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Green Business Model Innovation

Empirical and literature studies



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Executive summary

This report provides fact based knowledge in relation to Green Business Model Innovation and it sums up the key learning points from a business case study, a literature review on economical and environmental effects, an impact assessment of a survey, as well as interviews with experts. The main emphasis has been on the business cases.

In total 41 companies¹ were interviewed and on the basis of the interviews business case studies were completed. The companies were selected based on desk research and recommendations from experts in a snowball analysis. The sample is small and our analysis is therefore based on a limited amount of companies, which cannot be considered representative for the group of companies working with green business model innovation. However, the knowledge from the business cases can give us a first impression of the characteristics of companies working with green business model innovation and next practice.

Types of green business model innovation

We structure the greening of businesses with respect to two main models: the incentive models and the life-cycle models. The incentive models include functional sales or product service systems and performance-based models which may have green effects such as Energy Saving Companies (ESCOs), Water Saving Companies (WASCO), Material Saving Companies (MASCO), Chemical Management Systems (CMS), and Design, Build, Finance, Operate (DBFO) etc. The life-cycle models include cradle to cradle, take back management, green supply chain management, and industrial symbiosis.

Many of the companies have employed different types of green business model innovation to support a more overall and general green business model. Their green business model innovations thus overlap and/or support each other by building on business approaches that derives from a focus on restorative value and materials streams. Few have so far focused their green business model innovation on both their

¹ 29 of the business case studies were used for the quantitative analysis and 20 for the qualitative analysis

input side (pre-production and production) and on their output side (use and after-use/reuse).

Case companies working with functional sales (FS) have seen competitive advantages and new revenue streams in selling the functionality of their product or adding services to it. They have changed the cost structure and risk schemes for their customers, due to lower investment cost, lower operational risks and higher customisation options.

Case companies working with green supply chain management (GSCM) source bio-based, energy-efficient or surplus and waste materials from external suppliers. This has proved to secure more stable sourcing, creating resource-efficient production or supporting the branding of the company by substituting core components that are crucial for their production and that will have the highest business impact.

Case companies working with cradle to cradle (C2C) design and produce biodegradable, decomposable and reusable products. They start by focusing on one product line to see if the product is profitable. A few larger companies have taken the approach further by using the cradle to cradle mindset as a driver to systematically take products and components back into own production.

Case companies working with take-back mechanisms (TBM) distribute waste and surplus materials to their own or other companies' production. They have all seen new revenue streams, cost-cutting opportunities and risk management in taking their own (or others') products or packaging back into own production. This creates an incentive to design products to be recyclable and decomposable and to retain product ownership.

Case companies working with industrial symbiosis (IS) is a collaboration where companies buy and sell residual products, materials and resources. It has created interlocking systems where companies cycle their surplus and waste materials to reduce cost and the need for new materials.

Company Characteristics

More than 40 percent of the companies interviewed were large companies with more than 1,000 employees. It is not possible to know whether our sample is biased towards large companies, but it is likely that it has been easier to identify larger companies than smaller ones since larger companies' actions are easier to identify.

When engaging in green business model innovation, almost 90 percent of the interviewed companies use in-house resources by engaging and training their own employees while more than 50 percent of companies hire experts and consultants

to guide them through the processes and changes that need to be implemented. An important factor that was identified to succeed with green business model innovation was creating a company culture where employees understood what sustainability meant to the company and why it is important. Consultants and experts are brought in when specific processes need to be initiated, such as going through a certification process.

At the same time, partnerships are developed with a range of different partners such as universities, other companies as well as governments and NGO's. Almost 50 percent of the interviewed companies created partnerships with universities, while just over 40 percent of partnerships were with other companies and 25 percent of partnerships with governments or NGO's.

Drivers of Green Business Model Innovation

One of the most important drivers for companies to initiate green business model innovation is increased consumer awareness towards sustainability. All of the companies use the green agenda as a driver for their green business model innovation - irrespective of the size or sector of the company. Customers are increasingly expecting companies to behave responsibly and offer sustainable products and services, and customers are also increasingly willing to pay for these products and services. Another important driver is the opportunity for companies to differentiate their products and services and create a competitive advantage by being greener and more sustainable than their competitors. The interviews showed that all case companies see green business model innovation as a way to counter growing competition and new market conditions that have arisen from new technology, the financial crisis, new global competitors, scarce resources, increased focus on corporate responsibility or changes in customer demands. Especially the smaller and family-owned case companies are also driven by a value of 'doing good'.

A driver of a different nature is related to increasing costs of resources and supply risk, which has forced companies to consider alternative resources for their production. In many cases companies have chosen more sustainable alternatives or implemented measure that can reduce the amount of resources used and thereby costs. The business case companies have set forth processes to cut costs and create new revenue streams by changing or expanding their focus on how to source from surplus materials, design recyclable products, add services to products or create take-back mechanisms for reuse of products or components. This can all be seen as examples of circular and holistic business approaches, where waste is used as a resource and products are designed, sold and supported to be restorative.

Barriers to Green Business Model Innovation

Some of the most important barriers encountered among companies changing their business models into greener ones, is a lack of knowledge and skills throughout the entire value chain. In the development and production phases, employees lack knowledge of what substances are contained in the materials they use, alternative materials to use and how to use new materials when developing and designing new products. Further down the value chain, marketing and sales staff lack knowledge of how to sell a sustainable product or service and suppliers do not understand the new green business model. Finally, while some customers are willing to buy more sustainable products and services, there is still a large group of customer that do not have enough knowledge about what sustainability is and who are too conservative to change their buying habits where price is the main purchasing incentive. Another great barrier for companies wanting to transform their business models is the large costs of new machinery and new materials or changes that must be implemented in new product development and design. Furthermore, recycling and reusing materials require infrastructure systems, which also are costly to develop and implement. The solution to many of the barriers might be to create partnerships, but for many companies this is also seen as a great challenge to initiate on their own.

Results of Implementing Green Business Model Innovation

Many companies' first attempts at green business model innovation are aimed at a limited number of product lines or initial attempts at selling services in a new way. While testing the different ways of doing green business model innovation focus is not initially placed on how to measure the outcomes. Since green business model innovation is still not prevalent among companies there is no general consensus on how to measure it, making it difficult to gather large statistical numbers of companies that can be evaluated according to the same template. Furthermore, the results achieved by individual companies are difficult to generalise as they vary across company size, sector and country. All of the companies see green business model innovation as a way to create positive environmental impacts, more innovation and financial benefit.

Among the companies we interviewed, some of them can document specific financial results based on thorough calculations, some have made rough estimates, while others reply that they would not have initiated the green business model innovation unless it would result in positive financial impacts. Two thirds of the case companies estimate that they have experienced, or expect to experience, financial benefits from introducing their green business model innovation. For the remaining companies it was difficult for the team to interpret the answers. Some companies could not indicate whether they had

achieved either a positive or negative impact, some replied that they had not attempted to measure the impact, and others had not been able to estimate the financial impact of their green business model innovation yet. A minority of the companies estimated that the green business model innovation would lead to break-even, while none of the companies indicated that they had experienced a negative financial result.

When asked what type of innovation the case companies achieved based on the transformation in their business model, 72 percent replied that they had changed the processes in their company, while 48 percent developed a new service and 34 percent a new product. Some companies experienced that the transformation in their processes also resulted in new products and services that were greener, while some companies experienced that the quest for a new product or service altered the processes in their company towards greener ones. 28 percent of companies saw changes in their products as well as processes, while 24 percent of companies experienced changes in their services as well as their processes. Especially the case companies that are experienced in working with a green business model have combined different kinds of innovation in all of their value chain. But for many case companies GBMI is still at an early stage, and the potential of the developed innovation has for some yet to unfold.

Environmental results might rarely show in the short run because it often takes time to build environmental management systems that create the intended impact, taking years before results can be documented. However, all of the companies that were interviewed in our study reply that they in one way or another have made or will make environmental improvements because of their green business model innovation. While some companies have made thorough and precise measurements of their environmental improvements and can present exact numbers, others have not measured it directly but base their answer on estimates. The most commonly reported environmental effect experienced by the business case companies were reductions in raw materials, energy consumption, water consumption, GHG emissions, toxic chemicals and waste.

The literature review shows that many international companies such as Texas Instruments, Dell, and PepsiCo have made large savings as well as reduced their environmental impact through f. e. source reduction, recycling and use of reusable packaging systems. Companies like Honeywell, LG Electronics, and Xerox have all implemented take back mechanisms and managed to cut costs as well as reduce a significant amount of waste. Similarly, the companies Timberland, Desso, and Ahrend have all embraced cradle to cradle which have made positive impacts on their business. The Kalundborg Industrial Symbiosis in Denmark, Kwinana Eco-Industrial Park in Australia, and the National Industrial Symbiosis Programme in England have all astonishing results on their economical and environmental impacts. Also, companies which implemented functional sales, ESCOs, CMS, DBFO show that there is a economical and environmental potential for these ways of doing business.

Finally, on the basis of a survey, the economical, environmental, and innovation effects of implementing GBMI were explored. From the limited data, it was not possible to establish statistical significant effects of implementing GBMI, but interviewed experts points to the fact that the correlation between sustainable activities and financial impacts is particularly hard to identify in impact assessments. Green business model innovation takes time and investments to develop and sufficiently implement, but other studies show that positive returns can be identified.

Preface

The *Green Business Model Innovation Studies* compendium is one of the four reports completed within the Green Business Model Innovation project for the organisation Nordic Innovation from august 2011 to august 2012. The work is a continuation of a previous project *Green Business Models in the Nordic Region - A key to promote sustainable growth*, completed for the Nordic Council of Ministers in 2010.

The purpose of this compendium is to provide fact based knowledge about, and to reveal the potential of a new type of business practices through a collection of different assessment methodologies of business cases around the world.

The work has been made possible thanks to funding from Nordic Innovation and the others partners on the project; The Danish Business Authority, VINNOVA, TEKES, Innovation Norway and Innovation Centre Iceland. The Nordic working group which has undertaken the work of this project has representatives of the Nordic innovation agencies and experts working with framework conditions, performance and funding green growth. We would also like to thank the group of experts whom have been interviewed and participated in workshops and discussions.

The Danish Business Authority has been the project lead, and the team at the Danish Business Authority consisted of: Kristian Henriksen, Special Advisor and project owner, Markus Bjerre, Head of section, Jakob Øster, Head of section, Alexandra-Maria Almasi, research assistant, and Emil Damgaard, research assistant. In addition the consultants Casper Høgenhaven from Hoegenhaven Consult and Tanja Bisgaard from Novitas Innovation have participated in the work, as well as the consultancy COWI. Tanja from Novitas Innovation took on the project management from January 2012.

Three of the total of five parts of this compendium (Part 1: Overview of Green Business Model Innovation Studies, Part 2: Quantitative Business Case Summary, Part 4: Literature Review of the Effects of Green Business Model Innovation) have been prepared by the Danish Business Authority project team. The other two parts (Part 3: Qualitative Business Case Summary and Part 5: Survey) have been completed by the consultancy company COWI in dialogue with the Danish Business Authority.

Part 1: Overview of Green Business Model Innovation Studies

In the recent years the business sphere has attracted an unprecedented level of criticism in the background of its role in different social, environmental and economic issues of our society. The sustainability performance is an important business aspect that is increasingly impacting companies' directions since there are several financial, regulatory and market place opportunities to innovate an organisation's activities to tackle environmental risk and enhance growth. All the changes that a company needs to address within its structure and value chain in order to approach a more sustainable activity have been gathered within this project under the name of Green Business Model Innovation.

The main objectives of the project was to provide clear definitions for the concepts of Green Business Model Innovation (GBMI) as well as to increase the fact based knowledge and to reveal the potential of this new type of business practices. A better understanding of this subject can enable businesses and policy makers to effectively address the factors that drive or impede companies in developing new and greener business models.

This part intends to reveal the most important results of the GBMI studies in a unified context, using the structural base of the project, namely the *business model*. The focus on the concept of business model is considered as being of high value, since it offers an opportunity to understand the mechanisms that are at the centre of how businesses operate GBMI. The studies focused on five types of GBMI: Green Supply Chain Management, Take-Back Mechanisms, Functional Sales², Cradle to Cradle and Industrial Symbiosis. These five types of GBMI address product and service innovations, as well as process innovation within a business model.

² Functional Sales is used as a generic name for all the Product-Service Systems types of innovation including Energy Saving Companies, Design-Build-Finance-Own, Chemical Management Systems, etc

Green Supply Chain Management (GSCM) is an integrated concept of greening activities in the supply chain focusing on upstream flow, cost reductions of and innovation in raw materials, components, products and services.³

Take-Back Management (TBM) extends the producers' responsibility of waste management through take back mechanisms of the down-stream use of the product. This includes manufacturers, retailers, consumers and recyclers.⁴

Cradle to Cradle (C2C) designs innovative and essentially waste free products that can be integrated in fully recyclable loops or biodegradable processes. Cradle-to-Cradle focuses both up-stream and down-stream in the value chain.^{5 6}

Industrial Symbiosis (IS) is a system approach to a more sustainable and integrated industrial economy which identifies business opportunities that leverage underutilised resources (materials, energy, water, capacity, expertise, assets, etc). The aim of Industrial Symbiosis is to reduce costs and environmental impact of participating companies and municipalities.

Functional Sales (FS) are represented by a mix of both products and services, and the provider offers the customers the opportunity to pay for the functionality or performance of the product instead of buying the product itself⁷. Because the payment is done per output unit of the product, there is an incentive, on the one hand, for the consumer to use the product less, and on the other hand, for the producer to improve the product's life span and efficiency.⁸

The different studies of the GBMI project are based on the assessment of the companies that already apply one or more of the five different types of GBMI. The identification of the companies was possible through the help of several experts on business model and green innovation from the private sector. The experts were asked to recommend companies that they perceived as having a green business model with innovative elements. This process resulted in a gross list of companies from different industries and regions, out of which 41 were interviewed. A significant part of the interviewed companies using GBMI are large ones, with a percentage of little over 40 per cent having more than 1,000 employees. The explanation lies in the fact that is easier for bigger

³ <http://www.effektivitet.dk/~media/858769ECCD3A45E1BA7D59B5DD06246E.ashx>

⁴ Van Rossem, C., Tojo, N., Lindhqvist, T. (2006): Extended Producer Responsibility – An Examination of its Impact on Innovation and Greening Products. The International Institute for Industrial Environmental Economics

⁵ Kelly, K. (2010): Out of Control – The new Biology of Machines, Social Systems and the Economic World. Perseus Books, Cambridge Massachusetts

⁶ <http://www.cleanproduction.org/Steps.Closed.php>

⁷ FORA (2010): Green business models in the Nordic Region – A key to promote sustainable growth. Green Paper for the Nordic Council of Ministers

⁸ For a detailed description of the GBMI types please consult the Conceptualization report.

companies to test GBMI, and initiate projects that only represent a small part of the company's business, whereas SMEs might find it difficult to initiate such projects since they might represent a large part of the companies' services or product lines.

Besides the interviews, a questionnaire was sent to 441 companies in the Nordic Region, Europe, North America and Asia. Out of the 441 companies, 54 companies completed the questionnaire. The survey revealed that for many companies GBMI is still at an early stage and the potential of the created innovation for some yet has to unfold. Because of this, the expert's reflections on the survey results indicate that it is not possible just yet to correlate direct impacts of sustainable activities and the financial, environmental and innovative performance of a company, especially in an impact assessment conducted across industries and countries. Furthermore, several of the companies have not developed methods of measuring the different parts of the green business model innovation.

Even though there is some way to go before solid statistics and sound evidence can be produced, the business case studies show that there is a clear business case for sustainability, but it differs from sector to sector.

To give a clearer image of the empirical studies of GBMI that form the basis of this compendium, a brief description of each of them is provided here. It should be noted that all the results that the empirical studies incorporate are based on the analysis of only the up-mentioned collection of cases. Because of the limitations imposed by the small number of companies which agreed to take part in the research phase of the project, it was decided to supplement the empirical studies with a desk research which revealed the economic and environmental impact results of GBMI around the world.

For more in depth information about the business case companies and the results obtained during each of the studies it is indicated that the interested parties consult the individual reports.

PART 2: Quantitative business case study summary - reveals the results of in-depth interviews conducted with the companies which have been identified as applying at least one type of GBMI. The results are mainly based on information from company representatives' self-experience and have been focused on an interview template common for all the five types of GBMI. The report illustrates the statistics on company size, ownership, motivation, barriers and drivers for applied GBMI, funding sources, policy instruments, etc.

PART 3: Qualitative business case study summary - captures insights from how companies have implemented GBMI, and lists the key findings segregated from the conducted interviews according to the five types of GBMI.

PART 4: Literature Review of Effects of GBMI – gathers the results of several studies around the world that tried to capture the quantitative environmental and economical benefits of the five types of GBMI. The data vary from company level, to industry and aggregate levels, but create a solid image of the benefits of GBMI.

PART 5: Survey – provides the processed results obtained from a survey conducted on 54 companies around the world. The companies were asked to state the focus and level of their business model innovation and to estimate the financial, environmental and innovative impacts relative to their industry equivalent years. Three international experts on sustainability issues provide reflections on the findings of the analysis.

Overview of GBMI Studies in a Business Model Canvas Context

The business model canvas is defined as an analytical tool and consists of nine basic building blocks (elements) covering four main areas of a business: customers, offering, infrastructure, and financial viability⁹. The overview is structured in nine different sections: each section encompasses the description of a business model canvas building block followed by the findings that match the nature of that certain block. The findings are represented by the results extracted from all the studies and merged together in the context of the block.

Figure 1. The Business Model Canvas¹⁰

Key Partners	Key Activities	Value Proposition	Customer Relationships	Customer Segments
	Key Resources		Channels	
Cost Structure			Revenue Streams	

The following sections take the business model building blocks one by one and discuss the changes and their implications generated by GBMI. Each section discusses both the

⁹ See Conceptualisation Report for in-depth description of the Business Model Canvas where two additional building blocks are added

¹⁰ The Business Model Canvas was created by Dr. A. Osterwalder in his book 'Business Model Generation' (2010)

positive outcomes of GBMI and the difficulties experienced by companies either in the process of approaching a type of GBMI or after its implementation.

Figure 2 is the illustration of the innovation impact level brought by the adoption of each of the five types of GBMI upon the nine business model building blocks and its purpose is to create a visual summary of the discussions provided within the following nine sections.

Table 1. The innovation impact brought by the five types of GBMI upon the business model blocks

	Value Proposition	Cost Structure	Revenue	Key Partners	Key Resources	Key Activities	Customer Relationships	Customer Segments	Channels
GSCM	✓	✓		✓✓	✓✓		✓	✓✓	
C2C	✓✓	✓✓	✓	✓✓	✓✓✓	✓✓	✓	✓✓	
TBM	✓	✓✓	✓✓	✓✓	✓✓	✓	✓✓	✓	✓
FS	✓✓✓	✓✓✓	✓✓✓	✓	✓	✓✓	✓✓✓	✓	
IS	✓	✓✓	✓	✓✓✓	✓✓✓	✓	✓	✓	✓
Legend: ✓ = low; ✓✓ = medium; ✓✓✓ = high;					= no impact perceived				

* it should be noted that each company has its own way of applying GBMI, tailoring it in relation to several factors, therefore the impacts upon the business model building blocks can vary from case to case;

** the table has a guiding purpose for the business sphere, and resulted from the discussions and brainstorming of the project team, which considered the implications of the five types of GBMI according to their full definition;

*** the table addresses the changes taking place in incumbent companies which embraced GBMI.

Source: team interpretation based on business case interviews

As *Table 1* shows, in the case of the companies which approach innovation towards sustainability, the business model building blocks that experience the highest level of change are the Value Proposition, Cost Structure, Key Partners and Key Resources. The types of GBMI which are most likely to bring a higher level of innovative change within the building blocks are C2C and FS. The explanation lies in fact that, by definition, these GBMI types address larger parts of a company value chain and therefore have the potential to generate a higher level of improvements when taking a system view. Out of the total number of interviewed companies, 11 are applying FS as a form of GBMI and 12 have developed C2C strategies.

1. Value Proposition

-The bundle of products and services that create value for specific Customer Segments-

Many of the interviewed companies have so far focused their GBMI on part of their

product or service range, in other words their value proposition. This measure tests the profitability and delineates the innovation to the most promising markets, where lessons learned can influence how subsequent GBMI can take form and how products can be designed, sold and taken back.

The companies that, for example, adopt C2C as a type of GBMI, improve their value proposition by offering their customers the possibility to purchase biodegradable, decomposable and reusable products. Usually they start by focusing on one product line to test the products' environmental and economic impacts, and as indicated by the different industries represented by these companies, the C2C principles can be applied to a wide range of products and sectors: from household products to components for building houses and textiles.

The business case studies showed that the markets have responded well, and some customer segments have been willing to pay above market price for the C2C product. In addition it had a significant marketing and branding value. But the companies have also experienced challenges in changing the product design and manufacturing systems, getting the materials suppliers on board, as well as marketing the benefits of buying a C2C product.

The adoption of FS as a type of GBMI is another possibility of innovating a company's value proposition. The key focus is on the functionality of the product rather than the product itself, because the customers purchase the functionality as a service rather than purchasing the product.

Business case companies have applied FS to different sectors, customising the value proposition to market and customer demands. This has created sub-labels of FS that range from car leasing and retailing to energy-saving companies and chemical management systems. The companies help their customers reduce energy consumption, resource use or waste by retaining product or packaging ownership, thus creating financial and environmental benefits. It should be mentioned that not all the companies adopting this kind of green business model innovation have left a traditional product sale system, but they have combined it with leasing and service models.

Other types of GBMI, like GSCM or IS, have an indirect impact on a company's value proposition. A company which enters an IS network will substitute a part or even all key virgin production resources with the waste or surplus materials provided by other partner companies. This switch ensures a lower environmental impact of the company, and implicitly enables it to indirectly improve its value proposition towards the customers.

GBMI generates the improvement of the value proposition through resource

efficiency and responsibility which translate into environmental and economic improved performance for both the supply and demand side.

2. Cost Structure

-All costs incurred to operate a business model-

There are many business case companies which have set forth activities for long-term cost reductions by changing or expanding their focus on how to source from surplus materials, design recyclable products, add services to products or create take-back mechanisms for reuse of products or components. These are seen as a valuable strategic choice for cost reductions taking into consideration the rising prices of virgin material resources generated by their global depletion.

The majority of the business cases indicate the *process* innovation as the most acknowledged form of GBMI application within their company's long term cost reduction plans. This can be explained by the fact that process innovation might be perceived as requiring a lower level of upfront investment in comparison with *product* or *service* innovation. The investments required by the introduction of totally new product lines are higher, since this implies also costs for market research, product design, new production technologies, and marketing strategies.

A low level of requested upfront investment is seen as a driver for the adoption of the different types of GBMI, since almost 90 per cent of the interviewed companies indicated that they use their in-house resources as an investment source. The second most popular sources of investment for GBMI are the conventional loans followed by private equity and national governmental grants.

A good example of process innovation is related to the business case companies working with IS. They became part of a collaboration where businesses buy and sell residual products, materials and resources. This creates an 'eco-system' which empowers companies to change their cost structures and reduce the overall costs in the long run (by avoiding landfill taxes and waste management costs, or by sourcing surplus materials), but also to reduce the need for raw materials. This also applies for companies that have take back mechanisms or are C2C certified.

Companies that have implemented FS have changed their cost structures by supporting the full investments for their customers' projects and by ensuring the maintenance during their functional life. The investments are recovered on the long run from the customers that have to pay periodical fixed amounts of money for using the service provided by the companies. In case the projects do not perform as agreed in the contract, the companies have to pay the customers the different sums. This is a very good incentive for improved products and services, with higher material and performance efficiency rates and lower environmental impacts.

GBMI types can generate long-term cost savings but require up-front investments. Even though currently the most popular sources of investment are in-house resources, there are several funding and incentives schemes at national and European level which are intended to proliferate GBMI.

3. Revenue Stream

- The cash a company generates from each Customer Segment-

It is too early in the evolution of GBMI within the business sphere to be able to notice strong correlations between eco-innovation and the bottom line of a company. However, sustainable activities are in many cases perceived as a driver for innovation and the business case studies show that positive returns can be identified, varying from case to case.

The results of the qualitative business case analysis indicate that, even though based on isolated calculations or rough estimations, around 70 per cent of the interviewed companies confirm they have experienced or expect to experience financial benefits generated by the adoption of GBMI. Some of the companies stated that they would not have initiated the GBMI unless it had positive financial implications.

The business case companies that have reported direct positive financial impacts after adopting a type of GBMI, are mainly the ones that have expanded their focus from input and production side to use and reuse phase of their products. Even though profits increase when bringing products back into the material cycle (as it leads to higher incomes from selling or buying what used to be waste/ surplus material), there are also examples of companies that obtained new revenue streams by introducing innovative and greener products. Even so, their number is not so high since these organisations only applied GBMI to very small parts of their value chain, a measure which cannot create noticeable impact especially for bigger companies.

The adoption of GBMI is perceived in many business case companies as a driver for improved overall financial performance.

4. Key Partners

-The network of stakeholders that make the business model work

The business case companies' overview reveals that different forms of partnerships have played a central role for the success of many of the companies. There might be an untapped potential for the success for GBMI in partnerships, regardless of their nature (public-private, private-private).

The interviewed experts indicate that the more a company is able to involve its business partners in its plans for GBMI, the more this is able to achieve the expected results in terms of improving its performance. Business cases show that, for example, GSCM

secures a more stable sourcing through close relations with preferred suppliers, and, in some cases, the close dialogue might create bonds that are so strong, that they also become clients. Even so, the adoption of GBMI implies that the partners make a certain level of changes, and companies can encounter difficulties regarding the unwillingness of some of the partners to take risks, make investments in sustainability issues or share information.

Some GBMIs might create totally new business partnerships, like in the case of TBM, when companies have to establish new relationships with suppliers, customers and sometimes even competitors to secure stable and cost-efficient take-back mechanisms. In the IS business case studies, companies have often based the systems on existing partnerships between suppliers and customers under a more formalised framework which could increase competitiveness and environmental performance. But this is not always the case, since more business opportunities/ synergy options could come from totally new business partnerships.

Knowledge exchange partnerships also play a very important role in the development and implementation of a GBMI. Many of the business case companies admitted that university partnerships have been an important source of knowledge, skills and competencies. In the same time business, government and non-profit partnerships can also be significant sources of knowledge.

GBMI generates increased positive financial, innovation and environmental results through the establishments of partnerships.

5. Key Resources

-The most important assets required to make a business model work-

The material resources used in the production processes are the kind of resource which suffer the highest number of innovative changes through GBMI. Companies usually take environmental aspects into account when sourcing material resources for production therefore they source bio-based, surplus or residual materials.

The business case companies have shown that the main way to gain benefits of the GSCM for example, is to analyse how to find sustainable bio-based alternatives to core components. By basing the production needed resources on renewable and abundant materials, a company can secure a stable supply.

C2C and IS also have a big impact on company resources, since they intend to close the material loop of a company or to help develop a closed eco-system of companies in terms of material exchanges. This requires innovation regarding the key resources and can generate several types of benefits both financial and environmental. Even so, the possible required investments and specific knowledge might be seen as a barrier for GBMI implementation.

Through GBMI companies integrate the environmental considerations into the selection criteria for production material supplies.

6. Key Activities

-The most important activities a company must do to make its business model work-

The main environmental impacts stem from company production processes and activities. Through developing a greener business model, companies usually engage in activities like recycling, reuse of waste, renewable energy generation and use, which can diversify their key activities range and at the same time lower environmental impacts. Not surprisingly, all of the interviewed companies indicated that they somehow made or expect to make improvements in terms of their environmental impacts generated by their GBMI type. While some companies made measurements of their improvements, others have not measured it directly, but base their answer on estimates.

The improvements experienced by the business case companies that have the potential to lower their environmental impact are the reduced amount of virgin materials in the production, reduced GHG emissions, reduced energy consumption, reduced amount of waste and increased recycling, reduced amount of chemical and toxic substances.

Companies adopting C2C and TBM sometimes extend their activities to also take back their own products or the products of other companies in order to use the incorporated materials. Some companies adopting C2C see this as much as a mind set for doing business innovation as a technique for certification and most business case companies have applied C2C by redesigning one or more of their product lines.

Companies with TBM distribute waste and surplus materials to their own or other companies' production. This creates an incentive to design products and packaging to be recyclable and compostable.

Small and medium sized companies see the extension of key activities through GBMI as being more difficult to realise since this implies upfront investments that might exceed their budget.

Usually GBMI implies the extension of a companies' activities to incorporate recycling, material reuse or renewable energy generation.

7. Customer Relationship

-The types of relationships a company establishes with specific Customer Segments-

Taking the example of FS, the young business case companies have centred their entire green business model on the innovation of leasing products or packaging to customers,

but the incumbent companies started to offer services as add-ons to their existing products. This strategy secures a foundation for continual upgrades and adaptations of the products, and extends the customer relationship from sales phase to the use and reuse phase. In this way, the companies create stronger bonds and better insights into customers' changing needs, shaping opportunities for more customer-driven innovation of products and services. Also, the relationship between the customer and the company changes from commodity sales relations to a trusted service partner through product service systems. Despite the benefits, there are companies that see FS as a complex process which sometimes encounters barriers like customers' consumption behaviour or the customer's need for product ownership.

A positive impact on customer relationships is generated also by TBM business model, which once implemented helps a company strengthen its image as a responsible company and enhance its customers' trust. These impacts might also be generated by a company's decision to implement C2C, an approach where loops are sought to be closed in cooperation with suppliers, distributors and customers.

GBMI leads to closer customer relationships, which determine opportunities for customer-driven innovation and mutual trust as well as the possibility to increase sales when the product is taken back.

8. Customer Segments

-The different groups of people or organisations that a company aims to reach and serve by its products or services-

There are several market instruments under the sustainability agenda that are intended to change the customer demand patterns towards sustainable companies and their products and services. Approaching GBMI as a driver for a company to improve its brand and create market potential through a green company profile can result in the possibility of reaching new market segments. Some of the business case companies applying C2C use their products as promotional flagships that can create new customer segments and strengthen a green market profile. But there are possibilities that a greener product might be more expensive than a traditional one, and this can scare some customers for whom any change in price is a determinative factor for the purchasing decision.

The incumbent companies which decide to extend their activities to providing services, are very likely to do this only for the business to business market. A good example are the energy saving solutions (ESCO) where, in order to be feasible, the projects have to be of a certain size, therefore a company's customer segments will include only large public and private organisations. Public sector customers are traditionally found through public procurement tenders.

Going further, the business case study reveals examples of companies that decided

to focus their attention and activities mainly on fulfilling the needs of the customer segments gained through GBMI.

A company can gain a green profile through GBMI which in turn is a trigger for environmentally conscious consumer segments. GBMI can also help companies to reach new customer segments which are interested in another value proposition.

9. Channels

-How a company communicates with and reaches its Customer Segments to deliver a Value Proposition-

This channels building block is the least affected by the 5 types of GBMI that have been chosen for analysis. Even so, there are some aspects that are worth mentioning.

Companies which implement C2C or TBM innovate their overall value proposition also by taking back the products at the end of their lives, avoiding the generation of waste and the use of a high level of virgin materials in a product. This implies the creation of additional channels of communication with customers and partners, or the extension of the old ones beyond the selling point of a product, therefore closing the material loop.

Companies within IS networks try to look “over the fence” and seek collaborations with closely physically located companies to keep transport costs low and synergies possibilities high. There have been cases where synergies were found through informal meetings between CEOs.

Taking a more unconventional approach, some are based on Internet platforms, even though these are not IS networks in the traditional sense. It is more a service provided for linking up companies that can benefit from exchanging resources and materials. The service provider makes a transparent marketplace for companies to buy and sell waste and surplus materials. This can create the foundation for new partnerships and locally based IS.

Through GBMI companies can create communication channels with customers which extend beyond the selling point of a product.

There are several external and internal factors which influence a company to consider innovation towards sustainability, and to approach different tools and design action plans that integrate GBMI into their everyday activity. Among the key drivers which determine the adoption of GBMI there are national and global regulations, corporate strategy, changing trends in markets or in the financial sector.¹¹ Because of this, it is hard for many of the companies to put a date on their decision of adopting such an approach.

¹¹ Jensen A.A.&Remmen A (2006): Background Report for a UNEP Guide to Life Cycle Management – A bridge to sustainable products

Many of the companies see GBMI as a new and long-term strategic investment to secure competitive advantages, more market shares and new revenue streams through production efficiency, a greener company profile and lower supply risks, especially when it comes to scarce resources. But even so, all use the green agenda as a main driver for their GBMI, irrespective of the size or sector of the company.

Part 2: Quantitative Analysis of Business Case Studies

This Quantitative Analysis gives an overview of the results of the business case interviews, based on a standard template and conducted with companies working with green business model innovation. The various partners in the project, VINNOVA, TEKES, Innovation Norway, Innovation Centre Iceland and the Danish Business Authority as well as consultants COWI conducted the interviews from January to March 2012. The total amount of company interviews conducted is 41. 29 of these companies have been evaluated as using at least one of the five types of green business model innovation mentioned later in this section. These 29 cases form the empirical basis for this qualitative analysis of the case studies.

The business cases have been selected on the basis of desk research and recommendations from experts. The sample is small and our analysis is only based on a limited amount of companies and cannot be considered representative for the group of companies working with green business model innovation. However, the knowledge from the business cases can us a first impression of the characteristics of companies working with green business model innovation and the results they achieve.

It is also worth noting that the case studies are based on companies' own observations and insights of their own company, and more objective methods for obtaining the information has not been used. It might be possible for companies to have a tendency to exaggerate for example their environmental benefits or improvements to seem more sustainable, but we have no reason to believe that this is the case in any of the interviews completed.

The interviews focused on five types of green business model innovation: green supply chain management (GSCM), take-back mechanisms (TBM), functional sales (FS), cradle to cradle (C2C) and industrial symbiosis (IS). For definitions and explanation of the business model types please see the conceptualisation report *Green Business Model Innovation: Conceptualization Report*. The following table shows the distribution of the different types of green business model innovation:

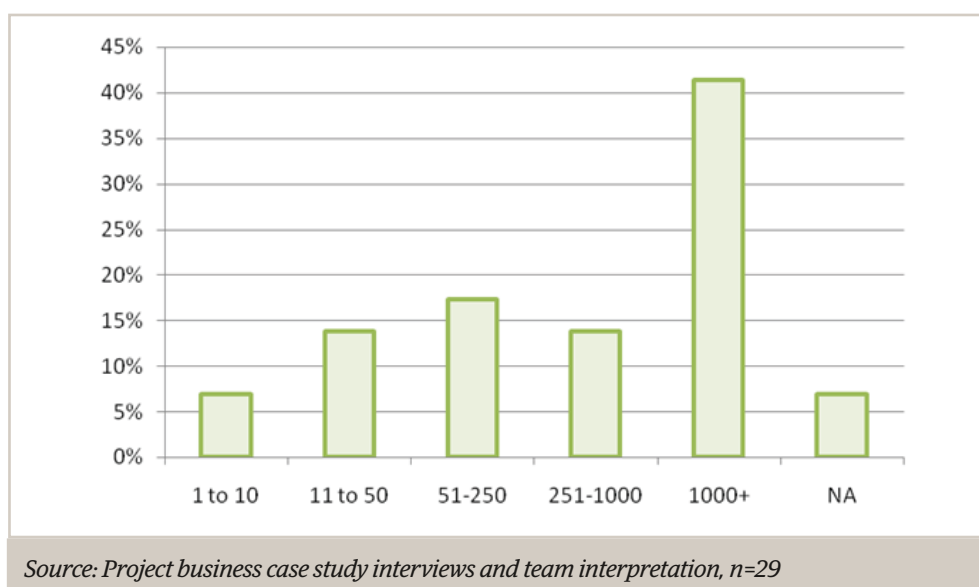
Table 2: Types of Green Business Model Innovation in business case companies

Types of Green Business Model Innovation	
Functional sales	11
Cradle 2 Cradle	12
Green supply chain management	6
Industrial Symbiosis	3
Take back management	6

Source: Project business case study interviews¹², n=29

Size of companies

A large part of the companies using green business model innovation are large ones where just over 40 % of the case companies have more than 1000 employees. It is not possible to know whether our sample is biased towards large companies, but it is likely that it has been easier to identify larger companies than smaller ones since larger companies' actions are easier to identify. It is worth noting that a high proportion of large companies seem to embrace green business model innovation as a way of fostering innovation and increasing their environmental and economic performance. It might be easier for larger companies to test working with green business model innovation, and initiate projects that only represent a small part of the company's business. Smaller companies might find it harder to initiate such projects since they might represent a larger part of the companies' services or product lines, and thereby also a larger part of their costs.

Figure 2: Number of employees in case companies

¹² Nine of the 29 interviewed companies have been categorized as using two types of GBMI, whereas the remaining 20 have been categorized as using one of the enlisted green business models.

Barriers

The case companies experience several different barriers throughout the entire value-chain when working with their green business models. At the beginning of the value-chain, one barrier concerning resources is the high cost of introducing new materials. When changing to materials that have been recycled, some companies experience some technical challenges because of lack of information about the content in the recycled materials. Initially it can also be costly to initiate a new business model as new types of manufacturing systems, product design and development require investments and increased knowledge in companies. Several companies also reply that they have experienced difficulties in working with partners, suppliers, distributors etc. characterised by unwillingness to take risks, make investments in sustainability or share information. Some of the case companies state that they struggle with conservative distributors that are hesitant to go new ways and try new procedures and ways of cooperation.

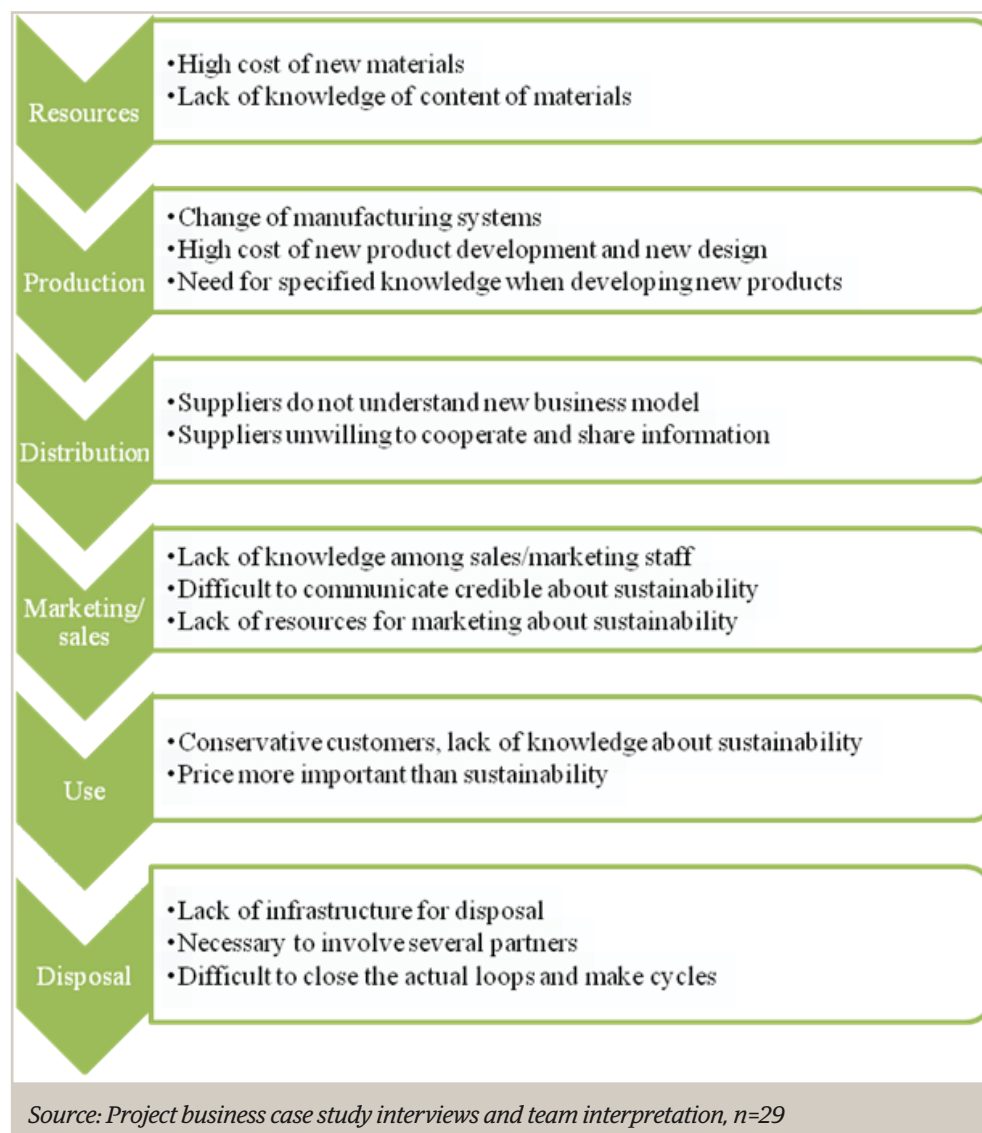
One of the greatest barriers experienced by the case companies is related to sales and marketing issues. For some companies it has been a challenge that their marketing staff simply have not had sufficient knowledge about their new and sustainable products and services and that there have been limited resources for marketing new and more sustainable products. Generally several companies find it difficult to communicate successfully about the sustainable elements of their products and a lot of companies express that they are struggling with old consumer habits, consumers' lack of knowledge about sustainability and hence difficulties in differentiating their product from "business-as-usual" products. An example is some functional sales companies that face challenges when trying to explain and convince potential customers to go from buying a product to leasing it as a service. Some companies have also realised that a green product or service is not a purchasing argument for all customers where the price tag is still more important. Companies with take back systems or sustainable ways of disposal call for better infrastructure for disposal and note that it can be difficult to involve and engage all of the necessary partners in this regard and that it is very difficult to close the actual material loops completely.

The companies have also experienced barriers that are not necessarily business model specific. Some of them are related to internal and organisational issues such as a conservative company culture which can be difficult to change and a lack of relevant skills among employees, the latter often being the case for companies initiating business model innovations that require specific product lifecycle information. Some companies also mention regulation as a barrier to promote green business model innovation, however, this was very industry specific. Barriers are also experienced with respect to infrastructure where for example the lack of a smart grid or government supply of electrical car recharging equipment act as a barrier to some companies. Several

companies express a lack of clear government policies as a barrier for them to move towards a green development in their area.

The figure below contains a brief overview of some of the barriers experienced by the companies throughout their value chain.

Figure 3: Barriers in companies' value chain.



Drivers

Numerous elements and factors have been mentioned by the interviewed companies as drivers of their green business models resulting in positive environmental, economic and innovation impacts. In the following section we have sought to compile, categorise

and describe some of the most frequent and important drivers experienced by the case companies. The table below is a brief overview of some of the most important categories of drivers, which will be elaborated in the following section. Some of the drives can be linked to each other as it is difficult to isolate them into separate categories.

Table 3: Drivers of Green Business Model Innovation

Five of the most important drivers for companies' green business models

- Increased consumer and media awareness and demand towards sustainability
- Market possibilities for sustainable products, now and in the future
- Increasing costs and decreasing availability of resources
- Government regulation in favour of sustainability
- Potential to create new and closer customer relationships as well as partnership opportunities

Source: Project business case study interviews and team interpretation, n=29

Several of the case companies list increased consumer and media awareness towards sustainability and the increasing demand for sustainable products as a driver of their green business model innovation. This is also connected to the fact that companies in general act because of market possibilities for sustainable products now and in the future and thus see green business model innovation as a way to ensure economic viability and keep the bottom-line healthy. Many companies experience increased focus on sustainable issues in society resulting in changing customer demand patterns towards sustainable companies and their products and services. However, embracing the emerging sustainability agenda acts as a driver for companies to help improve their brand and credibility and thus create marketing potential through a green company profile as this creates new opportunities and the possibility to reach new market segments. Some companies - including most of the interviewed C2C-companies - also reply that trying to create a unique and green product or service can help them differentiate their product and create a competitive advantage with a value-added product. However, it is worth noting that some companies also mention conservative customers and the market not being ready for green products and services as barriers that need to be overcome in order to create successful green business model innovation.

Increasing costs and decreasing availability of resources is making it more important for companies to focus on their bottom-line in order to ensure economic viability and lower the supply risks. Many argue that the ongoing tendency with increasing prices, volatility and decreasing availability on many resources - including oil - drive them to introduce new business models where waste is often seen as a resource. Some of the companies simply reply that acting green and being production efficient is the only way to survive as a company in the long run because of the expected future resource scarcity.

Government regulation in favour of sustainability is considered as a driver behind the green business models of several companies. The combination of this tendency and subsidies for many “green” products or activities has increased the incentives for the companies to turn green and thus benefit from the new market conditions.

The potential to create new and closer customer relationships as well as the potential to establish new partnerships is especially a driver for many companies dealing with functional sales since this type of business model often opens up for and requires long-term partnerships and contracts.

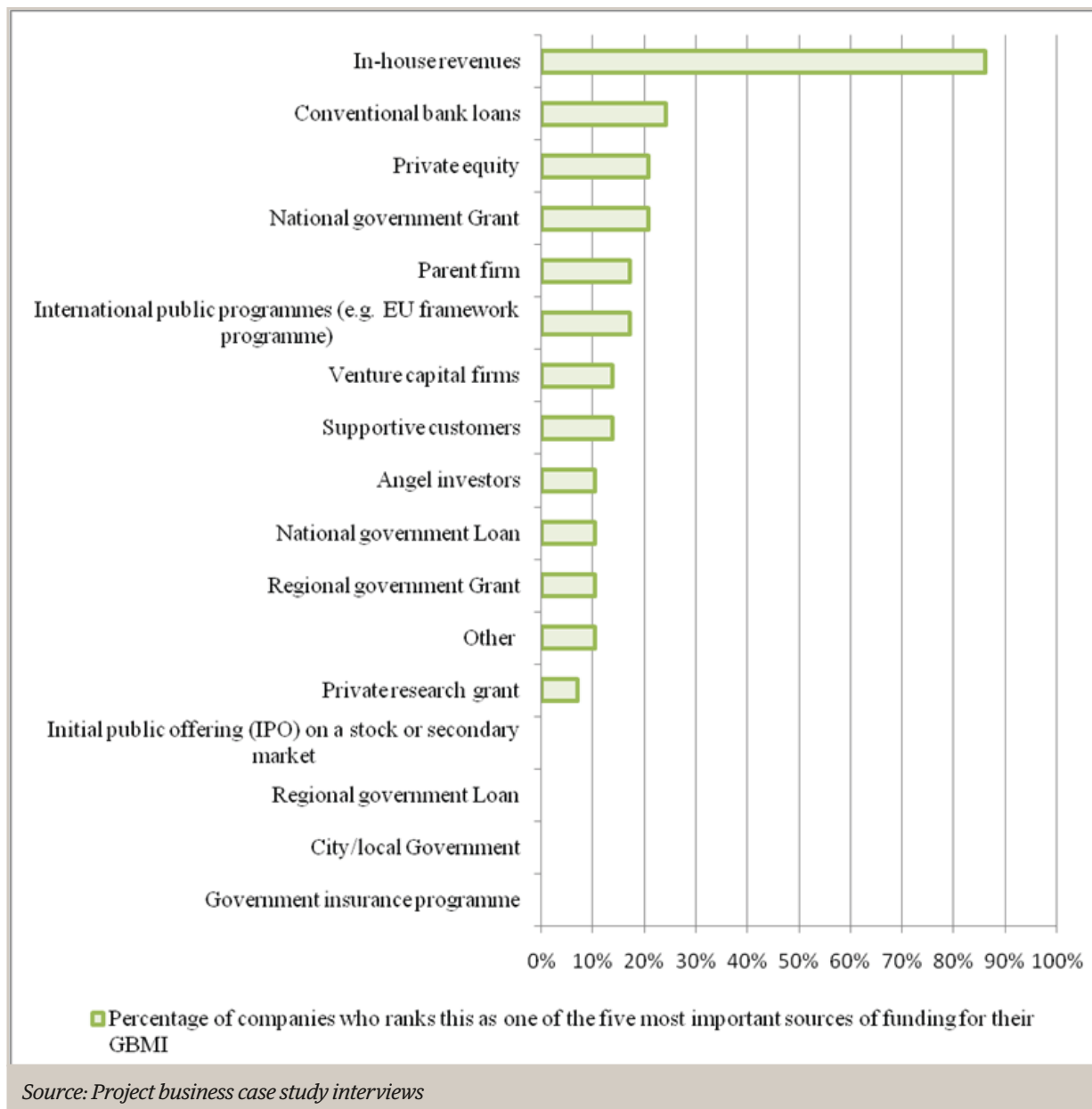
Some companies, especially the smaller and family-owned case companies are also driven by a social mission, a wish to be environmentally responsible as a goal in itself, regardless of competitive advantages or marketing possibilities.

Some of the companies list a strong dedication from executives as a crucial driver for succeeding with their green business model innovation as this has helped to disseminate a strong company culture among employees. Some C2C-companies also reply that implementing the C2C-philosophy has in itself been an important driver for fostering innovation in the company since it has resulted in new mindsets, methods, processes and generally has been an engine for creativity and innovation.

Funding sources

The most important and the only consistent widespread funding source for green business model innovation among the case companies is in-house revenues. No other funding source has played as an important role for the case companies, but among the secondary used funding sources are conventional bank loans, private equity, international, national and regional loans, grants and programs. This tells a story that companies *can* succeed in creating successful green business model innovations without direct government support or funding. However, if the numbers for regional, national and international loans and grants are added a lot of the case companies have benefitted from a combination of in-house revenues and public funding.

Figure 4: Sources of funding for green business model innovation

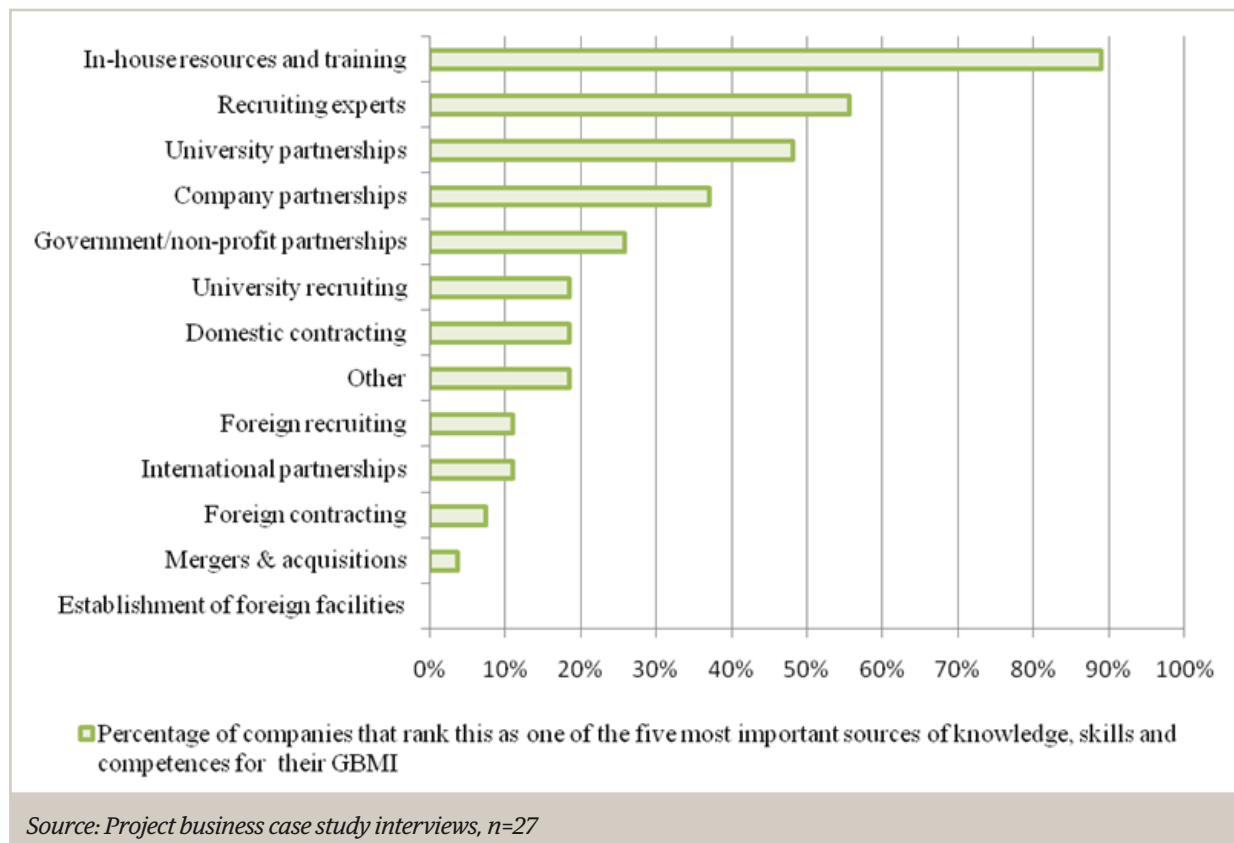


Knowledge and Human Resources

To introduce and implement green business model innovation often requires new knowledge and human resources. In-house resources and training are the most important sources where 89 percent of the companies rated this as one of the five most important sources of knowledge and human resources. Recruiting experts is also an important source for more than 56 percent of the companies and this tendency is especially prevalent among cradle to cradle companies that require the assistance from consultants and experts when implementing a C2C certification process. This number

can be explained by the fact that many companies thread new ground as they introduce green business model innovations and thus do not necessarily have the sufficient in-house resources. Partnerships also play an important role for many of the companies, where 48 percent of the companies reply that university partnerships have been an important source of knowledge, skills and competencies. Company, government or non-profit partnerships have also been significant sources of skills and knowledge for many companies as shown in the figure below.

Figure 5. The most important sources of knowledge, skills and competencies for companies working with green business model innovation



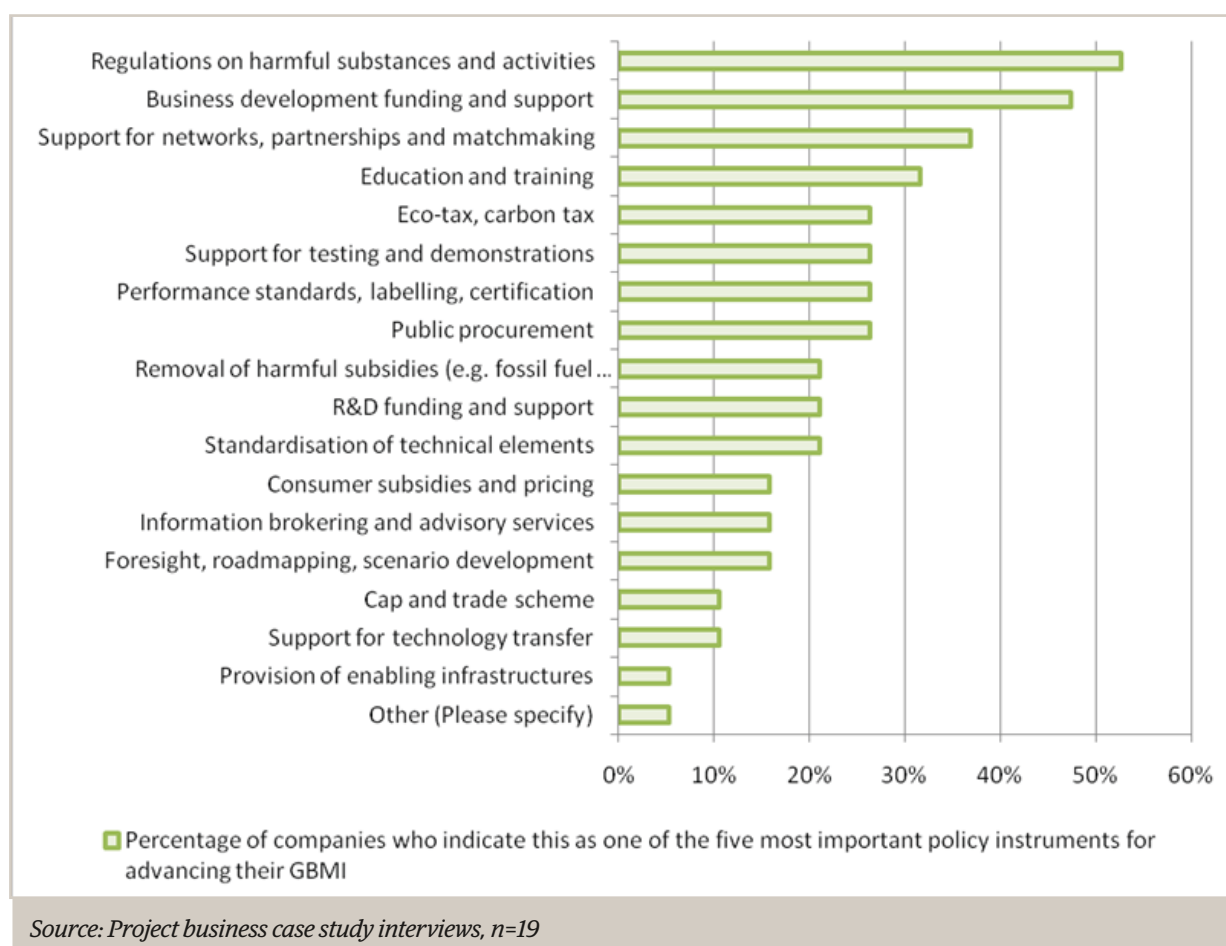
It is noteworthy that different forms of partnerships have played an important part for the success of many of the companies and there is reason to believe that there is an untapped potential for the success of green business model innovation in partnerships, both public-private partnerships, company partnerships and university partnerships.

Policy instruments

Regulation has played an important role for several of the case companies when

changing their business models. 53 percent of the case companies indicate regulation on harmful substances and activities as among the five most important policy instruments for advancing their green business model innovation. Business development funding and support is ranked as the second most important policy instrument by 47 percent of the case companies, and around a third of the companies rank support for networks, partnerships and matchmaking as well as education and training as important policy instruments. Policy measures such as eco-taxes, support for testing and demonstrations, performance standards, labelling, certification and public procurement have also played an important role for several of the case companies in advancing the green business model.

Figure 6: Policy instruments that changed case companies' business model



The results are similar to the ones found in the case studies described in Technopolis Group's work on Business models for systemic eco-innovations, 2011¹³. The use of the top four policies by companies suggest that they can create an effect for companies

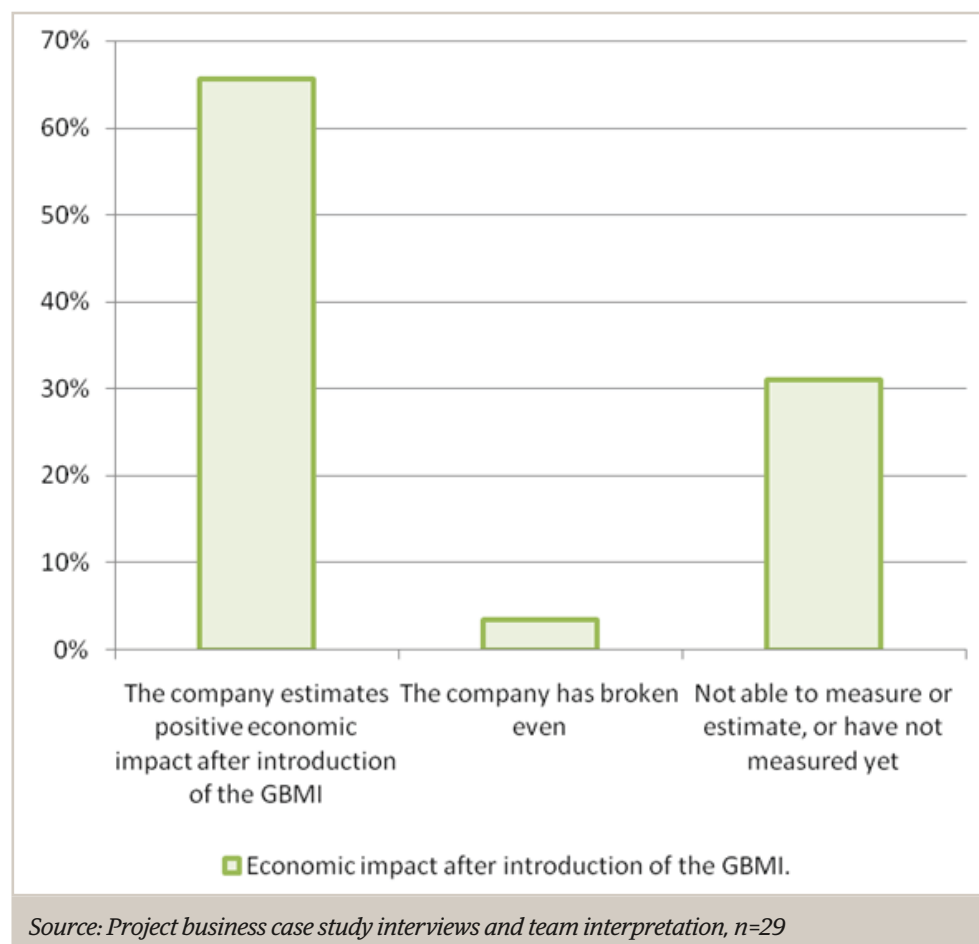
¹³ Technopolis Group, 2011

wanting to transform their business models and indicate that these policy areas could further be supported in the Nordic region.

Economic impact

66 percent of the case companies estimate that they have experienced, or expect to experience, financial benefits from introducing their green business model innovation. Some companies have made thorough and isolated calculations on this matter, some have made rough estimates, while others simply reply that they would not have initiated the green business model innovation unless it had positive financial implications. 33 percent of the companies have either submitted answers which have been difficult for the team to interpret clearly as either a positive or negative impact, or have replied that they have not attempted to measure the impact, or have not been able to estimate the economic impact of their green business model innovation yet. A minority of the companies is estimated to have broken even, while no companies clearly state that they have experienced a negative economic impact.

Figure 7: Economic impact after introduction of the GBMI



Environmental impact

Not surprisingly, 100 % of the companies reply that they somehow have made or will make environmental improvements because of their green business model innovation. While some companies have made thorough and precise measurements of their environmental improvements and can reply these in exact numbers, others have not measured it directly, but base their answer on estimates. The most commonly reported environmental results are listed in the table below:

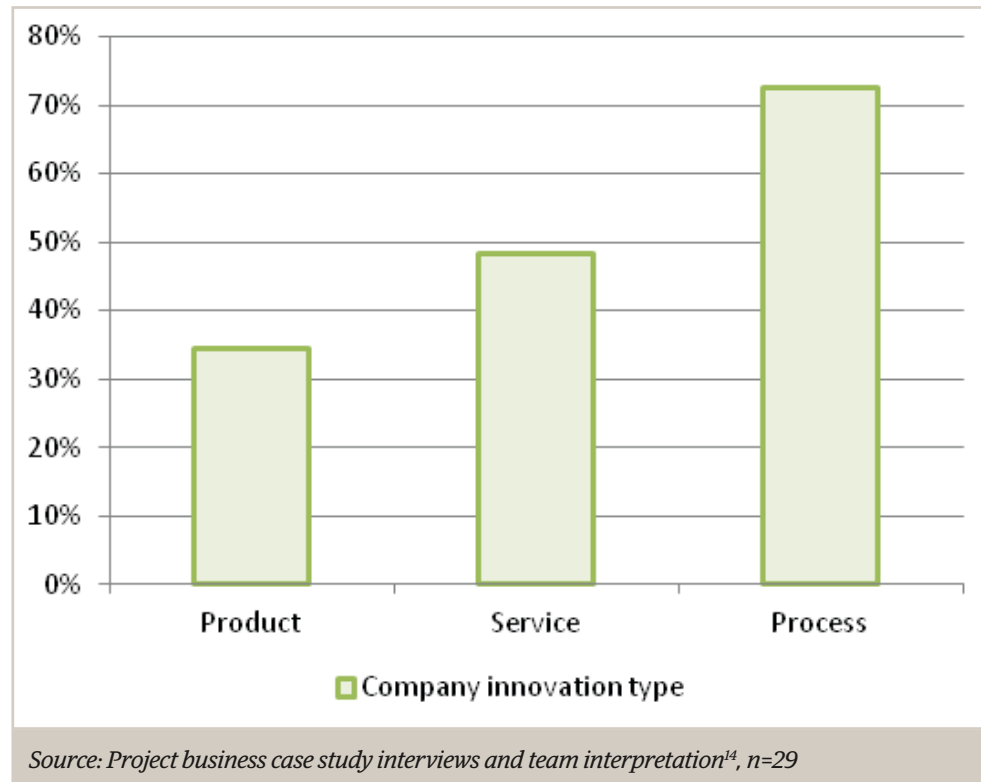
Table 4: Selection of environmental impacts among the case companies

Environmental results as experienced by the case companies
• Reduced amount of new raw materials • Reduced GHG emission • Reduced energy consumption • Reduced amount of waste and increased recycling • Reduced amount of chemicals and toxins • Reduced water consumption

Source: Project business case study interviews and team interpretation, n=29

Innovation impact

When asked what type of innovation the case companies achieved based on the transformation in their business model, 72 percent replied that they had changed the processes in their company, while 48 percent developed a new service and 34 percent a new product. Some companies experienced that the transformation in their processes also resulted in new products and services that were greener, while some companies experienced that the quest for a new product or service altered the processes in their company towards greener ones. 28 percent of companies saw changes in their products as well as processes, while 24 percent of companies experienced changes in their services as well as their processes.

Figure 8: Type of innovation outcome

¹⁴ The sum of the pillars in the bar chart equals more than a 100 percent because the team evaluated some of the business case companies as using more than one the three types of innovation.

Part 3: Qualitative Analysis of Business Case Studies

Green business model innovation (GBMI) here primarily refers to non-technological 'green' innovation, cf. the conceptualization report. This case study has been conducted as part of revealing the potential of GBMI.

The case study focused on five types of green business model innovation: green supply chain management (GSCM), take-back mechanisms (TBM), functional sales (FS), cradle to cradle (C2C) and industrial symbiosis (IS). Each of these types is defined, characterised and exemplified in this report.

The case companies were identified by contacting experts on business model and green innovation in the private sector. The experts were asked to recommend companies that they perceived as having a green business model with innovative elements. They were also asked to provide initial information on the companies and their business model.

The input from the experts created a gross list of companies from different industries, regions and using one or more of the five different types of green business model innovation. The companies from the gross list were then contacted and invited to participate in an interview.

42 companies were contacted out of which 20 companies were interviewed. The 20 companies, their green business model innovation (GBMI) and their business focuses are listed below. All 20 cases can be read in the annex to this report.

Table 5. The 20 business case studies which form the base of the Qualitative Analysis (conducted by COWI)

Company name	GBMI	Business focus
IKEA	GSCM	IWAY: household furnishing and house goods.
Schüco International KG	GSCM	Energy-efficient aluminium housing solutions.
Trimo	GSCM	Complete solutions for steel buildings.
NatureWorks LLC	GSCM (and C2C)	Low carbon polymers in plastic and fibres.
Elvis & Kresse	GSCM (and TBM)	Bags and accessories.
Van Houtum Papier	C2C	Washroom hygiene.
Gabriel	C2C	Supplier of furniture textiles and fabrics.
Trigema	C2C	Manufacturer of textiles and clothing.
Maersk Line	C2C	Triple-E ships: container shipping and services.
Desso	TBM and C2C	Carpets and floorings.
Van Gansewinkel	TBM and C2C	Waste management and recycling in closed loops.
Steelcase	FS and C2C	Office solutions and workplace concepts.
SafeChem Europe GmbH	FS and TBM	Solutions and services for the use of solvents.
Eco2Distrib	FS and TBM	Dispenser machines for fluid consumer products.
Car2Go	FS	Car sharing service
Siemens Building Technologies	FS	Building, automation and monitoring.
Philips	FS	Complete lighting installations and services.
Eastex Materials Exchange /Bright Green	IS	Online exchange of surplus materials.
Rantasalmi	IS	Log house design and construction.
E.ON	IS	Heat energy production and waste management.

New ways of doing business

The interviews for the case study were conducted from January to March 2012. An interview guide was sent to the companies' interviewees beforehand. The interview guide can be found in the annex to this report.

All 20 case interviews were documented in a case description focusing on the companies' value proposition, cost structure, revenue stream, key partners, key resources, key activities, customer relations, customer segments and benefits, impacts and drivers and barriers in relation to their green business model innovation.

The case companies have all experienced - or expect to experience - financial, environmental and innovative benefits from working with green business model innovation.

The interviews showed that all case companies see green business model innovation as a way to counter growing competition and new market conditions that have arisen from new technology, the financial crisis, new global competitors, scarce resources, increased focus on corporate responsibility or changes in customer demands. Especially the smaller and family-owned case companies are also driven by a value of 'doing good'. All the case companies have set forth processes to cut costs and create new revenue streams by changing or expanding their focus on how to source from surplus materials, design recyclable products, add services to products or create take-back mechanisms for reuse of products or components. This can all be seen as examples of circular and holistic business approaches, where waste is used as a resource and products are designed, sold and supported to be restorative.

Especially the case companies that are experienced in working with a green business model have combined different kinds of innovation in all of their value chain. But for many case companies GBMI is still at an early stage, and the potential of the developed innovation has for some yet to unfold. There is therefore some way to go before solid statistics and sound evidence can be produced.

Key findings

This report captures the latest trends and provides an insight into how companies have implemented green business model innovation. The key findings across the case companies are that:

- All use the green agenda as a driver for their green business model innovation - irrespective of the size or sector of the company.
- All see green business model innovation as a way to create positive environmental impacts, more innovation and financial benefit. All companies have positive expectations about gaining - or increasing - positive impacts from their initiatives as they consolidate and gain more experience from their innovations.

- Many see green business model innovation as a new and long-term strategic investment to secure competitive advantages, more market shares and new revenue streams through production efficiency, a greener company profile and lower supply risks (especially of scarce resources).
- Many of the companies have employed different types of green business model innovation to support a more overall and general green business model. Their green business model innovations thus overlap and/or support each other by building on business approaches that derives from a focus on restorative value and materials streams.
- Many companies have so far focused their green business model innovation on part of their product and service range. This tests the profitability and delineates the innovation to the most promising markets, where lessons learned can influence how subsequent green business model innovation can take form and how products can be designed, sold and taken back.
- Few have so far focused their green business model innovation on both their input side (pre-production and production) and on their output side (use and after-use/reuse).
- Case companies working with **green supply chain management (GSCM)** source bio-based, energy-efficient or surplus and waste materials from external suppliers. This has proved to secure more stable sourcing, creating resource-efficient production or supporting the branding of the company by substituting core components that are crucial for their production and that will have the highest business impact. Although green supply chain management has not significantly changed their revenue streams.
- Case companies working with **cradle to cradle (C2C)** design and produce biodegradable, decomposable and reusable products. They start by focusing on one product line to see if the product is profitable. A few larger companies have taken the approach further by using the cradle to cradle mindset as a driver to systematically take products and components back into own production.
- Case companies working with **take-back mechanisms (TBM)** distribute waste and surplus materials to their own or other companies' production. They have all seen new revenue streams, cost-cutting opportunities and risk management in taking their own (or others') products or packaging back into own production. This creates an incentive to design products to be recyclable and decomposable and to retain product ownership.

- Case companies working with **functional sales (FS)** have seen competitive advantages and new revenue streams in selling the functionality of their product or adding services to it. They have changed the cost structure and risk schemes for their customers, due to lower investment cost, lower operational risks and higher customisation options. This has often created new and closer customer relations.
- Case companies working with **industrial symbiosis (IS)** is a collaboration where companies buy and sell residual products, materials and resources. It has created interlocking systems where companies cycle their surplus and waste materials to reduce cost and the need for new materials.

The green business model innovations

The following is a detailed description of the key findings of the case study, focusing on the five types of green business model innovations: green supply chain management (GSCM), cradle to cradle (C2C), take-back mechanisms (TBM), functional sales (FS) and industrial symbiosis (IS).

Each green business model innovation is defined, characterised and exemplified, so that the key findings from the case study are highlighted.

Green supply chain management

Case companies working with green supply chain management have the following characteristics:

- They are most often larger companies that are experienced in working with supply chain management and now seek to take environmental aspects into account when sourcing resources and materials for production.
- They focus parts or their entire production on sourcing bio-based materials or surplus and waste materials from external suppliers.
- They strive to secure more stable sourcing, creating a more resource-efficient production or supporting the branding of the company.
- They substitute core components that are crucial for their production and that will have the highest positive impact on their cost structures. Although it has not significantly changed their revenue streams.
- They have focused their innovation on their sourcing and have therefore made few changes in their customer relations, sales channels and customer segment.

Green supply chain management focus on how the price of materials and supplies will change over time. Actions are taken to keep prices low and supply lines stable through close relations with preferred suppliers.

The focus on the green aspects of supply chain management is created by a growing global demand for resources and an increased focus on corporate responsibility. This has strengthened incentives for a stronger environmental focus in the way materials for products are sourced.

IKEA has, as an example, developed and implemented a green supply chain management solution known as IWAY. It creates a strong focus on cost-minimisation through maximum resource utilisation and business process optimisation that not only allows the company to produce affordable products but also facilitates innovative, social and environmental advances.

The case companies working with green supply chain management are looking into how surplus, energy-efficient and waste materials can replace, substitute or become a supplement to new and newly extracted raw and non-sustainable materials. New technologies and cost-efficient and reliable recycling systems have accelerated this process by offering new ways to source and reuse waste and surplus materials. This cuts costs and secures more stable supplies of production materials that are less rare and less vulnerable to for example fluctuations in price.

NatureWorks, for example, produce polymers whose feedstock is not petroleum-based, and which can be offered at competitive and stable prices by basing the polymers on renewable and abundant crops. The company is just establishing its second manufacturing facility, where production of polymers will be based on sugar cane and cassava; locally abundant renewable resources.

Companies that produce clean tech and energy-efficient products have also seen business opportunities in adding environmental aspects to how they source materials for production. These companies base most or parts of their product branding on a green image. A way to secure and maintain this image is through a systematic and strategic sourcing of materials that leave a smaller environmental footprint or which can be decomposed to a higher degree or recycled after end use.

As an example Schüco is a case company that produces solar panels from recyclable materials and with a minimum use of silicone. This reduces the performance of the panels slightly, but it also minimises both their damaging impact on the environment and the cost of producing them.

The cases show that the main way to gain the benefits of green supply chain management

is to analyse how to find sustainable and bio-based alternatives to core components that are produced on fossil, with less energy, contain less chemicals or carry a lower risk of fluctuations in price or supply.

This often happens through an intensified dialogue with suppliers to secure cost-efficient and stable supply lines. Such close dialogue can create bonds with suppliers that are so strong that they also become customers. The waste innovation company Elvis & Kresse collects fire hoses for their production directly from the London Fire Brigade across the entire UK, which prevents landfill and saves money for the brigade. This gives the London Fire Brigade an interest in buying products and promoting Elvis & Kresse through newsletters and other press and PR efforts.

Cradle to cradle

Case companies working with cradle to cradle (C2C) are characterised by the following:

- They see waste as a resource and are designing and producing products to be biodegradable, decomposable and reusable.
- They differ in size and sector. Cradle to cradle (inspired) products can be found in both smaller, medium sized and large companies.
- They start by focusing their innovation on one product line to see if the product is profitable and to learn from experience how to produce and sell a cradle to cradle product to existing and new customers. A few case companies have taken the approach further and are systematically taken products and components back into own production.
- They see cradle to cradle as much as a mindset for doing business innovation as a technique for certification¹⁵ - this especially applies to the larger companies such as Phillips, Maersk Line and Desso.
- They use their cradle to cradle products as promotional flagships that can create new customer segments and strengthen a green market profile - this applies to for example Van Houtum and Gabriel.

Cradle to cradle can be a strong driver for green business model innovations as it implies a strong focus on a circular business approach where loops are sought to be closed in corporations with suppliers, distributors and customers. For the case companies this focus is most apparent in the way that products are designed to be biodegradable,

¹⁵ The Environmental Protection Encouragement Agency (EPEA) has for many case companies played an important role in applying the Cradle to Cradle®-methodology to the design of new processes, products and services:<http://epea-hamburg.org/index.php>

decomposable and reusable.

The case study shows that cradle to cradle can be a source for green business model innovation throughout a company's value chain. Cradle to cradle as a business approach is applied on the input side in the way materials are sourced and how products are designed. It can also be applied to the output side in how product materials are brought back into cycles for reuse.

The case study shows that cradle to cradle as a concept so far is most developed on the materials side, and there is still potential for further business model innovation. Most case companies have applied cradle to cradle by redesigning one or more of their product lines. The demarcated focus is a way to control investment costs and to see how suppliers and customers respond to a new product. For Van Houtum the cradle to cradle product line only constitutes 2-5 per cent of the company's total sale, but the number is growing rapidly.

The cases show that their markets have responded well, and some market segments have been willing to pay an above market price for the cradle to cradle product. In addition, it has had a significant marketing and branding value. But the case companies have experienced challenges in changing its product design and manufacturing systems, getting its materials suppliers on board, as well as marketing the benefits of buying a cradle to cradle product.

Applying cradle to cradle implies a process of finding and analysing the products that are suitable for redesign, creating products that are biodegradable, decomposable and/or waste-free, but not necessarily cheaper to source.

The environmental impact of the Danish textile company Gabriel's move towards a green business model, for example, mostly occurs in the production phase of the company's products. Effects can however also be found at the end-of-life stage of their products. In line with the cradle to cradle concept and certification, the company's Gaja products are completely compostable without any harmful environmental effects, not even from the product dyes. This is of value both for the customers and Gabriel's own production. The case study shows that the cradle to cradle mindset can be applied to a wide range of products and sectors: from household products to components for building houses and ships. Maersk Line, for example, are building 20 new container ships, known as Triple-E ships, due to a strong focus on economies of scale, energy efficiency, and environmental performance. The cradle to cradle mindset is here applied to create a passport of information to identify areas where changes in ship design, construction and/or materials can improve ship performance and material recyclability.

Some case companies have expanded their focus from the input and production side

to the use and reuse phase of their products. This creates new revenue streams when bringing product materials back into cycle as it leads to higher revenue on selling what used to be waste or surplus materials.

Take-back mechanisms

Companies working with take-back mechanisms have the following characteristics:

- They are mostly larger companies with numerous supplier and customer partnerships and with a deep insight into their own (and others') value chains.
- They have established new relations with suppliers, customers and sometimes also competitors to secure stable and cost-efficient take-back mechanisms.
- They have all seen new revenue streams, cost-cutting opportunities and risk management in taking their (or others') products and packaging back into own production. The main driver for working with take-back mechanisms is sector specific, but a common denominator is that waste is seen as a resource.
- They distribute waste and surplus materials to their own or other companies' production. This creates an incentive to design products and packaging to be recyclable and decomposable. It also creates an incentive to retain product ownership, because one or more parts of the products become valuable, for example in terms of lowering production costs.

The best-known take-back mechanisms are the ones for bottles, batteries and electronics, often orchestrated by national recycling systems or through retailers.

Take-back management in this study focuses on the products that are not part of such a waste management system, but which are orchestrated by the manufacturer or partnership companies. The study shows examples of how financial, environmental and innovative benefits can be created by take-back mechanisms. It also shows that take-back mechanisms can be complex to create and facilitate.

It takes a streamlined value chain to set up the right incentives for customers, end-users and partners to gain support for the process of distributing products back to manufactures. But by accepting surplus materials, manufacturers can acquire low-cost feedstock for new manufacture or remanufacture, and offer a value-added service to buyers.

Van Gansewinkel is a Dutch waste management company that has developed a new and unique assessment of their revenue streams through take-back mechanisms. Van Gansewinkel's key activities are to provide services for managing their own and their

partners' production cycles. Van Gansewinkel combines the logistics of transforming waste products into raw materials with take-back mechanisms; thereby designing and managing the coordination of closed-loop production cycles.

The complexity of integrating take-back mechanisms challenges the management of waste streams and there are indications of market failures, in particular for plastics¹⁶. But the case study shows that there are significant financial and environmental benefits connected to take-back mechanisms – especially in combination with a product service system where companies, through cooperation or partnerships, have created new mutually beneficial revenue streams.

The growing global demand for scarce materials has emphasised the benefits of setting up more take-back mechanisms. Many high-tech products for example contain metals that are indispensable ingredients for the production development of technologically sophisticated products. Transforming the raw material scarcity into benefits for the company is one of the main drivers for transforming the waste collection into take-back systems.

The mindset behind take-back mechanisms has similarities to the mindset of cradle to cradle. One of the case companies has combined the mindsets. Desso, a manufacturer and supplier of a wide range of carpets, carpet tiles and artificial grass, offers to take back the customers' old carpets – even if produced by competitors. The Desso Take Back™ secures recycling and recoveries of raw materials from the used carpets, which can then be used to make new carpets and strengthen product innovation.

Industrial symbiosis

Case companies working in industrial symbiosis have the following characteristics:

- They are larger companies based and most often physically located close to each other to keep transport costs low and synergies high.
- They have created interlocking systems by cycling surplus and waste materials from agricultural production, heat production, waste management and manufacturers.
- They see waste and surplus materials as key resources and cornerstones of the industrial symbiosis – for example centred on a substituting fossil-based fuels and materials for waste and biomass.
- They have often based the industrial symbiosis on existing partnerships between

¹⁶ See report from the European Commission Enterprise and Industry: http://ec.europa.eu/enterprise/policies/innovation/files/swd_tmi_midterm_progress.pdf

suppliers and customers under a more formalised framework which could increase competitiveness and environmental performance. The exception is a case company that uses a web platform to create and facilitate partnerships.

The case study shows that it takes strong relations to establish efficient industrial collaborations. A few strong industrial actors have taken the initiative to formalise it into a symbiosis. This formalisation creates stability and strong interconnection and a basis for long-term investments in streamlining resource streams and minimising distribution and production costs.

An industrial symbiosis can consist of both public and private actors. In the Nordic region, where one of the case companies is based, the public plays an important role in the symbiosis. It can for example also be seen in the industrial symbiosis in Kalundborg that is transforming waste to heat production as a key activity.

In Händelö, close to the city of Norrköping in Sweden, E.ON is a part of a symbiosis that facilitates the industry's and the municipality's use of each other's by-products, by taking advantage of the synergy effects between energy companies and the process industry. The symbiosis creates an interlocking system of cycling of materials that has changed the process of heat production by increasingly basing it on waste, biomass burning and steam.

The cases show that an industrial symbiosis accelerates business opportunities and supply chains for companies that need or have resources that fit into the loops that have been created between the industrial actors. An industrial symbiosis is in this sense based on closing loops between suppliers and customers.

In the Rantasalmi eco-industrial park companies have enhanced and expanded existing partnerships under a more formalised framework and also collaborate on exchanging labour and sharing equipment, logistics and storage when needed. For Rantasalmi, a manufacturer of log houses, some of its main suppliers e.g. of windows, doors, staircases, blades and transport services, are also members of the eco-park.

Not all industrial symbioses are local. Some are based on Internet platforms. This is not an industrial symbiosis in the traditional sense. It is more a service provider for linking up companies that can benefit from exchanging resources and materials. The service provider makes a transparent marketplace for companies to buy and sell waste and surplus materials. This can create the foundation for new partnerships and locally based industrial symbiosis.

The Eastex Material Exchange, as an example, provides a web-based platform, where companies can find or search for other companies' surplus materials (or register their

own surplus materials), which can then lead to reduced raw material expenditures, avoided waste and an overall better environmental performance. The platform also gives detailed real-time statistical and graphical insights into waste saved by all member transactions.

Functional sales

Case companies working with functional sales have the following characteristics:

- They are both small and large companies that have seen competitive advantages and new revenue streams in selling the functionality of their product or adding services to it.
- They have applied functional sales to different sectors; customising the business approach to market and customer demands. This has created sub-labels of functional sales that range from car leasing and retailing to energy-saving constructions and chemical management systems¹⁷.
- They have changed the cost structures and risk schemes for their customers, due to lower investment costs, lower operational risks and higher customisation options. This has often created new and closer customer relations through product service systems.
- They have reduced energy consumption, resource use or waste by retaining product or packaging ownership, thus creating financial and environmental benefits for both supplier and customer. This means that the products or packaging by some case companies are taken back into new own production.

The case study confirms that product service systems come in various sizes and shapes¹⁸. Common is that these companies build on new tendencies in their markets, where customers ask for convenience and lower investment costs or lower operational risks.

Functional sales are based on customers' willingness to pay for the selling companies to take these risks. The companies are paid for the functionality or performance of the products, the services connected to the products or for example in leasing rates that often include services.

The case companies that are newly started have centred their entire green business model on the innovation of leasing products or packaging to customers. They have spotted new trends in existing markets by offering products that are more customised

¹⁷ Energy saving companies (ESCOs), chemical management services (CMS), design, build, finance and operate (DBFO) and sharing are examples of green business model innovations related to functional sales.

¹⁸ See green paper "Green Business Models in the Nordic Region" by the Nordic Council of Ministers (FORA, 2010)

in both use and in the reuse phase. Not all of these have left a traditional product sale system, but they have combined it with leasing and service models.

Eco2Distrib, as an example, is a French manufacturer of dispensing machines for retailers to sell fluid consumer products, such as soap, detergents, beverages and paints, without the use of individual product packaging. The machines dispense intelligently and without any kind of internal or external spills when filling up the end-user's container. In-store tests show that sales of the manufacturers' brands have expanded considerably. The larger and more established companies have started to offer services as add-ons to their existing products. This secures a foundation for continual upgrades and adaptations of the products, and extends the customer relationship from the sales phase to the use and reuse phase; thereby creating stronger bonds and better insights into the customers' changing needs and creating incentive for more customer-driven innovation of products and services.

Philips Lighting, for example, provides complete lighting installations by producing, installing, maintaining, monitoring and paying for usage, take-back and to the extent possible reuse or regenerate materials from the lighting system. In return the customer pays a service charge over the entire period agreed upon. This changes their customer relations from commodity sales relations to a trusted service partner through a product service system (PSS).

Siemens Building Technologies is another good example of functional sale and is often referred to as an energy saving company (ESCO). They perform contracting services to provide customers with low-risk and self-financed energy saving solutions for large buildings and ships. The energy savings lead both to less money spent on energy consumption and lower CO₂ emissions.

The case study shows that it can be a complex process to have functional sales and to build up a product service system, as revenue streams do not only stem from product sales, and because it requires new customer relations and a customer understanding that there are environmental and financial benefits connected to paying for the function or process instead of a product.

SafeChem is a successful example of a chemical management system (CMS) where customers buy tailored and sustainable solutions based on chlorinated and non-chlorinated solvents. SafeChem manages the product-specific risks of chlorinated solvents to optimise the cleaning process as well as the solvent consumption. The basis is a closed-loop concept: the SAFE-TAINER™ system is a double-walled safety steel container system for the easy and safe handling of fresh solvents and the take-back of used solvents for recycling. SafeChem is continuously developing innovative concepts such as chemical leasing, where customers can lease the complete cleaning process

for a fixed monthly leasing fee. A close cooperation with the customer allows efficient monitoring and optimising of the entire cleaning process at customers' sites.

Part 4: Literature Review of Effects of Green Business Model Innovation

Green Business Model Innovation (GBMI) is still in its beginning as a concept used in the business community and the companies we interviewed. It is a strategy where the benefits often are seen in the long run, since changes are made in several areas and take time to implement throughout a company and its value chain. The question asked is whether these changes in companies' business models actually lead them to become more sustainable and green - and whether it is worth the effort for other companies to follow suit.

It is often a challenge for a company to try to assess the specific environmental and economic benefits of the green business model innovation. The changes in the business model might only be implemented in a small part of the company making it difficult to measure the results of small and isolated processes or products, or the changes might be implemented in processes throughout the entire company, making it difficult to measure the effects as isolated results. It was therefore considered relevant to also take a look at other studies around the world describing companies that specifically assessed their environmental or financial benefits after adopting a form of GBMI. A desk research was performed including information at company level, but also at industry and aggregate levels.

The literature review is structured according to the five types of GBMI and includes information on both economic and environmental benefits.

Green Supply Chain Management

Economic benefits

Most companies operating in local and global markets are both suppliers and customers. As globalisation increases supply chain complexity, it also increases social awareness

and expectations on companies to take responsibility for what they buy, sell and produce and how they go about it.¹⁹

Greening supply chains aims to balance marketing performance with environmental issues. To meet with challenges such as energy conservation and pollution abatement, enterprises have tried to green their supply chains, that is, to create networks of suppliers to purchase environmentally superior products or to build common approaches to waste reduction and operational efficiencies.²⁰

Texas Instruments has a long-standing presence in many of the world's major markets and has the best geographic coverage in the semiconductor industry. With manufacturing sites, sales and support offices located in Europe, Asia, Japan and the Americas, the company can provide products and services to customers wherever they do business. Texas Instruments saves \$8 million each year (20% annual savings) by reducing its transit packaging budget for its semiconductor business through source reduction, recycling and use of reusable packaging systems.²¹ Similarly, Dell saves over \$20 million annually as a result of supply chain packaging improvements. In fact, this market leader achieved its goal of becoming carbon neutral by 2008.²²

From its humble beginnings over a century ago, Pepsi-Cola has grown to become one of the best-known, most-loved consumer products provider throughout the world. The company saved \$44 million by switching from corrugated to reusable plastic shipping containers for one litre and 20-ounce bottles, conserving 196 million pounds²³ of corrugated material.²⁴

Adidas-Salomon Canada had as a goal to transform an organisation that was fragmented into one that is integrated. This meant integrating consumers and retailers with Canadian distribution and Asian manufacturing operations. They integrated three merged companies and eight major brands. The bottom line for Adidas-Salomon Canada was an almost instant 400% ROI and a long term ROI which is growing constantly.²⁵

The study 'Retail Chains and Consumer Product Goods - A Canadian Perspective', aimed at providing unique insights to help Canadian retail and consumer products supply chain executives understand the current trends and to recognize the benefits of adopting Green Supply Chain Management in distribution activities. The study reveals

¹⁹ Nordic Partnership, 2004

²⁰ Zhu & Cote, 2004

²¹ LMI, 2005

²² Cognizant, 2008

²³ The numeric values are displayed as in the original source (1 pound <lbs> = 0.453 kg)

²⁴ LMI, 2005

²⁵ MSE, 2005

that over 80% of the best consumer product goods logistics and transportation service providers have gained significantly in terms of improved distribution efficiency, reduced distribution costs, and increased service differentiation. Also, over 40% of them have experienced 20-50% improvements in compliance processes and customer retention.²⁶

Environmental benefits

Eclipse Berry Farms is a leading grower of berries and grape tomatoes in the US. Based on third-party lifecycle inventory analysis findings, the company has reduced solid waste generation by more than 33,000 pounds annually, decreasing greenhouse gas emissions by about 25,000 pounds, and saving enough energy to power 20 homes with electricity through using CHEP pallets (global leader in pallet and container pooling). Shippers using CHEP's pallet pooling system in lieu of limited-use white wood pallets are achieving measurable gains reducing their environmental footprint.²⁷

Starting in 2008, Burton, the world's leading snowboard producer turned to GXSManged Services to automate its B2B transactions. Automated supply chain transactions with trading partners can have significant cost benefits, but it also can directly minimize the company's environmental impact. Burton made a significant dent in reducing its paper usage for electronic transactions. In doing so, 4 tons of wood was saved, 30 million BTU²⁸, 5882 pounds CO₂, 22.219 gallons²⁹ wastewater, 1,909 pounds solid waste (July 2008- June 2009)³⁰.

In 2010 the San Pedro Bay Port Air Action Plan was updated, building upon the success of the original, which since being enacted in 2006, has initiated a range of air pollution reducing measures for the ships, trains, trucks, and other heavy machinery used to move approximately \$300 billion worth of freight throughout the port complex every year. The air emissions related to port-facilitated goods movement have declined 33% to 56% since 2005.³¹

For the third year in a row, the rail carrier BNSF provided its intermodal, automotive, industrial products and agricultural products customers with customised letters analysing their total carbon footprint and savings compared to movements of those shipments via the highway. In 2010, BNSF customers reduced emissions by more than 23 million tons of CO₂ through using the company's services, which is equivalent to reducing the consumption and resultant emissions of more than two billion gallons of diesel fuel.³²

²⁶ SC&L Association Canada, 2008

²⁷ Inbound Logistics, 2011

²⁸ British Thermal Unit

²⁹ 1gallon = 3.785 liters

³⁰ http://www.greensupplychain.com/burton-riding_the_green_supply_chain_wave.html

³¹ Inbound Logistics, 2011

³² Inbound Logistics, 2011

Take Back Management

Economic benefits

Take-back programs give manufacturers the physical responsibility for products and/or packaging at the end of their useful lives. By accepting used products, manufacturers can acquire low-cost feedstock for new manufacture or remanufacture, and offer a value-added service to the buyer.

Milliken's Earth Square program, formerly called Earthwise Innovations, or E2, allows modular carpet commercial applications to be cleaned, re-textured, re-patterned, and sent back into use. After the carpet has been refurbished, Milliken will return it to the same customer or resell it to someone else if the original customer does not want it back. Milliken stresses that its carpet is "renewed," and that it thus recaptures higher value than recycled products. In addition to keeping discarded carpet out of the landfill, the program claims to make refurbished carpet available at about half the price of new³³.

The carpet industry concentrated in Georgia is a \$10 billion industry in the U.S. Over 3 million tons of carpets are produced every year and about 2 million tons are discarded. Carpets account for about 1% of municipal solid waste by weight and 2% by volume. Given the thousands of products in the waste stream, this is not a small amount. Many players in the U.S. carpet industry are actively competing to develop take-back and recycling programs. Such programs are being implemented by the large nylon producers like Honeywell (formerly Allied Signal), DuPont, and BASF, as well as by the companies that make and distribute carpet, such as Collins & Aikman, Milliken, Shaw, and Interface. Most of these programs are not currently profitable, although some may become so in the future.³⁴

In November 1999, Evergreen Nylon Recycling LLC opened a large recycling facility for nylon 6 in Augusta, Georgia. The nylon 6 made from recycled materials can be recycled indefinitely and will be marketed under the Infinity trademark. Honeywell produces two-thirds of the caprolactam it needs and buys the rest from chemical companies. Caprolactam made from reprocessed nylon 6 carpet is cheaper than the caprolactam bought on the open market. Honeywell and DSM have invested \$85 million in the project and claim that recycling 200 million pounds of nylon 6 per year will reduce oil use by 700,000 barrels³⁵.

Environmental Benefits

LG Electronics encourages the use of recycled materials in order to reduce the amount

³³ <http://www.informinc.org/carpettakeback.php>

³⁴ <http://www.informinc.org/carpettakeback.php>

³⁵ <http://www.informinc.org/carpettakeback.php>

of waste generated during manufacturing or at the end of the products' useful life, and to minimize the amount of virgin resources being used. Teaming up with Waste Management³⁶, LG built a recycling program that makes it easy to dispose of electronics in an environmentally safe way. The customers can bring the unwanted LG products to any participating Waste Management eCycling drop-off centre and recycle it for free.³⁷ Between January and December 2011 the total take-back amount reported by LG was 11,690,483 lbs³⁸.

In the early 1990s, Xerox pioneered the practice of converting end-of-life electronic equipment into products and parts that contain reused parts. The company developed a comprehensive process for taking back products and established a remanufacture parts reuse and recycling program that fully support their waste-free initiative. A Xerox product which design is based on previous models may have 60% of its parts by weight in common with previous equipment. The practice of reusing parts reduces the amount of raw material needed to manufacture new parts³⁹. Equipment remanufacture and the reuse and recycling of parts prevent million of pounds of waste from entering landfills each year - 106 million pounds (48,000 metric tons) in 2008 alone⁴⁰.

The Sony National Take Back Recycling program makes it easy for its customers to recycle. Since the inception of the program in 2007, Sony has collected over 34.1 million pounds of unwanted electronics. The amounts according to years are:

2007: 2,056,575 lbs

2008: 12,662,987 lbs

2009: 10,862,646 lbs

2010: 8,584,458 lbs⁴¹

Samsung Electronics has also established take-back systems to comply with the requirements of recycling laws where they exist. The company works closely with governments and industry associations to develop more effective take-back systems and meet its obligations. Recycling rates for 2010 in Korea:

TVs - 42% (based on an average life-span of 10 years, 2000)

Computers - 16% (based on an average life-span of 7 years, 2003)

³⁶ <http://www.wm.com/index.jsp>

³⁷ <http://www.lg.com/global/sustainability/environment/take-back-recycling.jsp>

³⁸ <http://www.lgrecyclingprogram.com/commitment.html>

³⁹ <http://www.xerox.com/corporate-citizenship-2009/xerox-report/waste-prevention.html>

⁴⁰ <http://www.xerox.com/corporate-citizenship-2009/xerox-report/waste-prevention.html>

⁴¹ <http://green.sel.sony.com/pages/recycle-3.html>

Mobile phones - 27% (based on an average life-span of 2 years, 2008)⁴²

Regarding the environmental benefits of the Honeywell case previously mentioned, the company managed to reduce the energy use by 4.4 trillion BTUs through nylon recycling and greenhouse gas emissions by 67% per year⁴³.

Cradle to Cradle

Economic Benefits

The company Ahrend organises its business operations according to the C2C philosophy, and its principles fit well with the company's ambition to be the most sustainable company in the sector of office furnishing in Europe. Three product lines received the silver C2C certification in 2010. More than one third of turnover being from its C2C certified products. This makes Ahrend one of the absolute top C2C companies in the Netherlands.⁴⁴

The company DESSO was taken over by NPM Capital in 2007. The new management wanted to change the course of the company to fight off the competition and to shed its old-fashioned image. It was hoped that by embracing the Cradle to Cradle philosophy DESSO would differentiate itself in the market in terms of both sustainability and design. DESSO's turnover remained the same even though the European market shrank by 35% and the Dutch market by 12%.⁴⁵

If the focus is to shed light on the effects at overall industry level, a good example is a case derived from an earlier selective deconstruction project in Germany. The purpose of the case study is to illustrate that selective deconstruction, following a cradle-to-cradle concept for disposal of buildings, offers a more profitable route than demolition. The comparison of each cost category is shown in Table 1 based on prices from 1993. It can be clearly recognised that high profitability can be achieved by selective deconstruction. In direct comparison the use of selective deconstruction is about 27% cheaper in 1993 and about 33% in 2002 than demolition.⁴⁶

⁴² <http://www.samsung.com/us/aboutsamsung/sustainability/environment/takebackrecycling/recyclingperformance.html>

⁴³ <http://www.informinc.org/carpettakeback.php>

⁴⁴ The terrace, 2011

⁴⁵ The terrace, 2011

⁴⁶ Simon et al, 2007

Table 6. Costs of demolition and selective deconstruction

Costs	1993			2002		
	Demolition	Selective deconstruction	Difference	Demolition	Selective deconstruction	Difference
Labour & plants	€ 26,633	€ 32,404	22%	€ 28,744	€ 30,721	7%
Disposable charges	€ 45,743	€ 10,582	-77%	€ 48,817	€ 8,706	-82%
Transport	€ 6,976	€ 15,178	118%	€ 8,371	€ 18,214	118%
Total	€ 79,352	€ 58,164	-27%	€ 85,932	€ 57,641	-33%

Source: Simon et al, 2007

Environmental Benefits

Haworth Inc. launched the Very family of seating, designed by Simon Desanta, in collaboration with Haworth Design Studio. The design engineers at both companies used sustainable materials and environmentally conscious design practices throughout the Cradle to Cradle programme. The highly sustainable chair is made of up to 71% recycled material, it is 98% recyclable and can be disassembled for recycling in less than 5 minutes. As a result, Very family of products has been recognised with a number of awards.⁴⁷

The Timberland Company has presented its Earthkeepers 2.0 boot. The boot is designed to be disassembled and recycled, rather than discarded. Boots may be returned to any Timberland store for recycling at the end of their life cycle, becoming technical nutrients for the production cycle of new shoes. Timberland says 80% of the Earthkeepers 2.0 boot can be recycled or re-used.⁴⁸

The Flemish Public Waste Agency promotes subsidised home composting systems such as wormeries, composting bins and tubs. At the container parks the principle of 'pay-as-you throw' is used through weighing balances. They compost about 30 m/Kg of green waste into compost. The company uses membranes and active aeration, to achieve a better quality and reduce the risk of odour. Compost is a very good soil improver and is sold to residents, companies and communities. There are 16 civic amenity sites, so that inhabitants only have to travel a maximum 3 km to reach the nearest collection point.⁴⁹

⁴⁷ Vezzoli et al, 2011

⁴⁸ Vezzoli et al., 2011

⁴⁹ Sips & Knoppers, 2011

Industrial Symbiosis

Economic Benefits

Some of the world's best known examples of Industrial Symbiosis partnerships are located in the Kwinana Eco-Industrial Park in Australia. The Kwinana 116 MWh combined heat and power plant was built in 1997 on BP Kwinana oil refinery's property. It meets all of the steam requirements for the refinery, and generates electricity for the BP refinery, as well as the grid from excess refinery gas, supplemented with natural gas. The combined heat and power plant discharges its wastewater to BP's wastewater treatment facility. The partnership with the Kwinana combined heat and power plant (CHP) saved BP refinery \$15,000,000 in capital expenditure whilst ensuring a reliable, cost competitive source of steam and electricity. In addition, the refinery had achieved greater process efficiencies as a result of increased availability of high pressure steam.⁵⁰

The National Industrial Symbiosis Programme in the UK facilitates symbiotic exchanges among companies belonging to different industries across the country. Total savings for the members go up to £860 million while the programme safeguarded or created 8770 jobs, boosted the UK economy by £1.5 billion and brought a total economic value of £900 million in new sales for its members⁵¹.

Sonae Industria (UK) Limited's Wet Electrostatic Precipitator (WESP) abatement process results in 2,000 tonnes per year of a waste product known as 'WESP crumb'. The material was previously sent to landfill, but since this option conflicted with Sonae Industria (UK) Limited's sustainability policy, the company was looking for a more environmentally friendly means of disposal. Avanti Environmental Group Ltd was able to collect and dispose of the material for use as a fuel in a renewable energy plant. This not only provided a more sustainable option but also generated significant cost savings for Sonae Industria (UK) Limited. An annual cost saving of £70,000 is anticipated.⁵²

Although it is difficult to get a precise picture, an early estimate of the Kalundborg Industrial Symbiosis exchanges showed that the total investments of all projects amounted to a total of \$75 million, the annual savings exceeded \$15 million and the total accumulated savings (until 1998) were likely to total \$160 million. Today the figures will be much higher.⁵³

Environmental benefits

Kwinana Industrial Area is the largest industrial site in Western Australia consisting of

⁵⁰ Harris, 2007

⁵¹ <http://www.nisp.org.uk/default.aspx>

⁵² NISP, 2011

⁵³ Christensen, 2007

approximately 120 km² and responsible for \$4.3 billion of annual economic output. The site has two combined heat and power plants which contribute to CO₂ savings in the region of 170,000 tonnes per annum in comparison to steam supplied by BP refinery and electricity supply from the grid.⁵⁴

Another concrete example is the HiSmelt plant, which is the first commercial scale application of the direct smelting technology, which allows for simpler, more flexible iron production. This technology allows emission reduction of 20% for CO₂, 40% for NO_x and 90% for Sox. The plant is able to source a number of by-products locally in the Kwinana area, such as lime, lime kiln dust and treated wastewater.⁵⁵

The exchange of material by-products that cannot be transported by pipeline or cable may entail GHG emissions. However it has been shown that the overall industrial symbiosis exchanges can in fact make substantial transportation savings and therefore GHG emissions. By substituting their original virgin materials source (which might be at a distance up to 240 km) with a compatible by-product from a company no further than 5 km away, the overall CO₂ reductions of the companies are approximately 290 tonnes of CO₂ per annum.⁵⁶

As the most mature and dynamic industrial symbiosis in the world, the Kalundborg system contributes every year to lower environmental impacts through interchanges. The quantities that have been avoided to enter in the environment are:

- 200,00 tons fly ash and clinker;
- 80,000 tons scrubber sludge;
- 2,800 tons sulfur as hydrogen sulfide in flue gas;
- 1 million cubic meters of water treatment sludge;
- 1,500-2,500 tons of sulfur dioxide avoided by substituting coal and oil;
- 130,000 tons CO₂ avoided by substituting coal and oil.⁵⁷

To give an example of symbiotic exchange, the case of Asnaes can be mentioned. The power plant saves 30,000 tons of coal by using Statoil fuel gas.⁵⁸

Besides the up-mentioned economic benefits of the National Industrial Symbiosis Programme in the UK, this example has plenty of environmental-related outcomes as well:

⁵⁴ Harris, 2007

⁵⁵ Harris, 2007

⁵⁶ Harris, 2007

⁵⁷ Ehrenfeld & Gertler, 2007

⁵⁸ Harris, 2007

- Reductions in CO2 emissions of 35 million tons;
- Diverted 39 million ton of industrial waste from landfill;
- Reductions of 2 million tons of hazardous waste;
- Saved 53 million tons of virgin materials;
- Saved 64 million tons of industrial water.

In the background of National Industrial Symbiosis Programme, Sonae Industria Limited is part of a synergy which resulted in the diversion of 2000 tons of material from landfill, with 555 tons of associated CO2 emissions reduction.⁵⁹

Functional Sales

Functional Sales is used as a generic name for the overall innovation that transforms a company's business model from selling a physical product to retaining the ownership of the product and selling its function as a service. Because this kind of business model permits a high degree of customisation, many industries have created their own models: Design-Build-Finance-Operate for the construction industry, Chemical Management Systems for the chemicals industry, Energy Saving Companies for the insulation/installations industry, sharing/leasing models for the car and machines industries and so on. Because of the high number of the models, only one will be analysed here, and that is the Chemical Management Systems.

Economic Benefits

If managers look only at the chemical purchasing costs, the total will sum up to approximately 7% of all the costs associated with chemical usage in a company. The other 93% are related to internal handling costs, inventory, delivery, collection & disposal, monitor/report/permits and liability costs.⁶⁰

The measurement of effects at company level revealed examples of economic benefits gained through CMS implementation. One Swedish plant has been used as a pilot within Volvo to test and evaluate the CMS (fluid management system) models. Volvo's experience with standardisation of lubricants and process fluids show monetary savings of 10-30% in chemical costs. In addition, savings in chemical assessment and risk management are essential.⁶¹

Haas Corporation seized an opportunity to provide chemical management services

⁵⁹ NISP, 2011

⁶⁰ Stoughton, 2003

⁶¹ Kurde, 2010

to General Motors, Ford and other major companies in the automotive and aerospace sectors. On the one hand, an analysis of the Oshawa General Motors plant has revealed 30% reduction of overall costs through 54% reduction in quantity of purge solvent, 77% quantity of paint tripper and 80% reduction in quantity of solvent masking. On the other hand, Ford - DuPont Central Processing Unit has registered 35-40% reduction of chemical quantity used in the final steps of its production processes. Similarly Chrysler's Neon assembly plant reached more than \$50,000/year from reduction of wastewater sludge generation.⁶²

Chemical Strategies Partnership worked with a Nortel semiconductor facility near Ottawa, Canada to initiate a CMS program. The program gave Nortel the opportunity to save 50% of the quantity of annual chemical consumption, \$120,000/year from chemical substitution and \$24,000/year from hazardous waste handling cost reduction.⁶³

Zooming out from the firm level characteristics, the Chemical Management Services Industry Report offers a very good overview of the aggregate economical benefits. In 2009 survey questionnaires were sent to CMS Forum members and non-members alike, with the purpose of characterising CMS as an industry. On the providers side, the study revealed mean estimates for earnings before interest and taxes of approximately 12%/year from 2006 to 2008. The 2009 market revenue of the CMS industry was estimated at \$1.3 -1.6 billion globally, with \$900-\$1 billion only in the U.S. market. On the other side, the CMS customers reported 37% savings from management cost reductions, 18% savings from chemical volume reduction and 16% savings from manufacturing process improvement.⁶⁴

In a similar study conducted by the United States European Protection Agency, 50% of the CMS customers reported reductions in total chemicals being applied and over 30% of them reported increases in process efficiencies.⁶⁵

Environmental Benefits

The environmental benefits of the Chemical Management Systems are also a very strong incentive for adopting this model. Among the companies that evaluated their environmental gains after switching to CMS are General Motors (Oshawa) and Ford-DuPont, whose volatile organic compounds emissions decreased with 75% and 50% respectively. Reduction in waste generation has been reported as the biggest environmental gain among the majority of the companies. For example Nortel is producing 8% less hazardous waste, Raytheon Systems reported 250% reduction in

⁶² Mont et al, 2006

⁶³ Mont et al, 2006

⁶⁴ ChemQuest Group, 2009

⁶⁵ US EPA, 2011

scrap rates and 71% reduction in paint waste, and Navister engine plant noticed a 90% reduction of coolant waste. Reductions of 25% in sludge generation were been reported by Chrysler at its Neon assembly plant.⁶⁶

At the European Union level, the screening LCA for car body painting in the car industry indicates that the reduction on environmental impact categories varies from 15 to 25 %.⁶⁷ Related to this industry, the highest reduction of environmental impact is for photochemical oxidation ('summer smog'), more than 25% due to the reduction of emitted solvents. The reduction for other environmental effects is about 15% due to less emitted solvents and waste generated through paint application.⁶⁸

⁶⁶ Mont et al, 2006

⁶⁷ EC, 2006

⁶⁸ EC, 2006

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Part 5: Survey

Green business model innovation (GBMI) is a new way of doing business and refers to non-technological 'green' innovation. This impact assessment study is the first of its kind and aims to establish more fact-based information about financial, environmental and innovation benefits of GBMI.

From December 2011 to March 2012 a questionnaire was sent to 441 companies in the Nordic Region, Europe, North America and Asia. The questionnaire was also sent to The European Network of Environmental Professionals (ENEP) and international and Nordic organisations (the Chemical Strategies Partnership, ESCO Network under the Confederation of Danish Industry and Innovation Norway among others) who distributed the questionnaire to their members.

Of the 441 companies 112 companies declined the invitation to participate, and 275 companies never replied to the invitation although they were contacted by phone or email. 54 companies completed the questionnaire.

On behalf of the Nordic Council of Ministers, Nordic Innovation and the Danish Business Authority we would like to thank all the 54 companies that participated in the study for the efforts in prioritising and completing the questionnaire.

Many of the companies that declined the invitations to participate added a short explanation. Most often they did not have time to participate due to urgent projects and important tasks. Others stated that for confidentiality reasons, they cannot share the kind of information asked for in the questionnaire. This often concerned financial data, although they were assured that all individual answers and information received would remain anonymous and confidential. Others declined because they do not see themselves as having a green business model.

Methodology

The data for the impact assessment were collected via a questionnaire sent to companies

that are identified by experts and studies to have a green business model.

The companies were asked to state the focus of their business model innovation (and its level) and to estimate the financial, environmental and innovative impacts relative to their industry in equivalent years. The companies were asked to focus all their answers on that part of the company (i.e. subsidiary company or business unit) that is using a green business model. The years in focus relates to the implementation of their GBMI.⁶⁹

Two main analyses were conducted: an analysis of levels and an analysis of developments.

Analysis of levels

An analysis of levels compares green business model innovation with levels of the companies' financial, environmental and innovative impacts in equivalent years. The purpose was to uncover whether the companies that use a given green business model innovation to a large extent are also the companies that perform well in financial, environmental and innovative terms.

Analysis of developments

The companies in the impact assessment vary on several parameters, such as company size, age and sector. This creates ambiguity in the analysis. The analysis of levels is therefore supplemented by an analysis of developments between years. The purpose of the analysis of developments compares was to uncover how the development in the companies' green business model innovation associates with the development in their financial, environmental and innovative impacts between equivalent years. Thus the parameter of interest is the correlation between the development in each of the independent variables (the five types of GBMIs) and the development in each of the dependent variables (the financial, environmental and innovative impact indicators).

Independent variables

The business model innovations form the independent variables in the analysis. It is expected that the independent variables consist of the following indicators. The indicators focus on the degree to which the company:⁷⁰

- has an environmental focus in the supply chain
- has an environmental focus through partnerships with their suppliers

⁶⁹ The years in focus are t-1, t+3 and the year for the newest accounting numbers (2010), where t=time of introduction of their green business model innovation. Newly started companies were only asked for their financial performance in 2010 (or expected financial performance in 2011). Companies which did not exist before they implemented their green business model innovation were asked for t=0 instead of t=-1.

⁷⁰ On a scale from 7 ("to a very high degree") to 1 ("to a very low degree")

- has take-back mechanisms for used products
- reduces material use in products/services
- designs recyclable products/services
- designs waste-free products/services
- is part of an industrial symbiosis
- maintains product ownership (by selling the product as a service)
- is paid by the output of their products/services.

The indicators made it possible to search for joint variations in response to latent variables. It was done to see which indicators are so closely related that they can be labelled as one of the five theoretically founded types of green business model innovation. It would also show whether the five types of green business model innovation can be found in the way that companies operate and innovate their green business model.

The indicators also made it possible to see how the companies have focused their business model innovation. Some companies have focused on one of the five types of green business model innovation. Others have not. It creates variations that enable an analysis where the companies can be compared⁷¹. Differences in impacts are thereby measured by using the variations in how the companies have focused their business model innovation.

Dependent variables

The analysis consists of three dependent variables: financial, environmental and innovative impacts which are all described in the following.

Financial impact

The financial impact variable measures the companies' financial performance, employment and cost effectiveness.

The data to assess financial performance consist of the companies' revenue, EBIT (earnings before interest and taxes) and total assets for three different years, which made it possible to calculate a number of useful financial ratios as well as their development. When there were no observations, the database Orbis was referred to⁷².

The financial ratio of primary interest is EBIT/total assets, which provides us with a measure which indicates how much operating income the company can generate on

⁷¹ The differences in how the companies have focused their green business model innovation create the 'control groups' in the analysis. Companies that - for example - have focused on green supply chain management are in the analysis compared to the ones who have not.

⁷² Orbis has information on over 75 million companies across the world and contains validated and standardised data on companies' financials and performance.

each Euro it has invested in assets. Thus the ratio reveals a return on assets (ROA), which eliminates the effects of interest and taxes. This is desirable in this context where we wish to assess the effect on the company's operations rather than the company's financial situation or tax status.

ROA can be interpreted in much the same manner as the percentage return which private individuals earn on for instance shares, bonds or other investments. The measure is considered the ultimate measure of performance, which encompasses both the operating income generated and the investments needed to generate this income. In order to investigate whether an observed effect on ROA would be likely to stem from an effect on profitability or a reduced need for investing in assets to generate turnover, the ROA was decomposed into EBIT/revenue and revenue/total assets, which are termed EBIT-margin and asset turnover, respectively.

Thus three measure of profitability were calculated:

- $ROA = EBIT / \text{total assets}$
- $EBIT\text{-margin} = EBIT / \text{revenue}$
- $\text{Asset turnover} = \text{revenue} / \text{total assets}$.

These indicators were obtained for several time periods in order to show the level of financial performance before (t-1) and after (t+3 and 2010) the implementation of a green business model. A similar approach was used to show the development in job creation (number of new jobs created).

To obtain measures on cost effectiveness we identified four expense items which are expected to be affected by the use of the green business model innovations:

- Research and development expenses
- Production expenses
- Sales and distribution expenses
- Administrative expenses.

For most variables, including the ones described above, we requested the data for the three given years (t-1, t+3, year 2010), and calculated the development as differences between the numbers for two years. Asking for the level of the three given years (t-1, t+3, year 2010) also made it possible to make impact analyses of differences in levels between years, also investigating the correlation between measures of the extent to which companies have applied their green business models and measures of the indicator of the three types of impact.

For the expense items (as well as innovative impacts described below) companies were

asked directly about the development rather than about the levels. This allowed us to perform analyses in differences between years.

Environmental impact

The environmental impacts were measured by asking companies to estimate the environmental impact in their:

- CO₂ and other greenhouse gas emission (per produced unit)
- Energy consumption (per produced unit)
- Consumption of non-renewable materials, incl. fossil fuel (per produced unit)
- Waste for recycling (per produced unit)
- Toxic chemicals (per produced unit).

These indicators were obtained for several time periods (t-1, t+3, year 2010, where t=time of introduction of their green business model innovation) in order to show the level of environmental performance before (t-1) and after (t+3 and 2010) the implementation of a company's green business model.

Innovative impact

The innovative impact focuses on the following indicators. The companies were asked to estimate the development in innovation in their:

- Materials
- Production and processes
- Products/services
- Management systems (for dealing with environmental issues)
- Marketing
- Infrastructure (the organisational structures for selling/taking back products).

Background information

While the questionnaire primarily consisted of questions eliciting the information above, background information was also collected focusing on the names of the company's primary industry, nationality, market regions and primary competitors. Provided that the sample is large enough, these background data allow analyses to show deeper insight into the impacts of green business model innovation.

Key findings

The two key findings of the impact assessment study are:

1. The analyses show that the five theoretically founded types of green business model innovation⁷³ can be found in the way that companies operate and innovate on their green business model. The indicators that are meant to describe the same green business model innovation show high correlation with each other and low correlation with indicators meant to describe other types of green business innovation.
2. The analyses do not show that green business model innovation or any of the five types of GBMI have significant financial, environmental or innovation impacts. All five types of green business model innovation were analysed in relation to the indicators of financial, environmental and innovative impact. Only minor statistical significances were found.

For many companies green business model innovation is still at an early stage, and the potential of the developed innovation has yet to unfold for many companies. The impact assessment shows that many companies are just starting up the process of finding new profitable and greener way to do business. There is therefore some way to go before solid statistics and sound evidence of impacts can be produced.

In the following the main results of the analyses are listed and described. Reflections on the results of the impact assessment follow subsequently. To support this COWI has conducted three expert interviews based on the results.

The analysis

The impact assessment study aims to investigate the association between, on the one hand, the extent to which companies use each of the five types of green business model innovation and, on the other hand, financial, environmental and innovative impacts related to their green business model innovation.

⁷³ Green supply chain management (GSCM), cradle to cradle (C2C), take-back mechanisms (TBM), functional sales (FS) and industrial symbiosis (IS).

Green business model innovation

A factor analysis⁷⁴ shows that the five (theoretically founded) types of green business model innovations can be found in the way that companies operate and innovate on their green business model. The indicators that were expected to describe the same model showed high correlation with each other and low correlation with indicators meant to describe other types of green business model innovation.

The factor analyses show that:

- Companies working with green supply chain management (GSCM) have an environmental focus in the supply chain, and they have an environmental focus through partnerships with their suppliers.
- Companies working with cradle to cradle (C2C) reduce material use in their products/services, and they design recyclable products/services and waste-free products/services.
- Companies working with functional sales (FS) maintain product ownership (by selling the product as a service) and are paid by the output of their products/services.
- The two remaining indicators are each expected to be a business model innovation on their own, and analysis partly confirms that they statistically differ from the indicators listed above⁷⁵. The two indicators are:
 - » Companies that have a take-back mechanism for their used products
 - » Companies that are part of an industrial symbiosis.

Further factor analyses confirm the results and link take-back mechanisms even more closely to cradle to cradle. This supports a circular business approach that is often closely related to the cradle to cradle mindset. This link is also confirmed in a case study that was conducted parallel to the impact assessment. In the following analysis, however, take-back mechanisms are kept as an independent business model innovation to test for significant differences in the impacts.

It is also worth noting that being part of industrial symbiosis (IS) seems to be linked to the two indicators of functional sale (FS). Such a link is difficult to explain in theory,

⁷⁴ Factor analysis searches for such joint variations in response to unobserved latent variables. The information gained about the interdependencies between observed indicators is used to reduce the set of indicators in a dataset to latent variables (the business model innovation). The factor analysis uses Cronbach's Alpha and shows that the indicators group within an acceptable range for consistence. The sample size of the factor analyses is 45 case companies.

⁷⁵ Meaning that the factor analysis does not show interdependencies 1) between the two indicators or 2) between the two indicators and the other observed indicators.

and the case study shows no link between being a part of an industrial symbiosis and working with functional sales. Industrial symbiosis is therefore used as an independent green business model innovation in the following analysis.

Impacts

The tables in the following illustrate the most important results. Numerous analyses have been conducted in search for significant correlations and tendencies. Far from all tests are therefore presented. The focus is on the main results and on the few significant correlations that have been found in the data.

The tables show whether there are correlations between a green business model innovation and the impact indicators. The correlations are significant if the numbers are marked with one, two or three * (asterisks). If there is no statistically significant result, there are no asterisks listed in the table⁷⁶. Correlations vary between -1 (a perfect negative correlation) and 1 (a perfect positive correlation).

Financial impact

Financial impact focuses on financial performance, employment and cost effectiveness. To gauge financial performance accounting data were collected to calculate useful financial levels as well as their development. Employment was assessed by the number of employees. Cost effectiveness was obtained by identifying research and development expenses, production expenses, sales and distribution expenses and administrative expenses.

Analyses of levels and developments in financial performance show no association between the extent to which companies use each of the five types of green business model innovation and financial performance.

The table below shows that no significant correlations can be identified between green business model innovation and financial performance. This was confirmed by other statistical tests⁷⁷. The analyses show similar results for employment and cost effectiveness; (so far) no significant correlations or strong tendencies can be identified between the green business model innovation and economic impact.

⁷⁶ A result is called "statistically significant" if it is unlikely to have occurred by chance. The analysis does not focus solely on the statistical significance but also on the patterns in the tables, though the sample (amount of companies in the analysis) is so small that the risks that such patterns will occur by chance are considerable.

⁷⁷ See under 'Methodology': Analysis of Levels and Analysis of developments

Table 7: Financial performance

	Return on assets (ROA)	EBIT-margin	Asset turnover
GSCM	0.00	0.01	0.08
TBM	0.00	0.02	-0.08
C2C	0.00	0.01	-0.15
FS	0.00	0.01	0.10
IS	-0.01	-0.06	-0.02
NOTE: Significance; * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Sample: $34 \leq n \leq 35$			
Outliers and missing observations are excluded from this simple linear regression			

Environmental impact

Environmental impact was measured by analysing how green business model innovation associates with CO₂ (and other greenhouse gas emissions), energy consumption, consumption of non-renewable materials (including fossil fuel), waste for recycling and toxic chemicals. All indicators are per produced unit.

Analyses of levels and developments in environmental impact show one significant correlation. The correlation shows that companies working with cradle to cradle use significantly fewer toxic chemicals, which is hardly a surprise, as this is most often seen as a fundamental part of the cradle to cradle mindset.

The table below shows that no other correlations are significant or contain indications of any strong tendencies. This was confirmed by numerous other analyses of levels and developments in companies' environmental performance.

Table 8. Environmental Impact

	CO ₂ and other gas emission	Energy consumption	Non-renewable materials	Waste for recycling	Toxic chemicals
GSCM	-0.10	-0.17	-0.17	-0.07	-0.17
TBM	-0.03	0.12	0.12	-0.20	0.02
C2C	-0.07	-0.16	-0.16	-0.15	-0.34 ***
FS	0.14	0.09	0.09	0.08	0.20
IS	-0.06	-0.05	-0.05	-0.37	0.23
NOTE: Significance: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$. Sample: $32 \leq n \leq 43$					
Outliers and missing observations are excluded from this simple linear regression					

Innovative impact

Innovative impact is measured by analysing how green business model innovation associates with innovation in the companies' materials, production and processes, products/services, management systems (for dealing with environmental issues),

The analyses show some significant correlations. The first relates to companies that work with take-back mechanisms (TBM) who have experienced innovation in their infrastructure (the organisational structures for selling/taking back products). Companies working with cradle to cradle (C2C) have to some degree experienced such innovation in their infrastructure.

Table 9: Innovative impact

These tendencies are confirmed in tests that sum the variable and indicators of five types of green business model innovation. The table below shows that companies working with green business model innovation (in a broad sense) are correlated to an improvement of their management systems (for dealing with environmental issues). The table also shows that companies working with green business model innovation (in a broad sense) to some degree have experienced innovation in their infrastructure (the organisational structures for selling/taking back products).

	In materials	In production and processes	In product/ services	In management systems	In marketing	In infrastructure
Sum of variables	0.01	0.02	0.01	0.11 **	-0.03	0.15 **
Sum of indicators	-0.14	0.18	0.11	0.42 **	0.21	0.29

NOTE: Significance: * $p < 0.1$; ** $p < 0.05$. Sample: $32 \leq n \leq 35$

Reflections

To conclude the impact assessment report reflections on the findings of the analysis have been made. The reflections were made by COWI and conducted through interviews with three international experts on sustainability strategies, eco-innovation and environmental innovation and performance.

The interviewed experts are Nick Johnstone, Renato Orsato and Tomoo Machiba. Their biographies follow after the reflections. In the following their main reflections on the financial, environmental and innovative impacts are highlighted, and references are made to findings from their studies and analyses.

The two main reflections are:

- Companies work with green business model innovations for reasons that are often intangible and complex to measure in an impact assessment across industries.
- Companies' financial, environmental and innovative performances are affected by various variables - not only their green business model innovations.

Intangible impacts

All three experts point out that companies are motivated to work with green business model innovations for various reasons. There is a business case for sustainability, but *it differs between sectors if companies create (measurable) impacts from their sustainable activities*.⁷⁸ The impacts of sustainable activities are therefore often intangible.

Most companies see sustainable activities as a way of gaining competitive advantages. Such competitive advantages have as an end goal to make the companies more profitable. But the direct impacts of sustainable activities often cannot be measured by their financial, environmental and innovative performance - at least not in the short run and not without looking at important intermediate variables.

Financial impacts

The correlation between sustainable activities and financial impacts is particularly hard to identify in impact assessments, and *empirical examples of a positive correlation between corporate eco-investments and profits are exceptions rather than the norm*.⁷⁹ The correlations might show in case studies, but the correlation can rarely be generalised, especially in impact assessments conducted across countries and sectors.

⁷⁸ Machiba, 2012

⁷⁹ Orsato, 2009

Green business model innovation takes time and investments to develop and sufficiently implement, but studies show that positive returns can be identified. A study on green supply chain management concludes that *the investments and the "sunk costs" largely prevail, especially for the first movers*.⁸⁰ But the experts state that such correlations are complex to find because the companies' financial performance is determined by various other variables. And *profit creation is only a part of the value creation* of green business model innovation.⁸¹

Building trust, strengthening customer relations and managing risk are strong examples of intermediate variables when assessing the financial impact of sustainable activities. *The financial result is the tip of the iceberg - what is underneath is the willingness to try new, or minimize risk*.⁸² It is what makes the direct correlation between green business model innovations and financial impact intangible and complex to measure.

Environmental impacts

The experts confirm that environmental impacts of green business model innovation are not as clear as would intuitively be expected. Nick Johnstone has looked into the motivations for and the impacts of environmental management systems and green supply chain management.

His studies confirm that building trust, strengthening customer relations and managing risk have often proven to be strong motivators for implementing environmental management systems. His studies further show that *the more a company is able to involve its business partners in the development of co-operative environmental plans, the more it is able to achieve the expected results and to improve its performance*.⁸³

These activities signal to customers and business partners that the companies have taken actions to improve their environmental performance. *Signalling is a strong motivation for the adoption and certification of environmental management systems, at least for larger facilities*,⁸⁴ but the link between environmental management systems and environmental performance is not very robust.

One reason that environmental impacts rarely show in the short run is because it often takes time to build environmental management systems that create the intended impact. This point can also be applied as an explanation as to why the impact assessment

⁸⁰ Testa, Iraldo & Johnstone, 2009

⁸¹ Machiba, 2012

⁸² Orsato, 2012

⁸³ Testa, Iraldo & Johnstone, 2009

⁸⁴ Johnstone & Labonne, 2009

does not show significant financial impacts of working with green business model innovation.

Innovative impacts

The interviewed experts state that sustainable activities are expected to improve innovation and to build innovative competences in the companies. And a preliminary analysis of business eco-innovation cases carried out by the OECD shows that *most changes [innovations] in the observed cases seem to take place in the activities component with research and development.*⁸⁵

Although not confirmed in this impact assessment, sustainable activities are in many companies perceived as a driver for innovation and as a way to *create a culture to be better.*⁸⁶ In an analysis which Nick Johnstone took part in it is concluded that *environmental performance standards induce innovation by giving firms incentives to seek out the optimal means to reduce environmental impacts.*⁸⁷

This leaves the open question why the innovative impacts do not show more clearly in this impact assessment.

Concluding remarks

The case study that was conducted parallel to this impact assessment confirms most of the experts' reflections. It provides an insight into how companies work strategically with circular and holistic business approaches, how they use waste as a resource and how they design, sell and support products to be restorative. For many case companies green business model innovation is still at an early stage, and the potential of the created innovation for some yet has to unfold. There is therefore some way to go before solid statistics and sound evidence can be produced.

The case study can be used to better understand the drivers and impacts of green business model innovation and to generate hypotheses for future impact assessments. The case study can be read in full on www.erst.dk

⁸⁵ Machiba, 2012

⁸⁶ Orsato, 2012

⁸⁷ Lanoie et al, 2011

Biographies

In the following biographies are listed for each of the three expert that have been interviewed on their reflections to the finding of impact assessment report.

Renato J. Orsato is a Professor of São Paulo School of Management (<http://eaesp.fgvsp.br/en>) and Academic Director of the Centre for Sustainability Studies (www.ces.fgvsp.br/) at Getúlio Vargas Foundation (FGV) in São Paulo, Brazil. From 2004 to 2010 he worked as lecturer and Senior Re-search Fellow at the INSEAD Social Innovation Centre, Fontainebleau in France, where he is currently a visiting scholar. As an academic and consultant in business administration, Dr Orsato worked with public organizations and private businesses in more than 20 countries. He is the author of Sustainability Strategies - When does it pay to be green? (Palgrave Macmillan - INSEAD Business Press 2009, www.sustainability-strategies.eu).

Tomoo Machiba is Senior Programme Officer for Knowledge Management at the International Renewable Energy Agency (IRENA) since February 2012. Prior to joining the IRENA, he served for the OECD as a Senior Policy Analyst in the Directorate for Science, Technology and Industry (DSTI) between 2008 and 2012. He managed a flagship project on Green Growth & Eco-innovation and worked for DSTI's contributions to the OECD Green Growth Strategy. Started his career as journalist, Tomoo has been involved in the field of corporate social responsibility (CSR), energy and resource efficiency, and sustainable consumption and production (SCP) over 15 years. He served as an associate for SustainAbility, a leading CSR consultancy based in London, and worked at the Global Reporting Initiative (GRI) headquartered in Amsterdam, as a programme manager for technical development of the GRI Sustainability Reporting Guidelines. Most recently, he was a senior consultant to the UNEP/Wuppertal Institute Collaborating Centre on SCP in Germany, working for the UN Marrakech Process. Tomoo holds an MPhil in development studies from the Institute of Development Studies (IDS), University of Sussex, UK.

Nick Johnstone, Ph.D., is Head of the Empirical Policy Analysis Unit at the OECD Environment Directorate. His current research interests include the analysis of environmental policy instrument choice, the links between environmental policy and technological innovation, the contribution of environmental factors to subjective well-being, and household behaviour in key sectors with environmental implications. He is the author of a number of books and chapters, with leading academic publishers (Routledge, Blackwell, Oxford University Press, Edward Elgar), and has published in leading journals in the field.

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Green Business Model Innovation

Empirical and literature studies

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