable material once again. Recycling can include: downcycling, in which the product or material is used in a lower value product, upcycling in which the value of the input is increased, and closed loop recycling, in which the product or material is maintained and continues in the function in which it was originally designed for.
Refurbishment	A series of improvement steps, such as cleaning, polishing, smoothing or lubricating, to bring a used product to a higher standard of quality.
Remanufacture	"A series of manufacturing steps acting on an end-of-life part or product in order to return it to like-new or better performance, with warranty to match" (CRR, 2009)
Re-use	The use of a product or its materials following its initial use phase.
Secondary data	Data gathered indirectly, from an unobserved source and reflective of a process – examples of secondary data include modelled, or LCA based data, or that based on characterization or equivalency methodologies.
Servicization	Servicization refers to the moving from continued sale of goods, to service of goods, through leasing, remanufacture, incentivized return and re-use.
Technical cycle	Society's technological metabolism to which a product designed as a technical nutrient can safely return

GLOSSARY

Upcycling	The process of converting materials or products into a secondary product of higher value than the original, through chemical, mechanical or physical processing.
Use phase	Phase of a product in which it is being utilized for the purpose it was intended, consumer phase.

GLOSSARY

ACRONYMS

CMRs	Carcinogenic, mutagenic, and reproductive toxins
CSR	Corporate social responsibility
EIA	US Energy Information Administration
EP&L	Environmental profit and loss
EPEA	Environmental Protection Encouragement Agency
FMCG	Fast moving consumer goods
FSC	Forest Stewardship Council
IEA	International Energy Agency
IO (model)	Input Output model
LCA	Life cycle analysis – a technique to assess environmental impacts associated with a product or service
LCSA	Lifecycle Sustainability Assessment
MBDC	McDonough Braungart Design Chemistry, LLC
NAICS	North American Industry Classification System
PEFC	Programme for the Endorsement of Forest Certification
P&L	Profit and Loss
REC	Renewable energy credit
RSPO	Roundtable on Sustainable Palm Oil
RTRS	Roundtable on Responsible Soy
SHdb	Social Hotspots Database
WWF	World Wildlife Fund/Worldwide Fund for Nature

CONTENTS

INTRODUCTION

The purpose of the research presented was to:

Develop a framework suitable for use by the Institute and stakeholders, to determine the impacts of the pursuit of Cradle to Cradle Certified™ products. This should be designed to measure the environmental, social and business benefit of pursuing initial product certification and subsequent optimization towards higher levels of achievement.'

An initial literature review identified that no individual methodology or tool was appropriate to capture both the quantity and quality of the impacts of certification in a manner relevant to the *Cradle to Cradle Certified* Products Program. A bespoke framework was therefore designed based on accepted and understood techniques, with further development to shape the methodology to fit the *Cradle to Cradle Certified* Products Program specifically.

To develop such a framework, a pilot study was undertaken to capture the impact of the *Cradle to Cradle Certified* Product Program across ten companies, each selecting an individual product which has undergone the certification process. This report provides detail of how a methodology was devised and the assessment process undertaken. It then goes on to provide findings of the research and recommendations for future work and opportunities. This is the first research designed to capture this information and provides a useful first step and evidence base for future development. The framework is considered to be dynamic, to be strengthened and developed through continued practical implementation and further analyses.

The report is defined in two distinct sections to allow easy navigation depending on requirements of the reader. The sections describe the journey undertaken by the Institute to capture the impacts of the *Cradle to Cradle Certified* Products Program, and the lessons learned from the pilot study respectively. The journey reflects the first steps taken by the Institute to quantify the impacts of its quality mark, and the initial development of the conceptual framework to capture these impacts. It also reflects possible next steps for further development, informed by the lessons learned during the development and implementation of this initial framework. A brief reader's guide accompanies each section to further aid the flow of the report:

Part One: *'Starting the journey'*

This section introduces the context of the research, providing detail of the objectives, the *Cradle to Cradle Certified* Products Program and detail of a literature review undertaken to identify best practice of impact assessment studies.

An outline of the conceptual framework and methodology deployed is then presented – providing justification for the techniques selected as well as guidance for those who are interested in repeating the work in the future. Detail is given over specific steps taken and data points used.

Part Two: *'Continuing the journey'*

The second section focuses on findings, and reflection on the learnings of the research. It identifies the opportunities to carry the work forward. A summary of project findings is given, with consideration of robustness of the analysis, and opportunities for further focus in future development. Recommendations to different stakeholders are then suggested, highlighting the role that the Institute, scientific community and companies can play to maximize benefit of using the framework and supporting the continued optimization of the work.

PART ONE

Starting the Journey

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CONTEXT

READER'S GUIDE

This first section sets the scene by providing background context for the research, an overview of the pilot study and its objectives and an introduction to the Cradle to Cradle philosophy and the *Cradle to Cradle Certified* Products Program. This provides the rationale for starting the journey and sets out exactly what the research wants to achieve.

PROJECT CONTEXT

Trucost was commissioned by the Institute to determine the impacts of *Cradle to Cradle Certified* product certification, and define a Framework that assists current and future stakeholders to carry out further analysis. This will enable companies to develop an insight into the returns on sustainable innovation in the fields of environment, society and business, to demonstrate the positive and negative impacts of certification to the company and at a product level, upon these three fields. Further consideration is given to the impact of optimization or continuous improvement, which is integral to the *Cradle to Cradle Certified* Product Standard, and apparent through advancement through certification levels, from *Cradle to Cradle Certified* BASIC to PLATINUM.

The Institute is guided by the following vision and mission:

Vision

'All products, worldwide, are designed and manufactured using healthy, safe materials and processes.'

The work of the Cradle to Cradle Products Innovation Institute and its partners will lead to a global reindustrialization; producing products that are designed and manufactured based on the laws of nature, and thus are safe for people and the environment.

Mission

Provide a continuous quality improvement standard to guide product manufacturers and designers in making safe and recyclable products for our world.'

The Institute's mission is to promote innovation in material chemistry and manufacturing processes to retain the value of materials for future re-use. The Institute maintains rigorous Cradle to Cradle standards in five categories: material health, material reutilization, renewable energy and carbon management, water stewardship, and social responsibility. It certifies materials and products that meet these standards, and generates demand among manufacturers, retailers, and government agencies and the public for *Cradle to Cradle Certified* products.

The Institute has set four strategic business goals to help achieve its vision and mission.

Goal 1: Establish *Cradle to Cradle Certified* as the preferred quality standard

Transform commonly-held perceptions of what makes a product beautiful, innovative, and high quality.

Goal 2: Generate demand

Create awareness and increase demand for certification and certified products worldwide.

Goal 3: Spur innovation

Encourage and support the development of materials that allow designers and manufacturers to produce safe, recyclable products that meet *Cradle to Cradle Certified* standards for GOLD level of achievement.

Goal 4: Build capacity

Strengthen the Institute's capacity to achieve its program goals both financially and operationally.

A partnership between the Institute and Trucost, enables the Institute to better understand, quantify, showcase, and independently verify the benefits of pursuing *Cradle to Cradle Certified* products. The work was reviewed throughout the process[1] by a team of independent scientists from leading international academic institutions; ensuring research is comprehensive and methodologically valid. A final review by a stakeholder group of industry experts, NGOs and thought leaders[2] was given, to ensure that the work was verified before publication, and that any additional considerations were addressed.

PROJECT GOALS

The objective of this research was to:

"Develop a framework suitable for use by the Institute and stakeholders, to determine the impacts of the pursuit of Cradle to Cradle Certified products. This should be designed to measure the environmental, social and business benefit of pursuing initial product certification and subsequent optimization towards higher levels of achievement."

The key research question is ' ***What are the actual and quantifiable impacts of pursuing the Cradle to Cradle Certified Products Program on business, the society, and the environment?" '***

This question aims to determine the positive and negative impacts from the point at which a company first starts its pursuit of product certification, through to continued improvement and attainment of higher certification levels. Further questions to be answered include:

- What are the narratives of the participating companies – what did the journey towards certification entail?
- What are examples of tangible cost savings or enhanced revenues?
- What examples of other business benefits?
- What are the current quantifiable impacts on society and the environment?
- What is the brand value of the *Cradle to Cradle Certified* Products Program?
- How will these impacts evolve when more companies and more products are certified?

The methodology is designed in such a way that it can be used as a framework in future research exercises determining the impacts of a

[1] At scoping stage, initial analysis, and a final review of the Technical report and final conclusions of the study.
[2] To be carried out in April 2014

company's pursuit of *Cradle to Cradle Certified* products. The research is the first study to address the impact of *Cradle to Cradle Certified* Products Program and is considered a pilot study, focusing on ten volunteer sample companies. The work is not intended to be representative of all certified products. However, the developed framework can be applied to obtain parallel results over a wider sample representation. The final outputs will be shared for learning purposes at *www.c2ccertified.org/impact.*

Specifically, the research determines the benefit:

- At a product level
- To the company
- To the *Cradle to Cradle Certified* Products Program

Benefits are considered in line with the five quality categories (material health, material reutilization, renewable energy and carbon management, water stewardship, and social fairness), and in relation to a commitment to continuous improvement, recognized through five award levels (BASIC, BRONZE, SILVER, GOLD, and PLATINUM). The approach is hoped to encourage further research on the added value of *Cradle to Cradle Certified* products, and the value of the *Cradle to Cradle Certified* brand.

INTENDED AUDIENCE

This Technical Report document is targeted for managers, academics, students and other stakeholders wishing to review and/or potentially repeat the analysis, for future or additional *Cradle to Cradle Certified* products. The document will showcase the research publicly, and will be available at the *www.c2ccertified.org/impact.* For those interested in the results of the research alone, the Management Summary Report details the top-level approach and project findings and is available at the same link.

The study is designed to encourage continued and new research projects, for example, through local educational institutions.

THIRD-PARTY REVIEW

The research has been reviewed by both the Institute's internal steering committee throughout the process and the academic panel at three stages of the process. The scientific panel includes: Dr Constance McDermott, of Oxford University, United Kingdom; Dr Gijsbert Korevaar of Delft University of Technology, Netherlands and Pavan Sukhdev, Visiting Fellow at Yale University, and founder of GIST Advisory.

These parties were involved in review of the scoping of the project to help shape analysis approach, the interim results analysis, and the creation of the final Technical Report. The panel were selected due to their range of expertise in certification schemes, business, social and environmental analysis. Their involvement helped ensure that robust and reliable methodology, assumptions, data and calculations were used.

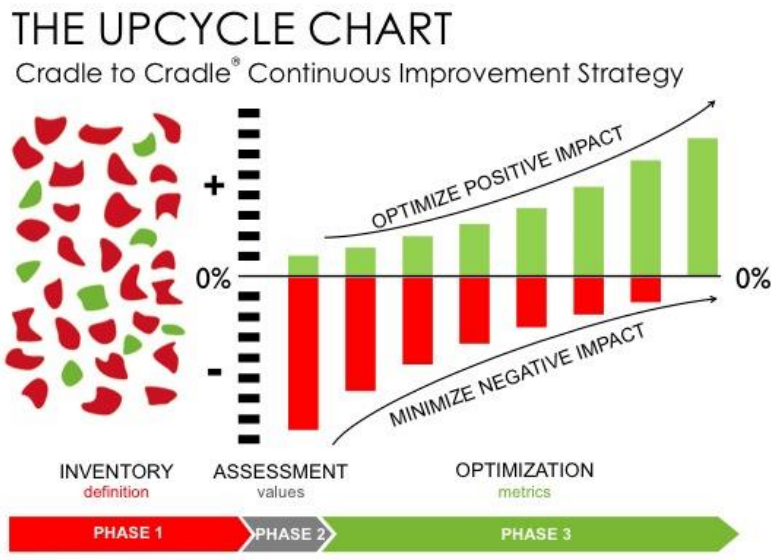
A further review of the final stages of the analysis was carried out by a Stakeholder group of industry associations and NGOs, in order to provide potential challenge and feedback to results before public launch.

INTRODUCTION TO CRADLE TO CRADLE

The Cradle to Cradle philosophy was developed by architect William McDonough and chemist Dr Michael Braungart, and detailed in their 2002 book, *Cradle to Cradle: Remaking the Way We Make Things*. The philosophy encourages rethinking conventional design approaches and focusing on using design as a positive force, seeking to become 'more good' rather than simply trying to be 'less bad'. By adding what McDonough and Braungart call eco-effective supply side approaches and integrating positively defined goals based on Cradle to Cradle values and principles, they are able to direct innovation and leadership towards a "positive footprint".

Cradle to Cradle reframes design as a beneficial, regenerative force—one that seeks to create ecological footprints to delight in, not lament. It expands the definition of design quality to include positive effects on economic, ecological and social health. Cradle to Cradle rejects the idea that growth is detrimental to environmental health; after all, in nature growth is good. Efficiency is good business. By adding eco-effective supply side approaches, and integrating positively defined goals based on Cradle to Cradle values and principles, the philosophy aims to direct innovation towards a 'positive footprint' (MBDC, 2013). This is a process of continuous improvement until a positive impact is optimized.

FIGURE 1: CRADLE TO CRADLE UPCYCLE CHART



Source: MBDC (2013)

Based on the Cradle to Cradle principles, McDonough and Braungart developed a certification standard to capture the concept within product manufacturing.

THE *CRADLE TO CRADLE CERTIFIED* PRODUCT STANDARD

The *Cradle to Cradle Certified* Product Standard is a multi-attribute, continuous improvement methodology that provides a pathway for companies to produce safe, recyclable and sustainable products. Unlike many standards available, it is developed around transparency, requiring robust disclosure of product and process data. It is administered by the Cradle to

Cradle Products Innovation Institute. The certification standard was launched in 2005, after many years of development by McDonough Braungart Design Chemistry, LLC (MBDC) in cooperation with EPEA Internationale Umweltforschung GmbH. Since the program began in 2005, over 200 companies worldwide have participated in the *Cradle to Cradle Certified* Products Program, with hundreds of product lines representing thousands of different products certified and millions of products sold. Companies include Herman Miller, Shaw Industries, Steelcase, Desso, PUMA and Ecover.

In 2012, MBDC licensed the *Cradle to Cradle Certified* Product Standard to the Institute, an international non-profit organization founded to *'bring about a new industrial revolution that turns the making of things into a positive force for society, economy, and the planet* (Cradle to Cradle Products Innovation Institute, 2013). The Institute was tasked with scaling up the number of products that meet the expectations of a Cradle to Cradle world. They also provide an independent and transparent management to the certification process.

The current standard is version 3.0, building on version 2.1.1 of the standard revised in 2010. It continues to be periodically revised to keep up with current research, data, and technologies. Subsequent revisions[3] are public and will be informed by five expert advisory groups and public comment periods. The process is managed by the Institute's independent Certification Standards Board[4] (CSB) with input from consumers, manufacturers, NGO partners, and other interested stakeholders.

The Standard has requirements for certification in five quality categories, which are based upon the Cradle to Cradle design principles. Overview of the certification requirements are given in tables 1-5, and full details of the standard can be found at http://c2ccertified.org/product_certification/c2ccertified_product_standard

THE CERTIFICATION PROCESS

For a product to be certified, five steps are followed (see figure 2 overleaf). Firstly, the company wishing to certify its product needs to select an Accredited Assessment Body[5] — these are companies trained and accredited by the Institute to assess the products put forward for evaluation.

The Accredited Assessment Body will work with the company to gather data on the product ingredients and manufacturing process, and will evaluate these according to the requirements in the five categories given overleaf:

[3] http://www.c2ccertified.org/product_certification/revisions_to_the_standard
[4] The Certification Standards Board (CSB) is an independent review panel, tasked with updating the standard and adjudicating disputes and appeals related to product certification http://www.c2ccertified.org/product_certification/certification_standards_board
[5] Accredited Assessment Bodies are organizations accredited and trained by the Institute to conduct product assessments for Cradle to Cradle product certification, they may be General or Material Health Assessors. http://www.c2ccertified.org/product_certification/accredited_assessment_bodies

THE PROGRAM

THE FIVE PRODUCT STANDARD CATEGORIES

The five *Cradle to Cradle Certified* Product Standard categories are designed to provide a pathway to manufacturing safe and sustainable products for our world. The five categories are summarized below:

Material health *Making products out of materials that are safe for humans and the environment*

Material reutilization *Designing products so all materials can return safely to nature or industry*

Renewable energy and carbon management *Assembling and manufacturing products with renewable energy*

Water stewardship *Making products in ways that protect and enrich water supplies*

Social fairness *Treating all the people involved in the product manufacturing*

THE PROGRAM

FIGURE 2: FIVE STEP CERTIFICATION PROCESS

1 PLAN
Visit c2ccertified.org to review the certification program overview and choose an accredited assessor who will review your product's preliminary information and respond with a comprehensive certification plan: timeline, estimated cost, trademark licensing considerations, and clearly assigned responsibilities for all aspects of data collection and assessment.

2 ANALYZE
Work with your assessor to establish what is in your product, how it is made, and what happens to it at the end of use. You will complete the product's Bill of Materials, optimization plans, and other documentation - usually with non-disclosure agreements in places between the assessor, your company, and your suppliers.

3 ASSESS
Your assessor follows the guidelines in the product standard to evaluate in detail the composition of product ingredients and manufacturing processes. This includes a site visit to the final manufacturing/ assembling facilities and the completion of an Assessment Summary Report to be submitted to the Cradle to Cradle Products Innovation Institute for review.

4 CERTIFY
Congratulations! Products that meet the criteria receive the Cradle to Cradle Certified hallmark at a specified level of achievement. You will be asked to sign the Institute's Trademark License Agreement to guide your use of the mark on the product and marketing materials. Your product will be added to the online product registry and circulated to the Institute's network of like-minded product listings. The Institute team is on hand to support your marketing efforts.

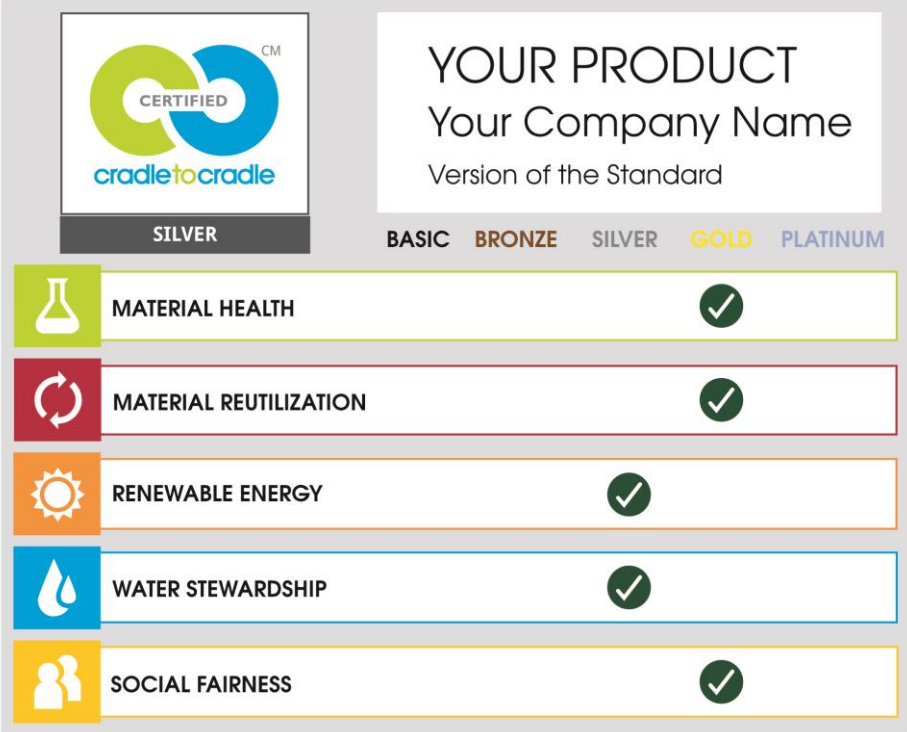
5 RENEW
Companies must maintain the certification by updating product and process data, as well as showing good faith efforts to make continuous improvement in all criteria categories.

Manufacturers work with Accredited Assessment Bodies to have their product materials and manufacturing process evaluated to determine if they meet the standard requirements and to increase their level of certification over time. Certification can be awarded at a BASIC, BRONZE, SILVER, GOLD or PLATINUM level, with requirements becoming more rigorous as higher awards are given. BASIC is considered a provisional step on the pathway towards positive products, rewarding human intention and a commitment to continuous improvement to meet the programs evermore rigorous criteria.

If products do not meet the standard, a company is able to work with the Accredited Assessment Body to develop an optimization plan including specific steps required to enable its product to achieve certification.

Once the criteria for the five categories are met, the Accredited Assessment Body will produce an Assessment Summary Report, which the company submits to the Institute for audit and a certificate is awarded. With version 3.0 of the standard, re-certification is required every two years, with a new re-certification Summary Report submitted, including any further developments or changes to the product or processes within that time. A product may not be re-certified to the BASIC level.

FIGURE 3: EXAMPLE *CRADLE TO CRADLE CERTIFIED* PRODUCT SCORECARD



An overview of the quality category requirements under v3.0 of the *Cradle to Cradle Certified* Product Standard and award levels is given over tables 1-5.

To enter the program, material health requirements state products must be 75% assessed (allowing for initial challenges in obtaining supply chain data). Details of the material health assessment are given in the Environment: Methodology section.

TABLE 1: MATERIAL HEALTH REQUIREMENTS

MATERIAL HEALTH	BASIC	BRONZE	SILVER	GOLD	PLATINUM
No Banned List chemicals	■	■	■	■	■
Materials defined as biological or technical nutrient	■	■	■	■	■
100% "characterized" (all generic materials)	■	■	■	■	■
Strategy developed to optimize x-assessed materials		■	■	■	■
At least 75% of materials assessed by weight		■	■	■	■
At least 95% of materials assessed by weight			■	■	■
No X-assessed materials due to CMR concerns			■	■	■
100% of materials assessed by weight				■	■
Formulation optimized (100% positive chemistry)				■	■
Meets Cradle to Cradle VOC emission standards				■	■
Process chemicals assessed and optimized					■

For the material reutilization quality category, companies pursuing certification define (and design) components of their products as biological or technical nutrients and design pathways for reutilization for these nutrients. Systems are developed to recover used products safely and continuously.

TABLE 2: MATERIAL REUTILIZATION REQUIREMENTS

MATERIAL REUTILIZATION	BASIC	BRONZE	SILVER	GOLD	PLATINUM
Defined the appropriate cycle (TN or BN)	■	■	■	■	■
Plan for product recovery and reutilization	■	■	■	■	■
Material (re)utilization score ≥ 35		■	■	■	■
Material (re)utilization score ≥ 50			■	■	■
Material (re)utilization score ≥ 65				■	■
Nutrient management strategy complete				■	■
Material (re)utilization score of 100					■
Product is actively being recovered and cycled					■

The renewable energy and carbon management quality category is developed to accelerate companies to increased use of clean and renewable energy.

TABLE 3: RENEWABLE ENERGY AND CARBON MANAGEMENT REQUIREMENTS

RENEWABLE ENERGY & CARBON MANAGEMENT	BASIC	BRONZE	SILVER	GOLD	PLATINUM
Quantify purchased electricity and on-site emissions	■	■	■	■	■
Renewable energy and carbon management strategy		■	■	■	■
5% of purchased electricity is renewable or offset			■	■	■
5% of direct on-site emissions are offset			■	■	■
50% of purchased electricity is renewable or offset				■	■
50% of direct on-site emissions are offset				■	■
>100% of purchased electricity is renewable or offset					■
>100% of direct on-site emissions are offset					■
≥ 5% of embodied energy from Cradle to Gate is covered by offsets or addressed + optimization strategy					■

The continuous improvement path for water stewardship moves a manufacturer through reducing water consumption, enhancing water quality, and monitoring performance over time.

TABLE 4: WATER STEWARDSHIP REQUIREMENTS

WATER STEWARDSHIP	BASIC	BRONZE	SILVER	GOLD	PLATINUM
No discharge violations within the last two years	■	■	■	■	■
Local- and business water issues characterized	■	■	■	■	■
Stated intent to mitigate identified problems	■	■	■	■	■
A facility-wide water audit is completed		■	■	■	■
Process chemicals in effluent are characterized & assessed ***or*** Strategy for >20% of supply chain water issues			■	■	■
Process chemicals in effluent are optimized ***or*** Progress against Silver level strategy				■	■
Water leaving the facility = drinking water quality					■

The social fairness quality category calls upon companies to demonstrate leadership by honoring employees, customers, communities and ecosystems, and report publicly on their achievements and challenges. Companies audit their standards and those of their suppliers for health, safety and ethical performance and ultimately become a partner to the communities and regions in which they operate.

TABLE 5: SOCIAL FAIRNESS REQUIREMENTS

SOCIAL FAIRNESS	BASIC	BRONZE	SILVER	GOLD	PLATINUM
Conduct streamlined self-audit					
Management plan to address identified issues					
Social responsibility self-audit + positive impact strategy					
Material specific audit/certification >25% of product ***or*** Supply chain issues investigated and strategy developed ***or*** Conduct an innovative social project					
Two of the Silver-Level requirements are complete					
All three Silver-Level requirements are complete					
Third-party facility-level audit is complete					

DEVELOPMENT OF THE STANDARD

Version 3.0 is the current version of the *Cradle to Cradle Certified* Product Standard, developed by McDonough Braungart Design Chemistry and licensed exclusively to the Cradle to Cradle Products Innovation Institute. Version 3.0 revises and expands on Version 2.1.1 (last updated in 2010). Any new products beginning the certification process after January 1, 2013, and any currently certified products due for recertification after January 1, 2015 will need to meet Version 3.0 requirements. The standard version under which a product was assessed is noted on the certificate, as well as the official *Cradle to Cradle Certified* Product Registry.

Many products that are currently certified have undergone slight variations in level of assessment to reach certification due to the two versions being adhered to. Several products have not yet undergone the transition to 3.0, which has more rigorous requirements in several categories and also a few additional variations. Details of all the specific differences can be found on the Institute website (Cradle to Cradle Products Innovation Institute, 2012), but the key changes are detailed below:

- The 'Banned List(s) of Chemicals' (one for materials of the biological metabolism, and one for materials managed in the technological metabolism) have been expanded and include substances that will disqualify a product from the certification program.

- BASIC level requirements have been simplified to facilitate 'getting on the path', although new BASIC level inventory requirements have been added for water stewardship and social fairness.
- BASIC level will be a 'provisional' certification, good for only 2 years with restrictions on use of the certification mark.

BRONZE Level

- Addition of BRONZE level between BASIC and SILVER. BRONZE was added to create a more logical, even pathway for products moving up the certification pathway.

SILVER Level

- Chemicals that are assessed as carcinogenic, mutagenic, and reproductive toxins (CMRs) are not allowed in products at the SILVER level if they are present in a form that may result in exposure.
- Use of renewable energy and carbon-offset strategies begins at the SILVER level.

GOLD Level

- No major changes

PLATINUM Level

- Over 100% of final manufacture energy must be renewably sourced.
- Cradle to gate emissions of the product are calculated, and partially off-set.

LITERATURE REVIEW

READER'S GUIDE

This section provides a review of other assessments that have attempted to analyses the impacts of 'sustainable' certification schemes. The review provides an opportunity to assess and document the learnings from other frameworks and tools – helping to better position the goals of the impact study and provide justification for the framework and methodology development.

REVIEW OF CERTIFICATION AND SUSTAINABILITY IMPACT ASSESSMENT FRAMEWORKS

Trucost carried out a review of assessments of 'sustainable' certification scheme benefits to identify best practice considered for inclusion within the *Cradle to Cradle Certified* Products Program impact study framework. As the Program is a quality mark rather than an ecolabel, there are no equivalent quality mark reviews due to the unique standing of the scheme. However there are some relevant lessons and challenges that are faced across the different initiatives and the following section briefly describes some of the key frameworks reviewed and contributions of each, and provides review of how these influenced the development of the framework.

REVIEWED FRAMEWORKS

The literature review included overview of the following ecolabels and schemes/initiatives, including websites and published reports or analyses carried out internally, by (or funded by) the organization themselves, or externally, including scientific papers. The schemes reviewed included;

- EU Ecolabel (the 'Ecolabel' or 'the flower')
- Forest Stewardship Council (FSC)
- Programme for the Endorsement of Forest Certification (PEFC)
- ISEAL Impacts Code
- Fairtrade
- Roundtable on Sustainable Palm Oil (RSPO)
- Roundtable on Responsible Soy (RSRS)

The review also focused on identifying other tools and mechanisms used to assess impacts, such as sustainable lifecycle analysis, social lifecycle analysis and product environmental declarations. The reflection is based on the considerations of the authors, and no input was requested from the individual study authors and certification and guidance schemes.

LEARNINGS FROM LITERATURE REVIEW

The literature review highlighted various approaches to impact assessment, with different schemes using individually designed, case dependent approaches to reflect the objectives of the individual ecolabels or initiatives. It is apparent that there is no 'one solution', with the Fairtrade assessments highlighting this particularly. Numerous studies have been undertaken to assess the impacts of Fairtrade, though these differ in approaches and findings, and Fairtrade have iterated that many do not capture the true impacts of the scheme (Pond & Nelson, 2011).

Environmental impact assessments used are more consistent than social evaluations, with approaches similar and often based on LCA style assessment. While indicators for environmental assessment varied, these were generally well-documented, with systems in place to capture environmental metrics data. Social evaluation is arguably a much wider ranging issue, with significant numbers of subjective and qualitative indicators used. For example, social evaluation may include relationships and trust, both of which provide assessment challenges. Of critical importance was a well-defined scope and boundary of the assessment, to ensure clarity of approach going forward. Costs and benefits should be well mapped and clear understanding of indicators to be measured developed, before undertaking the impact assessment itself.

The review highlighted various approaches to impact assessment, both across the many schemes reviewed and tools available, yet common themes run through most. Four key steps are identified as underlying a robust analysis, regardless of the tools used or criteria assessed. These may then differ in the application and detail of the methodology, but provide a strong basis for analysis. These are:

1. Define the scope and boundaries of the assessment
2. Determine the inventory (selection of indicators to be assessed)
3. Impact assessment
4. Interpretation

The *Cradle to Cradle Certified* Products Program is multi attribute program, incorporating social and environmental criteria across five quality categories. The program recognizes that any manufacturer's knowledge may vary widely regarding the chemicals used in a product, the extent to which its materials can be re-used in biological or technical cycles, and the energy and water used to produce it. It also recognizes that product impacts vary depending on the manner of use and processing details ('the right materials at the right place at the right time'). The goal of the continuous improvement is not to simply reduce the human and environmental impact of a product, but instead combines the progressive reduction of "bad" with the increase in "good" to reach the eco-effective Cradle to Cradle goal.

No individual methodology or tool reviewed was considered appropriate to capture both the quantity and quality of the impacts of certification in a manner relevant to the *Cradle to Cradle Certified* Products Program. A bespoke framework has therefore been designed and implemented based on accepted and understood techniques from best practice learning of the literature review, with further development to shape the methodology to fit the *Cradle to Cradle Certified* Products Program specifically.

This methodology is described in detail in coming sections of the report.

OVERVIEW OF SCHEMES

Schemes reviewed

The EU Ecolabel and Fairtrade are both certifications available to consumer goods over a wide range of product types (and some services); though the Ecolabel has an environmental focus and Fairtrade a more social aim.

The Ecolabel impact was addressed by the European Commission (through DG Environment), who commissioned work to create a methodology for evaluating benefit of the Ecolabel. A formula was calculated which assessed

the total benefit of the scheme, based on the benefit of individual product and the market share.

The Fairtrade certification label is arguably one of the most successful ecolabels in the world, and the subject of numerous academic and non-academic studies. By Fairtrade consideration, many of these reports do not accurately reflect on impacts of Fairtrade (Pond & Nelson, 2011). The review suggested that Fairtrade's own impact studies focus on specific indicators, rather than a holistic aggregation of all impacts.

Mapping, or identification of relevant impacts was apparent throughout all frameworks reviewed, and several studies highlighted the importance of capturing indirect impacts as well as those more direct and obviously apparent. For example, the FSC-US created a cost benefit analysis, and iterated some business benefits, not quantified, yet important, ranging from better communication between workers and management to, fewer safety - related losses, and better accounting resulting in tax savings (FSC, 2011). The FSC P&C require (appropriate to the scale and intensity of the operation) that companies have a "social management plan" that identifies social goals and risks and outlines how they will be addressed. This in turn facilitates social impact assessment (SIA), for which a variety of guidelines and tools already exist – see, for example the "Manual for social impact assessment of land-based carbon projects" by CCBA *et al* (2010). This manual outlines a step by step process, including mapping out of stakeholders, development of a reference scenario, a "theory of change" outlining how various interventions are intended to improve the social situation, identification of indicators and a monitoring plan.

The literature review also highlighted difficulties of data gathering, with different certification schemes achieving varied levels of impact assessment due to data issues. PEFC set out to assess the environmental benefit of forest management certification, however reported that it found that at an LCA level, there were not enough data to compare certified to non-certified forest across common environmental attributes on a global average scale (e.g., due to variance between countries), but it was able to compare the benefit gained from certification associated with reduced deforestation (Quantis, 2013).

The ISEAL Code of Good Practice for Assessing the Impacts of Social and Environmental Standards (Impacts Code) is designed to help standards systems to better understand the sustainability results of its work, as well as the effectiveness of its programs. The Impacts Code provides a framework for building a monitoring and evaluation system capable of examining both short-term and long-term outcomes and requires standards systems to publicly report on the results of their evaluations. The ISEAL framework requires quantification in a more embedded manner; organizations must define monitoring indicators and track them on an on-going basis (ISEAL, 2010). System managers are required to define the social, environmental and/or economic issues linked to their goals, and where there is likelihood these impacts will occur. Short and medium term outcomes are then defined, and these need to have specific indicators selected for them, in order to measure progress.

Tools reviewed

Many different tools exist to capture social, environmental and business impacts, and these each have benefits and limitations. No single approach is perfect, and suitability depends on data availability and type of impact being captured. Numerous tools were reviewed, and these are considered below,

with reflection given to suitability for purpose in the individual fields of environment, business and society.

Environment

- Environmental lifecycle analysis (LCA). An environmental LCA quantifies the inputs and outputs, and environmental flows of a product or service, for its entire cycle.
- Environmental profit and loss accounting (EP&Ls). A financial valuation of environmental impacts along the entire value chain of a product to help companies combine sustainability metrics with traditional business management.
- Environmental Product Declarations (EPDs). EPD's provide environmental data for a product based on pre-set parameters based upon rules known as Product Category Rules.
- Input-output (IO) modelling. Quantification of environmental impacts based on modelled sector data.
- Natural capital valuation. Application of economic valuation to natural capital, to allow for unified reporting metrics.

An interesting example of corporate innovation is the 'Closed Loop Calculator', developed by Kingfisher to assess a product's closed loop properties. Kingfisher provided the following definition of a closed loop product:

'Closed loop products waste nothing when created and used. They are made from recycled or renewable materials and use only renewable energy in manufacture and use. If they break or are no longer needed their materials and component parts can be harvested to make new products'.

To achieve its goal to create 1,000 products with closed loop properties by 2020, Kingfisher designed a tool to enable it to assess these properties. This tool had to be easy to use and scalable. It identified 10 key- credentials to determine to what extent a product has closed loop properties. 10 questions are used to measure how the product's properties met closed loop requirements. Criteria include what the product is made from, if it can be rented or repaired, and whether it can be disassembled into component parts or materials.

The Calculator is currently being tested by Kingfisher, but it plans to share this with suppliers and other businesses once fully tested. *Cradle to Cradle Certified* products could be considered to be moving further towards being truly 'closed loop' as they advance along the certification levels. This tool is therefore interesting and potentially offers useful insight into products, though it is not yet available publicly and not addressing all *Cradle to Cradle Certified* quality categories.

An LCA is a well-defined and understood approach to environmental impact assessment, though with limitations and sometimes limited applicability to the assessment of the five *Cradle to Cradle Certified* Product Standard categories. It is not recommended that LCAs are used as a sole means to assess *Cradle to Cradle Certified* Product impact, as iterated in the "Usability

of Life Cycle Assessment for Cradle to Cradle Purposes" position paper published in 2011 (NL Agency Ministry of Infrastructure and Environment, 2011).

Valuations take this one step farther, placing a financial value on the environmental flows – this is further discussed on page 37.

An input-output model offers modelled data only and should be used to fill data gaps rather than providing comparative data, as no company or product specific data is used.

Society

- Social lifecycle analysis (S-LCA). A social impact assessment technique capturing social and socio-economic aspects of products across their whole cycles.
- Social risk characterization mapping (such as the Social Hotspots Database). Quantification of social risks based on sector-region of product type and point of manufacture.
- Social and human capital valuation. Application of economic valuation to social and human capital, to allow for unified reporting metrics.
- Analysis of supply chain audits. Review (and potentially quantification) of audits of working conditions and other social indicators.

Unlike environmental LCA, S-LCA's are less widely used, and data is therefore less available. While supply chain audits are useful due to the company specific data, these are not standardized across different companies, and may be self or third party assessed. When reviewing a wider range of products across different companies, this approach may not provide comparable findings.

While social risk characterization mapping is limited to the typical risks associated with sector-regions, this provides a useful 'hotspot' identification of key risk areas. This can then be combined with other data directly collected by the company where possible.

Valuations are useful, placing a financial value on capital flows and assisting understanding with a single economic metric. However, social valuation is a relatively immature and complex area with less well-defined approaches than natural capital valuation. This offers an opportunity for future research to allow inclusion within unified metrics for net benefit analysis.

Business

- Valuation of all economic capitals (including financial, natural, social and human)
- Profit and loss accounting. Summarizes all revenues, costs and expenses occurred by a company in a given year.
- Review of conventional accounting indicators such as market share, profit margin, cash flow, cost of goods sold etc. Comparison of company level indicators allows for indication of business success.
- Life cycle costing (LCC) Aggregation of all costs applied to a product over its whole cycle.

- Industry financial benchmarks. Mapping company trends to indexed sector level data, reducing variation due to external factors such as economic downturn.

Financial indicators may be conventionally widely available, however commercial sensitivity may limit data available for public disclosure or external analysis. Where possible, data should be gathered, with separation of the company's *Cradle to Cradle Certified* and non-certified product portfolio s, to highlight variation and thereby provide understanding of impact.

Where companies report on this information, surveys may reflect on employee and customer satisfaction, which in turn may reflect higher retention rates, productivity and customer loyalty. This can be a useful indicator where quantifiable data is not possible or relevant.

Combined

- Lifecycle sustainability assessment
- Global Reporting Initiative (GRI)

Few tools incorporate all three impact fields, though a useful approach to consider is the lifecycle sustainability assessment (LCSA). This combines three separate tools; the (environmental) LCA, LCC and the S-LCA, addressing environment, business and social impacts in a complementary manner. For a detailed review of LCSA, UNEP/SETAC (2011) provides an excellent reference. This identifies the key steps required for each individual assessment type included within the LCSA and lists practical guidance and case examples for review.

The GRI promotes the use of sustainability reporting as a way for organizations to become more sustainable and contribute to sustainable development. It has developed a comprehensive Sustainability Reporting Framework that has been widely adopted, and includes social, environmental and economic disclosure requirements. While not product specific, the framework details KPIs for reporting in each of the three fields, and provides guidance and templates to assist companies in implementation.

As discussed in the section 'Learnings from the literature review', no single tool or methodology was reviewed that was deemed fit for purpose to capture all impacts relevant to the Cradle to Cradle Certified Products Program. The conceptual framework was therefore developed using best practice existing guidelines and techniques, further developed for greater relevance to the Program's five quality categories and impact fields. The framework and its application are detailed in the coming section.

CONCEPTUAL FRAMEWORK

READER'S GUIDE

This section introduces the conceptual framework that has been developed to capture the impacts of the *Cradle to Cradle Certified* Products Program. The conceptual framework outlines the main principles that guide the implementation of methodologies, tools and techniques. The framework helps ensure consistent and repeatable assessments in future years and will allow companies and other stakeholders to consistently measure and report on the outcomes achieved.

INTRODUCING THE CONCEPT OF 'CAPITAL'

The *Cradle to Cradle Certified* Products Standard is a multi-attribute standard, so a holistic concept is needed to understand how it drives change in a company's relationship with the environment, society and business. The concept of 'capital' is a useful starting point.

All companies depend on various forms of capital for their success. These capitals are stores of value that can, in one form or another, become inputs to a company's business model or be affected by its outputs (such as emissions from product processing). They are increased, decreased or transformed through the activities of the company. There are six main types as defined by the International Integrated Reporting Council (IIRC), financial capital, manufactured capital, intellectual capital, human capital, social capital and natural capital.

Financial capital *is broadly understood as the pool of funds available to an organization. This includes funds raised from both debt and equity finance.*

Manufactured capital *includes man-made physical objects (as against natural physical assets) that are used in the production of goods or the provision of services*

Intellectual capital *is defined by IIRC as knowledge-based intangible assets, in which they include tradable & private intellectual property such as patents, copyrights, software, etc. as well as "organizational capital" such as tacit knowledge, systems, procedures and protocols*

Human capital *consists of the individual's health and capabilities (knowledge, skills and experiences), as well as the motivation and capacity they have to enhance these capabilities.*

Social or relationship capital *is the relationships and networks together with shared norms, values, trust and understandings that facilitate co-operation within or among groups. Examples include the relationships found in families, communities, businesses, trade unions and voluntary organizations.*

Natural capital *is any stock of natural resources or environmental assets that provides a flow of useful goods or services now and in the future. This includes resources such as timber, fish, water and minerals, as well as ecosystem services from which humans benefit such as climate regulation.*

In environmental economics literature, however, there are typically only *four* broad categories of capital - physical, human, social and natural capital. These two categorizations are in fact consistent. *'Physical capital'* is the value stored in man-made assets, be they "financial" or "manufactured" or "intellectual", as they are related: they are mostly privately owned, and one can be converted to the other through markets. *'Human capital'* includes the

intellect and knowledge of humans – it resides in human minds. When owned by businesses in the form of patents, copyrights, and software it can also be classified as physical capital. *'Social capital'* resides in human relationships at various levels, enabling social interaction and reducing transaction costs: without social capital, normal business would become impossible to conduct. *'Natural capital'* is made by nature, not man, and includes all valued supplies of goods, services and embedded intellectual property (used in bio-mimicry) emanating from all levels of biodiversity – ecosystems, species and genes.

Together these capitals are the basis of a company's value creation. They also underpin the quality of human well-being. Natural capital, for example, underlines the need to maintain stocks of our natural assets such as rainforests, grasslands, wetlands, and mangroves. These provide flows of services that benefit society, such as clean air, fresh water, climate regulation, crop pollination and protection from natural hazards. Similarly, financial capital when invested and distributed fairly allows for the creation of jobs and goods and services which ultimately benefit humans. These capitals are also interrelated and can influence each other directly and indirectly.

At present the stocks of natural, human and social capital are not recognized on a company's balance sheet and are seldom the subject of management attention, and as such are being degraded or lost. In recent years, for example, growth in financial capital has often come at the expense of serious natural resource depletion and pollution impacts, representing costs to natural capital (sub-soil assets as well as wilderness of many kinds) and human capital (human health). The impacts of this imbalance are increasingly being felt on society and business through increased healthcare costs, increased volatility in the price of raw materials, and intensifying 'polluter pays' regulations, to name but a few.

SUMMARY OF THE CONCEPTUAL FRAMEWORK

Eco-effective products are considered to provide 'more good', delivering benefit to human well-being. Underpinning the conceptual framework is the principle that the manufacture of eco-effective products demands the maintenance and enhancement of *all* forms of capital upon which companies and their products rely.

The five *Cradle to Cradle Certified* Product Standard categories drive change in companies by encouraging them to improve environment, social and business performance to enhance and protect all forms of capital, conscious of the fact that much capital is neither priced by nor traded in markets, and is in the nature of club goods or public goods. Therefore, good business management is about enhancing capital owned privately by the firm whilst simultaneously also enhancing, or at least not damaging, capital owned by communities (club goods, or Common Pool Resources) and by the public at large (public goods). Eco-effective products are considered to provide 'more good', delivering benefit to human well-being. Underpinning the conceptual framework is the principle that the manufacture of eco-effective products demands the maintenance and enhancement of *all* forms of capital upon which companies and their products rely.

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management is about enhancing capital owned privately by the firm whilst simultaneously enhancing, or at least not damaging, capital owned by communities (club goods, or Common Pool Resources) and by the public at large (public goods).

The range of impacts of a typical large corporation operating in many countries and contexts is immense – it cuts across almost all categories of capital in all forms of ownership (see table below). Hence the challenge of corporate sustainability is tantamount to the challenge of creating positive impacts on *all* these capital categories in *all* ownership classes, not just in the single box of physical capital owned privately by the firm.

TABLE 6: CAPITALS AND OWNERSHIP

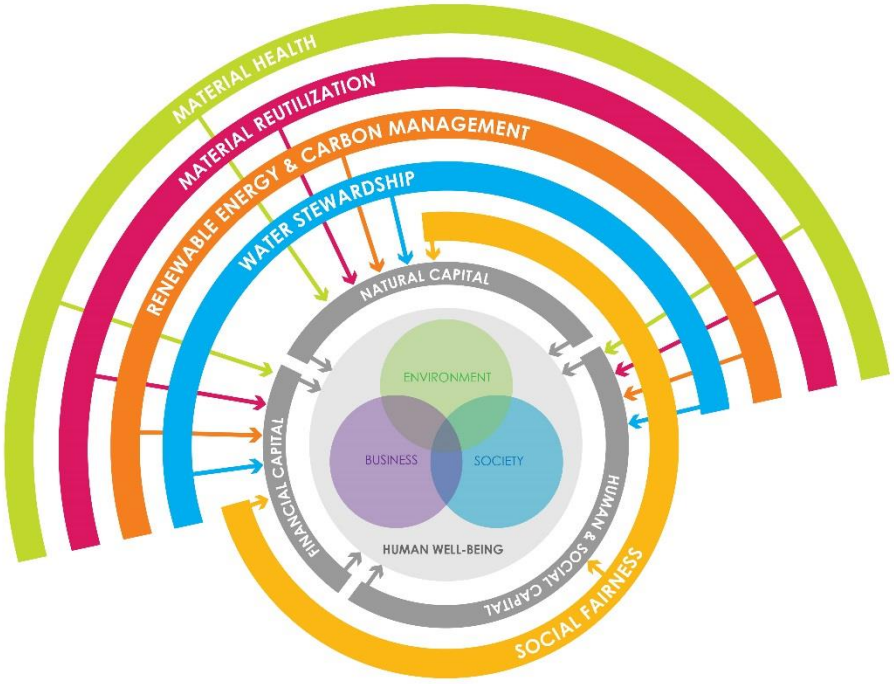
<table>
<tr><th></th><th>Physical capital (including financial, manufactured and intellectual)</th><th>Human Capital</th><th>Social Capital</th><th>Natural Capital</th></tr>
<tr><td rowspan="3">Private Ownership</td><td>Factories & Buildings</td><td>Health</td><td rowspan="3">Corporate systems, procedures, protocols</td><td>Gardens</td></tr>
<tr><td>Cash & Securities</td><td>Intellect & Education</td><td>Fields</td></tr>
<tr><td>Patents & Software</td><td>Job Skills & Training</td><td>Forests</td></tr>
<tr><td rowspan="2">Community ownership (club goods)</td><td>Community Centers</td><td rowspan="2">Traditional knowledge</td><td rowspan="2">Community Norms and Customs</td><td>Community Forests</td></tr>
<tr><td>Community Schools</td><td>Village Grazing Commons</td></tr>
<tr><td rowspan="3">Public Ownership (public goods)</td><td>Roads</td><td>Public databases</td><td>Law & Order</td><td>High Seas fisheries</td></tr>
<tr><td>Bridges</td><td rowspan="2">Non-patented knowledge</td><td>Tax Compliance</td><td>National Parks/ Forests</td></tr>
<tr><td>Central Bank Reserves</td><td>Social Equity & Inclusion</td><td></td></tr>
</table>

To illustrate an example: let us consider the *Cradle to Cradle Certified* program's material health category, which encourages companies to quantify and understand their product material composition, identifying these as biological or technical nutrients, and removing hazardous chemicals, while replacing less healthy materials for optimized 'good' inputs. The adherence to this quality category motivates companies to improve understanding of their products and continuously work to improve this, through detailed scientific assessment. By reducing toxicity, the natural capital stock of clean air and unpolluted water is maintained, which itself has a positive indirect effect on human capital through improved health.

The figure overleaf outlines the conceptual framework.

CONCEPTUAL FRAMEWORK

FIGURE 4: THE CONCEPTUAL FRAMEWORK



Financial capital is used as it is a term more widely understood – however, on the graphic this actually represents 'physical capital', incorporating financial, but also manufactured and intellectual capital. The term 'physical capital' is often less well understood, however, so financial capital is included as representative of all three capital types.

NET BENEFIT/LOSS ANALYSIS

By quantifying the financial (and wider physical), natural, social and human capital values associated with products and their pre-certified or non-certified counterparts, it is possible to calculate a net capital benefit or net capital loss resulting from the certification process. A net benefit/loss is therefore considered to be the change in capitals between the two products under analysis.

Net benefit/loss calculations are versatile and can be applied to the program's five quality categories, individual drivers of change as well as across different product use-phases. This can help communicate the benefits of certification to a much more diverse number of internal and external stakeholders.

IMPLEMENTING THE FRAMEWORK

A robust methodology is required to implement the framework. Using insights from the literature review, four steps were defined as common requirements across any robust impact analysis. These are:

1. Define the scope and boundaries of the assessment – determining the limitations of the study and defining the areas upon which the impacts are relevant, for example, social groups affected, areas of business to include, or phases of a product cycle.
2. Determine the inventory - selection of indicators to be assessed, i.e. identification of what needs to be measured. The inventory may include environmental indicators such as tons of CO_2e emitted, or m^3 of water consumed, or may involve social indicators such as risk of child labor within any tier of the supply chain, as framed by the chosen boundary.
3. Impact assessment – carrying out calculations or other qualitative analysis of the impacts.
4. Interpretation – evaluation of the results and translation of data into findings placed into a context that is understandable.

These four steps form the basis of Trucost's methodology. Each step is considered in relation to the framework, incorporating the *Cradle to Cradle Certified* program's quality categories, the capitals in which the adherence of these categories impacts, and the three fields of environment, business and society in which the ultimate implications for human well-being exist.

METHODOLOGY OVERVIEW

READER'S GUIDE

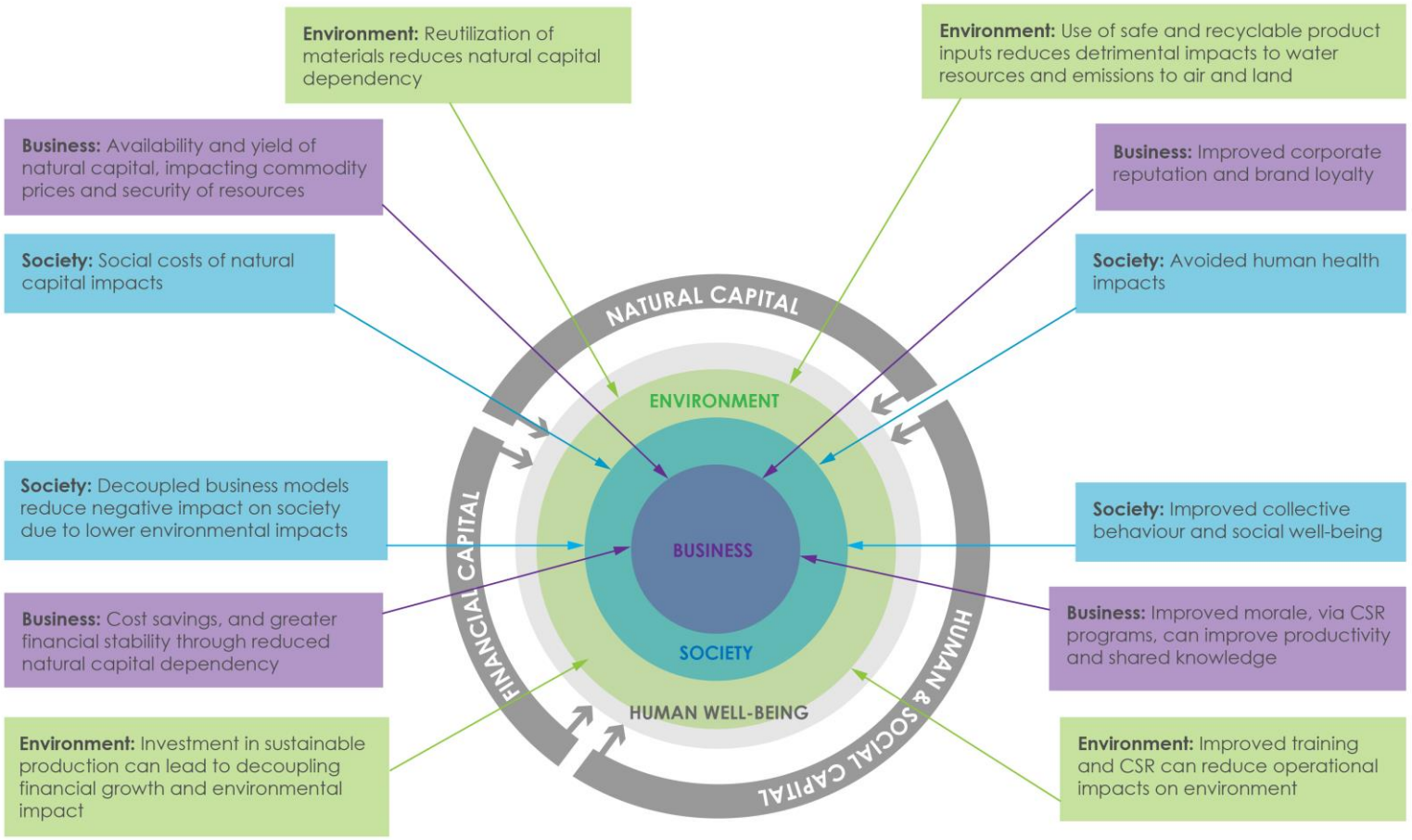
This section defines the methodology used by Trucost to apply the conceptual framework to determine the impacts of the *Cradle to Cradle Certified* Products Program across products of ten companies. The section starts with a high level overview of the methodological approach and the boundaries of the analysis. It then details the specific methodology used to assess the environmental, social and business impacts associated with the program. This section provides the necessary guidance to ensure that the study could be repeated in the future by companies and other relevant stakeholders. It also includes company-specific case studies, to reflect examples of how the methodology is applied to products and companies.

OVERVIEW

The positive and negative impacts of product certification under the *Cradle to Cradle Certified* Products Program can be considered on several levels and across three impact fields: environmental, social and business. Environmental and social impacts may be apparent internally and externally, affecting both the company and third parties. Business impacts are directly linked to the company and operations and can be considered internal. Each of the three impact fields are given equal weighting for significance, though these will be approached in different manners. Figure 5 considers how the capitals feed into the three elements of human well-being.

METHODOLOGY OVERVIEW

FIGURE 5: HOW CAPITALS FEED INTO HUMAN WELL-BEING



METHODOLOGY OVERVIEW

Businesses operate within society, which is in turn contained within the environment. While these three aspects of human well-being can be considered separately, they are also interrelated as shown in figure 4. Each type of capital flows into these three aspects of well-being, and these are identified in examples given in figure 5. Not all impacts are detailed, however, this provides some context of how the capitals each apply to the individual fields.

To capture all impacts and capitals, the individual impacts associated directly with the manufacture, use and end-of-use of a particular product were compared to the equivalent product before optimization for certification. The second consideration applies to the wider context of the benefit to the company of having one or more *Cradle to Cradle Certified* products.

The following steps were taken to determine the positive and negative impacts associated with *Cradle to Cradle Certified* product certification at the varying levels of influence.

ALIGNMENT OF THE *CRADLE TO CRADLE CERTIFIED* PRODUCTS PROGRAM TO THE FRAMEWORK

Environmental, social and business drivers associated with each of the quality categories were identified, quantified and evaluated across product use phases using a combination of quantitative and qualitative analysis.

FIGURE 6: ALIGNMENT OF QUALITY CATEGORIES

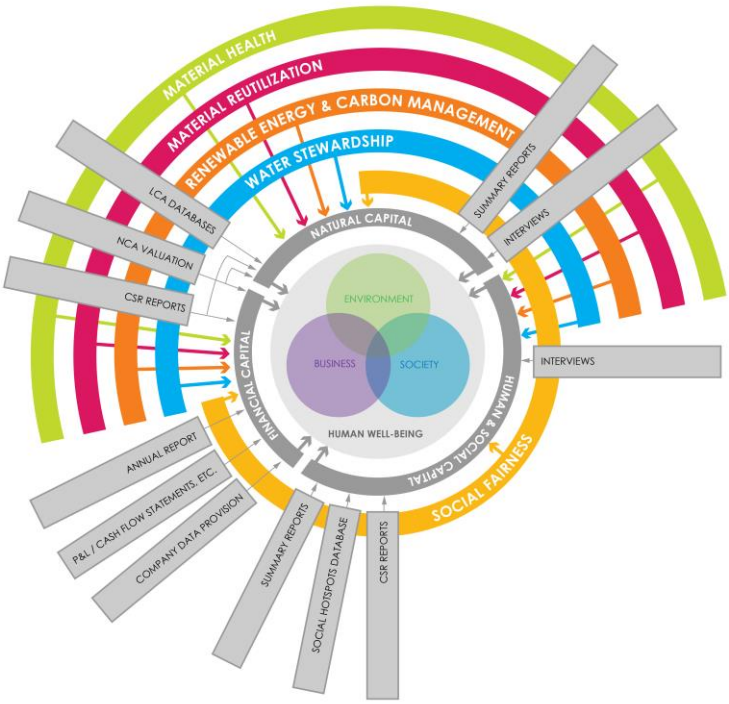


Figure 5 provides an overview of data sources used to measure impacts included within the fields of the framework. All five of the *Cradle to Cradle Certified* quality categories can be said to have an impact within each of the three impact fields. For instance, social fairness may produce a positive

company reputational benefit, increasing product sales, identified from annual reports and financial data provision. Both material utilization and renewable energy improvements create less negative, or even a positive impact on global air quality, which has a social impact on human health. These factors are all reflected within the indicators considered. More detail of the specific indicators is given in the individual methodologies for each of the impact fields and a full list of indicators is given in Appendix III.

Once quantified, the environmental impacts will be valued to reflect wider impacts than those highlighted within a simple LCA study or similar approach. Valuation can be applied to tangible impacts such as volume of water consumed, or tons of greenhouse gas emitted, and capture a more comprehensive reflection of the damage that these impacts have on society and the environment. Values correlate with the benefits associated with the *Cradle to Cradle Certified* Products Program. These valuations reflect social issues, such as the health impacts of air quality. Social capital includes less easily defined indicators, such as networks, values, and trust. These pose challenges to valuation. Specifically the field of social valuation is less mature, associated with finer complexities, and inherently less quantifiable than, for example, natural capital valuation. Social indicators captured within the social analysis are not valued within this research, though there is opportunity to develop this in future research. Qualitative approach to social impacts is often more appropriate for examining indirect and large-scale impacts. As an example, Auld *et al* (2008) takes a nested look at forest certification's direct and indirect impacts, capturing qualitative impacts as a key method for wider indirect impacts.

STUDY BOUNDARIES

The Institute initially invited companies to volunteer to participate based on several criteria, including achievement of certified GOLD in at least one of the program's quality categories. Ten companies were selected for analysis, and listed in table 7. Companies were selected with the aim of including a wide range, with the following factors considered:

- Product group and sector
- Geographic variation
- Certification level
- Early/late adopters of certification
- Proportion of total product portfolio certified

Each of the companies chosen for inclusion selected one product for analysis before and after certification, resulting in 20 product analyses.

SELECTION BIAS

This research is a pilot review, providing the first step towards a full understanding of the impacts associated with the program. Ten individual companies and product comparisons were selected for detailed analysis. Because these companies volunteered to participate there may be some level of bias. It should be remembered that the research is a pilot and the small number of products selected for analysis is not intended to represent all *Cradle to Cradle Certified* products.

Selection bias has been minimized where possible, through selection of a wide range of companies in a varied geographic locations. It should also be noted that current certification uptake is largely limited to Europe and North America. Other countries may be included in future years and impacts may be varied due to different social and demographic regions.

PRODUCT SELECTION

The specific products for analysis were determined within the first engagement with the participating companies. The participating companies were given opportunity to select their own products, but following the criteria below where possible[6]:

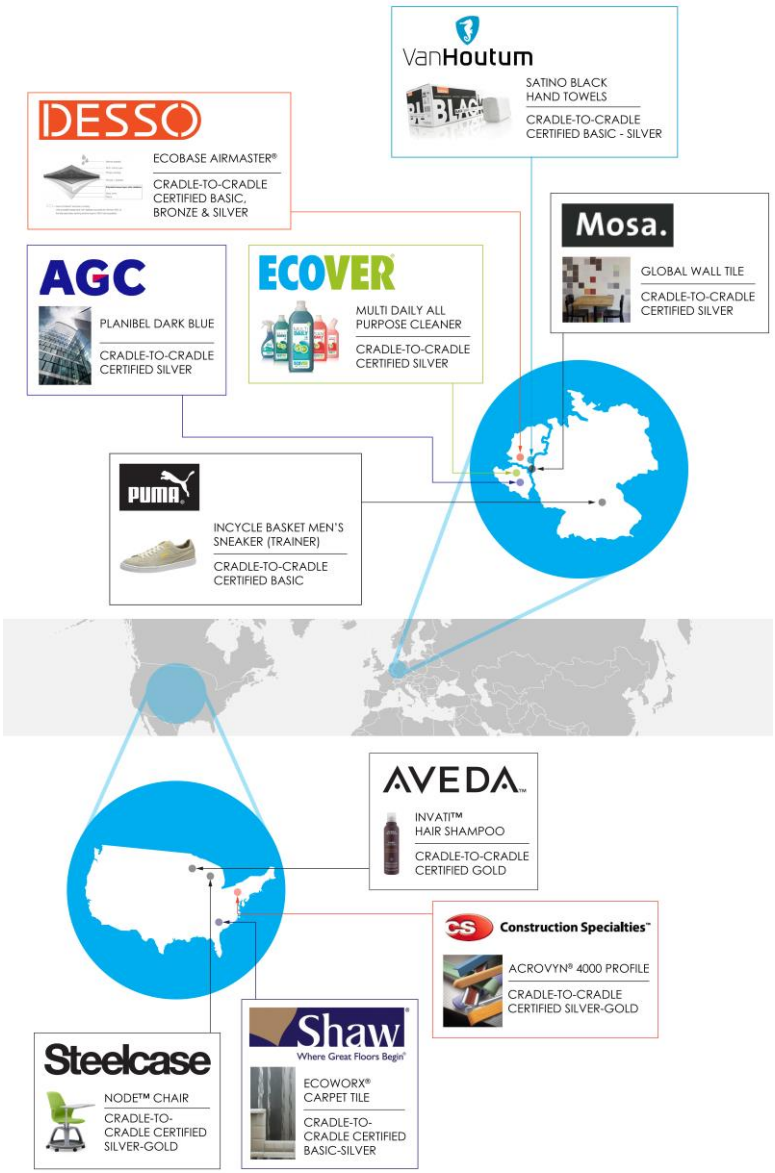
- The product must be certified (at any level, BASIC to PLATINUM).
- The product should have once been available without certification, or at a lower certification award level (where this is unavailable, equivalent products are compared).
- The product must have a well-understood optimization process, backed with quantified data.
- The company should have access to product data.

Some companies design products specifically for certification, and as such, an equivalent earlier version of the same product is not available. Where this is the case, comparison to a similar product within the company's portfolio is used as a comparison. Where this is also unavailable (due to lack of similar product), hypothetical comparison products made from materials which are conventionally used are given as the baseline comparison.

[6] As with company selection, some caution must be taken when considering the products selected, as bias may be involved due to company preferences. This is not considered to be detrimental to the methodology, but may not be reflective of all products undergoing certification.

STUDY BOUNDARIES

FIGURE 7: LOCATION OF PARTICIPATING COMPANIES, WITH ANALYZED PRODUCT AND CERTIFICATION LEVELS ACHIEVED ACROSS PRODUCT PORTFOLIO



The figure above identifies the product analyzed for each of the companies within the pilot study. The certification levels identified represent the range of certification achieved across all *Cradle to Cradle Certified* products sold by the company.

BASELINE PRODUCT SELECTION

Following company and product selection, discussion was held with the individual companies to determine the appropriate baseline comparison. Where possible, if the product was available before certification, this was selected as preference. Several companies launched products already certified, so alternative comparison products were selected. This was either an equivalent product available non-certified within the company's portfolio, or an equivalent hypothetical product, given properties of the certified product without design decisions selected for certification (for example, a

product made specifically for certification, with a base material selected for certification adherence was compared to a hypothetical product made with the conventional material used within the sector, but banned for *Cradle to Cradle Certified* eligibility.

TABLE 7: BASELINE COMPARISON PRODUCTS SELECTED

Company	Product	Baseline Comparison product
AGC Glass Europe	Planibel Dark Blue Float Glass	Product before certification
Aveda	Invati Shampoo	Due to commercial sensitivity, the ingredients of the product could not be shared, therefore operational impacts before and after certification were reviewed, plus packaging.
Construction Specialties	Acrovyn 4000	Equivalent earlier certification level product (Acrovyn 3000), and compared to pre-certified equivalent
Desso	Airmaster Ecobase	Pre certification hypothetical (bitumen based but same process)
Ecover	Multi Daily	Product before certification
Mosa	Global wall tile	Product before certification
PUMA	Incycle Trainer	Non-certified conventional PUMA trainer
Shaw	EcoWorx carpet tile	Product before certification
Steelcase	node chair	Hypothetical equivalent produced with PVC
Van Houtum	Satino Black hand towels	Product before certification

Where the full product and its packaging was not available for comparison, analysis was still carried out, although it could not be considered representative of all impacts of the process. One example was Aveda Invati shampoo, which had a highly commercially sensitive formula that was not available for comparison. Operational and packaging data were used for the analysis. Packaging was the component of which the material itself was considered altered due to the certification process (the key optimization for the packaging was the increase in post-consumer recycled (PCR) HDPE content), and the impact of this on supply chain is addressed. Operational data of processing was also included, but all supply chain impacts of the product itself were not calculated, though these were not considered to have been affected by the certification process.

TOP LEVEL APPROACH

Trucost followed four high-level steps to carry the natural capital impact assessment:

- Scope and boundaries
- Inventory
- Impact assessment
- Interpretation

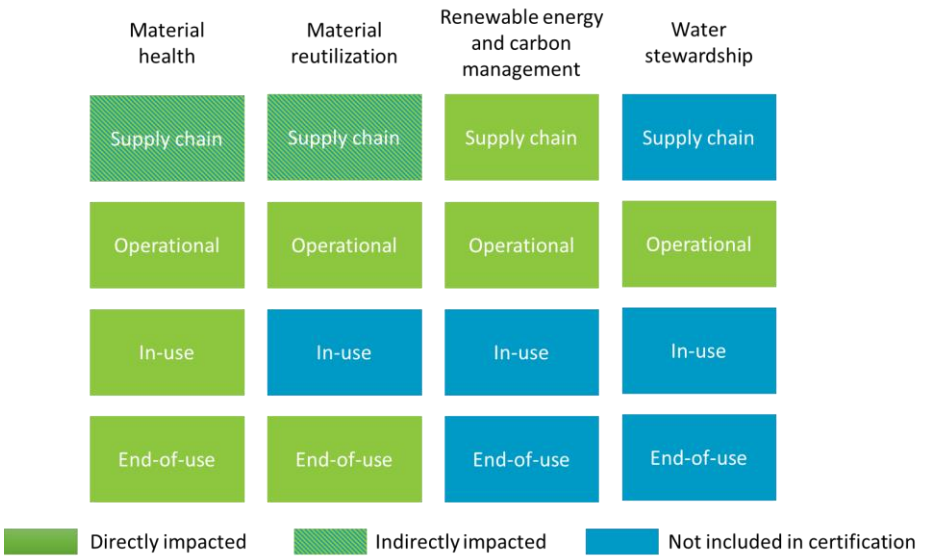
These steps are detailed below.

SCOPE AND BOUNDARIES

DEFINING THE SCOPE OF THE ENVIRONMENTAL ANALYSIS

Requirements in the *Cradle to Cradle Certified* Product Standard categories drive improvements at different stages of the product cycle. Each one of the four selected categories directly and indirectly drives improvements in one or several product phases. The application, adherence and improvement along the lines of quality categories can also have an impact beyond the product cycle boundaries directly considered within the Product Standard itself. Trucost assessed both aspects as part of this analysis. The following figure illustrates the stages affected by the certification directly, and those which are affected as an indirect effect of the main certification requirements.

FIGURE 8: PRODUCT PHASES COVERED BY EACH QUALITY CATEGORY



Green boxes indicate the phases that are directly impacted by the four *Cradle to Cradle Certified* Product Standard categories. Where possible, Trucost also captured the indirect spillover effects of adhering and implementing the *Cradle to Cradle Certified* Product Standard over the full product cycle, represented by the stripped boxes on Figure 8 (these may include direct impacts as well). Blue boxes are not included within the certification process. Where the final point of manufacture is considered outside of a company's facilities, this is included within 'operational' though is technically tier one of the supply chain.

The material health category assesses the toxicity of materials when used in

manufacturing processes and by end customers, as well as how it affects the product's recyclability in its end-of-use. The material health impacts of sourcing and manufacturing materials are not considered directly within the category, but may be indirectly impacted by the phasing out and substitution of certain materials and chemicals with others.

The material reutilization category specifically looks at materials that are either re-used, recycled, recyclable, rapidly renewable bio-based and/or biodegradable; the supply chain and end-of-use stages are thus taken into account for parts of the material make-up of the product assessed. Trucost also assessed the supply chain of the other materials that make-up the product. Using reused, recycled, biodegradable and/or renewable materials may also directly impact the operational and in-use phase, through processing or take back schemes. Due to lack of data and calculation uncertainties, Trucost excluded this from the analysis, however this may be relevant for future analyses. Energy and water variation in operations due to any factors are captured within the other quality categories however.

The renewable energy category mainly encompasses the operational stage of the product cycle, i.e. the energy that is used during operations. In order to achieve the PLATINUM level, the *Cradle to Cradle Certified* Product Standard recommends the characterization and quantification of embodied energy (i.e. supply chain), as well as the implementation of offsets or other types of projects to address it. The standard does not consider directly the energy usage of the product when in-use – and this phase is not likely to be impacted by the renewable energy category.

Finally, the water stewardship category covers the operational stage and the supply chain stage at higher levels of the certification. In order to achieve a certification level higher than SILVER in v3.0 of the standard, companies that do not generate product-relevant effluents are requested to characterize, devise a strategy and demonstrate progress around water-relevant issues for at least 20% of their tier one suppliers. Trucost also included the total water embodied in the supply chain of the product in order to put operational water usage into perspective. The analysis therefore focuses on not just quantification but also the quality of water discharged and water consumption is addressed in relation to the scarcity of the region from which it was sourced. Where a product is certified to v2.1.1 of the standard, SILVER level requires creation or adoption of water stewardship principles or guidelines. While these may vary in detail, example principles given in the standard[7] include improving wastewater quality and minimizing negative impacts on water ecosystems, along with improvement of water use. Water principles created by companies were reviewed, and quantitative analysis is considered reflective of the impacts of these principles, and in turn the certification process itself.

For the purposes of this study, retail impacts are excluded based on immateriality relative to other product use cycle stages. This assertion is based on previous reviews of similar complexity products. This may differ if other products are considered, specifically food and drink products where refrigeration is required (though currently excluded from *Cradle to Cradle Certified* Products Program). Further, it is unlikely that the retail impact of pre- and post-optimized products vary significantly since retail impacts are often associated with non-product specific requirements. One exception is the use of refillable containers with electronic pump systems (e.g. product refills)

[7] Such as World Business Council for Sustainable Development – Water Principles (http://www.wbcsd.ch/web/publications/sinkorswim.pdf) pg. 11, and Hannover Principles: Design for Sustainability – Water http://www.gemi.org/water/resources/hannover.htm

or products that can be repaired at the retailer's location. This is irrelevant, however, for the products selected within the scope of this analysis.

INVENTORY

Requirements of four of the five *Cradle to Cradle Certified* Product Standard categories directly drive improvements in natural capital and the environment – material health, material reutilization, renewable energy and water stewardship. The social fairness category may indirectly drive change in natural capital and the environment through, for example, increased salaries and consumption from employees. However, as this link is not well understood, Trucost excluded its assessment from the scope of this study.

For each *Cradle to Cradle Certified* Product Standard category, Trucost identified material environmental impacts to be included in the analysis.

ENVIRONMENTAL INDICATORS SELECTION

The following table outlines the environmental impacts that Trucost included in the research for each quality category. These were selected based on the materiality of each impact to the participating companies as well as their relevance to the categories themselves.

TABLE 8: ENVIRONMENTAL INDICATORS IDENTIFIED WITHIN EACH QUALITY CATEGORY

Quality Category	Environmental indicators
Material health	Percentage of each ABC-X material (and grey 'unassessed') by weight Number of phased out materials (and ranking) Human and eco toxicity associated with material composition of products.
Material reutilization	Technical or biological nutrient cycle Material reutilization score Captures indicators associated with the material used and recovered at end-of-use, including Greenhouse gases, air pollutants, water consumption, toxicity
Renewable energy and carbon management	Energy used (and captures indicators associated with the energy used in operations and within supply chain, including greenhouse gases, air pollutants, water consumption, toxicity) Percentage and quantity of renewable energy (by source) at final manufacturing stage Percentage and quantity of energy at final manufacturing stage offset
Water stewardship	No water discharge permit violation Water consumption volume Wastewater discharged volume (and associated indicators, e.g. COD, BOD)

The next sections detail how data was collected on the identified environmental impacts and phases identified.

DATA COLLECTION

For each environmental impact, Trucost gathered primary and secondary data from participating companies through review of the Summary Report, an Excel-based questionnaire (see Appendix IV) and communication with relevant people. Trucost did not engage with suppliers to collect data.

The Summary Report is created by the Accredited Assessment Body working with the company to achieve certification. The Accredited Assessment Body undertakes product analysis and engages with suppliers for a comprehensive data gathering process, and the findings of this work, and as such the award level for certification for each quality category, are given within the document. The Summary Report is then audited by the Institute, and if deemed to be appropriate then the Institute issues the certification. These reports were therefore primary data sources for this analysis, though they can contain sensitive information and therefore non-disclosure agreements (NDAs) were issued.

The following table lists the data points included in the research.

TABLE 9: ENVIRONMENTAL DATA COLLECTION

Data	Specific data points
Bill of materials, product and optimization data	Assessment summary reports were used to determine the specific ingredients of the certified products, supported with bills of materials to provide percentage composition and greater detail such as sourcing location of each material[8]. Where pre-certified products were analyzed, companies were asked to provide a list of materials phased out for optimization purposes. The summary reports are also used to gather specific data for the analysis, particularly for the material health category.
Operational data	Includes energy usage per type, waste generated per type and management routes (e.g. landfill, recycling), water use, waste water quantity and COD content. Waste water quantity and quality was not available from all companies, with only two companies providing COD. Operational data was collected at a product level were possible, and where not, site level data was used, with impacts allocated to product based on production ratio (see production data below).

[8] Aveda were unable to provide the bill of materials or compositional data for the Invati shampoo due to commercial sensitivity.

Production data	Where product level data was not provided[9], site impacts were allocated based on number of units of production at site, as a percentage of total production based on weight. For certified and non-certified products, number of units produced, sold and revenue from product sales were requested, though only 5 companies shared data of sales by unit[10], due to commercial sensitivity or lack of disaggregated data available.
Transportation	Outbound transportation distances and modes was collected for 6 companies, and where unavailable, final country of sale was used and average transport distances were mapped.
Countries of sale	Percentage of sales in each country, where possible pre and post certification.
Use specifications	For eight of ten products, use phase did not vary between certified and pre-certified versions. Use phase data such as cleaning requirements and energy or resource requirements or benefit were provided[11].
End-of-use scenario	Companies provided insights on end-of-use scenarios for the product and where relevant information on take-back schemes. Where no specific take back scheme was in place (for seven of the ten companies), national waste statistics and recovery data was used to estimate end-of-use pathways apparent for the products.

Secondary data includes lifecycle analysis datasets covering the physical quantities of emissions generated during the manufacturing, use, transportation and end-of-use phases of the certified products and their pre-certified or non-certified counterparts. Trucost used LCA databases such as Ecoinvent 3.0 to gather environmental impact data that reflect typical impacts and industry averages. Conducting a full LCA goes beyond the purpose of this study, which aims to stay at a screening level. Moreover LCA alone is inadequate for assessing *Cradle to Cradle Certified* principles and achievements.

Where possible, companies were asked to provide data at the product level, but not all companies have data at such a granular level (for example water consumption may not be metered to product specific processes). Where companies were only able to provide data at a site level (for example, volume of water consumed at site), a percentage of use was allocated by mass to the specific product under analysis.

[9] Only one company provided all data at product level
[10] Where unavailable by unit, indexed sales and/or percentage growth over previous comparison year was provided.
[11] As examples, the Desso Airmaster carpet tile captures and holds particulate matter from the environment, for which Desso provided laboratory test results. Other products such as Mosa tiles required water and soap for periodic cleaning.

Results of the data collection process

All companies provided Trucost with bills of materials, excluding Aveda due to the commercial sensitivity of its formula. The majority were able to provide Summary Reports, though confidential edited versions were necessary for some (Summary Reports often contain material sensitive to suppliers, not only the company with certified product). All companies provided Trucost with operational data, with varying indicator coverage. Only two companies were able to provide specific and quantified end-of-use data, as this is not often measured by companies unless takeback schemes in place.

The following sections detail the main assumptions and methodological considerations used in the calculation of each environmental indicator selected within the use-cycle phases highlighted in the previous sections.

IMPACT ASSESSMENT

This section provides more information on specific methodological considerations given when quantifying environmental indicators for the assessment.

DATA ASSUMPTIONS

Credits and burdens

When considering the quantification of the impacts generated by the alignment and improvement along the lines of *Cradle to Cradle Certified* quality categories, Trucost included both credit and burdens. Credits refer to a positive impact, and have been allocated for the use of recycled content, recycling/composting and incinerating with energy recovery at the end-of-use, and any other benefits linked to the certification. Burdens refer to negative impacts such as resource consumption of processing. The performance of a product can thus be improved by either reducing burdens (eco-efficiency) or increasing credits (eco-effectiveness), or both.

Allocation

Companies provided operational data at a site or company-level. In order to attribute the environmental impact to the relevant unit of product analyzed, Trucost used mass allocation due to data availability (for example, a certified product may account for 25% of the total tonnage of products manufactured at a particular site, and therefore 25% of water and energy use are attributed to the particular product). When allocation had to be performed to construct factors, Trucost used mass allocation as well to maintain consistency.

Exclusion

Some material inputs were excluded from the analysis based on data gaps, uncertainty and materiality thresholds. Excluded inputs make up less than 2% of the total weight of the product and are comprised of glue and adhesives, pigments and inks, and other chemical inputs. While these material inputs are not significant when using a weight threshold, they might be when calculating their overall environmental impact. These exclusions thus introduce some uncertainty and most likely underestimate the total environmental impact of each product.

Regionalization

Where possible and relevant, country-specific or region-specific factors were used, taking into account variation in processing methods and other regional variations. In order to regionalize further, the first-tier electricity mix of the main materials was adapted based on the sourcing location reported by companies (each country has different national grid emission factors based on the generation of electricity in the particular region). Inbound transportation factors were adapted based on the sourcing location where possible.

Proxies

For material inputs not available on Ecoinvent, LCA factors were retrieved from secondary literature to use directly, combined with Ecoinvent factors and construct proxies. This includes recycled plastics and metals, biogas, bio-based plastics, certain chemicals and energy usage. Table 10 overleaf lists the modelling techniques, improvement opportunities and sources for each of these inputs.

TABLE 10: MAIN SOURCES AND USE OF PROXIES

Material input	Modelling technique	Improvement opportunities	Sources
Recycled Plastics	Burden: Combined data on the quantity and type of fuel needed to sort and recover polyethylene with impact data from Ecoinvent and Defra/EPA on using these fuels. Credit: A credit was allocated based on the avoided burdens that the manufacture of primary raw materials would have generated.	Burden: Polyethylene mechanical recycling was used as a proxy for every recycled plastic; and transportation distances and modes for waste collection Credit: No displacement rates or quality loss considerations included.	Franklin Associates 2010, DEFRA 2012, EPA 2013, Ecoinvent 2013, Eurostat 2010, North American Transportation Statistics Database 2010
Recycled Metals	Burden: Ecoinvent factors were combined on the collection, preparation and treatment of metal scrap and the energy requirements to remelt secondary metals. The relative proportion of energy inputs needed to remelt primary and secondary metal was derived from secondary LCA sources. Credit: Allocation of a credit based on the avoided burdens that the manufacture of primary raw materials would have generated.	Burden: The average of steel and aluminum was used as a proxy for zinc; and transportation distances and modes for waste collection Credit: No displacement rates or quality loss considerations included.	Allwood et al. 2010, DEFRA 2012, EPA 2013, Ecoinvent 2013, Eurostat 2010, North American Transportation Statistics Database 2010
Recycled Paper	Burden: Ecoinvent factors combined on the sorting of waste paper and proxies on transportation distances and mode for the collection phase. Waste paper is reprocessed in-house in the pool of companies analyzed. It was thus assumed that the environmental impact of re-pulping is included in the operational impact data. Credit: The quantity of wood needed in one unit of paper was quantified and the environmental impact of growing the wood calculated from Ecoinvent. It was assumed that re-pulping waste paper uses 50% less energy that pulping wood, and assigned a credit to the displacement of the environmental burden that the pulping of primary wood would have generated.	Burden: A proxy was used for transportation distance and mode in the collection phase. Credit: No displacement rates or quality loss considerations included.	Van Oel & Hoekstra 2010, DEFRA 2012, EPA 2013, Ecoinvent 2013, Eurostat 2010, North American Transportation Statistics Database 2010, Firoz et al. 2013
Recycled Glass	Burden: Combined Ecoinvent factors on the sorting of waste glass and proxies on transportation distances and mode for the	Burden: A proxy was used for transportation distance and mode in the	DEFRA 2012, EPA 2013, Ecoinvent 2013, Eurostat 2010,

Material input	Modelling technique	Improvement opportunities	Sources
	collection phase. Glass cullets are reprocessed and remelted in-house in the pool of companies analyzed. Trucost thus assumed that the environmental impact of remelting is included in the operational impact data. Credit: A credit was allocated based on the avoided burdens that the manufacture of primary raw materials would have generated.	collection phase. Credit: No displacement rates or quality loss considerations included.	North American Transportation Statistics Database 2010
Recycled Silica	Burden: Only transportation impact was included as the silica is re-processed in-house in the pool of companies analyzed. The environmental impact of re-processing the material is thus assumed to be included in the operational impact data. Credit: A credit was allocated based on the avoided burdens that the manufacture of primary raw materials would have generated.	Burden: Intermediate steps to prepare the material for re-processing such as crushing are excluded and likely underestimates the environmental impact of recycling this material. Average transportation distance and modes were used. Credit: No displacement rates or quality loss considerations included.	Ecoinvent 2013, Eurostat 2010, North American Transportation Statistics Database 2010
Biogas	Burden: In order to calculate the environmental impact of biogas production from manure, energy and water input data was used, allocated by mass. The quantity of energy input needed was multiplied by the relevant factors taken from Ecoinvent for the supply chain and DEFRA for direct emissions generated by their use. Credit: No credits were allocated to biogas	Burden: While energy inputs are likely to be the most material in the overall impact of biogas from manure, the exclusion of the supply chain impact of other inputs (such as infrastructure and chemicals) underestimates the overall results. Credit: No credits were allocated to biogas. A possible improvement is to allocate a credit based on the displacement of conventional fuels	Biogasmax 2013, Ecoinvent 2013
Bio-based Plastics	Burden: The quantity of ethanol from sugarcane needed to manufacture one unit of bio-based plastic from stoichiometric relationships was derived. Ecoinvent factors were then used to calculate the impact of manufacturing ethanol from sugarcane,	Burden: Energy requirements of the polymerization phase, i.e from ethylene to polyethylene are not included but likely to be immaterial compared to the overall use	Liptow & Tillman 2012, Ecoinvent 2013, DEFRA 2012, EPA 2013,

Material input	Modelling technique	Improvement opportunities	Sources
	and secondary LCA sources to derive the quantity and type of fuels needed to in the ethanol to ethylene transformation. Credit: No credits were allocated to bioplastics	cycle impacts. Credit: No credits were allocated to bioplastics. A possible improvement is to allocate a credit based on the displacement of conventional plastic.	
Chemicals	For chemicals not available in Ecoinvent, stoichiometric relationships and molar mass were used to derive a proxy.	Energy requirements to react chemicals and the supply chain impact of certain inputs are excluded.	Ecoinvent 2013, ConvertUnits 2013
Energy use	To calculate the impact of energy usage, combined Ecoinvent factors for supply chain impacts, and Defra/Webfire for the direct impact of burning/using these fuels were used.	Direct factors for water and toxicity were excluded for lack of appropriate data. Supply chain impacts on these KPIs are included and likely to be more material.	Ecoinvent 2013, DEFRA 2012, EPA 2013

Indicator-specific assumptions

Air pollutants, greenhouse gases, water consumption and toxicity are directly retrievable from Ecoinvent Life Cycle Inventory or Life Cycle Impact Assessment data and secondary LCA literature.

The environmental impact of treating waste and wastewater in the supply chain is already built into the other environmental indicators. For example, the quantity of air pollutants generated by the manufacturing of plastics includes the quantity of air pollutants generated by the treatment of waste and wastewater along the supply chain. The environmental impact of waste and wastewater at the operational level was calculated additionally, but supply chain excluded as already accounted for. The methodology used for waste and wastewater are given below;

Waste

Companies reported the quantity of waste generated before and after certification per waste type (hazardous and non-hazardous) and waste management route (landfill, recycled, re-used, composted, incinerated, incinerated with energy recovery). The exact waste composition was unknown, as companies do not typically record this data, however Eurostat (2008) publishes industry level data for non-hazardous waste generation per country for the EU27 which can be used in place of actual data. Trucost mapped each waste type to an Ecoinvent record and retrieved environmental indicator quantities for both landfilling and incinerating burdens. Trucost then combined the Eurostat data and Ecoinvent factors in order to create a weighted average per industry of the burdens generated by landfilling or incinerating non-hazardous waste.

In general terms, a hazardous waste is a waste with a chemical composition or other properties that make it capable of causing illness, death, or some other harm to humans and other life forms when mismanaged or released into the environment. Hazardous waste is not as material in weight terms as non-hazardous waste for the participating companies. Consequently, Trucost did not calculate a weighted average per industry as done with non-hazardous waste and retrieved factors directly from Ecoinvent.

Trucost allocated credits to waste recycled, composted, re-used and incinerated with energy recovery. Credits for recycling, composting and re-using waste are equal to the displaced burden of manufacturing raw material. Credits for incineration with energy recovery are equal to the environmental impact that generating the energy recovered would have had. Trucost calculated the industry-specific weighted average of the higher heating value of waste based on Eurostat and Ecoinvent data and attributed a credit to the quantity of waste incinerated with energy recovery based on the industry-specific higher heating value and the average electricity grid emission factors in the country where the participating company operates.

Wastewater

In countries where the companies selected operate, wastewater is usually treated off-site or on-site before being released in the environment. Trucost thus assessed the impact of higher wastewater quality by calculating how much greenhouse gases, air pollutants, toxicity and water is needed to treat wastewater at different quality levels. Trucost used COD content as a proxy for wastewater quality and adapted Ecoinvent factors based on a linear relationship between COD content and environmental impacts generated by treating the water. Where companies were not able to provide Trucost with COD content, Trucost used an industry proxy.

Outbound transportation

In order to model the environmental impact of outbound transportation, Trucost used average distances from the manufacturing location to the main country/continent of sales, either the United States or Europe in the pool of companies participating to this study. Data from the North American Transportation Statistics Database (2010) and Eurostat (2010) was used to estimate the modal split. Finally, Trucost applied Ecoinvent factors expressed in ton-kilometer based on the average distance and the modal split derived in the previous two steps.

Use phase

Where possible and relevant, Trucost calculated the environmental impact associated with the use phase of the product. Apart from one company (Desso), the use-phase impacts do not differ pre- and post-certification and are just used to put in perspective the other use cycle phase's impacts.

End-of-use

Where available, customer research data supplied by the participating company was preferred, though where this was unavailable, regional waste statistics were applied. Where companies operate a take back scheme, details and data were also gathered directly. Credits and burdens were allocated the same way as operational waste.

INTERPRETATION: VALUATION

For the environmental impact analysis, interpretation consisted of two stages, valuation of indicators and alignment with *Cradle to Cradle Certified* Product Program's quality categories. This section details the valuation methodology.

The previous section describes how environmental indicators were quantified in physical terms. Environmental profit and loss (EP&L) accounting takes this one step further, placing a financial value on the environmental impacts. This step translates the physical impact (m^3, tons) into a common metric (US$) expressing natural capital risks and opportunities.

This section details the methodology used to monetize the value of unpriced environmental impact and derive the social environmental costs applied to quantities of each impact. Trucost's valuation of environmental impacts estimates the value of a natural good or service in the absence of a market price to allow direct comparison with financial performance and appraisal of potential profit at risk. This approach provides insight into exposure to an increase in the private cost of natural capital following internalization. Valuations were derived from academic journals, government studies and established environmental economics techniques. The way in which these are applied depends on the environmental indicator. Greenhouse gases, for example, have the same impact wherever they are emitted. Values for other pollutants and water use depend on local biophysical and human geography, and so require a technique called benefit transfer to apply a value estimated in one location to another. Each valuation is described in more detail below.

Environmental externalities can be internalized through a number of mechanisms, for example, environmental taxes, legislation on resource consumption, emissions, pollution release, and the price of commodities can be influenced by climate related events such as drought and flooding. Analysis carried out for TEEB for Business found that the profits of apparel retailers were impacted by up to 50% through cotton price volatility in recent years (Trucost, 2013). Commodity prices overall increased by nearly 150% in the ten years between 2002 and 2010 (World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, 2014).

GREENHOUSE GAS (GHG) EMISSIONS VALUATION METHODOLOGY

A greenhouse gas is a gas in the atmosphere that absorbs and emits radiation within the thermal infrared range. The primary greenhouse gases are water vapor, carbon dioxide, methane, nitrous oxide and ozone. Greenhouse gas emissions can be valued using a marginal abatement cost, a market price or the social cost of carbon. This section defines these three methods and justifies why the social cost of carbon is the preferred valuation method. It then describes the valuation study used to derive the natural capital valuation applied in this study.

Step 1: Selecting an approach for valuing greenhouse gas emissions

Three approaches for valuing the marginal or incremental cost of an additional ton of GHG emitted are summarized in the table below.

TABLE 11: GHG VALUATION APPROACHES

Marginal abatement cost (MAC) Definition: Valuing carbon using the known costs to reduce carbon to achieve an emissions reduction target, for example through energy efficiency improvements, renewable energy, materials substitution and/or carbon capture and storage technology. Advantages: Based on the known actual costs of existing reduction efforts. Disadvantages: Costs of reduction will fluctuate over time, by sector and by geography. Different reduction targets will translate into different MACs for each country. Estimates of the costs or benefits of increasing energy efficiency or switching to renewable energy are influenced by fossil fuel prices, carbon prices and other policy measures. The policies and technologies used to support carbon abatement will therefore influence pricing.
Market price Definition: The value of traded carbon emissions rights under policies that constrain the supply of emissions permits, credits or allowances. The market price should be equal to the MAC for a given target, if the carbon market covers all emissions sources and is competitive. In the absence of a comprehensive international emissions trading scheme, a cap consistent with the optimal stabilization goal would result in a market price of carbon equal to both the MAC and social cost of carbon (Department of Energy & Climate Change, 2011). Advantage: Market prices are easily accessible. Disadvantages: Market-based mechanisms have been slow and fragmented so companies are unlikely to pay market prices for emissions across global operations. Traded market prices do not reflect non-traded carbon costs, nor the impact of other market-based mechanisms such as carbon/fuel taxes, subsidies for removal of fossil fuels, or support for low carbon technologies (i.e. feed-in-tariffs for renewable energy supplies). Current market prices are too low to induce the level of emissions reductions required and are not representative of future abatement costs of the expected costs of damages from climate change impacts.
Social cost of carbon (SCC) Definition: The global cost of damages resulting from GHG emission-induced climate change. The value is based on the present value of each metric ton of carbon dioxide equivalent (CO_2e) emitted now, taking into account the full global cost of the damage that it imposes during its time in the atmosphere. Advantages: The SCC signals what society should be willing to pay now to avoid

the future damage caused by carbon emissions and therefore best reflects the total damage caused by emitting one ton of CO_2e. In theory, climate policy would set emissions reduction targets that result in a MAC equal to the SCC and, in perfect markets the price of carbon should equal the SCC. SCC is therefore the most complete measure of the damage generated by the emission of GHGs and is the method used by Trucost.

Disadvantages: SCC valuations are highly contingent on assumptions, in particular the discount rate chosen, emission scenarios and equity weighting. These assumptions vary in relevance to the principles of the *Cradle to Cradle Certified* Products Program across the academic studies used by Trucost to determine the valuation to apply, however as discussed below, a mean of valuation figures is used to best capture the range of options. Please see the next section for a discussion of each.

Trucost uses the Social Cost of Carbon method as it best reflects the total damage by the emission of one ton of CO_2e. In theory, optimal climate policies would set emissions reduction targets that result in a MAC equal to the SCC. Further, in perfect markets, the price of carbon should be equal to its damage cost (i.e. to the SCC). Therefore, the SCC is the most complete measure of the damage generated by GHG emissions.

Step 2: Calculating the social cost of carbon

Over 300 studies attempt to put a price on carbon, valuing the impact of climate change on agriculture, forestry, water resources, coastal zones, energy consumption, air quality, tropical and extratropical storms, and human health. The Stern Review (2006) is the largest and most widely cited document on the economic impact of climate change. It proposed a damage cost per ton of CO_2e emitted of 85USD2006. This report, however, has had mixed reviews. It has been suggested that the report's purpose was to prompt immediate action on climate change and was therefore based on ethical rather than scientific grounds (Weitzman, 2007).

Trucost has therefore used the results of a meta-analysis conducted by Richard Tol in his 2011 paper "The Economic Effects of Climate Change" to value the Social Cost of Carbon. Tol conducted a review of 311 estimates of the marginal damage costs of carbon and provides the mean, standard deviation, mode and median of the distribution. Estimates across studies vary from below-zero to four-figure estimates, mainly due to four factors:

Emissions scenarios: In order to derive the social cost of carbon, assumptions need to be made on future emissions, the extent and pattern of warming, and other possible impacts of climate change, so as to translate climate change to economic consequences. Tol (2011) identified three methodological approaches undertaken by the literature – expert review, enumerative method, and statistical method – and conducted a meta-analysis of the results. Studies are in broad agreements on the fact that the negative effects of climate change outweigh the short-run benefits of inaction. Tol (2011) identified nine studies of total economic cost of climate change, which in turn yielded more than 200 estimates of the marginal cost of carbon.

Discount rate: The discount rate used to calculate the present value of future economic damages resulting from carbon emitted today can be the most significant source of variation in estimates of the social cost of carbon (Tol, 2011). Higher discount rates result in lower present day values for the future damage costs of climate change. Variations in discount rates can be due to differences in assumptions about factors such as the rate of pure time preference, the growth rate of per capita consumption and the elasticity of marginal utility of consumption.

Equity weighting: A global SCC can take into account variations in the timings and

locations at which the costs of climate change impacts will be internalized, which may differ from the locations where the GHGs are emitted. Some studies including Stern (2006) and Tol (2011) take account of equity weightings – corrected for differences in the valuations of impacts in poor countries.

Uncertainties: Variations in valuations are influenced by uncertainties surrounding estimates of climate change damages and related costs. However climate change studies since 1995 tend to take account of net gains as well as losses due to climate change (Tol, 2011). The mean estimate of the social cost of carbon, as well as the standard deviation, have declined since 2001, suggesting decreasing uncertainty in the understanding of climate change impacts (Tol, 2011). Further, GDP loss estimates in relation to climate change have declined over time, as later studies focus on the positive *and* negative effects of climate change and take adaptation into account.

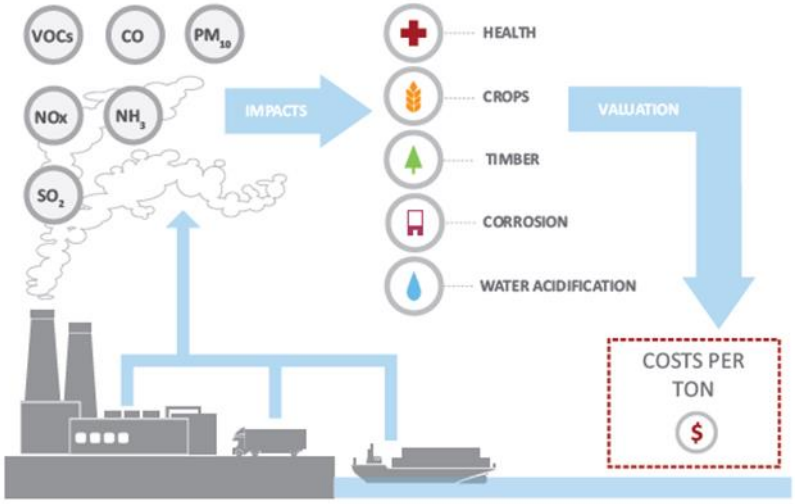
Trucost uses the mean of the values taken from 220 peer-reviewed studies. By using the mean rather than the median, the risk of catastrophic scenarios is better accounted for, as expressed in the higher damage costs calculated in the literature. Further, using a mean of values taken from different studies rather than relying on a single study such as the one from the Stern Review has the advantage of smoothing out any differences in assumptions through statistical analysis. Finally, Trucost adjusted for inflation to derive a cost of carbon for 2012. As a result, the SCC calculated by Trucost equals 121 USD 2012 per ton of CO_2e.

AIR POLLUTANT EMISSIONS VALUATION METHODOLOGY

Air pollution is not directly included within the *Cradle to Cradle Certified* Products Program, but is impacted by material use, energy use and recycling/reuse, and reflects improvement to human well-being through product optimization. For example, by switching fuel use to renewable energy generation, fewer air pollutants are released and through reuse, recycling or remanufacture of products, air pollutants released through the production of new products are reduced. The main air pollutants for analysis include sulphur dioxide (SO_2), nitrogen oxides (NOx), particulate matter (PM), ammonia (NH_3), carbon monoxide (CO) and volatile organic compounds (VOCs). Each pollutants impacts human health and/or crop and forest yields in a unique way. The economic damage caused per unit of pollutant depends on the specific location, and is driven by population and crop and forest density.

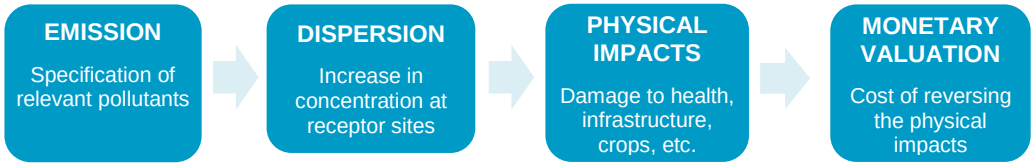
Each pollutant is associated with different but overlapping types of external costs. Some effects are caused directly by the primary pollutant emitted (e.g. health impacts of particulates) and some are caused by secondary pollutants formed in the atmosphere from pollutants that acts as precursors (e.g. sulphur dioxide forming sulphuric acid as well as sulphate compounds which contribute to smog). As each pollutant has a unique set of effects, each pollutant is valued using an individual methodology (although there is overlap between methodologies).

FIGURE 9: AIR POLLUTION VALUATION



Studies of the costs of damages from air pollution use the Impact Pathway Approach (IPA) to identify burdens (e.g. emissions), assess their impacts and value them in monetary terms (ExternE, 2000). In this approach, emissions are translated into physical impacts using dose–response functions (DRFs) which use peer-reviewed scientific data to measure the relationship between a concentration of a pollutant (the dose) and its impact on human health, building materials, crops, etc. (the receptor). A financial value is then assigned to each impact.

FIGURE 10: IMPACT PATHWAY APPROACH



Step 1: Identifying the main impacts for each air pollutants

Trucost identified which environmental impacts to consider for each air pollutant using the Impact Pathway Approach. Where impacts are excluded, such as the impact of Particulate Matter on crops and forestry, it was due to immateriality relative other effects. The table below summarizes which impacts are included for each air pollutant.

TABLE 12: AIR POLLUTANT ENVIRONMENTAL IMPACTS CONSIDERED

Air Pollutant	Environmental Impacts
Particulate Matter (PM)	Health
Ammonia (NH_3)	Health and forestry
Nitrous Oxides (NOx)	Health, crops and forestry
Volatile Organic Compounds (VOCs)	Health, crops and forestry
Sulphur dioxide (SO_2)	Health, freshwater, forestry and materials

Step 2: Building country specific valuations

Air pollutant impacts on health

The health costs include the cost mortality; chronic bronchitis; hospital admission; asthma attacks; restricted activity days; respiratory symptom days; congestive heart failure; chronic cough; cough and wheeze; and Bronchodilator use. Health costs were calculated for use across previous studies and applied in the context of Cradle to Cradle. These costs were calculated as follows:

Calculation of number of end points

Data was compiled on the number of end points (number of health impacts) generated by the emission of one ton of each air pollutant. In the context of health impacts, the number of end points is driven by population density, which is country specific.

Development of global average health costs

A literature review was conducted to identify country specific studies calculating the willingness to pay to avoid the different health impacts listed above. Using these studies, a country specific model was built and global average costs calculated weighted by population for each health impact. A global average was chosen to avoid the ethical considerations of applying different values of health and life across countries.

Application of global average costs

Natural capital valuation coefficients for each air pollutant are obtained by multiplying the number of end points by the global health costs.

Environmental impacts of other air pollutants impacts

Natural capital valuations of air pollutant impacts on crops, timber, water and building materials are country specific and were calculated as follows:

Literature compilation

Trucost compiled data from IPA studies on the cost of air pollutants' damages on crops, timber, water and building materials.

Adjustment of the cost based on receptor densities factors

Trucost adjusted the country-specific data obtained from the literature based on receptor densities such and percentage of crop or forest cover in a country. Impacts on building materials use maintenance costs which have been adjusted using purchasing power parity. Impacts on water acidification, included in the valuation of SO_2 are a global average.

WATER USE VALUATION METHODOLOGY

Water that is directly abstracted is rarely fully paid for despite having significant value to society. The more scarce water resources are in a particular region, the more valuable. The water stewardship quality category includes regional importance of water used: *'the water stewardship category encourages manufacturers to identify relevant issues in the local watershed of a manufacturing facility'*. Through calculating the scarcity of the water in the region, and including this within the valuation applied, availability issues for local communities is also considered.

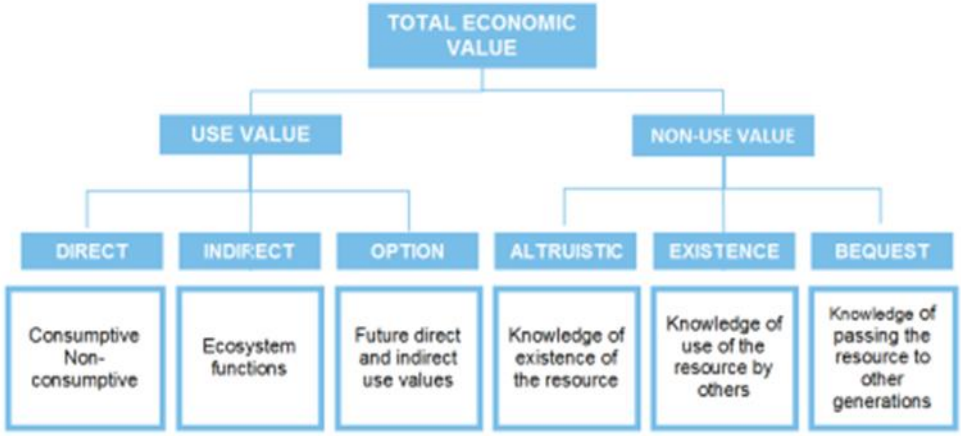
Step 1: Identifying the main impacts of abstracting water

According to the Total Economic Value (TEV) framework (EFTEC 2010), the value of water can be broken down into "use" values and "non-use" values (see Figure 11 below). Use values can be further broken down into direct use, indirect use, and

option values. Within direct use, the values can apply to "consumptive" or "non-consumptive" uses.

The "cost" of water consumption is the change in the TEV, and since it is not known whether a change in the industrial application of direct consumptive use would increase or decrease the value, this is excluded. Option and non-use values were also excluded due to the difficulty in valuing these uses. Therefore, direct non-consumptive use and indirect use values were estimated. Specifically, values for recreation, biodiversity, groundwater recharge, and others including salt dilution were identified in the academic literature in different geographic locations (example studies include Moran & Dann 2008, Payton 1990, Loomis 1987), and the water scarcity in each location was estimated using the FAO Aquastat database (Aquastat 2012). Values were adjusted to reflect 2012 prices, and comprised both marginal and average values. Monetary values are applied per cubic meter (m^3) of water.

FIGURE 11: COMPONENTS OF THE TOTAL ECONOMIC VALUE OF WATER

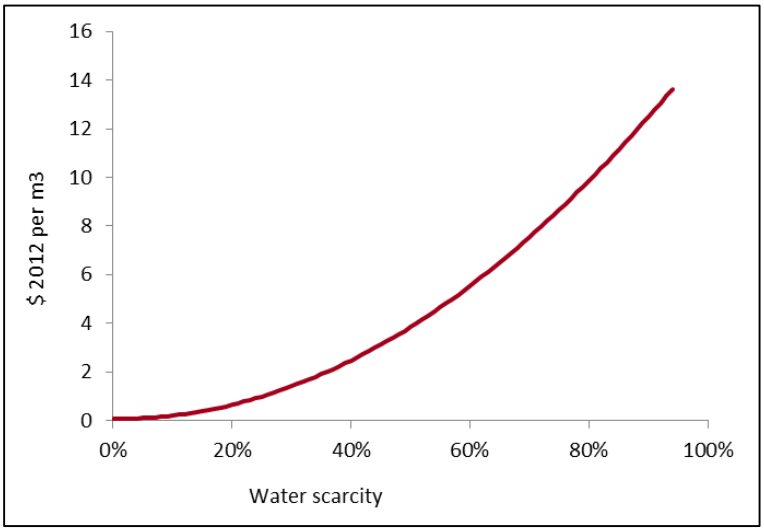


Step 2: Building country specific valuations

A function of water value (in US$ per m^3) relative to water scarcity (% of internal renewable water resources abstracted) was developed by Trucost based on the value of the services identified above, in US$ prices. This function was then used to estimate the environmental cost of water in any location where the scarcity is known, by adjusting the function estimate for purchasing power parity at that location.

The figure below illustrates the relationship between the environmental value of water and water scarcity.

FIGURE 12: ENVIRONMENTAL VALUE OF WATER AND WATER SCARCITY



TOXICITY VALUATION METHODOLOGY

Terrestrial, freshwater and human toxicity is expressed in kg 1,4 Dichlorobenzene (DCB) equivalent in Recipe Midpoint Hierarchist characterization model.

Step 1: Derive a country-specific valuation for Terrestrial and Freshwater ecotoxicity

Toxic substances, here 1,4 Dichlorobenzene, have an impact on terrestrial and freshwater ecosystems through reduced biodiversity. To value biodiversity, a study must define biodiversity, quantify biodiversity losses due to emissions of toxic substances through dispersion and deposition models, and then place a monetary value on these losses. Research projects which have attempted the latter (such as ExternE ("External Cost of Energy") and the NEEDS project ("New Energy Externalities Developments for Sustainability") revolve around calculating the damage cost of pollutants released by energy generation. The ExternE study is the result of more than 20 research projects conducted in the past 10 years, financed by DG Research and the European Commission. The NEEDS project (2006) was run by a consortium of organizations, including 66 partners from the academic, public and private sectors.

The NEEDS (2006) approach developed a formula to estimate the monetary cost per kilogram of toxic substances deposited on terrestrial and freshwater environments in each European country using the three following steps:

1. Calculate the willingness-to-pay to restore an area of land and freshwater

A meta-analysis of 24 studies and 42 value observations across regions and ecosystem types was conducted to calculate the willingness to pay to avoid damage to ecosystems. This is measured using a metric called Ecosystem Damage Potential (EDP), based on species richness.

2. Estimate the EDP of 1,4 Dichlorobenzene (DCB)

Trucost used the USES-LCA2.0 model (Van Zelm et al, 2009) to calculate the EDP of 1,4 DCB at a continental level.

3. Derive of a function to adapt the value to different countries using benefit transfer

Within the NEEDS project, a regression analysis between willingness-to-pay and

several variables was performed. The EDP valuation is known to have a positive correlation with population – as more people live close to an area with high biodiversity there will be more people that value biodiversity. The EPD value is known to have a negative correlation with the ecosystem size – if an ecosystem covers a larger area, the value per unit area will be less. Similarly, as biodiversity change increases, the value per unit of biodiversity diminishes. Using these variables, the formula below calculates the value of EDP in different regions.

Ln (VEDP) = 8.740+0.441*In(PD)+1.070*FOR–0.023*RIV+0.485*COA–2.010*dEDP–0.312 In(AREA)

VEDP= Value of ecological damage potential (willingness-to-pay)

PD= population density (‘000 inhabitants/km^2)

FOR= dummy variable for forest ecosystems

RIV= dummy variable for river ecosystems

COA= dummy variable for coastal ecosystems

dEDP= change in EDP

AREA= size of ecosystem in hectares

The value of ecosystem damage is a function of the change in biodiversity due to the emission of 1,4 Dichlorobenzene (DCB) and the willingness to pay for biodiversity (adjusted for purchasing power parity).

Step 2: Derive a country-specific valuation for human ecotoxicity

In order to value the health impacts of 1,4 DCB, Trucost first estimated the damage to human population, expressed in Disability Adjusted Life Years (DALYs) and valued DALYs.

Calculate the damage to human population of 1,4 DCB in DALYs

Trucost used the USES-LCA2.0 model (Van Zelm et al, 2009). USES calculates human toxicological effect and damage factors per substance with information related to intake route (inhalation or ingestion) and disease type (cancer and non-cancer) at a continental level.

Damage factors express the change in damage to the human population, expressed in DALYs, as a result of exposure. They consist of a disease specific slope factor, and a chemical-specific potency factor. USES includes cancer specific and non-cancer-specific slope factors. The chemical-specific factors relate to the average toxicity of a chemical towards humans, separately implemented for carcinogenic effects and effects other than cancer. USES’s risk assessment is conducted at a continental level and comprises of an exposure, effect and incidence assessment.

Estimate the value of DALYs

In order to put a value on the years of life lost, Trucost used the NEEDS project approach (NEEDS, 2007; OECD, 2011). The results of this approach are based on a contingent valuation questionnaire applied in nine European countries: France, Spain, UK, Denmark, Germany, Switzerland, Czech Republic, Hungary and Poland. The value was adapted to other countries based on country-specific income levels. To avoid ethical criticisms on the value of life and disease incidence in different countries, Trucost applied the global median value to value DALYs in different countries.

Correct for double counting with the health impact of VOCs

The valuation of VOCs includes impact on human health. VOCs are also included in freshwater, terrestrial and human toxicity calculations. In order to avoid double counting, Trucost subtracted the VOCs valuation of impact on human health from the human toxicity valuation.

INTERPRETATION: ALIGNING ENVIRONMENTAL IMPACTS WITH *CRADLE TO CRADLE CERTIFIED* QUALITY CATEGORIES

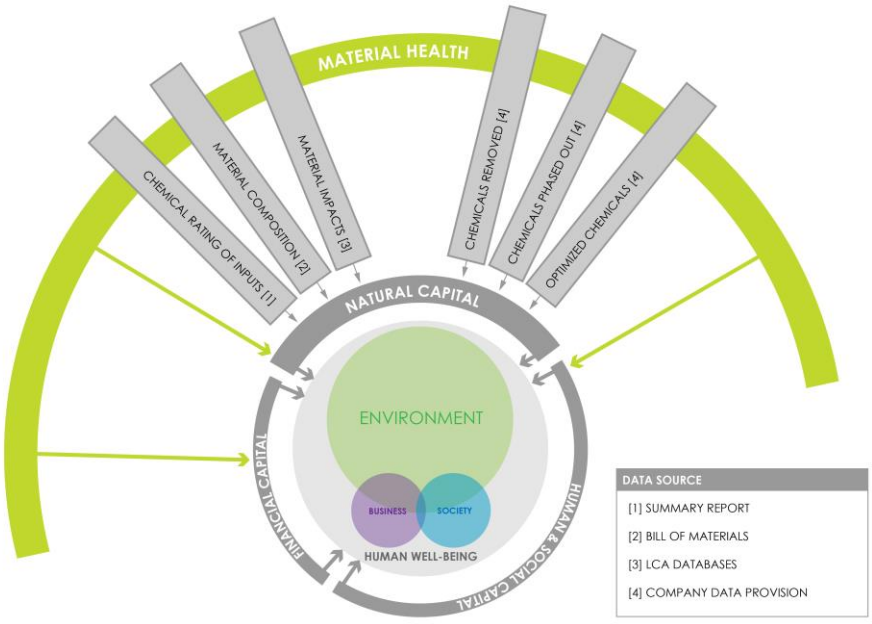
Finally, environmental impact results in both physical and financial terms are aggregated to calculate the direct impact of each quality category. As explained in previous sections, total use cycle impacts are also calculated in order to put each category in perspective and identify potential trade-offs and burden-shifting.

MATERIAL HEALTH

According to the *Cradle to Cradle Certified* Product Standard, Version 3.0,

The aim of the material health assessment methodology is to characterize the hazards of chemicals present in a product, and in turn generate material assessment ratings based on those hazards and their relative routes of exposure during the intended (and highly likely unintended) use and end-of-use product phases. […The chemical profiling procedures] use existing toxicological data from peer-reviewed sources on single chemicals and then conservatively extrapolate the human and environmental health risk of complex mixtures, materials and products based on that data.

FIGURE 13: MATERIAL HEALTH DATA SOURCES AND INDICATORS



The final ABC-X rating outlined in each Summary Report is determined through a robust assessment by an Accredited Assessment Body. The process is complex, and detailed in the 'Material Health Assessment Methodology' (MBDC, 2013). The following section gives a brief overview of the key steps.

First, each material is disaggregated at a chemical level. Each chemical is evaluated across a total of 24 human health, environmental health, and chemical class hazard endpoints.

Chemicals that have been assigned a 'red' or 'grey' hazard rating in any endpoint(s) (other than Organohalogen, Persistence, and Bioaccumulation) then undergo exposure assessment. This includes research of specific studies on the substance(s) in

question in the context of the material matrix in which the substance(s) is/are present, the function and location of these materials in the finished product, and the product's intended and likely unintended use, production, and end-of-use scenarios.

Single chemical risk ratings are assigned to individual chemicals. These ratings apply only in the context of the material and product for which they were assigned. The material is then conservatively assigned the worst single assessment result of all chemicals in the material. This "Overall Risk Assessment for Material" is finally combined with a "Cyclability Assessment" based on its fate in the future post-consumer scenario to give the final ABC-X rating.

The Summary Report provides the final results of the analysis at a material level without disaggregating each step or providing the individual hazard endpoint ratings.

TABLE 13: MATERIAL HEALTH RATING DESCRIPTION

Material assessment ratings	Explanation
A (Green)	The material is ideal from a Cradle to Cradle perspective for the product in question.
B (Green)	The material supports largely Cradle to Cradle objectives for the product.
C (Yellow)	Moderately problematic properties of the material in terms of quality from a Cradle to Cradle perspective are traced back to the ingredient. The material is still acceptable for use.
X (Red)	Highly problematic properties of the material in terms of quality from a Cradle to Cradle perspective are traced back to the ingredient. The optimization of the product requires phasing out this ingredient or material.
Grey	This material cannot be fully assessed due to either lack of complete ingredient formulation, or lack of toxicological information for one or more ingredients.
Banned (Black)	This material contains one or more substances from the Banned list and cannot be used in a certified product.

As part of traditional LCA, it is not possible to assess if a material is suitable for its use and end-of-use context (NL Agency, 2011), as toxicity is only assessed throughout the supply chain and does not take into account the chemical content of the material. The *Cradle to Cradle Certified* Product Standard assesses each material for the context in which it is intended to be used, based on its properties and its capacities to support the Cradle to Cradle scenario, while LCA quantifies the emissions occurring over the life cycle.

An initial approach of determining valuations for the human, terrestrial and freshwater toxicities of chemicals within the material health bands proved unsuccessful due to limited toxicity assessment of chemicals available. All chemicals within the available databases were considered to fall into 'X' rated or 'banned' materials, reducing the ability to accurately apply valuation to other bandings. Valuation of impact on human well-being does help to overcome the issue of material health inconsistency with LCA, however, so potentially offers opportunity for future assessment, though this would need to be further developed with the assistance of the Accredited Assessment Bodies and the Institute.

For the purposes of this study, the products were mapped against the ratings given by the Accredited Assessment Bodies, and compared (where possible) against baseline products. Comparison was only possible where the baseline product is an earlier version of the certified product and therefore ingredient assessment has been undertaken. In the example of PUMA, the comparison product is produced alongside the certified Incycle trainer, and is composed of entirely separate materials, none of which has been assessed for purpose by the Accredited Assessment Bodies.

COMPANY NARRATIVE: VAN HOUTUM

Van Houtum is a family-owned Netherlands-based company which offers total solutions for toilet areas, from toilet paper to soap and mirrors and dispensers. Founded 75 years ago, it now counts 200 employees and has an annual turnover of over 60 million Euros. The company has grown from manufacturing paper to complete washroom solutions across four quality lines: Satino Black, Premium, Comfort and Basic. The Satino Black line is *Cradle to Cradle Certified* SILVER for v2.1.1 of the standard. The choice of the "black" color was a conscious decision: it is one of the few colors that can be produced in according to material health preferences, while still being considered 'stylish' by the company.

The Satino Black Hand towels achieved SILVER level for the material health quality category.

Following initial analysis, three areas were particularly problematic, including the wet strength additives and trash catcher chemicals. The wet strength additive is a chemical used as an input in the production process to give paper strength when it is wet. After two years of collaboration with its suppliers, Van Houtum managed to produce a wet strength that is biodegradable.

Trash catcher chemicals are used to remove the glue present on waste paper that would otherwise contaminate the machines. Here again, Van Houtum worked with its suppliers to develop an alternative. One supplier was unable to change their product, so Van Houtum changed suppliers.

All 'x' rated chemicals are now removed from the product and packaging. The less acceptable materials are present in very small volumes, used in inks and color within the packaging only.

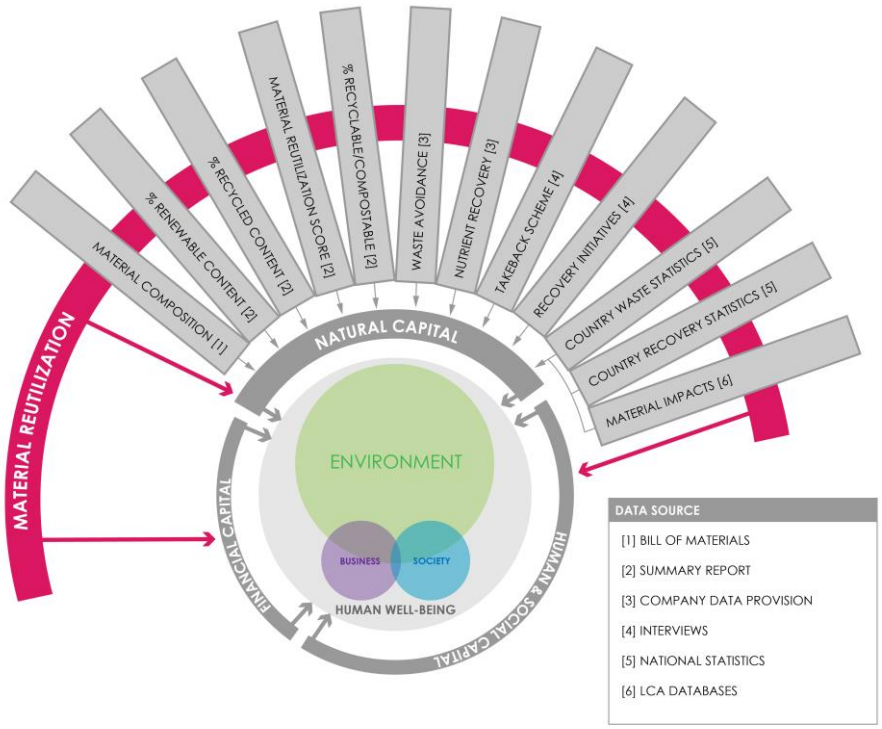
MATERIAL REUTILIZATION

The *Cradle to Cradle Certified* Products Program defines all materials as "food" (=nutrient) for something else in either the biological or technical cycle. This should be understood as "the right material, at the right place at the right time", where "right" reflects the suitability of materials for a defined use in a defined context (NL Environment, 2011). The suitability to context is a combination of toxicity (as captured by the material health category) and recyclability/compostability.

$$\text{Reutilization Score} = \left(\frac{\left(\left(\begin{array}{c}\%\text{ of the product considered} \\ \text{recyclable or compostable}\end{array} \right) * 2 \right) + \left(\begin{array}{c}\%\text{ of recycled or rapidly renewable} \\ \text{content in the product}\end{array} \right)}{3} \right) * 100$$

The impact of material reutilization optimization was determined using the indicators and data sources shown in figure 14.

FIGURE 14: MATERIAL REUTILIZATION DATA SOURCES AND INDICATORS

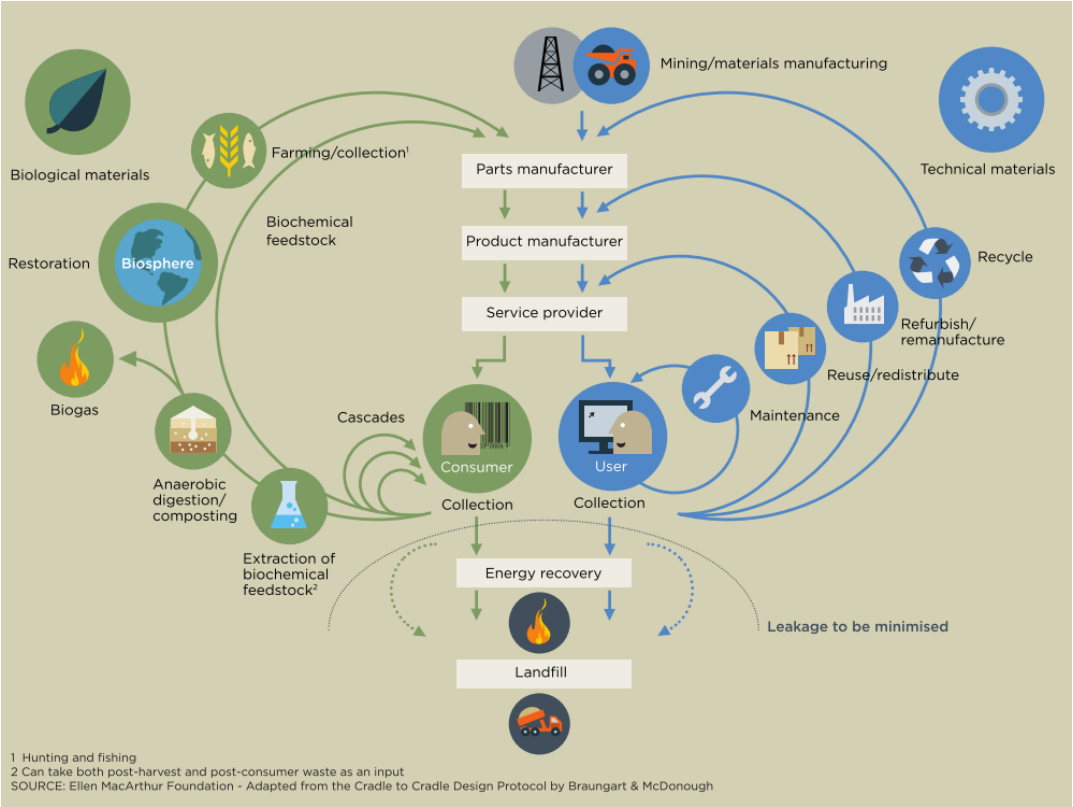


The certification level achieved by each product depends on the identification of the appropriate cycle for the product (technical or biological), the development of an appropriate recovery and management strategy, and the material reutilization score. Each material can pertain to either the technical or biological cycle, which will dictate what the most appropriate nutrient management strategies are. Possible nutrient management strategies include partnerships to support more effective municipal, third party private and industry-specific recycling and composting programs, or product/company specific take back or collection programs. Finally, the Reutilization score is based on the inherent recyclability or biodegradability of the product, combined with the amount of recycled material and/or rapidly renewable content used in the product.

As recognized by NL Environment (2011), LCA can be a useful tool to assess the impact of the material reutilization category, if the system boundaries are correctly drawn. Trucost thus devised a methodology based on burden and credits allocation that aligns as much as possible with the reutilization score, is able to capture different nutrient management strategies, and take into account both the solution-offering side (is the product recyclable/ compostable) and the solution-using side (do the appropriate structures to ensure that the product will be recycled/ composted exist?).

The following figure from the Ellen MacArthur Foundation *et al* (2014), adapted from the Cradle to Cradle Design Protocol illustrates the different nutrient management strategies and how they relate to the "Waste equals Food" guiding principle.

FIGURE 15: CIRCULAR ECONOMY – NUTRIENT CYCLES



Source: Ellen MacArthur (2012) Adapted from the Cradle to Cradle Design Protocol by Braungart & McDonough

The Ellen MacArthur Foundation *et al* (2012) stress that in a truly circular economy, consumables are largely produced from non-toxic biological nutrients (possibly chemically beneficial) and can be returned to the biosphere safely for consecutive uses. Durables are made from technical nutrients, which are designed for re-use, or where subject to technical advancement, products are designed to be upgraded.

The *Cradle to Cradle Certified* Products Program looks closely to materials formulations and addresses materials purity issues as well, this fits very well with one of the key messages in the Ellen MacArthur report (2012), describing that: 'Defining materials formulations is the key to unlocking change'.

Products analyzed as part of this study all follow either a recycling or composting strategy. The functional unit selected for the comparative analysis is thus "one product". However, in the case where the nutrient management strategy extends the use cycle of the product, such as in re-using or repairing scenarios, the functional analysis should be selected to illustrate the life extension, for example impact of the product per year of use.

The following table outlines how credits and burdens have been calculated to the use of recycled/ renewable content at the sourcing stage and to the end-of-use phase of the cycle. Credits refer to positive impact, while burdens refer to negative impact. Previous sections detail the specific assumptions and opportunities to improve the approach relating to particular materials.

TABLE 14: CREDITS AND BURDENS ATTRIBUTION

Factor	Definition	Burdens	Credits
Recycling	A mechanical, physical or chemical process on a material to transform it into a usable material once again.	Includes collection, sorting and composting (1/3)	Avoided burden through the displacement of new virgin raw material being manufactured (2/3)
Composting	Biological decomposition in a compost site as part of an available program.	Includes collection, sorting and composting (1/3)	Avoided burden through the displacement of fertilizer being manufactured where appropriate (2/3)
Recycled content	The proportion of material, by mass, sourced from recycled material.	Includes collection, sorting and processing (2/3)	Avoided burden through the displacement of new virgin raw material being manufactured (1/3)

In order to avoid double counting, specific weighting factors were applied to credits and burdens. In order to avoid double counting, specific weighting factors were applied to credits and burdens. The reutilization score formula (see below) is more heavily weighted towards the recyclability/compostability of the product (two thirds) over the recycled/rapidly renewable content (one third). Trucost thus assigned two-thirds of the credits and one third of the burdens for recycling and composting at the end-of-use, and two thirds of the burdens and one-third of the credits to the use of recycled content. This is in line with the weighting used in the reutilization score formula while ensuring no double counting of credits or burdens over one use cycle that both uses recycled content and recycling.

Rapidly renewable material is also recognized within the material reutilization score, however, this is not considered to require additional processing and therefore no burden or credit is associated with the use of such is calculated.

The reutilization score formula gives full score to materials which are potentially recyclable or compostable, even if not recycled or composted due to existing waste management systems and practices. Trucost adjusted the percentage of recyclable/compostable content to account for actual practices in the countries of disposal. This captures the requirement "The product is actively being recovered and cycled in a technical or biological metabolism" that is required to achieve the PLATINUM level of the material reutilization category. Furthermore, this allows differentiating between two companies that manufacture the same product, with one not actively managing the end-of-use of its product and the other having in place a nutrient recovery plan.

COMPANY NARRATIVE: PUMA

PUMA developed a biodegradable *Incycle* sneaker product, but were concerned that consumers might not dispose of the products effectively due to the inconvenience of accessing suitable composting facilities. To ensure that product recovery was both possible and optimized, PUMA provided collection banks in many of its stores, run in co-operation with international recycling company I:Co. Six months later, the biodegraded product nutrients will be used to feed crops and plants, thereby fulfilling the desired transition from linear manufacturing process to a circular continuous loop nutrient cycle.

Analysis from the EP&L previously carried out captures the air emissions, GWP, water consumption, waste generation and land use impacts, consistent with the *Cradle to Cradle Certified* approach used here, with the exception of land use (not included here) and toxicity (not included within the original study).

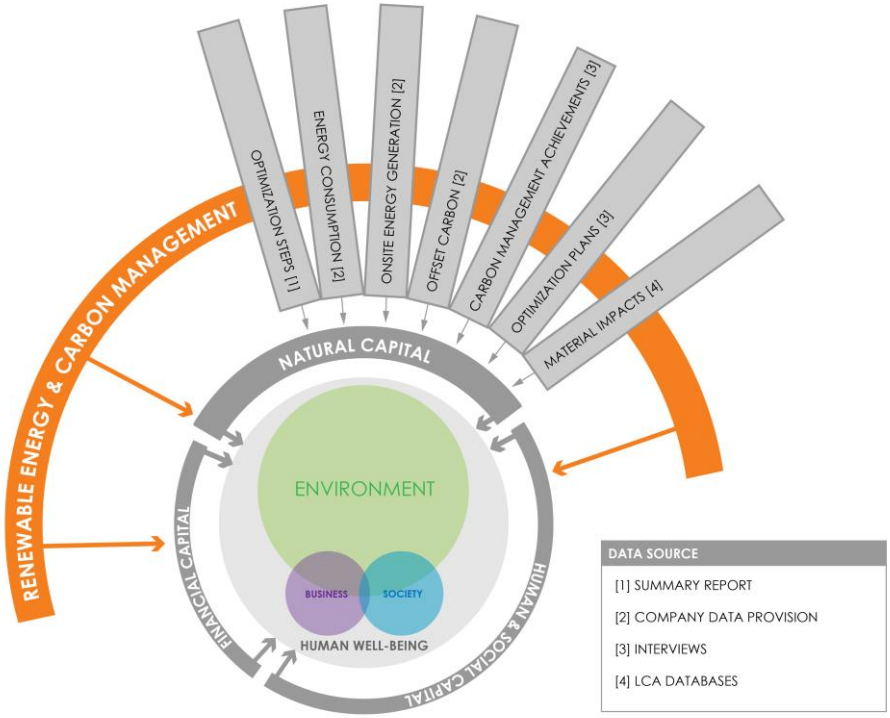
Based on the *Cradle to Cradle Certified* categories, and value given to both end-of-use and recyclability, the end-of-use data was recalculated, to better fit the *Cradle to Cradle Certified* Products Program. The end-of-use pathways were determined using national waste statistics for Germany (where the analysis was based, due to the piloting of the I:Co scheme). Conventional trainers were presumed to be reused or disposed of to landfill at typical national rates, while Incycle shoes were mapped according to different scenarios, depending on the success that is achieved through the take back in store. As the Incycle Basket sneaker was only launched in spring 2013, actual collection rates are not yet available, and success of the in-store collection banks is to be determined. If all of the *Cradle to Cradle Certified* BASIC Incycle Basket are composted at end-of-use, the PUMA Incycle Basket has an 87% smaller impact at end-of-use than the conventional sneaker, reduced from 21 US¢ to 3 US¢ per pair. A potential reduced environmental cost of 1.14US$ per pair of shoes is seen if 100% of footwear is recovered and composted.

By providing a net benefit due to higher credit for displacement of either footwear (reuse) or through composting, than burden of processing, the Incycle footwear can be seen to not only be offering less negative impact, but actually create 'more good' for the end-of-use. Credit is given to both reuse and composting, for displacement of virgin materials required to produce the alternative product, and 33% of the burden (with the majority of the burden allocated to product in its next format). This approach is in line with LCA cut off methodology, while also being consistent with the formula of material reutilization for the *Cradle to Cradle Certified* Products Program, where recyclability and recycled content are weighted 2:1.

RENEWABLE ENERGY AND CARBON MANAGEMENT

The renewable energy and carbon management category requires companies to understand and then set a strategy and manage greenhouse gas emissions from energy use during the manufacturing processes included in the final manufacturing stage of the product. To achieve the PLATINUM level, the embodied energy associated with the product from the sourcing of raw materials to the factory gate has to be quantified and at least 5% of it must be addressed through supply chain projects or offsets.

FIGURE 16: RENEWABLE ENERGY AND CARBON MANAGEMENT DATA SOURCES AND INDICATORS



As outlined by NL Environment (2011), LCA can be used as a tool to calculate the benefit of switching to renewable energy sources. Trucost compiled operational energy use data per product and per type for each company in the dataset, pre and post certification, and calculated the external cost based on country-specific LCA records for each type of energy. Country-specific factors were also used for electricity grid and non-renewable energy – hence the improvement in the external cost in percentage terms reflects both energy and country-specific factors. While the renewable energy and carbon management category focusses mainly on carbon and greenhouse gases in general, Trucost analysis encompasses all the environmental indicators as listed in the "Scope" section of this report.

The renewable energy and carbon management category refers mainly to the final manufacturing phase until the PLATINUM level to limit the complexity of the calculation. No company analyzed has yet achieved the PLATINUM level.

COMPANY NARRATIVE: VAN HOUTUM

The analysis for Van Houtum focuses on a comparison of the current, *Cradle to Cradle Certified* SILVER Satino Black hand towel, and a hand towel previously sold by the company in 2008, prior to the optimization steps taken for certification. Van Houtum provided company level energy consumption data, detailing the quantity of different fuel sources per year for the respective years of production before and after certification. Electricity data was given by source, and whether renewable or non-renewable. The quantity of energy per unit of product was calculated by determining the proportion of tonnes of Satino Black hand towels produced, over the total tonnage of production of all products at the site. Though simplified and presuming that all products require equal energy requirements per ton. Future opportunity exists to refine this through more granular data collection at the site (companies with more granular data provided this as a preference).

Consumption of renewable energy for manufacture of the hand towel increased from 8% to 100%, sourcing both hydroelectricity and green gas in 2012. Trucost used country-specific Ecoinvent factors for grid electricity regionalised to the country of operation (Netherlands) and for hydroelectricity. Secondary LCA data was used for green biogas. This was used to calculate the quantity of greenhouse gases, air pollutants, and toxicity associated with these energy sources.

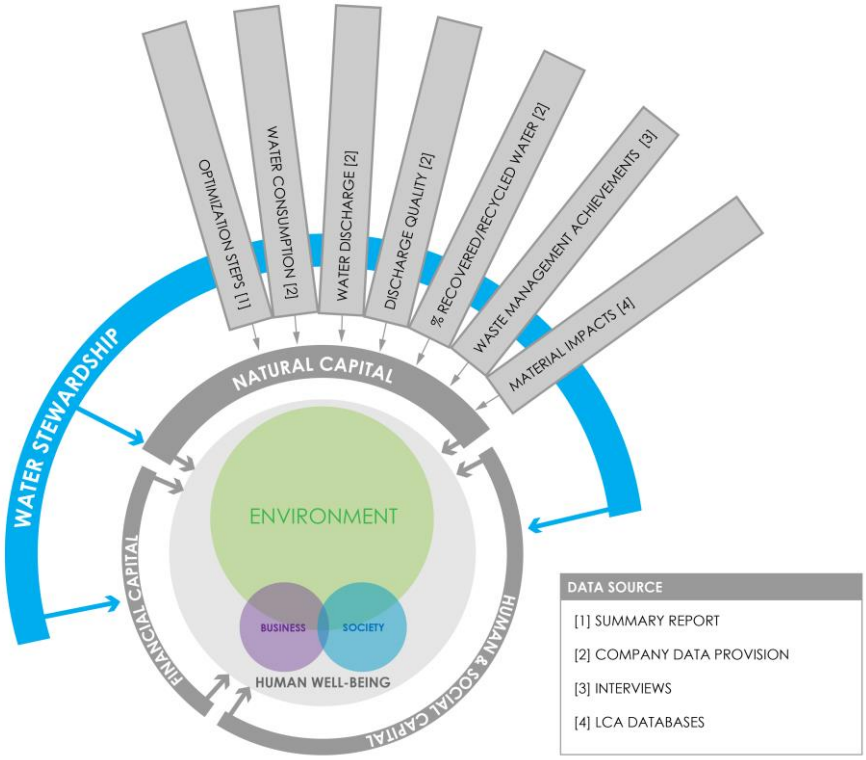
The absolute physical units of impacts were then multiplied by valuation co-efficients (as detailed in Environmental Valuation Methodology), to determine the monetary cost to human well-being associated with the generation of energy required for a unit of the two different hand towel products.

The optimization from non-renewable energy sources to renewable hydroelectricity and green gas has led to an 81% decrease in the environmental impacts of the direct energy supply for the product from US$80 to US$15.

WATER STEWARDSHIP

Water stewardship creates awareness and drive towards the treatment of water as a valuable resource by encouraging effective management and use strategies. The water stewardship category includes requirements on both water quantity and quality to create awareness and drive towards effective management and use strategies of this valuable resource.

FIGURE 17: WATER STEWARDSHIP DATA SOURCES AND INDICATORS



Requirements include, for example, understanding local- and business- specific water-related issues, conducting a facility-wide audit, monitoring process chemicals in effluents and developing a positive impact strategy for at least 20% of tier one suppliers (where company facilities have no product related effluent). The category thus mainly refers to operational water use, and includes supply-chain considerations starting at the SILVER level only where product related effluent is not apparent (for example, where manufacture occurs at a Tier one facility).

Several significant differences exist between version 2.1.1 and 3.0 of the certification standard. The later version of the standard has become more rigorous, particularly at lower certification levels where criteria only required for GOLD level in v2.1.1 are now required for BASIC (for example compliance with effluent permit regulations) and/or BRONZE (for example facility wide audit) levels. Initial review of Summary Reports provided detail of requirements met for certification, and further interview was undertaken with companies to determine the steps taken to achieve these standards.

Trucost compiled operational data on water use and where possible water quality from each company. Data points include water quantity per unit of product (m^3), wastewater quantity (m^3), and if available wastewater quality (COD content). Previous sections give greater detail on the computation of the environmental impact of wastewater.

As mentioned above, the water stewardship category does not include a systematic and full supply chain assessment. Trucost used LCA as a tool to assess supply-chain water impact, in order to put the operational improvements into perspective and identify any trade-offs and burden-shifting.

The valuation of water (as described in the 'Water Valuation Methodology' section earlier in this chapter) applies valuation in the context of local water scarcity, capturing the local water issues as required to be characterized in all levels of certification in v3.0.

Qualitative interviews were also undertaken to understand the water stewardship optimization steps taken by companies, such as any water stewardship principles or strategies developed, plans in place to improve water management, and any innovative measures in place to improve discharge quality.

COMPANY NARRATIVE: ROYAL MOSA

Royal Mosa produce ceramic wall and floor tiles in Maastricht in the Netherlands. The first tiles were certified to the *Cradle to Cradle Certified* product standard in 2010, and now almost 100% of all tiles produced by Mosa are certified at the SILVER level. The Global wall tile range was selected for further analysis. The wall tiles were compared to tiles produced by the company in 2007, before certification.

Mosa provided site level data on water consumption, and this was disaggregated to a product level by mass allocation. The proportion of Global wall tiles of total production tonnage of tiles at the site, was presumed to be equal to the proportion of water consumed in the processing of Global wall tiles. This data was collected for the year prior to and after certification and the difference between production years quantified.

Water has been a critical focus for Mosa's tile production since certification, and the company has taken several steps to improve water efficiency and effectiveness on site. In particular, the cooling system water cycle has been 'closed', recapturing water after it has been used, and reducing the operational footprint per tile by over 50%. The wastewater footprint has also seen significant impact reduction through onsite water treatment, with residual sludge recycled within the tile production process.

Valuation was applied to both the water consumed in the production process, and the wastewater disposed of at site, according to the scarcity of water in the region from which it is abstracted, as detailed in the approach described in the 'Valuations Methodology' in previous section. The impact on human well-being associated with waste water from direct operations was reduced from 1.4¢ to 0.4¢, a reduction of 68%.

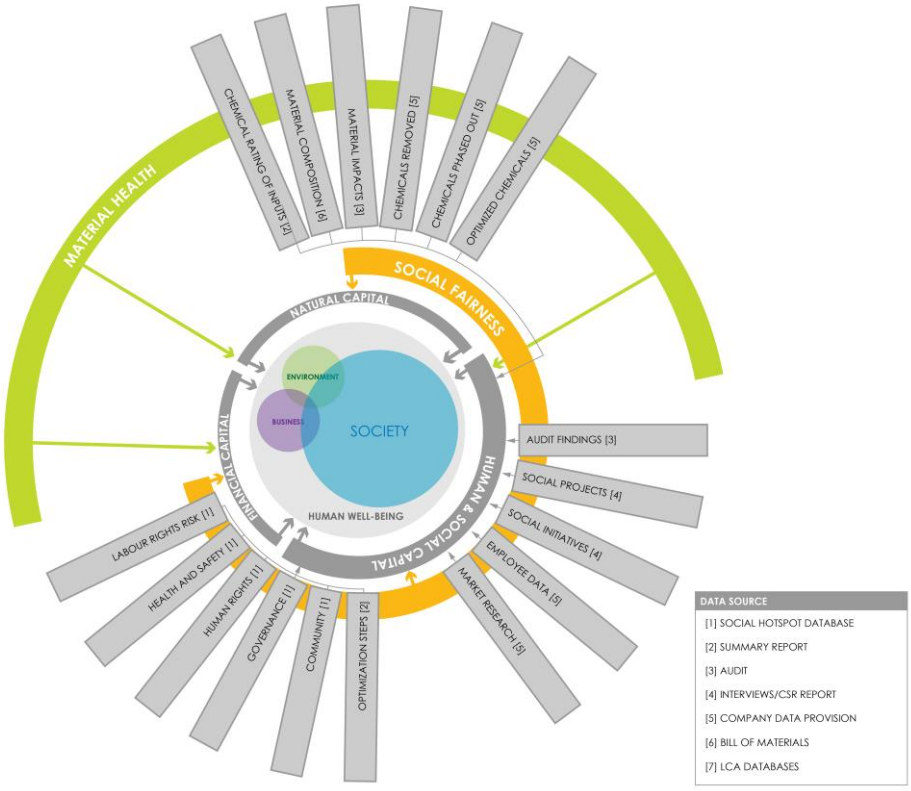
SOCIETY

The social fairness quality category of the *Cradle to Cradle Certified* Products Program ensures that progress is made towards sustaining business operations that protect communities and workers along the value chain and contribute to all stakeholder interests including employees, customers, community members, and the environment. It is important for business ethics to go beyond the confines of the corporate office and permeate the supply chain, engaging responsible manufacturing, enforcing fair treatment of workers, and reinvesting in natural capital.

The program focuses on more than merely 'less bad' (i.e. a 'safeguards' approach for ensuring supply chain production sites and processes do not violate any human rights), and encourages a move towards 'more good', creating environments where people are treated fairly in working conditions that supports and empowers them, both during working hours but also outside. A 'green economy' is defined (UNEP, 2011) as one which achieves human well-being *and social equity* whilst reducing environmental risks and ecological scarcities, thus the concept of "social fairness" is well embedded in this widely accepted framing of the only viable economy of our future.

Figure 18 below identifies the key data sources and indicators used to capture impacts of the social fairness quality category and wider social impacts.

FIGURE 18: IMPACTS ON SOCIETY, DATA SOURCES AND INDICATORS



TOP LEVEL APPROACH

The *Cradle to Cradle Certified* Products Program has specific social requirements, and also impacts on society through impacts driven by environmental criteria within the quality categories. This is captured within the conceptual framework through human and social capital, and largely driven by the social fairness quality criteria. Natural capital impact is driven by the remaining four categories and this is captured within the environmental section, natural capital valuation. In line with the UNEP/SETAC guidelines on social lifecycle assessment (UNEP/SETAC 2009), the study approached social impact assessment using four steps:

- Scope and boundaries
- Inventory
- Impact assessment
- Interpretation

These steps are detailed below.

SCOPE AND BOUNDARIES

DEFINING THE SCOPE OF ANALYSIS

The concept that social benefits must be created by products raises the question of "*whose* benefits?" Hence the first step is to map the social stakeholders of the product. The program's social fairness category stipulates sustainable business should include '*all stakeholder interests including employees, customers, community members, and the environment.*' There are many different groups impacted upon, and the list below highlights the key categories considered within the analysis:

- Customers
- Employees (direct)
- Supply chain workers
- Local communities (for each point of the value chain)
- Global community

Supply chains can be complex, and it would not be feasible to include evaluation of stakeholders at every point of the chain. For example, a single product may have many hundreds of suppliers when considering raw material extraction and processing up each step.

At a BASIC level (and for all higher levels of certification), the minimum requirement includes a streamlined self-audit to be conducted to assess protection of fundamental human rights. This is advised to be based on risk characterization such as through the Social Hotspots Database (SHdb – detailed later in the section), and management procedures created to address social risks identified. The scope of the research is focused around the standard, with all stakeholders considered but focus of quantified data around direct and tier one suppliers, where data is more readily available.

INVENTORY

Development of the inventory includes an initial identification of social sub-categories relevant to the assessment. Several sources are available to provide suggested impact categories, for example UNEP/SETAC 2009. The

minimum approach of the *Cradle to Cradle Certified* Products Program's social fairness category (for version 3.0 of the product standard) is to carry out a streamlined self-audit to assess protection of fundamental human rights. These need to include at a minimum the following eight criteria, considered by *Cradle to Cradle Certified* Product Standard 3.0 to have an impact on 'fundamental human rights':

1. Child labor
2. Forced labor
3. Excessive work time
4. Provision of a living wage
5. Worker health and safety
6. Wage Assessment (potential of average wage being less than non-poverty guideline)
7. Accidents and death in workplace
8. Toxicity or chemical exposure in workplace (if data are available)[12]

These are defined according to the Social Hotspots Database (SHdb) and this is therefore taken as a source for benchmarking sector practice. The intent of the self-audit is to determine if any final manufacturing facilities, contract manufacturing facilities, or tier one supplier facilities are operating in countries and/or industries identified as having high or very high potential for issues with any of the given themes.

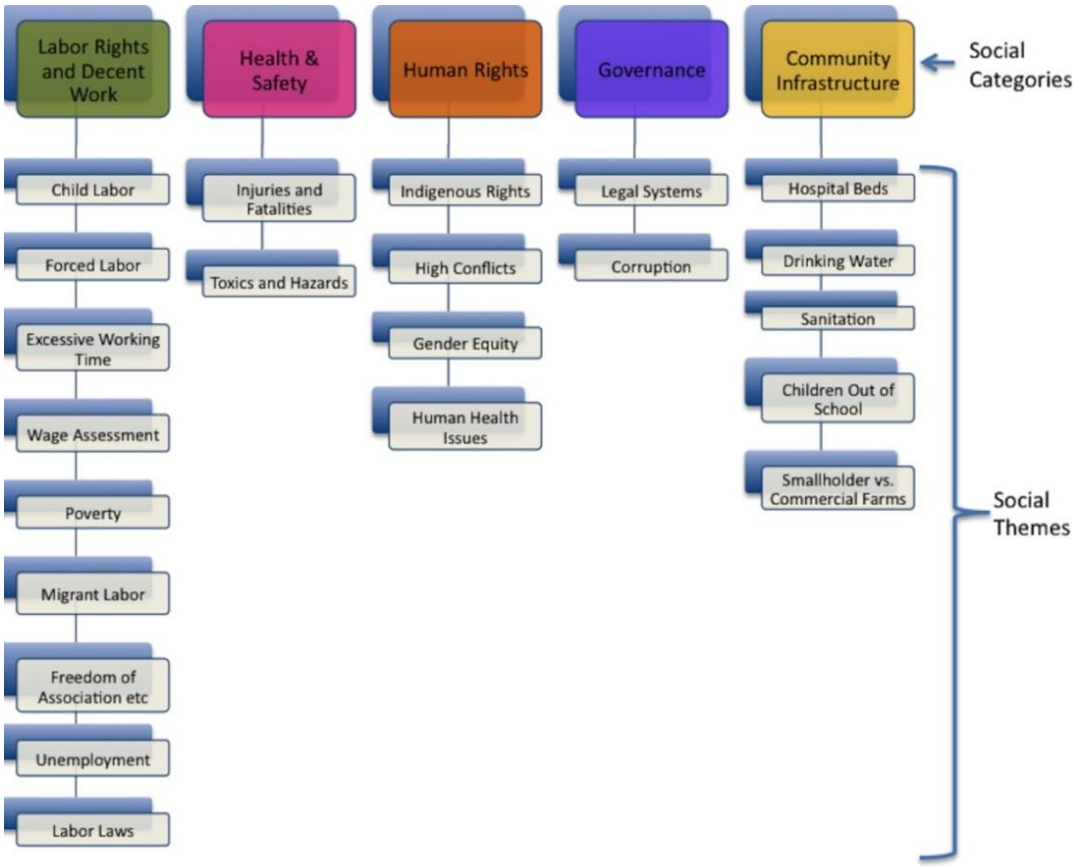
The SHdb provides a characterization model of social risk to a country-sector level. This provides the typical social risk apparent to workers in the given product sector within the country of origin of the supplied material/ component and within the first tier of the supply chain. The SHdb provides data on five social categories given below:

- Labor rights
- Health and safety
- Human rights
- Governance
- Community

These are further subdivided into 22 social themes (such as child labor, wage assessment, gender equality), and further, into specific indicators (such as 'risk of child labor in sector, male'), of which there are 130.

[12] The toxicity analysis of the *Cradle to Cradle Certified* material health category is included in the environmental analysis, but has an important relevance to society also. Analysis is not carried out within the society section however, to avoid double counting.

FIGURE 19: SOCIAL CATEGORIES AND THEMES PRESENT WITHIN THE SOCIAL HOTSPOTS DATABASE



Source: Social Hotspots Database (2013)

The *Cradle to Cradle Certified* Product Standard lists several other references that can also be used to help characterize social risk within the supply chain. These include UNICEF, U.S. Department of Labor, List of Goods Produced by Child Labor (U.S. Dept. of Labor, 2009), International Labour Organization (ILO) country reports, World Bank poverty data, UN Human Development reports, U.S. Department of State Human Rights reports, sweatfree.org non-poverty wages, U.S. Bureau of Labor Statistics, AFL-CIO, International Trade Union Confederation country profiles, and the World Health Organization. For this research the SHdb was selected as it is both strongly linked to the standard, and is also available to carry out comparative social risk mapping of different sector-regions with relative limited data.

Indicators for impact on stakeholders outside of the supply chain were also defined, and wider activity of companies in the social impact field. These are given in Table 15.

TABLE 15: SOCIAL INDICATORS FOR MAPPED STAKEHOLDERS

Stakeholder group	Indicators
Customers	Customer impacts of certification can be difficult to determine without engagement. Where market research has been carried out, qualitative indicators should also be used, such as customer preferences, trust of company/product, recommendation.
Employees	• Number of employees • Turnover of employees (can be reflective of staff morale[13]) • Wages and salaries • Sickness and injury frequency[14] (may be included in annual report, corporate report), and/or human resource systems and reports for some country operations
Supply chain	Numerous - see SHdb in section above, and more detail given in appendix, but examples include; • Percentage risk of child labor • Number of worker injuries • Percentage risk of communicable diseases
Local communities	• Number of local community projects undertaken • Number of local community projects funded
Global communities	Indicators associated with environmental impacts with global ramifications, for example GHG emissions

Qualitative data can be expanded in future research, bringing into consideration poverty alleviation, trust, security and other such indicators which are highly relevant, yet difficult to measure quantitatively.

Local and global communities will be impacted by environmental impacts of supply chain processes, such as water consumption and air pollution (locally) and GHG emissions (globally), and these are captured and valued within the environmental impact assessment.

DATA COLLECTION

The first step in the data gathering process was to supply the company with an Excel based questionnaire. This included operational/employee related questions, and questions based on the social fairness category.

The full Excel questionnaire is included within Appendix IV

The table overleaf describes the key data sources used to gather social information.

[13] Though not required for certification, an indirect social benefit of certification may be staff satisfaction for working in a better environment and through working for a company that is trying to improve social fairness and well-being.
[14] Though the examples used in the research for the ten companies analysed did not influence employee sickness and injury, the phase out or reduction of hazardous chemicals, improved staff morale, and other impacts could theoretically influence staff attendance. This indicator is therefore included for potential future relevance.

TABLE 16: DATA REQUIREMENTS AND SOURCES FOR SOCIAL IMPACT ASSESSMENT

Example data sources	Indicators
Annual report Financial documents Corporate social responsibility report	• Employee data • Funding of social projects
Social audits Corporate social responsibility report Summary Reports	• Social projects undertaken • Supply chain data (e.g. typical work hours at site, number of injuries, frequency of sickness etc.) • Further employee data (such as hours of training provided, employee diversity)
Qualitative interviews	Qualitative trends and anecdotal evidence, such as; • Employee and Customer feedback • Bespoke social activity • Specific steps taken to meet *Cradle to Cradle Certified* Product Standard

There is a wide range of social aspects relating to manufacture of products and an initial self-audit helps identify the aspects of social risk on which companies should focus, which in turn may help companies select third party audits or social surveys of which to undertake. Audits reviewed vary in the format, indicators and monitoring systems applied, and may be self-assessed or carried out by a third party. For example, a simple compliancy criterion may exist (evidence of child labor – yes/no), where non-compliance requires immediate action, or loss of service, while other audits may be more data specific (for example, the number of worker accidents in the past year, wage expressed as a percentage of the 'living wage' for the region). Several tools and initiatives are recommended for v3.0 of the standard, celebrating diversity and allowing companies to make decisions on the program or initiative which is most fit for purpose. Due to the transition process, and several companies having been certified to v2.1.1, few companies had audits carried out and available for review.

Where audits were not available other sources of social information were used such as interviews and corporate social responsibility reporting.

Where available, employee-related performance data (see Table 15 for indicators relating to employees) was reviewed over the period prior to certification up to the present day. This allowed for a greater understanding of the trends in employee social and human impact as companies advance along the certification journey.

Qualitative evidence included a review of the initiatives undertaken by companies, either directly through *Cradle to Cradle Certified* Products Program, or through other drivers. These initiatives are not restricted within the standard, though a higher level achievement requires an audit by an internationally recognized third party.

Interviews

Several interviews were undertaken within the process of data collection, the first of which was an exploratory interview to determine what steps had been

taken to meet social fairness requirements for the certification. Company representatives were encouraged to provide their own response to allow their thoughts and own interpretation of what positive social impacts have been apparent. This was then followed with questions such as:

- What social audits do you carry out?
- Do you have available (and would you please provide) completed social responsibility self-audits based on UN Global Compact Tool or B Corp application?
- Did you carry out social audits prior to certification on any product lines?
- What management procedures were developed to address any identified issues regarding social fairness, and how have these evolved since the start of pursuing Cradle to Cradle product optimization?
- What percentage of materials used in your products are certified (through external social certification such as Fairtrade?
- Can you provide examples of how your company has driven social improvement since certification?
- Did you actively engage with your company's direct environment and employees to review your social fairness approach and if so, in what manner?

The full interview prompt sheet is included in Appendix V. A risk of bias exists for interview data collection, and where possible, evidence of activity was sought.

A second interview was conducted following the collection and review of data sources such as corporate social responsibility reports (listed in Table 16 above). Further questions were put to the companies based on initial findings, reflecting known (or absent) social activities. For example, discussion was given to known projects and initiatives in which the companies were involved, and specifically any activities undertaken for the purpose of product certification.

The results of the individual interviews are provided in the separate product analyses.

IMPACT ASSESSMENT

The social fairness category underwent several changes during recent revision of the *Cradle to Cradle Certified* Product Standard, from 2.1.1 to 3.0. The requirements for certification became more rigorous at earlier stages of certification, with version 2.1.1 not requiring an audit until the GOLD certification level. To meet requirements of version 2.1.1 for SILVER, adoption of a public statement signed by the CEO regarding social and ethical performance goals was required. The statement had to address fair labor practices, corporate and personal ethics, customer service and local community. Several of the products have not yet made the transition to version 3.0 of the product standard and therefore did not have audits carried out.

SOCIAL RISK CHARACTERISATION MAPPING

Social risks for each mapped sector region are given in the following format

TABLE 17. SOCIAL HOTSPOTS DATABASE INDEX RISK

SOCIAL HOTSPOTS INDEX RISK				
Community infrastructure	**Governance**	**Health and Safety**	**Human Rights**	**Labor rights**
0-100	0-100	0-100	0-100	0-100

The five risk categories are scored against a potential score of 100 per category, giving a total maximum risk of 500 for a sector region. These are considered to be the 'typical' social risks of the sector region, and are used as a benchmark for the company comparison, where data prior to certification is unavailable.

Social audits were reviewed where available and the benchmark adjusted to take account of the specific social data provided. Three companies shared actual audits or social surveys such as BCorp results, while two were in the process of setting up social auditing for certification. Only the country of the final manufacturing stage of the product was assessed, as there may be several hundred individual suppliers across all supply chain tiers. For some companies this is their own site. Others, such as PUMA, do not manufacture its own products, and therefore the research captures its tier one suppliers.

Social audits were compared against the risk characterization mapping of the sector-region to determine whether each company was operating at a 'better than benchmark' standard. As audits were sometimes inconsistent, and the social fairness category is non-prescriptive, a standard quantification against the benchmark was difficult to complete in a uniform manner, and a level of subjectivity is apparent. However, qualitative evidence was collected to help substantiate the findings.

Where the SHdb highlighted the most material social risks, particular focus was given to determine whether risks were identified by the company. Steps taken by the company to mitigate these risks were then sought and reviewed if present. As some countries are typically associated with higher social risk (through lack of legislation and human rights protection for example), it is important that risk hotspot mapping is not used to drive companies to conduct business in low risk areas. Engaging in high risk areas can have a positive impact assuming proactive work to improve social conditions, increasing a company's 'positive impact'. There is a need to better communicate the proactive efforts undertaken by companies within the framework.

QUALITATIVE ASSESSMENT

Many social impacts are more appropriately assessed through qualitative review, particularly where impacts are subjective, such as quality of work environment, respect, trust and similar such perceptions. Though quantifiable data may reflect some of these perceptions, qualitative review is also highly important, and a combined approach is often best (World Bank Institute, 2006).

Interviews provided a useful source of qualitative information, providing company perceptions and anecdotal evidence of staff morale, case examples of social activities, and future plans and aspirations. These also helped to

identify any challenges that companies faced in improving social performance or areas in which they identified opportunity to improve.

Assessment of qualitative data included review of any bespoke activities undertaken by the companies since certification, and particularly initiatives or projects carried out specifically to achieve certification or improvement in certification award level. Where audits or social review had been undertaken, any actions that were resultant of these review findings were also captured within company narratives.

Several companies had products certified to the version 2.1.1 of the *Cradle to Cradle Certified* Product Standard, with less stringent requirements within the social fairness category than in version 3.0. These companies noted on occasion that already high standards of social behavior meant that they met certification requirements without needing to optimize activity. In version 3.0 of the standard, self-assessment audit is required at a BASIC level. It is expected that more data for analysis will therefore be available in future analyses following the transition of products to the later version.

COMPANY NARRATIVE: CONSTRUCTION SPECIALTIES

Architectural building products manufacturer Construction Specialties design and produce "products that make buildings better". The company carried out the B Corporation (BCorp) survey in late 2009 to improve its social fairness certification level. Scoring 111 was ample to meet survey principles, but also highlighted areas of potential focus. The survey findings were shared for the purposes of the research and compared against the social risk mapping in the SHdb.

Taking the survey compared the Construction Specialties business model to the BCorp standard and in the area of Community it scored least highly. Construction Specialties believed it fell short of the mark in an area that is very important to it. As such, a conscious plan was made to become more purposeful and meaningfully involved in its community. This has resulted in the creation of CS^2 (Construction Specialties Community Support), a funded and staff-led initiative with the following mission:

'Our mission in servicing the natural and human environment is to improve our quality of life by building a more sustainable community. Through education and awareness we will create hope, opportunity and action for all.'

Many Construction Specialties products now meet the *Cradle to Cradle Certified* GOLD requirements for social fairness. By taking the survey, it has not only moved to understand its social impacts, but also responded proactively, focussing on the area of least advancement and creating a social program to achieve improved activity within this area. This is more advanced than simply attempting to avoid human rights violations, and rather moves to bring social benefit and provide a positive influence to the local community.

Examples of the operational and supply chain schemes and initiatives that some of the ten companies in the pilot research project either followed or were involved with included:

- B Corporation (BCorp)
- International Labor Organization (ILO)
- Supply Chain (GANTSCh) project with GRI Global Action Network for Transparency
- Local occupational health and safety certifications
- SA8000
- Fair Labor Association
- OHSAS 18801

Companies were also noted to commit to international principles and publicly follow guidelines for social standards, for example the UN Universal Declaration of Human Rights and the UN Global Compact Principles (UNGC)

INTERPRETATION

SOCIAL CAPITAL VALUATION

Natural capital valuation incorporates social impacts as well, but they are not easily disaggregated, so they are reported on within the environmental analysis. Environmental impacts have indirect drivers of change on society. For example, toxicity is valued based on the impact it has on human health, and air quality is quantified based on the release of harmful pollutants such as sulfur dioxide (SO_2), nitrogen oxides (NOx), particulate matter (PM), ammonia (NH_3) carbon monoxide (CO) and volatile organic compounds (VOCs). Each pollutant is associated with different but overlapping types of external damage costs, including those associated with health care. The benefits highlighted in the natural capital valuation are also relevant to social capital for both local and global communities. As such, this social capital valuation can be disaggregated and evaluated seperately.

Social capital valuation is complex and incorporates many issues. The valuation applied here is considered a first step towards a full valuation incorporating additional factors such as human relationships and capacities. At present, it focuses on key impacts from environmental analysis. The opportunity exists to develop this methodology using more detailed human and social capital analysis to strengthen the wider ranging impacts on society, and to progress through qualitative evaluation to quantitative evaluation of some aspects of social capital. This is considered with the 'Reflections' section of the report.

QUALITATIVE EVALUATION

As described earlier, social capital includes trust, rules and norms governing social action, and various aspects of human networks. There are many kinds of social data to evaluate social capital - such as perceptions, satisfaction, quality of experience and levels of trust, which are all inherently qualitative yet highly relevant to evaluate social capital. A qualitative evaluation is given as a discussion within the product analyses documents, highlighting the social activities and drivers relevant to the individual companies. Where

companies have undertaken a social audit, this is reflected against the SHdb risk mapping of the sector to give an indication of whether the company is performing to a better than typical standard within the sector-region in which they operate.

Where specific initiatives where implemented, or companies have engaged with third party organizations (for example if they have pledged to meet social commitments), literature was reviewed to discuss what the benefits and weaknesses of such actions are.

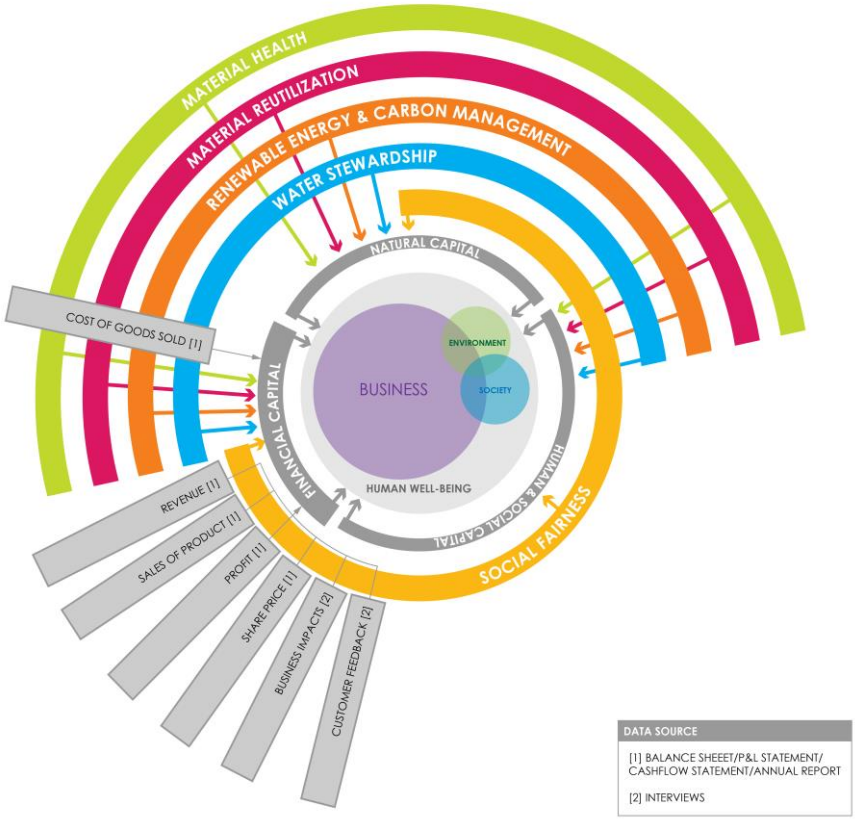
Qualitative discussion is given to actions and bespoke social projects carried out by companies. Where particular case examples of good practice exist, these are highlighted.

BUSINESS

An integral aspect of the Cradle to Cradle philosophy is the concept that good design equals good business. Through improved manufacturing processes, material sourcing and design for end-of-use, positive impacts can be seen for all three impact fields of the environment, society and business. Production of effective, safe and recyclable goods can impact the competitive advantage and many other aspects of business.

This section reviews the impacts that certification may have on a company and product, and the methods by which these impacts may be captured

FIGURE 20: BUSINESS IMPACT DATA SOURCES AND INDICATORS



TOP LEVEL APPROACH

In line with the methodology set out in the conceptual framework, four steps were taken to determine business impacts. These were applied in a slightly different manner, as described below:

- Scope and boundaries
- Inventory – financial and business performance indicators defined
- Impact assessment
- Interpretation

These steps are detailed below.

SCOPE AND BOUNDARIES

DEFINING THE SCOPE OF ANALYSIS

Business impacts were considered in the context of the specific product across its entire cycle (for example the financial implications of change of material type, reduction of water use, and take back of products at end-of-use). Several areas of business activity were considered relevant to the analysis and these were selected with the input of the external steering committee. Key areas of business to consider are listed below:

- Finance
- Operational
- Sales and marketing
- Employee
- Environmental

INVENTORY

Indicators relevant to the business performance of each of the different business areas defined above were selected, based upon the *Cradle to Cradle Certified* program's five quality categories. Different product groups have differing material impact fields depending on where and how they are produced and used. An overarching list of categories was defined to capture relevant material impacts for all groups. The Institute and the study's steering committee were called upon to help determine the possible optimization processes that may be undertaken by companies in the process of certification and continuous improvement.

Product optimization has a potential to impact on competitive advantage. This is an important consideration and reflects on the ability to perform better than rivals by doing different activities or performing similar activities in different ways (Porter, M, 1996). For *Cradle to Cradle Certified* products, product optimization may offer new and niche markets, economic benefits of innovation, greater ability to achieve premium price points, or conversely, lower price points offering cost leadership. There may also be impact on innovative capability, with new design approach and policy offering opportunity. These aspects present challenges to quantify directly, particularly without gathering new market research, but indicators such as price points, new products to market (and first to market for new innovations) were sought.

DATA COLLECTION

Data was gathered separately for two categories where possible[15]: *Cradle to Cradle Certified* products and non-certified products. Financial reports, profit and loss statements and other conventional financial reporting documents (such as company annual reports) were reviewed to gather company level data, and companies were required to provide the proportional split between

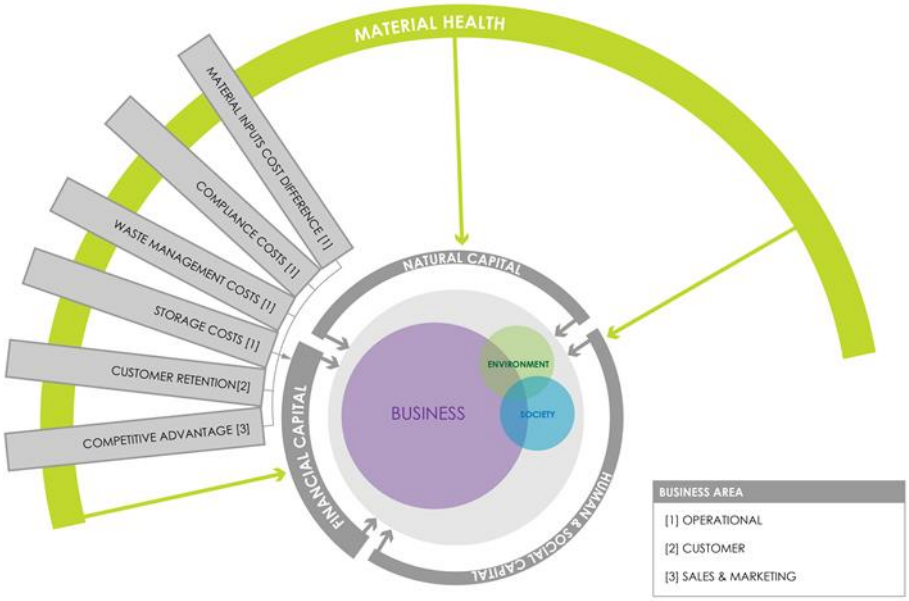
[15] As the first attempt to capture the business impacts of the *Cradle to Cradle Certified* Program, companies were not able to deliver all the business data requested. Three companies provided separated *Cradle to Cradle Certified* product information alongside non-certified, with the majority of companies only collecting data at a company level.

categories. In practice, companies largely recorded company level data only, and disaggregation was not apparent for many of the indicators.

The *Cradle to Cradle Certified* Product Program's five quality categories each impact on financial capital in differing ways. These are displayed in figures 19-23.

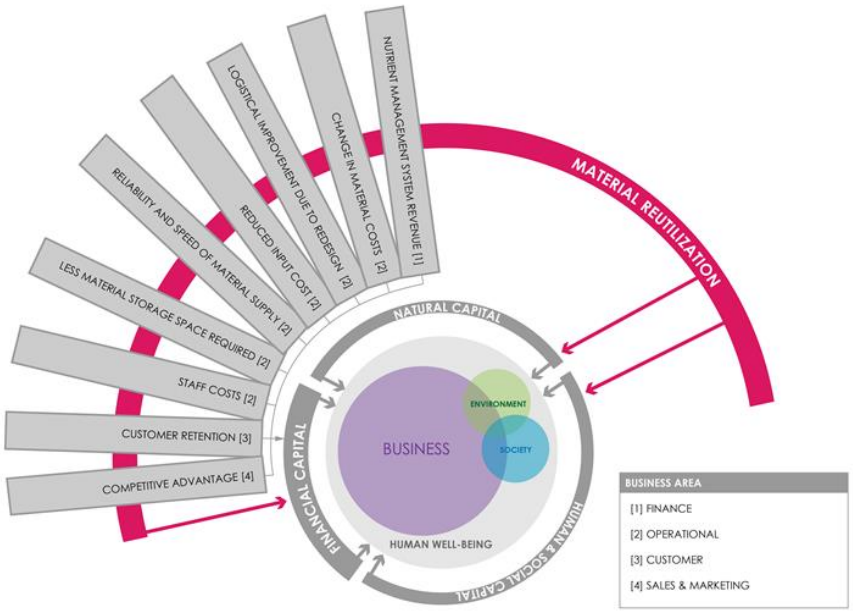
Material health ensures the phasing out and optimization of chemical inputs to products, which in turn can have an influence on costs of inputs, compliance costs and other business considerations, shown below.

FIGURE 21: BUSINESS INDICATORS OF MATERIAL HEALTH



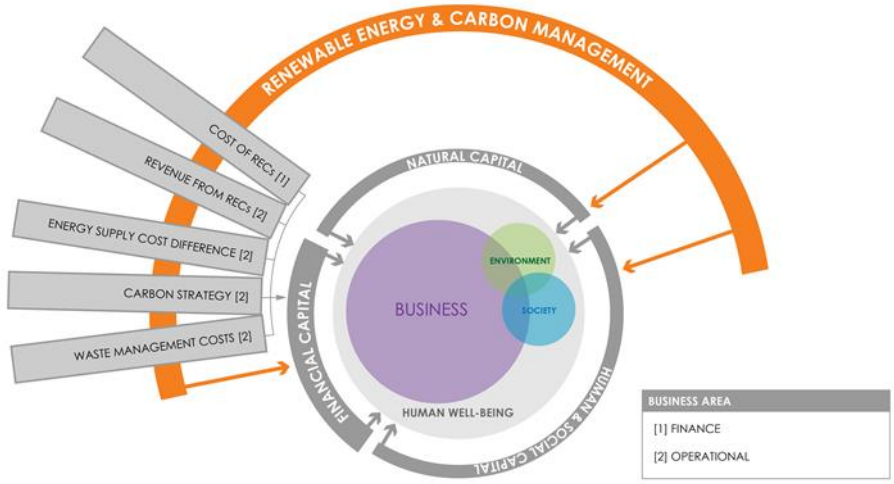
Material reutilization can offer numerous opportunities for cost savings and for return on materials, key examples considered are displayed below.

FIGURE 22: BUSINESS INDICATORS OF MATERIAL REUTILIZATION



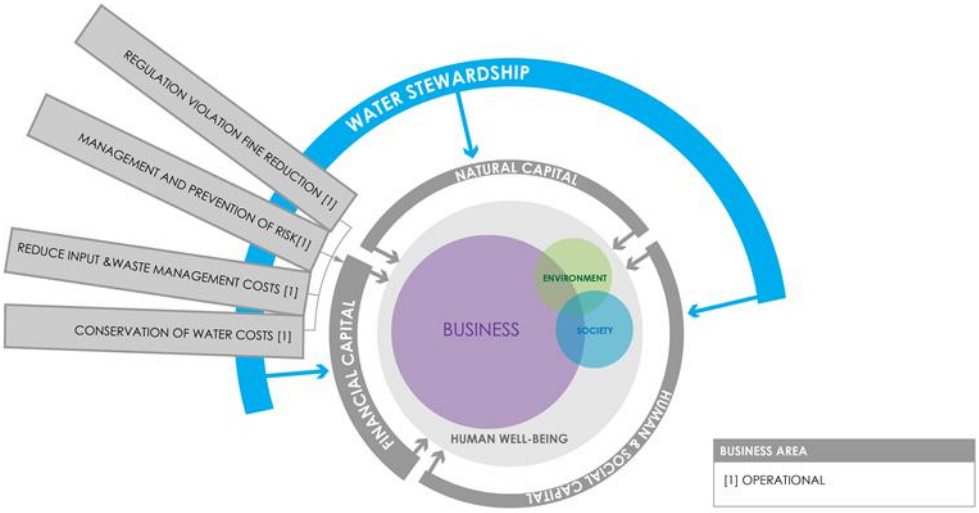
Renewable energy and carbon management includes both sourcing of renewable energy and management of carbon and energy efficiency (considered an on-going part of process optimization). This in turn impacts on the cost of supply and potentially income from excess energy sales if developing onsite energy generation.

FIGURE 23: BUSINESS INDICATORS OF RENEWABLE ENERGY AND CARBON MANAGEMENT



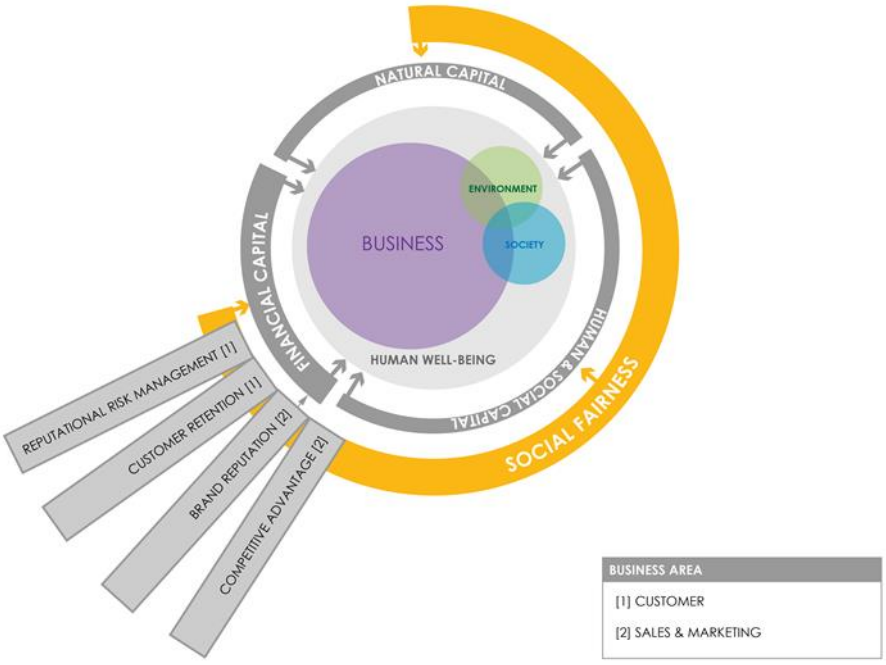
The *Cradle to Cradle Certified* Product Program's water stewardship quality category creates awareness and drive towards the treatment of water as a valuable resource by encouraging effective management and use strategies. Water is supplied and treated at a cost to the company, and improved management therefore has an impact on the business performance.

FIGURE 24: BUSINESS INDICATORS OF WATER STEWARDSHIP



Impacts associated with the social fairness quality category can be considered to relate to brand reputation and avoidance of negative publicity, as well as improving relationships with stakeholders.

FIGURE 25: BUSINESS INDICATORS OF SOCIAL FAIRNESS



An additional aspect of business impact is regulatory risk, though this is more difficult to measure. The natural capital valuation of environmental impacts provides an understanding of impacts in a financial context. These financial costs (which can be positive if a product is eco-effective and

bringing benefit to the environment and society) are considered to be externalities as they are not currently borne by industry (see Environment, Interpretation: Valuation section). There are several mechanisms that can result in these externalities being internalized, resulting in cost to the companies involved. Regulatory risk is associated with high environmental externalities – for example, as resources are becoming scarcer, there is a greater likelihood that stricter and more robust regulation of these resources may become apparent in the future. A company with greater natural capital dependency may be more at risk if internalization of these externalities becomes evident in the future.

Other areas of business impact are also difficult to quantify, but may have significant benefit to business performance. Increasingly, sustainable procurement criteria are becoming apparent for larger corporations and public sector (for example the EU Green Public Procurement (GPP) requirements). In North America, the LEED (Leadership in Energy and Environmental Design) green building rating system was originally developed by the US Green Building Council (USGBC) to provide a recognized standard for the construction industry to assess the environmental sustainability of building designs. *Cradle to Cradle Certified* products can earn project teams additional credits in LEED v4, up to two Materials & Resources points for Building Disclosure and Optimization—Material Ingredients. These credits are earned in the following way:

- Material Ingredient Reporting - Select at least 20 permanently installed products that are *Cradle to Cradle Certified* v2 BASIC or higher or *Cradle to Cradle Certified* v3 BRONZE or higher.
- Material Ingredient Optimization - *Cradle to Cradle Certified* v2 GOLD or higher for material health, or SILVER or higher for *Cradle to Cradle Certified* v3.

TABLE 18: DATA REQUIREMENTS AND SOURCES FOR BUSINESS IMPACT ASSESSMENT

Example data sources	Data points
Profit and loss account **Balance sheet** **Financial statement** **Statement of cash flows** **Annual reports**	• Revenue • Cost of goods sold • Profit • Historic sales (by unit and value) • Stock value • Shareholder return
Company data provision	As above, with split by *Cradle to Cradle Certified* product portfolio if available Source and cost of energy and water provision
Qualitative interviews (carried out with different company representatives, and including the CEO where possible, to capture varying levels of viewpoint)	Qualitative trends and anecdotal evidence, such as; • Customer feedback • Customer loyalty • Certified product demand in sector • Certification recognition in sector • New market opportunities • Optimization financial impact • Market research • Innovation rate • Innovation challenges • Price point trends

Data points such as revenue and profit were firstly sought at a product level, to make direct comparison of the impact on product performance following certification. Company level data was also sought, whereby company performance is impacted through the association of products being certified. An example of the latter may be improved consumer perception through certification of a single product increasing sales across all products, including non-certified.

Interviews

Several interviews were undertaken within the process of data collection, the first of which has an interview prompt sheet included in Appendix V.

Following the collection and review of data sources such as financial reports and profit and loss accounts (listed in Table 18 above), a second interview was conducted. Further questions were put to the companies based on initial findings.

Company representatives were encouraged to provide their own thoughts as to what the business benefits apparent to the company were, as well as any negative impacts the process had. Company performance is affected by numerous factors, so by leading with open questions representatives were given freedom to provide detail on any impacts perceived. Specific questions were then given, with some examples of information sought provided below (see Appendix XX for full interview prompt sheet);

- How has certification affected business costs?
- How has certification affected business sales?
- What is the market demand for certified products?
- Have any sales been directly resultant of *Cradle to Cradle Certified* product achievement?
- What response have customers had to your *Cradle to Cradle Certified* products?
- Have you received positive/negative feedback from
    - Staff?
    - Customers?
    - Supply chain?
- Has certification opened new markets?
- How do you communicate the certification of your product(s)?

DATA ASSUMPTIONS

Individual assumptions for specific cases are detailed within the company reports. Some general assumptions for business data are given below.

Industry data was collected to compare to company financial data such as sales and cost of goods sold. Comparative data was assumed to be for the country of production, rather than the specific sales regions in which a company operated.

As the approach is the first research to attempt to capture the business impacts of certification, not all companies were able to deliver all required data. Where recorded data was unavailable, anecdotal and indicative data was used, though this is caveated in each of the individual examples of occurrence to ensure transparency is absolute throughout the reporting of findings.

IMPACT ASSESSMENT

QUANTITATIVE ANALYSIS

Company performance

Financial data is compared over a minimum of five years preceding product certification to determine trends apparent within the company unrelated to the certification process. Due to numerous factors influencing business performance, correlation of trends alongside the certification process is to be observed. However, causative factors were not addressed, as disaggregation of all external factors would require substantial external data and research.

Data was provided at a company level where it was available, with profit margin, cost of goods sold, gross profit, gross margin and net income being most typical. Six companies provided company level revenue, net income and data to allow profit margin to be determined (one of which could only share in an indexed format due to sensitivities). Four companies were able to provide cost of goods sold. No companies were able to provide financial data specific to the *Cradle to Cradle Certified* product portfolio. Commercial sensitivities restricted sharing of data within public reports for all but two of the companies, whose financial information is publicly reported in their annual reports.

To overcome this, data were then mapped against industry indicators for the equivalent years of performance. Industry statistics were gathered from country or region-specific statistical databases. These databases included:

1. PRODCOM
2. US Census
3. FACTSET

To gather industry data, companies were firstly defined by classification number and then data collected and tracked for sector level country or regional performance. For European companies, firms were defined by Statistical Classification of Economic Activities in the European Community (NACE) codes and data gathered from the European Commission Eurostat database PRODCOM (Production Communautaire – Community Production). This provides statistics on the production of 3,900 different types of manufactured products. For companies based in the USA, the US Census was used, with companies mapped to their NAICS code (North American Industry Classification Systems). For example, AGC Glass Europe produce float glass within Europe, and therefore company data was mapped against PRODCOM float glass manufacturer production data (including 5 categories of glass: non reflective; reflective less than 3.5mm thickness; reflective, greater than 3.5mm thickness; colored; and other sheets of float glass). Industry sales in Europe were mapped for the years from comparison noon-certified production to 2012, and the sector showed negative sales growth of 13.8% over the time period. Though AGC Glass Europe were also showed a reduction in annual sales over the same time frame, a drop of only 1.8% of baseline sales were apparent.

Where necessary, data was adjusted for inflation to normalize data and remove external artificial growth in spend. For example, the cost of goods sold, if steady, is likely to show an increase due to inflation over several years.

Once industry performance data was gathered, both industry and company data was indexed to 1 for the original year of data collection. Then the following years were mapped based on trend from the index baseline. This allowed for trends to be shown of company performance against the industry while masking the actual commercially sensitive figures.

The FACTSET database was also accessed to draw on real company data of equivalent sector organizations for historic years to show comparative competitor trends. Due to sensitivity of this data, public reporting of figures was not possible, though performance trends noted and discussed within narratives where relevant.

Resource costs

Product-level energy requirements by type and country of use were collected for both the baseline and *Cradle to Cradle Certified* products, and price per unit calculated using regional data sources. The US Energy Information Administration (EIA) was used to collect US energy prices and the International Energy Agency (IEA) was used for European country energy prices.

The number of units sold of each product was multiplied by the price of energy per unit and a company saving calculated.

Water costs and wastewater discharge costs were then calculated in the same manner. The Global Water Intelligence survey average water and wastewater costs per country were used as a proxy providing average savings for water saved per company.

QUALITATIVE ANALYSIS

Interviews were carried out with each company to glean product and company level information regarding qualitative aspects of business and financial performance and impacts. This included anecdotal trends of sales, customer demand, informal feedback (where not formally recorded elsewhere), internal company marketing, training, morale, talent acquisition, employee performance and retention, and other factors, which either directly or indirectly affect the business operations and therefore contribute to competitive advantage.

Media such as newspaper reports, journal articles, trade association discussions and press releases were reviewed to reflect public perception of company performance and contribution of certification to improved corporate reputation.

An interview with the Chief Executive Officer (CEO) or other senior executive at each company was conducted to highlight the wider business case for the *Cradle to Cradle Certified* process and relate this to the company's product innovation strategy. Indirect benefits and anecdotal evidence were collected and described within the individual company narratives to highlight benefits, which were noted but not reflected in quantifiable data.

Business and financial media publications and interviews were also reviewed, to garner further insight into performance from a top level perspective. An example includes CEO interviews in the Financial Times, such as with Stef Kranendijk (Financial Times, 2010), in which Cradle to Cradle design is highlighted as a business-building concept.

COMPANY NARRATIVE: ECOVER

Ecover produce detergents, cleansing agents and personal care products to business and consumer markets, growing exponentially every year. With growth of more than 17% in the last year it is aiming to become the market-leader in the Benelux countries within the next five years through the expansion of its professional line of *Cradle to Cradle Certified* products. Governments and public sector bodies are increasingly moving towards sustainable procurement, with initiatives such as the European Green Public Procurement helping to drive selection of responsibly produced products and services.

One of Ecover's latest successes was a new contract with the city of Ghent, Belgium, the first city in the world to exclusively use professional cleaning products awarded a *Cradle to Cradle Certified* label. Ghent's procurement strategy is in favor of minimal packaging and recycling in line with the *Cradle to Cradle Certified* Products Program. The Ecover range of *Cradle to Cradle Certified* products was deemed to be an appropriate match for its standards.

Alderman Martine De Regge, responsible for the Facility Management, Personal Affairs & Administration of Ghent declares: "We all know that we need to take care of our climate. The City Ghent, known as a Belgium's, ecological pioneer takes again the lead. I am proud to be the first European city to take the next step in the right direction. We hope to inspire other cities to clean in a more environmental friendly way."

INTERPRETATION

BUSINESS IMPACTS OF SOCIAL AND NATURAL CAPITAL VALUATION

Natural capital valuation applies a monetary value on the impacts to the environment and on human well-being, captured within the conceptual framework. Natural capital dependency has been linked to corporate risk, with the value of nature becoming increasingly visible as environmental events impact resource availability and lead directly to lower profitability (see the 2012 TEEB report for examples). Trucost's research for the United Nations' Environment Programme Finance Initiative and Principles for Responsible Investment estimated that the world's 3000 largest publicly traded companies had US$2.15tn of profits at risk due to their impact on the environment in 2008.

This was quantified within the environmental analysis of certification and also discussed within the social evaluation, due to the implications for human health and social bearing.

The potential risk to corporate sustainability from the environmental and social impacts of product manufacture are therefore considered for the companies involved. Consideration was given to future resource scarcity and internalization of these externalities – how companies would be affected should legislation, taxes, or other factors mean they have pay these external costs. A further literature review was undertaken to collect latest research in this area.

Consideration was then given to the benefits and reduced risks potentially offered from *Cradle to Cradle Certified* products due to improved environmental and social performance and reduced natural capital dependency.

QUALITATIVE EVALUATION

Evaluation of the qualitative information from interviews and media attention was given. For example, the potential corporate reputational benefit of positive media coverage regarding *Cradle to Cradle Certified* products and optimization of processes is discussed in individual company case studies (see Ecover for an example).

Companies provided anecdotal evidence of the numerous business benefits of certification. For example, business opportunities from projects or contracts won based on customer demand of *Cradle to Cradle Certified* products. Other examples included improved supplier relationships, ability to meet public procurement criteria, improved supply chain control and providing evidence of corporate sustainability claims.

COMPANY NARRATIVE: CONSTRUCTION SPECIALTIES

Construction Specialties highlighted several business benefits during interview which are not directly captured within quantified data, but are considered directly attributable to the pursuit of *Cradle to Cradle Certified* certification. One such example is the improved relationship with some of its suppliers, and the company has seen adoption of the principles trickle through to their suppliers. Upon witnessing Construction Specialties' journey for example, one plastics resin supplier has since pursued and achieved *Cradle to Cradle Certified* SILVER for its resin. This has an additional benefit of improving environmental performance not just for its own products, but across operations outside of its control.

Cradle to Cradle Certified products can also have a positive influence on sales opportunities. The US Green Business Council offers an Innovation credit for the use of *Cradle to Cradle Certified* products, which draws opportunity for increased customer base. The certification also provides verification for customers that the company is performing to the standards it claims to be.

Finally, Construction Specialties exercising greater control over the production of its PETG products supports increased risk management of future supply, and can ensure the material inputs are created in line with the Cradle to Cradle thinking.

PART TWO

Continuing the journey

This section reflects on the lessons learned from the research and identifies opportunities for future work. A brief summary of the project's findings is given with consideration of the robustness of the analysis.

Recommendations to different stakeholders are suggested, highlighting the role that the Institute, companies and the scientific community can play to maximise the benefit of using the framework and supporting the continued optimization of the work.

SUMMARY OF FINDINGS

READERS GUIDE

This section begins with a high-level summary of the main findings of the research. It then focuses on lessons of the research and outlines the opportunities that exist for future development of the frameworks and methodologies deployed. Reflection and recommendations are provided to help all stakeholders work to advance the transition towards a circular economy, and ensure products advance to be truly healthy and provide net benefit to human well-being.

SUMMARY OVERVIEW

This report highlights the findings of the first research undertaken to capture the impact of the *Cradle to Cradle Certified* Products Program across a range of product types and categories. The research shows a promising account of the positive impact and added value achieved by ten companies during their pursuit of certification. While the research is not intended to provide scientific verification or demonstrate causality, it does contribute an important evidence base demonstrating the economic, environmental and social potential of the *Cradle to Cradle Certified* Products Program.

As this study represents the first attempt to assess the economic impact of pursuing *Cradle to Cradle Certified* product certification, the approach was new and bespoke, and companies were not yet able to deliver all of the requested data at a product level. For those companies that were able to provide data, the economic potential of certification was indicated by higher than average sales performance, positive growth and increased profit margins compared to baseline years. There are many factors affecting a company's performance over time and the impact of certification would likely be only a part of larger fluctuations caused by other factors. However, as a first step to capture business impacts of certification, companies were unable to provide more granular data on their certified portfolios. Stronger than industry sales was noted across the majority of companies, and this is considered a useful point for further investigation in future work. Further cost savings relating to water and energy efficiency improvements were also evidenced. Though these are not direct requirements of certification, management steps have offered water and energy savings, which are reflected in business benefit.

Environmental and social benefits were also identified through replacement of toxic and questionable ingredients by non-toxic and defined alternatives, conservation of product materials in continuous product cycles, increased renewable energy use and improved energy and water efficiency. The research provides evidence of certification encouraging movement on the pathway to more positive products. This is shifting focus from the more conventional sustainability approach of eco-efficiency, achieving production with impact reduction, towards eco-effective products which provide a positive influence on society and the environment, while bringing financial reward to the companies undertaking such steps.

The top level findings of the research, as applicable to the Program's five quality categories, are summarized in the following sections, and individual product analyses can be found here.

The current state of materials purity, recycling, repair and re-use within the wide range of *Cradle to Cradle Certified* products evidences the synergies between the Cradle to Cradle-design philosophy and the circular economy.

SUMMARY OF FINDINGS

This research points out that *Cradle to Cradle Certified* products are excellent real-life examples of products suited and optimized for the circular economy.

Although many of these products are now produced, used and disposed of in mostly linear processes, they could be used to their full potential, if the appropriated resource recovery infrastructures were put into place. Companies operating under Cradle to Cradle principles have evidenced the success these infrastructures can achieve, utilizing take back and reprocessing of nutrients to ensure continued cycling of materials. For example, Steinbeis, the German office and magazine paper producer, established an effective take back of paper, to upcycle into new products. The same paper fiber is kept in constant rotation through an ongoing cycle of use, disposal, recovery and reuse, minimizing the need for new resource input. Another example is the *Cradle to Cradle Certified* SILVER REWORK workwear by Van Puijenbroek Textiel. This is a range of apparel items for workers, which can be leased by the customer. The suppliers retain ownership of all the materials, repair and maintain the clothing, and at end-of-use, take the garments back for further reuse, or if unsuitable, for conversion back into yarn or compost. There is huge opportunity to use these examples to spark exactly the transition towards the circular economy that the Ellen MacArthur Foundation and the World Economic Forum are calling for.

MATERIAL HEALTH

Product ingredients are inventoried throughout the supply chain and evaluated for impact on human and environmental health. The criteria at each level build towards the expectation of eliminating all toxic and unidentified chemicals and becoming nutrients for safe and, continuous cycles.

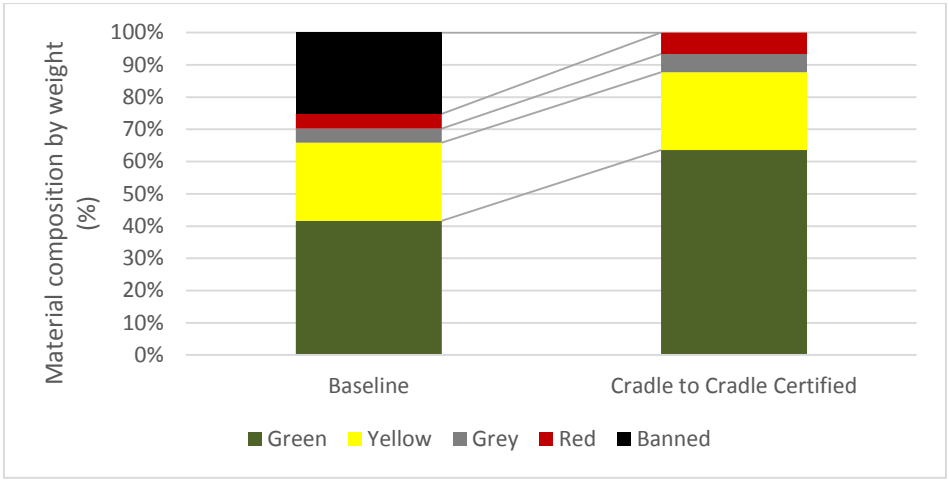
Toxic product materials contribute to irreversible environmental impacts such as biodiversity loss and human health impacts including cancer, endocrine or hormonal disturbances and respiratory diseases. They also inhibit opportunities to recycle product materials at the end of their typical use leading to toxic waste impacts on our land, oceans and biodiversity. Permanently removing toxic materials from products means healthier materials for nature, human well-being and future product manufacturing.

The majority of companies participating in the pilot research phased out or eliminated toxic materials[16] during the certification process such as harmful packaging inks, toxic coatings and unhealthy dyes, replacing them with positively defined, non-toxic alternatives. In some cases optimization occurred prior to certification, simply to meet the entry-level certification requirements – for example Steelcase designed the *Cradle to Cradle Certified* SILVER node™ chair for certification and excluded PVC in the design phase, though earlier products used PVC. If designed without *Cradle to Cradle*

[16] Toxic materials include banned (cannot be present in certified products) and highly problematic (can be present but needs phasing out) inputs – marked as black and red on the graphics respectively.

Certified design, a hypothetical chair is considered to have been produced using PVC, making up 25% of the product weight and banned under the *Cradle to Cradle Certified* Product Standard, and as such, the baseline product would not have been suitable for certification. The product also comprises 22% greater proportion of 'B' rated materials, largely supporting Cradle to Cradle objectives for the product. Optimization is on-going for the remaining 'X' rated materials. By ensuring material inputs are safe, they are suitable for continued cycling within the technosphere, to be retained as nutrients and inputs into new products.

FIGURE 26: MATERIAL HEALTH OPTIMIZATION FOR STEELCASE NODE™ CHAIR



Material Reutilization

MATERIAL REUTILIZATION

Products are designed either to biodegrade safely as a biological nutrient or to be recycled into new products as a technical nutrient. At each level continued progress must be made towards increasing the recovery of materials and keeping them in continuous cycles.

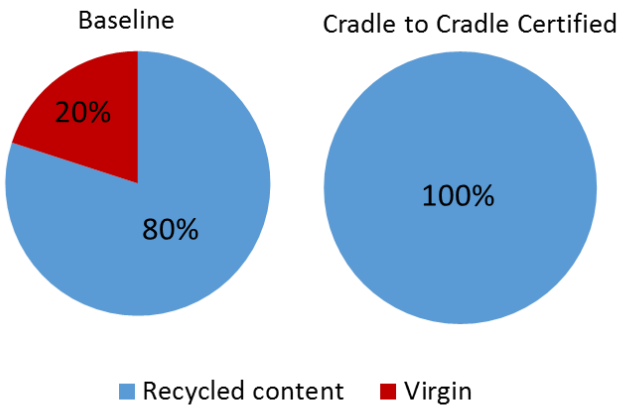
By designing biodegradable or re-useable product materials, and ensuring effective systems for recovering those materials, manufacturers protect diminishing natural resources by eliminating resources leaking out of the nutrient cycle and eventual disposal. This also avoids adverse health and other social impacts arising from landfill or incinerated waste disposal, and provides opportunities for business to re-use or re-market product materials at the end-of-use to generate new revenue streams and improve profitability.

Five of the ten product comparisons reflected an increase in recycled or rapidly renewable content (rapidly renewable material being that which can be regrown within ten years or less). Two further products already offered pre-certified products with over 80% content, and no improvement is necessary to maintain high standards. Material can be considered to be retained within cycles through use of recycled inputs and through recycling/composting at end-of-use, ensuring nutrients do not enter the waste stream. Across the ten product comparisons, increase in material retained within technical or biological cycles ranged from 1-282kg per ton.

One example of increased recycled content was identified within the Aveda Invati shampoo packaging optimization. Packaging is made from 100%

recycled high density polyethylene (HDPE), optimized from earlier composition of 80% recycled content

FIGURE 27: RECYCLED CONTENT OF AVEDA INVATI SHAMPOO PACKAGING



The packaging for Invati shampoo meets PLATINUM requirements for content, with a reutilization score of 96.8%, but further development of a recovery plan is required to achieve this overall for the product.

Renewable Energy

RENEWABLE ENERGY AND CARBON MANAGEMENT

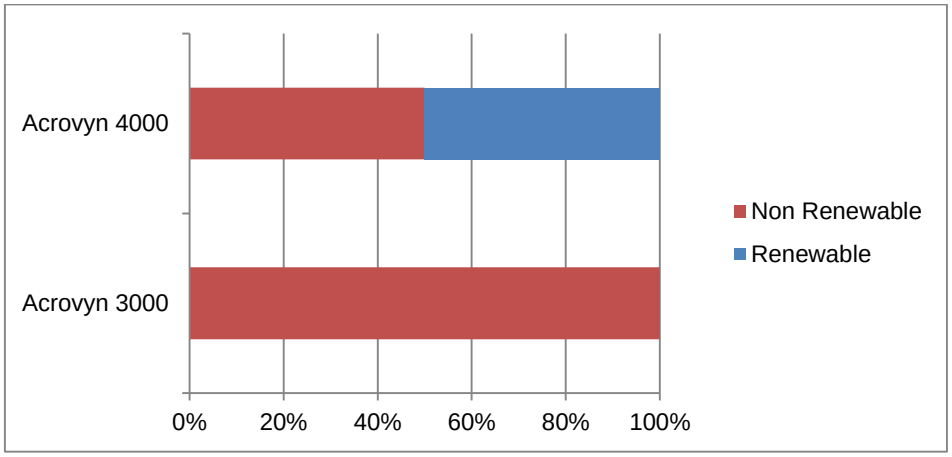
Cradle to Cradle envisions a future in which industry and commerce positively impact the energy supply, ecosystem balance and community. This is a future powered by current solar income and built on continuous and circular material flows. The *Cradle to Cradle Certified* Product Standard's renewable energy and carbon management category is a combination of these core principles of Cradle to Cradle design. The category requirements at each level of certification build towards the expectation of carbon positivity and powering all operations with 100% renewable energy.

Renewable energy provides a myriad of environmental and social benefits, including avoided air pollution and climate change impacts, alongside decreased dependency on finite fossil fuel resources. It also provides business benefits from reduced risk exposure to volatile energy prices and intensifying 'polluter pays' regulatory costs.

Half of the companies reviewed increased the renewable energy sourced or offset for the production of their product following optimization. A further two companies can be considered to operate at very high standards before certification, one sourcing 100 % of energy from renewables, the second sourcing 100% of electricity.

As an example saving, Construction Specialties achieved *Cradle to Cradle Certified* GOLD level for renewable energy for the Acrovyn 4000 range. Energy is offset through the purchase of renewable energy certificates (RECs). In 2008, no renewable sourcing of energy was in place. Since certification, this has increased to 50% of the total energy supply through the purchase of wind energy RECs (figure 28). This is associated with significantly less harmful emissions, for both people and the planet, than generation of energy through conventional non-renewable fossil fuel sources

FIGURE 28: PERCENTAGE RENEWABLE ENERGY USED PER UNIT OF PRODUCT, CONSTRUCTION SPECIALTIES



Impact on human well-being is influenced by both energy efficiency and the move towards more sustainable renewable energies. Savings per ton of product ranged from US$9.7 – nearly 100 per ton.

Water Stewardship

WATER STEWARDSHIP

Processes are designed to regard water as a precious resource for all living things. At each level, progress is made towards cleaning up effluent and process-water to drinking water standards.

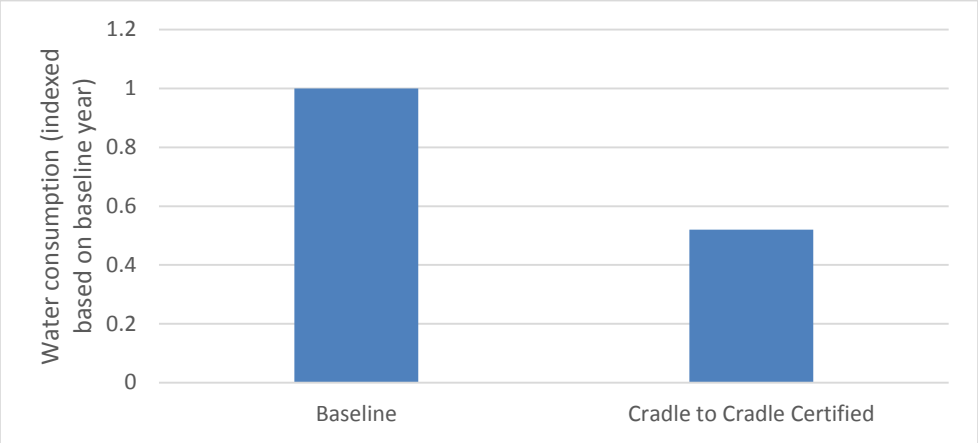
Water conservation and protection provides vital social and environmental benefits including sustenance and climate regulation, as well as underpinning essential business inputs. Businesses risk fines and social licenses to operate for poor water stewardship, alongside increasing water costs in water-constrained regions.

Of the eight companies that had comparable data, four showed a decrease for direct operational water consumption per unit of product, with two products requiring slightly more water per unit and two products remaining unchanged. When normalized to a ton of product, water savings ranged from 0.6m^3 to 14.9m^3, while increases ranged from 0.2-0.7m^3 per ton.

As part of its certification, Shaw has developed water stewardship principles and achieved *Cradle to Cradle Certified* SILVER level for its EcoWorx carpet tile. The analysis shows that water efficiency has significantly improved, an increase in efficiency of 49%. This improvement over 8 years is attributed to several factors, including Shaw's sustainability efforts.

SUMMARY OF FINDINGS

FIGURE 29: SHAW OPERATIONAL WATER FOOTPRINT PER SQUARE YARD OF ECOWORX CARPET TILE



SOCIAL FAIRNESS

Company operations are designed to celebrate all people and natural systems and make progress towards having a wholly beneficial impact on people and the planet.

Adhering to robust social fairness principles helps companies to provide healthy and safe working environments for employees and suppliers thereby maintaining a happy workforce, reducing sick days and improving performance. The *Cradle to Cradle Certified* Products Program inspires a best practice approach to social fairness that goes beyond simply avoiding human rights violations to supporting employees and suppliers in their everyday working and personal environments.

All companies with certified products were found to have addressed appropriate social risk factors for their business and almost 50% of companies undertook external audits of their health and safety procedures. Companies evidenced a range of social fairness monitoring routines, both operationally and throughout supply, including audits, management systems and third party certifications.

SOCIAL FAIRNESS INITIATIVES UNDERTAKEN AND PRINCIPLES COMMITTED TO BY COMPANIES WITH *CRADLE TO CRADLE CERTIFIED* PRODUCTS: UN Universal Declaration of Human Rights, UN Global Compact Principles (UNGC), B Corporation (BCorp), International Labour Organisation (ILO), Supply Chain (GANTSCh) project with GRI Global Action Network for Transparency, Local occupational health and safety certifications, SA8000, Fair Labour Association and OHSAS 18801. Bespoke local community projects and social activities are also routinely undertaken.

Limited information prior to product certification, as well as current transition towards v3.0 of the standard, has resulted in opportunity for building on future social fairness analysis. As companies generally had minimal optimization requirement to meet the criteria within this quality category,

step changes of social impact generated, through an understanding of current social status is apparent. Process based activity, such as risk assessment, offers a beneficial first step towards understanding and improving social impacts, which can be further progressed as the transition towards v3.0 is advanced, and more substantial data generated. Potential future inclusion of wider impact assessment is discussed in the 'Reflections' section.

BUSINESS IMPACTS

Business impacts were assessed within the study to provide important economic context to the research findings.

The study evidenced wide ranging business benefits from the pursuit of *Cradle to Cradle Certified* products including reduced costs, improved product value, new revenue streams and avoided risk. These findings clearly demonstrate the benefits of adopting the *Cradle to Cradle Certified* Products Program as a pathway towards the circular models of growth for which the World Economic Forum and the Ellen MacArthur Foundation are calling.

Reduced costs were achieved by re-using product materials and increasing resource efficiency, product value was enhanced with environmentally and socially superior credentials and new revenue streams derived from re-marketing product materials at the end of their traditional use. The Ellen MacArthur Foundation (2012) highlights that through maximized re-use of materials and waste elimination, economies will benefit from substantial net material savings. For fast moving consumer goods (FMCG), the full value of circular opportunities globally could be up to US$ 700 billion per annum *(*Ellen MacArthur Foundation, *2012)*

Re-using product materials also enabled companies to avoid traditional resource markets, thereby reducing risk from volatile prices and supply disruption. Companies also avoided risk from intensifying environmental costs by minimizing greenhouse gas emissions and other pollutant impacts.

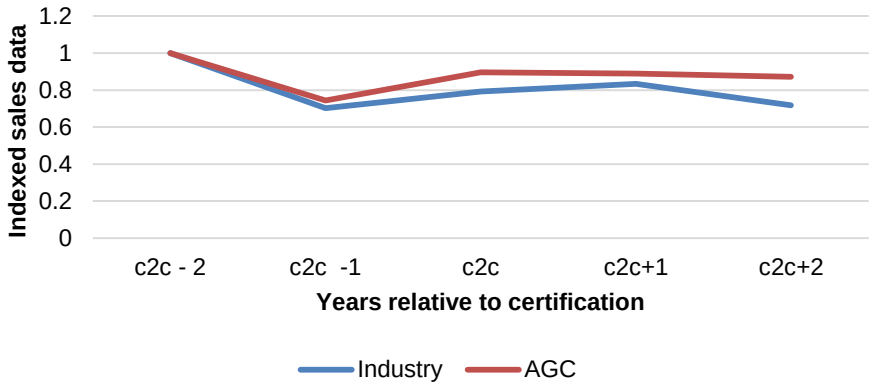
Resource depletion is a very real risk across many sectors, for a wide range of materials. With consumerism increasing and resource depletion becoming a greater issue, re-use of products and inputs helps protect companies against material scarcity. Material security is particularly an issue for finite resources, and the use of rapidly renewable materials further protects companies from supply chain risks in coming years. Construction Specialties have developed a system to exercise greater control over the production of PETG in its products, as this material was difficult to source but was a safer and recyclable alternative to PVC. PETG is 100% recyclable, and Construction Specialties offers a take-back scheme for materials no longer required by customers. This supports increased risk management of future supply, and can ensure the material inputs are created in line with Cradle to Cradle thinking.

SUMMARY OF FINDINGS

While the downturn has had an effect on AGC's sales, compared to the sector they have performed strongly with 21.4% more sales two years after product certification.

Against a backdrop of challenging economic conditions, the robust outperformance by companies achieving with *Cradle to Cradle Certified* products is particularly significant. For example, AGC Glass Europe publicly report on revenue, and though the flat glass sector has seen a decline in sales in recent years following the economic slowdown, the company has performed strongly relative to industry.

FIGURE 30: AGC GLASS EUROPE INDEXED COMPANY AND SECTOR SALES BASED ON 2008 BASELINE



AGC Glass Europe states its *Cradle to Cradle Certified* products are beneficial in helping the company win business, especially in the green building market. Some sustainable building certification schemes such as LEED V4 awards extra credits to new projects that use *Cradle to Cradle Certified* products.

Former CEO and co-owner of Desso, Stef Kranendijk highlighted the business benefit of Cradle to Cradle design, and the adoption of the concept as a business model in an interview with the Financial Times in 2010. Desso committed to new Cradle to Cradle sustainability goals in 2007 under Kranendijk's leadership, and launched the concept as a design and quality initiative that would boost innovation capability with positive effects on the environment and public health. The process was initially costly, but led to "so much innovation" that pay out was swift (Financial Times, 2010). The *Cradle to Cradle Certified* Products Program was seen as a driver of innovation for many of the companies reviewed, and often saw additional benefit of driving this up the supply chain, encouraging suppliers to develop new materials and optimize products themselves.

The combined impacts of certification are considered in relation to the three specific fields of environment, society and business. This is discussed in the following sections.

ENVIRONMENT

The World Economic Forum's Global Risks 2013 report cites water supply crises, extreme volatility in energy and agricultural prices, rising greenhouse

gas emissions and failure of climate change adaption among the top 10 global risks over the next 10 years, as measured by likelihood and scale of global impact.

The requirements of the *Cradle to Cradle Certified* Products Program fundamentally drive natural resource savings, waste reduction and development of safe product materials thereby protecting vulnerable natural resources and minimizing pollution impacts. The goal of the program is to regenerate positive impacts on people, planet and profits

SOCIETY

The International Labour Organization (ILO, 2012) identifies wide-ranging benefits associated with enhanced socially responsible behavior including raising the capacity to attract and maintain a qualified and motivated workforce, improved relations with staff and increased productivity.

The *Cradle to Cradle Certified* Products Program is founded on best practice social fairness principles that inspire employees and suppliers towards achieving their full potential in their everyday working and personal environments, rather than simply avoiding regulatory or reputational risks.

The social fairness benefits of pursuing *Cradle to Cradle Certified* products are most strongly linked to improved transparency and commitment towards social goals. It should be noted that for the majority of companies taking part in the research, social commitments were largely in place and little additional effort was required to meet *Cradle to Cradle Certified* standards. This is considered to partly reflect the ethical and social commitments of these companies, apparent in the desire to have *Cradle to Cradle Certified* products, though it is also noted that v2.1.1 of the Standard does not have strict criteria requirements for BASIC or SILVER levels of the certification. Should all companies be required to meet the social fairness criteria *Cradle to Cradle Certified* GOLD under v3.0 of the standard, step change is likely to be more significant.

To achieve truly advanced social benefit and ensure companies and products are having a net benefit (rather than a less damaging impact'), more empirical data is required and steps can be taken to advance the steps across a larger number of suppliers, reaching further along the tiers of supply.

Additional social benefits were derived from environmental benefits such as reduced pollution impacts linked to healthier product materials and increased renewable energy use.

BUSINESS

The Ellen MacArthur Foundation's 'Towards the Circular Economy' report estimates that the circular economy represents a net material cost saving opportunity of over $1 trillion a year globally

The innovation pathway offered by the *Cradle to Cradle Certified* Products Program optimizes product design and manufacturing to deliver the economic potential of circular economy cost savings and reverse cycle revenue streams. But this is just one of three areas which the *Cradle to Cradle Certified* program is designed to provide business value. Critically, product certification was conceived to extend beyond the economic scope of circular economy principles to deliver social, environmental well-being and economic well-being.

SUMMARY OF FINDINGS

Despite current linear manufacturing systems, the financial benefits of product certification are being evidenced by increased company revenues, alongside cost savings related to water and energy efficiency improvements.

In addition to financial benefits, this study identified environmental and social business value creation linked to the protection of vulnerable natural resources, reduced pollution impacts and enhanced social fairness initiatives. In this way, the *Cradle to Cradle Certified* Products Program can be implemented from an economic perspective – as well as from the perspective of environmental and human well-being.

CONCLUSIONS OF RESEARCH

The study identified several companies with *Cradle to Cradle Certified* products that achieved higher than average sales performance and increased revenues, alongside cost savings related to resource efficiency improvements. As this study represents the first attempt to assess the economic impact of pursuing *Cradle to Cradle Certified* product certification, the approach was new and bespoke, and companies were not yet able to deliver all of the requested data at a product level. However, the findings reflect the transparency apparent for the Standard, with detailed disclosure of data to Accredited Assessment Bodies for material assessment, as well as process and tier one supply chain transparency for achievement of higher level certification.

Business benefits linked to improved resource efficiency, resource re-use and reduced toxicity of product materials were also identified, including mitigation of risks associated with price volatility, supply crises and 'polluter pays' regulatory costs, as well as the creation of new revenue streams and improved product value. The removal of toxic materials from *Cradle to Cradle Certified* products creates additional benefits for human well-being and future product use cycles through more positive product material inputs, safer product production and greater re-use of product materials.

Limited social optimization related to social fairness was evident, in part due to the companies taking part in certification having already met *Cradle to Cradle Certified* Product Standard social fairness requirements. Advancement to higher *Cradle to Cradle Certified* award levels and transition to the latest version 3.0 of the standard will deliver enhanced social benefits. Social benefits related to human health were achieved through reduced pollution impacts from increased renewable energy mixes, safer product materials and increased recycling of materials.

Current recycling processes typically reduce products to their lowest nutrient level. Looking to the future there are opportunities for companies to transition to tighter re-use cycles which better conserve embedded energy and labor inputs by repairing or refurbishing products.

With no action to preserve natural resources through improved recycling processes and re-use of product materials, volatile prices will continue to be driven by increasing populations, consumption, and resource extraction costs linked to diminishing resource availability and increased impurity of material flows.

SUMMARY OF FINDINGS

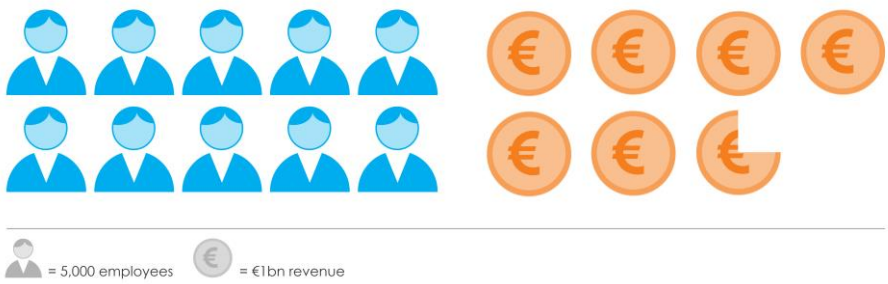
The *Cradle to Cradle Certified* Products Program provides a powerful continuous learning pathway to developing resource efficient, healthy business models that deliver environmental and human well-being alongside economic well-being. Business models that are best positioned for the transition to a resource effective, regenerative economy.

REFLECTION

This study identified, quantified and evaluated the environmental, social and business drivers of change derived from the *Cradle to Cradle Certified* Product Standard category requirements.

Ten companies operating in US, European and global markets representing a wide range of product portfolios from carpet tiles to toiletries participated in the research. These companies had combined revenues of over €6.75bn and employed global workforces exceeding 50,000 people.

FIGURE 31: EMPLOYEES AND REVENUE OF TEN PARTICIPATING COMPANIES



ROBUSTNESS OF ANALYSIS

The study represents pilot research designed to contribute an initial evidence base for *Cradle to Cradle Certified* Products Program and to get people thinking about what they can do to change production and consumerism into a positive force for people, planet and profit. While the study is not intended to provide scientific verification or demonstrate causality, it does provide an initial indication of the very significant economic, environmental and social potential of the program. More detailed research considering a wider sample of companies is needed to strengthen the pilot findings. Opportunities to build upon these findings are discussed in the following section. The main factors that affected research robustness are:

- The study compared *Cradle to Cradle Certified* products and non-certified benchmark products. Challenges were faced in attributing impacts specifically to the certification itself, as other variables are also present.
- Due to commercial sensitivities, Chemical Abstracts Service (CAS) numbers could not be shared for many companies' products, and therefore material health toxicity of the products were not quantified. Analysis was based on the allocation of material health 'ABC-X' rankings by the Accredited Assessment bodies.
- The burden for recycling is that of collection and sorting. The credit is that of displacing the primary material or product being avoided. Weighted allocations were based on the *Cradle to Cradle Certified* Product Standard's material reutilization ratio – recycled content: recyclability (1:2). This ensures no double counting for burden occurs across end-of-use of product and raw material for new product, while maintaining *Cradle to Cradle Certified* principles.
- For outbound transportation, companies provided data on distances and mode of transport. Where this was unavailable, sales locations were mapped and typical transportation routes and modes were applied.

- Wastewater was scaled down based on COD content. While other indicators can be used to reflect wastewater impacts, COD was considered appropriate based on available data. Further opportunity may exist in expanding this indicator further, working with companies to encourage data availability.
- Impacts were mapped to the country of supply for all tier one suppliers. This is the most appropriate method of mapping without further data and potentially supplier engagement, but opportunity exists to improve robustness in future work by improving data from higher tiers.
- Quantified social data was limited and social impact was not quantified, though mapping of sector-region was included for reference with qualitative discussion around material risks.

OPPORTUNITIES FOR FUTURE DEVELOPMENT

INCREASE THE NUMBER OF PRODUCTS REVIEWED

As a pilot study, ten sets of similar products were analyzed and compared across a range of product categories. This has provided detailed insight into the benefits seen across these products and companies, and has provided an initial evidence base for further development. This can now be built upon with wider ranging products, more numerous examples of the same types of product and a larger number of country representatives. Multiple products from individual companies can also be assessed, providing greater insight into company variation and the specific manufacturing and other processes undertaken.

Geographically, *Cradle to Cradle Certified* product certification is currently most common in North America and Europe. As the market develops, and the number of *Cradle to Cradle Certified* products increases, it is recommended that wider ranging products are analyzed, taking local cultural behaviors and infrastructures into consideration. For example, end-of-use behavior, recycling availability, material sourcing and other such relevant factors.

By incorporating a wider sample size, greater understanding of the effects of certification can be achieved. Increasing the sample size of each product type increases the statistical significance of the analysis, allowing the impacts of *Cradle to Cradle Certified* products to be determined. The larger the sample size, the less the influence of external variables such as commodity price fluctuation on sourcing decisions.

In particular, the performance indicators for business impacts are difficult to disaggregate to certified and non-certified product portfolios. A wider range of analyses would offer better understanding of the correlation.

RECOMMENDATION: Use of framework

Stakeholders to use the framework to carry out further analyses

Actors: Cradle to Cradle Products Innovation Institute, scientific community, companies

Required action: Companies with *Cradle to Cradle Certified* products should use the framework, with the support of the Institute and the scientific community, to carry out further analyses on a wider range of products and more examples of current products. This will enable companies to understand the impact of certification on their own products and operations, and the return on investment achievable in *Cradle to Cradle Certified* product optimization. This could be used to create a forecasting tool and help to develop a dashboard for analyses.

In addition, stakeholders will better understand the typical impacts achieved through product certification and gain an improved understanding of overarching benefit and value to the *Cradle to Cradle Certified* brand.

BUILD UPON MATERIAL HEALTH ASSESSMENT

Robust material health assessments are carried out by the Accredited Assessment Bodies for inputs from suppliers, on the specific composition of products. Yet this information is often unavailable to companies because it is protected by confidentiality agreements. Companies, suppliers and Accredited Assessment Bodies should work to determine a suitable means to share data from material health assessments without breaching confidentiality agreements and maintaining the confidence of supply chain.

It was noted by two companies that the confidentiality offered by Accredited Assessment Bodies to their suppliers allowed for this detailed analysis. This is considered a strength of the *Cradle to Cradle Certified* product certification process, providing security that other certification schemes could not offer.

RECOMMENDATION: Develop a means to share data for material health analysis

Incorporate Accredited Assessment Body material health disaggregated evaluation results.

Actors: Cradle to Cradle Products Innovation Institute, Accredited Assessment Bodies, companies, and suppliers

Required action: All stakeholders should work together to develop a suitable means to incorporate data derived from material health assessments without breaching confidentiality agreements, building on the existing strengths of the *Cradle to Cradle Certified* product certification process.

INCREASE DATA CONSISTENCY

Environmental data are fairly consistently reported by many of the companies. This varied across the different types of indicators, but was present at some level across all the impact fields.

Opportunities exist to improve the collection and reporting data, with collaboration between stakeholders beneficial.

RECOMMENDATION: Create reporting and performance indicators

Create more prescriptive indicators for reporting on all issues, particularly business and social indicators (detailed more specifically below)

Actors: The Cradle to Cradle Products Innovation Institute, with input from companies

Required action: The Institute and companies should collaborate on creating more prescriptive indicators for all areas, but especially for social and business issues. These are not required to be certification requirements, for example, providing the Institute with the number of staff injuries per 100 employees per year, without additionally requiring companies to meet thresholds of these, would allow for a greater understanding of certification, without becoming too stringent and requiring significant additional effort by companies.

RECOMMENDATION: Develop a reporting platform

Create a reporting platform for ease of data collection

Actors: The Cradle to Cradle Products Innovation Institute, Accredited Assessment Bodies

Required action: The Institute is recommended to work with companies to develop a reporting platform or mechanism in which companies are able to capture indicators recommended above.

An easily accessible, and simple tool to report indicators would present two significant benefits. Firstly, data would be consistently reported and in the format most appropriate for analysis. Secondly, companies are able to input data as it becomes available, rather than having to undergo a potentially resource intensive collection process if they wish to undertake a product analysis.

INCREASE DATA FOR SOCIAL ANALYSIS

The transition from version 2.1.1 to 3.0 of the *Cradle to Cradle Certified* Product Standard is not yet complete. Once all companies and products have made this change, further social audit data will be available for future analyses. It is recommended that the social fairness category builds upon initiatives and global schemes developed specifically for improved social practice, rather than developing new and replicated requirements. This said, opportunity exists to increase the data collected by companies to analyze their social impacts building on the data consistency recommendations above. This is apparent both for social indicators covering a company's operations as well as those on the supply chain.

In regards to external social impacts, the number of initiatives is not important but rather the amount of social benefit generated and risks averted. One way that this could be addressed is to develop standardized, prescriptive performance-based indicators for social impacts within the standard. Given the range of products produced by *Cradle to Cradle Certified* companies, and variation in size, location and other variables, this poses challenges.

Another more flexible approach is to require more systematic reporting on impacts, including both qualitative and quantitative data where available, in a way that allows comparisons and summations across certified companies.

This reporting could be organized around a set of standardized, key categories, including capacity building, training and education; poverty alleviation; and health, and could include some standardized metrics across all companies. This would facilitate assessment and communication of the substantive social impacts (rather than merely outputs) of *Cradle to Cradle Certified* products and respective companies. A yet more flexible approach, would be to allow companies to choose their own reporting frameworks (as they do now) but companies then produce clear substantive data, including quantitative data, on their social impacts (such as impacts on poverty or education for example) which could then be summarized in assessment reports such as this one. This would facilitate greater transparency on the substantive social impact of *Cradle to Cradle Certified* product companies.

RECOMMENDATION: Social indicators

Collect, record and report on more granular social indicators

Actors: Companies, the Cradle to Cradle Products Innovation Institute

Required action: The Institute and companies with certified products should work together to develop more prescriptive indicators for social analysis, and move away from process based assessment only.

EXPAND RISK CHARACTERIZATION OF SUPPLY CHAIN

The social fairness category of the *Cradle to Cradle Certified* Product Standard highlights the aim to ensure that progress is made towards sustaining business operations that protect the value chain and contribute to all stakeholder interests including employees, customers, community members and the environment. It is important for business ethics to go beyond the confines of the corporate office and permeate the supply chain, engaging responsible manufacturing, enforcing fair treatment of workers, and reinvesting in natural capital.

An important consideration is the limitations associated with excluding the lower tiers of the supply chain. Social impacts may be apparent in developing countries, which are may be highly involved within the earliest stages (e.g. tier four suppliers for example), and optimization to the highest levels of social fairness may not be captured. Further building on the social risk characterization mapping of the sector-region, opportunity exists to expand the analysis further than final point of manufacture. The Institute is currently launching Initiatives, like Fashion Positive, to start certifying products from the fibers up, ensuring social fairness across all stages of the supply chain, focusing on certifying building blocks of products, to lower hurdles for companies to adopt Cradle to Cradle Product Certification, and this will strengthen the data available and the steps involved for improved analysis.

RECOMMENDATION: Expand range

Expand reach of social analysis further than final point of manufacture

Actors: Scientific community, supported by the Cradle to Cradle Products Innovation Institute, Companies, Supply chain

Required action: Expanding the assessment to begin at the start of the supply chain with raw material growth and primary sectors would offer a beneficial starting point to a greater understanding of supply chain impacts. (Note, for Version 3.0 of the standard, all tier one facilities relevant to manufacture of the product are required to be listed and risk/opportunity assessed – this step would simply require expanding this to incorporate baseline products)

Rolling this out to all significant supply chain actors (determined through a hotspot analysis for example) would be beneficial, though a screening level social LCA or similar may be more realistic and achievable. Data requirements would be greater than currently available to many of the companies interviewed.

EXPAND DATA GATHERING TO INCORPORATE PRIMARY DATA FROM SUPPLIERS

The analysis used primary data where available, for example, the operational environmental and business data and direct company social and business information. Impacts of supply chain are modelled based on Trucost's I-O model and secondary LCA data amongst other sources. Engagement with suppliers is a beneficial exercise to capture more robust data and particularly capture improvements 'rolled out' down the supply chain, which may otherwise not be captured.

RECOMMENDATION: Engage suppliers

Engage with tier one suppliers to gather primary data

Actors: Scientific community, users of the framework

Required action: During the data-gathering phase of analysis, suppliers could be contacted and requested to provide primary data on key indicators. Data may not be available for all, though key material indicators such as energy use by source and type, water consumption, material use, waste, employee data and other certification/standards should be.

EXPAND SOCIAL INDICATOR INCLUSION

Social capital includes relationships and networks not captured within the impact assessment currently. This is due to many complexities involved, data limitations, lack of direct contact with wider ranging stakeholders and other practicalities making this unfeasible within the study. The assessment currently focuses primarily on physical factors such as health and safety, and output based indicators (as used within the SHdb), such as number of years of school.

RECOMMENDATION: Expand social boundaries

Expand boundaries of social impact to capture indicators outside of social and output based impacts

Actors: Scientific community, Cradle to Cradle Products Innovation Institute

Required action: Analysis may be enriched by expanding the assessment to include further 'dynamic stock' embedded in social relationships and capacities. Other tools may be used for social analysis given more time and resource, for example the completion of a full social LCA may add further insight into these relationships and human and social capital.

DISAGGREGATE BUSINESS DATA FOR CERTIFIED PORTFOLIO AND PRODUCTS

The business analysis was focused on company performance and other company level data for much of the quantified evaluation. This is largely due to lack of recording of economic and performance data at the *Cradle to Cradle Certified* product range, or commercial sensitivity of financial data.

There may be some indicators for which there is challenge with disaggregation, and exceptions should be made in these situations. For example, funding on research and development may be a joint approach for 'sustainability', rather than specifically related to the *Cradle to Cradle Certified* product, or products. One company stated that they have several certifications, including *Cradle to Cradle Certified*, on a single product. The cost of development of the product to meet all the categories was therefore not attributable to any single one.

RECOMMENDATION: Gather more granular business data

Collect, record and report on more granular business data for business indicators

Actors: Companies, the Cradle to Cradle Products Innovation Institute

Required action: The Institute and companies with certified products should work together to determine how to better attribute business impacts to certification processes, and companies be encouraged to record data at a disaggregated level. Specifically, where possible, companies should report indicators to the institute disaggregated by product or by certified product portfolio where feasible.

Examples of some of the 'low hanging fruit' for business indicators would be separate figures for *Cradle to Cradle Certified* portfolio and non-certified portfolio level;

- COGS
- Revenue
- Profit (or percentage profit margin)
- Input material costs
- Waste disposal costs
- Utility costs (if metered at a detailed level)

Some companies were able to provide this level of data, however due to small sample size, aggregated data was not provided as this could not be considered representative of the group.

INCLUDE QUANTITATIVE EVALUATION OF 'SOCIAL CAPITAL'

Various recent studies illustrate the pervasiveness of, and provide useful impressions of the political, economic and social influence of social capital (Fine, 2001; Jack and Jordan, 1999; Montgomery, 2000). Given this potential for contributing towards socio-economic change, it is important for any economy, business or society to identify, value and measure social capital as an indicator of wellbeing.

Due to its collective and relationship nature, it is difficult to formulate any single measure for social capital, and valuing social capital is a challenging and emerging field. However, the concept of 'social capital' does need to be defined and measured carefully, if it is to provide anything more than just broadly suggestive thinking about growth (Temple, 2001).

The Organisation of Economic Cooperation and Development (OECD) define social capital as, "networks together with shared norms, values and understandings that facilitate co-operation within or among groups"; wherein networks consist of real-world links between groups or individuals. Companies today invest heavily in building and developing such real-world links.

Among the most prominent examples of the development of these links is the advent of Corporate Social responsibility (CSR), linking a company formally with society through a structured agenda of company-funded activity. CSR is defined broadly as a company's "status and activities with respect to its perceived societal or, at least, stakeholder obligations." (Bhattacharya % Sen, 2004). More companies than ever before are backing CSR initiatives such as corporate philanthropy, cause-related marketing, minority support programs, and socially responsible employment and manufacturing practices – and they are doing so with real financial and marketing muscle (GIST Advisory, 2013).

At the corporate level, social capital can be quantified by valuing the benefits to society generated in the process of improving relationships and networks by the company's CSR activities, by their socially responsible business models and company policies (Minette & Murphy, 2001), including along the supply chain, as they contribute towards individuals, who collectively constitute networks or groups, external to its core area of operations.

Research on social capital has attributed its benefits across a wide range of domains including facilitation of higher levels of, and growth in, gross domestic product (GDP); facilitation of more efficient functioning of labor markets; lower levels of crime; and improvements in the effectiveness of institutions (Alridge et al., 2002; Halpern, 2001; Kawachi et al., 1999; Putnam et al., 1993). Moreover, social capital is an important contributor towards educational attainment (Alridge et al, 2002; Israel et al, 2001); public health (Coulthard et al, 2001; Subramanian et al, 2003); community governance and economic problems (Bowles and Gintis, 2002).

Companies today generate a wide range of social benefits via their CSR activities. Such actions have the potential to improve the companies' image (i.e., brand value) when consumers attribute it with sincere motives (Yoon et al, 2006) and such positive consumer patronage linkages often motivate CSR investments.

Prevailing accounting practices generally reflect only the cost-to-business of undertaking CSR activities. While it is a necessary indicator for financial reporting, a mere cost-based approach is not sufficient to enable maximization of social capital, since it does not reflect the efficiency of resource use and time invested by businesses, and provides little information on the "social" value generated by a particular CSR program.

Reflecting changing trends, businesses today are realizing the concomitant and urgent need to measure the returns to various CSR programs – hence the interest in calculating "Social Returns on Investment" (SROI). This trend is an example of valuation practices evolving to capture the true social value of streams of benefits generated by corporate CSR in a form that reflects its materiality to society and its justification to companies.

RECOMMENDATION: Quantify and apply social capital valuation

As with natural capital, monetization of social capital is a means to better understand the combined impacts of social and human impacts. Valuation is complex, but development of valuation methodologies, and application of coefficients can be a longer term aspiration

Actors: Scientific community, Cradle to Cradle Products Innovation Institute

Required action: Analysis may be enriched by determining an overall monetary valuation of social impacts from certification and business practice optimization.

NEXT STEPS

READER'S GUIDE

The research provides some exciting findings and useful steps towards developing a deep and robust understanding of the impacts of the *Cradle to Cradle Certified* Products Program. This section builds upon recommendations given for future development of the research and defines next steps to be taken by stakeholders.

STAKEHOLDER NEXT STEPS

Individual recommendations are provided in the reflections section, following on from identified opportunities for future development of work. These are further touched upon within these stakeholder focused sections, providing additional detail where considered beneficial.

THE CRADLE TO CRADLE PRODUCTS INNOVATION INSTITUTE

As the first study to attempt to capture impacts of *Cradle to Cradle Certified* product certification, the research provided significant quantitative and qualitative information. Opportunities exist for strengthening and developing the research further with specific examples of how to take this forward provided in the previous section.

The study also provides an initial evidence base, which indicates the benefits seen through certification. Case examples have identified reduced impact on human well-being due to product optimization, as well as potential indirect impacts and trends observed which reflect positive business performance. This message should be promoted to encourage further good practice. Specific examples are considered below.

Promote impact opportunities to encourage wider move of industry representatives to move towards a circular economy

The research highlights the benefits to the environment, society and business of moving product manufacture away from conventional (linear) processes, and towards a Cradle to Cradle design approach. The products are designed for a circular economy, though currently used in a conventional linear system. Should transition towards a more circular economy become apparent, the benefits achieved may become more compelling, for example with greater retention of end-of-use products within their respective cycles. Recent research by the Ellen MacArthur Foundation and partners (World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company, 2014) highlights the increase in attractiveness of circular models where resource prices are high and if the costs of establishing necessary reverse cycle networks decline.

The research should be used to communicate these benefits and encourage other industry representatives to 'remake the way they make things', and promote the transition towards the circular economy. Products can be used to promote best practice, helping to illustrate benefits to other manufacturers and inspire such a move.

Promote benefit to the general public

Anecdotally, awareness of the *Cradle to Cradle Certified* Products Program is limited within the general public, though this varies across differing geographies. An example of how this affects businesses is the case of Ecover, which has undertaken certification on its business-to-business range of products but not on its wider consumer facing product range, partly due to wider recognition within the business environment. By using the impact study to raise public awareness of the benefits of *Cradle to Cradle Certified* Products Program, consumer demand may be increased and this in turn may drive company demand for certification.

COMPANIES WITH *CRADLE TO CRADLE CERTIFIED* PRODUCTS

Product certification provides third party independent verification of a company's sustainability claims, however the net benefit of the certification process has previously been unreported. Companies should work to promote the evidence base developed and encourage their customers, competitors and suppliers to understand the benefits of Cradle to Cradle Certification.

To carry out more effective and streamlined analysis in future product evaluations, companies should work to collect more data at a product and certified portfolio level. This is particularly important for social and business performance, both of which were less widely available. Difficulties were faced accessing data, which is likely collected by the companies within the business, yet due to different departmental responsibilities, and communications, was often unavailable.

Companies have taken many steps to achieve product optimization, and improve performance, though this may not be fully reflected until improved data collection provides more granular data. Firstly, a more robust analysis provides greater understanding of impacts associated with the move from conventional manufacture to certified products, but may help with business decisions and future design processes also. The analysis not only captures the net benefit associated with certified products, but also highlights opportunities for further improvement. As all certified products are under a regime of continuous improvement, knowledge of the greatest impact areas will help focus the most material aspects of the products design, production use and end-of-use.

Secondly, better knowledge of impacts offers a greater opportunity for communication, to promote the achievements at a product and company level to customers and investors. Better external communication can further develop

SCIENTIFIC COMMUNITY/ EDUCATION

The scientific community can use the framework to build upon the evidence base started, both through the continuation of additional product analyses, but also the development and evolution of the framework itself. The framework can be used as an educational tool and help encourage new stakeholders to understand the benefit of the Cradle to Cradle Products Program, but can offer learning through development also.

Optimal benefit will be apparent if the scientific community work alongside the other stakeholders, particularly the Institute and companies looking to assess their own products, and use the framework to jointly assess new products, differing scenarios, and potentially different use phases and impact

categories, as is deemed necessary for the particular cases. This will help identify gaps in the methodology that were not required for the ten products analyzed in the pilot study.

APPENDICES

CONTENTS

I. REFERENCES

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II. OPPORTUNITIES

The individual methodologies for environmental analysis each have various assumptions made on data, inclusions, attribution and other factors. Opportunity exists to potentially strengthen these approaches, and these are given for individual aspects of the analysis below.

Opportunities to improve the waste analysis approach include:

- The industry-specific weighted average of the environmental impact non-hazardous waste disposal assumes that the composition of waste incinerated or landfilled is similar. Some waste categories however may be recycled more than others (either by the generator or because some facilities are equipped with pre-sorting facilities), thus leading to different waste composition.
- Waste generation throughout the supply chain of materials and energy inputs has not been modified from the way it is treated and built-in to the factors used. Ecoinvent 3 is the primary dataset used in modelling the supply chain impacts of inputs and does not attribute credits for energy recovery when waste is incinerated. Trucost adopted a conservative approach in not modifying this as it can be argued that companies do not have a say in how their suppliers manage their own waste, especially further down the supply chain. This may overstate the supply chain emissions of companies that do encourage their suppliers to manage their waste.

Opportunities to improve the wastewater approach include:

- Trucost used COD content as a proxy for waste water quality, in order to scale up or down the impacts of treating wastewater from Ecoinvent record. While the relationship yielded an acceptable positive correlation when tested, this remains an approximation which introduces some uncertainties.
- This methodology applies to cases where wastewater is treated before being released to the environment. A different approach should be used when wastewater with pollution content above acceptable levels is released directly into the environment.

Opportunities to improve the material reutilization approach include:

- No credit has been allocated to renewable content of sourced materials. Similarly, the burdens have not been weighted following the methodology above, that is, 100% of the burdens of manufacturing renewable materials have been attributed. This is because the credit of using renewable material would be best captured through environmental indicators that are not included within the scope of this work, such as material depletion.
- The credits and burdens methodology does not capture the full cascade that materials managed in a technical or nutrient factor undergo following their first use. For example, paper can be recycled up to seven times as paper, then as cardboard or tissues once the fibers become too short before it eventually returns to the biosphere as a nutrient. Trucost methodology only takes into account the next use cycle in its attribution of credits and burdens, and ignores the rest of the cascade for two reasons. Firstly, the further down the cascade, the higher the uncertainties involved in modelling. Secondly, what happens following the initial use cycle is not considered to be under the companies' influence and is independent of its intention or nutrient management plan. The non-inclusion of the full cascade in the calculations of credits and burdens likely

underestimates the net benefit associated with recycling and composting.

- Loss of material and property losses have not been captured in the burden and credit analysis. This may overestimate the credits attributed to recycling and composting at the end-of-use, and of recycled content in the sourcing phase.
- The weighting of credits and burdens is based on the reutilization score formula. Trucost recognizes that many other methodologies exist to model the use and end-of-use of recycled, recyclable, rapidly renewable content and compostable materials which will differ in different stakeholders' opinions. The weighting used reflects Cradle to Cradle Certification value judgment.

Opportunities to improve the renewable energy and carbon management approach include:

- Electricity and in general energy-mixes were regionalized for the operational impact and the most important materials in weight or materiality terms. However, most embodied energy mixes have not been regionalized.
- Additional KPIs could be included in order to capture the costs and benefits of each energy type more holistically. This includes for example land use which can be material for solar electricity generation and biofuels.

Opportunities to improve the material health approach include:

- Valuations derived are based on LCA characterization models which assess substances using a slightly different approach as how Accredited Assessment Bodies assess each material, and as such should only be considered as proxies. For example, as seen above, an exposure assessment is part of the material health assessment, which is not built in LCA characterization models. Furthermore, fate and exposure factors taken into account do not align perfectly.
- Valuing rating bands rather than particular substances implies a loss of granularity.
- Valuation factors are derived based on LCA characterization models which assess substances, and applied to materials. This conservative approach likely overestimates the absolute results.

III. INDICATORS TARGETED

The table below provides all KPIs which could be captured to reflect impacts of *Cradle to Cradle Certified* product certification across the three impact fields of environment, society and business. These were defined in the scoping phase of the research, however companies were unable to provide many of these, and Part 2 details actual KPIs captured.

TABLE 19: ALL KPIS TARGETED FOR INCLUSION

Impact field	Category	Key Performance Indicator	Data source
Business	Finance	• Revenue (total, by product category and by user) • Profit (net, product and category profit) • Turnover • Sales by unit • Unit price • Total shareholder return • Stock value • Certification costs • Customer profitability • Brand value (where available) • Operating expense ratio • Sales volume projection	Balance sheet Profit and loss statements Cash flow statements Annual reports
	Customer	• Customer complaints • Customer positive feedback • Customer profitability • Customer re-buy • Returned products • Number of requests for *Cradle to Cradle Certified*	Customer surveys Available market research Interviews
	Sales and marketing	• Market share (by product, and by certified product category) • Market growth rate • Brand equity (where available) • Quotation conversion rate • Cross selling success rate	Available market research Interviews
	Operations	• New products to market • Failure rate of innovation • Return on innovation investment • Source and use of energy • Source and use of	Interviews

		water • Compliance costs • Quality index rates • Innovative capability (if available) • Competitive advantage (if available)	
	Employee	• Number of staff directly employed • Turnover • Total sick days • Total injuries • Time lost to sickness/injury • Productivity (yield per employee, dependent on product type) • Average applications to open posts	Company annual reports Interviews Internal company research (staff surveys, reviews etc)
	Environmental	• Energy source and consumption • Water consumption • Savings due to improvement efforts • Waste recycling rate	CSR reports Summary Reports Interviews Company audit data
Environment	Material Health	• Chemicals removed from product • Chemical sin the process of being phased out • Human toxicity • Marine toxicity • Freshwater toxicity • Air toxicity • Number of optimized materials/chemicals	
	Material reutilization	• Waste avoidance • Nutrient recovery • Nutrient re-use • Number of plans in place for material recovery • Recycling rate • Take back volumes	
	Renewable energy and carbon management	• Air quality • Energy source and consumption • Onsite energy generation • Achievements through carbon management strategy • Spend on offset	

		• Percentage of energy use that is offset • Revenue from energy generation (RECs or other)	
	Water stewardship	• Water quality • Water use • Number of water strategies in place • Achievements through water management	
	Social fairness	• Social impacts of environmental KPIs • Percentage of supply chain audited	
Society	Labor rights	• Child labor • Forced labor • Freedom of association • Wage assessment • Poverty	Social Hotspot Database (KPI's are based upon characterization model of the SHdb portal, with adjustment of improvement through audit processes. Further benefit is also considered through external sources such as those given below.) Company CSR report Audit data Interviews
	Health and safety	• Number of employee injuries • Risk of communicable disease • Risk of non-communicable disease	
	Human rights	• Gender equality • High conflict zones	
	Governance	• Legal systems • Corruption	
	Community	• Drinking water • Sanitation • Number of community projects engaged with	

IV. DATA COLLECTION SHEETS

List of data requirements

Notes on filling in data

Please fill in the white boxes where appropriate with specific data as requested.
Grey boxes are locked, these update automatically, based on input into other cells, and cannot be adjusted.
All green cells are drop boxes, and give options of possible answers - please place cursor on the small arrow on the right of the cell to open list.
The data requirements are given in the table headings. Clicking on the headings brings up some more detail for the less straight forward data requirements.

Essential	Select link below to go to page
General This provides general company and product data, including certification details, product analysed and to be compared to, and top level business performance.	General data
Corporate environmental performance Annual company level data is required, to allow us to determine the company level impacts of certification. The data should reflect the same two years as the product analysis.	Corporate env. performance
Site information Annual site data is required, to allow us to determine the company level impacts of certification. The data should reflect the same two years as the product analysis.	Site env. performance
Product information Both the product codes, and product names (if different), descriptions, and volumes sold in 2012 (for Certified product - if available). For the pre-certified product, please state the year of which sales are analysed.	Product information
Bill of materials Bill of materials for each product; including quantities (weights) purchased and amount spent. This must include packaging	Bill of materials
Product In-use phase Please provide any emissions data or other research carried out on the impacts of product during use phase. This should	In-use
Product end of use and maintenance Please provide data on any take back schemes, or recommended recovery routes for your product. If available, specifiy what percentage of products are recovered after consumer use phase.	Product end of use
Logistics Logistics data by product type broken out by: Factory to Port, Port to Port, Port to Distributor and Distributor to Retailer. These may not all be relevant to your product.	Logistics
Economic data We expect variation in financial data available, so please complete as you can. We will populate in advance with data from financial documents provided	Economic and social data

IV. DATA COLLECTION SHEETS

General information

Cradle to Cradle Certified Impact Study - General information

Data requirements for company and product

Return to data requirements

Please state currency used	

Company detail

Name	
Location	
Number of manufacturing sites	
Manufacture on site?	
Year for data analysis (2012 if available)	

Product detail

Product name	
Product category	
Year of certification	
Year of product comparison (this must be prior to certification)	
Level of award	

If it is not possible to disaggregate these financial figures between c2cCertified and Non c2cCertified products, please fill in the total column only.

Current (2012)

	Analysed product	c2cCertified (incl. the certified product chosen)	Non certified	Total
Number of SKU's				0
Sales (in units)				0
Sales (in revenue)				
Cost of goods sold				0
Number of customers				
Gross profit	0	0	0	
Selling, General and Administrative expense				
Operating profit				0
Discretionary costs				
Tax				
Net profit				0

Year of comparison ()

	Analysed product	c2cCertified	Non certified (incl. the baseline product chosen)	Total
Number of SKU's				0
Sales (in units)				0
Sales (in revenue)				
Cost of goods sold				0
Number of customers				
Gross profit	0	0	0	0
Selling, General and Administrative expense				
Operating profit				0
Discretionary costs				
Tax				
Net profit				0

IV. DATA COLLECTION SHEETS

Optimisation

What changes were made to bring product up to certification standards?
This data should be largely available from the certification summary report, and may be determined through online review also.

Return to data requirements

Material health

How many and what materials/chemicals (banned list/x-assessed) were phased out as result of the Cradle to Cradle product optimization process?	
How many and what hybrid materials were phased out?	
How many and what X assessed chemicals are in the process of being phased out?	
How many assessed materials do not contain any carcinogenic, mutagenic, or reproductively toxic chemicals as a result of the optimization process?	
How many assessed materials/chemicals had their formulation optimized?	
How many and what materials/chemicals meet the Cradle to Cradle emission standards as specified in V3.0 of the Cradle to Cradle Certified Product Standard?	
How many and what x-assessed process chemicals were replaced?	

Material reutilisation

What plans have been developed for recovery or recycling of material? Have you developed a take back scheme, either directly or through a partner?	
Number of chemicals and substances defined in the appropriate cycle (technical or biological) and their development since start of pursuing Cradle to Cradle product optimization?	
Number of chemicals and substances defined in the appropriate cycle (technical or biological) and their development since start of pursuing Cradle to Cradle product optimization?	
Number of plans in place for product recovery and reutilization and their development since start of pursuing Cradle to Cradle product optimization?	
Number of products designed or manufactured for the technical or biological cycle with a material (re)utilisation score >= 35, >=50, >=65, =100, and their numbers since start of pursuing Cradle to Cradle product optimization?	
Presence of a defined nutrient management strategy (including scope, timeline and budget) for developing the logistics and recovery systems for products or materials currently being used?	
Number of products and volumes actively being recovered and cycled in a technical or biological metabolism and their volumes since start of pursuing Cradle to Cradle product optimization?	
How did material reutilization affect your supply chain in terms of quality of materials, availability in quantity and time and material flows?	

Renewable energy

How has energy sourcing changed?	
Do you generate any energy onsite?	
Have you reduced energy requirements for the production of the product?	
What % of energy is offset?	
Purchased electricity and direct on-site emission data associated with the final manufacturing stage of the product and their development since the start of pursuing Cradle to Cradle product optimization?	
The amount of renewable energy used and the growth of renewable energy usage since the start of pursuing Cradle to Cradle product optimization?	
The results of the companies' carbon management strategy and their development since the start of pursuing Cradle to Cradle product optimization – achievements and number of products in the portfolio use renewable energy?	
Percentage of the company's purchased electricity that is currently renewably sourced or offset with renewable energy projects and its development since the start of pursuing Cradle to Cradle product optimization? Percentage with each certified product?	

Water stewardship

What improvements have you made to your water management? Number of product-related process chemicals in effluent optimized?	
Characterize local and business-specific water-related issues?	
Results from the companies' statement of water stewardship intentions and of facility-wide water audits since the start of pursuing Cradle to Cradle product optimization?	
Number of product-related process chemicals in effluent phased out?	
Percentage of Tier 1 suppliers that have characterized supply-chain relevant water issues and have defined a strategy to improve at least 20%?	
Number of product-related process chemicals in effluent optimized and their effect on water quality?	
When will the water exiting the manufacturing facility meet drinking quality standards?	

Social fairness

Social audits carried out? Do you have available (and would you please provide) completed social responsibility self-audits based on UN Global Compact Tool or B Corp application?	
Did you carry out social audits prior to certification on any product lines?	
Description of management procedures developed to address any identified issues regarding social fairness and their development since the start of pursuing Cradle to Cradle product optimization?	
Number of certified materials used in products, described in a % of the product material by weight and their development?	
Can you provide examples of how your company has driven social improvement since certification?	
Did you actively engage with your company's direct environment and employees to review your social fairness approach and if so, in what manner?	

IV.DATA COLLECTION SHEETS

Product information

Return to data requirements

This tab gives you an opportunity to describe the processes and value chain of the ctocCertified and baseline product.
The following tabs gather data to perform a LCA on both products, in order to assess the net environmental benefit of certification

For the product selected, please provide brief description of value chain
Describe Onsite Manufacturing/Assembly Processes
Please describe any changes made to this process for certification

Corporate level information

This tab has been pre-populated with data from your company's CSR report. Please feel free to modify or add any information.
Please include only data that covers the totality of your operations.
If you do not measure or report this data, Trucost will estimate it using industry averages.

Year of analysis	0	0			
Certification status	Prior to certification	After certification			
Energy	Quantity		Unit	Comments	Explanations
Coal					Overall consum
Fuel Oil					Overall consum
Natural Gas					Overall consum
Petrol					Overall consum
Diesel					Overall consum
Biomass					Overall consum
Other (please specify)					
On-site electricity					Please specify t
Purchased grid electricity					
Purchased renewable electricity					Please specify t
Energy management strategy in place?			NA		
Emissions offsets?					Please provide
Water	Quantity		Unit	Comments	Explanations
Total water use					
Water abstracted					If it is not possi
Water purchased					If it is not possi
Water management strategy in place?			NA		
Waste generation	Quantity		Unit	Comments	Explanations
Total non-hazardous waste	0	0			Please provide
Non-hazardous waste recycled					Please provide
Non-hazardous waste re-used					Please provide
Non-hazardous waste composted					Please provide
Non-hazardous waste landfilled					Please provide
Non-hazardous waste incinerated					Please provide
Non-hazardous waste incinerated (with energy recovery)					
Other (please specify)					
Total hazardous waste					Please provide
Hazardous waste recycled					Please provide
Hazardous waste re-used					Please provide
Hazardous waste composted					Please provide
Hazardous waste landfilled					Please provide
Hazardous waste incinerated					Please provide
Non-hazardous waste incinerated (with energy recovery)					
Other (please specify)					
Total waste	0	0			Please fill-in th
Waste recycled	0	0			Please fill-in th
Waste re-used	0	0			Please fill-in th
Waste composted	0	0			Please fill-in th
Waste landfilled	0	0			Please fill-in th
Waste incinerated	0	0			Please fill-in th
Non-hazardous waste incinerated (with energy recovery)	0	0			Please fill-in th
Other (please specify)	0	0			Please fill-in th
Waste management strategy in place?			NA		
Air emissions	Quantity		Unit	Comments	Explanations
Sulfur dioxide					Please include
Nitrogen oxide					Please include
Particulate matter <2.5					Please include
Particulate matter >2.5, <2.5					Please include
Particulate matter >10					Please include
Particulate matter, total					Please include
Volatile Organic Compounds					Please include
Ammonia					Please include
Carbon monoxide					Please include
Other (please specify)					Please include
Other (please specify)					Please include
Other (please specify)					Please include
Other (please specify)					Please include
Other (please specify)					Please include
Other (please specify)					Please include
Other (please specify)					Please include
Other (please specify)					Please include
Other (please specify)					Please include
Water emissions	Quantity		Unit	Comments	Explanations
Waste water quantity					
COD					
Waste water utilisation and treatment					Please indicate
Land emissions	Quantity		Unit	Comments	Explanations
Spills					Please indicate

IV. DATA COLLECTION SHEETS

Site level information

This data should represent the total resource consumption and arisings at the final manufacturing site of the product being analysed. Please note that if you have several manufacturing sites, the data is different than the total environmental KPIs reported in your CSR report. Where your product is made in several locations, the combined data should be given. ***Please feel in the first table in order to allocate the site-level environmental impact to a product-level.***

	Baseline product	c2cCertified product	
Number of manufacturing sites	0		
Is the product manufactured within multiple sites?			
Are other products manufactured on the same site(s)?			**If "yes", please fill in the two following lines**
Overall mass of product under interest manufactured per year			**This information is used to allocate the site environmental impact**
Overall mass of other products manufactured on the same site per year			**to specific product lines, and ultimatly to one unit.**
Total number of products manufactured in a year	Please fill in 'Sales Unit' on the General tab	Please fill in 'Sales Unit' on the General tab	

Year of analysis	0	0					
Certification status	Prior to certification	After certification					
Energy	**Quantity**		**Unit**	**Comments**	**Baseline product - allocated impact**	**c2cCertified Product - allocated impact**	**Explanations**
Coal					NA	NA	Overall consum
Fuel Oil					NA	NA	Overall consum
Natural Gas					NA	NA	Overall consum
Petrol					NA	NA	Overall consum
Diesel					NA	NA	Overall consum
Biomass					NA	NA	Overall consum
Other (please specify)					NA	NA	
On-site electricity					NA	NA	Please specify
Purchased grid electricity					NA	NA	
Purchased renewable electricity					NA	NA	Please specify
Energy management strategy in place?			NA				
Water	**Quantity**		**Unit**	**Comments**	**Baseline product - allocated impact**	**c2cCertified Product - allocated impact**	**Explanations**
Total water use	0	0			NA	NA	
Water abstracted					NA	NA	If it is not possi
Water purchased					NA	NA	If it is not possi
Water management strategy in place?			NA				
Waste generation	**Quantity**		**Unit**	**Comments**	**Baseline product - allocated impact**	**c2cCertified Product - allocated impact**	**Explanations**
Total non-hazardous waste	0	0			NA	NA	Please provide
Non-hazardous waste recycled					NA	NA	Please provide
Non-hazardous waste re-used					NA	NA	Please provide
Non-hazardous waste composted					NA	NA	Please provide
Non-hazardous waste landfilled					NA	NA	Please provide
Non-hazardous waste incinerated					NA	NA	Please provide
Non-hazardous waste incinerated (with energy recovery)					NA	NA	
Other (please specify)					NA	NA	
Total hazardous waste	0	0			NA	NA	Please provide
Hazardous waste recycled					NA	NA	Please provide
Hazardous waste re-used					NA	NA	Please provide
Hazardous waste composted					NA	NA	Please provide
Hazardous waste landfilled					NA	NA	Please provide
Hazardous waste incinerated					NA	NA	Please provide
Non-hazardous waste incinerated (with energy recovery)					NA	NA	
Other (please specify)					NA	NA	
Total waste	0	0			NA	NA	Please fill-in th
Waste recycled	0	0			NA	NA	Please fill-in th
Waste re-used	0	0			NA	NA	Please fill-in th
Waste composted	0	0			NA	NA	Please fill-in th
Waste landfilled	0	0			NA	NA	Please fill-in th
Waste incinerated	0	0			NA	NA	Please fill-in th
Non-hazardous waste incinerated (with energy recovery)	0	0			NA	NA	Please fill-in th
Other (please specify)	0	0			NA	NA	Please fill-in th
Waste management strategy in place?			NA				
Air emissions	**Quantity**		**Unit**	**Comments**	**Baseline product - allocated impact**	**c2cCertified Product - allocated impact**	**Explanations**
Sulfur dioxide					NA	NA	Please include
Nitrogen oxide					NA	NA	Please include
Particulate matter <2.5					NA	NA	Please include
Particulate matter >2.5, <2.5					NA	NA	Please include
Particulate matter >10					NA	NA	Please include
Particulate matter, total					NA	NA	Please include
Volatile Organic Compounds					NA	NA	Please include
Ammonia					NA	NA	Please include
Carbon monoxide					NA	NA	Please include
Other (please specify)					NA	NA	Please include
Other (please specify)					NA	NA	Please include
Other (please specify)					NA	NA	Please include
Other (please specify)					NA	NA	Please include
Other (please specify)					NA	NA	Please include
Other (please specify)					NA	NA	Please include
Other (please specify)					NA	NA	Please include
Other (please specify)					NA	NA	Please include
Other (please specify)					NA	NA	Please include
Other (please specify)					NA	NA	Please include
Water emissions	**Quantity**		**Unit**	**Comments**	**Baseline product - allocated impact**	**c2cCertified Product - allocated impact**	**Explanations**
Waste water					NA	NA	
COD					NA	NA	
Waste water utilisation and treatment	NA	NA	NA		NA	NA	Please indicate
Land emissions	**Quantity**		**Unit**	**Comments**	**Baseline product - allocated impact**	**c2cCertified Product - allocated impact**	**Explanations**
Spills					NA	NA	Please indicate

IV. DATA COLLECTION SHEETS

Bill of materials

Return to data requirements

Trucost will use this information to assess the environmental impact of both products from cradle-to-gate. **Please include information on both the c2cCertified and the baseline product. Please include any inputs, from packaging to chemicals and additives.**

Product (c2cCertified or Baseline)	Material Name	CAS number	Quantity Purchased (Weight)	Unit	Recycled content of material if known - (Please use same unit as Quantity Purchased)	Total Cost	Monetary unit	Sourcing Country	Comments
							0		
							0		
							0		
							0		
							0		
							0		
							0		
							0		
							0		
							0		

In-use product information

Return to data requirements

Year of analysis	Product Code	Product Name	Most significant country of sale	Percentage of total sales	Other countries of significance	Expected years of use	Other product use expectancy	Use recommendations (if applicable)	Comment
0		0							
0									

If you have information on in-use emissions, please feel in the following table. Please make sure to add explanations in the comments section, such as the methodology used to measure the use-phase impacts.

	0	0		
	Prior to certification	After certification		
eKPI	Quantity		Unit	Comments

IV. DATA COLLECTION SHEETS

Product end of use phase

Please input data ONLY where you know this to be the actual percentage of product managed in a particular way. Suggested management and recyclability are considered elsewhere.

Return to data requirements

Product Code	Certification status	End of use management (% of total product discarded per year)											Comment
		Composted	Recycled	Repaired/refurbished/ remanufured by you	Repaired/refurbished/ remanufured by third party	Reuse by you	Reuse by another party	Incineration (with energy recovery	Incineration (without energy recovery	Landfill	Other	Total	
0	Prior to certification											0	
0	After certification											0	

Outbound Logistics: Total product transportation from factory to retailer

Return to data requirements

Product Code (if variation between pre- and post- certified product route)	Transport stage	Leaving address	Distance travelled (Km)	Mass (t)	Transport Mode	Additional transport mode information (e.g. size and age of ship etc.)

IV. DATA COLLECTION SHEETS

Economic and social company indicators

Please provide data where possible, and leave spaces where data is not available, or not recorded. Where available, economic impact data is required every year, from 2012, back to 5 years prior to certification.

Year of certification	0

Nb. Continue for up to 5 years prior to certification

Year of analysis	2012	2011	2010	2009	2008	2007	2006	Comments/ Explanation
Sales (units)	0							
Sales (revenue)	0							
Net profit (EBIT)	0							
Number of different products certified								
Stock value (if not listed, estimated enterprise value)								
Total shareholder return								
Price of product								
Market share (product)								
Market share (company)								
Number of complaints (related to the manufacturing process)								
Number of complaints from customers (product in use)								
Number of analysed product related complaints								
Number of returns								
Number of analysed product returns								
Cross selling success rate								
Number of employees								
Number of sick days								
Number of work related injuries								
Employee productivity: this may be number of units/worker/year for example - however defined within your company (please type in unit below)								
% of women in workplace								
Average number of hours worked per FTE								
Number of staff complaints								
% of workforce provided with training								
Salary competitiveness rtio								
Diversity index								
Average applications for open posts								

V. INTERVIEW PROMPT SHEET

The interview prompt sheet is not expected to be a complete question list, rather a guidance document for the interviewer, providing minimum questions required. As product processes become better understood, and initial data is received, the questions may vary, or become more product specific. The interviewer is skilled in understanding the analysis required, and relevant information that may evolve through research and discussion with the participating company.

Cradle to Cradle evaluation of impact of certification process - Interview prompt notes

Pre Interview

The interview should take place after an initial contact email with the company. This email should introduce Trucost and the representative to carry out the interview. The following data request will be sent to them after initial contact, along with suggested dates for interview:

- Documents (where these are publicly available, we will source them directly if possible, to reduce burden on participating company)
    - CSR reports
    - Balance sheets, annual P&L statements and cash flow statements, up to five years prior to certification
    - Any audits available for review (social/environmental)
    - Summary Report

Specific data required will be taken from the provided reports/documents where possible, the list below gives an indication of the data required, but should be excluded if provided indirectly through the documentation.

- Company data including
    - Economics data (historically to five years prior to certification:
        - Revenue (historic to 5 years prior to certification)
        - Revenue by certified and non-certified products
        - Costs associated with production of goods
        - Stock value
        - Shareholder return on investment
        - Cross selling success rate
    - Number of *Cradle to Cradle Certified* products (and level),
    - Date of first *Cradle to Cradle Certified* product
    - Number and detail of complaints (*Cradle to Cradle Certified* and non),
    - Employee data
        - Number employed
        - Total sick days
        - Total injuries per year

        - Productivity
    - Onsite energy use (by type and also percentage of renewable)
    - Provision of audit data (social, water and other if available)
    - Innovation data
        - Number of new products to market per year
        - Investment and cost of innovation
        - Failure rate
- Data on the specific product to be evaluated, including
    - Current price per unit
    - Product assembly process description
    - Historic sales, by unit and value,
    - Number of complaints (if any),
    - Date of certification,
    - Cost of innovation and certification
    - Bill of materials (including quantities of input materials, spend per input, supplier location and packaging data (a template will be provided for this)
    - Water consumption
    - Logistics data
- Consumer use and product disposal understanding, including
    - Country of sale (units per geography if more than 1)
    - Country of use (if different from above)
    - Any available market research data
    - Any available product LCA data or company research regarding product life/usage/ disposal etc.
    - Any company take back schemes and recovery rates

It is particularly important that the product and manufacturing process is fully understood before proceeding with the analysis. ***Do not hand the questionnaire to the interviewee, this is a prompt for personal assistance, and ease of writing up only.***

V. INTERVIEW PROMPT SHEET

Product details

Certified product being evaluated

What version of certification? Choose an item.

Was this product available before certification? Choose an item.

If yes - What was the motivation behind certification?

What was the optimization requirement needed?

What reduction of materials has occurred due to optimization (including

a) Material input?
b) Packaging input?

What is the product yield? (*please provide unit relevant to the specific product discussed*)

What barriers were there to meeting criteria, and what processes have you changed to overcome these? ***Note: try not to prompt if possible, but if no responses given, try these follow up questions***

<u>Material health</u>

- How many and what materials/chemicals (banned list/x-assessed) were phased out as result of the Cradle to Cradle product optimization process?
- How many and what hybrid materials were phased out?
- How many and what X assessed chemicals are in the process of being phased out?
- How many assessed materials do not contain any carcinogenic, mutagenic, or reproductively toxic chemicals as a result of the optimization process?
- How many assessed materials/chemicals had their formulation optimized?
- How many and what materials/chemicals meet the Cradle to Cradle emission standards as specified in V3.0 of the *Cradle to Cradle Certified* Product Standard?
- How many and what x-assessed process chemicals were replaced?

<u>Material reutilization</u>

- What plans have been developed for recovery or recycling of material? Have you developed a take back scheme, either directly or through a partner?

- Number of chemicals and substances defined in the appropriate cycle (technical or biological) and their development since start of pursuing Cradle to Cradle product optimization?
- Number of chemicals and substances defined in the appropriate cycle (technical or biological) and their development since start of pursuing Cradle to Cradle product optimization?
- Number of plans in place for product recovery and reutilization and their development since start of pursuing Cradle to Cradle product optimization?
- Number of products designed or manufactured for the technical or biological cycle with a material (re)utilization score >= 35, >=50, >=65, =100, and their numbers since start of pursuing Cradle to Cradle product optimization?
- Presence of a defined nutrient management strategy (including scope, timeline and budget) for developing the logistics and recovery systems for products or materials currently being used?
- Number of products and volumes actively being recovered and cycled in a technical or biological metabolism and their volumes since start of pursuing Cradle to Cradle product optimization?
- How did material reutilization affect your supply chain in terms of quality of materials, availability in quantity and time and material flows?

Renewable energy and carbon management

- How has energy sourcing changed? Do you generate any energy onsite? Have you reduced energy requirements for the production of the product? What % of energy is offset?
- Purchased electricity and direct on-site emission data associated with the final manufacturing stage of the product and their development since the start of pursuing Cradle to Cradle product optimization?
- The amount of renewable energy used and the growth of renewable energy usage since the start of pursuing Cradle to Cradle product optimization?
- The results of the companies' carbon management strategy and their development since the start of pursuing Cradle to Cradle product optimization – achievements and number of products in the portfolio use renewable energy?
- Percentage of the company's purchased electricity that is currently renewably sourced or offset with renewable energy projects and its development since the start of pursuing Cradle to Cradle product optimization? Percentage with each certified product?

Water stewardship

- What improvements have you made to your water management? Number of product-related process chemicals in effluent optimized? Water audits carried out?

- Characterize local and business-specific water-related issues?

- Results from the companies' statement of water stewardship intentions and of facility-wide water audits since the start of pursuing Cradle to Cradle product optimization?
- Number of product-related process chemicals in effluent phased out?
- Percentage of tier one suppliers that have characterized supply-chain relevant water issues and have defined a strategy to improve at least 20%?
- Number of product-related process chemicals in effluent optimized and their effect on water quality?
- When will the water exiting the manufacturing facility meet drinking quality standards?

Social fairness

- Social audits carried out? Do you have available (and would you please provide) completed social responsibility self-audits based on UN Global Compact Tool or B Corp application?
- Did you carry out social audits prior to certification on any product lines?
- Description of management procedures developed to address any identified issues regarding social fairness and their development since the start of pursuing Cradle to Cradle product optimization?
- Number of certified materials used in products, described in a % of the product material by weight and their development?
- Can you provide examples of how your company has driven social improvement since certification?
- Did you actively engage with your company's direct environment and employees to review your social fairness approach and if so, in what manner?

Business

- Have you received any (positive or negative) customer feedback regarding the certification of products?
- Have you been asked by customers if a product is certified?
- How has certification affected competitive advantage?
    - cost advantage?
    - differentiation from market?
    - niche market approval?
- How have you communicated this to your customers?
- Was customer demand a driver for certification?
- How has certification of the first product driven further innovation (have later products 'skipped' the non-certified stage, how many new products are released per year, and how has this changed etc.?

V. INTERVIEW PROMPT SHEET

- Have you noticed any changes to staff behavior since certification (allow interviewee time to respond, but if no answer, prompt with suggestions such as 'productivity, engagement with concept, suggestions for improvement, motivation)?
- What design and policy changes have occurred since certification?
- Was third party certification a requirement in your market? What were the requirements (e.g.an LEED requirement, a government purchasing decision)?
- Has certification allowed you to penetrate new markets, or new market segments, if so, which?
- Have you incorporated *Cradle to Cradle Certified* into marketing and sales materials?
- Do you focus on a particular aspect of certification (e.g. material reutilization versus material health) in the way you market your product? Which, and why, and does this vary by segment?
- Why did you select *Cradle to Cradle Certified* over other certifications?
- How did certification change the way you went to market with the product?
- Did the area your company is located in contribute to the certification process and if so, in what way? (e.g. business park offering renewable energy, water stewardship, legislation on social fairness, waste management, emissions, etc.)
- Did you get or could you have applied for government funding for the certification process?
- Did competitors follow your initiative and are they successful?
- How do you see the future benefit of Cradle to Cradle certification for your product and company?
- Do you actively communicate your certification and efforts taken to certificate?