

PILOT STUDY

IMPACTS OF THE CRADLE TO CRADLE CERTIFIED PRODUCTS PROGRAM

Mosa Company Narrative



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:



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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.

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Economic growth has been accompanied by serious natural resource depletion and severe pollution impacts in recent decades.

According to the Global Footprint Network, 1.5 planets are needed to support our current natural resource dependency and waste generation. And if current population and consumption trends continue, moderate UN estimates predict that we will need the equivalent of two Earths to support us by the 2030s.

The *Cradle to Cradle Certified*TM Product Standard was established to reverse unsustainable growth trajectories by transforming the way products are designed, what's in them and where they go after use. Following circular economy principles, products are designed from the outset to provide healthy nourishment for new products at the end of their traditional use – continually circulating as pure and viable materials that add value in the context in which they are used – and have as many positive marks as possible. In this way, product manufacturing and product use become a positive force for people, planet and profit by regenerating and restoring negative impacts caused by unsustainable growth.

Because of these characteristics, *Cradle to Cradle Certified* products are aligned with and can demonstrate the benefits of the circular economy powered by Cradle to Cradle on a product-level and contribute to sparking the transition towards more circular systems.

The Cradle to Cradle Products Innovation Institute asked Trucost to quantify and assess the environmental, social and business impacts of its certification program across its five quality categories: material health, material reutilization, renewable energy, water stewardship and social fairness.

The Institute also engaged a panel of scientists from Oxford, Yale and Delft universities, as well as expert stakeholders, to validate the research methods and outcomes.

THE RESEARCH

Trucost carried out in-depth analysis of twenty products; ten certified to the *Cradle to Cradle Certified* Products Standard and ten baseline pre-certification or non-certified counterparts, with the aim of identifying and quantifying the actual environmental, social and business impacts – and actual added value – of the *Cradle to Cradle Certified* Products Program.

What emerged was a promising account of impact and value achieved by ten companies undertaking *Cradle to Cradle Certified* product certification.

Across the ten companies, the economic potential of *Cradle to Cradle Certified*TM product certification was evidenced through examples of higher than average sales performance, positive growth and increased profit margins, alongside significant cost savings related to water and energy efficiency improvements.

Environmental and social benefits were also evidenced through replacement of toxic and questionable ingredients by less toxic and defined alternatives, conservation of product materials in continuous product cycles, increased renewable energy use and improved energy and water effectiveness.

The study research provides an evidence base demonstrating the economic, environmental and social potential of the *Cradle to Cradle Certified* Products Program. It is not intended to provide scientific verification or demonstrate causality.

READER'S GUIDE

This case study details the findings of the analysis of a single *Cradle to Cradle Certified* product compared to a non-certified equivalent. The document is one of ten examples intended to support the [Technical Report](#) which provides more information on the framework developed and findings of the pilot study across a range of products and companies. This document introduces the Mosa company narrative and product analysis and identifies and describes impact improvements in the fields of business, society and environment, related to Mosa's pursuit of Cradle to Cradle Certified product certification.

An overview of the methodology is given on page 13 with a more detailed discussion of the approach available in the supporting [Technical Report](#). The research findings (page 17) review work done by the company to optimize product performance across the five quality categories of material health, reutilization, energy, water and social fairness, and its effect on business performance. This includes hazardous chemical reduction, water efficiency improvements and increase of recycled content.

CRADLE TO CRADLE CERTIFIED PRODUCTS PROGRAM

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. 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, nearly 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.

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 revisions¹ 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 Board² (CSB) with input from consumers, manufacturers, NGO partners, and other interested stakeholders.

Full details of the certification can be found at http://c2ccertified.org/product_certification/c2ccertified_product_standard

Products are analyzed by Assessment Bodies³ that have been trained and accredited by the Institute. After auditing of this assessment, the Institute awards the product an overall score or level while encouraging continual improvement. Product certification is awarded at five levels (BASIC, BRONZE, SILVER, GOLD and PLATINUM), with the expectation that an applicant will optimize each aspect of their product over time. The ultimate goal is to encourage innovation and the design of products that effectively and positively impact people and the environment. Products are evaluated according to the requirements in five categories based on the Cradle to Cradle design principles.

THE FIVE PRODUCT STANDARD CATEGORIES

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

¹ http://www.c2ccertified.org/product_certification/revisions_to_the_standard

² The Certification Standards Board (CSB) is an independent review panel, tasked with updating the standard and adjudicating appeals related to product certification
http://www.c2ccertified.org/product_certification/certification_standards_board

³ For detail of the Accredited Assessment Bodies see
http://www.c2ccertified.org/product_certification/accredited_assessment_bodies

THE PROGRAM



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*

INTRODUCING THE CONCEPT OF 'CAPITAL'

The *Cradle to Cradle Certified* Product 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 opposed to 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 that 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

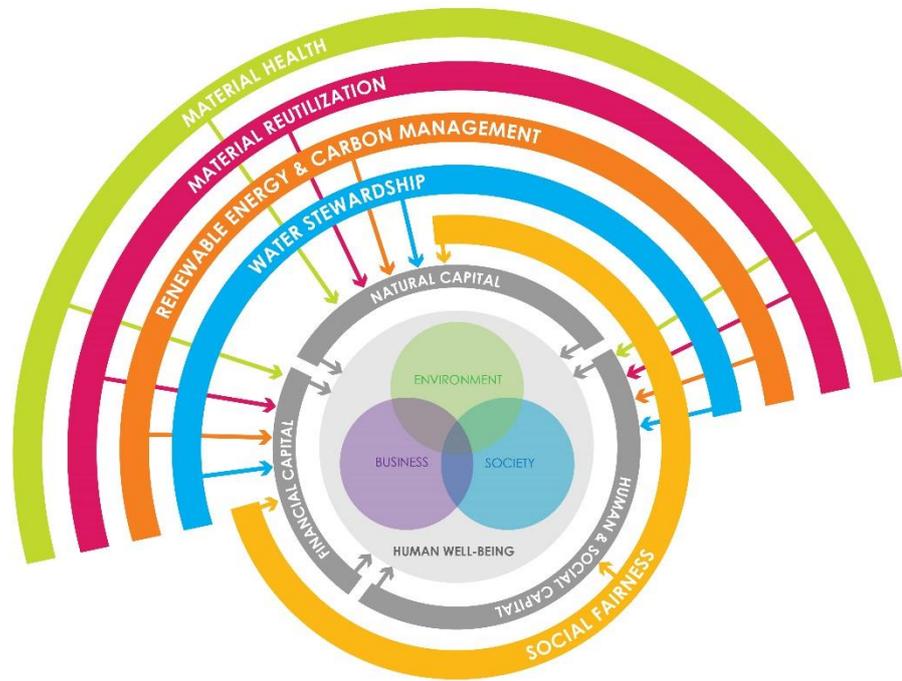
To capture the impacts of *Cradle to Cradle Certified* product certification, a conceptual framework was developed to highlight the impact areas that are affected through product optimization. Eco-effective products are considered to provide 'more good', delivering benefit to human well-being. Underpinning 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 (for more detail on the framework and methodologies, see the [Technical Report](#)).

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 ingredients as biological or technical nutrients, and removing hazardous chemicals, while replacing with optimized 'good' inputs. The adherence to this quality category motivates companies to improve understanding of their products through detailed scientific assessment and continuously work to improve them, through ongoing optimization. By reducing and ultimately eliminating toxicity, the natural capital stock of clean air and 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 1: THE CONCEPTUAL FRAMEWORK



'Sustainability is one of the core values for a healthy company in the future'

Arthur
Thomaes, CEO
Royal Mosa

COMPANY

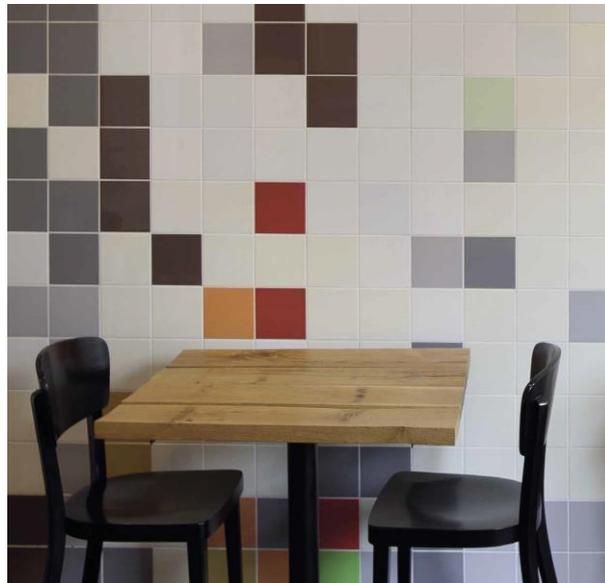
Royal Mosa (referred to as Mosa within the narrative), based in Maastricht in the Netherlands, produces and supplies over 7 million m² of wall and floor tiles per year to 30 countries on 4 continents. Sustainability is a cornerstone of Mosa's mission and principles. The company believes the Cradle to Cradle approach is highly compatible with its business philosophy. Over the past six years, Mosa has been working closely with its Accredited Assessment Body to optimize its product lines and integrate the Cradle to Cradle design principles into its strategy. In December 2010, three years of development was rewarded with the *Cradle to Cradle Certified SILVER* certificate for 99% of Mosa's product range.

THE PRODUCT

Mosa selected its Global wall tile range for analysis, based on study selection criteria⁴. This is a natural product, manufactured from sand and clay excavated within 400km from Maastricht, where the two Mosa manufacturing facilities are based. Less than 5% of the product is glaze and pigments, which is sourced from Spain and Italy because these are unavailable more locally.

The analysis compared 1m² of Global wall tile with the product before it was optimized to meet the criteria of version 2.1.1 of the *Cradle to Cradle Certified* products program at the SILVER level.

FIGURE 2: INSTALLED MOSA WALL TILES



⁴ Selection criteria included ensuring the product was certified, had a well understood optimization process, and data was available for the product both before and after optimization.

This section defines the methodology used by Trucost to apply the conceptual framework to determine the impacts of certification across ten companies' products. The section provides an overview of the methodology used to assess the environmental, social and business impacts associated with the *Cradle to Cradle Certified* Products Program. The detailed methodology is provided within the Technical Report, which is available at www.c2ccertified.org/impact.

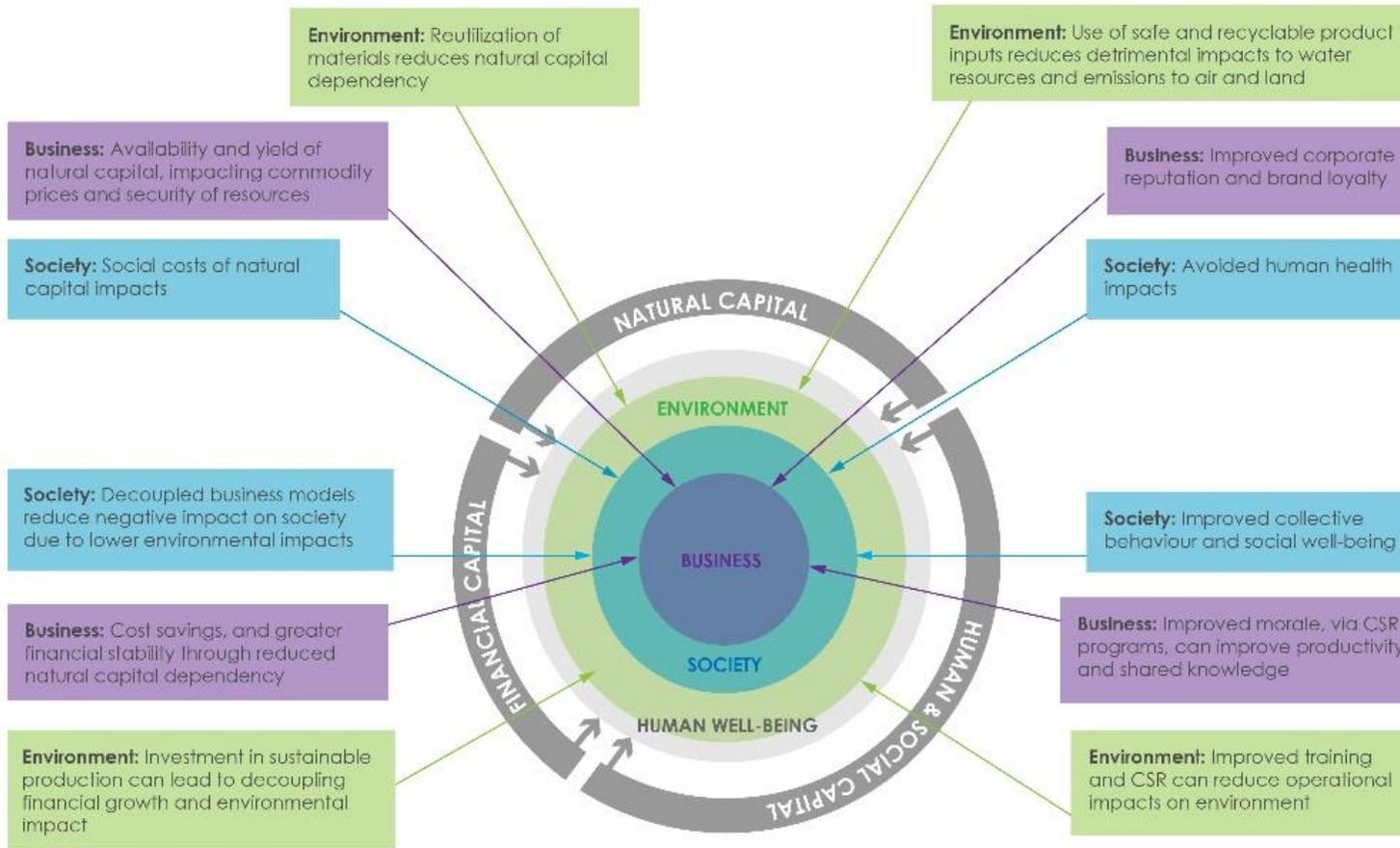
APPROACH

The 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 3 considers how the capitals feed into the three elements of human well-being.

An example given is the reutilization of materials. This reduces the dependency on natural capital as less resource is required. This includes not only material resource (such as wood, metal etc.) which is not required as recycled content is used in place of virgin, but also recycling often reduces the processing requirements required to convert raw material to product material (for example crude oil needs to be extracted then separated and processed into usable plastics for products – recycled plastic requires less processing to return the product material to a useable input material). This results in societal benefit through lower emissions and human health impacts due to manufacturing processes (the social cost of natural capital impacts). In turn, this impacts financial capital, directly related to business performance, through greater control of material inputs, less commodity dependency with associated price fluctuations and less external reliance on potentially scarce resource.

METHODOLOGY OVERVIEW

FIGURE 3: 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 3. Each type of capital flows into these three aspects of well-being, and these are identified in examples given in figure 4. Not all impacts are detailed, however, this provides some context of how the capitals each apply to the individual fields.

Figure 4 below provides detail of the source of data and approach used to capture impacts across these different categories.

FIGURE 4: ALIGNMENT OF QUALITY CATEGORIES



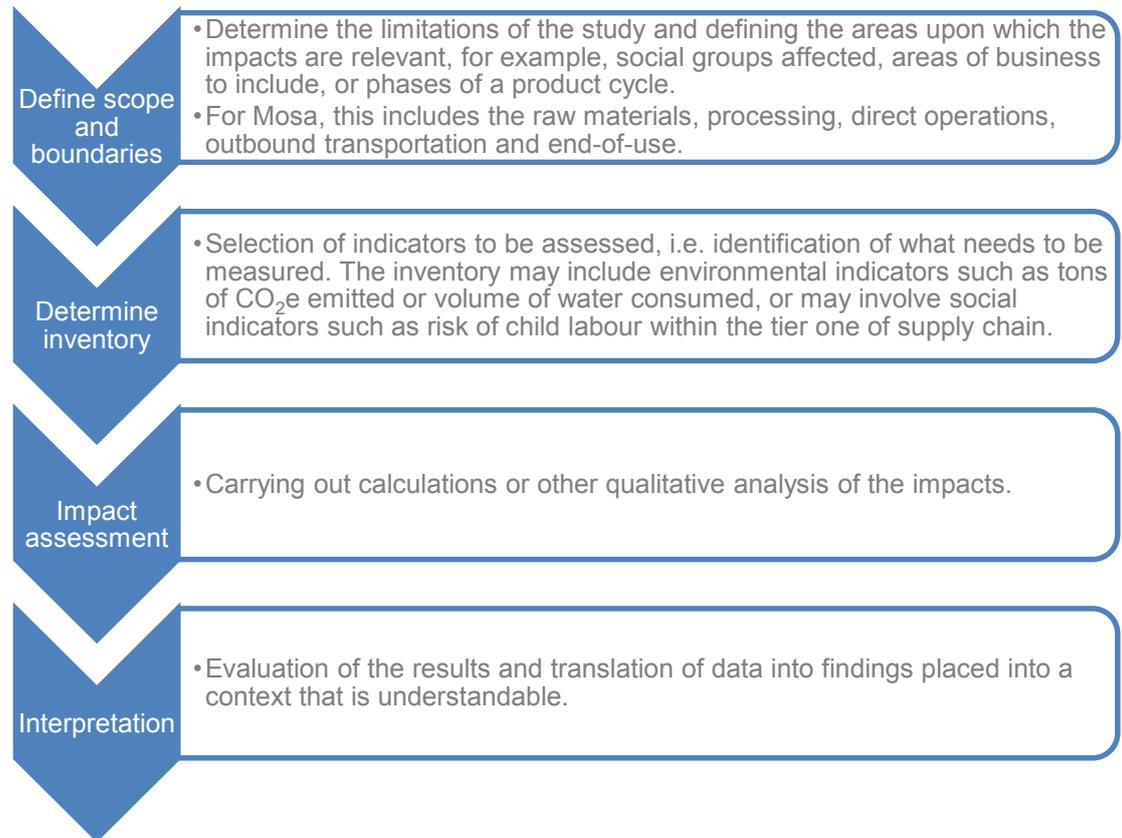
Firstly, the individual impacts associated directly with the manufacture, use and end-of-use of a particular product are compared to the equivalent product before optimization for certification. The second consideration applies to the wider context of the benefit to the company of having one or more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

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.

The methodology is framed around four steps, given in figure 5.

METHODOLOGY OVERVIEW

FIGURE 5: METHODOLOGY OVERVIEW



Each step is considered in relation to the *Cradle to Cradle Certified Product Standard* quality categories and the three areas of environment, business and society in which the ultimate implications for human well-being exist.

The individual steps may be more or less significant for different scenarios, but are always appropriate to consider. Complex quantitative work may involve several steps within the impact assessment stage if numerous calculations are required, whereas qualitative information may be more directly understandable with less analytical processing required.

For the environmental impact analysis, interpretation includes the valuation of indicators. Valuation of environmental impacts estimates the value of natural goods and services in the absence of market prices to allow direct comparison with financial performance and appraisal of potential profit at risk. By applying valuation, the impacts are more aligned with the Cradle to Cradle philosophy, placing the impacts into context, for example by accounting for scarcity of water in the region it is consumed and the localized impacts of air pollution at the point at which it is emitted.

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.

For the social and business evaluations, qualitative interviews were carried out to determine company trends and patterns that had been noted, but not evidenced through quantitative data. These took into account the staff and customer feedback, media responses and other anecdotal evidence of impact.

KEY FINDINGS

This report demonstrates the sustainable business benefits of the *Cradle to Cradle Certified Product Standard* for tile manufacturer Mosa.

In 2010, Mosa achieved *Cradle to Cradle Certified SILVER* under v2.1.1 of the product standard for its Global wall tile range. A SILVER level product certified under Version 2.1.1 is at least 95% defined by material, down to 100 parts per million, with strategies in place to phase out any problematic chemicals. All materials have been characterized as either being a part of the biological or technical cycle, with a material reutilization score of greater than 50 (see material reutilization below), and energy requirements for production have been characterized, with a strategy developed for using solar income for product manufacture.

Trucost compared the environmental, social and business benefits of a certified wall tile with a non-certified tile.

The results show that optimization has:

- Significantly reduced the number of hazardous chemicals used in the wall tiles
- Increased the recycled content of wall tiles fourfold
- Cut the water footprint of wall tiles by half
- Strengthened sales under difficult economic conditions⁵

FIGURE 5: CERTIFICATION SCORECARD FOR GLOBAL WALL TILE



cradletoocradle

WALL TILES
KONINKLIJKE MOSA BV

Certification Standard Version 3.0

	SILVER	BASIC	BRONZE	SILVER	GOLD	PLATINUM
Material Health					✓	
Material Reutilization					✓	
Renewable Energy				✓		
Water Stewardship					✓	
Social Fairness				✓		

⁵ During the period under review, the European ceramic tiles sector saw a 29% drop in sales, based on PRODCOM sales data.



MATERIAL HEALTH

Product ingredients are inventoried throughout the supply chain and evaluated for impact on human and environmental health according to the Material Health Assessment Methodology for the Cradle to Cradle Certified Product Standard⁶. The criteria at each level build towards the expectation of eliminating all toxic and unidentified chemicals and becoming nutrients for a safe, continuous cycle.

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

The material health quality category gives a material health 'rating' to each material in the product, based upon robust analysis of toxicity including consideration of both the hazard and the risk associated with their relative routes of exposure during the intended (and likely unintended) use and end-of-use product phases. Other material specific factors are also included such as recyclability or biodegradability. A description of these ratings is given in table 1.

TABLE 1: MATERIAL HEALTH RATING DESCRIPTION

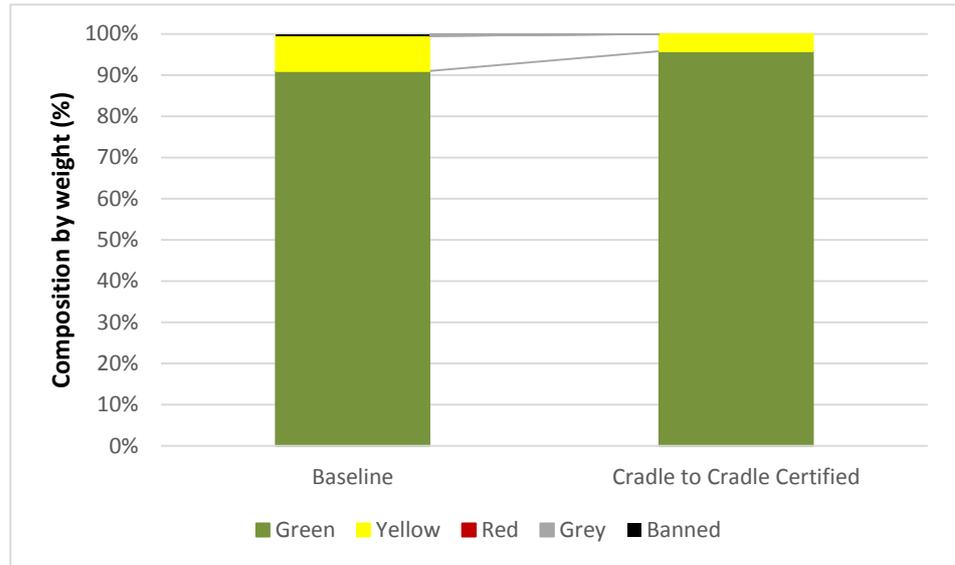
Material assessment ratings	Explanation
A (Green)	The material is ideal from a Cradle to Cradle perspective for the product in question.
B (Green)	The material largely supports Cradle to Cradle objectives for the product.
C (Yellow)	Moderately problematic properties of the material in terms of quality 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	This material contains one or more substances from the Banned list and cannot be used in a certified product.

Mosa wall tiles are a largely natural product, based on clay, chalk and similar mineral inputs for the majority of the content. However, some hazardous chemicals were identified in the initial product material assessment. Pigments responsible for a total of 0.5% of the material weight contained high

⁶http://www.c2ccertified.org/images/uploads/C2CCertified_Material_Health_Methodology_121112.pdf

concentrations of cadmium, lead and mercury. Mosa removed these substances enabling it to achieve first the *Cradle to Cradle Certified* SILVER level in material health and then, through further improvements, the GOLD level for material health. At the *Cradle to Cradle Certified* GOLD level for material health the product formulation is optimized, and the product meets Cradle to Cradle emission (VOC) standards. Mosa tiles are fired at very high temperatures in excess of 1,000°C. At such high temperatures, any organics that might be present in clays or binders are completely burned away. As a result, the final product is inert and has no VOCs that can be emitted.

FIGURE 5: MATERIAL HEALTH OPTIMIZATION BY PERCENTAGE COMPOSITION



The optimized product is 100% analyzed by weight and contains no grey, un-assessed or 'X' rated (highly problematic) materials. Though only a small percentage of the composition, Mosa excluded all banned chemicals from its production of wall tiles and further optimized 'C' rated chemicals to result in 96% of the composition being 'preferred' materials from a Cradle to Cradle perspective.

The certification process has helped drive the Mosa Global wall tile towards using healthy and safe materials that enable continuous re-use. The product optimization has led to the removal of unhealthy red and banned materials, and also ensured there are no undisclosed 'grey' rated materials which may have a negative impact on human well-being. Through continuous improvement and progress up the certification award levels, the wall tile is on the pathway towards a product with a truly positive profile.

Monetization of the material health assessment offers opportunity for greater understanding of the impact on human well-being, but requires more granular data and further development of an appropriate methodology that is reflective of Cradle to Cradle principles. An LCA approach is not sufficient due to less focus on toxicity within LCA's than in a Cradle to Cradle context. Even when considering valuation, which brings in a localized relevance (a criticism of LCA for Cradle to Cradle purposes), further work is required to ensure all Cradle to Cradle aspects are captured.



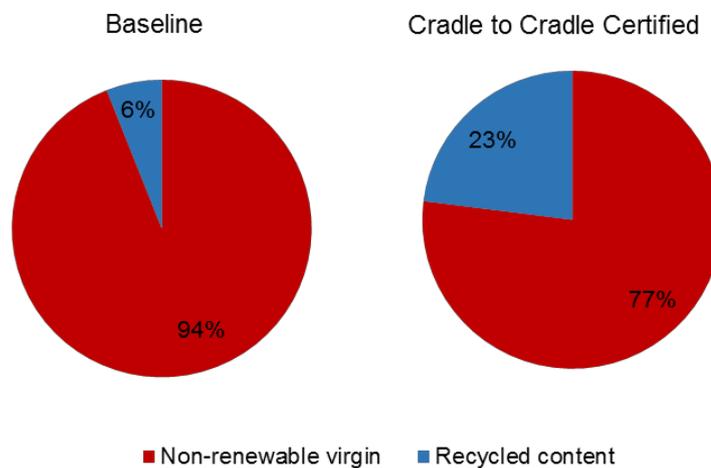
MATERIAL REUTILIZATION

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.

Designing biodegradable or re-useable product materials, and ensuring effective systems for recovering those materials, protects diminishing natural resources by eliminating resource loss and disposal. It 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.

Mosa's Global wall tiles are classified as a technical nutrient product, but are safe for the biological cycle (meaning the product is intended for recycling but would be safe to be composted where this is appropriate). The tiles are considered to be 100% recyclable at end-of-use, thus achieving the 'GOLD' level in material reutilization since the initial certification. Through product optimization, the recycled content of wall tiles in 2012 was almost four times higher than before certification in 2007 (figure 6). In 2012, the wall tiles used 4% recycled scrap material from the company's manufacturing processes and 19% recycled silica from the French stone sector. In 2007 the same amount of recycled scrap material was used in the tiles, but only 2% recycled silica was contained within the product.

FIGURE 6: COMPOSITION OF PRODUCT BASED ON RECYCLED OR RAPIDLY RENEWABLE CONTENT



Mosa tiles are designed to be recycled, but current linear systems result in end-of-use products that are typically being downcycled as aggregate. The Netherlands recovers most of its construction waste for use as aggregate in the road laying sector, and as such 98% of tiles are considered to be captured in this cycle.

The analysis found that the benefits of using recycled tiles to reduce the need for virgin aggregate outweighed the costs of the recycling processes needed.

Through recycling of ceramic tile into aggregate, the tiles displace production of aggregate gravel. Recycling is therefore associated with a benefit to human well-being, due to none of negative impacts of the processing of such

virgin aggregate material (in particular the GHG emissions associated with processing).

Currently the tiles are processed in a linear system. Mosa is keen to improve on this by encouraging higher value uses for its recycled tiles. Upcycling, as it is known, is a fundamental part of the Cradle to Cradle philosophy. By maintaining product quality, products remain nutrients for continued cycling, and losses from the cycle are minimized. Mosa has been working with other companies, including an adhesive manufacturer, to reduce contamination of tiles with adhesive, inhibiting their reuse in higher value products. This could potentially result in continuously recyclable products that can be returned to the ceramic sector once removed and collected. Through these innovative steps, Mosa is contributing to improved sustainability for both the ceramics and the adhesive sectors, and encouraging cross sector collaboration. Were the sector to move towards a circular economy, these benefits would be better captured.

Material can be considered to be retained within cycles through use of recycled inputs and through recycling/composting at end-of-use, both scenarios ensuring nutrients do not enter the waste stream. Through increased use of recycled content, and the steps taken to try to improve collection infrastructure and to maintain value of secondary use opportunities for the material within the Global wall tiles, Mosa is progressing in the transition towards a circular economy, and continuous cycling of nutrients.



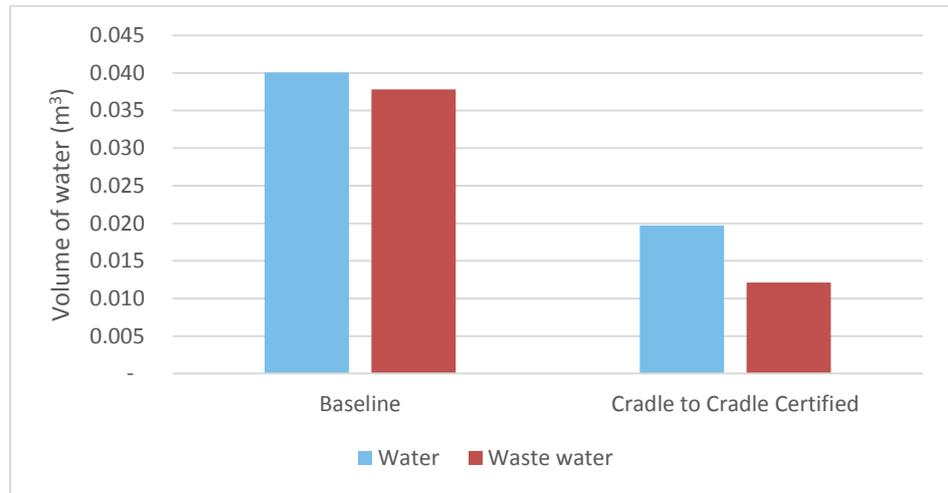
WATER STEWARDSHIP

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 provide vital social and environmental benefits including sustenance and climate regulation, as well as underpinning essential business inputs.

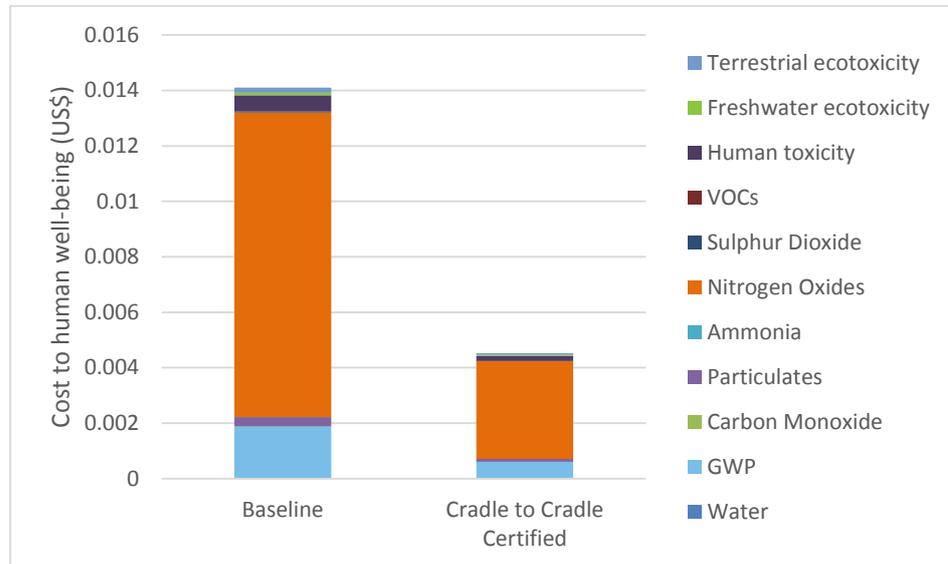
Water has been a critical focus for Mosa since certification. Its Global wall tile range achieves the GOLD level for water stewardship, having advanced from an original SILVER certification in 2009. This means the company has adopted water stewardship principles and characterized water flows associated with product manufacture. Mosa uses water during a variety of process operations, such as substrate preparation and glazing application, as well as pressing the tiles and calibrating the finished products. The cooling system water has been used in a closed system, recapturing water after it has been used and reducing the direct footprint per tile by over 50% (see figure 7).

FIGURE 7: OPERATIONAL WATER CONSUMPTION AND DISCHARGE



The process water is purified in an in-house water treatment plant and the residual sludge is recycled in the tile production process. Improvements to the on-site treatment of water have significantly reduced the human well-being cost of waste water, as can be seen in figure 8.

FIGURE 8: OPERATIONAL WASTE WATER COST TO HUMAN WELL-BEING



The cost to human well-being associated with waste water from direct operations was reduced from 1.4¢ to 0.4¢ per m² of tile, a reduction of 68%. In 2012, this equates to a human well-being benefit of US \$ 6,090 in comparison to baseline product.

Mosa developed water principles based on the *Cradle to Cradle Certified* water quality category and continues to seek further optimization of water systems.

Mosa has reduced the water consumption on site by 130,600m³ per year across both the wall and floor tile operations since 2009. Based on national average utility costs in Netherlands in the given years, this equates to a financial saving of US\$ 360,000 per year.



SOCIAL FAIRNESS

Company operations are designed to celebrate all people and natural systems and progress is made 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.

Mosa made publicly available statements regarding its social and ethical performance goals. These address fair labor practices, corporate and personal ethics (including its sub-suppliers in South Africa for example), customer service, and local community.

Mosa complies with the appropriate working conditions and ethical principles required for *Cradle to Cradle Certified* SILVER. Pursuant to this requirement Mosa implements the local-for-local principle whenever possible, for example, maintaining production close to the market and sourcing raw materials close to the factory – helping to keep transparency of supply. Virtually all raw materials are sourced from controlled quarries within a distance of 500 kilometers from Maastricht. The final manufacturing site was mapped against the Social Hotspots Database (see Table 2).

TABLE 2: SOCIAL HOTSPOTS SECTOR-REGION RISK MAPPING

Social Hotspots index risk				
Community infrastructure	Governance	Health and Safety	Human Rights	Labor rights
3	1	18	2	7

Health and safety is the most significant risk for the sector-region. The 5 risk categories are scored against a potential score of 100 per category, giving a total maximum risk of 500 for a sector region. Four categories score less than 10% risk for manufacturing in the Netherlands. Though not a requirement for v2.1.1 of the certification standard, reflecting on social risks allows the company activity to be placed in context, and where necessary, can be used in the future to help focus further social optimization. Mosa monitors risks and has ensured that employee exposure to dust is within appropriate limits, and as such helps to reduce the most significant risk associated with its sector-region.

Mosa is looking for further opportunities to improve performance on supply chain, staff and customers. In 2012 and 2014, the firm was awarded the hallmark Top Employer certification (awarded every two years), independently recognized for good treatment of staff.

Social fairness includes many qualitative trends and quantification is not appropriate for many of the benefits recognized through *Cradle to Cradle Certified* product certification. Monetization is applied to social costs of natural capital impacts, but not currently applied to social capital impacts, and future opportunity could exist in incorporating this for a single metric approach to quantification of certification impact.



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 circular material flows. The 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.

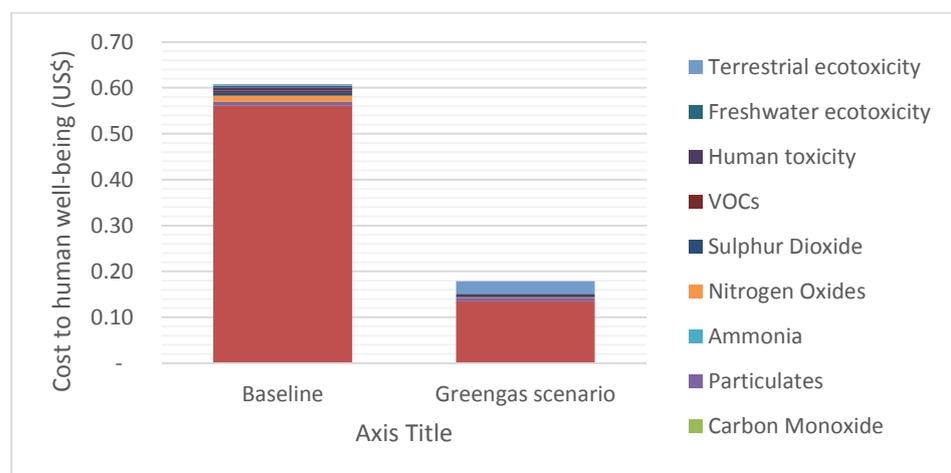
Renewable energy provides a myriad of environmental and social benefits, including avoided air pollution and climate change impacts, alongside decreased dependency on finite fossil fuel resources. It also provides business benefits from reduced risk exposure to volatile energy prices and intensifying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

Mosa has been working to improve energy efficiency for several years, and had already achieved advanced energy management before certification. Carbon emissions were reduced by switching to renewable hydroelectricity to meet all of its electricity needs, and efficiency steps taken resulted in a baseline product that was already optimized for renewable energy. The Global wall tile achieved SILVER in the renewable energy category as part of the initial certification. Mosa is attempting to source an alternative to natural gas, the fuel used to heat its kilns, which accounts for almost 90% of its total energy requirement.

Due to the economic downturn, production at Mosa's manufacturing site decreased between the comparison years of 2007 and 2012 (as was apparent across the whole sector). This meant its kilns could not be operated at optimal efficiency, increasing energy consumption. Evidence over the preceding years indicates a temporary anomaly, and this is not considered to reflect typical energy requirements.

A comparison scenario was given, using green gas in place of natural gas, to highlight the benefit that would be apparent should Mosa meet its objective of alternative fuel sourcing (see figure 9).

FIGURE 9: IMPACTS OF ENERGY USE PER M² TILE, 2007 AND 2012



Mosa has made many steps towards improved energy efficiency, having modernized its site over the previous decade, for example recovering furnace heat to use in processing and to heat the building. Electricity consumption during recent years has decreased at the site level. Mosa has worked to maximize sustainability and efficiency of its practices through modernization



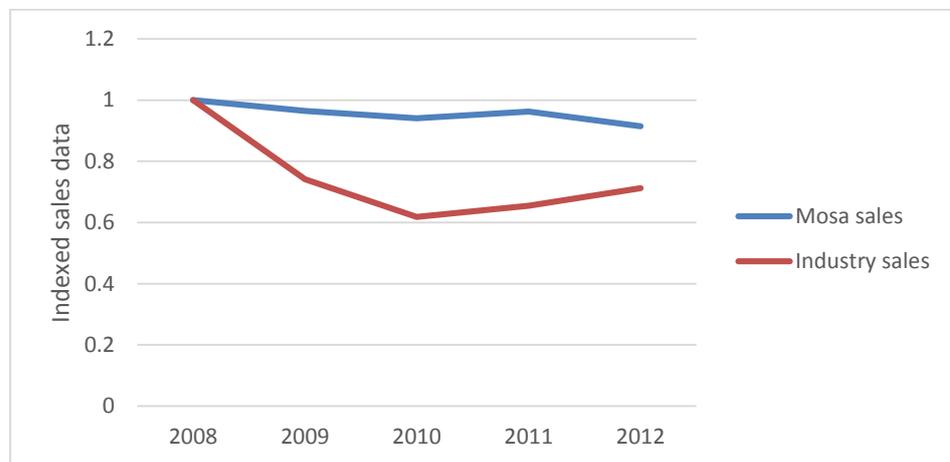
of the factory. Since 2010, the first year of certification, electricity consumption at the site has been reduced by 13%.

BUSINESS IMPACTS

Business impacts were assessed by the Impact Study to provide important economic context to the research findings.

Mosa has experienced strong business performance with sales 20% higher than the rest of the industry in recent years (see figure 10). The ceramic tiles sector saw a decline in sales following the economic crisis. While Mosa's sales were also affected, the impact has been less apparent than for other firms.

FIGURE 10: INDEXED COMPANY AND CERAMIC SECTOR SALES BASED ON 2008 BASELINE



Since 2008, the industry has seen almost 40% decrease in sales leading up to 2010, regaining some of this by 2012. Mosa's sales, while impacted by the economic downturn, have seen a decline of less than 9% over this same period. 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 is considered a useful point for further investigation in future work.

Since the year before certification in 2009, Mosa has reduced the water consumption on site by 130,600m³ per year across both the wall and floor tile operations. Based on national average utility costs in Netherlands in the given years, this equates to a financial saving of €280,000 per year. When calculated year by year, using actual water use and annual utility prices, this gives the total saving for water consumption as €626,800 between 2010 and 2012.

NET BENEFIT OF HUMAN WELL-BEING

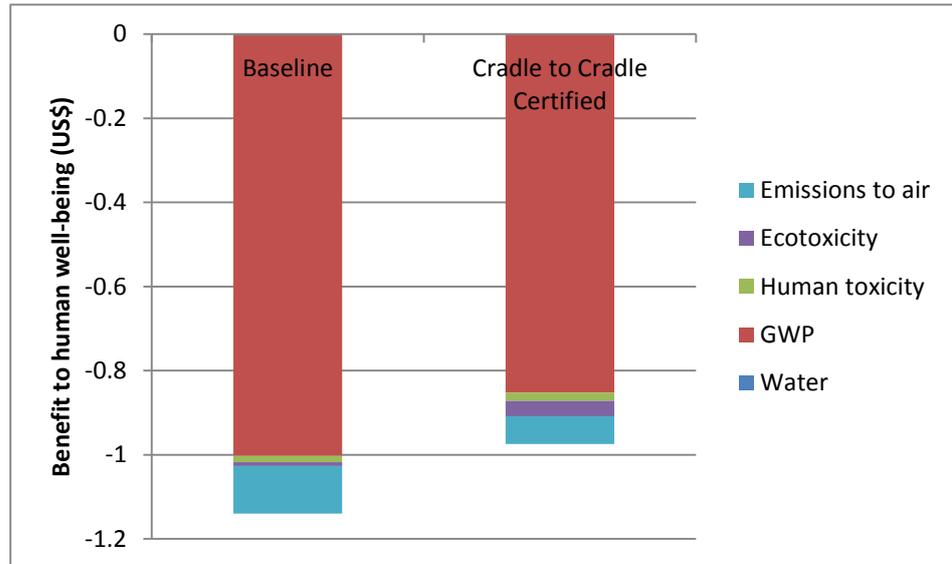
Combined valuation of impact on human well-being was quantified by aggregating the total positive and negative impacts for each stage of the product cycle. A typical m² of Mosa Global wall tile was associated with a human well-being cost reduction of 17¢ per unit between baseline and

RESEARCH FINDINGS

certified comparison years (figure 11). Based on 2012 production, this equates to a total benefit to human well-being of US \$105,440.

The net benefit calculation captures monetization of three of the quality categories – material reutilization, water stewardship and renewable energy and carbon management. Further benefit may be identified if future research incorporates appropriate monetization of material health and social fairness also.

FIGURE 11: NET BENEFIT OF HUMAN WELL-BEING



To place this in a customer context, a typical large commercial office space may have approximately 1,670m² of ceramic wall tile covering for sanitary spaces (kitchens and bathrooms). Using the baseline tile, this installation would be associated with US\$ 1,900 cost to human well-being. If installed using *Cradle to Cradle Certified* SILVER Global wall tiles, this same installation would have an associated cost of US\$ 1,630, an approximate cost reduction of US \$270 per commercial office space installation.

The valuation of natural capital is currently not recognized in the market; however, increased resource demand and growing pressure on natural capital may lead to future internalization of these costs. 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).

Companies' business performance will be negatively affected should legislation, taxes, or other factors result in payment of these external costs. Through the optimization steps taken by Mosa and reduced cost to human well-being, Mosa is considered to benefit from reduced risk through improved environmental and social performance lowering dependency on natural capital.

QUALITATIVE TRENDS

Mosa reports that cross departmental communications have been improved and *Cradle to Cradle Certified* category requirements are considered

throughout all stages of product design. Customer demand for *Cradle to Cradle Certified* products has seen an increase, particularly in regions such as the Netherlands, Mosa's largest market.

Demand has shown particular growth in the public sector spend, with social housing and other public sector development having sustainability specifications, within which *Cradle to Cradle Certified* products are rewarded. Mosa iterates that some building specifications favor *Cradle to Cradle Certified* products, offering business opportunity:

'Cradle to Cradle products are being specified for more and more building projects. Also because they contribute to obtaining building labels such as LEED.' Arthur Thomaes, Royal Mosa CEO

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.

LATEST DEVELOPMENTS

The Global wall tile achieved *Cradle to Cradle Certified* SILVER v2.1.1 certification in 2010, and analysis was carried out on this version. Since analysis, the Global wall tile has achieved SILVER level under v3.0 of the standard. This progress is likely to have further advanced the Mosa product benefit of certification, achieving more advanced criteria for the quality categories.

The Global wall tile is an excellent example of how continuous improvement, integral to the *Cradle to Cradle Certified* Products Program, can drive industry towards a circular economy, creating a healthier business model and improving business impact on human well-being.

CONCLUSIONS

'Our clients can be confident that they are buying a "good" wall or floor finishing: non-toxic, no VOCs, produced in a responsible way with respect for employees and with the help of renewable energy. And all of this is externally verified.'

*Arthur Thomaes,
CEO Royal Mosa*

Cradle to Cradle Certified has provided numerous benefits to the sustainability of Mosa's Global wall tile range, boosting the company's already high standards of environmental and ethical production.

The Global wall tile material input was optimized through certification, ensuring exclusion of unhealthy, toxic banned and red materials, while increasing the percentage composition of preferred materials considered to largely meet *Cradle to Cradle* objectives for the product. The certification process has helped drive the Global wall tile towards a healthy and safe nutrient for continuous cycling. The wall tile has been continually improved and has progressed from SILVER under v2.1.1 to SILVER under v3.0 of the *Cradle to Cradle Certified* Product Standard, with further improvements targeted. This has helped the tile along the transition towards a product which has a truly positive profile.

Further benefits include increasing the use of recycled material from 6% to 23% of the total input. Mosa's Global wall tiles use 4% recycled scrap material from internal processes and 19% recycled silica. This has led to a 77% reduction in the total supply chain environmental cost to human well-being.

On the operational side, the cooling water system has been closed, recapturing water after it has been used, reducing the direct footprint per tile by over 50% and reducing the human well-being cost associated with wastewater treatment by 68%. Operational energy use has slightly increased due to economic downturn, but the total quantity of renewable energy on site has increased.

Mosa achieved SILVER level for its social fairness. High standards of reporting were apparent before optimization, though further improvements have been seen. Mosa is involved with initiatives with its supply chain, staff and customers, and strive to continually improve upon this.

Mosa has experienced robust business performance in difficult economic conditions, with sales in 2012 that were 20% higher than the rest of the industry. *Cradle to Cradle Certified* products are recognized in the company's largest market of the Netherlands where their demand is growing, especially in the public sector due to green procurement standards

'Our clients can be confident that they are buying a "good" wall or floor finishing: non-toxic, no VOCs, produced in a responsible way with respect for employees and with the help of renewable energy. And all of this is externally verified. Especially architects and interior designers appreciate these benefits, as Cradle to Cradle products are being specified for more and more building projects. Also because they contribute to obtaining building labels such as LEED.' Arthur Thomaes, Royal Mosa CEO

Through lowering dependence on natural capital, Mosa has potentially reduced the corporate risk associated with environmental externalities. Combined valuation of impact on human well-being was determined to show a cost reduction of 17¢ per m² of wall tile between baseline and certified comparison years. Based on 2012 production, this equates to a total benefit to human well-being of US \$105,440, decreasing risk to the company of potential internalization through increased legislation, taxes, or other factors.

CONCLUSIONS

The *Cradle to Cradle Certified* Products Program provides a powerful continuous learning pathway to developing innovative, resource efficient and healthy business models. Such business models are best positioned for the transition to a more sustainable and equitable economy that values human and environmental well-being alongside economic growth.

ASSUMPTIONS

ASSUMPTIONS AND DATA GAPS

Factors for analysis were regionalized where possible, for example supply chain impacts were adjusted based on the regional electricity for the country of supply. This makes the assumption that the country of supply is the origin of the material, which may not be accurate, but further analysis of the lower tiers of the supply chain is not realistic.

Specific transportation distances were not available, so distribution of product was based upon transport by truck to the two Mosa warehouses in the Netherlands. From there, transportation distances to destination countries were taken as the percentage of sales sent to the mid-points of those countries.

No data was collected for the end-of-use product phase. The analysis is based on assumptions made by Mosa that 98% of its products are recycled as aggregates.



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