Cases of implementing resource efficient policies by the EU industry

Final report - November 28th, 2014

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Executive Summary

The purpose of this study is to provide a set of 20 case studies illustrating how, in practice, industry has improved its resource efficiency and the results obtained in terms of environmental, social and economic impacts. The study also inquires about the motivations for applying resource efficiency methods, hindrances and the link with the policy framework.

Resource efficiency is high on the European policy agenda. 'A resource-efficient Europe' is one of the seven flagship initiatives of the Europe 2020 agenda. In June 2014 the European Commission adopted the Communication 'Towards a circular economy: a zero waste programme for Europe' with the goal to promote a resource efficient EU economy. The Commission estimates that through the introduction of new waste targets 180,000 new jobs will be created in the EU by 2030. Numerous other policy initiatives have been taken in the field of resource efficiency including for instance the Energy 2020 initiative, the low-carbon economy 2050 roadmap, the Waste Framework Directive, the Roadmap for a resource-efficient Europe, the Action Plan towards a sustainable bio-based economy by 2030. At Member States' level various resource efficiency policies and initiatives exist as well which complement the EU policy initiatives.

In order to select the case studies first a review of information sources was done. Subsequently potential measures were identified and 99 case briefs were made including a short description of the measure, and a qualification of the measure in terms of a set of selection variables such as the type of resource affected, the drivers, environmental impact potential, economic and social impact potential, up-scaling potential, maturity and information availability. On the basis of this information the Commission selected 24 cases to be worked out in more detail and five reserve cases. In the course of the project five additional cases were selected. The cases were elaborated on the basis of desk research and interviews. In total 34 companies were invited for doing a case study interview. 21 case studies were made which are in Annex 1 of this report.

Without going into detail of each and every case study a number of interesting findings came to the surface with respect to the environmental impact, the economic and social impact, the drivers and obstacles and the relation with the local, regional, national and EU policy framework. In the following paragraphs the main insights will be presented in this order.

From the 21 case studies that have been made, the more efficient use of materials and improvements in energy efficiency - which is accompanied by a reduction in GHG emissions - have most frequently been reported. Virtually half of the cases identified water issues as particularly relevant. The measures taken range from improvements in the production processes, development of new sustainable products and services to valorising material streams and upgrading and reusing waste streams. The cases are drawn from eight industries. The employment size of the companies ranges from 3 to 69,000. The following table provides an overview of the cases by industry.

Industry *(CPA code)*	Company	Case study title
Basic metals (C24)	Ruhl & Co. GmbH	Resource savings at Ruhl & Co., a German electroplating company
Chemicals and chemical products (C20)	BB-Lightconcepts	100% recyclable LED light pipes
	Braskem	Sugarcane ethanol-based Green Polyethylene (bio-based polymer)
	BASF Antwerp	BASF Antwerp's new water sourcing strategy
	Evonik Degussa Antwerp	A new combined heat-power plant
	Solvic (Solvay)	Closing the cycle: recovery of sulphuric acid at Solvic, Belgium
Pharmaceutical products (C21)	Janssen Pharmaceutica	Closing the cycle: introducing a chemical leasing process for the recuperation of a chemical solvent at Janssen Pharmaceutica
Coke and refined petroleum products (C19)	Neste Oil Porvoo	Use of waste- and residue -based materials in renewable diesel production
Machinery and equipment n.e.c. (C28)	Grundfos Manufacturing Hungary Ltd.	Fluid management system
Other non-metallic mineral products (C23)	Cobiax Technologies AG	Cobiax (void former modules)
	Ecocem	Low carbon cement from Ecocem
	Gyproc/Saint-Gobain Construction Products Belgium SA	Recycling of gypsum for the plasterboard industry
	Royal Mosa BV	C2C certified Silver ceramic tiles
	Gypsum Recycling International A/S	Gypsum waste recycling from landfill to raw material
	AGC Glass Europe	Oxycombustion furnace design, AGC Glass Europe, Boussois site, France
	Nexiform Ltd.	Nexiform – Business Reinvention through Resource Efficiency
Paper and paper products (C17)	Metsä Fibre Kemi	Replacement of two old water treatment and demineralization plants with a new energy efficient and water-saving flootech process
	UPM Kymmene Austria GmbH -Steyrermühl paper mill	Material efficiency improvements at Steyrermühl paper mill
	Van Houtum BV	Satino Black Cradle-to-Cradle (C2C) certified washroom collection
Rubber and plastic products (C22)	NaKu	Providing Knowledge and Feedstock for Bio-Based Plastic Products
	The Goodyear Tire & Rubber Company	Zero Waste to Landfill

The case studies illustrate that a wide scope of improvements in environmental footprint and resource efficiency have been achieved in various sectors and across a variety of company sizes. In terms of resources and impact categories, the more efficient use of materials and improvements in energy efficiency/reduction of GHG emissions are the ones most frequently reported. However, companies seem either unable to quantify the changes effected by their resource efficiency measures or are unwilling to share such quantitative information. Qualitative information is more readily available.

Nevertheless clear and tangible improvements in resource efficiency and reductions in environmental impacts have been reported. Recycling of energy within the production process and the integration of renewable energy resources may generate significant energy efficiency improvements and reductions in GHG emissions. For instance Van Houtum has reduced energy consumption per unit of product by 5% by the installation of a new heat capturing system. Royal Mosa reduced its CO2 emissions per tonne product by 48% over a ten year period through the contracting of renewable energy services. Although energy and GHG emissions are the most commonly addressed issues for efficiency measures, in terms of financial savings efficiency improvements in material flows are often substantially larger since on average material costs constitute 40% of total business costs for EU manufacturing compared to 1-2% for energy costs. The reduction of waste in the production process and increased recovery, recycling and upcycling of production waste are important measures to reduce the material requirements and environmental impact of production. Also water efficiency measures both in terms of the use of water resources and the reduction of waste water feature heavily in the case studies. The case studies illustrate that there exists a clear potential for resource efficiency and environmental improvements within the selected industries.

In terms of economic and social impact cost savings is a predominant outcome. These result from savings in raw and virgin resources as well as from more efficient production processes and valorisation of material streams which in the classical production methods would be a net cost factor. For instance Gypsum Recycling International A/S indicates that plasterboard plants save at least 30% of material purchasing costs due to material recycling. Metsä Fibre Kemi reports cost savings which amounts to more than € 300,000 annually. UPM Steyrermühl indicates that all its resource efficiency measures generate an annual cost saving of € 1.1 million compared to the benchmark year 2010 due to production process improvements. This figure is expected to increase as more measures are being implemented.

A set of resource efficiency cases also witnessed access to new market opportunities, such as introduction of new products and services, and also entirely new business models. Examples reported are NaKu with the production of bio-plastics, and Nexiform which transformed from a conventional small scale ceramics production unit towards a sustainable production process of an eco-friendly alternative. Additionally, new business models, such as chemical leasing, generate new business opportunities for the chemical leasing companies and provide at the same time services based on functionality resulting in substantial cost savings for the client company. Case examples are Janssen Pharmaceutica and Solvic.

Evidently cost reductions and new business opportunities contribute to the competiveness of a company. This may result in higher profit rates, better solvency and net job creation. While not every case presented a net growth in the number of jobs, quite a number did. Net job creation rates between 1.3% for a large company such as Braskem and 8.4% for a small one such as Ecocem were found. In a number of cases the resource efficiency measure helped to sustain employment. Without the measure jobs would have been lost. ACG Glass Europe indicated that without the resource efficiency measure 140 jobs would have been lost. Also Neste Oil Porvoo and Metsä Fibre Kemi have reported that jobs are safeguarded due to the resource efficiency measures.

Rolling-out resource efficiency measures require investments. The case studies indicated pay-back periods within acceptable standards for their industries. These range between two years to maximum five years depending on the industry. It has to be indicated that economic viability is the minimum condition for resource efficiency measure to obtain a go-ahead from the management. As such one has to be aware that sample selection occurs in the sense that resource efficiency measures with inacceptable long payback periods or negative returns on investment will not be implemented and therefore cannot be found as a case.

The main drivers for implementing resource efficiency measures are the desire to produce more resource efficient and with less environmental footprint, often made explicit in a company's sustainability strategy, as well as the associated economic benefits. The latter include in the first place a better control over potential risks related to access to materials, price variability of (raw) materials, and the reduction of environmental pollution risks and accidents. The expected cost reductions are a key driver as well for implementing resource efficiency measures. Examples of company sustainability strategies are UPM's group-wide Material Efficiency Programme, The Goodyear Tire and Rubber Company's Zero Waste to Landfill, Grundfos' carbon neutrality strategy, Johnson & Johnson's Healthy Future objectives and Earthwards^{TM} standards, and Solvay's 'Solvay Way'.

Companies did not indicate the policy framework as an important driver, except in one case. The policy framework appears in the first place to influence company strategies in a rather indirect manner by providing a long-term vision and policy commitment for regulations and standards, e.g. in the area of the circular economy. Examples of EU regulations mentioned were the EU Waste Framework Directive, the EU Roadmap for Resource Efficiency, the EU Water Framework Directive.

In a more direct manner regulations and standards intervene in the practical deployment of the resource efficiency measure. Here a number of areas for improvement were highlighted. A number of cases highlighted the differences in the implementation of the Waste Framework Directive across Member States. The Take Back Chemicals initiatives – a variant of chemical leasing solutions – illustrated in the Janssen Pharmaceutica and Solvic cases remain confined to the regional level (in these cases Flanders) since the end-of-waste certificates are not necessarily recognised as such in other regions of the EU. Also for up-scaling other resource efficiency solutions across Europe this condition is experienced as a serious impediment. The oversupply of emission rights in the EU ETS has been indicated in one case as a competition distorting factor for companies that provide resource efficiently produced substitute products. On a more general level changes in legislation over time are experienced as obstacles that make the implementation of resource efficiency measure more costly. Other obstacles include access to finance, especially for SMEs and newly start-ups, access to technological know-how and expertise.

Given the above observations, it is possible to formulate a number of policy suggestions for enhancing resource efficiency in businesses, especially with respect to realising the upscaling potential in the EU and to foster the effectivity of the resource efficiency measures taken. These can be formulated concisely as follows:

- Reduce the differences in the implementation of relevant EU directives across Member States.
- Facilitate SME finance for implementing resource efficiency measures and for developing new products and services that contribute to resource efficiency.
- Provide a stable legislative framework over time with clear long-term policy directions.
- Promote platform creation for bridging information and knowledge gaps and for raising public awareness of resource efficiency solutions.
- Optimize the existing legislation with respect to its effects on the effectiveness of resource efficiency measures. The Waste Framework Directive and the EU Emission Trading Scheme have been mentioned explicitly in the cases.

Since this study is based on case studies, it is inevitable that not all types and magnitudes of impacts have been covered. One has to bear in mind that the value added of the cases does not lie in providing an exhaustive overview of resource efficiency measures taken by companies in the EU, but rather in providing a practical insight in the drivers and obstacles that industrial companies experience in developing and applying resource efficiency measures, as well in the impacts generated and in the links with policy. Insofar as companies have not already engaged in the implementation of resource efficient measures, these cases may be inspiring examples. Also in the field of policy optimisation the cases are instrumental in providing valuable suggestions based on real life examples.

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Preface

This final report includes the results of 21 case studies on resource efficient strategies of companies that are located in the EU or operate on the EU market. The cases were made according to a pre-defined uniform format addressing the nature of the resource efficiency measure, its environmental impact, the business, economic and social impact, drivers and barriers, as well as the policy context.

The goal of the study is to obtain real-life evidence of the methods that the EU industry has developed and implemented to improve its resource efficiency, as well of the impacts for the environment, resources, and economy. The study also endeavours to get a better insight in the drivers and obstacles that the companies experience when implementing their resource efficiency measures and the links with the policy framework.

Although the cases come from various sectors, countries, and size classes, given the heterogeneity across the entire population of enterprises in the EU the measures reported in the case study are by no means to be interpreted as covering the entire spectrum of resource efficiency methods that abound in the EU and elsewhere. Yet they do provide valuable insights in the environmental and economic benefits of resource efficiency measures and in the critical success factors for the implementation of these measures. The cases also provide clear examples of the nature of the measures taken and their underlying motivations.

This final report is structured as follows: the next section defines the goals of the study and the policy context. Section 2/ describes the methodology to select the cases and the final set of selected cases. Section 3/ provides the results from the analysis of the environmental impact, while section 4/ does this for the economic and social impact. Section 5/ presents an analysis of the drivers and obstacles for implementing resource efficient measures and section 6/ discusses the links with the policy framework.

We are very grateful to all the interviewees for their cooperation and for sharing their experiences. We also would like to thank the European Commission for insightful discussions in various phases of the project.

Dr. Valentijn Bilsen

Project leader

Brussels, 28th November 2014

List of interviewees

Name			Title	Company
Mr	Chiel	Bekker	Managing Director	BB-Lightconcepts
Ms	Milena	Beltrami Tudisco	Marketing Manager Green PE Unit	Braskem S.A.
Mr	Frank	Benner	Head of Marketing & Sales	Ruhl & Co GmbH
Mr	Gert	De Bruyn	Senior Consultant – Project Manager, Industrial Sustainability	Royal Haskoning DHV
Ms	Connie	Deibel	Manager, Global Sustainability Communications	The Goodyear Tire & Rubber Company
Mr	Noël	Eeckeloo	Head Energy Policy	Evonik Degussa Antwerpen NV
Mr	Nicolas D.	Eghbali	Project Coordinator Rotterdam Cluster	The Institute for Sustainable Process Technology
Mr	Bas	Gehlen	Managing Director	Van Houtum BV
Mr	Cedric	Isaac	Government Affairs EMEA	The Goodyear Tire & Rubber Company
Mrs	Riikka	Joukio	Senior Vice President Sustainability and Corporate Affairs	Metsä Fibre Oy
Mr	Paul	Langston	Managing Director	Nexiform Ltd.
Mr	Ilmari	Lastikka	Head of EU Affairs	Neste Oil Oyi
Mr	Dr. Marko	Lesiak	Manager Mill Service	UPM -Kymmene Austria GmbH
Mr	Jean-Benoît	Lhoest	Site Manager AGC Technovation Centre	AGC Glass Europe
Mr	Henrik	Lund-Nielsen	Company Executive Officer	Gypsum Recycling International A/S
Ms	Beatriz	Luz	Sustainability Leader	Braskem S.A.
Ms	Kathleen	Marien	Energy and Climate Policy	BASF Antwerpen NV
Mr	Thomas	Mayr	Manager R&D	UPM -Kymmene Austria GmbH
Mr	Dennis	McGavis	Global Director, Sustainability	The Goodyear Tire & Rubber Company
Mr	Hugo	Meier	Company Executive Officer	Cobiax Technologies AG
Mr	Conor	O'Riain	Managing Director	Ecocem Materials Limited
Mr	Pekka	Posti	Operation Manager	Metsä Fibre Oy
Mrs	Päivi	Rissanen	Director, Environment and Responsibility, UPM Paper ENA	UPM -Kymmene Austria GmbH
Mr	Tom	Rommens	Sustainability Manager	Gyproc / Saint-Gobain Construction Products Belgium NV/SA
Mr	Ulrich	Schnellbach	Regional Environmental Manager EMEA	The Goodyear Tire & Rubber Company

Mr	Jeffery	Sussman	Manager, Global Remediation and End of Life Tires	The Goodyear Tire & Rubber Company
Mr	Pekka	Tuovinen	Director, Sustainability and Supplier Compliance	Neste Oil Oyi
Ms	Katalin	Urbán	Chief CSR and Communication	Grundfos Manufacturing Hungary Ltd.
Mr	Mark	Van Breda	Vice President Health, Safety, Environment and Energy Policy	BASF Antwerpen NV
Ms	Dorien	Van der Weele	Business Development, Sustainability	Royal Mosa BV
Mr	Bart	Vander Velpen	Director Business Development and Innovation Manager, Energy and Mining	Royal Haskoning DHV
Mr	Johann	Zimmermann	Managing Director	NaKu e.U.

PART 1
Final report

1/ Introduction

1.1 Objectives of the study

The aim of this study is to provide a list of evidence of the methods that EU industry hitherto has used to improve its resource efficiency and of the results in terms of economic, social and environmental impacts. The study should also indicate the motivations for applying these methods, the factors of success or failure, and should provide as well an indication on the scope for further up-scaling at EU level.

With respect to the cases the Request for Services indicates that special attention should be given to sectors that are at the risk of carbon leakage, in particular glass, ceramics, chemicals and the refining industry. Special attention should also be given to the whole value chain: the measures that affect suppliers upstream as well as clients and ultimately consumers downstream, such as reuse and recycling. The Request also indicates that cases outside the EU would be welcomed. The cases should be written in an easy to access standard approach and should be relatively recent.

1.2 Policy context: from policies to platforms and public-private partnerships

1.2.1 Resource efficiency: a policy priority at the EU-level

Resource efficiency is high on the European policy agenda. A resource-efficient Europe is one of the seven flagship initiatives of the Europe 2020 agenda. Resource efficiency should be the guiding principle for EU policies on energy, transport, climate change, industry, commodities, agriculture, fisheries, biodiversity and regional development. Examples are the thematic strategy on the sustainable use of natural resources[1] and the thematic strategy on waste prevention and recycling[2]. The policy framework that this flagship creates is meant to boost economic performance while reducing resource use, identify and create new opportunities for economic growth, improve the EU's competitiveness, ensure security of supply of essential resources and limit the environmental impact of resource use.

In June 2014 the European Commission adopted the Communication "Towards a circular economy: a zero waste programme for Europe" with the goal to establish a common and coherent EU framework to promote the circular economy[3]. The ultimate goal is to obtain a more resource efficient Europe, while at the same time making EU enterprises more competitive. The Commission estimates that through the introduction of new waste targets 180,000 new jobs will be created in the EU by 2030. Also in terms of materials recovered this policy initiative is expected to have a significant impact, with the ultimate potential the 600 million tonnes of materials that are contained in waste and which are lost annually in the EU[4].

Also the initiatives on a bio-based economy are important examples of EU policies stimulating resource efficiency. In 2012 the European Commission adopted a communication on a European Bio-based Economy[5] that aims to promote the production and use of bio-based fuels, material and chemicals. Further, in July 2013 The European

[1] http://ec.europa.eu/environment/natres/index.htm

[2] http://ec.europa.eu/environment/waste/strategy.htm

[3] http://ec.europa.eu/environment/circular-economy/index_en.htm

[4] European Commission (2014) Memo Questions and answers on the Commission Communication "Towards a Circular Economy" and the Waste Targets Review, Brussels 2 July 2014, http://europa.eu/rapid/press-release_MEMO-14-450_en.htm.

[5] Communication from the commission on Innovating for Sustainable Growth: A Bioeconomy for Europe (COM(2012))

Commission adopted a communication on Public-Private partnerships in Horizon 2020[6] that will invest in research and innovation to address the major challenges through Joint Technology Initiatives (JTI). JTI on Bio-based industries[7] aims to develop new and competitive bio-based value chains that replace the need for fossil fuels and have a strong impact on rural development. Bio-based chemicals and biomaterials are one of the most important value chains to be developed by the industry under the JTI on Bio-based industries.

Indeed numerous policy initiatives have already been taken to stimulate resource efficiency. Without having the ambition to be complete, the following list provides an overview of resource initiatives taken by the EU other than the ones mentioned above.

- Energy 2020: A strategy for competitive, sustainable and secure energy;
- Energy infrastructure priorities for 2020 and beyond – A Blueprint for an integrated European energy network
- Low-carbon economy 2050 roadmap;
- European Energy Efficiency Plan 2020;
- White Paper on the future of transport;
- 2020 EU biodiversity policy and strategy;
- Revision of the Energy Taxation Directive;
- Roadmap for a resource-efficient Europe;
- Cohesion Policy Reform;
- Energy infrastructure package;
- Trans-European Networks for Transport (TEN-T) revision;
- Energy Roadmap 2050;
- Smart grids;
- Security of energy supply and international cooperation;
- Review of priority substances mentioned in the Water Framework Directive;
- Strategy for the sustainable competitiveness of the EU construction sector;
- Action Plan towards a sustainable bio-based economy by 2020;
- Strategic Transport Technology Plan;
- Revision of the legislation on monitoring and reporting of greenhouse gas emissions
- Waste Framework Directive
- Sustainable Consumption and Production Action Plan
- Eco-Innovation Action Plan

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[6] Communication from the Commission on Public-private partnerships in Horizon 2020: a powerful tool to deliver on innovation and growth in Europe COM(2013) 494

[7] Proposal for a council regulation on the bio-based Industries Joint Undertaking COM(2013)496

1.2.2 The concept of resources and resource efficiency

Reviewing this list, one of the conclusions is that the relevant policy context is the one that depicts the concept of resources in a broad sense: the concept encompasses raw materials such as minerals and biomass which are non-renewable or exhaustible if overexploited. Resource efficiency with respect to critical raw materials is particularly relevant for European industry a number of high industrial sectors which provide a very significant added value and jobs (such as construction, chemicals, automotive, aerospace and machinery) are highly dependent on the import of raw materials which are in limited supply[8]. In addition critical metals are of high importance for future sustainable technologies, such as renewable energies and energy efficient technologies, and are the basis for cleaner technology innovation. This is the reason why the European Commission adopted the Raw Materials Initiative, a strategy to secure and improve access to raw materials for the EU[9]. It is clear that activities to promote recycling of critical materials have an important role in the provision of future sustainable technologies. The concept of resources, however, also includes environmental media such as clean air, water and fertile soil, which are available in declining quality or quantity. Land is another resource which is required to produce or sustain all other resources to a greater or lesser extent.

Resource efficiency means reducing input use for a given level of economic output. Since costs will be reduced for a given production level, it also means increasing productivity. This can lead to an integration of environmental sustainability with economic growth, such as put forward in the Sustainable Consumption and Production Action Plan[10]. A number of recent studies have indicated that businesses are not always using resources efficiently, and that there is still an untapped resource efficiency potential which could be addressed by policy.

1.2.3 Member State initiatives promoting resource efficiency

Indeed, there are a number of policy measures, industry platforms and public-private partnerships that have as their aim to improve resource efficiency. Industrial symbiosis is a promising strategy in this respect which has lots of potential for further up-scaling in the EU. Since 2005, the UK National Industrial Symbiosis Programme has set the stage for efficiency measures by sharing resources among companies. The NISP is a resource exchange platform where companies can network and which also acts as a knowledge exchange platform for sustainable resource management practice. A number of different industrial symbiosis platforms have since arisen in Europe of which many are based on the NISP design. Many examples can be cited such as SMILE (http://www.smileexchange.ie/) platform in Ireland or the Symbiose Workshops (http://www.fi-sch.be/nl/programmas/valorisatie-van-nevenstromen/symbiose/) in Belgium. In the USA, there is a culture of industry – government cooperation programmes to improve resource efficiency. An example of this is the Green Suppliers Network which has the aim to engage large manufacturers in reviewing the process lines of their small and medium-sized suppliers. This leads to efficiency improvements in terms of more efficient material and resource use. Other policy programs are more top-down and steered by government such as the law on creating a circular economy in China. In conclusion, it is clear that there is significant action being taken both at the policy and the corporate level to improve efficient use of resource. This is a necessity in the current climate in which demand for resources is ever increasing and supply stocks are shrinking.

[8] http://www.criticalrawmaterials.eu/

[9] http://ec.europa.eu/enterprise/policies/raw-materials/

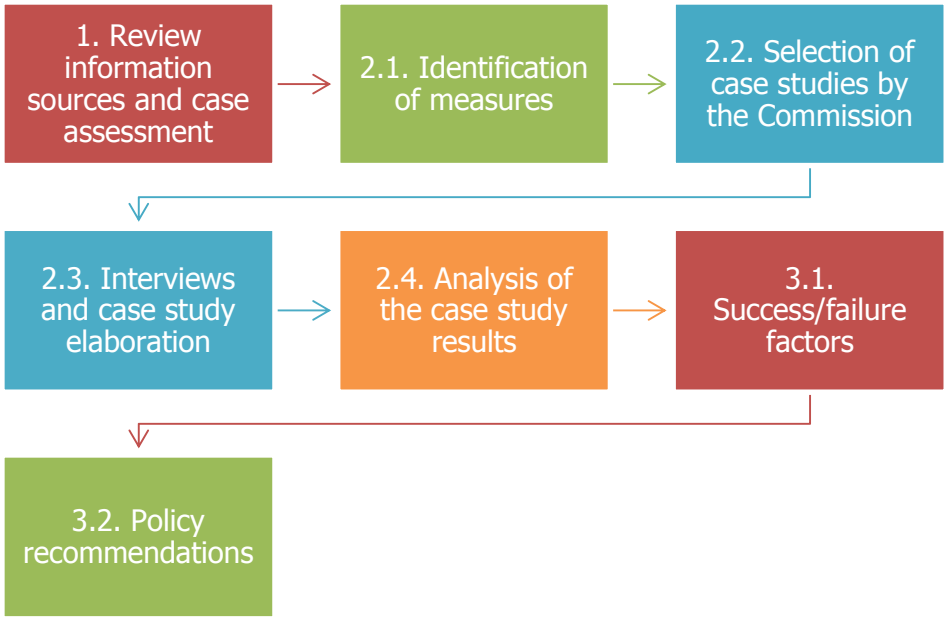
[10] http://ec.europa.eu/environment/eussd/escp_en.htm

2/ Overall methodology and the selection of the case studies

2.1 General approach

Figure 1 presents an overview of the various steps in the project. First a review of information sources is done and an assessment is made about which cases at company level are potentially interesting for this study. Subsequently the selection is taken a step further by collecting meta-data and meta-information on the basis of which the nature of the measures in terms of economic, social and environmental criteria are assessed. This results in a long list of resource efficiency cases that is presented to the Commission. Subsequently the Commission makes a selection which is followed by the elaboration of the case studies using interviews, and valuable and recent data/information resulting in a concise and standard case report. The results of the cases are then analysed in terms of impacts, followed by an assessment of the success and failure factors for resource efficiency policy implementation. The study concludes with adding proposals for enhancing resource efficiency policies related to businesses.

Figure 1: Overview of approach and resulting deliverables



2.2 The elaboration of the long list

The method for the elaboration of the long-list of cases is depicted in Figure 2. Following the proposed analytical framework and the elaborated work plan[11] a top-down selection approach was applied. On the basis of a review of information sources, platforms promoting resource efficiency and a literature review in Task 1, a list of relevant business networks promoting resource efficiency at business level were selected. Subsequently, within these selected business networks, examples of resource efficiency cases were identified and assessed against a set of criteria.

[11] These have been elaborated in the inception report

Figure 2: Steps in elaborating the long list of potential cases

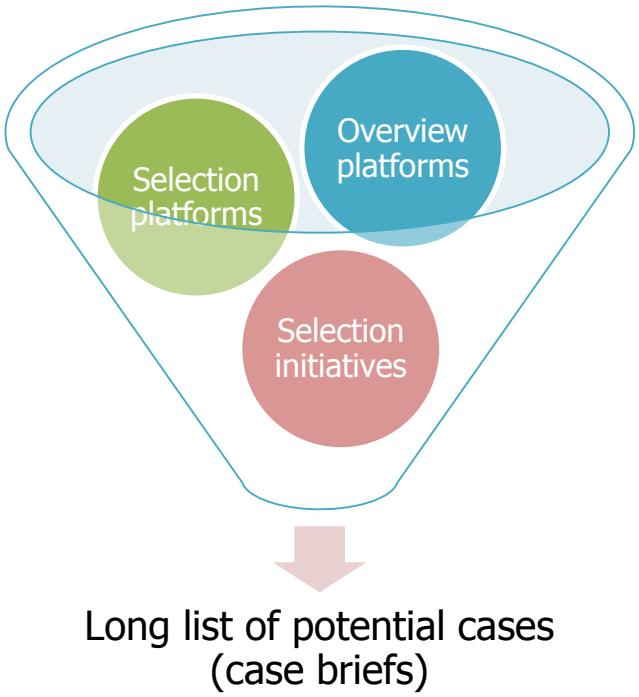


Table 1 provides an overview of platforms, agencies and business associations that were identified as relevant starting points for helping to identify resource efficiency policy measures at the business level. Both business associations from the priority sectors are included as well as platforms focussing on resource efficiency. REMake and REBus are EU-funded multi-country initiatives, respectively from the Innova+ initiative and LIFE+.

Through desk research, web searches and contacts potential cases of resource efficiency were identified. Although the interesting cases were not always at the front page of the web site, through a snowballing search and interview method references to e.g. particular member organisations, specific companies or organisations could be obtained.

Table 1: Overview of platforms, associations and agencies by country used as a source for selecting resource efficiency policy cases

ID	Platforms/Associations/Agencies	Country
1	WBCSD Head Office	CH
2	NISP UK	UK
3	Effizienz-Agentur NRW (EFA)	DE
4	EPE - European Partners of the Environment	BE
5	SMILE Resource Exchange	IR
6	The European Container Glass Federation (FEVE)	BE
7	The European Glass and Glazing Association (UEMV)	DK
8	Glass for Europe,	BE
9	European Ceramic Industry Association (Cerame-Unie)	BE
10	European Ceramic Society (ECERS)	BE
11	European Chemical Industry Council (CEFIC)	BE
12	European Petroleum Industry Association (EUROPIA)	BE
13	Confederation of European Paper Industries (CEPI)	BE
14	European Organisation for Packaging and the Environment (EUROPEN)	BE
15	Alliance for Beverage Cartons and the Environment (ACE)	BE
16	REMake	
17	REBus	
18	European Industrial Symbiosis Association (EUR-ISA)	BE
19	WRAP	UK
20	UK Water Efficiency Awards	UK
21	Követ	HU

A set of evaluation criteria were applied in order to select potential resource efficiency measures for the long list. The selection criteria are presented in Table 2. These include among others sector, type of resources affected, environmental impact potential, economic and social impact potential, up-scaling potential, maturity and information on drivers. Also general information availability was taken as selection criterion since it is a necessary condition for obtaining informative cases.

Table 2: Overview of selection criteria and variables in the long list of potential resource efficiency cases

Type of information	Selection variable	Description and values
General information	name	Name of the case
	Short description	Concise description of the measure
	Country	Country where the case/measure is applied
	Sector	Business sector
	Priority sectors	Rating: yes or no; Priority sectors are glass and ceramics, chemicals, refining industry, pulp and paper
	Platform ID	Number of the platform, see Table 1 of this report
	General information availability	Rating: 0 = disappointing, 1= sufficient, 2 =excellent
	Scale of initiative	Rating: small, medium, large; Explanation: Small scale: the initiative is implemented on a local or sub-national level. Medium scale: the initiative is implemented nation-wide or among neigbouring countries. Large scale: the initiative is implemented on a wider international level
Type of resources	type of resource affected	Resource types: materials, biomass, water, land, energy
	critical raw materials	Rating: yes or no
Environmental impact potential	reduce resource use	Rating: no dot: small potential for reducing resource use; ● medium potential for reducing resource use; ●● high potential for reducing resource use; n.i.: no information
	reduce environmental impact	Rating: no dot: small potential for reducing environmental impact; ● medium potential for reducing environmental impact; ●● high potential for reducing environmental impact; n.i.: no information
Economic & social impact potential	cost reduction	Rating: no dot: small potential for cost reduction; ● medium potential for cost reduction; ●● high potential for cost reduction; n.i.: no information
	risk mitigation potential	Rating: no dot: small potential for risk mitigation; ● medium potential for risk mitigation; ●● high potential for risk mitigation; n.i.: no information
	job creation	Rating: no dot: small potential for job creation; ● medium potential for job creation; ●● high potential for job creation; n.i.: no information

	SME perspective	Rating: no dot: small potential for SMEs for up-scaling the case; ● medium potential for SMEs for up-scaling the case; ●● high potential for SMEs for up-scaling the case; n.i.: no information
Diffusion	**up-scaling potential**	Rating: no dot: small potential for up-scaling; ● medium potential for up-scaling; ●● high potential for up-scaling; n.i.: no information
Maturity	**year of implementation**	The year when the measure/policy/initiative was launched
	maturity of the initiative	Rating: very recent: less than 1 year; recent: 1 to 5 years; old: more than 5 years
URL	**Web address**	URL of the web site
Drivers	**Type of change**	Rating: process=1; product =2; service=3; technology=4; system=5
	Drivers	Short description of the main drivers in tekst format

In total 99 cases were selected for the long list. Cases from paper and pulp/cardboard industry represented the largest sub-group with 19 potential cases, followed by the glass and ceramics industries with 18 potential cases. In chemicals and plastics 13 cases were identified and in refineries 8. Construction counted 5 potential cases. For the aluminium sector 2 resource efficiency cases were identified and for the food sector 4 cases as well as for textiles.

2.3 The selected cases

As part of Task 2, the Commission selected 24 cases of the long-list to be elaborated and 5 cases for the reserve list. 18 cases were undecided while 52 were not selected. In the course of the interview phase (Task 2.3) five other cases were added to the reserve list. In total 34 companies were invited for doing a case study interview. Nine companies refused to cooperate, for various reasons, and four did not make a decision.

Figure 3: Case selection process: from long-list to short-list

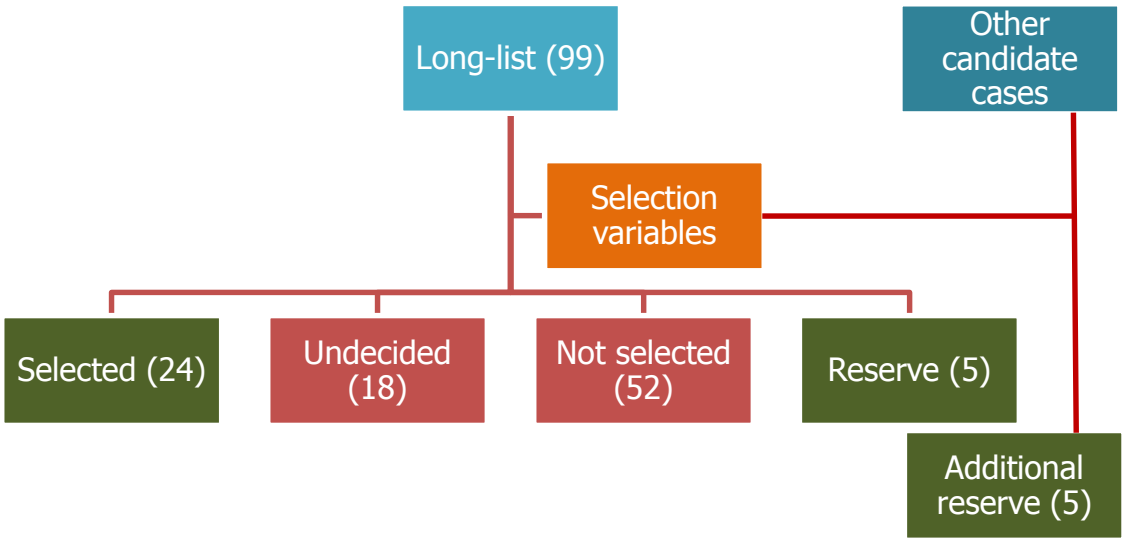


Table 3 provides an overview of the cases by sector. Although each of the companies varies significantly in terms of activity, the cases can be grouped in eight aggregated activities. Seven cases are in the sector "Other non-metallic mineral products" and five cases in "Chemicals and chemical products". The sector "Paper and paper products" counts three cases. The sector "Rubber and plastic products" has two cases. The study has one case in the sector "Coke and refined petroleum products", one in "Machinery and equipment", one in "Basic metals" and one in "Pharmaceutical products". For the year 2011 these sectors represent about 40% of the total value added created in the EU-28 manufacturing sector. In terms of employment the share of these sectors is 31% of total EU-28 manufacturing and in terms of the number of enterprises these sectors represent virtually 16% of all the enterprises in manufacturing in the EU-28[12].

The detailed cases are presented in Annex 1/ in alphabetical order.

[12] Calculated on the basis of Eurostat's Structural Business Statistics: Annual detailed enterprise statistics for industry (NACE Rev. 2, B-E, [sbs_na_ind_r2], accessed 16.07.2014.

Table 3: Overview of selected cases by sector

Industry *(CPA code)*	Company	Case study title
Basic metals *(C24)*	Ruhl & Co. GmbH	Resource savings at Ruhl & Co., a German electroplating company
Chemicals and chemical products *(C20)*	BB-Lightconcepts	100% recyclable LED lightpipes
	Braskem	Sugarcane ethanol-based Green Polyethylene (bio-based polymer)
	BASF Antwerp	BASF Antwerp's new water sourcing strategy
	Evonik Degussa Antwerp	A new combined heat-power plant
	Solvic (Solvay)	Closing the cycle: recovery of sulphuric acid at Solvic, Belgium
Pharmaceutical products (C21)	Janssen Pharmaceutica	Closing the cycle: introducing a chemical leasing process for the recuperation of a chemical solvent at Janssen Pharmaceutica
Coke and refined petroleum products *(C19)*	Neste Oil Porvoo	Use of waste- and residue -based materials in renewable diesel production
Machinery and equipment n.e.c. *(C28)*	Grundfos Manufacturing Hungary Ltd.	Fluid management system
Other non-metallic mineral products *(C23)*	Cobiax Technologies AG	Cobiax (void former modules)
	Ecocem	Low carbon cement from Ecocem
	Gyproc/Saint-Gobain Construction Products Belgium SA	Recycling of gypsum for the plasterboard industry
	Royal Mosa BV	C2C certified Silver ceramic tiles
	Gypsum Recycling International A/S	Gypsum waste recycling from landfill to raw material
	AGC Glass Europe	Oxycombustion furnace design, AGC Glass Europe, Boussois site, France
	Nexiform Ltd.	Nexiform – Business Reinvention through Resource Efficiency
Paper and paper products *(C17)*	Metsä Fibre Kemi	Replacement of two old water treatment and demineralization plants with a new energy efficient and water-saving flootech process
	UPM Kymmene Austria GmbH -Steyrermühl paper mill	Material efficiency improvements at Steyrermühl paper mill
	Van Houtum BV	Satino Black Cradle-to-Cradle (C2C) certified washroom collection
Rubber and plastic products *(C22)*	NaKu	Providing Knowledge and Feedstock for Bio-Based Plastic Products
	The Goodyear Tire & Rubber Company	Zero Waste to Landfill

Note: the CPA code refers to Eurostat's Statistical Classification of Products by Activity in the European Economic Community, 2008 version.

3/ Environmental impact

3.1 Introduction

This section provides an overview of the environmental and resource impacts included in the currently complete and validated case studies on resource efficiency initiatives in EU industry. A brief description of the methodological considerations and delimitations is followed by a summary of the type quantitative information provided in each of the twelve currently complete case studies. A short synthesis then provides a qualitative analysis of the case studies completed to date. In particular, this will examine which types of resources are typically addressed and highlight particularly successful initiatives. The data that the companies are able or willing to provide limits the extent to which broader quantitative conclusions can be drawn.

Next, the specific information on environmental and resource impacts of each case study is explored. Here, the information provided by each case study is sub-divided into background information, process improvements, and product benefits. This helps to more accurately define each initiative and identify aspects that are transferable.

3.2 Methodological comment

The environmental and resource achievements outlined in the case studies provide only a snapshot of the potential for improvements across European industry. However, they do not constitute a basis for extrapolation, and do not contain sufficient quantitative information (standardised or non-standardised) to make cross-sector or cross-company comparisons. Such an analysis would require a considerably more representative sample of companies from each specific sector, and would benefit from a macro analysis of the sector to provide a baseline average. The JRC has conducted a similar type of analysis of energy efficiency and CO_2 emissions (and improvements) within the Steel[13] and Cement[14] industries that could be a useful reference for future work.

Generally, the companies that agreed to participate in this project were very open regarding the drivers behind their RE initiatives, the difficulties faced during implementation and the overall environmental and economic benefits gained from the exercise, although this is unsurprising given that this project selected successful initiatives. However, quantifying the environmental improvement from the measures has, in many cases proved difficult. This is both down to a reluctance to divulge information into the public domain, but also that often the exact impacts remain unknown even within the company.

As part of the project design, the companies surveyed have different product portfolio, and use different processes and technologies. This means that it is neither possible nor useful to use a widely single indicator to benchmark resource efficiency improvements in the companies. Where possible, we have provided the results as percentage improvements. However, percentage improvements have two intrinsic problems in this context: we have not requested information for a defined time period (to increase the quantity of information received) and; the initiatives do not, in any case, necessarily produce results that can be aggregated over a given time period (often producing a stepwise, rather than gradual, change). In addition to this, even in the presence of a baseline for a given company, there is no immediate way to assess whether the baseline is representative of other businesses in that sector: i.e. impressive efficiency improvements could have been achieved on the back of a very poor starting position, or relatively favourable local conditions and resource availability. The practical implication of this is that the case studies cannot be used to provide meaningful comparable improvement values.

[13] N. Pardo, J.A. Moya, K. Vatopoulos, 2012, Prospective Scenarios on Energy Efficiency and CO2 Emissions in the EU Iron & Steel Industry, JRC Scentific policy report

[14] J.A. Moya, N. Pardo, A. Mercier, 2010, Energy Efficiency and CO2 Emissions: Prospective Scenarios for the Cement Industry, JRC Scentific and technical report

This does not mean that the information on environmental impacts is valueless. On the contrary, it can provide a very useful indication of what one can expect to achieve from the implementation of an initiative: This is more useful information for European businesses than an overview of total reductions in the sectors covered here, or a comparison between different initiatives.

Nonetheless, we have isolated all of the quantitative date provided in the case studies and classified these data by resource/impact, together with the specific unit in which the resource/impact saving is expresses. This provides a useful overview both of the types of information provided in the case study and the types of data used by companies to measure environmental performance within each sector. Table 4 provides an overview of the type of quantitative information included in each case study; this does not distinguish between information on process improvements and product benefits.

Table 4: Overview of quantitative environmental information provided for 21 validated cases

		Relevant resources and impacts									Quantified resources/ Impacts	
		Materials	Waste	Energy & GHG	Air emissions	Land & soil	Water	Biomass	Critical materials	Other	Resoures/impacts with qunatative info.	How they are specified in Case study
1	AGC Glass Europe			X	X						Energy CO_2 Air Emissions (SOX,NOX)	Energy % saving Energy absolute saving CO_2 % saving CO_2 absolute saving SOX % saving SOX absolute saving NOX % saving NOX absolute saving
2	BASF Antwerpen						X				Water	water % saving water absolute saving
3	BB-Lightconcepts	X	X	X					X		Materials (Steel Aluminium Copper) Packaging Waste	materials/ product materials absolute materials saving / product materials saving absolute waste absolute (for Steel&AL, CU, plastic) shipping cartonne absolute reduction
4	Braskem			X		X	X	X			Water Waste CO_2 Energy	water/tonne crushed cane; CO_2 /tonne product; waste/tonne product; energy/tonne product; total reductions from all products reduced impacts from use of product
5	Cobiax Technologies AG	X		X	X						Materials Air emissions	material saving (concrete and steel) % harmfull emissions %
6	Ecocem	X		X		X					No quantiative information provided	
7	Evonik Degussa Antwerp		X	X							CO_2	CO_2 absolute saving CO_2 tonne product
8	Grundfoss Manufacturing Hungary Ltd.	X					X				Materials Hazardous waste Waste water	materials absolute savings hazardous waste absolute savings waste water absolute savings
9	Gyproc / Saint-Gobain Construction Products Belgium NV/SA	X	X								Materials	total recycing of gypsum absolute
10	Gypsum Recycling International A/S	X	X	X			X	X			CO_2	CO2/ tonne product (generic)
11	Janssen Pharmaceutica	X	X	X			X			chemicals	Materials Water Energy	materials % saving water % saving energy % saving
12	Metsä Fibre Kemi mill			X			X				Water Energy CO_2	water %/product energy absolute energy % CO_2 absolute CO_2 %
13	NaKu	X		X				X			CO_2	consumer CO_2 savings
14	Neste Oil Porvoo	X	X	X	X			X			Waste	waste utilisation absolute
15	Nexiform	X	X	X							No quantiative information provided	
16	Royal Mosa BV	X		X	X		X			Toxic material	Water Waste CO_2	water % saving recycled input % supply chain impacts % CO_2 % saving/product
17	Ruhl & Co. GmbH	X		X			X				No quantiative information provided	
18	Solvic	X		X			X			chemicals	Materials Water Energy	materials % saving water % saving energy % saving
19	The Goodyear Tire and Rubber Company		X								Waste	waste to landfill % reduction
20	UPM-Steyrermühl paper mill		X	X			X	X		Chemicals	Energy Water Waste	energy absolute saving water % saving recycling of biomass tonnenes
21	Van Houtum	X	X	X		X					Water Waste CO_2 Energy	water consumption absolute reduction water/tonnene product recycling rate (%) of residue emisison to water absolute reductions CO_2 emissions absolute reductions CO_2 emissions/tonnene product gas/tonnene product (reduction) supply chain GWP impacts absolute
	Totals	14	10	17	4	3	9	5	1			

3.3 Synthesis

The case studies demonstrate that a broad range of improvements in environmental and resource efficiency have been achieved across a variety of industries.

In terms of the relevance of particular resource and impact categories for the selected case studies, the more efficient use of materials and improvements in energy efficiency / reduction of GHG emissions appear to be the most prominent of the twenty one case studies processed, seventeen indicated energy and GHG emissions, while fourteen mentioned raw materials as key efficiency factors. This is not particularly surprising given the discourse around energy and climate and the use of CO_2 emissions as a proxy for environmental impacts, and that energy efficiency measures are often easy to implement and provide immediate benefits.

Nine companies identified waste issues and nine identified water issues as particularly relevant. Other categories (air emissions, land and soil, biomass, critical materials, toxic materials) were mentioned as relevant by five or fewer companies. We would typically expect these to be representative of the respective industries/sectors within which the companies operate. Of course, the remaining case studies could reveal other priority resources impacts.

However, companies seem either unable to quantify the changes effected by their resource efficiency measures, or are unwilling to share such quantitative information, or relative improvements, with this project: only six have so far provided any quantitative information on CO_2 emissions, only seven companies have provided information about improvements in energy supply/energy efficiency. Only six have provided details on the changes in the levels of material use, two of which are product rather than process savings. Six companies have provided useful information on waste reductions and recycling however. Reducing material waste and improving recycling of waste seems to be a popular and measurable step that improves the environmental profile of companies and products, and can provide immediate economic returns by reducing material input. Quantitative and qualitative improvements in water efficiency have been reported by nine companies, with impressive results.

Looking at the specific quantitative information provided, it is clear that real and tangible improvements in resource efficiency and reductions in environmental impacts are possible across all of the industries/sectors represented by the case studies. Table 5 provides an overview of the actual quantitative information provided in the case studies pertaining to GHG emissions and Energy.

Table 5: Quantitative information provided in case studies on GHG emissions and energy

	Company	industry	saving	short description
CO_2				
1	AGC Glass Europe	Glass	CO_2 emissions saving of 15%* (+/-3%) over two years	process improvements
1	AGC Glass Europe	Glass	15 325 tonnes CO_2 per year	process improvements
4	Braskem	Chemical	offsetting 25% of the GWP100 production emissions for Braskem's average ethanol supply.	Green electricity is co-produced with sugarcane ethanol, which helps decrease emissions from power generation in natural gas power plants, offsetting 25% of the GWP100 production emissions for Braskem's average ethanol supply.
4	Braskem	Chemical	0.63 tons of CO_2 per ton of product	target of 0.6 tons of CO_2 per ton of product by 2020
7	Evonik Degussa Antwerp	Chemical	80 000 tonnes of CO_2 per year, equivalent to 0.48kg CO_2 per tonne product	Installation of a new CHP plant. Partially fueling plant from waste production gasses
12	Metsä Fibre Kemi mill	Paper	*confidential*	by energy efficiency measures
16	Royal Mosa BV	Ceramics	reduce CO_2 emission/tonne finished product by 48% over the last 10 years.	Acheved by switching to hydropower electricity
21	Van Houtum	Sanitary products	CO_2 emissions per unit have decreased by 13%; from 577 kg/tonne of product in 2009 to 524 kg/tonne of product in 2013	This is partly due to the introduction of the use of biogas, from relying only on natural gas in 2009 to using 1 438 tonnes of biogas in 2013
21	Van Houtum	Sanitary products	GWP emissions in recycled tissue paper supply chain of has decreased by 75%.	due to displacing pulpwood (virgin raw material) by implementing c2c resource efficiency.
Energy				
1	AGC Glass Europe	Glass	25% reduction in energy consumption	recalibration of production processes
4	Braskam	Chemical	0.22GJ / tonne product less in 2012 than 2011; 1.7% reduction	energy conservation and efficiency measures
4	Braskam	Chemical	1.359 million GJ saved globaly in 2012 from 2011	energy conservation and efficiency measures
11	Janssen Pharmaceutica	pharmaceutical	20 % reduction in energy use compared to old process	higher energy use for transportation of solvent, but much reduced energy for upcycling and solvent recuperation process
12	Metsä Fibre Kemi mill	Paper	64.5 GWh saved per annum	energy efficiency measures
18	Solvic	chemical	20% reduction	net savingsincluding the increased energy use for transport and upgrading of the Sulfuric Acid
20	UPM-Steyrermühl paper mill	Paper	2.2GWh saved per year	energy and material efficiency measures in production process
21	Van Houtum	Sanitary Products	5% reduction in energy consumption reduction, or 16m^3 of gas per tonne product	deployment of a heat capturing system .

Energy efficiency improvements and reductions in GHG emissions tend to come from the recycling of energy within the production process, and from the integration of renewable sources of energy, either externally (such as contracting a "green" electricity supply) or internally, from the utilisation of biowaste or bio-by-products as an

energy source). Royal Mosa reduced CO_2 emissions per tonne product by 48 % over 10 years through the contracting of renewable energy services, while Van Houtum have reduced the CO_2 emissions per tonne product by 13 % from 2009 to 2013, primarily by integrating bio-gas into their energy supply, but also from the installation of a new heat capturing system, which decreased energy consumption per unit product by 5 %.

Materials and waste play an important and often interlinked role in many of the case studies. Table 6 provides an overview of the quantitative information provided in the case studies covering waste and materials. Please note that two of the examples in this table (Ecocem and Cobiax, *italicised*) cover product benefits, not process improvements.

Table 6: Quantitative information provided in case studies on waste and materials

Waste				
4	Braskem	Chemical	14.6% reduction in waste per tonne product in 2012 over 2011	Ongoing strategic improvements in waste management
8	Grundfoss Manufacturing Hungary Ltd	Chemical	176 Tonnes of hazardous waste avoided per year in Tatabanya Plants	implementation of the FLUID management program.
8	Grundfoss Manufacturing Hungary Ltd	Chemical	660 Tonnes of hazardous waste avoided per year in Székesfehérvár Plant	a variety of measures were used along the process to reduce the quantity of hazardous waste water, including the instalation of magnetic filters to remove metalic contaminants
16	Royal Mosa BV	Ceramics	use of recycled material increased from 6% to 23% of total input.	of this, 4% crap from internal processes, and 19% from recycled silica
19	The Goodyear Tire and Rubber Company	Tires	Eliminated waste to landfill	by seperately collection waste and seiding the fractions to either associated interal or external processes, or where not possible, incineration.
20	UPM-Steyrermühl paper mill	paper	5 350 tonnes of fibres and fillers returned to production process from waste streams	improvements in production process
21	Van Houtum	Sanitary products	21 percentage point increase in paper residue recycling rate: from 5 339 tonnes (21%) in 2009 to 9 845 tonnes (42%) in 2012	paper residue is used in a neighbouring plant to produce paperboard, which we use as product packaging
Materials				
4	BB-Lightconcepts	Manufacturing	saved 66 tonnes of Aluminium per year	Achieved by redesigning product; reduced product weight from 23kg to 16kg.
4	BB-Lightconcepts	Manufacturing	saved 6.3 tonnes of shipping cardboard	Achieved by using reusable shipping solution between suppliers.
5	*Cobiax Technologies AG*	*construction*	*Product allows 35% reduction in concrete and up to 20% reduction in steel reinforcement*	*n.a.*
6	*Ecocem*	*construction*	*Product saves 1.6 tonnes of clay, shale and limestone per tonne product*	*n.a.*
8	Grundfoss Manufacturing Hungary Ltd	Chemical	Saves 176 m^3 emulsion/year; which in turn save 7 000 litres oil /year	implementation of the FLUID management program.
11	Janssen Pharmaceutica	pharmaceutical	20% reduction in material use compared to old process	mainly due to the reduction of virgin solvents, which in the end leads to a reduction of crude oil imports
18	Solvic	Chemical	90% material saving	process and product improvements

The reduction of waste through the production process is one method used to reduce the overall material requirement, and increased recovery and recycling of production waste (of for energy recovery) further reduce the material requirements and environmental impacts of production. Van Houtum increased the paper residue recycling rate from 21 % in 2009 to 42% in 2013. BB Lights slashed the weight of their key product from 23kg to 16 kg per unit, saving significantly on the amount of aluminium required for production. The Goodyear Tire and Rubber Company has eliminated waste going to landfill throughout its global operations, achieved by separately collecting waste streams and using the resultant clean fractions internally or selling them as resource, or sending them to incineration.

Water efficiency measures, both for the use of water resources and the reduction of waste water, featured heavily in the case studies, and was supported by quantitative information, as summarised in Table 7.

Table 7 Quantitative information provided in case studies on water and waste water

Water				
2	BASF Antwerpen	Chemical	reduced drinking water by 90% since start of project	long term project, but water now taken directly from surface resources rather than pumped groundwater.
4	Braskem	Chemical	80% reduction over 20 years per tonne of cane: from 5m3 in 1992 to 1m3 in 2012	Upstream improvements
8	Grundfoss Manufacturing Hungary Ltd	paper	660 tonnes of hazardous waste in waste water per year in Székesfehérvár Plant	a variety of measures were used along the process to reduce the quantity of hazardous waste water, including the instalation of magnetic filters to remove metalic contaminants
11	Janssen Pharmaceutica	pharmaceutical	20% reduction in water use compared to old process	more efficient upstream processes in the upcycling phases
12	Metsä Fibre Kemi mill	Paper	5% of fresh water are saved per product	Achieved by reusing warm cooling water as raw water for productior
16	Royal Mosa BV	Ceramics	> 50% Reduction in direct water footprint per tile	The cooling water system has been closed, recapturing water after it has been used
16	Royal Mosa BV	Ceramics	68% reduction in impact associated with wastewater treatment	The cooling water system has been closed, recapturing water after it has been used
18	Solvic	chemical	20% reduction in water use compared to old process	process improvements
20	UPM-Steyrermühl paper mill	paper	20% reduction in fresh water consumption from 2010 to 2013.	from changes to water management system
20	UPM-Steyrermühl paper mill	paper	23% reduction in waste water.	from reduction in fresh water consumption
21	Van Houtum	Sanitary products	Total reduction in water use from 437 161 m^3 in 2009 to 419 392 m^3 in 2013	from process changes to comply with c2c certification
21	Van Houtum	Sanitary products	decreased by 10% over 4 years per tonne product: from 10.5 m^3 in 2009 to 9.5m^3 in 2013.	from process changes to comply with c2c certification
21	Van Houtum	Sanitary products	emission of COD (chemical oxygen demand)pollutants have fallen from 61 tonnes to 54 tonnes between 2009 and 2013, and BOD (biochemical oxygen demand) emissions to water have fallen from 3.3 to 3.1 tonnes over the same period.	although there has been fluctuation throughout the period.

The water requirements for Braskem's raw material – bio ethanol from sugar cane – has decreased significantly over the two decades from 1992 -2012, resulting in a reduction of water required in the cradle to cradle processing from 5m^3 / tonne of product to 1m^3 / tonne product (although much of this reduction lies with the primary processing of the sugar cane). Elsewhere, Royal Mosa implemented a water-savings plan, which closed the loop on the cooling water cycles and reduced the annual water consumption by 60 %.

While there are no legally binding quantitative caps on use of materials and generation on waste and use of water (although there are some policy objectives on these issues), for other resources, like air emissions have more quantitative and hard legislations, i.e. limits on air emissions and potentially lower benefits in terms of resource and monetary savings with further improvements. Only one case study included quantitative information on the effect of resource efficiency measures on air emissions (Table 8).

Table 8 Quantitative information provided in case studies on air emissions

Air Emissions				
1	AGC Glass Europe	Glass	83% (1065 tonnes) reduction in NOX emissions 38% (170 tonnes) reduction in SOX emissions	recalibration of production processes

Although energy and GHG emissions are the most commonly addressed issues for efficiency measures, the financial savings that these measures can generate is often not particularly large relative to total business costs:: while material costs constitute around 40% of manufacturing companies in Europe, energy costs are typically much lower, i.e. 1-2% in the manufacturing sector, and are around 10% in the most energy intensive sectors see e.g Hennicke and Sewerin (2009)[15]. As such, the financial return alone does not seem sufficient to explain the focus on energy efficiency within the companies. The precise level of reduction achieved depends greatly on the sector and products produced, and as such no generalisation can be drawn.

[15] Hennicke P., Sewerin, S. (2009) Decoupling GDP Growth ('Quality of Life') from Resource Use: Achievements and Shortcomings for 'Strategic Governance' in Germany (On behalf of the International Panel for Sustainable Resource Management), 13 pp. Accessible from: http://wupperinst.org/uploads/tx_wupperinst/Decoupling_GDP.pdf

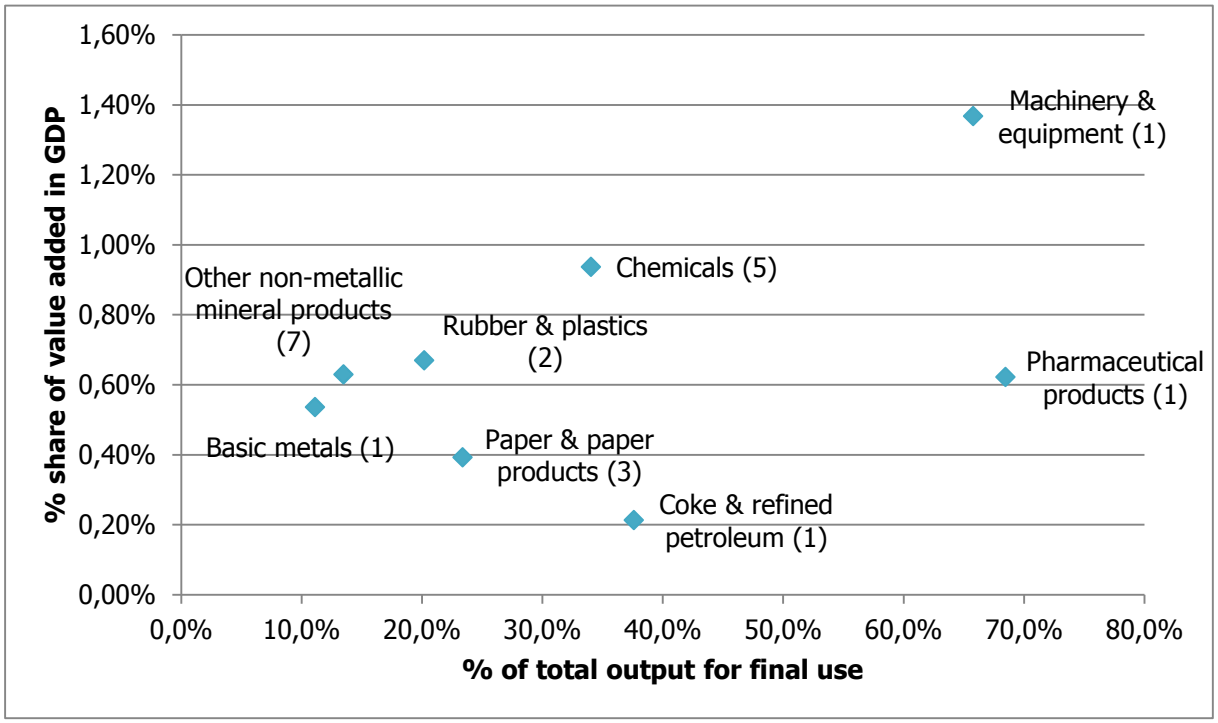
4/ Economic and social impact

4.1 The cases in the EU value chain

In order to gain a broader perspective on the positioning of the cases in the European economic landscape we have situated the cases and the sectors to which can be assigned in the EU value chain. The EU value chain can be approximated on the basis of the EU input-output table. Figure 4 shows the position of the case sectors in the EU value chain, approximated by the sector's share of output sold for 'final use', and the sector's share in value added creation as the percentage share in GDP. Industries that are positioned towards the left side are relatively more focussed on B2B activities upstream of the value chain, while industries on the right side focus relatively more on B2C, exports, and investment goods. The vertical axis indicates the relative importance of the industry in the EU-27's GDP.

From a value-chain perspective 18 of the 20 indicated cases are relatively more focussed on B2B within the EU-27. For the other two cases, the sector tends on average to be more oriented towards final consumers, export outside the EU and investment goods. Evidently all cases are unique and, as witnessed in Annex 1/ every company has its own resource efficiency story to tell. For example, although rubber and plastics as a sector is relatively more B2B oriented, NaKu, an Austrian SME, developed its own niche solution providing services and materials to bio-plastics producers, and providing a sales platform for bio-plastics products for the consumer as well.

Figure 4: Positioning of the cases and sectors in the EU value chain



Source: own calculation on the basis of the EU IO table 2009. The number of cases is indicated in brackets.

4.2 Results from the cases

Based on the information from the validated cases on the economic and social impact, a first synthesis was made with the objective to find a range of evidence of potential cost savings, investments, job creation and other benefits from implying resource efficient polices at the firm level. As in the previous section on the environmental impact, also here one has to bear in mind that the evidence consists of a relatively limited number of case studies which however provide a good insight into the nature, drivers and obstacles of the measures. The cases are less suited to be interpreted in a pure statistical manner for trying to derive frequencies and representativeness. Nevertheless recurring factors across cases do indicate certain patterns which are relevant for this study.

The degree of economic and social impact information varies significantly between the case studies. Very small companies of, largely, start-up nature have conducted only limited analysis of the economic impact of the resource efficiency measure on their operations. This seems to be somewhat related to the small size of the companies and henceforth, their relatively early stages of business development. For instance, the difficulty of obtaining access to funding for Nexiform has prevented the business from developing to its full potential hence the lack of economic analysis of the impact of the resource efficiency measure. Evidently also the age of the RE initiative itself plays a role in the availability of information on economic impacts.

The larger SMEs among the interviewed companies were generally able to provide somewhat more detailed levels of information regarding social and economic impact. For example, Ruhl & co.'s (32 employees) implementation of the resource efficiency measure with the aim of reducing waste in the production process has resulted in an increase in profits of 70.000 EUR (around 10%) in four months following the optimisation of the industrial process and the prevention of the loss of a significant amount of kilos of chemicals (approximately 15.000 kg) used in the production process. Ecocem Materials (90 employees) has been able to sustain 300 jobs in the related enterprises/value chain in the home country and to create 7 new jobs due to the implementation of the resource efficiency measure. Furthermore, the development of the low carbon cement has awarded the company with a market advantage as its resource efficient product is cheaper than those of conventional cement producers. Another example is BB-Lightconcepts (22 employees), which has hired 14 new employees in the span of four years and which has increased production efficiency by 30 % compared to pre-C2C implementation levels. Metsä Fibre has achieved substantial energy savings amounting to more than 300.000 EUR/year following the replacement of the two old water treatment systems.

Some of the largest companies among the interviewees were able to provide more detailed figures on the economic and social impact. For example, Braskem (8000 employees) has been able to create 100 jobs because of the construction of its green ethylene plant. Thanks to the implementation of the resource efficiency measure, Braskem has also been able to reach new markets. Royal Mosa (600 employees) has increased its number of employees since the implementation of the C2C certification and this figure has remained stable over the past two years. Van Houtum's (200 employees) resource efficiency measure has created 5 new full-time jobs, decreased costs by 1 million EUR, and increased sales of approximately 1 million units.. UPM (520 employees) has improved its production process (savings of 1.1 million EUR compared to 2010) and Grundfos Hungary (2028 employees) has recorded significant cost and materials savings, it has saved a total of 109,400 EUR in materials use and waste treatment in its two plants. Goodyear's waste management initiative has decreased costs and today the programme either generates revenue or is cost neutral across its regions of operations. The company also views its resource efficiency achievements as a marketing value for the organisation – being able to advertise it online can also be a way of attracting new talent to the company. AGC Glass Europe's development of the more energy-efficient method of producing flat glass allowed the company to sustain 140 jobs, which would've otherwise been cut. BASF has recorded a decrease in production costs due to the switch from drinking water to surface water.

The cost of the given investment and its payback time differs significantly among the interviewed companies – Ruhl & co.'s investment was fairly small (EUR 4000) and the estimated payback time was 4 months while Royal Mosa invested approximately 3 million EUR. The payback time of Metsä Fibre's investment in a new energy efficient process was in a medium term range. The Solvic and Janssen Pharmaceutica RE measures were capital intensive as well. Yet in these cases shorter payback times have been reported, respectively three and two years. The majority of the interviewed companies did not provide any data on the cost of investment and the payback

time. Yet it is safe to conclude that if the RE measure is not economically feasible with acceptable payback times, it is very unlikely that it will be implemented.

Cost reductions are one of the main economic impacts of the RE measures. Alongside the improved environmental footprint, this generates in turn an improved competitive position which in turn helps to secure employment as well as financial performance. However the magnitudes differ widely. For instance Van Houtum BV reports an increase of its solvency rate by 5% and an increase of its EBITDA by 0.7%. The paper company Metsä Fibre Kemi indicates that its RE measure generated more than € 300,000 cost savings per year, which is approximately 0.6 € per tonne produced. The RE measure at Metsä Fibre Kemi did not create new jobs but rather existing jobs were maintained. At Van Houtum BV five new jobs were created which indicates a net job creation rate of 2.6%.

The final outcome on employment is very much case dependent. This certainly reflects specific company features such as the degree of capacity utilisation, but as well sectoral characteristics and the economic climate in which companies have been operating. In relatively new initiatives such as Solvic and Janssen Pharmaceutica the net employment impact of the initiatives are still uncertain. At ACG Glass Europe 140 jobs could be retained which is virtually half of the total amount of jobs in the site where the RE measure was applied. BB-Lightsconcepts which was a micro company five years ago created over a period of four years 14 new jobs which amount to an annual job creation rate of 29%. The RE measure at Braskem led to the creation of 100 new jobs which represents 1.4% of the actual workforce. At Ecocem 7 new jobs were created which is a net job creation rate of 8.4%.

Other economic advantages reported include access to new market niches as for instance reported by Braskem, Ecocem Materials, Metsä Fibre Kemi, Royal Mosa BV, productivity increases which goes along with an increase in production efficiency as e.g. in BASF Antwerp, BB-Lightconcepts, Evonik Degussa, Neste Oil Porvoo, Nexiform, Royal Mosa, Ruhl & Co, UPM Steyrermühl and Van Houtum BV. A detailed overview of the various economic and social impacts by case is provided in Table 9.

Table 9: Overview of main economic and social impact and detailed (quantitative) specifications by case

Companies	**Employment***	**Investment cost**	**Payback time**	**Job creation**	**Costs/materials savings**	**Change in sales**	**Improvement of market performance/competitiv e ness**	**Financial status**	**Change in production/productivity**	**Detailed (quantitative) specification**
ACG Glass Europe	280 (14,500)			X	X			X		-Energy savings from the measure have had direct financial & economic impacts (data not disclosed) -140 jobs, that would've otherwise been cut, were saved
BASF Antwerp	3063 (112,206)				X		X		X	- Lower costs of surface water in production operations compared to the previously used drinking water - Positive contribution to internal CSR policies - Marketing: customers' and key stakehodlers view on the company's efforts in resource efficiency
BB-Lightconcepts	22		X	X	X			X	X	-Payback time is 12 weeks for the company – 3,5 years for clients before they start making money with the LED light pipes -14 news jobs within 4 years -Cuts in materials use

										-Expected 2014 EBITDA of 17 % -Increase in production efficiency by 30 %
Braskem	8,000			X			X	X		-100 new jobs -Access to new markets/reach new clients -Positive EBITDA developments signs (not documented)
Cobiax Technologies AG	24				X					-Cost & time savings: materials & machinery savings estimated to be up to 20 % compared to traditional approach
Ecocem Materials	90	X		X			X			-2,5 million investment in bagging facility -Sustention of 300 jobs indirectly in the home country, direct creation of 7 new jobs (expected to increase in line with production) - Improvement of market performance & access to niche markets (product priced lower than those of conventional product competitors)
Evonik Degussa	1,063 (33,000)				X				X	- Cost reduction - More efficient production
Gypsum Recycling International A/S	25-30		X	X	X			X		-4 years for the customers (plants around Europe) to make profit -1 job created for every 4000 ton of gypsum demolition /construction waste recycled -Plasterboard plants save minimum 30 % of purchase costs (can save up to 2,5 million EUR/year), waste customers save minimum 25 % of disposal costs (can save up to 5 million EUR/year) -10% ROI in countries where full EU regulation on landfilling is implemented
Grundfos Manufacturing Hungary Ltd.	2,028	X			X					-Investment of 66.700 EUR in one facility -Cost savings (less raw material needed), combined raw materials and waste treatment savings of approximately 45.000 EUR. Reduction of 64.400 EUR at a second plant.
Gyproc / Saint-Gobain Construction Products	224 (187,071)						X			-Developed expertise in gypsum recycling to meet future raw material scarcity & regulation in the field
Janssen Pharmaceutica	4,600 (128,700)		X							- Investment paid back within 2 to 3 years - Net employment effect is uncertain
Metsä Fibre Kemi	200 (900)		X	X	X		X			-Medium-term payback time of investment -Energy savings in the production of pulp because of bark savings (64.5 GWh/year) -Over 300.000 EUR cost savings/year (approx. 0,6 EUR per tonne produced) -No new jobs created but existing jobs were maintained -Improvement of competitive position (better product quality) & potential access to new markets
NaKu	4			X						-Creation of 10 indirect jobs
Neste Oil Porvoo	1,900 (5000)			X	X		X		X	-Lower raw material cost although higher cost of raw material processing (waste)

										-Better control over the supply chain -Improvement of competitive position -No new jobs created but existing ones were sustained
Nexiform Ltd.	3			X					X	-Increase in materials use (from 3-5 tonnes between 2012-2013) -Job creation possible if business takes off
Royal Mosa BV	600	X		X			X		X	-Investment of 3 million EUR -Increase in employment since C2C implementation (although constant for the past two years) -Productivity increase -Outperformed competitors by being 20 % above market average -Reach 'green customer' segment
Ruhl & co GmbH	32	X	X	X	X		X		X	-Investment of 4.000 EUR -4 months payback time -No new jobs -Prevention of the loss of 15.000 kilos of chemicals -70.000 EUR increase in profits -Optimization of product quality
Solvic	581 (29,400)		X		X					-Investment paid back in 3 years -Cost reductions -Reduction of administrative burden -Stable net employment in the short run
The Goodyear Tire & Rubber Company	69,000			X	X		X			-Revenue generator or cost efficient in all regions -Cost reductions -New vendors because of better segregation (generation of employment in the supply chain) -Marketing value (website & recruitment) -Social partnerships
UPM - Steyrermühl	520		X		X		X		X	-Up to a few year payback time -Cost savings (reduced materials use & sourcing costs for waste paper, water, wood, electricity, gas & waste disposal costs), cost savings from small operations around 1000 EUR -Improvement in competitiveness -Production process improvement (1,1 million EUR saved compared to benchmark year 2010)
Van Houtum BV	200		X	X	X	X	X	X	X	-1-3 years payback time. -5 new jobs - Cost reduction of 1 million EUR - Sales increase of 1 million units -Improvement in competitiveness -Increase in investments by 0,1 million EUR

										-Slight decrease in production -Increase in solvency rate (by 5 %) & increase in EBITDA (by 0,7 %)
Average/frequency	4,403	4	8	13	14	1	11	5	9	

(*) For subsidiaries the total of the entire group or company worldwide is provided in brackets.

5/ Drivers and obstacles

5.1 Drivers

Table 10 provides an overview of the drivers of 21 case studies. One of the most common drivers among the companies interviewed regardless of employment size is the desire to improve resource efficiency and the sustainability of the production process. This is often formalised into an explicit sustainability company policy, such as Goodyear's Zero Waste to Landfill, Grundfos' carbon neutrality strategy, Johnson & Johnson's Healthy Future objectives and Earthwards™ standards, Solvay's 'Solvay Way' and UPM's group-wide Material Efficiency Programme. The overall goal is to reduce the company's environmental footprint. Yet also more commercial oriented drivers are involved, such as protection against potential future scarcity of certain materials, cost reduction, and entering new niche markets, especially the markets of sustainable products and processes.

From a value chain perspective, producing sustainable goods and services requires further upstream inputs that are produced in a sustainable manner as well. This can be linked to the consumer markets, where certain companies face the demand for green products and for recycling measures from its client base. Yet it can also be linked by the increasing demand from companies for greener inputs and greener solutions throughout the value chain. For instance, UPM Steyrermuhl has indicated its desire to be a front-runner in resource efficiency as an important driver and Grundfos Hungary is motivated by the Danish mother company's desire to be carbon neutral and its aligned targets. Goodyear has indicated its desire to be a 'good corporate citizen' as a driver behind the implementation of its resource efficiency measure. The same holds, to a certain extent for BASF Antwerp.

The concept of resource efficiency as such can also to be the driver behind the entire business model, rather than a particular measure in an existing company. NaKu and Nexiform are two examples. What is interesting to note here is that both are small companies, which, to a certain extent, can be classified as start-ups, and that resource efficiency is one of the main drivers for the business model. Also larger existing companies have reoriented their business model based on the general desire to improve resource efficiency across the business, for instance Ruhl & co, with the desire to optimize the production process and reduce waste, Braskem and Van Houtum which introduced the RE measure in the context of expected future scarcity of its primary raw material, and Royal Mosa with the goal to minimize emissions. The chemical leasing solutions applied in Janssen Pharmaceutica and in Solvic imply the introduction of a new business model based on functionality rather than volumes of chemicals sold. Unlike the original situation where both companies had to pay for the volumes of the particular chemicals used in the production process and for their treatment, in the chemical lease model, the price is determined on the basis of the results obtained in the production process with the upgraded recovered chemical agent.

Risk management is another important driver that comes to the foreground. Risks consist in the first place of uncertainties with respect to the raw material input, e.g. in the case of BASF Antwerp, Braskem, Gyproc/Saint-Gobain, Neste Oil Porvoo, and Solvic. Yet also the prevention of risks related to environmental pollution have been mentioned. In particular the management of hazardous wastes is important in this respect, as e.g. indicated by Grundfos Manufacturing Hungary. ACG Glass Europe, Cobiax Technologies AG, and Ruhl & Co indicated the reduction of pollution and waste as a driver in this respect.

The prospect of increased profits is another important driver among the companies interviewed – Gypsum Recycling International, BB Lights Concept, Ecocem Materials, Cobiax and Nexiform all mentioned the prospect of an increase in revenue as a driver. Again, this increase in revenue seems to be linked to the prospect of gaining access to new markets and henceforth, to optimize revenue generation. The potential access to new niche market also seems to be a driver among some of the interviewed companies – this is the case for Ecocem Materials, where the company's 'green alternative' has a lower price than competitors' conventional products. Nexiform provides products made from recycled waste. The new product provides a new functionality. NaKu provides bio-plastics products and solutions which is a new market niche as well.

Table 10: Overview of drivers by case

Drivers / Companies	Revenue	Costs	Brand & Customer Reputation (green products)	Innovation, Efficiency & Competitive Edge	Risk Management	Policy Incentives and/or Environmental Regulations
ACG Glass Europe		Need to reduce high energy costs			To reduce energy and henceforth, pollution	Carbon policy/regulation on carbon emissions (subject to the EU ETS system)
BASF Antwerp		Need to reduce costs (drinking water is more expensive than surface water)		The desire to improve the sustainability of its operations	Improve the security of its supply of water: having more available sources of water in its production processes makes it less dependent on possible raw material shock	The EU Water Framework Directive, which limits the use of drinking water from protective areas
BB-Lightconcepts	Possible revenue increase from new market opportunities		Possible market opportunity (green products)	The desire to improve sustainability		
Braskem			Possible market opportunity (green products)	The desire to improve resource efficiency	Predicted future scarcity of main raw material	EU Roadmap for Resource Efficiency goal to cut carbon emission from 1990-2015
Cobiax Technologies AG	Increased profits	Decrease costs		Improve efficiency and develop competitive edge (sustainable building structures)	Reduce pollution	
Ecocem Materials	Potential to increase revenue from new markets (lower price than non-green products)			The desire to develop a competitive edge (through RE) and gain access to new niche markets		

Evonik Degussa	Increased market opportunities	Cost efficient energy production				
Grundfos Manufacturing Hungary Ltd.		Cost savings	Improve quality of cooling/cutting oil	Meet reduction targets set by mother company	Avoid environmental accidents (hazardous waste management)	Compliance with environmental management system (ISO 14001)
Gyproc / Saint-Gobain Construction Products			Demand for green products from customers		Predicted scarcity of the raw material	Establishment of covenant in the industry
Gypsum Recycling International A/S	Revenue increase expected from new business opportunity			New business opportunity driven by the high costs of landfilling → better market for recycling		EU Regulations on landfilling
Janssen Pharmaceutica		Optimization functionality of existing installations	Corporate policy: Healthy Future objectives and Johnson & Johnson's Earthwards™ recognition	Desire to reduce environmental footprint		
Metsä Fibre Kemi		Cost effectiveness considerations		Competitiveness considerations & reinvestment need	Sustainability concerns	Needed to reach goal set by the Finnish government (reduction of energy use by 1 %)
NaKu			Follow the general market trend of 'greening'	Develop an innovative business dedicated to the passions/beliefs of the owners Development of a 'unique green' business model		

Neste Oil Porvoo			Increase in the demand for biodiesel		The scarcity of the former primary raw materials (oil from palm and rapeseed)	Regulations: the Renewable Energy & the Fuel Quality directives (EU level), Finnish national regulations & global greenhouse gas emission targets
Nexiform Ltd.	Increase profits			Develop a competitive edge through the redesign of the business		
Royal Mosa BV				Improvement of resource efficiency expected to lead to better business performance & product quality	Minimize emissions	
Ruhl & Co GmbH				Optimize the production process	Reduce waste	
Solvic		Cost reduction of production process	Part of overall corporate sustainability strategy 'Solvay Way'	Reduction of environmental footprint	Security of supply	
The Goodyear Tire & Rubber Company		Potential to save costs		The desire to comply with internal beliefs in strong CSR policy		Indirectly influenced by policy (landfilling bans etc.)
UPM Steyrermuhl		Cost savings (raw materials, waste disposal, electricity)	Respond to customers' demand for RE	Front-runner in RE measures		Compliance with certifications (ISO 9001)
Van Houtum BV		Recycling expected to lead to cost savings		Foresee the predicted future scarcity of the main raw material through the establishment of sustainable sourcing mechanism at plant	Predicted future scarcity of main raw material	
Frequency	6	11	9	18	12	11

5.2 Obstacles

Around half of the case studies indicate obstacles related to regulations and policy. Although one has to be aware that 21 case studies are certainly not representative for all the RE measures applied in the EU industry, it suggests that in many cases the implementation goes without unsurmountable regulatory and policy problems, yet that there is still room for improvement. In the latter area four important recurring hindrances can be identified. The first is the diversity across Member States in the national implementation of the Waste Framework Directive. The chemical leasing solutions applied in Janssen Pharmaceutica and Solvic currently remain confined to the region of Flanders, Belgium because of the end-of-waste certificate for the upcycled material stream is not recognized in the other Member States. This suggests that in the certification of the end-of-waste status there is currently no level playing field within the EU. Given the importance of scale effects in industry, this may constitute an important impediment for the upscaling of new RE measures across the EU. Differences in the implementation of EU directives across Member States have also been reported for landfilling, green public procurement and in areas related to biofuel production.

The second area of improvement is having a stable legislative framework over time. For instance, Evonik Degussa Antwerp indicated this explicitly as an obstacle for the implementation of its RE measure. Frequently changing laws, regulations and interpretations not only generate additional uncertainty, which hampers investment in RE applications, but also incur adjustment costs during the timeframe of the RE application. A clearly defined and credible long-term policy helps in promoting the application and also development of RE measures. Supporting case evidence for this point of view in the context of biofuel production can be found in the case of Neste Oil Porvoo.

The third area is an optimisation of the EU Emissions Trading System. An oversupply of emission rights in conventional sectors reduces the incentive to invest in RE technologies and measures. In areas where the conventional products from companies under ETS compete with products that are produced with resource efficient methods from companies that are not under ETS, a competitive disadvantage may arise for the latter. An illustration is found in the Ecocem Materials case.

Fourth, a number of companies reported a perceived lack of public support for the implementation of their RE measure. In certain cases, such as Van Houtum support can be interpreted as financial support which helps to bridge the so-called ‘valley of death’ for applying new RE measures that just left the laboratory. Yet in other cases, such as NaKu support is to be interpreted in providing industrial policy priorities and legislative framework which allows a particular RE measure, or even a sector (for NaKu this is bio-plastics), to gain market and expertise in the country.

Access to finance is another important type of obstacle that can be perceived. The implementation of RE measures requires investments which in turn require financial means. Investments include not only the hardware, but changes in processes, procedures, certificates as well. For instance The Goodyear Tire and Rubber Company experienced that in the implementation phase of its ‘Zero Waste to Landfill’ initiative, the process of segregation, waste management and recycling was more expensive than the alternative which is landfilling. Yet through continued efforts of cost containment and valorisation of waste material streams the programme became economically viable. While large companies may have enough financial leverage to finance the transition towards RE measures, SMEs tend to be more vulnerable. The two micro companies in our sample of cases indicated problems for obtaining investment funds. NaKu indicated that it was hard to obtain funds for product development, and Nexiform reported its experience that as a micro enterprise, it is difficult if not virtually impossible to obtain a bank loan for an innovative project. Yet also larger companies reported access to finance as a challenge, e.g. Braskem, BB-Lightconcepts and Gyproc/Saint-Gobain Construction Products. Evidently the phase in the actual business cycle matters as well. Royal Mosa pointed to the economic crisis as an important co-determinant.

In valorising the potential of resource efficient processes and products marketing is still very much needed to explain and communicate the benefits of the ‘green alternative’, which in turn requires additional efforts and finance. Conventional alternatives are often cheaper and are usually better known than the new RE options. A sense of scepticism in the market at the stage of launching the product is not uncommon. Yet it has to be admitted that in recent years the public opinion is more favourable towards sustainable products.

The implementation of new RE technologies is another challenge which has been reported. The implementation of new RE measures requires specialised know-how which is not always present within the company itself. For instance, Evonik Degussa Antwerp insourced the necessary know-how and machinery from a group of specialized energy companies. In the case of Grundfos Manufacturing Hungary, part of the implementation was done within the company, yet specialised know-how needed to the insourced as well. ACG Glass Europe highlighted the strong dependence on a specialised technology partner as one of the challenges.

In view of the company relations across the value chain, certifications are important. Green output requires green input. Although certificates have clear benefits, there are challenges and costs attached as well. For instance Van Houtum reported that it was challenging to motivate its suppliers to comply with C2C regulations. BB-Lightconcepts found it quite challenging to phase out non-C2C compliant materials from its production process. Also Royal Mosa had similar experiences. The Goodyear Tire and Rubber Company indicated that the implementation of its 'Zero Waste to Landfill' initiative required changes in its network of suppliers. Also downstream of the value chain this initiative had ramifications. New vendors were sought, which were able to valorise the residual and waste streams in a resource efficient manner, and generating as such also additional value for The Goodyear Tire and Rubber Company.

An overview of the type of obstacles by case is found in Table 11.

Table 11: Overview of obstacles by case

Obstacles / Companies	Access to Funding, Costs & Changes in Manufacturing	Customers & Marketing Efforts	Access to Raw Materials	Regulation & Public Policy	Market Competition	Implementation of C2C criteria/ technical innovations
ACG Glass Europe						Financial risk in the implementation phase & strong dependence on the technological associate partner in the implementation
BASF Antwerp	The need to implement a strict monitoring programme for water quality control given the lower quality of surface water					
BB-Lightconcepts		Extensive marketing efforts to sell their 'greener product' – hard to convince customers their alternative is better			Higher price than that of 'non-green' competitors	Phasing out materials that are part of the production process but not compliant with C2C demands

Braskem		Extensive marketing needed to convince customers that their 'green product' is better than market alternatives			Non-green products from competitors (fossil-based polyethylene) are cheaper	
Cobiax Technologies AG		The low willingness of the construction sector to embrace innovations				
Ecocem Materials				Distortions in the EU Emissions Trading System imply benefits for polluting competitors while uneven application of green public procurement across EU Member States hinders the roll-out of low-carbon cement production across the EU		
Evonik Degussa				Changes in legislation over time		Access to specialized technological know-how was insourced from a specialised company
Grundfos Manufacturing Hungary Ltd.	Personnel training in new implementation system				Finding the right partners in the supply chain for the waste management system	Installation of new technology (central emulsion treatment equipment, vacuum evaporator)
Gyproc / Saint-Gobain Construction Products	High investment required			Low political willingness to support the further development of recycling measures		

Gypsum Recycling International				Strong dependency on public implementation of EU Landfill and Waste Framework Directives	The price of competing products	
Janssen Pharmaceutica			High quality of upgraded solvents is essential	This chemical leasing solution remains confined to Flanders only due to different interpretations of WFD across Member States		Essential to obtain certification of end-of-waste status with Flemish Public Waste, Materials and Soil Agency; REACH compliance
Metsä Fibre Kemi				Possibly the Resource Efficiency Roadmap (EU) which doesn't distinguish between renewable and non-renewable materials and problems with waste utilization in relation to the EU Waste Framework Directive		
NaKu	Hard to obtain access to funding for product development	Strong marketing efforts needed to communicate the benefits of the more expensive biobased plastics to the end-customer		General public skepticism and low awareness of the benefits of biobased plastics	Difficult to expand sales abroad (requires access to the right partners)	

Neste Oil Porvoo	Technical adaptation to new raw material – new processes needed to be developed			Lack of harmonization of regulation within the EU (recognition of specific types of fuel) making market penetration more difficult, animal fat is not allowed to be used to the same degree in all EU countries & no long-term policy framework encouraging the investment in biofuel production		
Nexiform Ltd.	Difficult to gain access to bank funding as a small, innovative company	Extensive marketing needed due to resistance from the public to a product which is 'made from waste'				
Royal Mosa BV	Economic crisis		Finding the right raw materials	Perceived lack of public support (renewable energy plant)		Compliance with C2C raw materials regulation
Ruhl & Co GmbH	After optimization of the production process at the plant the staff had difficulty adapting to new technology					
Solvic				This chemical leasing solution remains confined to Flanders only due to different interpretations of WFD across Member States		Essential to obtain certification of end-of-waste status with Flemish Public Waste, Materials and Soil Agency

The Goodyear Tire & Rubber Company	Allocation of additional internal labour to waste management operations, additional space needed for storage of segregated wastes and on loading docks for shipment of wastes, more containers required for segregation and storage operations and more compactors and bailers required	New vendors required to handle segregated materials and limited number and types of waste vendors			Cost structures (waste management more expensive than landfilling initially)	
UPM Steyrermühl					To optimize in an industry that is already characterized by large optimization efforts	
Van Houtum BV		Extensive investment in retail marketing needed to increase revenue	Scarcity of raw materials (recycled fiber & biogas) to be used for RE implementation	In the company's view the EU waste regulations rather delayed receiving a permit to process drinking carton waste (a move towards grass fiber, a possible alternative future raw material) & lack of public funding/support		Difficult to get suppliers to comply with C2C implementation criteria
Frequency	9	7	3	11	7	8

6/ Links with the policy framework

One of the objectives of the study is to inquire and analyse the relationship between the RE measures and the policy framework. In particular the question to which degree (environmental) policy stimulated the development and implementation of the RE measures. Among the companies that have been interviewed, only Neste Oil has indicated explicitly that its resource efficiency measure was implemented as a direct response to a regulation. The company has indicated that its investments in renewable diesel were driven by The Renewable Energy Directive and the Fuel Quality Directive and national Finnish energy regulations. Despite the fact that none of the other companies have indicated that the given resource efficiency measure had been implemented as a direct response to a regulation there does seem to be an indirect relation between these two factors among the rest of the companies.

For instance, NaKu has indicated that the ban of plastic bags in Italy was an important driver for the development of alternatives, while the same development has not taken place in Austria and subsequently, the company feels that public awareness and support is fairly low in the country. The EU directive on landfilling has presented a business opportunity for Gypsum Recycling International, which offers a product that is often a more economical alternative for companies compared to the scenario of them having to pay high landfilling cost of waste. Braskem has indicated the 'EU Roadmap for Resource Efficiency goal to cut carbon emissions from 1990-2015' as a driver for the company implementation of the resource efficiency measure – the implementation of the measure is expected to have put the company on the forefront before the implementation of future regulations. Metsä Fibre's replacement of the two old water treatment plants was partly driven by the energy reduction goal of 1 % as set by the national Finnish government. Furthermore, AGC Glass Europe also indicated that the company's decision to reduce its carbon emissions was driven by EU carbon policy and regulations on emissions (hence, the EU ETS system). BASF's decision to switch to surface water in the production process was partly driven by the EU Water Framework Directive. The Goodyear Tire and Rubber Company's decision to implement the 'Zero Waste to Landfill' initiative was indirectly driven by changing landfilling regulations (bans etc.). Interestingly, the company's achievement of the 'Zero Waste to Landfill' goal has helped realising the 'post-consumer value chain' as the company has had to identify new waste vendors and develop entire waste management infrastructures in some of its global regions of operations.

In two cases proposed but yet-to-be-implemented EU legislation has led to the early implementation of resource efficiency measures with the scope of generating new business and gaining access to new segments. This suggests that the resource efficiency policy measures rather influence company decisions indirectly through shaping the company 'environment' in which it operates. In this respect it is worth noting that the anticipative nature of the measures seems to have co-determining effect.

This does not mean that policy does not have any effect at all. The information presented in the cases suggest that one has to make a distinction between the drivers for starting up the initiative and the drivers for further growing the company. In our view the cases suggest, among others, that implementing resource efficiency measures are mainly done for other reasons than policy regulations, yet that the success of the measure and business viability may be substantially co-determined by them.

Indeed regulations at national and/or EU level may in certain cases also be viewed as an obstacle as indicated in previous section. For example, Ecocem has indicated that through the ETS system more polluting competitors receive the economic benefits despite the company's own efforts in resource efficiency. Royal Mosa has indicated how the small size of its organisation prevents it from building a renewable energy plant on its own (a step towards better energy efficiency in compliance with C2C certification) and how it has experienced a lack of public support for the construction of such kind of a plant. Van Houtum perceives national public administration and EU Waste Regulations as a factor that delays the company's process of obtaining a permit to process drinking water (a further step in its resource efficiency process), while it also experiences a low public support for its efforts. The same applies to Gyproc and NaKu. NaKu has also indicated that it feels that the public awareness of the benefits of its product is low but that the tide is changing. Neste Oil has expressed the lack of harmonisation of a number of policies across the EU as an obstacle – for example, the fact that its primary raw material (animal fat) can't be used to the same degree in all Member States is viewed as an obstacle. Metsä Fibre has indicated the EU Waste

Framework Directive as a challenge as it presents problems with waste utilisation for the company. It is interesting to notice that this particular obstacle was indicated by small and large companies alike.

Indeed the policy framework plays an important role in upscaling RE measures at the level of the EU market. The Janssen and Solvic cases showed that the chemical leasing solution could not be readily applied in other Member States because the end-of-waste certificate from the Flemish government is not recognized as such in other regions and Member States. Also the diversity in implementation of the Waste Framework Directive, the Landfill Directive, Green Public Procurement practices hinder the further upscaling of the RE measures across Europe. Evidently access to know-how, technology, and the availability of resources in terms of material streams as well as capital both human and financial, play an important role as well.

Given the above observations, it is possible to formulate a number of policy suggestions for enhancing resource efficiency in businesses, especially with respect to realising the upscaling potential in the EU and to foster the effectivity of the RE measures taken. These can be formulated concisely as follows:

- Reduce the differences in the implementation of relevant EU directives across Member States. Although in principle these differences should be minimal given that they are the translation into national legislation of an EU directive, yet differences in interpretations, standards, required certificates, etc. do frequently occur which may confine the resource efficiency measure to the national/regional market and limit its valorisation potential in the EU. For instance more consistency between Member States' implementation of the Waste Framework Directive would be very much welcomed by businesses.
- Facilitate SME finance for implementing RE measures and developing new products and services that contribute to resource efficiency. While large companies have the resources to set-up adequate financing mechanisms, for most SME, especially micro and small companies, this is beyond their core business. Given the specific technical nature of the RE solutions, and the related uncertainties, a financing gap may occur leaving the measure on the drawing table. Various types of specialised government support schemes for SMEs can be instrumental.
- Provide a stable legislative framework over time with clear long-term policy directions. This reduces the business uncertainty which is in turn conductive to investment in resource efficiency measures. It also minimises the adjustment costs over time. A clearly defined and credible long-term policy helps in promoting the application and development of RE measures.
- Promote platform creation for bridging information and knowledge gaps and for raising public awareness of RE solutions. This can be done at various levels, each with its own focus, ranging from the EU level to the regional level.
- Optimize existing legislation with respect to its effects on the effectiveness of RE measures. The Waste Framework Directive and the EU Emission Trading Scheme have been mentioned explicitly in the cases.

Part II: Annexes

1/ Validated case studies

1.1. AGC Glass Europe

Company Name: AGC Glass Europe
Case study title: Oxycombustion furnace design, AGC Glass Europe, Boussois site, France.
Year of implementation: 2008 to present.

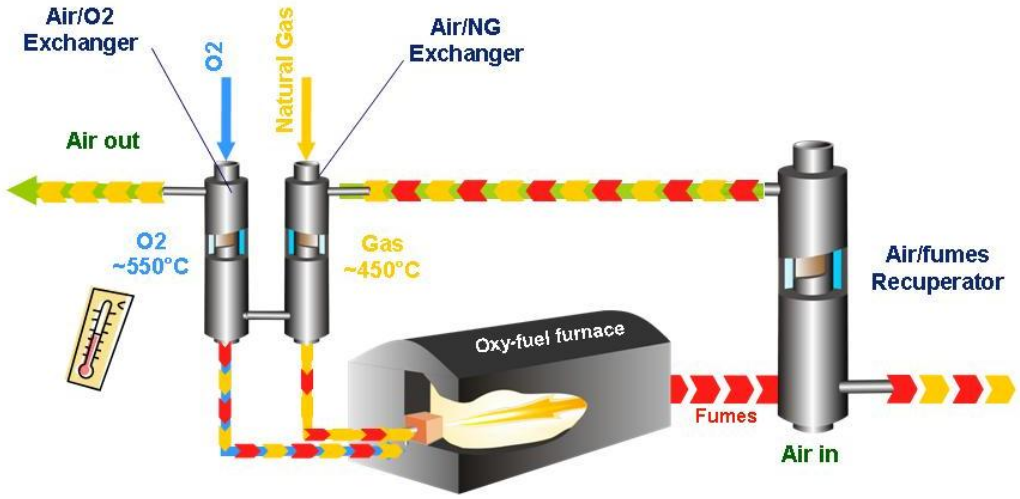
COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
Corporate address: AGC Glass Europe - Headquarters Avenue Jean Monnet 4, 1348 Louvain-la-Neuve, BELGIUM Site of Boussois: 100 rue Léon Gambetta 59168 Boussois, FRANCE	Division 23, Group 23.1, Class 23.11 Manufacture of other non-metallic mineral products/ Manufacture of glass and glass products/ Manufacture of flat glass	Global corporation: 14,500 employees worldwide. Site: 280 employees as of 2009.
Type of resource(s) affected		
Energy, atmosphere		

Company description
AGC Glass Europe produces, processes and distributes flat glass for the construction (external glazing and interior decorative glass), the automotive (original & replacement glass) and the solar sectors. It is the European branch of AGC Glass, the world's largest producer of flat glass with over 100 sites throughout Europe, from Spain to Russia and a worldwide marketing network.

Description of the resource efficiency (RE) measure(s)
The initiative to develop a more efficient furnace through oxy-combustion (i.e. a technique which uses pure oxygen instead of air as oxidizer in the combustion process) to produce flat glass had two objectives: • reduce energy consumption in the flat glass production process. • reduce air pollutants emissions, especially NOX and SOX Although some previous examples of oxy-combustion exist in the USA, they do not recover the heat from exhaust fumes. The innovative concept of the “HotOxyGlass” furnace lies in the combination of: • the oxy-combustion technique • the pre-heating of reactants involved in the combustion (fuel and oxygen) to very high temperatures with the recovered heat from the exhaust fumes

In the furnace depicted below, the exhaust gases (1450°C) are re-injected into a recuperator when leaving the furnace combustion chamber. The recuperator allows a heat exchange between the flue gases and atmospheric air, which then is heated to 750°C. In turn this hot air conveys heat to the oxygen (to 550°C) and natural gas (to 450°C).

Figure 1. Technology of the HotOxyGlass furnace - Scheme of the concept



Source: Reproduced from Air Liquide and AGC Glass Europe (n/d) LAYMAN'S REPORT. HotOxyGlass project. LIFE07 ENV/F/000179 http://www.oxyfuel-heatrecovery.com

How has the company implemented the RE measure(s)?

The measure was implemented following a successful pilot trial (2008-2010) developed in partnership with the research of the company Air Liquide[16] (www.airliquide.com) through a Life + project.

Implementation of the RE measure: drivers and obstacles

Why was the measure taken?

Glass production is particularly energy intensive and is associated with the emission of pollutants. Although energy intensity has substantially decreased to a 10th of what was needed in the late 19th century[17], energy remains a major cost factor.

[16] Air Liquide is the world leader in gases for industry, health and the environment, and is present in over 75 countries with 43,000 employees. Oxygen, nitrogen, hydrogen and rare gases have been at the core of Air Liquide's activities since its creation in 1902. Using these molecules, Air Liquide continuously reinvents its business, anticipating the needs of current and future markets. The Group innovates to enable progress, to achieve dynamic growth and a consistent performance. Air Liquide explores the best that air can offer to preserve life, staying true to its sustainable development approach.

[17] To produce 1 tonne of flat glass today, about between 6 to 7 giga-joules are needed down from the 60-70 needed in the 1880s.

Energy intensity is a challenge in the glass industry and efforts to manage and reduce such intensity are continuously being developed. As such, this process innovation is in line with a general strategy followed by the company.

What problems did the company encounter when implementing the RE measure?

The following aspects can be highlighted as implementation challenges:

- The level of financial risk associated with real-life implementation of technological implementation in this type of large-scale industries. Although upstream R&D investments were committed in developing the measure for this improved version of oxy-combustion by the company, testing it in an operating furnace was enabled by external support through the Life + project.

- The implementation of the measure depended on the successful partnership with Air Liquide, the technological associate. The contractual aspects of the ownership of the results from the projects required careful consideration and efforts to ensure a stable post-project relationship and the fruitful development of next generation innovation by both partners.

Incentives & drivers for implementing RE measure [(1)]

- *Regulatory framework*

Carbon policy and the cap on carbon emissions by the glass industry have influenced the drive towards more efficient technologies. The glass industry is regulated and subjected to GHG emission quotas since the first round of the implementation cycle of the EU emission trading system (EU ETS). As such this has been one of the factors that influenced the decision in developing this RE measure.

- *Implementation of Environmental Management Systems (EMAS or ISO14001),*

AGC Glass Europe already met the requirement of the European Commission's "Integrated Pollution Prevention and Control (IPPC) Reference Document on Best Available Techniques in the Glass Manufacturing Industry" (BREF 12.01, December 2001).

In addition to the drive to drive down energy intensity and related costs, internal sustainable development is an important part of AGC Glass Europe's Corporate Social Responsibility. The group has an Environmental Management System (EMS) to control and reduce its activities' environmental impact. A growing number of AGC Glass Europe plants have now achieved ISO 14001 certification. All factories in the raw glass division have acquired ISO 14001 certification by 2008. Furthermore the group plays a proactive role in developing new legislation. It is indeed at the forefront of innovation for implementing environment-friendly techniques for glass production.

- *Involvement in research programmes (FP7, ….)*

In addition, the financial structure of the project was partly supported by public funding through both EU and French sources, as illustrated in table 1.

Table 1. Subsidies and sources of funding

French Energy Agency (ADEME)	€ 1M
ERDP	€ 2.4M
Life +	€ 3.4M

It is probable that the availability of public funding enabled the implementation of the measure at its full potential and without delays following the R&D upstream investments. The subsidies facilitated taking the life-size testing risks associated with large scale industrial operations.

Difficulties encountered in implementation phase?

No specific administrative or regulatory aspects were highlighted as particularly cumbersome. However, to benefit from the Life + subsidies the company hired a team of specialists to put together the technological dimensions of the proposal with its administrative as aspects for submission.

Technologically, the most delicate part was related to the handling pure oxygen at high temperatures which can represent a hazard but was not considered as a barrier per se but a crucial aspect of safety.

Scaling up and dissemination opportunities:

The successful development of the pilot and definitive solution at Boussois of the new process prompted the ACG Glass Europe to implement similar solution at wider scale in the ACG Group. The technology is available for other glass makers or industries requiring high levels of combustion (e.g. steel, iron, cement, boilers industries).

In short-term, glass industry remains a privileged candidate for dissemination as it still represents a large sector in terms of furnace to be converted (for information: 58 Float tanks in Europe, 175 containers glass furnaces…). A wider implementation of similar furnaces can easily be expected by the end of 2020. As a matter of fact, a new furnace has been refurbished to be fitted with this upgraded oxycombustion system by AGC Glass Europe in the Czech Republic.

Resource impacts

The case study impacts on fuel source use (natural gas) and air quality. As such, and following a two year calibration period the furnace resulted in the following impacts (Table 2 below):

Table 2. Main environmental impacts

Environmental indicator	Reduction measured (with margin) compared to a state of the art air-fired furnace
Energy consumption	- 25% (margin of 2%)
CO2 emissions	- 15%[(1)] (margin of 3%)
NOX emissions	- 83% (margin of 5%)
SOX emissions	- 38% (mean value)

[(1)] *when taking into account the environmental cost of oxygen production*

Source: Reproduced from Air Liquide and AGC Glass Europe (n/d) LAYMAN'S REPORT. HotOxyGlass project. LIFE07 ENV/F/000179 http://www.oxyfuel-heatrecovery.com

In absolute terms, for one full year of operation, these savings translate in average into:

- 15 325 tonnes of CO2, equivalent to taking a total of around 3 400 cars out of circulation
- 1 065 tonnes of NOX;
- 170 tonnes of SOX.

HotOxyGlass is today the less fuel consuming and the less pollutant among the 58 flat glass furnaces in Europe.

Economic and social impacts
A direct social impact has been that the innovation saved about 140 jobs that were to be axed without the successful refurbishment of the plant at Boussois. Specific financial data was not provided given the sensitive nature of this information; however the energy and related carbon emission have direct economic implications for a company in an energy intensive industry.

Local/regional/national/EU resource policy framework
As mentioned above, carbon emissions of the glass industry are regulated and subjected to quotas since the first round of the implementation cycle of the EU emission trading system (EU ETS). In addition, the availability of EU and national funding also influenced management in going ahead for the full implementation of the measure as financial risk was pooled between the company and the public funding.

Further information
Company: AGC Glass Europe http://www.agc-glass.eu/English/Homepage/Our-Values/Environment/Environmental-Report-2013/Oxycombustion-furnace-design/page.aspx/1654 Project: HOTOXYGLASS (life + project) http://www.oxyfuel-heatrecovery.com/ Link to EEA RE country profile (scroll down to the link for France): http://www.eea.europa.eu/themes/economy/resource-efficiency/resource-efficiency-policies-country-profiles

1.2. BASF Antwerpen

Company Name: BASF Antwerpen
Case study title: BASF Antwerp's new water sourcing strategy
Year of implementation: 2011

COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
Belgium, Scheldelaan 600, 2040 Antwerpen	20 - Manufacture of chemicals and chemical products	End 2013: 3,063 employees Total group 2013: 112,206.
Type of resource(s) affected		
Process water		

Company description
BASF Antwerpen NV is 100% owned by BASF SE, the world's leading chemical company. The BASF site on the north side of the port of Antwerp is the biggest integrated chemical complex in Belgium and the second biggest 'Verbund' site[18] of the BASF group worldwide. BASF Antwerp NV produces chemicals, plastics and performance products in more than 50 plants. With ca. 3,000 employees in 2013, BASF Antwerpen generated a turnover of €6.88 billion. More information is available on www.basf.be.

Description of the resource efficiency (RE) measure(s)

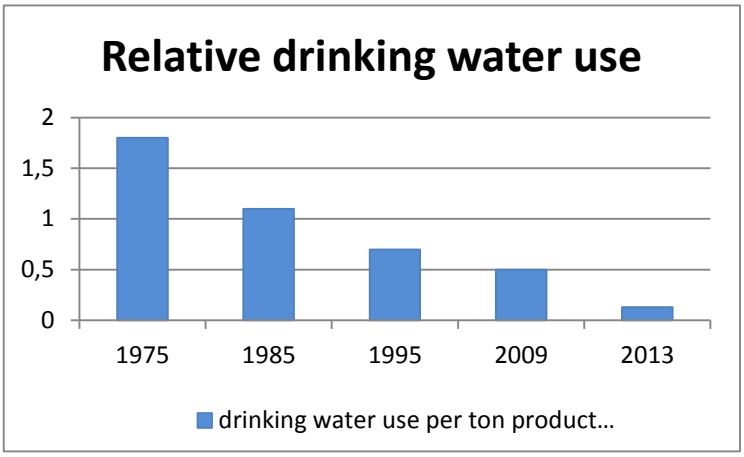
Water is an important resource for BASF, as it is used as a process input, for steam generation (in demineralized form[19]) as well as for cooling. Since its establishment in 1967, the three key principles of the water management at the BASF Antwerp site are:
- A continuous improvement in both quantities and quality of water consumed:
  o maximize reuse
  o local water purification
  o separate water cycles for process, demineralised (demin) and cooling water
- The application of an integrated site water concept in line with the BASF 'Verbund' principle, which is an intelligent interlinking of production plants in order to maximize resource efficiency.
- Doing water risk assessments for improving the security of supply.

[18] BASF organises its production plants in six large Verbund sites. The idea behind the Verbund sites relates to the intelligent interlinking of production plants, energy flows and infrastructure. Also, know-how and customers are intelligently connected to each other. For more information, see:

http://www.basf.com/group/corporate/en/investor-relations/basf-in-brief/verbund/index

[19] Demineralised water is water that had almost all of its mineral ions removed, e.g. sodium, calcium, ... When water is to be used for steam generation, it needs to be demineralised.

The graph below shows that these efforts have allowed a continuous decrease of relative water usage (the amount of water used (m^3) to produce one ton of final product) over the past decades.



In 2010 two-thirds of the drinking water was sourced from river water, e.g. the Albert canal, and one third from groundwater from the Kalmthoutse Heide which is a national park in the North of Belgium. Less than 5% of the drinking water supplied to the site was for sanitary purposes while the remaining 95% was used for industrial purposes. At the same time the need for demineralised water was increasing. For cooling purposes on the other hand, dock water is used.

In 2011 BASF Antwerp switched to using river water rather than drinking water for industrial processes. The use of ground water was abandoned and fully replaced with the use of surface water. This resource efficiency measure was established through a partnership with Evides Industrial Water (EIW). This company supplies surface water to the industry from their basins located in 'De Biesbosch', a national park in The Netherlands close to the Belgian border. The water from these basins origins from the river Meus (Maas). The geographical location of the Antwerp site made it possible to connect to the industrial water grid of Evides Industrial Water coming from the north (Netherlands). The water is transported to the BASF Antwerp site by cross border pipelines.

Implementation of the RE measure: drivers and obstacles

The drivers behind this measure are manifold:

- Ecological: in its efforts to maximize the sustainability of its operations, the company wanted to reduce strongly its use of drinking water.
- Economical: surface water is less costly than drinking water
- Security of supply: the company has now multiple sources from which it can obtain water.

From the side of regulation, the EU Water Framework Directive was an important trigger as well, as it limits the use of drinking water from protected areas such as the Kalmthoutse Heide. Together with the increasing need for demineralised water and the fact that the existing contract for water supply ended in 2011, there was a clear case for establishing a new source of water supply.

Switching to surface water however required some modifications to existing operations, as the water quality is lower compared to drinking water. Therefore, a strict monitoring programme for water quality was implemented taking into account the requirements for high pressure steam generation and the impact on biological corrosion.

Resource impacts
The measure reduced drinking water consumption at the site by 9 Mio m^3 water per year. This corresponded to a reduction of 90% of total drinking water used. The remaining 10% are used for sanitary purposes and as back-up process water.

Economic and social impacts
The economic impact, taking into account the additional investments needed to work with surface water, was evaluated positively. This positive impact is driven by the lower cost of surface water compared to drinking water. The social impact is evaluated positively as well. Firstly, the measure contributes to the EHS (Environment, Health and Safety) goals of the BASF group. In addition, the efforts with regard to water efficiency increase the general social acceptance of the business operations. The efforts were welcomed by Natuurpunt which is a regional environmental NGO. In general, the company strives towards maximizing social acceptance of its business operations. As such, it is also involved in regular dialogue with representatives from the nearby local community.

Local/regional/national/EU resource policy framework
The EU water framework directive entails an increased protection of water resources, particularly in freshwater ecosystems such as the Kalmthoutse Heide in Belgium. Taking into account the increased need for demineralised water, sourcing water from this area was not a sustainable option. It was therefore decided to switch to surface water.

Further information
More info on the measure: http://www.evides-cn.com/references/basf-antwerp/ More info on the various efforts of the Belgian chemical industry w.r.t. sustainability: http://www.essensciaforsustainability.be/About-this-Report/About-this-Report

1.3. BB-Lightconcepts

Company Name: BB-Lightconcepts
Case study title: **100% recyclable LED lightpipes**
Year of implementation: 2007 started development of the LEDlightpipes; in 2010 BB LightConcepts introduced the new LEDlightpipe.

COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
NETHERLANDS, Fabriekstraat 16-04 7005 AR Doetinchem	Downstream chemicals : light pipes with LED technology	22 FTEs, SME
Type of resource(s) affected		
Materials, energy		

Company description
BB-Lightconcepts was created in 2004 producing standard Lightpipes with Metal Halide lightsources, and changed to LED Lightning production in 2007. In 2008 it became part of the TKH Group, a cable manufacturing company listed on the stock exchange in Amsterdam, which now owns 100% of BB LightConcepts. TKH has a yearly turnover of 1.2 billion EUR and 74 companies in its portfolio. BB-Lightconcepts currently operates in 8 countries. The manufacturing point is in the Netherlands and is designed with potential to scale up productivity due to their Lightpipes' modular design; the LED light pipes are made mostly of semi-assembling components, which are assembled in the final product at their factory in Doetinchem. BB LightConcepts manufactures several collections of LED pipe models, suitable for use in tunnels, warehouses, factories, cark parks and train stations. Their products contribute to decreasing energy consumption due to various technologies customized for each light pipe collection e.g. their LEDlightpipes come with a parking guiding system in garage spaces reducing search traffic and CO_2 emissions, and they can be used with an active dim program that minimizes power consumption, compared to conventional light fixtures. Additionally, their products require minimum maintenance, installation can be done quickly and light tubes can easily be replaced. The latter implies a significant advantage compared to conventional LED fixtures, which need to be replaced once a single tube breaks. **Product data on BB-Lightconcepts' C2C (cradle-to-cradle) compliant LED light pipe** The LEDlightpipe are compliant with C2C requirements and has an integrated emergency lighting (illumination by deliberate use of light to achieve a practical effect), very low UGR (unified glare ratio) values, step-less dimmable up to 5% for maximum energy savings, has a DALI (digital addressable lightning interface), bi-directional communication with every individual fixture, which allows consumption measurements, and its LEDs have a life

span of over 100 000 hours, equivalent to their use over a period of 21 years, 13 hours/day.

C2C product certification

The company has been working with Cradle-to-Cradle (C2C) certification process since the beginning of 2008, and by 2010 they received a certificate of compliance from EPEA Hamburg, Prof. Dr. Michael Braungart's (one of the C2C pioneers) certification agency. This means that BB-LightConcepts manufacture its products in compliance with the five C2C criteria. The company has not yet received a level certification, since some of their products' components, deemed blacklisted by the EPEA's material library, cannot be replaced with current technologies (for example, the polycarbonate component and a small fraction of gallium present in the LED). Other than the issue posed by these two components, their LEDlightpipes are produced in conformity with C2C philosophy.

Cradle-to-Cradle states that waste is food. Therefore, C2C product and process implementations are evaluated against five main criteria: material health, which implies removing any toxic components from the product; material reutilization, which concerns product complete recyclability, either as technical nutrient or biological nutrient re-entering the production cycle; water stewardship, linking it to protecting water sources; renewable energy, as opposed to non-renewable, CO2 emitting fossil-fueled energy and; social fairness.

Source: http://www.C2Ccertified.org/

Description of the resource efficiency (RE) measure(s)

Context information

Towards the end of 2007 the Managing Director, Chiel Bekker, attended a conference on C2C held by Michael Braungart, in Antwerp, Belgium. At that time Bekker was interested in building a marketing concept based on functional, environmentally-friendly product design that would source materials from local suppliers. In addition to this, the market was showing signs of interest in environmentally sustainable products. The C2C concept presentation seemed to support this vision, and BB LightConcepts started cooperating on product re-design with EPEA Hamburg in the beginning of 2008; due to high costs of implementation for product re-design, Bekker decided to sell 80% of his shares in the company to TKH Group in 2008 (which now owns 100% of the company's

shares, as of 2013). This contributed positively to the C2C implementation process, as TKH provided the company with a 200 000 EUR investment for the implementation of the C2C process. At that time, the company had 8 full time employees, and the C2C process was managed by Chiel Bekker and R&D Manager Bennie Elfrink.

Detailed description of the measure

The BB-Lightconcepts' case study is not focused on a resource efficiency measure per se, but rather on the environmental and economic impact of implementing a C2C process both internally, within the organization, and externally, in relation to the environmental and economic benefits incurred by their customers who purchase the LEDlightpipes.

Phasing-out materials conflicting with C2C criteria

First, the company focused on phasing out materials which couldn't comply with the C2C criteria on toxicity and recyclability. They started the process by eliminating polyvinyl chloride (PVC), a common petrochemical polymer blacklisted by the EPEA's material library. Rubber had to be phased out as well; although not a harmful or scarce material, it is not a recyclable material, it can only be downcycled. They replaced the rubber with a thermal plastic material, which can be reused at the end of product's life span. Similarly, halogen and flame retardants in the wires were conflicting with C2C toxicity requirements and were thus removed.

Innovation at product level

Their products are designed as technical nutrients, according to C2C acceptance criteria, which means that it is easy to take them apart and it is easy to recycle components at the end of the product's life span. Where component replacement proved difficult in terms of preserving quality and functionality, the R&D department sought to innovate and come up with new solutions that would meet both their criteria for functionality and the C2C environmental criteria. For example, the LEDlightpipe housing used to require a resistant aluminum disk with a rubber vulcanized ring and a PVC component. This has been replaced by using a thermoplastic pyroplast disk designed to allow wires to push through specially shaped holes, saving 6-7 components. Pyroplast is a safe material according to EPEA's criteria and can be recycled.

Changing the production line

The complete redesign of the production machine also aimed to replace the glue used to position the foils into the tube. The glue was used to ensure precise positioning of the foils, facing exactly the right spot, and finding a functional replacement proved difficult. The solution required the creation of a bending technology applied on the foils, which would press the foils against the inner side of the tube without the use of glue. The redesign of the production machine incurred the highest investment costs and took almost two years to be finalized at a fully functional level.

Improving resource efficiency

BB-Lightconcepts uses 100% renewable energy in supplying its production processes of their LED light pipes. Waste is sorted at the factory site into stainless steel, aluminium, copper, soft foil, hard foil, polyester and polycarbonate. The plastics are shredded at their site and sold as raw material to waste collecting companies, leftovers from the polycarbonate tubes are sold as quality waste and turned into granulate raw material, which can serve in other production cycles, and aluminum waste is sold per kilogram. In addition to these, the company has sought to reduce packaging waste as well, by purchasing sixteen $1m^3$ boxes as transportation units between suppliers and the manufacturing plant. All these waste sorting processes have cut down waste disposal costs and are adding value instead. Energy suppliers are chosen among companies that can provide clean energy, produced sustainably e.g. wind energy, solar power, biogas. Cable suppliers are sourced locally in order to save CO_2 emissions by cutting down traveled distances and carriers are required to use vehicles equipped with special exhaust filters to diminish impact of emissions.

How has the company implemented the RE measure(s)?

BB-Lightconcepts ordered an assessment of its product components in relation to C2C criteria on material health and reutilization and was advised to start phasing out components that were conflicting with the C2C acceptance criteria, soon scaling up the C2C process implementation by taking efficiency measures in connection with energy consumption, waste sorting and carbon footprint reduction of their logistics system.

In relation to the process of re-designing the production machine, the R&D work was done mainly by BB LightConcepts, in cooperation with one of the sister companies in the TKH Group; the project design of the machine is a proprietary technology of BB-Lightconcepts, and the actual execution of components of the machine was performed by a third party. EPEA representatives assisted in searching for replacement materials to phase out components conflicting with C2C requirements.

Implementation of the RE measure: drivers and obstacles

The management wanted to find a functional, sustainable alternative to LED lighting products available on the market at that time. The management decided to start re-designing its products and to build a marketing concept based on the principle of material reutilization. They wanted to start producing recyclable light pipes and avoid having to compete on price with other products on the market that lacked both functional quality and environmental, good performance. Re-designing their products meant re-branding the company as a sustainable solutions provider.

What problems did the company encounter when implementing the RE measure?

Phasing out materials
The process of phasing out materials conflicting with C2C criteria proved challenging, as there were no existing functional replacement for the PVC, rubber and polycarbonate components. PVC was replaced in time with a metal board and rubber was eventually removed as well. The polycarbonate tube, however, could not be replaced efficiently, so this is one component still present in their LED Lightpipes. According to research, polycarbonate can be dangerous for human health when eaten; in the context of BBLight Concepts' manufacturing process, the polycarbonate poses no significant negative impact therefore it is approved by EPEA.

Re-designing the production machine
The re-design took almost two years, from creating the first design specifications to the actual building of a functional machine, as the technology required was not provided by the market at the time. The main problems involved design of the processes for positioning the foils inside the tube. The solution was provided by the company's R&D department.

Finding a clean energy supplier
According to management, finding a clean energy supplier in their region was also a challenge, overcome through perseverance.

Working towards a C2C level certification
Being unable to replace polycarbonate and gallium from the LED components, the company got stuck in its process towards C2C certification, as EPEA constantly refused certification, arguing the need for 100% compliance with its list of banned components. Given that there areno functionally effective replacement of polycarbonate that would be conformant with C2C criteria, finally the company was awarded C2C label in their marketing products.

Reluctance in the market
LEDlightpipes require higher initial investment cost; they are more expensive to purchase than conventional light fixtures. This is one challenging factor in selling the product. However, an LCC study from 2013 shows that the lifetime costs of LEDlightpipesare lower than the investment in conventional fixtures.

In addition to this, the C2C certification is still not widely recognized, and the company felt that marketing one's products as "sustainable" or "recyclable" is met with reluctance on the market, possible due to widespread greenwashingin the business sector. Convincing customers of the genuine environmental benefits of the products requires that BB LightConcepts tell the complete story of producing C2C compliant LED Lightpipes, by comparing

the present product with their old one, in terms of economic and environmental efficiency.

Link with RE platforms and business associations

In 2012 BB LightConcepts was one of five sponsoring members of a C2C group in the Netherlands.These members were active is very different industrial sectors , however, so had little support to offer each other in terms of the C2C implementation process. As such, the group has been abandoned..

The potential to apply it elsewhere or on a bigger scale? (up-scaling potential?)

There is up-scaling potential given the architecture of the production process at their plant in the Netherlands; here, the production staff is doing the final assembling of semi-assembled product components. In case productivity increases, the company plans to scale up work in the plant from 1 shift to 3 shifts, that is, adding additional 8 people to the current number of staff.

The process has shown that technical barriers to resource efficiency can be overcome, and in this way similar initiatives could be undertaken in businesses in the lighting electrical fittings industry.

Incentives & drivers for implementing RE measure

- ***Implementation of Environmental Management Systems (EMAS or ISO14001),***
  The company is on its way on gaining the ISO 9001 certification. In terms of environmental performance, the company will continue efforts to obtain the Bronze or the Silver level C2C certifications. Obtaining the certification does not mean the company will cease efforts for further improvements, on the contrary, in order to preserve their C2C certification, the company will need to report annually on its performance across C2C's five main criteria listed in the first section of this study.

- ***Policy regulation***
  No specific information provided, there is no policy forcing them to implement measures for environmental performance. However, there is recognition among management that future environment policy will become stricter in terms of imposing, for example, carbon reduction targets, and believes it is wise to take pre-emptive measures at a product level before regulation comes in place (first mover's advantage).

- ***Competitors,***
  The management considers current competitors in the market for sustainable light pipe solutions not relevant yet for their market share.

- ***Consumers,***
  Most of their customers are municipalities around Europe, which are relatively influenced by environmental policies in sourcing products with a low carbon footprint or which would lower their carbon footprint. One case in point is the Venlo municipality in the Netherlands, which has committed to purchasing only C2C solutions. The company has noticed that governments and triple A companies are becoming more and more aware of the importance of material reutilization in relation to economic impact, as opposed to low-cost solutions.

- ***Labelling or product standards,***
  Cradle-to-Cradle process and product implementation. Main factors influencing the innovation measures for the past 6 years are due to the process of increasing the environmental performance overall, at company level, and at product level, in relation to functional and environmental performance.

- ***First mover's advantage***
  According to company management, the C2C concept embeds the business case for environmental performance, as the positive effect on environmental indicators translates in the overall positive impact on the business (Life Cycle Cost calculation study), for example decreasing production costs, reducing emissions, better brand positioning, gaining first mover's advantage. The company believes having a C2C certification contributes to its differentiation on the market compared to other green standards and

certifications, particularly in light of concrete benefits (environmental and economic) made through increasing resource efficiency.

Resource impacts

- **Environmental resources and media affected**
  Waste materials from production process, emissions, energy (data available in connection to production process in Netherlands, there is no data provided on activities by its dealer organizations in Europe).
  BB LightConcepts currently uses 40-50 tonnes of aluminium per year, at a value of roughly 150 000 EUR/year (there is no specific data provided on other materials used in the production process in relation to absolute or relative volumes/year). The company uses 100% renewable gas and electrical power to fuel its production process; according to its clean energy provider, EssentEnergieVerkoop Nederland BV, it has been calculated that BB LightConcepts requires 5525 m^3 green gas to fuel its production in 2013-2014. Its consumption of green electricity by purchasing Wind 220 (produced by carbon neutral, 220 wind turbines at sea and on land nearby Netherlands) has been calculated at 15 000 kWh for the same period of time. According to management's clarification, due to increase in production, the clean energy consumption has increased in 2013 compared to previous years; there is no specific data provided for previous years. Water is not an affected resource, as it is not used in their manufacturing process, but only in their kitchen and washroom facilities.
  There is no data provided on the amount of emissions issued during the manufacturing activities at the company's plant; there is no data provided on the emissions created through the logistics process (impact on emissions from export activities to European dealer organizations), nor is there aggregated data on total emissions volume per company as a whole (plant in Netherlands and dealer organizations in Europe).

- **Resource use per product saved (number of units saved, total cost savings in terms of raw material inputs or monetary terms)**
  The manufacturing process leads to 1190 kg of stainless steel and aluminum waste/year, 150 kg of copper waste/year and the total waste of polyester and polycarbonate is as much as 1440 kg/year. The company sells this production waste as clean recycling fractions, and by doing so gains approximately 700 EUR/year compared to the costs of waste disposal.

- **Total resource savings (i.e. tonnes of CO_2 emissions p.a.)**
  By purchasing special $1m^3$ carton boxes to transport materials from suppliers to the factory in the Netherlands, the company is saves 6 300 kg of carton/year. Due to the re-design of its LEDlightpipes to fulfil C2C requirements, the weight of the 6 meter LED light pipe has decreased from 23 kg/lamp pre-compliance certification to 16 kg materials/lamp post-compliance certification. This has resulted in an absolute saving of 66 tonnes of aluminium/year; given a market price of app. 3 EUR/kg aluminum, this results in savings of approximately 200 000 EUR/year.
  Additional details on the re-design process and impact are not open for disclosure.

- **Critical raw materials affected; *Antimony, Beryllium, Cobalt, Fluorspar, Gallium, Germanium, Graphite, Indium, Magnesium, Niobium, PGMs (Platinum Group Metals), Rare earths, Tantalum, Tungsten***
  The LED component contains a fraction of gallium, which is one material conflicting with the C2C requirements, cannot be recycled. Until recently, replacing gallium was not possible, but progress in product development performed by LED suppliers suggests that gallium will be phased out eventually. This measure is not dependent on BB-Lightconcepts though, but on their LED suppliers.

- **Impacts over the value-chain** (business and environmental impacts for customers, no available data in relation to impact on suppliers; source: LCC Verlichtingconceptenparkeergarage, 2013)
  According to a Life Cycle Cost study (2013) made on the BB LEDlightpipe EVO, assessed against a T5 industry standard surface mounted fixture, BBLight Concepts' products are more efficient than conventional

lamps, in relation to both environmental and business performance. The LCC made the assessment of these 2 products, used on an area of 3 600 m^2, at a rate of consumption of 8 760 burning hours/year, and at an energy cost of 0.16 EUR/kWh.

- **Energy savings**
  Thus, the LEDlightpipe EVO (28 fixtures) uses 1.27 W/m^2, whereas the T5 surface mounted fixture (87 fixtures) uses 1.46W/m^2. The energy consumption including dimming by DALI (bi-directional communication system with every individual fixture) in the case of T5 surface mounted fixture is 5 238 W, and 1 646 W in the case of the LEDlightpipe EVO. The full load energy consumption is 5 238 W in the case of the T5 fixture, and 4 572 W in the case of LEDlightpipe.

- **Emissions reduction**
  A 2012 assessment that evaluated the difference between LEDlightpipe and a conventional fixtures used in an indoor parking space of 3 213 m^2, at a rate of 8760 hours/year. LEDlightpipes were responsible for 4.84 kg CO_2/m^2 less than conventional fixtures, which can be roughly approximated at savings of 16 000 kg CO^2/year.

- **Marketing strategy**
  Their marketing concept is emphasizing their products' environmental and economic performance, in light of their C2C compliance implementation. The success factor in persuading customers to buy their products is the business case of the LEDlightpipe. Although it comes at a premium price compared to conventional fixtures (approximately twice the price, according to the LCC study cited above), BB LightConcepts' products offer cost savings relatively quickly (after 3.5 years customers start earning money from energy savings and reduced maintenance costs) and after 20 years, the total cost of ownership is approximately half of conventional fittings. Reductions in CO_2 emissions are also a factor of growing importance for BB Lights' customers.

  The company has created a hire-purchase model that allows customers to pay a monthly rate until they paid off the fixture and it becomes their property.

  BB LightConcepts can also guarantee energy savings in comparison to conventional fixtures, as a way to engage customers. They have also made the initial investment onbehalfof customers, which is subsequently recovered from the energy savings of that specific customer (monthly bill payments). The company uses the DALI system and the Life Cycle Cost calculation based on European qualifications NEN-ISO 15686-1 and NEN-ISO 15686-5 to calculate these energy savings.

- **Material recovery strategy**
  The management has sought to contract a waste collecting company to recover their LEDlightpipes as the end of their life span (20-25 years) but that project did not work as planned. In turn, after consulting with EPEA, the company decided to commit to producer responsibility mechanism, which means that BB LightConcepts will ensure a take-back system of these products. One idea in the pipeline is to reward customers returning the LEDlightpipes at the end of their life span, by offering customers an economic incentive: 20-25% of the value of the materials in the LEDlightpipe. In a collection of 1 000 lamps, each containing 12 kg of aluminum valuated at 3 EUR/kg, the pay-back money could be 10 000 EUR. In absence of this economic incentive, the management believes customers will not abide to this practice.

Economic and social impacts

Economic and social impact, business impacts

Overall business impact has been assessed as positive, due to decreased production costs and to increase of product energy efficiency. The impact of C2C implementation has been especially positive given the economic crisis in Netherlands; the C2C story attracts customers and this factor has helped the company to increase

productivity. Due to the implementation of C2C compliance at product level, production costs post-compliance certification have decreased by reducing the weight of the product, and its efficiency has increased by 30% compared to pre-compliance certification. The number of full time employees has increased from 8 in 2008 to 22 FTEs in 2014, mainly due to increase in production; this was influenced by re-designing the production machine, which allowed for increasing productivity in light of its bigger size.

Economic and social impacts of the RE measure for the company and/or for other companies in the value chain

The company has increased the number of full time employees from 8 people in 2008 to 22 in 2014.

Type of jobs created/lost, safeguarded

The new jobs have been in the production, sales and support departments. There is significant potential for up-scaling production, according to company management, which will create additional 8 full-time jobs at their plant in Doetinchem to cover the 3 shift-work schedule planned for this scenario.The company aimed at establishing a first mover's advantage by undergoing product re-design according to C2C requirements; according to management, their marketing concept based on C2C has had a positive impact on their competitiveness. No specific data provided, not open for disclosure.Since implementing the re-design of their production machine in 2009-2010, productivity has grown by 20% each year. They broke even in 2013 and this year they expect to register profit; their EBITDA for 2014 is 17%.Their goal in the next 2-4 years is to reach a figure of 6 million EUR in total sales (Netherlands and European dealer organizations in Europe).

Local/regional/national/EU resource policy framework

According to management, the C2C implementation measures were not linked to policy enforcement.

One observation in relation to public tender process relates to the principle of awarding the tender to the cheapest bidder, where BB-Lightconcepts cannot compete. It would help significantly if public institutions support businesses manufacturing sustainable solutions by changing procurement rules to focus on actual environmental benefits and not on up-front costs only; another suggestion would be to take into consideration the life cycle cost studies of the product when performing the tender process. As suggested here, on the long-term, it is more efficient to use sustainable solutions that help cutting costs on the long run. Additionally, it would helpful if the government displayed a more pronounced focus on certified producers, eg C2CCertified, which could enable business innovators to bring their products in the market with a normal margin. Also, there is a need to change mindsets concerning quality over price, which requires paying more for sustainable products.

Further information

Links to relevant information sources (e.g. company information, press releases, information on relevant public policy measures): http://www.C2Ccertified.org/ and http://www.C2C-centre.com/company-and-organization/epea-gmbh

Links to company website or detailed case study on the web

http://www.bb-lightconcepts.eu/en/ and
http://studenttheses.cbs.dk/bitstream/handle/10417/3148/lavinia_cristina_iosif_lazar.pdf?sequence=1

Link to EEA RE country profile: http://www.eea.europa.eu/themes/economy/resource-efficiency/resource-efficiency-policies-country-profiles

References:

- LCC verlichting concepten parkeergarage, 2013
- LEDlightpipe power point presentation, 2012

1.4. Braskem

Company Name: BRASKEM
Case study title: Sugarcane ethanol-based Green Polyethylene (bio-based polymer)
Year of implementation: 2007, pilot project; 2010: launched at a commercial scale

COUNTRY, Address of installation or company	Industry (NACE Rev 2)	Company size
BRAZIL, Rua Lemos Monteiro, 120, 22º andarEdifício Odebrecht São Paulo, Butantã, São Paulo SP	Chemical & Petrochemical products	8000 employees in total, app. 100 employees in the Green PE business unit
Type of resource(s) affected		
Biomass (sugarcane ethanol), land, water, energy		

Company description

Braskem is a Brazilian company manufacturing thermoplastic resins. Braskem is expanding to the international market; the company was formed in 2002 through company consolidation and is currently listed on the New York Stock Exchange, registering net revenue in 2013 of 19 billion USD.

Braskem's headquarters are located in São Paulo and it has offices in the Americas, Europe and Asia, partnering with clients in over 60 countries worldwide. The company employs 8 000 people in 10 international offices worldwide. It owns 36 industrial units in Brazil, USA and in Germany, with a production capacity of 16 million metric tons/year of thermoplastic resins and other chemical products.

The main office in São Paulo is focused on developing biotechnology research, as well as fossil fuel-based polymers out of naphta (petroleum distilate), producing polyethylene, polypropylene and polyvynil chloride (PVC); Braskem is the largest producer of polymers in Brazil, with a capacity of 5.7 million tons of resins production.

Description of the resource efficiency (RE) measure(s)

The Triunfo Petrochemical complex located in the South of Brazil is the home of the world's first Green Ethylene Plant, in Rio Grande do Sul. This is where the green chemistry project, ran by Braskem's innovation unit on R&D, started as a pilot project on developing green polymers in 2007, and later developed into a bio-based ethylene feedstock processing plant in 2010.

Detailed description of the measure

Braskem's green chemical products are not resource efficiency measures per se, but they do offer its customers

the option of decreasing their carbon footprint.

Polyethylene is the most widely used plastic in the world. Braskem's green polymer, the Green Polyethylene (Green PE), is produced from sugarcane ethanol, a 100% renewable material. Braskem's plant capacity of 200 000 tons of Green PE would require 0.02% of Brazil's arable land, roughly 68 000 hectares.

Braskem's innovation lies in the production of the green ethylene from the sugarcane ethanol and thus diversifying the uses of sugarcane feedstock, from bio-fuel to bio-feedstock material. Once the green ethylene is produced from sugarcane ethanol through a dehydration process, it enters the purification stage and the processing continues with the stage of polymerization, where the Green Polyethylene is created.

The Green PE performs and presents the same characteristics as the non-renewable, fossil-based conventional PE. This means that customers avoid additional investments in new resin processing technology; the Green PE can be processed with the same technologies used to process convention polyethylene in creating plastic products eg. cosmetic product bottles. Additionally, since the Green PE is a low-density polymer, it reduces the weight of the final product.

In addition to developing the Green Polyethylene product, Braskem's innovation unit in Triunfo developed the Green Polypropylene (Green PP), also manufactured from sugarcane ethanol. Propylene is the second most widely used plastic in the world. The manufacturing process of the Green PP is similar to that for Green PE. However, the production of Green PP has been put on hold for two main reasons: first, Braskem is postponing its 100 million USD investment in a new plant that would innovate the bio-technology to obtain the propylene directly from the sugarcane ethanol (rather thanhaving to first produce green ethylene as a feedstock); second, the company has decided to prioritize current investments in other areas eg. investing 4 billion USD in collaboration with Mexican company Idesa in an integrated petrochemical complex in Mexico, operational in 2016.

How has the company implemented the RE measure(s)?

The Green Polyethylene carries the name "I'm Green", which represents Braskem's line of green chemical products and is also the marketing label Braskem's customers use to communicate that their products come from a renewable source. The main beneficiaries from Braskem's Green PE are the packaging industry, the automotive industry, cosmetics, toy, personal hygiene and cleaning products industries.

Braskem had started working with green plastics in 1990s, thus developing the technology to process sugarcane ethanol into bio-based polyethylene. The company revisited this project in 2006, re-evaluating at the same time the receptivity of such a product at market level and decided to start a pilot project in colaboration with one of their most important clients and distributors in Asia, Toyota Tsusho. The pilot project, meant at the time to test the market for green plastics, required an investment of 4 million USD to set up the plant, based on Braskem's proprietary technology. At the same time, in 2007 Braskem ran an environmental impact assessment to evaluate the potential benefits involved in the project; based on this secondary data-based assessment, which focused on the eco-efficiency of bio-polymers such as the green polyethylene, the company decided to scale up the project at an industrial level. For this purpose, it invested 290 million USD at its existing plant in Triunfo to set it up for the manufacturing of Green PE, which began industrial scale production in 2010.

Implementation of the RE measure: drivers and obstacles

Why was the measure taken?

The Green PE project was implemented in 2010 at an industrial scale, when Braskem realized the market was mature enough to understand the benefits of bio-polymers in the context of the low-carbon economy and potential levers in supporting it eg. bio- polymers that capture CO_2 emissions throughout their life cycle from cradle to gate. Also, Braskem's sustainability strategy, mirrored in its climate change manifesto in 2009, highlights green

chemistry products as one of its three pillars (in addition to sustainable operations and sustainable solutions).

What problems did the company encounter when implementing the RE measure?

Innovation cost
The main challenge is the innovation cost, transferred in the premium price at which the Green PE is sold to its customers: Green PE is more expensive than fossil-based polyethylene. As emphasized by the interviewees, one factor to tackle this challenge would be policy requirements targeting the decrease of carbon footprint for the packaging sector. This would motivate this sector to invest more in sustainable packaging solutions. For example, Europe's Roadmap of Resource Efficiency could list biobased materials as one element aiding the low-carbon economy in addition to already stated key points eg. eco-design, reusability, recyclability etc.

Responsible sourcing of sugarcaneethanol
Sugarcane ethanol suppliers working with Braskem need to commit to Braskem's Code of Conduct for Ethanol Suppliers, drafted by the company as a reference for good social and environmental management practices in the sector. Braskem's code of conduct for ethanol suppliers is in line with national regulation on sugarcane plantation impact on biodiversity issues; the Brazilian Agro-ecological Zoning Program establishes strict boundaries for sugarcane land use, which impedes sugarcane ethanol plants from receiving licenses to operate in the Amazon Rainforest region.

In its 2012 annual report, Braskem reported that 95% of the volume of ethanol purchased by Braskem's Green PE business unit was acquired from mills that were signatories to the code of conduct. The company has developed a structured monitoring programme to check suppliers' compliance to the code of conduct. Initially, close supervision of farmers' practices was carried out through regular site visits by company's officials and afterwards a 3rd party auditing programme was established for an independent and more thorough investigation. This checks compliance with labour and human rights requirements and also with environmental specifications, such as eliminating the practice of using fire for manual harvesting, which leads to the release of toxic compounds into the air.

Need for increased awareness and international certifications at product level
According to the Braskem officials, discussions on ways to promote the bio-based industry should look at two factors: on one hand, carbon reduction metrics are not promoted at a product level, but merely at an industry level in the context of bio-economy, low-carbon economy, carbon emissions schemes and carbon trade. As a consequence, the market for bio-based products lacks the economic incentives to scale up production, because at present the cost of producing the bio-based feedstock translates into a premium price for their customers.

One factor that could help would be to create market mechanisms that benefit products with reduced environmental footprint. This would contribute to the design of products that conserve resources, encourage green procurement and help consumers to understand and recognize sustainable products. This would support the development of the biobased industry.

On the other hand, the biopolymer industry is growing but it is still a new industry. As a result, a number of guidelines and certifications to assess biobased feedstock are being developed to assist brand owners on material selection. Two key initiatives supported by Braskem are the BFA (Biobased feedstock Alliance), an initiative led by WWF - USA where a scorecard was developed to assess biobased feedstock for biopolymers. Another one is Bonsucro, a certification created to promote measureable standards in key environmental and social impacts of sugarcane production but designed specifically for biofuels. In relation to Bonsucro, further actions must be developed to guarantee the chain of custody from the farmer to the product level and be eligible for Braskem's clients.

Link with RE platforms and business associations
Braskem is working closely with the Ethanol Production Association in Brazil in order to understand the challenges of this sector and contribute to its development. As highlighted in its annual integrated report for 2012, Braskem is working on an initiative to set up an LCA Brazilian Business Network, a voluntary forum for companies

that meet to discuss LCA (life cycle assessment) practices and the use of this tool in the business environment. Additionally, Braskem is a co-leader in the International Council of Chemical Associations of the draft guide project for emissions avoidance studies based on the LCA methodology developed by the Japan Council Industry Association.

The potential to apply it elsewhere or on a bigger scale

The current production of Green PE at the Rio Grande dol Sul in Triunfo is about 200 000 tons per year, about 50% of total global capacity, and management expects productivity growth in the near future. It is expected the productivity of the plant will grow, in direct proportionality with the increase in market demand and sales volume; Braskem management estimates the sales of Green PE will grow each year, as the product wins more visibility in relation to its potential of lowering their customers' carbon footprint.

Incentives & drivers for implementing RE measure [(1)]

- ***Implementation of Environmental Management Systems (EMAS or ISO14001),***

  Braskem is using the Global Reporting Initiative (GRI) to document its annual performance on environmental indicators.

- ***Policy regulation,***

  Braskem was influenced by the EU Roadmap for Resource Efficiency's goal by 2050 to cut carbon emissions by 80-95% compared to 1990s as it reflects the principles of the low-carbon economy and other similar concepts eg. Bio-economy, biobased materials, biobased products, biobased fuels etc., which are mirrored in Braskem's commitment to develop sustainable products in tackling the challenges of climate change.
  National Climate Change Policy establishes a target for reducing emissions by 2020, which could contribute to Braskem's increase in operational costs. For this purpose, the company has taken initiatives to increase its resource efficiency and reduce carbon emissions.

- ***Consumers/customers***

  The bio-polymers' market is expected to grow due to growing demand from the packaging industry for the fast moving consumer goods. Decreasing CO_2 emissions and lowering carbon footprint as part of sustainable packaging solutions. Since most of the Green PE's applications are focused on the packaging sector, the market demand of Green PE is dependent on the interest in this particular industry.

- ***Labelling or product standards,***

  In 2011 the Green PE received the "OK Bio-based" certification from the Belgian company Vinçotte, a certifying organization of products with renewable content. All samples received a four-star level certification, which is the highest quality rating offered by the Belgian company. The certification is a test of carbon 14, meant to differentiate the Green PE from conventional PE as they look and perform in the same manner. The carbon 14 test establishes the percentage of biobased carbon embedded in the Green PE, which is more than 80% biogenic carbon (carbon captured by the sugarcane plant).

- ***Raw material scarcity and rising prices***

  The risk of rising prices for oil distillates such as naphtha, one of Braskem's main feedstocks in producing fossil-based polymers, as well as growing uncertainties in relation to supply, means that it is good business sense to invest in the development of non-fossil-based alternatives such as the Green PE.

Resource impacts

- **Environmental resources and media affected**
  Sugarcane production, land, air, water, renewable energy
  The sugarcane crop is resource-efficient in itself. Braskem's consumption capacity is approximately 460 million litres of sugarcane ethanol per year, about 2% of Brazil's total production of sugarcane ethanol in

2013/14 season, using roughly 68 000 hectares of land for sugarcane crops. (One hectare of land, roughly the size of a soccer field, yields 82.5 tons of sugarcane, which provides 7200 litres of sugarcane ethanol, raw material for 3 tons of Green PE.)

GHG emissions are reduced by eliminating the use of chemical fertilizers during the agricultural phase; sugarcane mills use vinasse, a by-product of the ethanol production rich in organic nutrients and water, as organic fertilizer in the cane field.

Sugarcane cultivation in Brazil is almost never irrigated; the water requirements are supplied by rainfall in producing regions. The industrial phase of processing the sugarcane plant requires water consumption and, according to the company's cradle to gate environmental impact assessment, industrial water consumption has been reduced from $5m^3$ of water per ton of cane crushed in 1992 to $1m^3$ of water per ton of cane crushed in 2012.
Sugarcane bagasse (the fibrous matter that remains after sugarcane stalks are crushed to extract their juice) can be used as biomass for energy production at the sugarcane mill; the sugarcane bagasse is a by-product of the milling process through which it is separated from cane juice. Bagasse is used to fuel the boilers generating steam and triggers the power generating turbines; the energy obtained fuels the mill and the energy excess is sold to the local power grid.

- **Resource use per product saved (number of units saved, total cost savings in terms of raw material inputs or monetary terms)**
  Every ton of PE produced captures and sequesters 2.15 metric tons of CO_2 from the atmosphere, according to the LCA study carried out in 2012 using primary data from Braskem's main suppliers and its production process. These results are strongly connected to the positive impact sugarcane crops have on the environment; sugarcane ethanol generates 9.3 units of renewable energy for each unit of fossil energy used in its production.
  At a global level, Braskem has managed to save 0.22 GJ m^3/ton of products in 2012 compared to 2011; GHG emissions have slightly increased in 2012 compared to 2011 by 0.01%, despite the increase in energy efficiency, due to higher use of natural gas-fired thermal power plants. Due to conservation and efficiency improvements implemented in 2012, savings in energy consumption summed up to 1 359 613 GJ. In 2012, Braskem achieved emissions intensity reduction target of 0.63 tons of CO_2 per ton of product, just short of its target of 0.6 tons planned for 2020.
  Solid waste generation ran to 2.28 kg/ton of product produced in 2012, which represents an improvement of 14.6% compared to 2011. Energy consumption in 2012 was 10.59 GJ/ton of product produced, the lowest since 2002 and an improvement of 1.7% from 2011.

- **Total resource savings (i.e. tonnes of CO2 emissions p.a.)**
  200 000 tons of Green PE correspond to a reduction of 850 000 tons of CO_2/year, which is equivalent to the emissions produced each year by 820 000 automobiles.
  According to an environmental assessment of Braskem's biobased PE resin performed in 2012/2013, the performance of biobased PE compared to its petrochemical counterpart is mixed across different environment impact categories; the Green-PE resin outperforms the petrochemical resin in terms of GWP (global warming potential) benefits and abiotic depletion, while in the other categories the fossil-based resin performs similarly if not better than the PE resin.

  Green electricity is co-produced with sugarcane ethanol, which helps decrease emissions from power generation in natural gas power plants, offsetting 25% of the GWP_{100} production emissions for Braskem's average ethanol supply. The petrochemical PE has a GWP_{100} impact of +1.83 kg CO_2/kg PE, while the Green PE resin present net benefits of GWP_{100} of -3.98 kg CO_2/ kg biobased PE when replacing the fossil material.

  Green PE resin has a higher impact in acidification potential of 0.4 kg SO_2/kg PE[20], and a higher Eutrophication potential where the biobased resins emits 0.016 kgPO_4/kg PE higher than the conventional

[20] SOx and NOx emissions due to bagasse combustion and in-field trash burning

resin. However, the emissions have to be carefully assessed and the production context evaluated as these are directly related to sugarcane cultivation.

- **Impacts over the value-chain**
  By purchasing the Green PE as raw material in the production process, customers save carbon emissions; 1 kg of Green PE has captured 2.15 kg of CO^2.

Economic and social impacts

The economic and social impacts of the RE measure for the company and/or for other companies in the value chain

There is no data available on specific economic and social impact of manufacturing the Green PE. Braskem considers the Green PE as a new market, therefore the specific economic valuation of the Green PE is not open for disclosure with third parties, neither is it open for disclosure in Braskem's annual financial report. According to Braskem officials the Green PE business unit is profitable in terms of EBITDA (cash flow generation), which showed positive effects right from the second year of launching the Green PE at an industrial scale.

The main benefits registered by Braskem in commercializing the Green PE are better positioning of the business, reaching new markets and improving their practices of reaching their clients and end-users. Other positive impacts on the overall business have been the awards and nominations for innovation efforts and product sustainability performance, received both by Braskem and by its customers. In 2014, the company has been listed under the Fast Company's list of most innovative 50 businesses in the world.

- ***Payback-time (Months)***
  For Braskem, the return on investment showed positive figures by the second year following the commercial launch of Green PE.

- ***Type of jobs created/lost, safeguarded***
  Internally, the plant in Triunfo employs approximately 100 people, but the operations are not labour-intensive. The Rio Grande do Sul plant manufactures more than just one product, therefore it is difficult to quantify exact labour hours spent on producing the Green PE.

- ***Impact on business performance: additional turnover, cost savings, productivity, profitability***

  The Green PE business unit started being profitable from the point of view of EBITDA in the second year of the project launch. Productivity has grown every year since commercializing the Green PE at an industry scale, which expected to grow by 20% or more in the following years.

Local/regional/national/EU resource policy framework

What is the relation with public policy?

Company officials are keeping an eye on both national and international regulation that might have an impact on their business operations eg. Brazilian National Climate Change Policy establishing targets for emissions reduction by 2020 and the Mandatory Greenhouse Reporting of the US Environmental Protection Agency enforcing a mandatory requirement of annual inventories.

Indicate relevant resource policy framework, policies and regulations that have co-determined or facilitated or even have hindered the implementation of the RE strategy of the company.

Not relevant in this case study, although there is recognition among company officials of the potential impact of EU Roadmap for Resource Efficiency in terms of open support towards business initiatives in the area of low carbon economy.

Further information
Links to relevant information sources (e.g. company information, press releases, information on relevant public policy measures) http://www.bonsucro.com/ http://ec.europa.eu/environment/resource_efficiency/about/roadmap/index_en.htm http://www.braskem.com.br/site.aspx/Releases-Details-USA/Braskem-publishes-the-Life-Cycle-Assessment-of-its-Green-Plastic- Link to company website or detailed case study on the web http://www.braskem.com/default.aspx Link to EEA RE country profile Not relevant for this case study

1.5. Cobiax Technologies AG

Company Name: Cobiax Technologies AG
Case study title: Cobiax (void former modules)
Year of implementation: 2004 – up to present

COUNTRY, Address of installation or company	Industry (NACE Rev 2)	Company size
Cobiax Technologies AG Bietenholzstrasse 3 CH- 8307 Effretikon	Nace 23: Manufacture of other non-metallic mineral products	SME (24 employees)
Type of resource(s) affected		
Materials, energy, labour (productivity on site)		

Company description
The Swiss group Cobiax Technologies AG was established in 2004. Headquarters of the company is located in Effretikon Switzerland, while it also has two subsidiaries – Cobiax Technologies GmbH in Wiesbaden, Germany and Cobiax Technologies (Asia) Pte Ltd in Singapore. Since its establishing, Cobiax has continuously evolved into a specialist for lightweight reinforced concrete floor slabs enabling biaxial load transfer. The main purpose of material efficiency thus lightweight in concrete slabs is to improve the overall efficiency of concrete frame structures for the benefit of being an important pre- requisite to achieve sustainable buildings. The Cobiax Group also advises building owners, architects, engineers and contractors during all phases of a project. It is also engage in development, distribution and licensing activities. Cobiax is holding international patents for its technology and products. Over the last three years Cobiax has been awarded and recognized with: - Swiss Environmental Award - German Material Efficiency Award - Top 3 German Sustainability Award 2013 „Category Sustainable Development" - 2013 Cobiax Product Homologation by DIBt (Authority of all German county Governments) according to EN - 2013 EPD Environmental Product Declaration according to EN & ISO - 2014 SG- Mark Platinum Award for Good Desgn by Design Business Chamber Singapore The Cobiax Group has 24 employees in total. Production of modules is outsourced to partner companies in Europe and Asia.

Description of the resource efficiency (RE) measure(s)

The product of Cobiax comprise in-situ slabs of various component heights with void former modules made of reinforcing steel support cages and integrated spherical void former modules made of 100% recycled plastic. Modules are used to construct reinforced concrete slabs with standard concrete in order to transfer vertical and horizontal loads in multi-store buildings. The void former modules are used with the aim of reducing the dead-load of the structure as well as reducing the materials used, thereby enabling more material-efficient bearing structures. As the void formers are arranged in the statically ineffective area of the slabs, the mechanical material features of slabs largely correspond with the features of solid reinforced concrete slabs. The void formers can also improve the insulating features of the slabs.

The void former modules made of reinforcing steel and void formers are supplied in the form of cages of 2.5 metres in length, 11.5 to 23.5 cm (Slim-Line) and 19.0 to 46.2 cm (Eco-Line) high, 19.0 to 50 cm wide and weighing 5.2 to 13.3 kg. In-situ concrete and reinforcement steel are delivered separately. The void former modules can also be fitted with concrete semi-precast elements. The semi-precast slabs void former modules, in-situ concrete and additional reinforcements are delivered separately.

Slim-Line void former modules are manufactured in an injection-moulding process in the Zella-Mehlis, Germany plant. As base materials, plastic recyclate in granulated form is fed into the injection-moulding machine and converted into a thermoplastic material with energy supplied in the form of electricity. Compressed air is used to form semi-shell elements which are assembled without any additional energy supply to form void formers before being fitted inside the reinforcement elements. Eco-Line void former modules are manufactured in a blow-moulding process at the Hanau, Germany plant. As at the Zella-Mehlis plant, plastic recyclate in granulated form undergoes thermoplastic conversion and blow-moulding to form finished void formers, dispensing with the intermediate step of semi-shell assembly. The finished void former modules are packed in bundles without packaging materials for delivery to the construction site. On delivery of the semi-precast elements for Slim-Line void formers, recyclable LLDPE foil is incurred.

Cobiax flat slabs can be designed as a "purely in-situ concrete solution" with conventional formwork or in combination with semi-precast elements (element slabs). In case of “in-situ solution”, void former modules are unloaded from the truck using a construction site crane. After installation of the lower flexural reinforcement layer, the modules are fitted using the Cobiax mounting aid and fixed in place. This is followed by installation of the upper reinforcement layer. Apart from concrete displacement, the void former modules also serve as spacers for the upper reinforcement layer. Cobiax void former modules are approx. 2.50 metres long and are cut to length in accordance with the dimensions indicated on the installation plan. The specified spherical grid must always be observed during assembly. In case of semi-precast variant, installation of elements is followed by the transverse and joint reinforcement. Then the Cobiax installation aid is used to position the void former modules between the cage modules on the semi-precast element. This is followed by application of the upper reinforcement layer. In both cases the concrete must be applied and consolidated in the specified quality grade.

Additional characteristics of the Cobiax void former modules are:

- No inter-reactions by hazardous substances of health or environmental relevance can be anticipated,
- Cobiax slab is regarded as a solid reinforced concrete slab in terms of technical fire safety,
- Contents released in the event of unforeseen mechanical destruction do not represent any environmentally-harmful risk,
- De-constructed slab systems featuring void formers are crushed and sifted conventionally,
- After the appropriate treatment, the processed void former waste can be redirected to the material circuit as plastic recyclate or recovered as energy,
- After processing (crushing and sifting), the concrete can be re-used as an aggregate material.

Implementation of the RE measure: drivers and obstacles

Cobiax was established as a profit making company based on its sustainability providing new concrete slab technology.

Main drivers which have been identified are:

- Generating economic benefit (profit),
- Environmental benefits – energy- and toxic pollution efficiency,
- Material- and cost efficiency,
- Increasing creative freedom of architects by allowing better architectural solutions.

Cobiax was one of the first companies ever to have its products listed in the Navigator of the German Sustainable Building Council (DGNB). DGNB is an independent platform providing planners and architects with a solid overview of the products which meet the criteria for the sustainable planning of buildings. The main factors at this place were the environmentally sound production of raw material from recycled plastic and the enormous potential savings offered by void former modules in practical use.

As the first-ever provider of void former modules with technical approval worldwide, Cobiax also holds the Environmental Product Declaration (EPD) in accordance with ISO 14025 and EN 15804. The EPD is issued in April 2013 by the IBU - Institut Bauen und Umwelt e.V. from Germany.

During its presence on the market Cobiax has faced with many challenges. The first to be mentioned is the fact that construction sector is very traditional one, when it comes to concrete frame structures, and not yet sensitive enough for innovations. Furthermore, complexity of decision making process in the construction sector is very high because it includes both technical and commercial decisions. Also, there are many stakeholders.

The up-scaling potential though is very high, even on the global level and Building processes remain the same as with traditional concrete flat slabs, hence know how transfer is focussing on Architecture and Engineering approach.

Resource impacts

Voided flat plate slabs patented by Cobiax have an excellent ecological balance sheet as the cage modules are sustainably produced from 100-percent recycled plastic. In addition, the modules reduce the emission of substances harmful to the environment by up to 20 percent according to LCA (Life Cycle Assessment conferring with ISO 14044, thus meeting one of the crucial requirements for a sustainable method of construction.

The spherical void formers replace the heavy concrete in the slab, allowing up to 35 percent of the concrete and up to 20 percent of the reinforcement steel per square meter to be dispensed with. Also, the reduced weight of the slabs optimizes the holistic building shell structure as load-bearing components and foundations can be designed with smaller dimensions than they can if solid reinforced concrete slabs are used.

The Cobiax technology allows an integrated concrete slab construction for long spans (up to 18m span) without beams which is a requisite to realise an increased sustainability of the building value and at the same time save resources. Additionally, the Cobiax technology implies reduction of size of building elements, reduction of reinforcement, optimization of construction time, reduction of foundation loads, and reduction of CO_2 emissions due to reduced using of energy-intensive building materials such as concrete and steel.

Economic and social impacts

Even if just considering the sum of all primary benefits, i.e. the savings made on material alone in the reinforced concrete slab itself, the use of voided flat plate slabs is completely cost-neutral - in fact, it is often cheaper than using conventional slabs, not even considering additional cost benefits such as secondary material savings in vertical load carrying elements and foundation as well as gains in productivity and time cost. The Cobiax technology contributes to optimizing the lifecycle cost and can also decrease the over-all building cost.

Direct cost savings of the Cobiax technology are related to the use of less:

- Steel,
- Concrete,
- Vertical elements (walls, pillars, wooden beams, building formwork)
- Building foundation,
- Construction machinery,
- Transportation.

Additional costs savings are achieved through:

- Material costs in Facades and Elevators due to reduced building height,
- Saving the time required for construction due to the use of lighter formwork and prefabricated fittings,
- Quantitative savings linked to the increased useful space in the building,
- Opportunity to utilize buildings in a flexible way, i.e. open space architecture for less restricted use

According to available analysis, cost saving potential of the Cobiax technology is up to 20% when compared to traditional approach. Also, it should be stressed that cost saving potential is depended on condition on related market.

Additional impacts worth mentioning are:

- Use of the Cobiax technology provides possibility for building spacious area, open plan flexibility, leads to better user acceptance and makes change of use easier,
- Due to weight reduction, the Cobiax technology increases earthquake resistance by limiting the damage risk.

Local/regional/national/EU resource policy framework

- Swiss Environmental Award 2010

- German Material Efficiency Award 2012

- Top 3 German Sustainability Award 2013 „Category Sustainable Development"

- 2013 Product Homologation by DIBt (Authority of all German county Governements) according to EN

- 2013 EPD Environmental Product Declaration according to EN & ISO

- 2014 SG- Mark Platinum Award for Good Desgn by Design Business Chamber Singapore

Further information

Links to relevant information sources: http://www.cobiax.com/ and http://www.cobiax.ch

Link to EEA RE country profile: http://www.eea.europa.eu/themes/economy/resource-efficiency/resource-efficiency-policies-country-profiles

1.6. Ecocem

Ecocem Materials Ltd
Case study title: Low carbon cement from Ecocem
Year of implementation: 2000 – up to present

COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
IRELAND, Unit F1 EastPoint Office Park, Dublin 3	Manufacture of cement, lime and plaster (C23.5)	SME (90 employees)
Type of resource(s) affected		
materials, land, energy		

Company description
Ecocem Materials Limited, an Irish company set up in 2000, undertakes industrial developments in Europe in the production and use of low carbon cement known as GGBS (Ground Granulated Blastfurnace Slag). Ecocem Ireland Ltd, incorporated in 2001, is a wholly owned subsidiary of Ecocem Materials Ltd. Ecocem Materials Limited built its first GGBS production facility in the Netherlands in 2002 supplying the Dutch and Belgian markets. This facility is operated by Orcem BV, a sister company of Ecocem Ireland. The following year the Irish facility opened. A 3rd facility was opened at Fos in the South of France in 2009 and is operated by Ecocem France. The facilities in Ireland and Holland can each produce approximately 350,000 tonnes of GGBS cement. The facility in France has a capacity to produce over 700,000 tonnes of GGBS.

Description of the resource efficiency (RE) measure(s)
Ecocem manufactures a range of cementitious products for use in concrete, mortars, renders, screeds, adhesives, grouts and a variety of other special applications. Traditional cement production involves the quarrying of raw materials from the natural landscape. This material is burnt at over 1800 °C in a kiln and then ground down to a fine material. This manufacturing process is extremely energy intensive and releases around one tonne of CO_2 for every tonne of cement produced. The fundamental difference in the manufacture of Ecocem's low carbon cement product involves the recycling of blast furnace slag, an industrial by-product from steel production. The recycling of blast furnace slag requires two different industrial processes: granulating by rapid quenching at the blast furnace, and grinding/drying at a special mill which does not need to be located at the blast furnace. It is the grinding/drying process that Ecocem carries out at its plants. The manufacturing of the low carbon cement releases 20 times less CO_2 emissions than

traditional cement production and significantly reduces the use of virgin raw material.

The two main products of the Irish company are:

- Ecocem Next Generation Cement. It is a mix of Ground Granulated Blastfurnace Slag and conventional cement available in 25kg bags. Compared to regular cement this is stronger and longer lasting and has lower environmental impact.
- Ecocem Ground Granulated Blastfurnace Slag cement. It is pure GGBS marketed for the construction industry. The purchaser can mix this product type with conventional cement in any necessary proportion for special applications.

The special technical properties of the Ground Granulated Blastfurnace Slag provide numerous benefits.

Ecocem has increased strength compared to ordinary cement, which reduces deterioration in structures, minimising maintenance and repair requirements. Ecocem also has higher durability than regular cement giving structures increased resistance against chemical attack, weathering and fire. The higher durability can be partly attributed to a lower lime content of the material, which leads to lower reactivity with water.

Ecocem GGBS cement is a near-white powder imparting a lighter, brighter colour to concrete, in contrast to the stony grey of concrete made with Portland cement. It also has a smoother surface finish, and the addition of GGBS to the mix prevents the formation of efflorescence. The near-white colour of GGBS concrete permits architects to achieve a lighter colour for exposed fair-faced concrete finishes, at no extra expense.

Implementation of the RE measure: drivers and obstacles

Drivers

- The technology of the company was developed and implemented with an aim to *gain a strong competitive advantage* on the market owing to the substantially reduced the carbon footprint and resource use of the production process.
- The special technical properties of GGBS (strength, durability, lower reactivity, lighter colour and smoother finish) enabled Ecocem to target *special market niches*.
- Partly the future prospects of the EU emissions trading system (EU ETS) and those of national policies aiming at Green Public Procurement (GPP) have brought Ecocem to life. The fact that Ecocem uses a low energy and resource efficient manufacturing process, allows it to satisfy all the key criteria of Green Public Procurement.

The approximately 15% lower price of Ecocem compared to that of the regular cement makes the product of the Irish company competitive on the market.

Obstacles

Failure to take account of the collapse of unprecedented booms in construction on cement demand led to competitive distortions of the ETS system in the cement industry. The EU cement industry is over-allocated due to the collapse of construction booms from levels that are unlikely to recover. Green cement producers, such as Ecocem, are excluded from the ETS as their CO_2 emissions are below the threshold. The regular cement companies enjoy a windfall profit from the sale of their excess credit allocation, which is a competitive advantage for them in competing with green cement producers. In addition, any gain in market share by the green cement producers caused less production of polluting cement in the ETS sector, which generates even more surplus credits for the cement industry. In effect, the reduction in CO2 emissions from the increased use of green cement results in an additional windfall profit for the polluting cement sector. The ETS ensures that the economic advantage of this reduction

goes to the more polluting competitor as a credit.

- *Ineffective GPP policies in certain countries of operation*

  Green public procurement is rather unevenly applied in Europe. In certain member states it has only a negligible effect. As a result Ecocem is struggling to benefit from the meeting the criteria for sustainable public procurement.

Upscaling potential

The reform of the ETS and more effective national green public procurement policies would substantially increase the upscaling potential of the low carbon cement production method.

Resource impacts

The blast furnace slag material is generally shipped from Europe where it would otherwise be disposed as a waste product. As opposed to the production of regular cement where approximately 1.6 tonnes of clay, shale and limestone are removed from the landscape for every tonne of cement manufactured, Ecocem has practically no depletion of natural resources associated with manufacturing their product. The manufacture of the low carbon cement generates very low CO_2 emissions compared to that of conventional cement. Ecocem currently has a carbon footprint of 26 kg/tonne. This compares with around 800kg/tonne for conventional cements. Ecocem also claims their cement product uses far less embodied energy than regular cement. The Irish company estimates that if their product had been used during the recent Irish building boom over 2,000,000 tonnes of CO_2 would have been saved. Additional benefits include no contribution to damaging the physical landscape through quarrying, less associated traffic, noise and dust.

Economic and social impacts

Economic impacts

Ecocem is benefiting from the special properties (strength, durability, eco-friendliness, lower reactivity, lighter colour and smoother finish) of its products managing to target a specific segment of the market and to maintain a gradually increasing market share.

Concrete made with conventional cement normally has a design life of 60 years. Concrete made with GGBS will typically achieve a design life of 120 years. This can provide major savings in avoidance of the cost replacement of concrete structures.

Based on figures in the report from the European Environment Agency[21] the damage costs of environmental pollution from the cement industry in Ireland is currently running at €90 million annually. Replacement of 50% of conventional cement with GGBS cement would reduce this annual cost by 40%.

The collapse of the Celtic Tiger – the economic boom in Ireland - has virtually eliminated the market for precast concrete in Ireland. Irish manufacturers have turned with success to exporting to the UK market, where large projects using precast concrete elements generally specify the use of low-carbon concrete, i.e. made with GGBS. The availability of Ecocem GGBS in Ireland has allowed Irish precast manufacturers to supply export markets in the UK. It is estimated that 300 jobs in precast manufacture in Ireland are sustained because of the availability of

[21] http://www.eea.europa.eu/publications/cost-of-air-pollution

this GGBS.

The construction boom in Ireland helped the gradual expansion of the company. By the time the economic downturn hit the construction sector, Ecocem already had a strong market share that helped the company to differentiate itself from its competitors on the market and to survive the crisis.

In early 2013 a bagging facility – a cement bagging plant - was opened in Dublin Port making the product of the company available for the everyday builders at DIY stores.

The company plans to enter the UK market in summer 2014 doubling the economic potential of its operation.

Social impacts

Ecocem Materials Limited has a staff of 90 employees and the company is also responsible for approximately 300 indirect jobs.

The 2.5 million investment for the bagging facility in Dublin Port has created 7 jobs and as production goes up in the coming two years, Ecocem intends to create additionally 25 direct jobs and 35 indirect jobs linked to the Dublin operation.

Local/regional/national/EU resource policy framework

Partly the future prospects of the EU emissions trading system (EU ETS) and those of national policies aiming at Green Public Procurement (GPP) have brought Ecocem to life. The fact that Ecocem uses a low energy and resource efficient manufacturing process, allows it to satisfy all the key criteria of Green Public Procurement.

Nevertheless the distortions of the ETS in the cement industry and the ineffective GPP policies in certain EU Member States continue to hinder the exploitation of the full market potential of Ecocem's low carbon cement.

Further information

Links to relevant information sources:

http://www.ecocem.ie/

http://www.ecocemcement.ie/

http://www.eco-innovation.eu/media/EIO_Country_Brief_2011_Ireland.pdf

Link to EEA RE country profile:

http://www.eea.europa.eu/themes/economy/resource-efficiency/resource-efficiency-policies-country-profiles

1.7. Evonik Degussa Antwerp

Company Name: Evonik Degussa Antwerp
Case study title: A new combined heat-power plant
Year of implementation: 2010

COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
Frans Tijsmanstunnel West B-2040 Lillo, Antwerp BELGIUM	NACE 20 Manufacture of chemicals and chemical products	In 2013: • 1,063 employees • € 502.5 mio turnover
Type of resource(s) affected		
Energy		

Company description
Evonik is a global specialty chemicals company, headquartered in Germany. The company concentrates its efforts on high-growth megatrends, especially health, nutrition, resource efficiency and globalization. The Antwerp site is one of the biggest multi-user sites of Evonik, with eleven production plants working for four Business Units: Inorganic Materials, Coatings & Additives, Advanced Intermediates and Health & Nutrition.

Description of the resource efficiency (RE) measure(s)
In order to produce steam with the highest possible energy efficiency, in 1999 Evonik Degussa Antwerpen NV started operating a Combined Heat and Power (CHP) plant in cooperation with the Belgian energy company Electrabel. This CHP plant generates 43 megawatts of electricity annually. It produces electricity by combusting natural gas, and recovers to a large extent the heat from the resulting combustion gases for the production of steam, thereby greatly improving the energy efficiency. With the start-up of new production activities in Evonik, the demand for additional quantities of steam increased. In order to meet this demand with minimal additional CO2 emissions, Evonik Degussa Antwerpen NV made a contract in 2007 with Lillo Energy NV for the construction a second CHP and running the operation of both the first and second CHP. Lillo Energy is a joint venture between two major energy companies Electrabel and E.ON specifically set-up for that purpose. In 2010 the new CHP plant started.

Implementation of the RE measure: drivers and obstacles
The main drivers for this RE initiative are: 1) the need and opportunity for increasing the production capacity which in turn implies an increased demand for steam and 2) the desire to provide this additional steam in a cost efficient manner. CHP provides a cost-efficient manner of producing the steam, which is mainly used internally. The amount of electricity that is produced by the CHP units is larger than what is needed within the company, which allows Evonik Antwerp to put the excess amounts on the distribution net, and gain additional return from it.

One of the challenges was the availability of and access to specialized technological know-how both for the development and operation, especially at such a large operational scale. This was insourced by contracting the Lillo Energy joint venture.

Resource impacts

The new CHP plant generates 42 megawatts of electricity from natural gas. In the combustion process very hot gases are formed. The key advantage of a CHP plant is that the heat of the combustion gases is largely recovered by producing steam with it. Such a combination of electricity and steam production consumes 30% less fuel than conventional separate production. Thereby the CO2 emissions are reduced in the same ratio, which is important from a climate perspective as indicated in the Kyoto agreements.

By employing best available technologies, the new CHP plant achieves an energy conversion efficiency of 85%. In order to save even more energy, the CHP plant does not only use natural gas as fuel but also waste gases resulting from production activities of the company on site. It thereby valorises production residues instead of using extra virgin fuel. Due to these investments, annually an emission of about 80,000 ton CO2 is avoided. In 2013, the CO2 equivalent per tonne of product was 0.48 kg.

Economic and social impacts

A positive economic impact is created by supplying the company with the necessary high quality steam input in the most energy efficient manner, thereby reducing costs. The CHP plant also allows the company to valorise the gases resulting from production activities by combusting them for energy production, thereby again lowering the energy costs.

Local/regional/national/EU resource policy framework

The company benefited from a public support measure which encourages the installation of CHP systems. This support measure was greatly welcomed and it was necessary to make the investment economically feasible. At the same time, however, the company experiences the frequent regulatory changes in this field as an obstacle for implementing resource efficiency measures.

Further information

Webilinks RE initiative:

http://corporate.evonik.be/region/belgium/en/company/belgium/news/Pages/WKK.aspx

Sustainbility report 2013 (in Dutch):

http://corporate.evonik.be/sites/dc/Downloadcenter/Evonik/Region/Belgium/nl/Publicaties/duurzaamheidsverslag-2013.pdf

Company information Evonik Degussa Antwerpen NV: http://corporate.evonik.be/sites/dc/Downloadcenter/Evonik/Region/Belgium/nl/Publicaties/Engels.pdf

1.8. Grundfos Manufacturing Hungary Ltd.

Company Name: Grundfos Manufacturing Hungary Ltd. (GMH)
Case study title: Fluid management system
Year of implementation: 2009- up to present

COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
Hungary Three sites (Tatabánya, Székesfehérvár, Biatorbágy)	C28.1 - Manufacture of general-purpose machinery	Headcount 2028 (2013) Not SME
Type of resource(s) affected		
Materials, water.		

Company description
Grundfos Manufacturing Hungary is part of the Danish Grundfos Group. Grundfos is a global leader in advanced pump solutions and a trendsetter in water technology. Climate strategy serves as central element for sustainability. The mother company in Denmark has decided for no less than total carbon neutrality by applying a wide range of innovative technology and renewable energy sources. As a first step, it was prescribed to every subsidiary to measure carbon dioxide emissions from 2009 then other programs were initiated to reduce emissions. The Grundfos companies are independently responsible to comply with the environmental requirements and to reduce the negative environmental impacts. However in order to define the basic strategic and environmental goals Grundfos had formed its central environmental and occupational safety group (Group EHS; from 2012 called Group Sustainability). The unit's tasks are composed of the follow-up of environmental and occupational safety performance of Grundfos companies, informing the management about results and coordinating the environmental and social projects at group level. Every year the companies receive a so-called Target Letter from the Group management containing the environmental and occupational safety goals regarding the following year. The letter contains the required reduction rates for CO2 emissions, energy using and water consumption. The factory managements accept the directives by signing the letter. For continuous compliance with the environmental requirements and permanent development of the environmental performance, the Environmental Management System (EMS) based on ISO 14001 standard was introduced in the GMH plants from 2004 on. With the first site opened in Tatabánya in 2000, now GMH has four plants in Hungary, employing more than 2000 persons. GMH produces motors and other components of pumps and assemble pumps in its three plants.

Grundfos Manufacturing Hungary	
Location	Headquarters at Tatabánya, Hungary Sites: Tatabánya, Székesfehérvár, Biatorbágy
Operation	Production of electric motors and pumps, development & engineering
Headcount (2013)	2028
Opening	2000.
Turnover (2013)	423 million euro

Description of the resource efficiency (RE) measure(s)

"FLUID Management" system

From sustainability point of view, besides achieving general strategic goals, one of the largest challenges for GMH used to be caused by emulsive waste, which produced 75% of the hazardous waste in the plants of Tatabánya (GMH1, GMH2). At the end of 2009, a comprehensive program was launched to deal with this issue.

With the FLUID management program the volume of emulsion waste was decreased by 36% (96 000 kg) in 2010 and by 66% (176 000 kg) in 2011 even with growing production. This resulted in significant reduction (approximately by 50%) in the volume of all hazardous waste. Furthermore the volume of other liquid wastes (e.g. mop water) was also reduced.

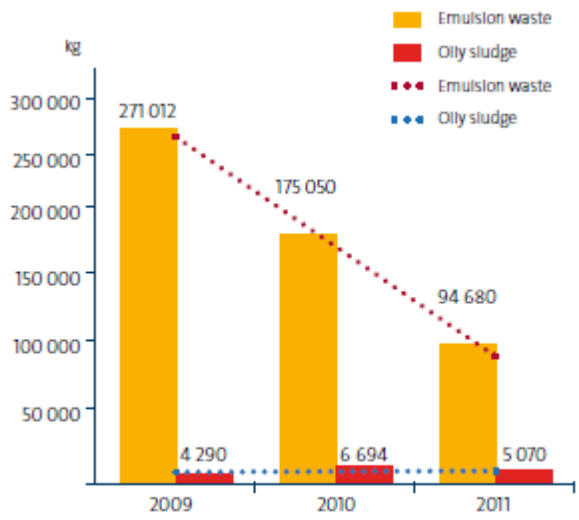


Figure 7. – Reduction in the volume of emulsion waste in plants GMH1 and GMH2

In Székesfehérvár (GMH3), based on local conditions the reduction was carried out by using the plants own vacuum evaporator. Thanks to the measures taken, an approximately 80% reduction had been realized in the area of emulsion waste. Through treatment of contaminated fluids, besides the used emulsion, local treatment of various kinds of wastewater and reuse of purified water had also become possible. This program, in addition to its obvious environmental advantages takes significant part in raising environmental awareness of employees.

70% of the hazardous waste, generated in GMH3 is originated from the water contaminated with heavy metal, which comes from wet polishing. With the revision of the procedure and the introduction of a new additive the company managed to decrease the volume of waste water by approximately 10%. Consequently the reduced

operation of waste treatment facilities (e.g. vacuum evaporators) resulted in an additional 10 000 kWh/year energy saving.

To reduce water consumption the following measures were introduced:
• The application of "FLUID Management" system prolongs the life of cooling and lubricating fluid in machinery, and therefore, the consumption of crude oil and water decreases.
• Installation of magnetic filters at certain technological points to reduce metal contaminants in the water tanks.

Implementation of the RE measure: drivers and obstacles

Why was the measure taken? What problems did the company encounter when implementing the RE measure?

Hazardous waste is one of the most significant environmental impacts of GMH.
At the Tatabánya plants (GMH1, 2) significant quantity of hazardous waste was generated from cutting oil (20 tons per month) which increased the risk of environmental accidents. At Székesfehérvár (GMH3) 60 m^3 wastewater results from production which requires pre-treatment (hazardous waste).

Incentives & drivers for implementing RE measure

- Environmental Management System (ISO 14001)
- Cost saving
- Improve the quality of cooling/cutting oil
- Grundfos Group expectations (to meet the targeted waste amounts)

Difficulties encountered in implementation phase

- Finding the right subcontractor (emulsion treatment)
- Installing central emulsion treatment equipment (GMH1,2)
- Installing vacuum evaporator (GMH3)
- Need for trainings about the implemented system (how to use & maintain)
- Finding the right treatment method (chemicals, concentration etc.)

Link with RE platforms and business associations

No.

The potential to apply it elsewhere or on a bigger scale (upscaling potential)

The fluid management system was benchmarked by other Grundfos companies in Europe. The return on investment is within one year, upscaling potential is good.

Resource impacts

What were the impacts in terms of resources?

- Environmental resources affected: water, hazardous material / waste
- Resource use per product: not applicable
- Total resource savings:
  - Tatabánya Plants (GMH1,2):
    Waste: 176 tonnes of hazardous waste/year
    Raw material: 176 m^3 emulsion/year → 7000 litres oil saving/year
  - Székesfehérvár Plant (GMH3)

660 tonnes of hazardous waste/year (wastewater from production).

- Critical raw materials affected: not applicable
- Impacts over the value chain: Extended lifetime of cooling/cutting oil with better quality which causes less hazardous waste generation.

Economic and social impacts

Economic/business:

- Tatabánya Plants (GMH1,2)
  - Economic/business: cost saving – less raw material needed for producing cooling and cutting oil; lower costs on hazardous waste treatment.
  - 176 000 kg hazardous waste reduction means 12.000 EUR/year saving on hazardous waste treatment. 7000 litres/year reduction in raw material consumption to produce emulsion for machinery. It means approx. 31.500 EUR/year saving.
- Székesfehérvár Plant (GMH3)
  - 60 tonnes/year of hazardous waste need to be treated instead of 720 tonnes/year.
  - Payback time: ~1 year
  - Investment: 66700 EUR; Saving: 64400 EUR/year

Social:

- Reduction of environmental footprint;
- increase the environmental awareness of the employees;
- decrease the probability and the extent of an accident.

Local/regional/national/EU resource policy framework

The measure was not obligatory and was not implemented as a result of a public policy or a particular regulation. However it was connected to BAT- Best Available Technology.

It is in line also with the principles of the new waste regulation of Hungary (Act CLXXXV/2012 on waste).

Further information

Links to company website

- www.grundfos.com
- www.grundfos.hu

Link to EEA RE country profile:

http://www.eea.europa.eu/themes/economy/resource-efficiency/resource-efficiency-policies-country-profiles

1.9. Gyproc/Saint Gobain Construction Products Belgium

Company Name: Gyproc/Saint-Gobain Construction Products Belgium NV/SA
Case study title: Recycling of Gypsum for the Plasterboard Industry
Year of implementation: 2005-2009

COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
Sint-Jansweg 9 - Haven 1602 9130 Kallo – BELGIUM	C - Manufacturing 23690 – Manufacture of Other Articles of Concrete, Plaster and Cement 23620 – Manufacture of Plaster Products for Construction Purposes	Belgian branch, 2013: 224 employees Saint Gobain Group, 2013: 187,071 employees
Type of resource(s) affected		
Recycling of waste materials (gypsum)		

Company description
Today Gyproc, formerly integrated in British PlasterBoard (BPB), is part of the global Saint Gobain group – a world leader in the manufacture and distribution of building materials[22]. Gyproc is the business division specialized in the manufacture of plasterboards for the building & construction industry (primarily in the B2B segment). The company offers a range of product lines including different types of plaster and plasterboards, ceilings & access panels, metals for construction & a number of DIY materials. The raw material used for the production of plaster and plasterboards is gypsum, a sulfate mineral composed of calcium sulphate dihydrate. The Belgian division of Gyproc employs slightly above 200 people and distributes its products mainly in the BENELUX. The Saint-Gobain Gypsum Activity, however, is a global market leading player, which is present in a wide range of countries & regions across the world including Scandinavia, Central, Southern & Eastern Europe and Southeast Asia[23]. The main Saint-Gobain Gypsum brands are Gyproc, Rigips and Placo.

[22] http://www.saint-gobain.com/en/group

[23] http://www.gyproc.com (Belgian, Italian, Irish & South African websites)

Description of the resource efficiency (RE) measure(s)

The Gyproc Recycling programme includes the recycling of plasterboard waste, which is turned into plaster that can be reused in the manufacture of new plasterboard. Due to advanced recycling technology all plaster building materials that end up as waste can be reprocessed into a primary raw material. This process can be repeated indefinitely, making it unique. Gyproc also recycles the condensed water released from the drying process in its production. Production based on this kind of closed material system significantly reduces demand for raw materials necessary for manufacturing plasterboard and it produces almost no waste. Additionally there are environmental benefits associated with avoiding extraction and transportation of raw materials and waste reduction (reducing the need for landfilling).

The recycling process takes place next to Gyproc's production plant in Kallo, Belgium and is managed by the Canadian company New West Gypsum Recycling, which operates an installation next to theirs. The full production of plasterboards was initiated in 2001 and in 2005 the initial steps towards today's recycling programme were taken when Gyproc engaged in a collaboration with New West Gypsum Recycling. This enabled Gyproc to have its production waste recycled at the site in Kallo.

A particularly important event of 2009 and the driver behind the subsequent improvement of Gyproc's external waste recycling capabilities, was the gypsum covenant – an agreement between all gypsum manufacturers in Belgium and OVAM, the Flemish waste agency, driven by OVAM's increasing focus on the concept of circular economy. The partners in the covenant include the Federation of Gypsum manufacturing industry in Belgium and Luxembourg (BLGV/ABLG), the Federation of construction industry (VCB), Federation of Demolishers Industry (CASO) and the Federation of Environmental companies (FEBEM). This gypsum convenant was established on a voluntary basis and entails a commitment of both government and industry to augment the efforts with regard to gypsum recycling. As a result of this convenant, Gyproc started in 2009 to recycle external (=domestic) waste in addition to production waste, and is currently still the only Belgian company that does so.

Since then Gyproc has continued to develop its sustainability programme through the Cradle-to-Cradle certification. The first step in this certification was financially supported by the Flemish Authorities but Gyproc has financed the implementation of subsequent stages itself. This certification implies the analysis of the material composition of the products in terms of the recycling potential and/or any potential harmful effects on human beings. As such, by reflecting well on the material composition, it can be guaranteed that it will be possible to recycle all materials once the product has been consumed and becomes waste.

Implementation of the RE measure: drivers and obstacles

Gyproc has a history of innovation, and also wants to be pioneer with regard to recycling of materials. From the market side a certain pull exists, as a growing number of players in the construction market are interested in recycling opportunities, and end users or purchasing departments more and more tend to ask for products containing recycled content. As a market leader in the production of plasterboards for the construction industry, Gyproc wanted to meet the expectations of these customers as well as other stakeholders.

One of the main obstacles in the implementation which Gyproc has faced, has been the costs. The recycling programme has required significant investments in terms of losses due to contamination in the recycled gypsum stream, compromising the technical quality of the products containing this recycled material. While customers are happy to work with products based on recycled materials, the general willingness to pay for 'green' products compared to regular products is very limited. Furthermore, Gyproc feels that there is still some reluctance with policy makers to really support further improvements in resource efficiency through, e.g. ambitious green public procurement criteria, asking for recycled content or supporting type I environmental labels.

Resource impacts

Gyproc has increased the amount of external waste recycled and henceforth its resource efficiency and it is thereby able to use a higher percentage of recycled raw material in the production of new plasterboard compared to before the implementation of the measure. It currently recycles about 30 000 ton gypsum waste (including production waste as well as construction and demolition waste) per year, mostly coming from Flanders. As such, it avoids low value reuse of gypsum (e.g. as filling material in construction) or landfilling of gypsum. However, there is still potential for more recycling, as it is estimated that in Belgium alone there is probably about 100 000 tonnes of gypsum that could be recycled per year. A key issue here is the collection phase of waste: if plasterboard waste is collected separately from other materials, it can be well recycled; if it is collected together with other materials, recycling of the plasterboard waste becomes infeasible in economic terms. Gyproc estimates that in Belgium, currently maybe only 20% of gypsum waste is collected separately from other demolition waste. Moreover, the gypsum-based waste stream will certainly grow in the future: plasterboard was only introduced in the Belgian market in the 1950's, and the lifetime of a plasterboard system is estimated at 50 years. So large amounts of plasterboard waste are going to be released in the coming years, given the growing number of renovation and refurbishing projects.

Economic and social impacts

With its recycling efforts, Gyproc meets the demands of its customers to use recycled materials in production. At the same time, it has done significant investments in the technology. The net economic impact at this point in time is therefore limited. However, the company is now a forerunner with regard to gypsum recycling, and is likely to increasingly benefit from this in longer term as raw material become scarcer and customers or purchasers become more demanding for products that are manufactured using recycled materials.

Local/regional/national/EU resource policy framework

Gyproc welcomes the evolution from a demolition culture to a deconstruction culture, whereby waste is seen from its potential to be reused. More specifically, the efforts done at government level to separate various waste streams are appreciated, as this is a necessary condition for recycling, although important differences exist across regions. In addition the high taxes on landfilling currently in place in Flanders provide a clear incentive to reuse gypsum and is therefore also evaluated positively by Gyproc.

However, the company finds that the ambitions of the EU with regard to recycling do not translate into the criteria for public procurement. Currently, for plasterboard, a recycled material content of only 2% is required for public procurement, which is rather easy to achieve. A more ambitious target (e.g. 10%) would be needed to give industry more incentives to engage in recycling of external waste.

With regard to sustainable construction, the company feels that there are a lot of parallel initiatives in the sector coming from both the construction industry as well as the EU in the form of the development of standards for EPDs and sustainable buildings, the Product Environmental Footprint, linkages to the CE marking, and schemes for the assessment of sustainable buildings. There is definitely a need for harmonization, also in order to help industries streamlining their sustainability strategies.

Further information

Links to the company website: http://www.gyproc.be/infinito; http://gypsumtogypsum.org/; http://www.saint-gobain.com

1.10. Gypsum Recycling International A/S

Company Name: Gypsum Recycling International A/S
Case study title: **Gypsum waste recycling- from landfill to raw material**
Year of implementation: 2001 - developed the gypsum waste recycling technology, 2003 - the current CEO, Henrik Lund-Nielsen, helped to save the company from bankruptcy and to launch it internationally

COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
DENMARK, Egebaekgaard Egebaekvej 98 2850 Naerum	Gypsum and plaster board waste recycling Nace 23: other non-metallic mineral products	25-30 FTEs, SME
Type of resource(s) affected		
Gypsum waste, land, CO_2 emissions		

Company description
Gypsum Recycling International A/S (GRI) is the Danish-based mother company of the operating units in the Gypsum Recycling Group. GRI was launched in Denmark in 2001 and it soon started to expand in the international market. The company currently operates through its subsidiaries in Denmark, Sweden, Norway, Germany, Holland, Belgium and USA. Originating from the largest demolition company in Scandinavia, GRI has developed an innovative recycling system based on its previous expertise in demolition and waste management. Its customers are divided into two categories: waste companies or municipalities that need to dispose of their waste at a lower cost than landfilling it, and plasterboard manufacturers that seek raw material for their production process which comes at a lower cost than virgin or synthetic gypsum, otherwise known as FGD (flue gas desulphurization gypsum). The company provides a product (recycled gypsum powder) by recycling gypsum based demolition and construction waste on one hand, and a service, through its logistic collection system on the other hand. GRI has more than 1000 clients in Europe, out of which more than 50% choose to benefit from their logistic collection system. GRI's particular recycling system deals with all types of gypsum waste from demolition and reconstruction activities (eg. plasterboard waste, drywall and gypsum wallboard waste), recycling them into gypsum powder for the production of new plasterboards. The waste handling technology is able to recycle up to 90% of plasterboard and gypsum waste, the remaining 10% consisting of recycled paper used for composting, heat generation, recovered paper etc; GRI's recycling unit tolerates as much as 2% contamination of the waste it processes, which can be removed by their recycling technology (eg. nails, screws, wood, plastic).

Description of the resource efficiency (RE) measure(s)

Context information

Originally started in 1999 and driven by high disposal costs of gypsum. As a result of a 2-year research project a technology to recycle gypsum was set up and accomplished in 2001. After 2003, driven by the idea of a potentially large market for gypsum recycling, due to EU regulations (EU landfill directive 31/1999 and related EU Council decision 33/2002, and later the EU Waste Framework directive 98/2008) and on landfill taxes increasingly applied by European countries, the company restructured its business model and managed to attract venture capital and build an international recycling business.

Detailed description of the measure

GRI are not implementing resource efficiency measures themselves, instead they are providing this service of to their customers, who can choose to lower their carbon footprint at a more convenient cost.

GRI's proprietary technology consists of a mobile recycling unit and containers for collection of the gypsum waste. The containers have a standard size of 30 cubic meters and can hold up to 6 tonnes of gypsum waste each. First, the gypsum recycling container is placed near where the waste is generated eg. demolition sites, sorting facilities, public recycling centers or on construction sites (15% of new plasterboard at construction sites comes out as waste). Once a container is full it is collected by a grab truck; one grab truck can contain waste from 6 fully-loaded containers, thus reducing the need to return to the recycling facility after every container has been unloaded. When the truck is completely full it goes to the nearest recycling facility. The recycling facilities are normally located close to the users of their recycled powder (the plasterboard plants) to save resources and transport costs; one facility can store up to 3 000 tonnes of waste. If the minimum quota of 2 000 tonnes has been gathered at the recycling facility, they send in a mobile recycling unit to recycle the waste. The mobile recycling unit spends approximately 10 days at the facility, then moves on to the next facility. The mobile recycling unit gives out two streams of materials: the paper and the clean recycled gypsum powder. Finally, the gypsum powder is loaded onto a trailer and driven to the nearby plasterboard plant where the recycled material is unloaded next to the virgin gypsum material; the recycled gypsum powder can replace approximately 30% of the gypsum material used to manufacture plasterboard, due to its purity of almost 99%, and can be used directly in combination with virgin raw gypsum.

How has the company implemented the RE measure(s)?

The key factor contributing to the development of their business in Northern Europe and in the Benelux countries was their mobile recycling technology; instead of setting up fixed plant recycling facilities in EU member states which would require multi million Euro investments, they patented a mobile recycling unit that could be transported to each of the countries and facilities where the company wanted to set up the business. According to their calculations, a minimum investment for the technology in a fixed recycling facility would have come as high as 1.5 million EUR per facility. Currently they own and use 3 mobile recycling machines, which allow them to operate in Denmark, Norway, Sweden, Belgium and Netherlands and on a limited basis in Germany. By strategically positioning the recycling facilities transport costs are saved. The machine operators are Danish employees, they drive and operate the recycling machines where needed, while the business administration of each subsidiary eg. warehouse management, client acquisition campaign etc. is done by local employees.

Implementation of the RE measure: drivers and obstacles

Why was the measure taken?

GRI was created in light of two types of business opportunities:

On one hand the EU Landfill Directive and related council decision (and later the Waste Framework Directive) cited above provided the context for market creation; specifically customers that would prefer gypsum and plasterboard waste recycling instead of landfilling, which would incur high costs and landfill taxes. Gypsum waste poses a threat to human health if landfilled and exposed to rain water and organic matter, as hydrogen sulphide gasses may be generated. In addition to the sulphate leachate of the gypsum waste may contaminate the ground water if no leachate collection is present in the landfill. Therefore the EU Landfill Directive has determined that gypsum waste should only enter into non-inert non-hazardous landfills with leachate collection, in special mono cells where no organic waste is present.

On the other hand, GRI has been developing over the years both the technical expertise and the business case of handling gypsum demolition and construction waste.

By combining these opportunities, at least the promise of opportunity in the case of EU Directives, GRI decided to expand its business in the international market, expecting that EU regulation would be adopted in national policy frameworks making the landfilling of gypsum waste more expensive: As an example, the cost of landfilling including the landfill tax in the Nordic countries could go as high as 150 EUR/tonne, while the cost of recycling sorted gypsum waste would be 80 EUR/tonne.

The implementation of EU Directives

As emphasized by the interviewee, the success of their business is dependent on the level of national policy implementation in accordance with the EU Landfill and Waste Framework Directives. Their largest market share for gypsum recycling has been in the Nordic countries (up to 80%) due to national policy implementation which helped creating a market for their services; although not a EU member, Norway has proved to be one of the most prolific markets for GRI, due to the Norwegian government's implementation of EU regulation and to their landfill tax; other notable markets have been Denmark, Sweden and the Benelux countries, which all have national policies in place to support the application of EU Directive on hazardous waste disposal, and which all have high landfill taxes. In Denmark, the company registered a market share of 80% as early as 2007, even though Denmark first implemented a national policy in accordance with the EU directives in 2012.

Market losses

In their attempt to have the first mover's advantage, they tried to cover UK and Ireland as well in 2005. They encountered resistance from the regulatory authorities at the time, especially in UK. By the time UK had the necessary regulation in place, the company registered significant losses (not disclosed by the interviewer) and decided to shut down its subsidiary in UK. In the Nordic segment they registered declining profits in 2008 as well, due to the building industry crisis, which reduced the volume of waste by 40%. After they re-organized their company in 2010 their economic situation stabilized, registering profit. In Germany they are still challenged with their business model due to the fact that the German regulations are not in correspondence with the EU directives and as Germany has no landfill tax. The cost for gypsum disposal is therefore down to only 20 EUR/tonne, which impedes Gypsum Recycling from effectively competing on this market. The minimum price for landfill disposal at which Gypsum Recycling can compete would be 50 EUR/tonne of gypsum waste.

Competing at a price level

Another issue is the price fluctuation in trading with the plasterboard manufacturers. Virgin raw gypsum is a very cheap material; in Spain the price can be as low as 7 EUR/tonne, which means that the company must generate

their income from the waste management operation and not from the recycled gypsum produced. In order to create markets for their products, GRI needs to offer the gypsum produced at a competitive price compared to other gypsum raw materials, such as the virgin raw material and the FDG material. The economic incentive is the only one that can actually create a volume market for GRI's recycled gypsum powder.

In absolute terms, their plasterboard customers need to save at least 10-25 EUR/tonne of recycled gypsum powder and in relative terms at least 30%, compared to alternative gypsum sources. Similarly, waste companies need to save at least 25% of their disposal cost in order to use GRI's services, which in absolute terms equals 25-50 EUR/tonne of gypsum demolition and construction waste.

Behavioural change

The production environment at the receiving plasterboard plants poses challenges to GRI in terms of reluctance to alter production process to accommodate GRI's product and services. According to the interviewer, production managers are often reluctant to make the necessary changes to existing production processes to accommodate GRI's product. As such, GRI need to compete on price to convince the senior management to approve the project, where production management would not accept process changes.

GRI is an associated member of the Euro Gypsum Association, a pan-European organization for plasterboard plants.

The potential to apply it elsewhere or on a bigger scale

The market is large and the implementation scalable. The potential of gypsum waste in Europe is approximated at 3 million tonnes; apart from one serious competitor in this market and some local competitors, and given the market was better regulated, GRI could, in theory, expect to get 30-40% of that market.

Incentives & drivers for implementing RE measure

- ***Policy regulation***
  EU landfill directive 31/1999, EU Council decision 33/2002, EU Waste Framework directive 98/2008

- ***Economic instruments***
  Landfill taxes would help significantly to create a market for GRI's demolition recycling service.

- ***Competitors***
  The FGD product (synthetic gypsum) poses a real challenge to promoting recycled gypsum powder. Large volumes can flood the market for plasterboard manufacturing, negatively influencing the price of raw gypsum material. In some instances, given that FGD is produced as residual waste in coal-fired plants (created when using scrubbers of lime in coal in fired-power plants to clean the smoke for sulphate), plasterboard manufacturers are even paid to remove FGD from power plants, as the alternative would be high transportation costs to landfill the synthetic gypsum. On the other hand, FGD could be viewed as an opportunity for GRI, because it reinforces the superior quality of industrial gypsum powder over virgin raw gypsum. Although there is currently a lot of FGD gypsum on the market, GRI believes it will become scarce in the next 10-15 years, as coal power plants are replaced by alternatives. On this basis GRI expects recycled gypsum powder to gain a larger share of the market. It should also be noted that FGD is predominantly used in plasterboard plants that are situated in the vicinity of coal fired power stations.

- ***Consumers***
  GRI's customers are both waste companies and plasterboard manufacturers. Waste companies are incentivised to a higher degree towards GRI's recycling service due to existing (in the Scandinavia and partially in Benelux area) and potential implementation (other European countries) of EU landfill and waste handling regulation regarding demolition and construction waste. Plasterboard manufacturers are

incentivised to a higher degree by the cost savings in purchasing recycled gypsum powder; customers genuinely interested in a sustainable solutions lowering their carbon footprint amount to only 5-10% of their current customer market, according to GRI.

- ***Labelling or product standards***

  GRI is the winner of the Cleantech Award from Vækstfonden awarded to the most promising Danish environmental company 2007 and the winner of the Swedish Recycling Award 2010.

Resource impacts

- **Resource use per product saved (number of units saved, total cost savings in terms of raw material inputs or monetary terms)**
  For each tonne of plasterboard recycled instead of landfilled, the rate of saved GHG emissions is 97%; in absolute terms, for each tonne of plasterboard recycled instead of landfilled, there is 0.2 tonnes of saved emissions.
- **Total resource savings (i.e. tonnes of CO2 emissions p.a.)**
  Construction and demolition waste in all countries makes up 30-40% of waste landfilled; by recycling this type of waste a significant amount of GHG emissions are saved. 1000 tonnes of plasterboard waste emits 104 tonnes of CO_2 if landfilled, and 96 tonnes of CO_2 from the transport and generation of new virgin gypsum; if recycled, using current technologies, 1 000 tonnes of plasterboard waste emits 6 tonnes of CO_2.
  Based on the WRAP technical report on Life Cycle Assessment of Plasterboard (2008), GRI is able to calculate GHG savings for their waste-side customers, due to recycling instead of landfilling; the CO_2 savings certificate offered to waste collection companies is meant to provide their customers with information on the impact of their activities. For example, a waste company collecting 11 956 tonnes of gypsum waste, contributes to cutting 2 393 tonnes of CO_2 emissions.

Economic and social impacts

Economic and social impacts of the RE measure for your company and/or for other companies in the value chain

- ***EUR per final cost saved (EUR/tonne or EUR/product)***
  Plasterboard plants save minimum 10-25 EUR/tonne in absolute terms, or in relative terms minimum 30% of their purchase costs; waste customers save between 25-50 EUR/tonne in absolute terms, or minimum 25% of their disposal costs.

- ***Total monetary savings (EUR)***
  As the yearly recycled volume is in excess of 100 000 tonnes, the minimum total savings can be calculated as follows:
  - For plasterboard plants: 1.0-2.5 million Euro
  - For waste customers: 2.5-5.0 million Euro

- ***Investment costs avoided/additional (EUR)***
  By choosing to develop a mobile technology, GRI saved approximately a 1.5 million EUR investment per recycling facility deployed.

- ***Payback-time (Months)***
  Their customers see the benefits of their product and services right away. As for GRI's investments in

subsidiaries around Europe, it takes 4 years to register profit, given the market share provides good conditions; the first year is spent on setting up the whole the subsidiary, obtaining the permits needed etc, the second year they start creating a customer base, third year their products and services get better visibility and the fourth year they register profits.

- ***Impacts on employment (number jobs created/lost)***
  For every 4 000 tonnes of gypsum demolition and construction waste recycled 1 job is created.

- ***Type of jobs created/lost, safeguarded***
  Waste handling activities (grab truck drivers, people operating the recycling unit) and business administration activities (managing the recycled gypsum warehouse, obtaining waste handling permits, customer acquisition etc.)

- ***Impact on business performance: additional turnover, cost savings, productivity, profitability***

  In markets where the EU Directives are implemented at a national level, and landfill taxes are issued for demolition and construction waste, GRI can register a return on investment of 10%.

Local/regional/national/EU resource policy framework

EU Directives on landfill and waste handling (EU landfill directive 31/1999, EU Council decision 33/2002, EU Waste Framework directive 98/2008) are highly relevant in this case study, as they have a direct effect on national policies that contribute to creating a growing market for GRI due to the increase cost of landfilling. Similarly, implementing increased landfill taxes for demolition and construction waste would create a growing market.

Implementation of EU Directives (EU landfill directive 31/1999, EU Council decision 33/2002, EU Waste Framework directive 98/2008) at a national policy level would determine an increase in the market share for the product and services provided by GRI. Lack of implementation would hinder its market growth and profitability.

Further information

Links to relevant information sources:

- http://www.globalgypsum.com/pdf/eGGNov2010nonsub.pdf (p 24-28)
- http://ec.europa.eu/environment/waste/landfill_index.htm
- http://ec.europa.eu/environment/waste/framework/
- http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2003:011:0027:0049:EN:PDF

Link to company website or detailed case study on the web:

- http://www.gypsumrecycling.biz/15892-1_Companyprofile/

Link to EEA RE country profile:

- file:///C:/Users/b012789/Downloads/DENMARK%20country%20profile%20on%20resource%20efficiency%20policies%20(1).pdf

1.11. Janssen Pharmaceutica

Company Name: Janssen Pharmaceutica NV
Case study title: Closing the cycle: introducing a chemical leasing process for the recuperation of a chemical cleaning solvent at Janssen Pharmaceutica, Belgium
Year of implementation: 2014

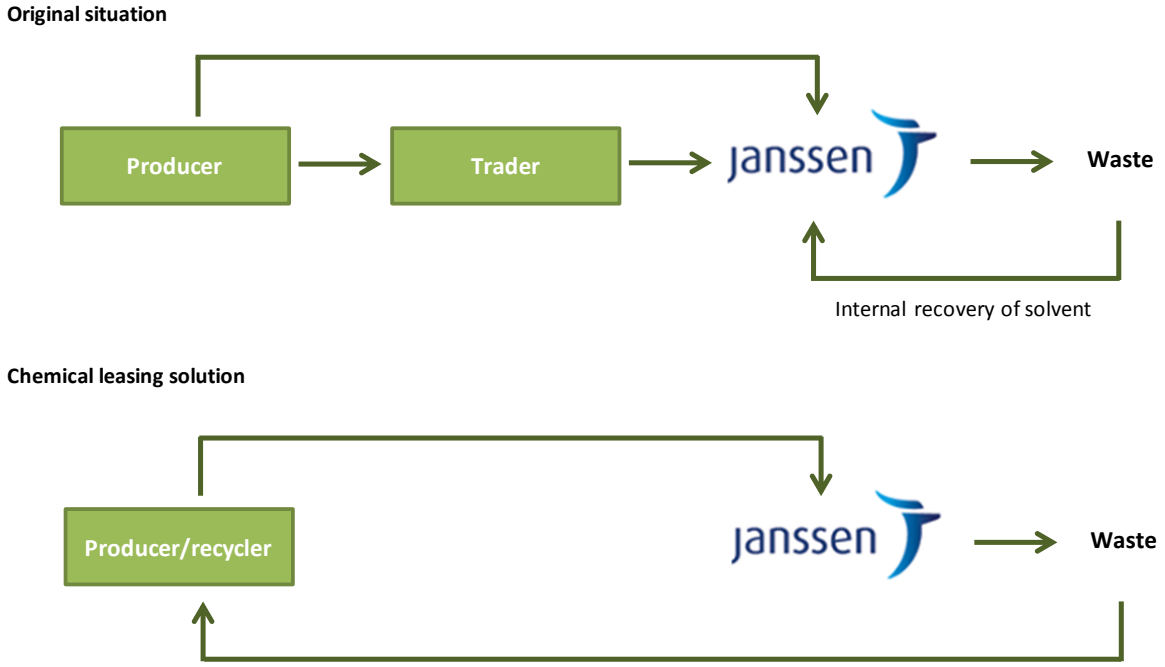
COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
Belgium Turnhoutseweg 30 B-2340 Beerse, Belgium	NACE 21 Manufacture of basic pharmaceutical products and pharmaceutical preparations	In 2014: 4600 employees
Type of resource(s) affected		
Water, materials (chemical solvents), and CO2 emissions		

Company description
Janssen Pharmaceutica is part of the Johnson & Johnson organisation. Its core business is researching, developing and producing medicines and therapeutic solutions for patients. The company was founded by Dr. Paul Janssen in the early 1950s and in 1961 joined Johnson & Johnson. Janssen Pharmaceutica hosts an important research division focussing on neurosciences, infectious diseases and vaccines, and oncology. The production is dedicated to fluid, semi-solid and injectable medicines. Janssen Pharmaceutica in Belgium covers the full pharmaceutical cycle from discovery to production and distribution.

Description of the resource efficiency (RE) measure(s)
The production of pharmaceutical (intermediate) products requires large volumes of organic solvents. The solvents are used to clean reactor tanks between batches of production loads. After being used as a cleaning agent the solvent stream contains water and a number of pollutants. The original practice is to recycle the solvents internally and upgrade them through distillation and afterwards reuse these solvents again. Beside a new batch of reusable solvents this method also generates a set of wastes. When the minimum quality standards of the solvent cannot be attainted anymore the last stage is incineration or external treatment by a certified waste handler. Within this setting up to 40% of all solvent streams are recycled. The resource efficiency measure envisaged consists in implementing a Take Back Chemicals initiative, a variant of chemical leasing, for a particular solvent. The upgrading of the stream of used solvent will be done externally by a specialised producer/recycler. The latter treats the used solvents on a dedicated installation in which only used solvent streams from Janssen Pharmaceutica will be treated, in order to guarantee quality standards agreed upon between the partners, Contrary to a traditional business model, the producer/recycler does not buy the waste stream from Janssen Pharmaceutica nor does the producer/recycler sells the upgraded solvents to Janssen Pharmaceutica. Janssen Pharmaceutica remains the owner of the solvent stream and the producer/recycler provides a service to the pharmaceutical company by upgrading the solvent stream to the

necessary quality. Janssen Pharmaceutica commits itself to reusing the upgraded solvent, subject to reaching the minimum quality standards. The monitoring of the upcycled solvent is done by Jansen Pharmaceutica in close cooperation with the producer/recycler. The following figure provides a schematic overview of the original practice and the chemical leasing resource efficiency measure.

Figure:1. A schematic view on the original and chemical leasing resource efficiency measure at Janssen Pharmaceutica Belgium



Source: based on De Bruyn et al. 2014, p. 20

Implementation of the RE measure: drivers and obstacles

The measure fits in the corporate policy aiming at an improvement of its environmental footprint as well as an optimisation of existing installations. For instance as part of the Johnson & Johnson group with its Healthy Future objectives, ten of the worldwide Janssen products must have earned Johnson & Johnson's Earthwards™ recognition for sustainable production by 2015. Janssen combines green chemistry, technological innovation and sustainable power consumption to reach that goal. It is within this context that the envisaged Take Back Chemicals RE initiative has to be situated, as part of a wider set of measures.

In practical terms, the minimum requirements are that the initiative would be economically and environmentally viable. The RE initiative should generate net benefits for both parties involved, minimize the impact on the environment, and create a win-win-win situation (supplier, user, environment).

The regulatory aspects turned out to be an important challenge. During the feasibility phase a lot of effort was devoted to obtaining the necessary certificates and complying with existing regulations. First of all, cooperation with the Flemish regulator for waste streams OVAM was set up in order to assess the regulatory feasibility in particular to make sure that the upgraded solvent stream would qualify for the end-of-waste status when the

solvent would go back to Janssen Pharmaceutica,. Second, the upgrading activities as well as the cleaning activities need to comply with the REACH regulation since waste treatment is considered as a production process and since the reused product is not considered as a waste.

The technical feasibility is another important condition, in particular the quality of the upgraded solvent. This requires a close cooperation between the producer/recycler and the pharmaceutical company, working on long-term relationships, on mutual understanding of processes and trust.

Provided that a mutual beneficial situation can be created between the various partners, at least in principle this RE initiative can be applied in other chemical and pharmaceutical companies as well. However legislation plays an important role. Due to different interpretations and implementations of the EU waste framework directive across Member States this initiative cannot be merely copied to other countries, nor can the upgraded solvents be exported as products. It is the experience of the initiative's team members that a material stream that received the end-of-waste status in one Member State may not always be recognized as such in another Member State unless specific rules have been implemented.

Resource impacts

The resource impact has been calculated using a delta LCA which compares the effects of all the processes that changed due to the introduction of the RE measure with the status of these processes before the introduction of the measure. Although the core activity of the process remains the same, namely the cleaning of the reaction tanks, the RE measure has ramifications for the preceding and subsequent processes. The LCA results have been summarized along three environmental impact categories: materials, water and energy. For all these categories an estimated reduction of 20% is expected. The 20% reduction of materials is mainly due to the reduction of virgin solvents, which in the end leads to a reduction of crude oil imports. The reduction in water use is mainly situated in the more efficient upstream processes in the upcycling phases. The LCA impact for energy consumption includes the increased energy use for transport. However this is more than compensated by the energy efficiency gains in the upcycling stage and in the solvent recuperation process. Due to company secrecy, details from the LCA have not been released.

Economic and social impacts

No particular economic and social impacts were reported, except that the necessary investments would be paid back within an acceptable time period of two to three years. Given the fact that the investments are substantial, this indicates that the chemical leasing concept is certainly worth considering for other chemical components within the company, as well as for other companies. An important part of the value capturing is the set-up of a solid remuneration model which takes account of all the partners' costs as well as benefits due to increased resource efficiency. The price for the upgrading and cleaning service depends on the degree of impurities to be removed from the solvents and the efficiency of the upgrading and cleaning processes. The system is developed in such a way that both the user of the upgraded solvents, Janssen Pharmaceutica, and the producer/recycler have both a financial incentive for improving efficiency.

A crucial element for obtaining profitability and therefore the acceptable pay-back time is being able to operate above a minimum threshold volume. The scale is indeed another important parameter determining the viability of the measure.

In terms of employment impact, one may argue that in the short-run employment remains the same since the upgrading process at Janssen Pharmaceutica is replaced by another one – albeit more efficient in terms of obtaining solvent quality – with the producer/recycler. However one has to bear in mind that insofar as solvent traders and waste handlers were involved in the original situation, these are largely out of the value chain in

chemical leasing solution. This leads at least ceteris paribus to a reduction in employment. Yet in a dynamic view, employment at Janssen Pharmaceutica and with the producer/recycler company may increase due to increased profitability. Since the initiative is relatively recent, it is too early to get a view on the net employment impact with all companies involved especially if one wants to include the dynamic behavioural reactions.

Local/regional/national/EU resource policy framework

The RE initiative is strongly linked with the regional resource policy framework and indirectly with that of the EU as well since the former is for several aspects the regional implementation of various EU directives in particular the EU Waste Framework Directive. Also the REACH regulation played an important role in the set-up of the initiative.

The Janssen Pharmaceutica initiative has been worked out in close cooperation with the Flemish Public Waste, Materials and Soil Agency (OVAM) in order to assess the feasibility within the current legal framework. The initiative fits well within OVAM's material strategy and particularly with the Flemish region's Decree concerning the sustainable management of material flows and waste streams, the so-called Materials Decree (Materialendecreet of 23th of December 2011). The RE initiative clearly contributes to reusing materials and avoiding the creation of waste streams. Prevention of waste generation and promotion of sustainable production and consumption is at the top of OVAM's priority ladder for materials management, which is consistent with the EU's Waste Hierarchy as defined in the Waste Framework Directive (2008/98/EC).

From a practical implementation point of view it is very important that the end-of-waste material status is certified, since the upgraded solvents are no longer waste and can be considered as non-waste material that is suitable for production. During the feasibility phase the required certificate has been obtained.

Further information

Links and references to relevant information sources

De Bruyn G., Vander Velpen B., Walraedt S., Hoppenbrouwers M., 2014, Publieke eindrapportage TaBaChem, MIP3 haalbaarheidsstudie. Take Back Chemicals: upgraden van een tradioneel verkoopsmodel van chemieproducten naar een lease-sale model, MIP Vlaanderen, 43 pp. (Public final report TaBaChem, MIP3 feasibility study. Take Back Chemicals: upgrading of a traditional sales model for chemical products to a lease-sale model.)

Link to company website or detailed case study on the web

http://www.janssenbelgium.be/en/discover-janssen

1.12. Metsä Fibre Kemi mill

Company Name: Metsä Fibre (Kemi mill)
Case study title: Replacement of two old water treatment and demineralization plants with a new energy efficient and water-saving flootech process.
Year of implementation: March 2012 taken into use

COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
Metsä Fibre Oy Kemi mill Pajusaarentie 150 A Fin-94200 Kemi FINLAND	17.11 Manufacture of pulp	Latest number of employees: 200 at Kemi mill (medium-sized) 900 total Metsä Fibre
Type of resource(s) affected		
Energy, water		

Company description

Metsä Fibre Oy was founded in 1973. Metsä Fibre is a subsidiary of Metsä Group. Metsä Group manufactures first-class bleached Botnia pulp grades at four mills in Finland. The combined production capacity of our mills in Joutseno, Kemi, Rauma and Äänekoski is 2.4 million tonnes. The Svir Timber sawmill in Russia is also a wholly-owned subsidiary Metsä-Fibre Oy.

Table 1: Key figures of Metsä Fibre

	2013	2012	2011	2010	2009
Sales (EUR million)	1,314	1,274	1,301	1,365	886
Result before tax (EUR million)	197	145	258	370	-107
Personnel 31.12.	873	876	873	881	1111
Gross capital expenditure (EUR million)	27	35	45	14	10
Production capacity (million tonnes)	2.43	2.41	2.41		

In 2013, Metsä Fibre's profitability increased mainly due to increased sales volumes and increased pulp prices[24]. Metsä Group consists additionally of Metsä Tissue, Metsä Board, Metsä Wood, and Metsä Forest. Together Metsä Group had sales of 4.9 billion € in 2013, and a personnel of 11,000.

The **Kemi mill** in Northern Finland was founded in 1893. Sulphate pulp has been manufactured in Kemi since 1919. The mill was largely rebuilt in the 1980s and adjoins the local export harbour within 10km distance. It employs around 200 people.
At an annual capacity of 590,000 t of softwood and hardwood pulp, the mill is specialized in producing pulps best

[24] *Source:* http://www.metsafibre.com/Company/keyfigures/Pages/Default.aspx

suited for tissue and speciality paper manufacturing as well as board. Around 45% of production is exported. The mill consumes 2.7 million m³ of wood annually, with 95.7% of the wood sourced from PEFC-certified production. Kemi mill is more than energy self-sufficient (producing 146% of own electricity consumption)[25].

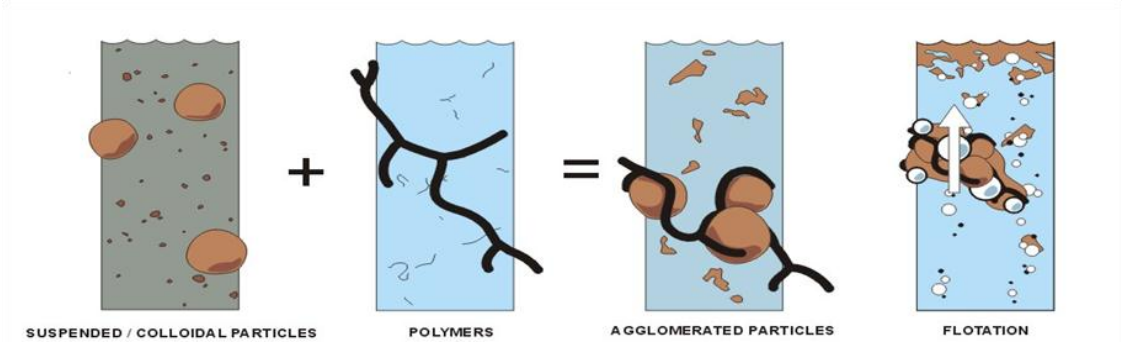
Description of the resource efficiency (RE) measure(s)

Detailed description of the RE measure:
Metsä Fibre Kemi Mill had carried out an energy assessment study in 2010 to further investigate the overall use of water in the mill. Water is used at the mill for various processes: mechanical and chemical cleaning as well as for boiler water. The water treatment plants were approaching the end of their use period and were to be renewed. The assessment showed that the plant provided plenty of 40-45 and 65 degree Celsius water coming from cooling and flue gas washing. Traditional water treatment plants operate in 20 degree Celsius, thus the warmer water was not suitable for the process and had to be discarded into the sea. Metsä Kemi wanted to challenge the technology developers to develop a technology that could use this warm cooling water directly and decided to replace two old water treatment and demineralization plants by a new energy efficient process.

The RE measure was delivered by a contractor in 2012. Flootech, a Finnish company supplying products and implementing processes in water and wastewater treatment, delivered a complete process solution that can operate also in high temperatures. The process includes raw water treatment, demineralization water treatment and condensate polishing. Due to the new user-friendly and energy efficient water plant, the mill can improve the quality of pulp and decrease waste material.

The raw water treatment plant has two lines; one so-called cold line operates in 20-35 degrees Celsius and the other so-called warm line operates in temperatures up to 60 degrees Celsius. High temperature flotation is a very exceptional solution for water treatment and only very few competitors could offer a similar system. The raw water used in the process is pre-heated cooling water from the evaporation plant and has not been exploited before. By reusing warm cooling water as raw water, the demand of source water has been reduced significantly (saves 130 litres of water per second in winter, and 160 litres per second in summer). This also saves the pumping costs as warm water can be recycled. Additionally, the process heat from flue gas condensate is used to warm chemically treated raw water up to 60 degree Celsius.

Micro flotation principle:



(Source: http://flootech.com/?page=references_metsafibre_kemi_mill#sub, interview and Metsä Figre Kemi power point presentation 6.5.2013 by Pekka Posti)

[25] *Source: http://www.metsafibre.com/Company/ProductionUnits/Pages/kemimill.aspx*

Implementation of the RE measure: drivers and obstacles

The reason for taking the RE measure was a mixture of current reinvestment need and sustainability / resource saving goals, coupled with cost effectiveness considerations. Consumer sustainability concerns and competitiveness considerations also played a role.

The existing water treatment plants were old and located at various locations at the mill. Furthermore the issues of safety and energy efficiency throughout the life cycle of the Kemi mill were under assessment. Based on the energy and water analysis it was known that there was plenty of 40 and 65 degree Celsius excess water from the processes that had currently no use. Kemi Mill wanted to reinvest using a new process that could efficiently use the energy stored in the process waters, and that allowed combining the previously existing plants into one.

Internal sustainability and economic goals drove the implementation. The company had committed to the Finnish government's "Motiva" target of reducing 1% of energy use per year, and received initial "Motiva" funding for the investment. Metsä Fibre had decided itself to become more environmental and energy efficient. Savings were gained in energy efficiency through a reduced amount of wood bark (by-product of the pulp and paper process) being burned into energy. Saved bark or electricity could be sold to other actors on the market which also brings additional revenues thus also driving the process.

The measure was also part of a larger process and commitment to reduce wastewater. Kemi mill has decreased the use of process water by altogether over 20% between 2010 and 2013 (26% per tonne of pulp). In addition to the measure described here, careful monitoring of water use led to many other small improvements, for example in pulp washing and causticising processes[26].

The RE measure did not have an impact on the implementation of Environmental Management Systems (EMAS or ISO14001) as Metsä mills are ISO14001 and EN 16001 certified in 2013 (see below). The company had already all necessary environmental permits. But it helps to showcase to clients what measures are taken to reduce the environmental impact and improve sustainability. Increasing pressure from consumers who become more demanding with regard to environmental impacts and sustainability thus also played a role in the implementation and in driving the internal sustainability goals.

All Metsä Fibre pulp mills have the following certificates:

- Quality management system SFS-EN ISO 9001
- Environmental management systems SFS-EN ISO 14001
- Occupational health and safety management system OHSAS 18001
- Food Safety Management Systems SFS-EN ISO 22000
- PEFC Chain of Custody with PEFC logo use rights
- FSC Chain of Custody and Controlled Wood
- Energy efficiency system EN 16001
- Kosher certificate, Äänekoski mill

Source: http://www.metsafibre.com/Sustainability/environmental/Pages/Default.aspx

[26] Source: http://www.metsagroup.fi/SiteCollectionDocuments/Vastuullisuus/Sustainability_Report_2013.pdf, p. 37; comparison of figures: http://www.metsafibre.com/News/Material%20Archive/Botnia_Annual_Review_ENG_25.5.pdf

http://www.metsafibre.com/News/Material%20Archive/Metsa-Fibre-Annual-Review-2013.pdf

Cost effectiveness was another key driver of the process. There are higher risks involved when taking up a technology or processes that have not been used on this scale before. This had to be evaluated carefully. In the competitive market of pulp, reducing costs and increasing the quality of the product at the same time can bring added value for the competitive position. This new technology made both possible.

The technology was tested from November 2011 to February 2012 before it was taken into use. After the introduction of the new technology, the old water treatment plant was shut down. Until now there have not been any problems since taking the process into use.

The RE measure has a good potential for up-scaling or uptake by other operators who have a vast amount of warm excess water available. Flootech sells these kinds of process solutions elsewhere. However, at this large scale this is first of a kind in the world.

Resource impacts

Of environmental resources affected, the most important ones were water and energy. Per product, 5% of fresh water are saved (130 l/s fresh water in winter, 160 l/s fresh water in summer), and altogether 64 500 MWh p.a.. In addition, as energy consumption was reduced, bark could be saved which is usually used to generate steam / electricity. Due to this additional bark and/or electricity, there is an indirect resource effect, as the electricity produced from bark potentially replaces electricity produced from peat (common in Northern Finland). The measure and its reduction in energy use also meant savings of 280 000 tonnes of CO_2 emissions p.a.; it did not affect critical raw materials as they are not used[27].

Economic and social impacts

In terms of economic impact, the RE measure saves energy (64 500 MWh/year) that is normally produced from bark through steaming. Therefore the plant has additional bark available, which can either be sold as bark on the market or be converted into electricity and sold as such. The mill can decide between these two options based on the bark price it receives and the price for electricity it receives.

The RE measure did not affect employment; the previous number of jobs was maintained as the staff from the previous water treatment plant would manage the new plant. They were trained to manage the new process. Actually it made the work easier for the staff, as instead of 2 plants as in the past there is now only 1 plant.

The measure did improve the mill's competitive position, as it allowed producing a better quality and more homogeneous product. This is also considered to have the potential to attract new clients in new markets. In addition, the savings of costs and creation of a new revenue stream (from selling bark / electricity) contributed further to strengthening the competitive position.

There is no precise data on the costs of the investment. However, it was necessary in the investment cycle to replace the old water treatment plants. Any costs additional to a basic reinvestment may be considered the extra investment costs for resource efficiency.

[27] Sources: Metsä Fibre : http://www.metsafibre.com/News/Material%20Archive/Botnia_Annual_Review_ENG_25.5.pdf

http://www.metsafibre.com/News/Material%20Archive/Metsa-Fibre-Annual-Review-2013.pdf

Local/regional/national/EU resource policy framework

We can distinguish between three types of regulations / policies relevant in the context of this RE case. First, there are policies affecting the pulp & paper industry in general, thus influencing the general competitive and market environment. Second, there are policies affecting the use of waste as a resource, which are important in the context of resource efficiency initiatives. Third, there are policies and legislations which were particularly relevant in the implementation of the RE measure discussed here.

Among the policies generally affecting the pulp & paper industry, the Renewable Energy Directive plays an important role, as it encourages using wood for energy production instead of other forest industry products (such as pulp and paper) which can be recycled and at the end of their lifetime be used for energy production. The industry sees a similar problem with the Resource Efficiency Roadmap, as it does not make a clear distinction between renewable and non-renewable raw materials, while this distinction would be important for the pulp & paper industry. For example, one of the resource efficiency scoreboard indicators is material use per capita, which does not differentiate between renewable and non-renewable materials (and yields particularly bad results for – thus putting particular pressure on – Finland due to its high renewable resource use and small population).

Policies affecting the use of waste as a resource include the EU's Waste Framework Directive and the corresponding List of Waste (determining the criteria for hazardous waste). Once waste is classified as hazardous, it is very difficult to still use it as a resource (waste treatment is required and the effect on the company's image needs to be considered). The most important waste from forest industries classified as hazardous is wood ash or bark ash (from energy production). At national level, Metsä Fibre reports problems with long permit procedures for waste utilisation; also, the so called MARA legislation referring to use of land and construction prevents the use of waste as a raw material on a larger scale, since it sets very strict limit values for certain elements in the waste.

The direct impact of policies on the RE measure at hand was surprisingly small – regulation was not mentioned among the main drivers, except for national self-commitments and national financial support. Environmental impacts (CO_2 emissions and water/energy usage) were reduced by installing the RE measure. This is in line with the company policy to reduce environmental impacts and become more energy efficient; this policy is also mirrored in the company's commitment to the Finnish government's "Motiva" target of reducing 1% of energy use per year. Kemi Mill received initial "Motiva" funding for the investment in the RE measure.

Although CO_2 emissions were reduced due to the RE measure, the EU-ETS does not seem to be considered to have an impact or be a driver due to the currently low prices. However, sales of ETS credits could become a driver in the future.

Further information

Information on the RE measure: http://www.metsafibre.com/Company/Pages/Default.aspx and http://flootech.com/?page=references_metsafibre_kemi_mill#sub

Reports by Metsä Fibre and Metsä Group:

- http://www.metsagroup.fi/SiteCollectionDocuments/Vastuullisuus/Sustainability_Report_2013.pdf
- http://www.metsafibre.com/News/Material%20Archive/Botnia_Annual_Review_ENG_25.5.pdf
- http://www.metsafibre.com/News/Material%20Archive/Metsa-Fibre-Annual-Review-2013.pdf

Examples for EU policies affecting the industry and its resource efficiency initiatives:

- Resource Efficiency Roadmap: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0571&from=EN
- Waste Framework Directive: http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0098&from=EN
- List of Waste: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CONSLEG:2000D0532:20020101:EN:PDF

For the EEA RE country profile of Finland, see http://www.eea.europa.eu/themes/economy/resource-efficiency/resource-efficiency-policies-country-profiles

1.13. NaKu

Company Name NaKu e.U.
Case study title: NaKu: Providing Knowledge and Feedstock for Bio-Based Plastic Products
Year of implementation: 2007

COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
Viktor Kaplan Strasse 2, 2700 Wiener Neustadt - AUSTRIA	Nace 22 Manufacture of rubber and plastic products Biotechnology (agriculture and chemistry)	8 people equivalent to 4 FTEs
Type of resource(s) affected		
Biomass, Materials (substitution of plastics), Air.		

Company description
NaKu (short for "Natürlicher Kunststoff" – natural polymers) is an Austrian start-up run by the family Zimmermann, currently in its 7th year of operation. The company specializes in the production of plastics made from biopolymers (so-called organic plastics) – natural and renewable resources are used for its materials, which are then manufactured into products, that are very similar to conventional plastics. The products from bio-plastics are 100 % recyclable & compostable albeit in various degrees and conditions depending on the specific composition of the material used. NaKu's product portfolio include the following: • Plastic bags • Foil and packaging • Compounds • Bottles & Preforms • Toys NaKu is entirely focused on bio-plastics in contrast to other companies in the sector, the majority of which dedicate only a fraction of activities to bio-plastics. The company's activities cover the entire value chain from the raw materials to the end-product. NaKu offers the feedstock for bio-plastics and provides the knowledge how to use that feedstock with the existing installations of plastic converters for bio-based plastic products. The following figure provides an overview of the value chain and in which parts of the chain NaKu provides value added. Sales activities are mainly concerned with the B2C segment although B2B sales are also prominently covered in the company's business model.

Description of the resource efficiency (RE) measure(s)

NaKu's innovation is the use of (residues of) locally grown plants such as corn, potatoes, grain, and sugar beet in the production of natural polymers. These polymers are polymerized lactic acids, or any other type of biopolymers. The company collaborates with so-called 'converters' – companies that receive the biopolymers for the conversion process into the final product. These companies typically don't know the chemistry behind this process so NaKu offers a service to the converter-company by bringing in knowledge about how to use the bio feedstock as well as the raw material itself.

NaKu places a strong emphasis on the development of the local value chain (for instance, it collaborates with an Austrian starch producer). It limits (global) transport and adjacent negative environmental effects such as CO2 exhaust. But it is also beneficial because the production process is knowledge intensive and requires an adequate tuning of the bio feedstock and production process to obtain the desired properties of the end product. Therefore short cycles are beneficial. So the converter-companies need to be located in the immediate vicinity. The production process is very similar to that of conventional plastics and it can be processed with the same technologies and machines.

Bio-based plastics (made from natural polymers) can be disposed through household waste or can be composted.

Implementation of the RE measure: drivers and obstacles

As a start-up the main driver behind NaKu's production of plastics made from biopolymers was the business potential as well as the importance of having a clear future vision (both environmentally as well as economically). For the company it has been important to create a product for which the employees can feel proudness and dedication.

The company has recalled that in the early days of its operations, it felt that the Austrian authorities didn't believe in the overall concept of its business (making plastic from biopolymers). The idea that it was possible to make polymers out of plants seemed like a foreign concept to the authorities.

In 2009 the awareness on the ecological problems rose and things started to change. Today the company is experiencing a stronger external belief and understanding of their business. In 2008 demand increased by 300 % in the span of six months. Nevertheless, NaKu indicated that it continues to feel a lack of public support. For instance, while Italian, Dutch and British authorities are quite supportive on bio-based polymers this is far from the case in Austria. The feeling is that there is still a low public awareness on the benefits of bio-plastics in Austria and that the market is fairly small. ~~Funding for development is hard to obtain~~. In Italy all conventional plastic bags have been banned. This gave a substantial boost to the Italian Bio-plastics cluster, which in turn urges the Austrian bio-plastic producers to focus on other niche markets.

Despite this NaKu believes that there's a significant up-scaling potential to other countries. In the course of the past four years it has been trying to increase its sales abroad primarily in Switzerland, Germany, Sweden and Italy. However it has been difficult to locate the right partner companies ('Distributors'). As indicated by NaKu, it has been particularly challenging to identify the right sales agents. The latter is important since bio-based plastics are more expensive than conventional plastics, but do have substantial environmental benefits. Therefore strong marketing efforts are needed. It is important to ensure that the company's vision is communicated well to the end-customer in order to be able to explain to them why their bio-based alternative is more expensive.

An indirect driver has been NaKu's nomination for the Austrian Climate Award in 2012 ("Österreichischen Klimaschutzpreis 2012, Kategorie "Klimaschutz durch Innovation").

Resource impacts

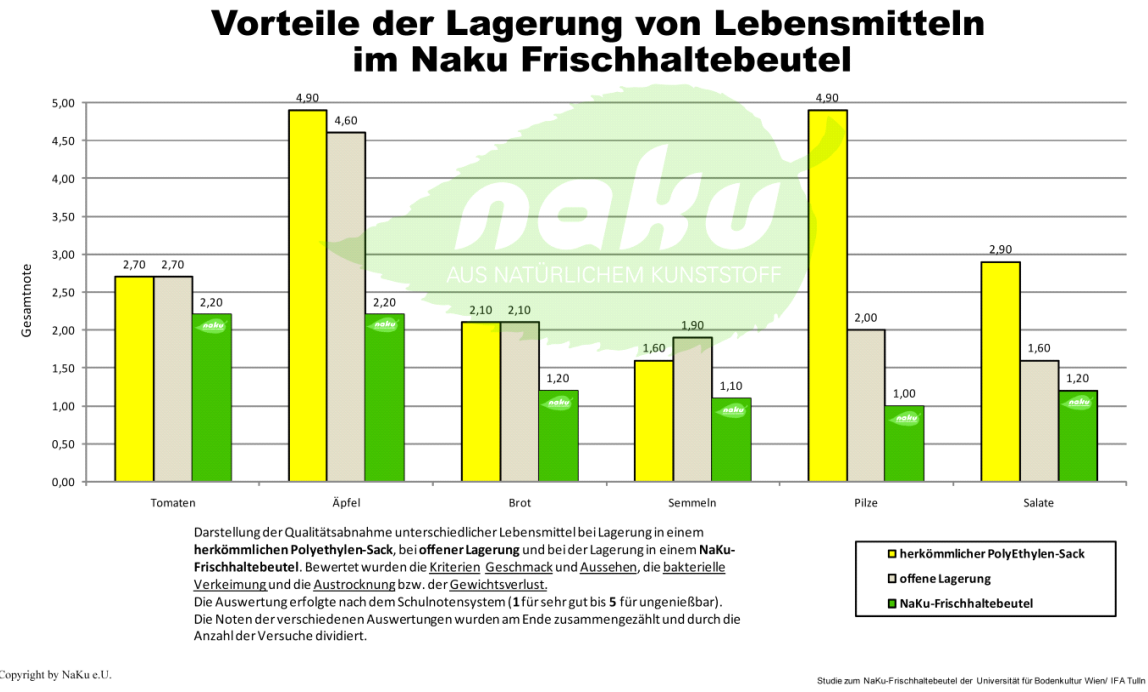
Resource impacts depend on the type of product addressed. In the case of NaKu's plastic bags, more CO2 is saved in the storage process (i.e. of bread or vegetables) compared to that saved in the plastic bag production process. Today approximately 30% of CO2 is saved in production in comparison with conventional plastics. This increases with production volume.

Similar amounts of energy are needed as for the processing of conventional plastics. Natural Polymer bags (where the raw material is produced from renewable resources and where the product is compostable) have a slightly better energy balance. The most considerable advantage of the use of Natural Polymers can be found in the CO2 balance and the subsequent impact on climate change.

The consumer saves approximately 20-65 % of CO2 emissions by using NaKu's PLA bottles compared to conventional alternatives.

As seen in the figure below, a study conducted by the company in 2009 has shown that NaKu plastic bags are better at keeping different types of food fresh compared to conventional plastic bags or the open storage of foods.

Figure 2: Comparative advantages of food storage using Naku's food storage bags



Note: The values indicate the decrease in quality of various types of fresh food in three situations: conventional polyethylene bags, open storage (no bag), and NaKu's food storage bags. The foods used in the test are respectively (left to right) tomatoes, apples, bread, cakes, mushrooms and salads. The value on the left vertical axe represents the average value across five properties: taste, visual look, bacterial contamination, dehydration, and weight loss. For each property a value was given between 1: very good and 5: inedible. Several test rounds were done and for each of the traits an average score over the test rounds was calculated.

Source: NaKu: http://naku.at/index.php/en/faqs/#Frage8

No critical materials are used (for instance, instead of crude oil, NaKu uses starch in the production). Conventional plastics can only be recycled, or used for energy recovery. Bio-plastic material has a wider set of use in the circular economy. It can be used for energy recovery (burning or biogas), recycling and

biodegradation. Obviously conventional plastics can't be biodegraded. The bio-plastic bags typically compost within 90 days, while this process takes longer for other bio-products.

NaKu has had an impact on the downstream value chain as well. For instance, one of its B2B customers is Hirsch, which produces bands for wrist watches. A particular part of the wrist watch band is made from NaKu's materials.

Economic and social impacts

NaKu spends approximately 25 % of its turnover on R&D. From the start of the business it has focused on assessing the potential of a wide range of products but it is reached a point in time where it is faced with the decision as to which products to maintain in its portfolio and which products to abandon in order to obtain a good balance between valorising existing product lines and developing new products. The idea-to-market time is typically one year but it can be up to six years as well. The company feels that it is difficult to estimate the market potential of its products.

There's significant competition in the plastic bag segment and the company is considering whether to abandon this segment. In the past, NaKu also experimented with the introduction of textile fibres, but this segment wasn't profitable and therefore it was abandoned. Generally, sales haven't been so promising this year.

In addition to its own employees, the company assesses that it has created 10 indirect jobs (primarily in converter companies). NaKu also focuses on social employment – for instance, one of its suppliers is a workshop for handicapped people.

There is a potential to further develop the local Austrian economy. The approach is very much based on local and short supply cycles in combination with a wide downstream market through the webshop which may in principle reach the EU as a whole.

Also in terms of upscaling potential the economic and social impacts can be significant. First there is the growth potential of the company itself. Second the concept can be applied in other countries with a strong plastic converter industry and with a sufficient bio feedstock. NaKu indicated that a gradual transition from conventional plastics to bio-plastics favors relatively more SMEs while large companies are relatively better equipped to deal with large and sudden changes that require large volumes.

Local/regional/national/EU resource policy framework

When NaKu was founded general public thinking was not in their direction but, as mentioned earlier, the public now has a better understanding of the business. Plastic's negative impact on the environment is widely discussed. The company now has a more prominent role in the media – it receives a significant amount of awareness from Austria and Germany.

NaKu believes there's a possibility for a better development of the local industry but according to the company, the government isn't seeing the chance of this possibility. Generally, the company believes it's difficult to communicate and optimize the business within the polymers industry which in Austria comprises roughly 500 entities of substantial nature.

The EU plastics industry is huge: approximately 1.45 million people work in more than 59,000 companies that generate a turnover of roughly 295 billion Euros. While the European sector has performed relatively well following the economic crisis of 2009, the sector faces the tendency that production is migrating to Asia, where the growth rates are higher and where companies face a less tight regulatory environment than in Europe (see Plastics Europe 2012).

Bio-based plastics currently account for about 1 % of global plastics production but they have experienced rapid growth over the past decade. The technical substitution potential of bio-based plastics is estimated at

approximately 90% according to a study conducted in 2009. However, the main challenges for bio-based plastics producers are resource availability, environmental aspects and economic viability.

Further information

Websites:

http://naku.at/

http://www.plasticseurope.org/documents/document/20121120170458-final_plasticsthefacts_nov2012_en_web_resolution.pdf

1.14. Neste Oil Porvoo

Company Name: Neste Oil Porvoo
Case study title: Use of waste- and residue -based materials in renewable diesel production
Year of implementation: 2009

COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
FINLAND Address of refinery: Neste Oil Oyj Porvoon refinery P.O. Box 310 06101 Porvoo Neste Oil's headquarters: Neste Oil Oyj Keilaranta P.O. Box 95 00095 NESTE OIL	19.20 Manufacture of refined petroleum products	Latest number of employees: Neste Oil as a whole: approximately 5000 Of which in Porvoo: 1900 (figure includes refinery, harbour, technology development centre)

Type of resource(s) affected
Renewable diesel is produced from waste and residues. The currently used waste raw material at Porvoo refinery is animal waste fat from the food processing industry /slaughterhouses. The process is fitting to use also other types of fat such as fish fat or palm oil, also in combinations. The raw material used in practice depends on market prices and availability of the raw material in sufficient quantities. Renewable diesel produced from waste that is not suitable for human consumption decreases the use of cultivated or gathered agricultural products (biomass) and thus does not compete with food production. Additionally, biodiesel saves fossil crude oil. NExBTL renewable naphtha produced as part of the refining of NExBTL diesel can be used e.g. as a bio-based gasoline component in blending gasoline, and in bio-plastics production thus replacing oil. NExBTL renewable products enable customers to reduce their carbon footprint. NExBTL renewable diesel helps customers to fulfil their bio mandates. Air quality: Eg. NExBTL renewable aviation fuel reduces sulphur emissions next to CO_2 emissions. NExBTL renewable isoalcane produced as part of the refining of NEXBTL diesel is a renewable alternative to traditional mineral oils and ideal for a wide range of chemical applications (paints, coatings, TPE additives, lubricants), thus replacing oil in yet another field.

Company description
Neste Oil is a refining and marketing company, with a production focus on premium-quality, lower-emission traffic fuels. The company produces a comprehensive range of major petroleum products and is the world's leading supplier of renewable diesel. The company had net sales of EUR 17.5 billion in 2013 and employs around 5,000 people. Neste Oil's share is listed on the NASDAQ OMX Helsinki.

Neste Oil is included in The Global 100 list of the world's most sustainable corporations and has been selected into the Dow Jones Sustainability World Index for several years in a row. CDP Forest has listed Neste Oil among the best performers in the oil & gas sector. Also, Neste Oil monitors and measures greenhouse gas emissions across all its operations, and reported on them in succession as part of the Carbon Disclosure Project (CDP).

	2013	2012	2011	2010	2009
Sales	17462	17853	15420	11892	9636
Other income	79	98	36	81	29
Share of profit (loss) of associates and joint ventures	-9	-3	26	15	20
Materials and services	-15424	-16186	-13962	-10493	-8167
Employee benefit costs	-353	-339	-316	-392	-301
Depreciation, amortization and impairments	-323	-332	-315	-259	-234
Other expenses	-800	-767	-616	-521	-648
Operating profit	632	324	273	323	335
Financial income and expenses					
Financial income	2	3	4	4	10
Financial expenses	-81	-87	-72	-34	-44
Exchange rate and fair value gains and losses	8	-7	1	3	-5
Total financial income and expenses	-71	-91	-67	-27	-39
Profit before income taxes	561	233	206	296	296
Income tax expense	-37	-74	-46	-65	-71
Profit for the year	524	159	160	231	225

(Source: http://www.nesteoil.com/default.asp?path=1,41,537,2455,5896)

Neste Oil provided employment to an average of 5,031 (4,926) people in 14 (14) countries in 2012[28]. Neste Oil's overall production capacity 2013 (2012) was 16,3 million tonnes (15,4 million), out of which 2,0 million tonnes (1,8 million) was renewable raw material-based NExBTL-diesel. The growth from the year 2012 was caused by growth of production at the Porvoo site as well as increase of production in Singapore and Rotterdam.

The Porvoo refinery concentrates in production on premium-quality, low-emission traffic fuels. It has four production lines and more than 40 process units. In production there are more than 150 products and product components.

Production:

The refinery came on stream in 1965. Three new process units have been built in the 2000's, production line 4 for producing diesel and two units for production of renewable NEXBTL diesel. Altogether these investments amounted approximately almost to 1 billion euros.

The refinery has a VHVI unit that produces 250,000 t/a base oils for top-tier lubricants.

Porvoo refinery is one of Europe's most advanced and versatile refineries. As a so-called complex refinery, its versatile cracking capacity enables the broad production structure and enhances the value of production. It has a refining capacity of approx. 200,000 bbl/d (9.8 million t/a) and produces some 12 million tons of petroleum products a year; it has 7 million m^3 of crude and product storage capacity.

Location:

[28] Source: http://2012.nesteoil.com/files/neste_ar2012/PDF2012/Neste_Oil_Oyj_Annual_Report_2012.pdf

Porvoo is also Finland's largest port in terms of volume of cargo throughput. 20–23 million tons of crude oil and petroleum products pass through the harbour annually. Porvoo refinery is situated in the Kilpilahti industrial area, some 30 kilometres east of Helsinki. The industrial area employs 3500 persons, approx. 1900 of which work for Neste Oil.

Table 1: Production at Porvoo (1000 tonnes of diesel (fossil and renewable)):

	Q4/2013	Q4/2012	Q3/2013	2013	2012
Porvoo refinery	3 042	2 864	3 242	12 016	11 511

The average capacity use for the Porvoo refinery was 88% in 2013 (87 % in 2012). The capacity use was affected by a maintenance stop on line 4 in Q2. Porvoo refinery average capacity use in Q4 was 93 % (89 % in 2012). In all Neste Oil refineries, renewable diesel production capacity use was on average 91% (85%) and they worked with full capacity in Q4/2013compared to Q4/2012 when capacity use was 90%. (Source: Neste Oil)

Description of the resource efficiency (RE) measure(s)

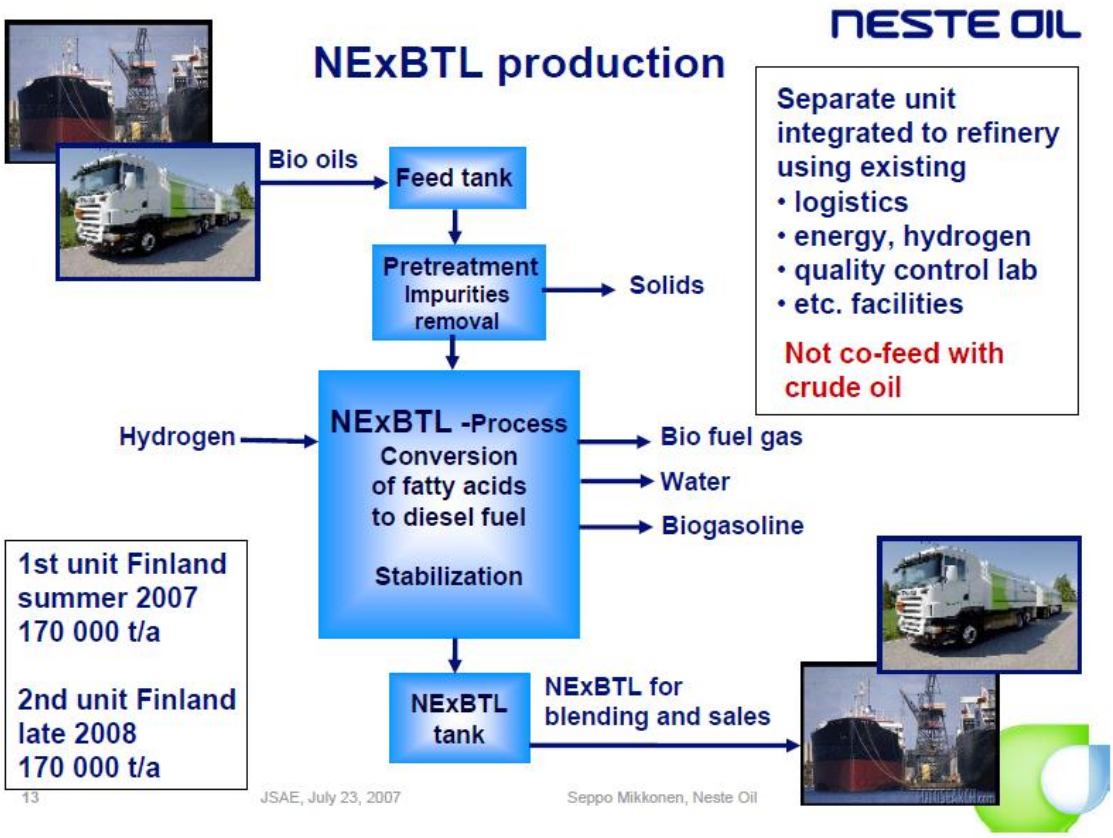
Using waste as a resource in refining

Unlike many other companies in the energy field, Neste Oil does not only use waste to generate energy, but also uses waste and residues to produce premium-quality, low-emission traffic fuels with the help of its NExBTL technology. Neste Oil used 1,2 million tons (742,000 tons) of waste and residues for refining purposes in 2013, equivalent to 52.6% (35.1%) of its total usage of renewable inputs. Neste Oil increased its use of waste animal fat and PFAD in particular, and produced enough renewable diesel from waste and residues in 2013 to power around 1.3 million cars for a year. If not used by Neste Oil the animal fat would have been used for incineration and for other existing oleochemical uses[29].

The current process at Porvoo refinery uses waste animal fat. The process could also run with fish fat, technical corn oil, and palm fatty acid distillate (PFAD), a by-product of palm oil production. It could also run with palm oil (that is how it started); however, since 2009 the Porvoo refinery has only used waste.

The process has been developed from the core expertise of oil refining into using organic material as raw material. The capacity is 380 000 tonnes per year.

[29] Source: Annual Report 2013, http://hugin.info/133386/R/1766757/600039.pdf , p. 114



Note that capacity has increased to 2 times 190 000 t/a by now, corresponding to the total capacity of 380 000 t/a reported above)

R &D and future projects to expand the renewable raw material base:
The use of animal fat as a resource is only one example of Neste Oil's general strategy of developing and diversifying its waste resource base. Continuous research is undertaken to expand the renewable raw material base and further develop the NExBTL technology (70% of R&D costs).

One example of R&D ongoing at Porvoo is a pilot plant to produce microbial oil from agricultural and industrial waste (e.g. straw, forest harvesting residue) by using yeasts and molds. Microbial oil has already been used to produce NExBTL renewable diesel in a laboratory setting. Commercial production of NExBTL with microbial oil is expected to be possible in 2015 at the earliest.

Ongoing efforts: Industrial symbiosis and material efficiency
Another example of resource efficiency efforts in Porvoo is how Neste Oil aims to leverage synergies with neighbouring plants in industrial areas. The Porvoo refinery, for example, generates around 10,000 tons of used wash liquor annually, which can be used as an input by pulp mills. The sulphur recovered from crude oil is processed into elemental sulphur, which can be used as a product in its own right. The Porvoo refinery also generates the majority of the energy used by Neste Oil and the other companies in the Kilpilahti industrial area.

Implementation of the RE measure: drivers and obstacles
A number of climate change-related legislations drove or is driving the investment in renewable diesel (in general, not particularly waste-based), such as (at EU level) the Renewable Energy Directive (RED) or the Fuel Quality Directive (FQD). Targets to cut greenhouse gas emissions, being set around the world, are additionally driving

demand for biodiesel that reduces traffic and transportation related emissions.

At Finnish national level, targets are even stricter than in the EU, with particular goals for the proportion of renewable energy in traffic and the bio-content of fuels. These binding targets give a long term perspective to the company and create a market pull for biodiesel, which in turn has created an incentive for the company to invest in development of renewable waste based biodiesel. (For more on the legislative drivers, see the section on the policy framework.)

At the beginning, Porvoo refinery used oil from palm and rapeseed. As there were limitations to the availability of sustainably produced raw materials, the company found alternative resources such as animal waste fat that does not qualify for food and is relatively cheap due to lesser quality as aprimary raw material input for the industry.

Implementation of Environmental Management Systems or other standards were not key drivers neither subsidies.. Rather a high quality product itself which would be driven by market demand. However, long-term policy perspectives were considered as a prerequisite for investments.

The development of the new processes was not easy. Technical adaptation to new raw materials was a challenge and a lot of innovative work was required to develop a process fitting for using waste. Pre-processing of the waste was an important question to solve. The large scale of the process requires large investments which required risk assessment.

Today, Neste Oil has already up-scaled / replicated the process and has large refineries in Rotterdam, the Netherlands and in Singapore.

For the microbial pilot plant at Porvoo, which is still at development stage, a credit was granted by the Finnish Funding Agency for Technology and Innovation (Tekes), providing financial support.

Resource impacts

- In terms of environmental resources, agricultural biomass (for food production) and crude oil are affected as they are saved; waste is affected as it is demanded and increased in value. If not used by Neste Oil, the animal fat would have been used for incineration and for other existing oleochemical uses.
- Total resource savings (i.e. tonnes of CO2 emissions p.a.), taking into account the whole life cycle of the fuel: NEXBTL renewable diesel produced from waste and residues generates 13 g CO2eq/MJ, renewable diesel produced from palm oil generates 40.0 g CO2eq/MJ, and Fossil diesel generates 83.8 g/MJ. Thus, NEXBTL diesel offers significant GHG emission reduction compared to fossil diesel taking into account the whole life cycle of the fuel. (Greenhouse gas balances calculated in accordance with the method defined in the RED Directive)
- NExBTL renewable diesel has additional impacts over the value-chain. For the use phase, field trials have shown that using 100% NEXBTL renewable diesel reduces vehicle emissions significantly compared to conventional sulphur-free diesel:
    - fine particulates are 33% lower and the number of particulates is also smaller
    - nitrogen oxides (NOx) are 9% lower
    - hydrocarbons (HC) are 30% lower
    - carbon monoxide (CO) is 24% lower, and
    - polyaromatic hydrocarbons (PAH) are also reduced.

Source: http://www.nesteoil.com/default.asp?path=1,41,11991,22708,22709,22710

Economic and social impacts

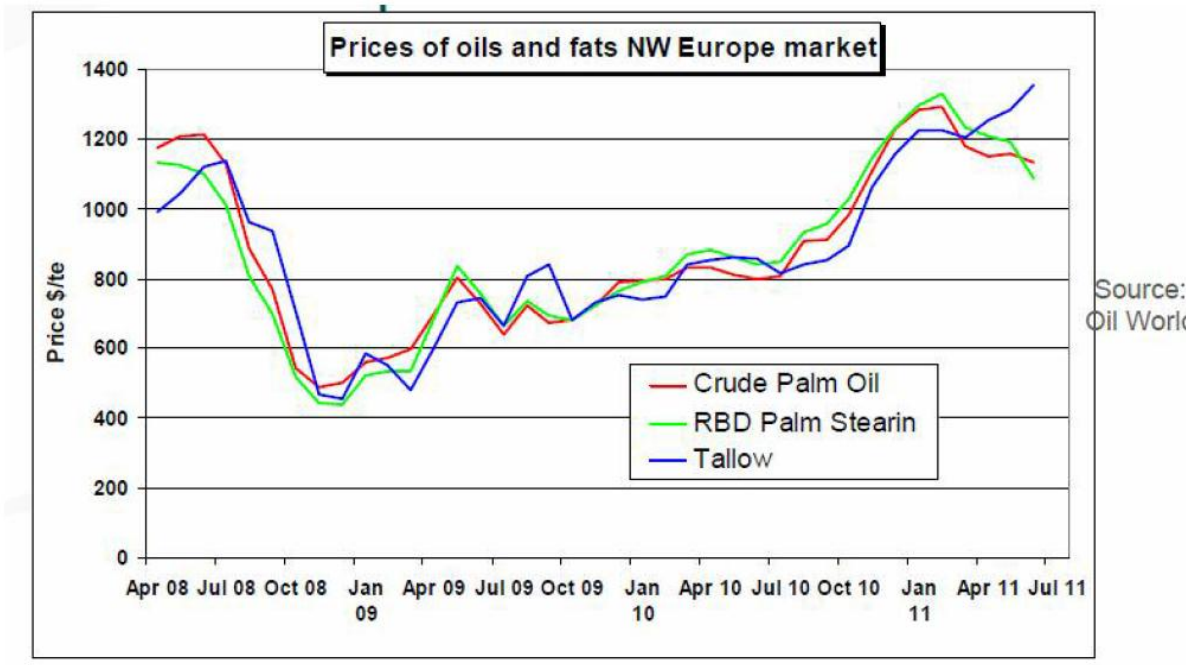
There are two main diverging economic impacts of the use of waste: from cost savings due to the lower price of the raw material, and cost increases due to pre-treatment. Although in open markets, the price for certain types of animal fats moves very closely to that of palm oil (* see below), the advantage of the business case in Porvoo is that it can use different types of animal fat, and that it sources directly from local slaughterhouses. This means

that no middlemen generate rents from the transactions. Additionally, it is easy for the Porvoo refinery to control the source and quality of the resource, which is sourced close to the refinery and usually does not imply competition with food sources or land use anyway. By contrast, in the case of palm oil (which Neste Oil uses in other refineries) the company pays a higher price in order to control and ensure sustainable sourcing.

The amount of money saved can thus be calculated as the difference between the rapeseed price and the price Neste Oil pays for waste, also taking into account the pre-treatment costs. Unfortunately, neither the prices of Neste Oil's contracts to procure animal fat nor the pre-treatment costs are known. From operational or investment cost perspective, the use of waste or residue material does not change significantly. However, the investment costs in oleochemical biofuel technology are higher than traditional biofuel technology. The NEXBTL process is flexible in terms of raw materials, but proper pre-treatment is required for many feed stocks.

**Market prices for animal fat and palm oil*

Prices of **animal fats** follow palm oil price development and crude palm oil usually forms the ceiling for category 3 rendered animal fat[30] prices. But also biodiesel production has an effect on rendered animal fat prices, without the demand from the biodiesel industry, prices of rendered animal fats would be much lower. Where palm oil prices determine the ceiling, demand from biodiesel production determines the bottom. After March/April 2011 however, prices of category 3 rendered animal fats have even peaked above crude palm prices. The graph below shows the development of tallow (a special kind of category 3 animal fat) in comparison to palm oil products. Note that tallow (as a category 3 animal fat) can e.g. be used for cosmetics or animal feed and thus has a use outside the refinery sector as well.



Source:
Oil World

Source: Ecofys (2011), Info Sheet Animal Fats

Given that the refinery can shift between different inputs without additional investment, the decision to focus on waste as a source material did not need to take into account any investment costs. Similarly, the RE measure did not have an effect on employment – it secured the existing jobs.

The uptake of this RE measure has, however, increased the competitive edge of the company. It can sell a higher quality product that fulfils the criteria set for renewable biofuels while saving costs. The radical change into renewable biofuels has increased the profitability of the company. The business performance of Porvoo refinery

[30] For a distinction between animal fat categories, see the section on the policy framework.

as such was improved as well: a small oil refinery turned into the largest bio-refinery running on waste.

The RE measure also allows society to benefit, as transport fuel is produced without using fossil fuels or food resources.

Local/regional/national/EU resource policy framework

An overview of regulation affecting Neste Oil is in the 2013 Annual report, pp. 109f.

In general, we can distinguish between three types of policy measures: first, those that promote the use of biofuels in general – they have mostly shown to facilitate resource efficiency measures (in the sense of all kinds of biofuels), including investments at Porvoo. Second, the specific renewable fuel policies create both opportunities and challenges, in particular through their lack of harmonization. Third, there are policy frameworks regarding waste and waste as a resource; these are largely seen in Porvoo as hindering the use of waste in biodiesel. As an overarching issue, the question of a stable and predictable policy framework is mentioned.

A couple of policy measures at different levels promote the **use of biofuels** (in general, not in particular waste-based) and thus created demand and investment incentives for Neste Oil:

- At national level, Finland aims at having 38% of all energy use coming from renewable energy sources by 2020 compared with 20% within EU. This can be reached by adding ethanol to gasoline, diesel from renewable raw materials to regular diesel, and bio-based oil to heating oil, for example. Furthermore, Finland aims at increasing the proportion of renewable energy in traffic to 20% by 2020 compared to 10% within EU. This is reached by increasing the bio-content of fuels by 2% every other year: 6% during 2011–2014, 8% from 2015 onwards, 15% from 2018 onwards and 20% from 2020 onwards. These binding targets give a long term perspective to the company and create a market pull for biodiesel, which in turn has created an incentive for the company to invest in development of renewable waste based biodiesel.
- At EU level, the **Renewable Energy Directive (RED)** requires member states to increase the energy content of transport fuels from renewable raw materials to 10% by 2020. Biofuels are required to meet (compared to fossil fuel) GHG emissions savings levels:

  •35% savings from 2011 on

  •50% savings from 2017 until 2020

  •60% savings from 2018 on within those installations that started production after Jan 1st, 2017

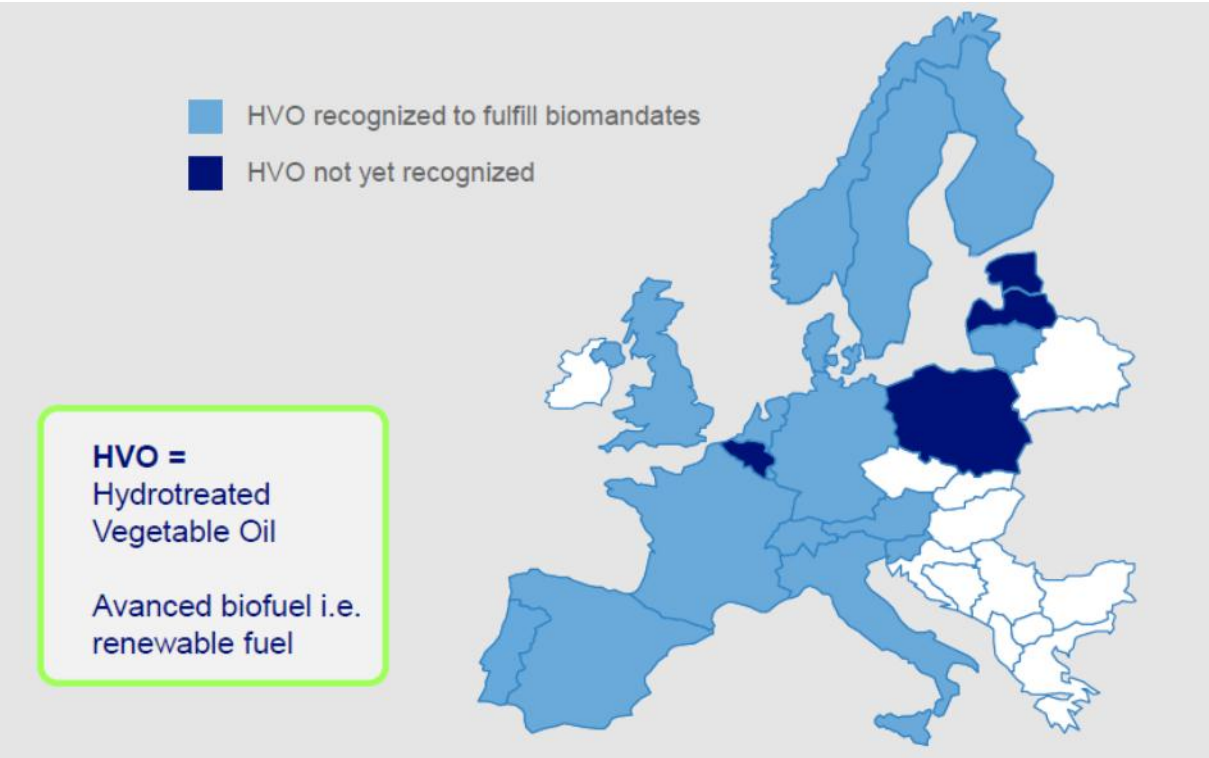
  Unfortunately for the Porvoo refinery, there is no minimum level of advanced biofuels in the targets and thus has primarily facilitated investment in conventional biofuels as the legislation has lacked sufficient long term incentives for advanced biofuel uptake. Moreover, the RED allows for large differences (and therefore distortions) between national markets (see below, renewable fuels standards).
- Further, the **Fuel Quality Directive (FQD)** defines technical specifications for fuel properties and sets binding targets to reduce fuels' GHG emissions. The GHG emissions of gasoline, diesel and other fuels should be reduced by 6% by 2020. (Note that the FQD also addresses indirect land use change due to biofuels and non-food biofuels, and thus links to the waste topic.
- Worldwide, **targets to cut greenhouse gas emissions** are set, e.g. 80% by 2050 within EU, Neste Oil has focused on producing low emission products to combat climate change by producing biodiesel that reduces traffic and transportation related emissions and fulfils bio mandates for the transport sector.

According to Neste Oil, renewable fuels standards play an ambiguous role. Diverging regulation can be a boon or burden. As Neste Oil tries to serve many markets, its broad feedstock base – including several types of waste – gives the company a competitive edge, because the company as a whole has "something to offer for any regulation". On the other hand, if a refinery like Porvoo wants to use its versatility and refine diesel from multiple

feedstock, this can create problems of compliance in different jurisdictions.

One example is the land change criterion (in order to calculate indirect land use change due to biofuels), for which different baselines / base years are used in different countries, thus creating a burden for complying with each regulation. However, as waste falls out of the land use discussion, the use of waste enables the Porvoo refinery to escape this problem – as long as it keeps focusing on waste as an input.

An example for inner-EU differences hindering market penetration and thus uptake of the RE measure is the difference in recognition of Hydro-treated Vegetable Oil (HVO) type biofuel: For example, according to Neste Oil, Italy, France, Spain, Poland and Portugal have been slow in recognising HVO type biofuels to fulfil bio-mandates (although at EU level there are no limits on advanced diesel blending components). Note that it could not be verified by the authors what this slow recognition means for the current situation. Also, non-recognition of a product in fulfilling bio-mandates does not necessarily imply that the product is not allowed on these markets (by contrast, there is evidence that two HVO refineries are soon to be built in Italy, and another one in Portugal[31]). The difference is (or was) that in these markets, HVO type biofuel would have to compete with normal fuel.



Source: Neste Oil

Finally, Neste Oil identified few **waste-related legislative measures and differences** which hinder the implementation of using waste as a resource in Porvoo and at Neste Oil. Firstly within the EU, there are differences in regulation on the use of animal fat as a raw material for biofuels. In Finland, all types of animal fat are accepted (1,2,3 categories)[32], in Denmark only few (1 and 2 category) and in Germany animal fat is not allowed to be used.

[31] see http://ec.europa.eu/energy/renewables/studies/doc/biofuels/2013_11_bringing_biofuels_on_the_market.pdf, p. 103

[32] • Category 3: ABPs that can be used for animal feed and cosmetics. For example parts of slaughtered animals, which are fit for human consumption in accordance with EU legislation, but are not intended for human consumption for commercial reasons.

Secondly, they also raised questions of definition of waste hierarchy and recycling. According to the EU Waste Framework Directive in its definitions of the different tiers of the waste hierarchy, "reprocessing into materials that are to be used as fuels" is considered to be lower in the hierarchy – in the recovery tier – than other reprocessing into products or materials. The legislation was created when sophisticated biofuels did not exist. The problem is that this suggests that wastes and residues should be used for biofuels only if they don't have other uses that are higher in the waste hierarchy. Thus, the company is of the view that refining waste to advanced biofuels should be considered as recycling – as are other uses that reprocess waste material into new products and not treated as recovery of energy. Wastes and residues are essential for an uptake of these processes.

To finish with, Neste Oil is of view that there is a general need of a stable, reliable and long-term policy framework to encourage investment, especially in a capital intensive activity such as advanced biofuel production. Currently binding targets for the transport sector drive the renewable biofuel production. Unfortunately the target is only fixed up to 2020; this creates uncertainty about the future after 2020. Regulatory uncertainty creates challenges to attract investments in advanced biofuels.

In terms of particular policies, Neste Oil mentioned that RE measures would profit from the RED having specific goals regarding advanced biofuels. They also suggest in the context of the 2030 climate and energy framework (where decarbonisation of road transport is mentioned) that biofuels should be evaluated with the well-to-wheels approach, which not only takes into account the raw material, its processing, refining and final use, but also considers the engine efficiency. The development of biofuel technology should be integrated with the needs of automotive sector in order for them to reduce emission and fuel consumption.

Further information

- http://www.nesteoil.com/default.asp?path=1,41,540,1259,1260,20492,22047
- http://www.nesteoil.com/default.asp?path=1,41,540,1259,1260,18523,20202
- http://www.nesteoil.com/default.asp?path=1,41,11991,22708,22722,22723
- http://www.nesteoil.com/default.asp?path=1,41,540,17988,7906,21235

Annual Report 2012: http://2012.nesteoil.com/files/neste_ar2012/PDF2012/Neste_Oil_Oyj_Annual_Report_2012.pdf

Annual Report 2013: http://hugin.info/133386/R/1766757/600039.pdf

Additional information on the availability of agricultural residues for biofuel production:

http://www.ieep.eu/assets/938/IEEP_Agricultural_residues_for_advanced_biofuels_May_2012.pdf

Legislative environment and current uptake of biofuels:

http://ec.europa.eu/energy/renewables/studies/doc/biofuels/2013_11_bringing_biofuels_on_the_market.pdf

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- Category 2: ABPs that can be used for soil enhancement and for technical purposes, such as oleochemical products and special chemicals. Examples of this category ABPs include manure and digestive tract content, (parts of) animals that have died from other causes than by being slaughtered for human consumption, including animals killed to eradicate an epizootic disease1;
- Category 1: ABPs that have a high risk for human health, for example animals suspected of being infected by a TSE2 or in which the presence of a TSE has been officially confirmed; specified risk material. ABPs in this category can be used for energy purposes and are not allowed to enter the human or animal food chains.

Source: Ecofys Infosheet on Animal Fats.

1.15. Nexiform

Company Name : NEXIFORM LIMITED.
Case study title: Nexiform – Business Reinvention through Resource Efficiency
Year of implementation: 2007

COUNTRY, Address of installation or company	Industry (NACE Rev 2)	Company size
Wales UK	Ceramics Manufacturer	3
Type of resource(s) affected		
Waste and recycled aggregates.		

Company description
Nexiform, founded by Julie and Paul Langston (both arts-educated), initially operated as a ceramics business selling hand-painted ceramic. As the business grew the company started selling its products to both individuals and larger retailers, while its number of employees grew to a staff of 25 people. However, Julie and Paul Langston reached a point in time where a reinvention of their business became necessary for the company to survive in the long-term. Due to the high energy costs for firing a kiln as well as the high material costs the small scale ceramics tile production facility using classical production methods became unprofitable. The company had to come up with a 'new' idea and make a sustainable business case for Julie and Paul Langston to continue their art. In order for them to be able to enter the global ceramic tiles market, it was deemed necessary to re-invent the ceramic tile and to develop an eco-friendly, sustainable product, which would decrease energy usage and allow the company to remain profitable (http://www.nexiform.com/about.html). Although the UK ceramic tiles market has shrunk slightly in connection with the economic crisis, today it is roughly equal to 400 mio. pounds per annum, indicating that even at a national level there is significant market potential for an eco-friendly product such as the new Nexiform product.

Description of the resource efficiency (RE) measure(s)
Julie and Paul Langston developed an innovative process to bind waste and recycled aggregates together to form a slab, which uses a 'cold cure' binding process to manufacture and decorate a slab material which is very similar in characteristic to a ceramic tile. The initial idea took roughly seven years to develop into today's Nexiform product. The actual resource efficiency measure involves the processing of a number of waste materials – for instance, gritstone dust, which is a waste product after crushing roadstone aggregates, and sand from a land-locked sand deposit, which is a by-product of extraction. Also slates and a variation of other products are used to make (various types of) the Nexiform product. The process has also been successful in binding together reprocessed 'nappy' waste, into what might be a useful 'sheet material' for the building/construction industry. All resource material is classified as a waste, a large percentage of which currently goes to landfill.

The Nexiform slab is a large format slab that is available in sizes up to 2000mm wide x 750 mm high, and available in many designs and styles. It has been sold as a splashback product for kitchen and range cooker specialists and recently an agreement has been made with an important range cooker specialist (Aga) to sell the product UK wide. Alternative uses of the Nexiform slabs are protection slabs behind wood burning stoves, and light weight 'concrete alternative' floor tiles.

All of the manufactured product is fully recyclable giving the company an effective 'closed loop'.

Implementation of the RE measure: drivers and obstacles

Mr Langston indicated that it is not really possible to quantify the economic and social impacts of the resource efficiency measure, "however it's fair to say that with current opportunities for sales, there's a potential 'large employing' business trying to get out". The main cause of the speed at which it has moved forward has been the economic recession, which has led to banks' reluctance to facilitate loans to small, innovative business projects. The banks are perceived as risk averse and typically unwilling to lend to business projects, which they don't fully 'understand themselves'. Unfortunately it's been a period of survival and waiting for a more opportune period for growth.

In sharp contrast to classical production methods in the ceramics industry that uses cobalt, fluorspar, and critical raw materials, the resource input material used by Nexiform has (currently) no real value. So any upscaling of its worth cannot but be beneficial. The production process means taking basically a 'no value' waste raw material, and producing a product that sells for many hundreds of pounds, in potentially large numbers, with global aspirations. Nexiform sees itself on the frontier of making waste materials into something truly worth purchasing. Yet this is not easy in the recent economic climate.

Nexiform has created a simple manufacturing process; it's extremely scalable, and relatively cheap in comparison to a ceramic manufacturing plant. The actual production cost is relatively low, which leads to a healthy profit margin. From that point of view it has the potential to create many jobs. The impact on the local economy could be substantial if it could access the adequate funding, at the approprate time.

Nexiform has no direct competitors for its unique product. But as a company it remains 'too small' to fully embrace the market potential to grow into a substantial business. As successful winners of the REMake competition in 2012, Nexiform has been unable to drive this advantage forward and create a successful business opportunity from it. This can both be related to the economic recession, but also largely to the total lack of understanding just how difficult it is to sell 'this type' of product i.e. made from waste/recycled materials, to the buying public.

The potential to 'upscale' is great, however for a small company like Nexiform it's extremely difficult to find a funding partner. Ideally the company would want to increase its staff by four people within the coming year in order to be able to increase production capacity.

Despite winning the REMake competition in 2012 the company has faced difficulties in trying to turn the project into something more 'tangible'. This perhaps is the most difficult obstacle to any business who manufactures anything from waste; there is a natural resistance by the public. Irrespective of the economic climate, the perception of the product is important. The experience is that the wording of the product description is absolutely essential. Waste is often interpreted as 'contaminated waste' which makes it virtually impossible to sell.

Another obstacle reported has been the delicate relationship with large companies and investors. There is an interest, yet at the same time a certain scepsis about the product's potential. This is why good marketing is required. Despite positive reception among its customers and show rooms, the company has yet to find a successful path to fully grow and commercialize its product. The obstacles have been access to finance (hard to raise funds and subsequently, hard to increase marketing), difficulty in being taken seriously, and contempt by peers.

Resource impacts

Nexiform's resources are other peoples waste. They sit in quarries awaiting going off to landfill, as it's a by-product of quarrying operations. Potentially the Nexiform product could be used in roofing slates, ceramic tiles, cladding materials and flooring to name a few. The process uses minimum energy, saving much CO2, it all prevents more 'raw material' being dug from the earth, and less kiln firing/energy usage. It is employment friendly, scalable, and profit centric, and therefore sustainable. It should therefore appeal to manufacturers across the general sector spectrum.

User benefits include ease of installation, good thermal insulation properties, good noise insulation properties, potential applications for smart floors.

As a company Nexiform hasn't really been able to fully grasp the impact of the resource efficency measure yet due to financial restrictions.

Economic and social impacts

Nexiform has received some grant funding from WRAP (UK Circular Economy and Resource Efficiency Experts), which has been spent with a well-known and respected marketing company for gaining a better understanding of the market and potential business development/commercialization/scaling up of the production. With a more focused and targeted marketing effort Nexiform could easily live up to its potential. However, despite the interest in Nexiform at all levels of the value chain, the further development and success of the company is entirely dependent on additional funding.

The value chain of the Nexiform slab goes from design with artistic skills to production which included carpenting for making the molds, and further downstream to selling.

The 'look' of this product is unique, there is relatively little competition, however glass, ceramic tile, metal, all compete in the same area of the market.

The next table provides an overview of material use and employment in the past and expected. The product has a high up-scaling potential and is very scalable.

Year	Material use in tonnes per year*	Employment
2012	3	3
2013	7	3
2014	16	4
2016	80	5
…		
…	5000	40 to 100**

* 90% of the input materials consists of secondary material streams (waste)

** labour intensity varies according to type product finishing e.g. adding colour, decoration, ornamental aspects

The upscaling potential can also be seen from an international perspective as the scalebility allows both micro and larger enterprises to operate, with a strong link to the local community of countries the industries of which generate the waste inputs required for the slabs.

Local/regional/national/EU resource policy framework

When the company began developing this product it was solely developed as a vehicle for Julie and Paul

Langston to keep their business going and hence, for them to continue developing their design skills.

During the development phase of today's Nexiform product various bodies assisted the couple by liaising them with WRAP, BRE and Welsh Assembly Government, to seek some sort of grant help/assistance to ease the development of the product. The grants Nexiform has received to date have been instrumental in getting it to where it is today. However, the company still requires additional assistance to further develop and commercialize the Nexiform product in the form of funding as well as practical help. Nexiform believes that governments/public administration (both at the national as well as at the international level) should better examine and analyze new (small) innovative business projects and henceforth value their efficiency and their applicability in a broader sense.

Further information

www.nexiform.com

1.16. Royall Mosa BV

Company Name: Royal Mosa BV
Case study title: **C2C certified Silver ceramic tiles**
Year of implementation: 2010 received the Silver level C2CCertification, 2011 received the Charter Organization C2CCertification

COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
NETHERLANDS, Meerssenerweg 358 6224 AL Maastricht P.O. Box 1026 6201 BA Maastricht	Ceramic floor and wall tile manufacturer	Approximately 600 FTEs, large company
Type of resource(s) affected		
Materials, water, energy, emissions		

Company description
Royal Mosa is an independent company owned by the Dutch equity firm Egeria. The company has been manufacturing ceramic floor and wall tiles at its two plants in Maastricht for almost 130 years, and in 2000 it started taking resource efficiency measures by increasing energy efficiency (heat recovery system) and recycling the water used in the manufacturing process. In 2008 the company started working with C2C implementation at product and process level, which had a significant impact on removing all toxic components in their tiles (for example, the glaze paint used in the finish). Mosa's production is assessed at around 8 million m^2 per year, exporting to 30 countries worldwide, although its main market is Netherlands and neighbouring countries. They use the local-for-local principle in sourcing their materials and other resources required in the manufacturing process e.g. clay in the tiles is sourced from quarries located no farther than 500 km from Maastricht; the goal of the local-for-local sourcing principles is to minimize CO_2 emissions thorough logistics system and to contribute to the growth of the local economy. In addition to its C2CCertification at Silvel level, Mosa has adhered to the LEED building standard as well, being an active member of the US Green Building Council; as a direct consequence, building using Mosa's tiles earn credit points in their LEED certification, credits awarded based on a set of specific requirements: the lifespan of the tiles is higher than 75 years, packaging materials are recyclable, tiles contain up to 45% pre-consumer recycled materials (waste material from construction sites), tiles are VOC-free (volatile organic compound), toxic-free. Mosa uses the ISO140001 and ISO9001 management systems and is also a C2C Chartered Organization, a special recognition awarded by EPEA, the C2C certification organization, which means its environmental indicators outperform other businesses in the same industry. According to an environmental impact study of their C2CCertified tiles, Mosa is 20% above the global industry average.

Cradle-to-cradle certification

Cradle-to-Cradle states that waste is food. Therefore, C2C product and process implementations are evaluated against 5 main criteria: material health, which implies removing any toxic components from the product, material reutilization, which concerns product complete recyclability, either as technical nutrient or biological nutrient re-entering the production cycle, water stewardship, linking it to protecting water sources, renewable energy, as opposed to non-renewable, CO_2 emitting fossil-fuelled energy and social fairness.

Source: http://www.C2Ccertified.org/

Description of the resource efficiency (RE) measure(s)

Context information

The company heard about C2C in 2007, when the senior management took part in a C2C conference in Maastricht. The company had been taken resource efficiency measures at their two plants located in residential Maastricht long before their encounter with the C2C concept, in order to prevent the risk of emissions, noise and dust emissions in the air. By 2007, the management was searching for a sustainability solution that would prompt the plants to take one step further in improving their environmental performance, at the same time with improving their the business performance. In 2008, the company started working with EPEA institute, the leading C2C certification organization in Hamburg, in order to assess its tile components against C2C requirements.

Detailed description of the measure

Mosa's ceramic floor and wall tiles are 99.5% Silver C2CCertified; the remaining 0.5% represents the amount of tiles with non-ceramic components eg. tiles containing LED lights, steel and glass, as well as the bright red and orange tiles, which require cadmium for the glaze, a forbidden substance in EPEA's material library catalogue. Because of their relative small share in Mosa's overall production, the management did not attempt to certify these, due to the amount of time usually invested in this type of projects.

How has the company implemented the RE measure(s)?

The company started their cooperation with EPEA in 2008; this meant all its tile components were scrutinized by EPEA consultants in relation to strict C2C requirements on material health and reutilization. The process was eased by the fact that Mosa's tiles are made of clay, sand and other minerals, which are natural compounds, safe for the environment if landfilled and easily recyclable. The challenge lay in replacing the toxic components in the dyes and glazes, which take only 2-4% of the tile weight but are the key components giving the tiles their final appearance and texture. Traditionally, ceramic tiles manufacturers use toxic substances such as cadmium, mercury and lead in their glazes and pigments. These components have been phased out by the technology department at Mosa. The last step in this process was getting the new tile components checked and assessed by EPEA for approval against C2C criteria. In order to comply with the reutilization criterion, the company is re-using its tile waste back into the production process, as well as purchasing residual material from the stone and glass industry.

Implementation of the RE measure: drivers and obstacles

The management wanted to enhance its efforts in improving Mosa's environmental performance; in so doing, they chose to work with C2C, persuaded by the fact that improving the carbon footprint of the two plants would have been possible simultaneously with improving the performance and quality of their products, as well as increasing the resource efficiency of their manufacturing operations.

What problems did the company encounter when implementing the RE measure?

The first challenge was finding the right replacement for the toxic components in dyes and glazes, which proved difficult due to C2C strict requirements on composition, 100 ppm (part per million).

The most challenging issue, however, was and remains the requirement to use 100% renewable clean energy; this poses a challenge because, on one hand, factory kilns need to run at very high temperatures (1100-1200 degrees Celsius), for which it needs a significant quantity of natural gas supplementing the supply of clean energy. On the other hand, the alternatives for natural gas currently available are insufficient to cover the demand at its two plants. Mosa is using 33% renewable energy to fuel its processes, the rest is covered by natural gas. In order to cope with this issue, the company is revising its energy plan on an annual basis; one measure to contribute to its energy efficiency is by capturing heat from factory operations. Apart from taking measures to increased energy efficiency, the company is off-setting 5% of their CO_2 emissions.

Another challenge in implementing the C2C requirements was that of convincing suppliers to undertake product innovation; the difficulty lay in the fact that Mosa was the sole customer at the time asking for sustainable solutions.

Renewable energy issue

Solving the energy challenge is particularly difficult, and policy support would be need to promote the development of renewable energy solutions in the Netherlands. There have been two initiatives already attempting at setting up a plant in their region. One private waste management company, collecting organic waste, tried to open a biomass plant in proximity of Mosa's plants. The plan didn't go through as the regional authorities only offered a 2-year permit for the construction and operation of this plant. Another initiative was the Sustainable Energy Plan in Maastricht, focused on three forms of energy: wind, solar panel and biomass. Due to citizens' protests, the City Council did not approve the plan, and the regional authorities withdrew their subsidies, originally meant for the construction of wind mills, which made the project unfeasible.

Link with RE platforms and business associations

Mosa took part in the C2C network of C2C companies, chaired by the Province of Limburg. The network was formally active for about 2 years; the members would meet 4-5 times per year at the regional government office. Chaired by the environmental department of the region, the network was meant to collect input from C2C companies and help with the implementation of C2C principles within the companies. The network is still active, but at an informal level.

Another initiative Mosa took part in was the European initiative on C2C, which discontinued in 2012; the initiative involved regional cooperation in the field of C2C, meant to generate interest to support C2C implementation.

The potential to apply it elsewhere or on a bigger scale? (up-scaling potential?)

The up-scaling potential depends on the ability to source more quantities of renewable energy, which continues to be the greatest challenge to this day since they started implementing C2C.

Incentives & drivers for implementing RE measure

- ***Implementation of Environmental Management Systems (EMAS or ISO14001),***
  ISO management systems are viewed as very useful in assessing the company's status with key environmental indicators, they are considered a transparency mechanisms that Mosa could use to communicate main indicators; however, ISO standards are not considered drivers for C2C implementation *per se*.

- ***Policy regulation,***
  Policy could help a great deal on two aspects: on one hand, policy-makers could support the development of renewable energy sources in their regions, by offering permits for those businesses interested in producing clean energy. On the other hand, it could openly support certifications such as C2C; this way, the connection between their efforts in implementing C2C to the actual standard would be clearer and could help the company in promoting their innovation efforts.
  One tentative example is the LEED (Leadership in Energy and Environmental Design), a green building certification program awarded to buildings using sustainable building materials, such as C2C certifield ceramic tiles; the link could be clearer though, not only in supporting companies with a sustainable product, but also companies implementing C2C in their organization. Because C2C is not mentioned in public official channels, Mosa needs to explain all the requirements that need to be fulfilled in C2C and hence, all the benefits incurred by their customers who purchase their tiles in receiving LEED points. Government could play a more active role if it would insist on green labels, it would help gearing the market in the direction where Royal Mosa could contribute significantly.

- ***Labelling or product standards,***
  C2CCertified products at Silver level; the C2C certifications drive the continuous environmental assessment of Mosa's business operations.

- ***Involvement in a national, international public or private initiative***
  No specific information provided

Resource impacts

- **Environmental resources and media affected**
  Materials, water, energy, emissions
  Water is one resource used in abundance at the two plants in Maastricht, in the preparation of the raw materials to the calibration of the end product in pressing, glaze preparation etc. The company's goal on its waster savings strategy is to close these loops by 2020; this means, for example, that water will be evaporating from the chimney. At the wall tile plant, the water savings plan managed to close the loop on the cooling water cycles, which reduced the water consumption by 60% per year.

In order to prevent CO_2 emissions and fine dust emissions in the air, filters have been installed in both plants, reducing the fine dust emission to almost zero.
According to a product environmental assessment done by Trucost in 2013, the use of recycled material has increased from 6% to 23% of the total input. Mosa's Global wall tiles use 4% recycled scrap material from internal processes and 19% recycled silica. This has led to a 77% reduction in the total supply chain environmental impact on human well-being.

Floor tile LCA 2010
An LCA was conducted on Mosa's floor tiles in 2010 based on 2008 data. The functional unit was $1m^2$ of tiles with a lifespan of 75 years. This revealed an overall lifecycle GPW impact of 15.951 kg CO_2eq for the functional unit, of which 8.81 kg CO_2eq was in the production stage. Production and end-of-life were by far the most prominent lifecycle phases for all impact categories in the study.

The process water is purified in an in-house water treatment plant and the residual sludge is recycled in the tile production process. Since 2010, the cooling water cycle is closed, which has reduced groundwater consumption by 60%.

- **Resource use per product saved (number of units saved, total cost savings in terms of raw material inputs or monetary terms)**
  According to the LCA study referenced above, by switching to hydropower electricity, Mosa managed to reduce 48% CO_2 emission/tonne finished product over the last 10 years. The cooling water system has been closed, recapturing water after it has been used, which reduces the direct footprint per tile by over 50% and reducing by 68% the impact associated with wastewater treatment.

- **Impacts over the value-chain**
  The most notable impact on suppliers has been Mosa's request that suppliers certify their products, following Mosa's own challenge of certifying its products against C2C strict criteria. In relation to clay suppliers, the company requires a land recovery plan which is needed in order to run the quarry; Royal Mosa's measures on this aspect involved imposing the requirement of the land recovery plan.

Economic and social impacts

What was the economic and social impact, business impact?

The overall impact of C2C implementation has been positive given the economic crisis in Netherlands; the C2C story attracts customers and this factor has helped the company to increased productivity, according to the management. Mosa has experienced a positive business performance in difficult economic conditions, the financial crisis in Europe, with sales in 2012 20% higher than the rest of the industry (Trucost study, 2013).

Combined valuation of impact on human well-being was determined to show a reduction of 17¢ per m^2 of wall tile between baseline and certified comparison years. Based on 2012 production, this equates to a total benefit to human well-being of US $105 440, decreasing the risk to the company of potential internalization through increased legislation, taxes, or other factors[33].

Has the impact been documented somewhere? Reference, link, …

No information provided.

[33] The net benefit calculation captures monetization of three of the C2C quality categories – material reutilization, water stewardship and renewable energy and carbon management.

Economic and social impacts of the RE measure for the company and for other companies in the value chain

- ***Investment costs avoided/additional (EUR)***
  The cost of the residual heat recovery system required an investment of 300 000 EUR per kiln; there are 9-10 kilns in the 2 plants in Maastricht. Investments are done step by step, since the kilns are not used simultaneously.

- ***Impacts on employment (number jobs created/lost)***
  The number of employees has increased since they started to work with C2C implementation, but for the last 2 years the numbers have remained constant at around 600 full time employees.

- ***Type of jobs created/lost, safeguarded***
  Since they started working with C2C in 2008, jobs were created mainly in the production department, occupying 2/3 of the personnel available; 1/3 of the personnel are working in development, marketing, sales, logistics, purchasing, health and safety issues and in management.
  As a result of the European financial crisis's effects on the housing market, the number of staff decreased from 605 in 2011 to 583 in 2012.

- ***Competitive position***
  According to a recent impacts study performed by Trucost on behalf of the Cradle-to-Cradle Innovation Products Institute in Oct. 2013, Mosa outperformed other businesses in its industry. While the ceramic tiles sector has seen a decrease in sales of round 30 % since 2008, Royal Mosa's sales have decreased only 9 %.

- ***Access to new markets***
  The company is interested in developing exporting activities, but this is a project in pipeline at the moment. Market expansion is triggered by the growing recognition among customers of the business case of sustainable products, a recognition that is currently spreading in the Nordic countries, Germany, England, France, Switzerland and in USA. IN the event of increased exports, Mosa would maintain the production site in the Netherlands and to set up an exporting mechanisms to other countries. Emission calculations as a result of CO_2 emitting logistics have not been provided, but the management seems to be aware of this indicator.

- ***Impact on business performance: additional turnover, cost savings, productivity, profitability***
  Royal Mosa does not measure business performance resulting from sustainability initiatives. In 2013 its productivity has decreased due to the economic crisis in the Netherlands, which also impacted the energy efficiency, slightly decreasing due to the fact that the kilns have to operate at maximum power but not maximum capacity. Sales and turnover have decreased as well.
  The 2012 financial report shows a 5% decrease in net turnover to 102.4 million EUR. This is due to the European financial crisis affecting the home market, where the net turnover decreased in 2012 by 8.3 million EUR. For this reason, the stock volume was decreased in line with lower sales. The net result decreased from 13.3 million EUR in 2011 to 10.1 million EUR in 2012. The equity ratio has a positive assessment in 2012, calculated at 44%.

Local/regional/national/EU resource policy framework

There was no specific policy acting as a driver behind Mosa's decision to start implementing C2C, but rather recognition among management that the company's factories, located in residential districts in Maastricht, had to avoid a negative environmental impact that could have impeded their activities in their current location. For this purpose, the company took measures to decrease substantially their emissions by installing filters at their plants; similarly, they had to decrease noise pollution as well. In that sense, going forward with the C2C was more a risk management strategy, which developed into the redesign of their manufacturing processes.

Resource policy framework, policies and regulations

One example of public policy impacting Royal Mosa's visibility on the market is the building regulation stipulating that for all new buildings higher than 100 m^2, there should be an environmental performance calculation eg. life cycle cost calculation, as sustainable products outperform the non-sustainable products. This policy is not a recognition in itself of the C2C label, but it is a recognition for producers of sustainable products.

Other examples hindering Mosa's implementation of C2C at its two plants in Maastricht have been the repeated refusal of local authorities to allow long-term permits to businesses in the area looking to focus on renewable energy production (mentioned earlier in the case study).

Further information

Links to relevant information sources (e.g. company information, press releases, information on relevant public policy measures)

- http://www.C2Ccertified.org/

Links to company website or detailed case study on the web

- http://www.mosa.nl/en/
- http://www.mosa.nl/us/algemeen-1/sustainable-production-process.aspx
- http://studenttheses.cbs.dk/bitstream/handle/10417/3148/lavinia_cristina_iosif_lazar.pdf?sequence=1

Link to EEA RE country profile:

- http://www.eea.europa.eu/themes/economy/resource-efficiency/resource-efficiency-policies-country-profiles

1.17. Ruhl & Co. GmbH

Ruhl& Co. GmbH
Case study title: Resource savings at Ruhl& Co., a German electroplating company
Year of implementation: 2011 – up to present

COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
Germany	Treatment and coating of metals; machining (C25.6)	SME (32 employees)
Type of resource(s) affected		
materials, water, energy		

Company description
Ruhl& Co. GmbH, based in Wetzlar, Germany is an electroplating enterprise, employing 32 people. Electroplating is the process of coating one metal with another (using electrical charges and metal ion solutions) to bestow specific qualities, such as rust and wear resistance. Ruhl& Co. undertake this process in eight automatic treatment plants, with all necessary metal pre- and post-treatments. Their customer base ranges from mechanical engineering to automotive applications. Electroplating is a resource intensive industry, and each year Ruhl& Co. treats around 2.4 billion metal parts, using 450 tonnes of chemicals, 80 tonnes of metals, and 7,500m^3 of water, making resource use a large part of company expenditure.

Description of the resource efficiency (RE) measure(s)
Under the scheme of the REMake project an expert from the German Material Efficiency Agency (demea) with a background in electroplating performed an audit of facilities Ruhl& Co. and identified areas where savings could be made. The voucher of the scheme covered EUR 10,050 of the consultancy cost, with Ruhl& Co. paying the rest. Using Material Flow Analysis, the consultant identified that incorrect operation of a de-oiling plant was leading to high resource waste. In particular, chemicals were lost as a result of 'drag out' (remaining on the metal surface) following chemical treatment. There was also a high water loss rate from rinsing treated metals and from improperly constructed bath covers that did not prevent evaporation. Evaluation also identified that a newly planned production hall was to have an inefficient heating system installed. Following the audit the laboratory of the German company worked on the optimization of the technological process in order to reduce the amount of chemicals used. As a result of the technological improvements, high quality new surfaces were used in the electroplating process resulting in less chemical and water use. Also due to the technological changes less waste water was produced leading to significant savings in work time needed for the production process. A redesigned process flow of the de-oiling system was created, coupled with a dragout recovery system to prevent chemical and oil waste. A new rinsing system was installed to reduce water waste. Further water loss was prevented by installing new bath covers to prevent evaporation. The problem of the heating system in the new production building was answered innovatively, with the installation of an under-floor

heating system that reused heat emitted by temper ovens used in the electroplating process.

The activities targeting improved resource efficiency in the technological process started with small steps and over years these were extended to the whole operation of the company. Ever since these technological improvements are continuous at Ruhl& Co.

In June 2012 Ruhl& Co. received a resource efficiency award for excellent performance in reducing chemical, water and energy use in electroplating from demea and the EU Europe INNOVA programme.

Implementation of the RE measure: drivers and obstacles

Drivers

The international REMake project, run under the Europe INNOVA programme of the EU, provided the incentive for Ruhl& Co. to assess the opportunities for resource efficiency solutions. The project introduced a funding scheme that made available vouchers for SMEs that allowed them to access technical, business and innovation support, in the field of resource efficiency and recycling. In Germany, the scheme was run by the German Material Efficiency Agency (Deutsche Materialeffizienzagentur - demea).

Ruhl & Co. was informed of the scheme of demea from its network and applied for an audit of its facilities. The initial incentive for the company to engage with the scheme was to make its technological process better. A two stage voucher of the REMake project allowed for a consultant selected from a demea vetted pool to assess material efficiency at Ruhl & Co.

Obstacles

The German company had the most significant difficulties related to enabling the staff to adapt to the new system and the number of changes in the production process. Instead of focusing on retraining the employees, the company where it was possible rather invested into technological changes. For the employees it was easier to adapt to the new technology than to adapt to new practices while using the old technology.

Up-scaling potential

There is an enormous potential for replication of the measures in similar businesses, though experience shows that in most of the cases experts are unwilling to admit that their production processes can be significantly improved.

Based on the experiences of the activities relating to the measures aiming at resource efficiency, Ruhl & Co. contributed to the development of an industrial network, REONET, that helps the industry in optimizing energy and material use

Resource impacts

The redesigned technological process prevented chemical, oil and water waste. In addition an under-floor heating system was designed that reused heat emitted by temper ovens of the electroplating business.

Economic and social impacts

Economic impacts

Originally the audit of the facilities of Ruhl& Co. was initiated with an aim to improve the technological process. Subsequently, as a result of the material efficiency assessment, it turned out that substantial cost savings can be achieved through optimization of the industrial processes. The results of the changes in technology eventually led to improved quality of the product, which in turn secured the place of the German company in the market.

The reconstruction of the plants cost around EUR 4,000.

Through the implementation of the identified resource efficiency measures, the company was able to make large resource savings:

- Preventing the loss of 15,000 kg of chemicals;
- Introducing water recovery and management to save 600 m^3 of water;
- Reducing the consumption of chemicals and water by between 5-8%.
- Saving energy with an innovative heating system.

These solutions reduced the consumption of chemicals and water by between 5-8%. Overall, Ruhl & Co. were able to increase their profits by EUR 70,000 (around 10%), with a return of investment in only 4 months.

Social impacts

Apart from the fabrication of new surfaces the changes in the technological process did not result in the creation of new jobs.

Local/regional/national/EU resource policy framework

The Europe INNOVA programme of the EU, through the REMake project stimulated all those technological changes at the facilities of Ruhl&Co.GmbH that eventually resulted in significant resource savings.

Further information

Links to relevant information sources:

- http://www.ruhlgmbh.de/
- http://www.ecomanufacturing.eu/1796.html

Link to EEA RE country profile:

http://www.eea.europa.eu/themes/economy/resource-efficiency/resource-efficiency-policies-country-profiles

1.18. Solvic

Company Name: Solvic NV
Case study title: Closing the cycle: recovery of sulphuric acid at Solvic, Belgium
Year of implementation: 2014

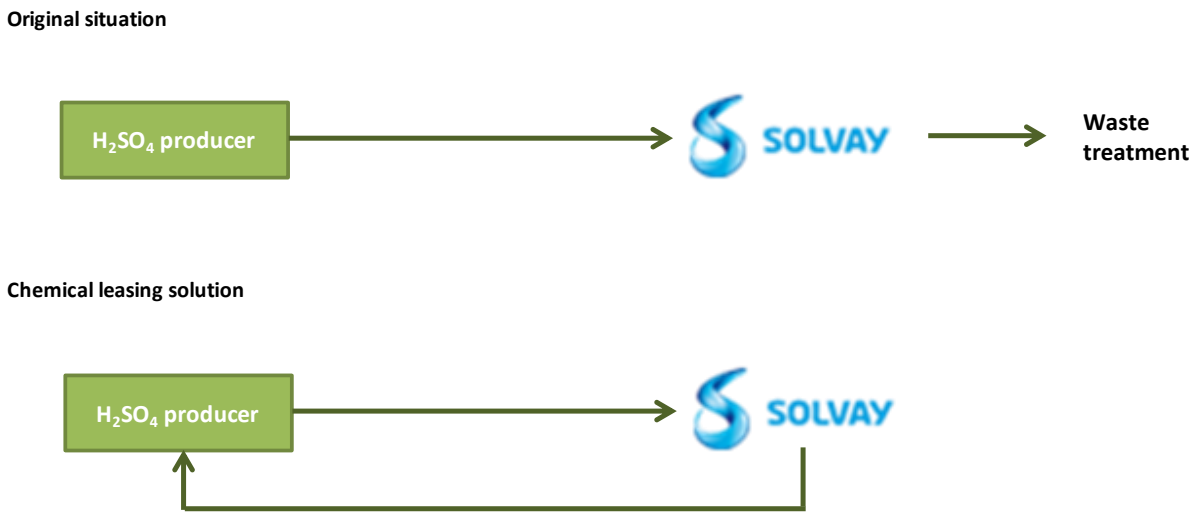
COUNTRY, Address of installation or company	Industry (NACE Rev 2)	Company size
Belgium Haven 647 Scheldelaan 480 B-2040 Lillo, Antwerpen	NACE 20: Manufacture of chemicals and chemical products:	Solvic 2012: 581 employees Solvay 2013: 29,400 employees of which 15,800 in Europe located in 49 industrial sites and 8 R&D centres.
Type of resource(s) affected		
Water, materials (sulphuric acid), and energy		

Company description
Solvic NV is a subsidiary of Solvay and as such is part of Solvay's environmental and global strategy. Solvay is one of the major global players in chemistry celebrating in 2013 its 150 anniversary. It has a wide product portfolio in chemical products servicing various markets such as consumer goods and healthcare, automotive and aeronautics, agro, feed and food, building and construction, electrical appliances and electronics, energy, environment and industrial applications. In 2013 net sales amounted to € 9,940 million. In that year 29,400 employees were working for Solvay worldwide of which 15,800 in Europe, 6,000 in Asia Pacific, 3,700 in North America and 3,900 in Latin America. In 2013, Solvay spent € 237 million on research and product innovation which represents 2.3% of its net sales. The number of people in research and innovation counted for1948 FTEs in 2013 which were located in 15 R&D centres worldwide. Total direct and indirect GHG-emissions in 2013 were 13.5 million tonnes CO2 eq. Since 2009 the Solvay group has reduced its GHG emissions by 12% due to e.g. improved energy efficiency in manufacturing processes. The Solvay group produced in 2013 213,111 tonnes of industrial hazardous waste, which implied an 8.2% increase compared to 2012 due to maintenance and process activities in particular facilities. In 2013, for the entire Solvay group 15% of the hazardous waste material was recovered, 50% incinerated with energy recovery, 29% incinerated without energy recovery and 6% was landfilled. Solvay has also its own PVC recycling activity in Ferrara Italy which started in 2009. In 2013 62% of the PVC waste received was recycled, reaching 4,875 tonnes. The Solvic subsidiary in Antwerp produces basic chemicals for the production of Polyvinyl Chloride (PVC). This production process involves the use of highly concentrated sulphuric acid for drying chlorine. Solvic is involved in a number of resource efficient initiatives within the Solvay group. As context information it is interesting to note that beside the RE initiative described in this case Solvic was also part of a FP7 financed project E4Water with the goal to pioneer new water saving approaches in large scale industrial applications. An industrial symbiosis initiative was set up with neighbouring companies to improve waste water recycling with the ultimate goal to reduce the intake of potable / demineralized water by 30%.
Description of the resource efficiency (RE) measure(s)

The original situation at Solvic NV is that the sulphuric acid that has been used in the drying process is either sent to the waste water treatment facility within the company or disposed as a waste. For the production of additional batches of chlorine new volumes of virgin sulphuric acid are purchased and used. As such there is a positive relation between the volumes of chlorine produced and the volumes of sulphuric acid purchased.

The resource efficiency measure envisaged consists in implementing a Take-Back-Chemical procedure, a variant of chemical leasing in which the producer takes back the used sulphuric acid and upcycles it to the quality that is needed for the drying process. The property of the upcycled sulphuric acid equals that of sulphuric acid made from virgin material. The upcycling is done at the producer's location, and the sulphuric acid remains the property of the producer. The following figure provides a schematic overview of the original practice and the chemical leasing resource efficiency measure at Solvic.

Figure:1. A schematic view on the original and chemical leasing resource efficiency measure at Solvic Belgium



Source: based on De Bruyn et al. 2014, p. 15

Unlike the original situation, the value capturing in the chemical leasing solution is based on the functionality of the upcycled sulphuric acid in the drying process. Solvic pays per tonne of dried chlorine and not anymore per tonne of sulphuric acid as in the original situation. The sulphuric acid material chain is now a closed loop system in contrast to the original situation where it was an open loop system. There is no longer a waste phase for the sulphuric acid.

Implementation of the RE measure: drivers and obstacles

The main driver for implementing this RE measure was that Solvic was looking for a solution to reduce the environmental footprint of the waste water purification process as well as the costs of it. Evidently the whole initiative would have to be economically viable and also feasible from a legal point of view.

Solvic's RE measure fits within the broader corporate sustainability strategy of the Solvay group, which is called 'Solvay Way'. It was launched in 2013 and contains a reference guide of 48 good practices with assessment criteria. The practices are aligned with the ISO 26000. Solvay's sustainability targets for 2020 include among others a 10% reduction in GHG emissions and primary energy consumption, a 10% reduction in the withdrawal of ground and drinking water, a 25% reduction in air emissions of substances with acidification potential and a 20%

reduction in water emissions with eutrophication potential.

One of the milestones in the project was to obtain the agreement that the waste phase was no longer relevant when changing from a linear life cycle to a closed looped system. Cooperation with the Flemish regulator for waste and material streams, namely the Flemish Public Waste, Materials and Soil Agency OVAM was set up in order to assess the legal feasibility of this transition. In this particular case, the upcycled sulphuric acid is legally no longer considered as a waste because the owner of the sulphuric acid (supplier) no longer wants/intends to discharge the substance. By switching to a product-service system, the supplier shifts its interest from selling a chemical to selling a service. It becomes then the interest of the producer of the sulphuric acid to optimize the use of the substance to its maximum and not to discard the substance. As the waste stage is no longer part of the closed life cycle, the sulphuric acid remains subject to the REACH regulation during its entire life cycle. This guarantees the monitoring and control as well as the risk management of the acid stream.

From a technical point of view obtaining the minimum acceptable quality of sulphuric acid is very important. This requires an excellent mutual understanding of the technical processes with Solvic and the sulphuric acid producer and also the necessary mutual trust.

Provided that a remuneration scheme can be set up where all partners have a positive net benefit the chemical leasing solution can be applied in other chemical companies as well. However legislation does play an important role. Due to different interpretations and implementations of the EU waste framework directive across Member States this initiative cannot be merely copied to other countries, nor can the upgraded acid be exported as a genuine product since the product certificate issued by the Flemish authorities is not (necessarily) valid in other regions and/or countries.

Resource impacts

The resource impact has been calculated using a delta LCA which compares the effects of all the processes that changed due to the introduction of the RE measure with the status of these processes before the introduction of the measure. The main process that changed in this RE measure is the drying of chlorine. The LCA results have been summarized along three environmental impact categories: materials, water and energy. For these categories an estimated reduction of respectively 90%, 20% and 20% has been estimated. The 90% reduction of materials is very significant and is mainly due to the reduction of virgin materials for the production of sulphuric acid which can be avoided due to the upscaling process and closing the material flow. The water reduction is mainly due to the elimination of the waste water treatment at Solvic and improved drying processes. The LCA impact for energy consumption includes the increased energy use for transport, drying and upscaling. However this is more than compensated by the energy savings which are linked with the strong reduction of virgin raw materials (mining, treatment and production phases). Due to company secrecy, details from the LCA have not been released.

Economic and social impacts

No particular economic and social impacts were reported, except that the necessary investments would be paid back within an acceptable time period of three years. Given the fact that the investments are substantial, this indicates that the chemical leasing concept is certainly worth considering for other companies. An important part of the value capturing is the set-up of a solid remuneration model which takes account of all the partners' costs as well as benefits due to increased resource efficiency. For Solvic the chemical leasing solution has several advantages:

- No costs related to waste water treatment of the used sulphuric acid
- Lower environmental footprint

- Reduction of administrative burdens and
- Security of supply.

The producer of sulphuric acid is able to deliver the same if not better service with less raw materials and has the potential to develop scale economies and valorise the benefits of specialisation. The close cooperation between Solvic and the producer results in a more efficient use of the sulphuric acid through for instance the adjustment of the degree of concentration of the acid in function of the application and circumstances.

Evidently both partners face investment costs and operational costs. The system is developed in such a way that both the user of the upgraded sulphuric acid and the producer/recycler have both a financial incentive for improving resource efficiency.

In terms of employment impact, one may argue that in the short-run employment remains more or less the same since the waste treatment process at Solvic is replaced by the upgrading activity at the sulphuric acid producer's plant. However when one expands the value chain upstream towards the suppliers of feedstock and raw materials for the sulphuric acid producers, one may expect, ceteris paribus, a shift of employment due to the transition from a linear to a circular system. On the one hand fewer raw materials have to be mined, treated and produced thereby decreasing the dependence of the value chain on raw material production but on the other hand additional transport and upcycling activities will be required. From a dynamic point of view, the ultimate employment outcome remains an empirical matter due to the complex economic interactions. The transition from linear to circular activities will contribute to the sustainability of the value chain and may in the long-run prevent the loss of employment.

Since the initiative is relatively recent, it is however too early to get a view on the net employment impact with all companies involved especially if one wants to include the dynamic behavioural reactions.

Local/regional/national/EU resource policy framework

The RE initiative is strongly linked with the regional resource policy framework and indirectly with that of the EU especially the Waste Framework Directive and REACH.

The Solvic initiative has been worked out in close cooperation with the Flemish Public Waste, Materials and Soil Agency (OVAM) in order to assess the feasibility within the current legal framework. The initiative fits well within OVAM's material strategy and particularly with the Flemish region's Decree concerning the sustainable management of material flows and waste streams, the so-called Materials Decree (Materialendecreet of 23th of December 2011). The RE initiative clearly contributes to reusing materials and avoiding the creation of waste streams. Prevention of waste generation and promotion of sustainable production and consumption is at the top of OVAM's priority ladder for materials management, which is consistent with the EU's Waste Hierarchy as defined in the Waste Framework Directive (2008/98/EC).

The recovered sulphuric acid is no longer subject to the waste legislation but is rather controlled via the REACH regulation. In particular the following aspects have been taken into account to grant the upcycled sulphuric acid the non-waste status:

- The producer of sulphuric acid remains the owner of the used and upcycled sulphuric acid, whereby
- The producer/recycler provides an upcycling service and is paid for the volumes of dried chlorine rather than volumes of acid delivered, and where
- A closed material loop has been established;
- Both companies guarantee the exchange of the material flow and
- Do not substitute it by another more environmentally harmful substance.
- Both the producer and user know the properties of the concentrated sulphuric acid very well and guarantee a safe application.

Over the entire life cycle of the upcycled sulphuric acid the REACH regulation applies.

Further information
Links and references to relevant information sources • De Bruyn G., Vander Velpen B., Walraedt S., Hoppenbrouwers M., 2014, Publieke eindrapportage TaBaChem, MIP3 haalbaarheidsstudie. Take Back Chemicals: upgraden van een tradioneel verkoopsmodel van chemieproducten naar een lease-sale model, MIP Vlaanderen, 43 pp. (Public final report TaBaChem, MIP3 feasibility study. Take Back Chemicals: upgrading of a traditional sales model for chemical products to a lease-sale model.) Link to company website and case study information on the web • Solvay, 2013, Building a new model of sustainable chemistry, Sustainable Development Report 2013, 114 pp. http://www.solvay.com/en/binaries/2013-07-SD-report-179257.pdf • Solvay, 2013, Annual Report 2013, http://www.solvay.com/en/binaries/2013-annual-report-EN-164627.pdf

1.19. The Goodyear Tire and Rubber Company

Company Name: The Goodyear Tire & Rubber Company
Case study title: Zero Waste to Landfill
Year of implementation: 2006

COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
The Goodyear Tire & Rubber Co 200 Innovation Way Akron, Ohio (United States)	C - Manufacturing G - Wholesale and retail trade; repair of motor vehicles and motorcycles	69.000 globally
Type of resource(s) affected		
Materials, Land		

Company description
The Goodyear Tire & Rubber Company is one of the world's leading tire companies and it operates 51 facilities in 22 countries worldwide. The company (and its US- and internationally-based subsidiaries & joint ventures) develops, manufactures, markets and distributes tires for most applications. Furthermore, Goodyear is a manufacturer of rubber-related chemicals and is one of the world's largest operators of commercial truck service and tire retreading centers. In addition to this, Goodyear operates approximately 1,240 tire and auto service center outlets where it offers its products for retail sale and provides automotive repair and other services. It has marketing operations in almost every country around the world[34]. The company places a strong focus on CSR and it currently manages multiple environmental programmes. The Zero Waste to Landfill initiative dates back to 2001 when Goodyear first started to look for ways of reducing the amount of manufacturing waste sent to landfill. Consequently, a global baseline for waste generation per unit of product was established and, by 2006, the company successfully reduced the amount of landfilled waste per unit of product by 34% (using 2001 as the base year)[35].

Description of the resource efficiency (RE) measure(s)
Although Goodyear had made significant progress in reducing the amount of waste sent to landfills by 2006, the company decided to make a bold change to improve its global waste stewardship while further reducing future waste management costs. A corporate directive was issued ordering all of Goodyear's manufacturing sites around the globe to eliminate manufacturing waste sent to landfill by the end of 2007. Each plant was to determine the

[34] Goodyear Annual Report 2013

[35] See http://www.goodyear.com/responsibility/environment-sections.html?3#zero-waste and Goodyear's Journey to Zero Waste to Landfill

best way of eliminating manufacturing waste sent to landfill and to implement the necessary changes to its waste management procedures.

At the time, Goodyear defined "waste" generally as anything that was no longer needed, and it employed a common approach to handling and disposing of most of that waste. To change, Goodyear realized it needed to gain a better understanding of its waste and subsequently discovered that much of its waste had value to other parties. The challenge then became how to better handle and segregate the waste so it could be used by others as valuable raw materials.

Goodyear provided extensive training for its associates in order to ensure the optimal implementation and execution of the Zero Waste to Landfill initiative. Waste management was discussed in daily team meetings which focused on the core of the Zero Waste to Landfill measure – reduce, reuse, recycle. Employees were directly involved in ensuring a satisfactory execution of waste segregation.

Source: www.goodyear.com

Each plant was asked to analyze all types of waste leaving its facility and subsequently, to identify how waste handling could be optimized and made valuable as a raw material to other parties. The typical types of waste that were generated at Goodyear's plants include glass, paper, cardboard and various types of metal. The analysis of waste was performed by placing waste in containers and determining the types of materials that were included in the waste streams. This led to a better understanding of the importance of segregating the waste streams in order to optimize the use of the waste materials elsewhere in the economy. For example, the analysis led to the realization that uncured scrap rubber (typically in combination with steel or fabric) could not be stored in large quantities so specific methods were developed in order to separate the rubber into smaller quantities and ensure it maintained its value as a potential raw material for other parties.

Following the analysis of waste materials and the company's understanding of the value of segregating these, changes were implemented across the entire network of old and new waste vendors. Better ties with other industries were developed, which allowed Goodyear to identify new raw material destinations from its waste segregation and the company also encouraged waste vendors to identify new potential uses for waste such that it could be a raw material for a new product.

Following the implementation of the Zero Waste to Landfill initiative, Goodyear now looks for the most efficient and the most valuable outlets for reusable scrap material. The sale of these by-products to waste vendors generates a small amount of revenue in the manufacturing process, which drives further improvements of the programme.

A small amount of the company's waste was determined to have no recycling or reuse potential but these materials had some energy value when burned, which is why they were determined as attractive to waste-to-energy facilities[36].

[36] Goodyear's Journey to Zero Waste to Landfill

Implementation of the RE measure: drivers and obstacles

The implementation of the Zero Waste to Landfill initiative was driven by Goodyear's desire to act as "*a responsible corporate citizen"* and the potential to influence future cost structures. Furthermore, implementing the initiative also allowed the company to proactively anticipate future compliance and liability issues. The company considered that regulation as an indirect driver – for instance in Europe, where landfilling bans were increasingly being implemented[37].

Goodyear faced a number of challenges in the implementation phase, which can be grouped in three categories:

1. Waste segregation
2. Cost containment, and
3. Changing the corporate culture.

1. Waste segregation
   Creating value from waste which in the conventional approach has no value required a new way of handling it, in particular systematic segregation. Whereas before, waste would be aggregated, waste streams needed to be segregated according to various properties. The set-up of a new segregation process required the need to allocate internal labour to waste management operations (the handling and management of the various segregated materials), additional space for the storage of segregated wastes, and loading dock space for the actual shipment of wastes. Also more containers were needed for the segregation and storage operations as well as more compactors and bailers. Interestingly, new vendors were required to handle the various newly segregated materials which had grown significantly because of the resource efficiency measure.

2. Cost containment
   A number of cost factors were identified as challenges in the implementation of the Zero Waste to Landfill initiative, especially in the context of a low cost alternative for landfilling. Recycling and waste-to-energy can sometimes be higher cost options. Many segregated or special wastes also require longer hauling distances and/or specific transportation considerations, resulting in higher costs for their recycling. Finally, Goodyear realized that there was a limited number of specialized vendors for certain wastes, and these companies often required special contractual agreements in order to ensure the financial viability of the given business relationship. According to the company it was challenging to identify waste vendors who would be willing to enter into longer-term contractual arrangements to maximize the value of the recyclable materials.

3. Changing the corporate culture
   Breaking the culture of putting all types of waste together in large volumes needed to be changed. An appropriate communication plan was set up that featured videos and informational posters in cafeteria and lunchrooms. Even beyond the corporate borders changes in corporate culture were needed both downstream, with vendors, and upstream with associates.

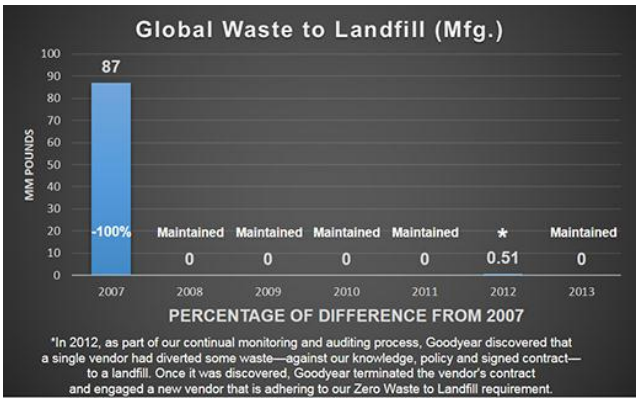
The high cost of implementing the Zero Waste to Landfill initiative was a major challenge. However the company's business strategy has been to compensate this by selling the wastes that had a positive market value and that could be used as a raw material by other parties[38].

[37] See also the section on the resource policy framework.

[38] Goodyear's Journey to Zero Waste to Landfill and interview

Resource impacts

The overall resource impacts of the Zero Waste to Landfill initiative is shown in the following figure.



Source: Goodyear: http://www.goodyear.com/responsibility/environment-sections.html?3#zero-waste

As can be seen from the graph, beginning 2007, Goodyear sent 87 million pounds of waste to landfills. In comparison to the beginning of 2006 the waste stream was already reduced by 34 %[39]. By the end of 2007 no waste was going to landfills with the exception of one facility that soon closed. Goodyear achieved Zero Waste to Landfill as a company by the end of the 1st quarter of 2008.

The material composition of the waste stream is diverse. As indicated earlier, the waste stream contains glass, paper, cardboard, and metal, but also uncured rubber that did not meet the quality standards for tyres. These waste types are re-used by vendors in a wide set of applications and intermediary products ranging from sheeting, synthetic wood products, to plastic materials for separation and also heat recovery. Concerning the latter, the share of waste used for incineration has recently been decreasing, although there is a large variation across countries. The Company aims to continue reducing the amount used as heat recovery over time.

Economic and social impact

Goodyear has turned the initial high costs of implementing the Zero Waste to Landfill initiative into a moderately profitable operation. The company receives more money from the sale of recyclable materials than the costs associated with the recycling programme from a global perspective.

The profitability of the Zero Waste to Landfill initiative has continued to increase since its implementation and, in 2012, the North America region's revenue generated from the sale of recycled materials exceeded the costs associated with the programme. In all of Goodyear's regions and countries of operations the Zero Waste to Landfill currently either generates revenue or is cost neutral.

The tangible results of the initiative are: proper segregation and handling, the identification of new vendors and the subsequent creation of a new value chain, lower-cost outlets for waste materials and alternate waste processing options. The measure has led therefore to cost reductions and, likely, to an increase of indirect employment due to the engagement of additional waste vendors.

Goodyear anticipates moderate increased revenue growth in the coming years as it continues to refine its recycling efforts and identify higher revenue outlets for segregated materials[40].

The Zero Waste to Landfill initiative has also had a certain social impact. For instance, 'Project Groenspoor' (a

[39] Goodyear's Journey to Zero Waste to Landfill

[40] Goodyear's Journey to Zero Waste to Landfill

collaborate initiative between Goodyear South Africa, Die Burger Newspaper and the Waste Trade Company as well as a local school) was established in 2011 with the scope of encouraging businesses to donate the proceeds from their recyclable waste to schools. Another example is a Slovenian division of Goodyear's collaboration with local companies to educate more than 6.000 high school students about waste handling[41].

Goodyear also assesses that the Zero Waste to Landfill initiative has a strong marketing value. Being able to write about the results of this initiative on the company's website can also be a way of attracting new employees, who are motivated by Goodyear's CSR results when seeking employment.

The companies that buy Goodyear's waste product include companies that produce rubber products (excluding tires) and a range of sectors that are able to integrate the recycled material into their own respective production processes. For example, Goodyear produces a large quantity of plastics, which is used in the process of segregating waste streams. According to the company there is a large market for this type of plastic – as an example, a US company that produces synthetic wood out of plastic was able to reuse Goodyear's plastic waste streams.

Local/regional/national/EU resource policy framework

As indicated, the company's decision to implement the Zero Waste to Landfill initiative was directly driven by its CSR goal of conserving natural resources, as well as reducing potential future liability and decreasing costs. Policymaking had an indirect effect on Goodyear's decision to implement the measure at all of its manufacturing plants around the globe – for instance, in Europe the increasing strict regulation on landfilling (entire bans or high taxes) meant that the company was compelled to change its waste management structures. Additionally, these policies also helped vendors to accept investigating the business opportunities for using waste as a resource, thereby improving resource efficiency along the value chain.

In this context, the company has also indicated how the presence of other parts of the value chain in its global regions of operation has had an impact on the degree of economic success of the Zero Waste to Landfill initiative. In some regions, entire waste management infrastructures were already present, in others they still had to be created. These infrastructures included segregation processes but also adequate transportation infrastructure. Goodyear also had to identify new waste vendors and customers in order to make the Zero Waste to Landfill initiative operational.

Essentially, Goodyear assessed that it has played a significant role in creating a post-consumer supply chain and that their resource efficiency initiative has generated downstream employment and turnover in other stages of the value chain as well.

Further information

http://www.goodyear.com/responsibility/environment-sections.html?3#zero-waste

http://www.wbcsd.org/Pages/EDocument/EDocumentDetails.aspx?ID=15750&NoSearchContextKey=true

[41] http://www.goodyear.com/responsibility/environment-sections.html?3#zero-waste

1.20. UPM Steyrermühl paper mill

Company Name: UPM – UPM-Kymmene Austria GmbH
Case study title: Material efficiency improvements at Steyrermühl paper mill
Year of implementation: 2011

COUNTRY, Address of installation or company	Industry (NACE Rev 2)	Company size
Steyrermühl: Austria Fabriksplatz 1 4662 Steyrermühl	16.10 Sawmilling and planing of wood 17.11 Manufacture of pulp (17111400, Mechanical wood pulp; semi-chemical wood pulp; pulps of fibrous cellulosic material other than wood) 17.12 Manufacture of paper and paperboard (no paperboard produced)	Paper mill: 430 employees, saw mill: 90 (this includes employees in training) – not an SME according to EU definition
Type of resource(s) affected		
The resource efficiency (RE) measure affected use of water, energy, chemicals, biomass (woodchips) and biomass waste (waste paper).		

Company description
UPM[42] UPM Kymmene Oyj is a Finnish company active in production of paper, pulp and wood products. UPM is specialized in using recovered paper; with around 3.6 million tonnes, the company is the world's largest user of graphic recovered paper to produce printing paper. The share of recycled fibre represents one third of all fibre raw materials used in UPM's paper production. UPM uses recovered paper when the raw material is available close to the mills. In countries with a small population and large forest resources, the use of fresh fibre usually predominates, whereas in countries with a high population and small forest resources, recovered fibre is used more frequently. Since 2009, UPM markets itself as "the biofore company" to describe its strategy towards a new forest industry: "bio" stands for the use of renewable sources in new areas, and the responsible use of them also in traditional business segments. "Fore" relates to the forest as the basis of UPM's business, as well as to being "at the forefront" of developments. The ideas behind the strategy include renewable raw materials, reusable and

[42] Sources: http://www.upm.com/EN/ABOUT-UPM/Pages/default.aspx, http://www.upm.com/de/upm-in-der-region/Pages/default.aspx, http://thegriffin.upm-kymmene.com/1_2010/ceo/ger.html, http://www.upm.com/en/about-upm/biofore-in-action/upm-uses-recovered-paper-efficiently/Pages/default.aspx

biodegradable products, renewable energy production, energy efficiency, and a reduction of the carbon footprint.

UPM's current structure, adopted in 2013, consists of six business and / or geographical areas: UPM Bio-refining, UPM Energy, UPM Raflatac, UPM Paper Asia, UPM Paper ENA (Europe and North America) and UPM Plywood.

In 2013, UPM's sales exceeded € 10 billion. UPM is present in 65 countries and has production plants in 14 countries. The company employs approximately 21,000 people worldwide. UPM shares are listed on the NASDAQ OMX Helsinki stock exchange.

Steyrermühl paper mill[43]

In Steyrermühl, two modern paper machines produce up to 500,000 tonnes of high-quality printing paper yearly. Sales in 2012 amounted to 464,000 tonnes. The premises cover an area of 260,000 m^2, of which around 120,000m^2 are built-up area. A sawmill is part of the plant and a 100% subsidiary. It produces up to 400,000m^3 of different types of cut wood yearly; the sawmill waste is used as one raw material for paper production. From the sawmill wood chips and waste paper, the mill produces mechanical pulp and recycled fibre, which is then used to make supercalendered paper and newsprint paper. Thus UPM Steyrermühl is already a resource efficient facility using significant amounts of waste as a raw material. The wood for both sawmill and paper mill is sourced at group level from sustainably managed forests.

The mill also has a three-stage biological sewage treatment plant, which treats all waste water from the plant's operations, as well as municipal waste water from the Laakirchen area. Moreover, the mill includes combined heat and power (CHP) facilities, with a fluidised bed boiler using residual materials. The electricity use of the mill is partly covered from this self-production and partly sourced from the grid.

Description of the resource efficiency (RE) measure(s)

The resource efficiency measure(s) at UPM Steyrermühl were started in response to the group-wide "Material efficiency programme". This programme is a group-wide initiative to save energy, water and raw materials (i.e. wood, esp. by reducing fibre losses), and to a limited extent process chemicals. Individual mills can present resource savings ideas that go beyond the usual and necessary investment; they explain which savings they expect and how much the investment costs will be. Based on this information, UPM decides on the allocation of monetary resources to the installations. A Steering Committee at group level supervises all activities and coordinates between all participating mills. The Material Efficiency Programme is one pillar to achieve UPM's overall environmental targets relating to water and energy / CO_2. According to this strategy, each mill has a reduction target depending on the mill (its age / technology) and the type of paper produced. However, despite the targets helping to steer at group level, the Material Efficiency Programme challenged for ideas regardless of the specific targets

At UPM Steyrermühl, a group was started in 2011 to coordinate different resource efficiency projects of different sizes – these projects range from small water savings due to improvement of small pipes, via modernisation of automatisation processes, to recirculation of fibres from waste water. This last measure, for example, led to savings of 1000 tonnes of woodchips per year. It consists of a press which separates reusables from waste material.; The challenge of this measure was to find the right spot in the process where this separation is possible. Currently, 21 projects are running under the programme.

The most important feature of "the RE measure" at Steyrermühl is thus that it is a carefully coordinated bundle of measures, which has looked at every step in the production process and has involved many of the mill's specialists in process technology. While at first the improvements were looked at in segments, a general overview

[43] Sources: UPM Steyrermühl interview, http://www.upm.com/de/upm-in-der-region/produktionsstandorte/upm-steyrermuhl/pages/default.aspx , http://wirtschaftsblatt.at/archiv/printimport/1476303/Papierfabrik-Steyrermuhl-schreibt-schwarze-Zahlen , http://www.upm.com/EN/RESPONSIBILITY/Principles-and-Performance/reports/Documents/EMAS2012/UPM_GlobalEMAS_2012_en.pdf

is also necessary to make sure that measures in one segment do not negatively affect another segment. The programme has also taken into consideration trade-offs in material use: for example, a reduction in water use may be achieved at the cost of an increase in energy use. The programme as a whole needs to make sure that there are savings in all resources.

As the RE measures were part of a group-level programme, the mill has also cooperated with other mills to share ideas and best practices; all ideas are available internally.

Overall, the measures led to a reduction in material use (woodchips / fibre) of 5,350 tonnes per year (compared to 2010). Yearly water use was reduced by 20% in the same time frame. This is particularly remarkable considering that the plant was already operating under high standards, and underwent constant improvements, even before the implementation of the measure: water use was decreased by more than 25% between 2000 and 2011, and then by additional 25% after 2011[44].

Implementation of the RE measure: drivers and obstacles

As described above, the implementation of the measure was triggered by the UPM group-wide Material Efficiency Programme, which both set targets and provided funds. The background to this programme is that on top of the already existing standards and certifications, UPM also wants to demonstrate customers that the company is developing its resource efficiency proactively; being a frontrunner in RE is part of the company strategy.

However, cost reduction was and is also a significant driver for the efforts at Steyrermühl: especially the rising demand for biomass and fibre waste due to energetic use of these resources has contributed to an increase in their prices and incentivised activities to save these inputs. Costs for electricity and for waste disposal (esp. waste water) are also high and increasing, and therefore provide further reasons to engage in resource efficiency activities.

Compliance with certifications has also played some role in RE efforts, such as the mill's ISO 9001 certification, which demands constant improvement measures (audited regularly). Steyrermühl's main certifications are:

- Quality: ISO 9001
- Environment: ISO 14001 and EMAS
- Safety at work: OHSAS 18001
- Chain-of-Custody: PEFC and FSC

By contrast, ETS is managed on group level and has not played a direct role on mill level in the RE measure implementation - in contrast to the sourcing of materials, the prices of which have a direct impact on the mill's business figures.

Resource efficiency platforms or business associations are also acknowledged at group level, but have not played a concrete role for the implementation of the measures at the mill.

Nevertheless, exchange of ideas on the measures has taken place, namely between different UPM mills which are all operating under the Material Efficiency Programme. Thus, some measures developed at Steyrermühl have been implemented in other mills, and vice versa.

The main challenge of the RE measure has been to find potentials for improvement in an environment that is already characterised by constant optimisation, and taking into account trade-offs between savings of different

[44] Sources: UPM Steyrermühl interview, http://www.upm.com/EN/RESPONSIBILITY/Principles-and-Performance/reports/Documents/EMAS2012/Steyrermuhl_EMAS_2012_DE.pdf, http://www.upm.com/EN/ABOUT-UPM/biofore-in-action/Material-efficiency-improved-at-UPM-Steyrermuhl/Pages/default.aspx

resources. Clearly the benchmark is not the performance of 10 years ago, but performance is compared to the years 2010-2011 and to industry benchmarks and competitors[45].

Resource impacts

The RE measures implemented at UPM Steyrermühl reduced annual freshwater consumption by 20% since 2010 (corresponding to a reduction of wastewater load of 23% in the same time frame). Thanks to the 21 projects currently running, 5,350 tonnes of fibres and fillers can be returned back to production annually, and are thus saved as resources. The measures also resulted in 2,200 MWh in energy savings per year. In addition, the mill has been able to eliminate the use of sequestrants for pulp bleaching, thus further reducing the environmental impact of waste water[46].

Economic and social impacts

Taking all RE measures into account, compared to the benchmark year 2010 the mill saves some 1.1 million euros annually due to the production process improvements, including savings generated by reduced process chemicals. This figure is expected to increase as more measures are implemented.

The cost savings come from reduced material use and thus reduced sourcing costs for waste paper, water, wood, electricity, and gas. These savings also become larger as resource prices increase. According to UPM Steyrermühl, the costs for waste paper, electricity, gas and wood are all increasing. Another cost saving impact is the reduction of waste, which reduces the costs for waste disposal (in the case of the mill, mostly waste water).

Looking at the individual measures implemented at UPM Steyrermühl, costs and cost savings vary widely. Some small improvement cost less than €1,000 and their investment pays back immediately – as in the case of an occasionally spilling over of a process water tank, which led to water losses of 14,000 m^3 yearly. Other measures are more capital intensive and have longer pay-back times. However, the main "investment" in this overall programme has been the time spent by qualified people trying to find potentials at every process step.

The measures have contributed to UPM Steyrermühl's competitive position by reducing costs and by creating an environment to improve technology[47].

[45] Sources: UPM Steyrermühl interview, http://www.upm.com/EN/RESPONSIBILITY/Principles-and-Performance/reports/Documents/EMAS2012/Steyrermuhl_EMAS_2012_DE.pdf

[4646] Sources: UPM Steyrermühl interview, http://www.upm.com/EN/ABOUT-UPM/biofore-in-action/Material-efficiency-improved-at-UPM-Steyrermuhl/Pages/default.aspx

[47] Sources: UPM Steyrermühl interview, http://www.upm.com/EN/ABOUT-UPM/biofore-in-action/Material-efficiency-improved-at-UPM-Steyrermuhl/Pages/default.aspx, http://wirtschaftsblatt.at/archiv/printimport/1476303/Papierfabrik-Steyrermuhl-schreibt-schwarze-Zahlen

Local/regional/national/EU resource policy framework

The political framework has not played a role in the implementation of the measure. The mill was already operating in line with the prescriptive limits for water usage and waste water quality to the effluent (each paper mill negotiates its own water rights and waste water limits with the authorities at regional level) and the measures have improved this position. The only policy-related driver that could be mentioned is the fact that the mill is ISO9001 certified and needs to prove yearly improvements in its audits.

Further information

Links to relevant information sources (e.g. company information, press releases, information on relevant public policy measures)

Information on the company and the mill:

- http://www.upm.com/EN/ABOUT-UPM/Pages/default.aspx
- http://www.upm.com/de/upm-in-der-region/Pages/default.aspx
- http://www.upm.com/de/upm-in-der-region/produktionsstandorte/upm-steyrermuhl/pages/default.aspx
- http://wirtschaftsblatt.at/archiv/printimport/1476303/Papierfabrik-Steyrermuhl-schreibt-schwarze-Zahlen

Information on sustainability measures at UPM:

- http://www.upmresponsibility.com
- http://www.upm.com/EN/RESPONSIBILITY/Principles-and-Performance/reports/Documents/EMAS2012/UPM_GlobalEMAS_2012_en.pdf
- http://thegriffin.upm-kymmene.com/1_2010/ceo/ger.html
- http://www.upm.com/en/about-upm/biofore-in-action/upm-uses-recovered-paper-efficiently/Pages/default.aspx

Information on resource efficiency measures at Steyrermühl:

- http://www.upm.com/EN/ABOUT-UPM/biofore-in-action/Material-efficiency-improved-at-UPM-Steyrermuhl/Pages/default.aspx
- http://www.upm.com/EN/RESPONSIBILITY/Principles-and-Performance/reports/Documents/EMAS2012/Steyrermuhl_EMAS_2012_DE.pdf

1.21. Van Houtum

Company Name: Van Houtum B.V.
Case study title: Satino Black Cradle-to-Cradle (C2C) certified washroom collection
Year of implementation: • 2007 - RE measures in line with C2C; • 2010 - launch of Silver C2CCertified Satino Black washroom assortment

COUNTRY, Address of installation or company	**Industry (NACE Rev 2)**	**Company size**
Netherlands, Boutestraat 125, 6071 JR SWALMEN	Toilet paper and other hygienic product manufacturing	200 employees
Type of resource(s) affected		
Virgin paper pulp, water, energy		

Company description
Van Houtum is a family-owned business addressing a B2B market, whose core activity is tissue paper manufacturing for toilet areas; the company offers a range of other washroom products such as soap, mirrors and plastic dispensers. Founded in 1935, the company employs 200 people and has an annual turnover of 65 million EUR. Its main market lies with the Benelux area and Germany, expanding sales to the Scandinavian region and other European countries, such as Spain and the United Kingdom. Van Houtum has diversified its product portfolio from tissue paper manufacturing to complete washroom solution across four product collections: Satino Black, Premium, Comfort and Basic. **Sustainability reporting** In addition to its C2C certifications for Satino Black, all Van Houtum's paper products are also FSC certified and carry the EU Ecolabel. Satino Black is also CO_2 neutral. Their manufacturing processes are certified in accordance with ISO 9001 (quality management), ISO 140001 (environmental management), OHSAS 18001 (health and safety management) ISO 26000 (Corporate Social Responsibility) and ISO 500001 (energy management). Van Houtum uses the Global Reporting Initiative (GRI) criteria in their annual environmental performance report.

Description of the resource efficiency (RE) measure(s)
In 2007 Van Houtum was seeking opportunities to improve the environmental efficiency of its manufacturing

processes at their plant in Swalmen. At that time, the World Horticultural Expo Floriade promoting healthy, sustainable produce took place in the Venlo region. Together with the Dutch Chamber of Commerce, the event organizers launched a call for projects on implementing C2C process improvement. Van Houtum's CEO at the time, Henk van Houtum and Bas Gehlen, the COO, saw both an opportunity to improve efficiency at their plant and cut down costs but also a necessity to establish a sustainable sourcing mechanism for Van Houtum's main feedstock, paper pulp.

Detailed description of the measure

Satino Black product assortment, containing toilet paper, paper hand towels, soaps and toilet seat cleaner, as well as plastic dispensers, has been Silver Cradle-to-Cradle (C2C) certified in the period 2010-2013. The choice of black colour for plastic dispensers was a consequence of environmentally friendly production choice: the black pigment seems to be the only option available to current recycling technologies and products are made out of 100% recyclable plastic. It was then translated into a marketing strategy.

Cradle-to-Cradle certification means that the environmental performance of their Satino Black product assortments improved: material toxicity is reduced, the paper products are made out of 100% recycled fibre, the plastic dispensers are 100% recyclable (old dispensers are recycled into new dispensers), water usage is minimized as much as possible (for which they qualify for the Gold C2CCertified level) and only renewable bio-gas (bio methane) is used to fuel the C2C manufacturing process. The main philosophy of C2C product and process certification is that waste is food, therefore companies implementing C2C resource efficiency measures need to report on material health indicators, waste savings, water savings and energy savings.

Source: http://www.C2Ccertified.org/

How has the company implemented the RE measure(s)?

Van Houtum started out the development of their Satino Black range by composing a team the project team in charge of running a C2C trial, which was formed by a technologist specialist, a chemist, a procurement officer and the COO at the time, Bas Gehlen. They addressed the process step by step, in accordance with the EPEA's material ratings. Van Houtum looked first at their core business, tissue paper. In order to avoid increasing their CO_2 footprint by sourcing recycled paper from relatively far away, the company decided to close the loop by implementing a local-for-local principle that would retain recovered paper in their region. By doing so, they convinced customers to return their recycled paper eg. shredded paper, in order to produce their toilet paper. The waste paper residue is sent to the cardboard manufacturers nearby to produce the boxes in which their products

are delivered to their clients; this way Van Houtum saves on waste collecting fees and the producing company saves on raw material costs, so the agreement between them is on sharing the transportation costs only from the supplier to the beneficiary.

In order to scale up their C2C paper production, the company also looked at alternative sourcing, such as recycling beer labels; the resulting pulp falls short of quality though, due to glass particles and other components, but pre-empting low quality raw material, Van Houtum optimized their technology to properly process them to the required quality level.

For this reason, among others, their paper-based products cannot achieve the top-level Gold C2C certification: its use of recycled paper is considered “undefined input” by C2C Product Innovation Institute due the high variability in waste paper quality.

The next step involved convincing suppliers to participate in their C2C process; their soaps are now free of toxic components, as are the soap and paper dispensers, which are recycled into new dispensers in order to close the loop on this process. These products carry the Silver C2CCertification as well. The energy required in the manufacturing process of Black Satino products is 100% renewable biogas (bio methane).

Implementation of the RE measure: drivers and obstacles

Why was the measure taken?
Van Houtum uses paper fibre as main feedstock in their production and the company is concerned about the supply of paper fibre potentially becoming scarce in the future. It is therefore looking at various sources of recycled paper, paying attention at the same time to their carbon footprint from manufacturing and logistics operations. They state circular economy as a guiding framework towards their RE measures.

Problems the company encounter when implementing the RE measure

- **Suppliers:** Specifically during the implementation of C2C process of the Satino Black collection, the main challenge has been convincing suppliers to tag along with their innovation efforts and to start improving the product composition according to strict criteria set by C2C organization EPEA. The main challenge has been to convince them to start doing trials; as the environmental benefits became more obvious, the suppliers agreed to work toward the C2C certification. The plastic dispensers obtained their C2C certification after two years of R&D.
- **Marketing and sales**: Another main challenge was training retailers in selling the C2CCertified products to their customers. For this purpose Van Houtum has hired five managers dedicated to assisting retailers in making the business case when selling the Black Satino product line.
- **Up-scaling** the C2CCertification across all of its product lines presently poses significant challenges, due to insufficient raw material (e.g. recycled fibre), and insufficient supply of biogas in the region. Van Houtum is currently evaluating grass fibre, which is a renewable raw material, as a future option they could use and would like to start trials on collecting drinking carton waste in their region, in collaboration with regional authorities, and recycling them into paper fibre. With respect to biogas supply, the company is looking at grass fibre residue as potential raw material for biofuel formation. One major problem lies with the delays in the trial process due to barriers in obtaining permits to handle and process drinking carton waste. The local authorities claim that EU waste regulation is the main obstacle in issuing Van Houtum the required waste collection permit, despite the fact that the authorities suggested this initiative Van Houtum in the first place.

Link with RE platforms and business associations

Van Houtum is part of the Cradle-to-Cradle business network in the Limburg province, a learning community whose goal is to contribute to its members’ understanding of measures that can be used to close loops according to C2C principles. The network activity has been slow for the past two years compared to the first year, when the members would meet 4-5 times a year. The network activity was initially finance by the Limburg authorities; after

these funds ceases, the members started contributing to the network, but after one year they stopped joining the meetings.

The potential to apply it elsewhere or on a bigger scale? (up-scaling potential?)

Up-scaling the C2CCertification across all of its product lines poses significant challenges presently, due to insufficient raw material eg. recycledfiber, and insufficient supply of biogas (bio methane). However, up-scaling the Satino Black to cover the entire production of its plant facility in Swalmen is a long-term goal at Van Houtum.

Given the focus on local supply of raw materials for the C2C line, the initiative could be potentially be replicated by other manufacturers in different locations.

Incentives & drivers for implementing RE measure

- ***Implementation of Environmental Management Systems (EMAS or ISO14001),***
  ISO standards are used as tools for periodically assessing the company's performance in relation to quality, environmental indicators, energy, work safety, health issues etc. These standards are used in combination in order to manage future improvement measures.

- ***Policy regulation***
  Policy at regional level in Limburg, hinders rather than contributes to Van Houtum's innovation activities. As mentioned above, the company is required a special permit in order to start handling drinking carton waste to explore its benefits as raw material in a trial process. The main problems lies with the amount of time needed to obtain that specific permit; company management expects that it will take more than 6 months for the authorities to issue this permit, based on previous, similar experience with reducing its paper residue by offering it to its cardboard box supplier as raw material.

- ***Competitors,***
  The management believes the company has a competitive advantage by treating waste eg. paper residue, as feedstock.

- ***Consumers***
  There is recognition among management that customers are interested in sustainable, green certified product.

- ***Labelling or product standards,***
  Cradle-to-cradle is a private product-and-process standard used to measure company's environmental performance across 5 main indicators: material health, material reutilization, use of renewable energy, water stewardship and social fairness. The highest level of certification level is Platinum, followed by Gold and Silver levels. Its main principle is the fact that waste is food for their natural systems of industrial systems, therefore waste needs to be eliminated and materials need to be divided into biological and technological nutrients before re-entering production cycles.
  In addition to C2C certification, Van Houtum is ISO, FSC and Ecolabel certified.
  With respect to ISO 50001 on energy management system, Van Houtum has been able to focus on energy management and to increase renewable energy sourcing which reduced its overall energy impact by as much as 80%.

- ***Involvement in a national, international public or private initiative***
  The C2C process at Van Houtum was initiated in response to initiatives taken by Limburg authorities and Roermond municipality to promote C2C among businesses in the region. Similarly, the authorities have collaborated with Van Houtum on running an awareness campaign on waste as resource. For example, the authorities have partnered with Van Houtum in campaigning for correct waste sorting throughout the region, especially the separation of drinking carton waste, which could become a new source of recycled paper fibre for Van Houtum's C2CCertified paper tissue.

- ***Working with EPEA, the C2C certification agency***

Using the material ratings in EPEA's library, Van Houtum was able to assess and rank the percentage of toxicity in its material composition. According to a study commissioned by the Cradle to Cradle Product Innovation Institute in October 2013, Van Houtum registered a 91% reduction of environmental value of impacts through the optimization of its formula, following R&D alongside EPEA.

Resource impacts

- **Environmental resources and media affected (paper residue waste, water, air quality)**
  - **Paper residue**: Data for 2013 displays a decreased in total volume of paper residue, from 25 876 tonnes in 2009 to 23 282 tonnes in 2013. The paper residue recycling rate has increased, from 5 339 (21%) in 2009 to 9 845 tonne (42%) in 2013. However, recycling was higher in 2010, 2011 and 2012 than in 2013 both in total weight of recycled residues and as a share of residues.
  - **Water consumption**: the total water consumption has decreased from 437 161 m^3 in 2009 to 419 392 m^3 in 2013, as has the water use per unit product – from 10.5 m3/tonne product in 2009 to 9.5m3/tonne product in 2013. These net reductions reflect reduction in the use of both ground water and surface water over the period.
  - **Emissions to water (via the public sewer plant in Roermond)**: conventional pollutants such as COD (chemical oxygen demand) have fallen from 61 tonnes to 54 tonnes between 2009 and 2013, and BOD (biochemical oxygen demand) emissions to water have fallen from 3.3 to 3.1 tonnes over the same period. It should be noted that both COD and BOD emissions have fluctuated significantly during the period.
  - **Air emissions**: total CO_2 emissions have decreased from 24 148 tonnes in 2009 to 23 026 tonnes in 2013; from 577 kg/tonne of product in 2009 to 524 kg/tonne of product in 2013. This is partly due to the introduction of the use of biogas, from relying only on natural gas in 2009 to using 1 438 tonnes of biogas in 2013.
- **Resource use per product saved (number of units saved, total cost savings in terms of raw material inputs or monetary terms)**
  - **Water consumption/product**: Van Houtum uses the nearby river Swalmen as water source, which it can recycle 20-40 times in its plant; this in turn decreases the need for surface water from 15 litres/roll of paper to 1 litre/roll of paper.
  - **Energy consumption/product**: the deployed heat capturing system enabled a saving in gas consumption of 16m^3 per ton of product in 2012, and reducing energy consumption by 5%, according to their CSR annual report 2012.
  - **Total cost reductions**: by increasing the rate of recycled resources, improving efficiency, decreasing material loss and decreasing water consumption, total cost reductions equalled 1 million EUR, according to a C2C impact assessment study performed in Oct. 2013, focused on Satino Black paper hand towel.
  - **Environmental cost of toxicity**: according to the same study referenced above, the C2CCertified Satino Black hand towel has reduced toxicity levels by 91%, from 215 USD/ton of product to 18 USD/ton of product
  - **Valuation of impact at the end of use of 1 ton C2CCertified hand towel**: the impact has been reduce from 24 USD/ton to 6.5 USD/ton.
  - **Valuation of environmental impact of direct energy supply of 1 ton of C2CCertified hand towel**: the impact has decreased by 81%, from 80 USD/ton to 15 USD/ton.
  - **Total valuation of impact of 1 ton of C2CCertified Satino Black hand towel:** pre-certification the impact was 18.5, post certification -122.9, resulting in a net benefit of -141.4/ton of Satino Black hand towel.
- **Total resource savings (i.e. tonnes of CO_2 emissions p.a.)**
  - **CO_2 emissions** total CO_2 emissions have decreased from 24 148 tonnes in 2009 to 23 026 tonnes in 2013; from 577 kg/tonne of product in 2009 to 524 kg/tonne of product in 2013..
  - **Water consumption**: the total water consumption has decreased from 437 161 m^3 in 2009 to 419 392 m^3 in 2013, as has the water use per unit product – from 10.5 m3/tonne product in 2009 to 9.5m3/tonne product in 2013. These net reductions reflect reduction in the use of both ground water

and surface water over the period.

- **Energy consumption**: the combined heat and power system delivers 30% more energy than conventional electric plant. Van Houtum has been using biogas since 2010, registering an increase in biogas consumption of 99% compared to 2012. Their gas consumption has increased in 2013 to 430.696 GJ compared to 428.345 GJ in 2012. Van Houtum uses 100% sourced electricity generated using hydropower and green natural gas.

- **Impacts over the value-chain:**
  - **Valuation of impact over the value chain**: according to the C2C impact assessment study performed in Oct. 2013, the GWP (global warming potential) across the supply chain of recycled tissue paper has decreased by 75%, due to displacing pulpwood (virgin raw material) by implementing C2C resource efficiency.
  - **Material health**: soap and plastic dispenser manufacturers have had their products C2CCertified at Silver level, as required by Van Houtum in following C2C certification criteria for their own product assortment
  - **Environmental benefits of the Satino Black product assortment for the end consumer.** The impacts have been assessed (and the assessment tool used has been audited/verified by third party) in a company with 1000 full time employees. The results are displayed on little black tiles in their customers washrooms to inform them of their choice in sustainable products:
    - ✓ Water savings: 160 500 litres (amount of drinking water/year by 730 employees)
    - ✓ Energy savings: 6 834 KWh (electricity usage of 78 laptops/year)
    - ✓ Emissions savings: 6 264 kg/CO_2 (emissions of 2 leased cars/year)

Economic and social impacts

The Satino Black environmental performance has had an overall positive influence on the business and on employees (growth in sales over the years, expected growth in staff numbers) (see below).

Business impacts were documented in *"Impact of C2CCertification Products analysis, Van HoutumSatino Black Hand towels",* prepared by Trucost, October 7th 2013.

Economic and social impacts of the RE measure for your company and/or for other companies in the value chain?

- ***Valuation of impact over the value chain:*** *according to the C2C impact assessment study performed in Oct. 2013, the GWP (global warming potential) across the supply chain of recycled tissue paper has decreased by 75%, due to displacing pulpwood (virgin raw material) by implementing C2C resource efficiency.*
- ***EUR per final cost saved (EUR/tonne or EUR/product),***
  The company has registered cost reduction of 1 million EUR according to an impact study performed in Oct. 2013 on the C2CCertified Satino Black hand towel, against a turnover of 65 million EUR for the same period.
- ***payback-time (Months)***
  1-3 years
- ***Impacts on employment (number jobs created/lost)***
  The number of jobs has been steady since the implementation of C2C
- ***Type of jobs created/lost, safeguarded***
  The company has increased its sales force and business development; in order to train wholesale distributors in telling the story of the Black Satino C2CCertified collection, the management has specifically hired additional sales people.
- ***Competitive position?***
  According to an impact assessment of C2CCertified Satino Black hand towel performed in Oct. 2013, it seems plausible that the business impact of implementing C2C has been positive, as Van Houtum has performed better than the market average since certification (0.2% better).
- ***Impact on business performance: additional turnover, cost savings, productivity, profitability***

- **Production**: production has slightly decreased from 43 968 tonnes in 2012 to 44 397 tonnes in 2013
- **Sales**: in 2013 there has been in increase in sales from 63 million to 64 million units.
- **Investments**: have increased as well in 2013, by 0.1 million EUR compared to 2012
- **Solvency rate**: has increased by 5% in 2013 compared to 2012
- **EBITDA**: has increased by 0.7% in 2013 compared to 2012.

Local/regional/national/EU resource policy framework

Van Houtum has mentioned issues in regards to a special permit from the province authorities that they would need in order to start a trial process of recycling drinking cartons that are being collected through the sorted waste collection companies. The authorities are motivating their delay in issuing this permit based on EU Waste Directive, which impedes waste handling by un-authorized actors.

Further information

Links to relevant information sources (e.g. company information, press releases, information on relevant public policy measures)

- http://www.vanhoutum.nl/media/document/001166_CSR%20report%202013.pdf
- http://issuu.com/worldwatcheurope/docs/wwie_report_3_issuu (pg.77-83)
- http://epea-hamburg.org/en/content/about-us
- http://www.C2Ccertified.org/

Link to company website or detailed case study on the web

- http://www.vanhoutum.nl/en/

Link to EEA RE country profile

- http://www.eea.europa.eu/themes/economy/resource-efficiency/resource-efficiency-policies-country-profiles

Other references:

"Impact of C2CCertification Product analysis, Van HoutumSatino Black Hand towels", prepared by Trucost and commissioned by the Cradle to Cradle Products Innovation Institute, October 7th 2013.

2/ Endorsement letter from the Commission

EUROPEAN COMMISSION
DIRECTORATE-GENERAL
ENVIRONMENT
Directorate F - Strategy
ENV.F.1 – Resource Efficiency and Economic Analysis
Head of Unit

Brussels, 17 March 2014

To whom it may concern

In the context of the Europe 2020 Strategy and its flagship initiative "A resource-efficient Europe" the European Commission commissioned a study "Cases of implementing resource efficient policies by the EU industry".

The study is conducted by a group of experts from IDEA Consult, Ecorys Netherlands, the Copenhagen Resource Institute, the Regional Environmental Center and ACTeon. The project is managed by Dr. Valentijn Bilsen.

The aim is to gather evidence of the methods that the EU industry has developed and implemented to improve its resource efficiency and of the results in terms of economic, social and environmental impacts. The study will also look at motivations of applying those methods, whether intrinsic or external, and also at success or failure factors. The final report will include up to 20 such cases from various industrial sectors and from different European locations. The results are expected to be published this summer.

The team has been asked to carry out targeted interviews with businesses to authenticate the information collected and to thoroughly document the cases. On behalf of the European Commission I would be grateful if you could dedicate some time to helping the team fulfil this mission.

In case of questions please do not hesitate to contact Mrs Kicia, the person coordinating this study work in my team.

Carina Vopel
Head of Unit

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