Guide to resource efficiency in manufacturing

EXPERIENCES FROM IMPROVING RESOURCE EFFICIENCY
IN MANUFACTURING COMPANIES

EUROPE INNOVA

Eco-Innovation

REMake

Acknowledgements

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Foreword

Sustainable use of resources has been on the political agenda for over 30 years now, with environmental policies and instruments focusing primarily on compliance with regard to emissions, energy efficiency and the reduction of waste and wastewater. Nowadays, it can be said that industrial companies have successfully responded to this challenge: emissions limitations are respected, and the use of resources per European inhabitant has practically been stable since the nineteen-eighties whilst in the same time the economy has grown by 50%.[1]

In the past, industry and policy have relied mainly on so-called 'end-of-pipe' measures: cleaning wastewater and air, recyling, and continuous improvements in energy efficiency. Moreover, material optimisation has generally focused on product functionality and less on resource use. Today, this approach is not sufficient anymore if Europe wants to ensure a sustainable future for its manufacturing industry.

Hence, over the last ten years, increasing attention has been paid to the potential depletion of abiotic resources and the rising costs of raw materials. Far ahead of personnel costs (at 20%), materials represent the largest cost for manufacturing companies at 35-40% of total expenditure, followed by energy costs at 10-15%. Thus, materials and energy are by far the most critical cost factors for a manufacturing company; its competitiveness in the global context will be determined by its capacity to use resources as efficiently as possible.

Since 2009, the European public-private partnership REMake ('Recycling and resource efficiency in manufacturing') has been designing and testing policy instruments and practical tools to support eco-innovation in manufacturing. REMake experts have already helped over 200 manufacturing companies in France, Germany, Hungary, Italy, Spain and the UK to assess their resource savings potential in a simple, hands-on manner and to discover how material efficiency and life-cycle approaches can increase their profitability.

This guide on resource efficiency in manufacturing presents the results and experiences of the REMake partnership and features a wide range of policy recommendations to support a faster up-take of eco-design, process efficiency and value chain optimisation in the manufacturing industry. In this light, we hope that our work will inspire policy measures that will improve resource efficiency and competitiveness in the more than 2,000,000 manufacturing SMEs in Europe.[2]

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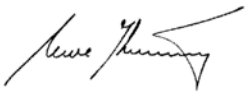


[1] European Commission, 2005
[2] Eurostat 2008

Doing more with less resources

By using fewer resources and optimising their use, businesses can become more environmentally friendly, competitive and profitable. A substantial increase in resource efficiency is essential to achieve sustainable green growth; it is also economically sensible; with **current inefficient use of resources calculated to cost European industry €630 billion per annum.**[1]

Since the Industrial Revolution, our wealth and well-being have relied on intensive exploitation of natural resources ("every component in nature susceptible to use by a human to satisfy his or her needs and with a real or potential value"), from metals, hydrocarbons and minerals to biodiversity, genetic resources and ecosystems.[2] With an ever growing economy, global resource extraction increased by 78% between 1980 and 2008, and is predicted to keep rising.[3] If the exploitation of our natural resources continues at this pace many critical resources will soon be depleted. In fact, if everyone in the world used the same level of resources as the average European today, we would require two-and-a-half earths to support ourselves.[4]

Decoupling growth from resource use

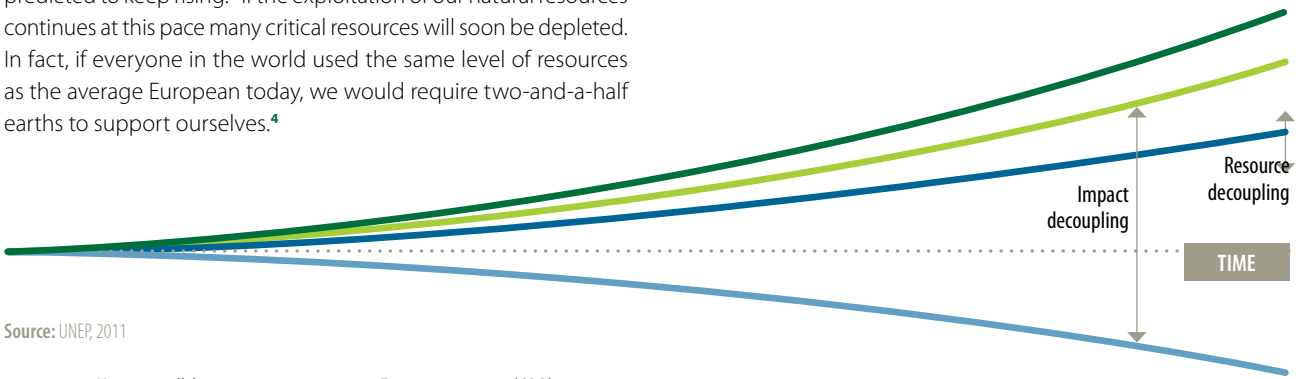
To become sustainable, we must therefore decouple our economic well-being from environmentally negative impacts and resource consumption. For example, there has been a historic trend linking the concurrent rise of GDP to greenhouse gas emissions. Decoupling is the breaking of such links between economic growth and environmental impacts.

Resource Decoupling

Reduction of resources used to create a unit of GDP.

Impact Decoupling

Reduction of negative environmental impacts from creating a unit of GDP.



Source: UNEP, 2011

1 **European Parliament** – Proceedings of the Workshop on 'Resource Efficiency' (2012)
2 **Spanish Law 42/2007 on Natural Heritage and Biodiversity** (2007)
3 **Eco-Innovation Observatory** – Closing the Eco-Innovation Gap: An Economic Opportunity for Business. Annual Report (2012)
4 **European Commission** – Fact Sheet: Sustainable Consumption and Production (2008)

The political landscape

Taking into account the depletion of vital resources and the resulting impact on Europe's global competitiveness, the European Union is rapidly moving resource efficiency higher on the political agenda.

In January 2011, the European Commission launched the Resource Efficient Europe Flagship Initiative, laying out the political will to pursue resource efficiency as a Europe 2020 initiative. The Roadmap for a Resource Efficient Europe followed in September 2011, with the Eco-Innovation Action Plan three months later, giving more concrete details to the Commission's direction.

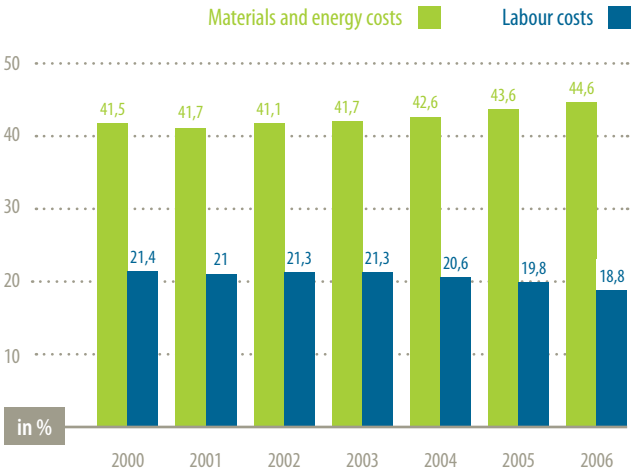
Ecomanufacturing (resource-efficient manufacturing) forms a vital part of the Commission's vision for a Resource Efficient Europe, with milestones set for 2020. These include minimum performance standards, market and policy initiatives that will reward business investments in resource efficiency, and decoupling economic growth from resource-inputs and environmental impacts.

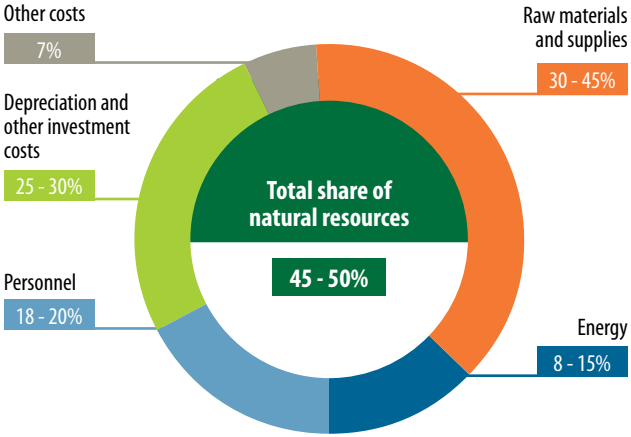
The following pages – based on the results and experiences from the European REMake project – discuss the potential contributions to these policy objectives by the European manufacturing industry, with its many small and medium sized enterprises, as well as the industry's specific needs and issues.

Resource efficient manufacturing

The resource efficiency of a manufacturing company (or a single manufacturing process) is the relationship between product output and resource input. It characterises how efficiently resources are used to add economic value. With natural resources increasing in scarcity and critical raw materials and resources becoming more expensive, resource efficiency is an important issue if European manufacturing companies are to remain competitive.

Increasing resource efficiency in manufacturing is also profitable. An overall savings potential of €630bn per year can be translated into substantial gains in each manufacturing company. European manufacturing firms spend on average 40% of their costs on raw materials, with energy and water pushing this to 50% of total manufacturing costs. This compares to a share of only 20% for labour costs. Resource-efficient products and processes therefore positively impact the profitability of any manufacturing firm.





The term 'resource' encompasses **raw materials, energy resources and all operating supplies** required for value generation. Increasing resource efficiency thus involves an integrated reduction of materials, energy, supplies and waste because these factors are usually strongly interlinked.

Hence, the benefits of increasing resource efficiency are often significantly higher than estimated when looking at only one particular resource. For example, saving €1 of disposal costs may result in about €7 – 12 of other costs e. g. for buying, processing and storing resources. Moreover, many resource efficiency measures are simple and inexpensive to implement. A study by DEFRA estimated that through low cost changes, UK business could save £6.4 billion (€7.7 billion) per annum.[5] Statistical data by demea (German Materials Efficiency Agency) from over 600 small and medium size manufacturing companies shows that savings of 5–10% of material inputs (equivalent to savings of 2–2.5% of turnover) could be achieved with return of investment in less than one year.[6]

[5] **Department for the Environment, Food and Rural Affairs** – Quantification of the Business Benefits of Resource Efficiency (2007)
[6] **Eco-Innovation Observatory** – Closing the Eco-Innovation Gap: An Economic Opportunity for Business. Annual Report (2012)

"Organizations that effectively weave resource efficiency into their core strategy and operations can drive revenue growth, cost reduction, better risk management and improve brand and reputation." **– World Economic Forum**

Besides higher profitability, resource efficiency can also unlock large potential for innovation and growth in the manufacturing industry, encouraging the emergence of new technologies and driving job creation. This relates to the optimisation of value generation across the full life-cycle, including manufacturing processes, design of eco-efficient products and recycling and reuse of waste streams.

Life-cycle approach

Analysing the life-cycle of a product reveals that resource inefficiencies occur along the value-chain. By focusing on all stages of the life-cycle, Life-Cycle Assessment (LCA) seeks to identify improvements to goods that can minimise waste, raw material extraction and conversion, manufacture, transportation, consumption, re-use, recycling and disposal.

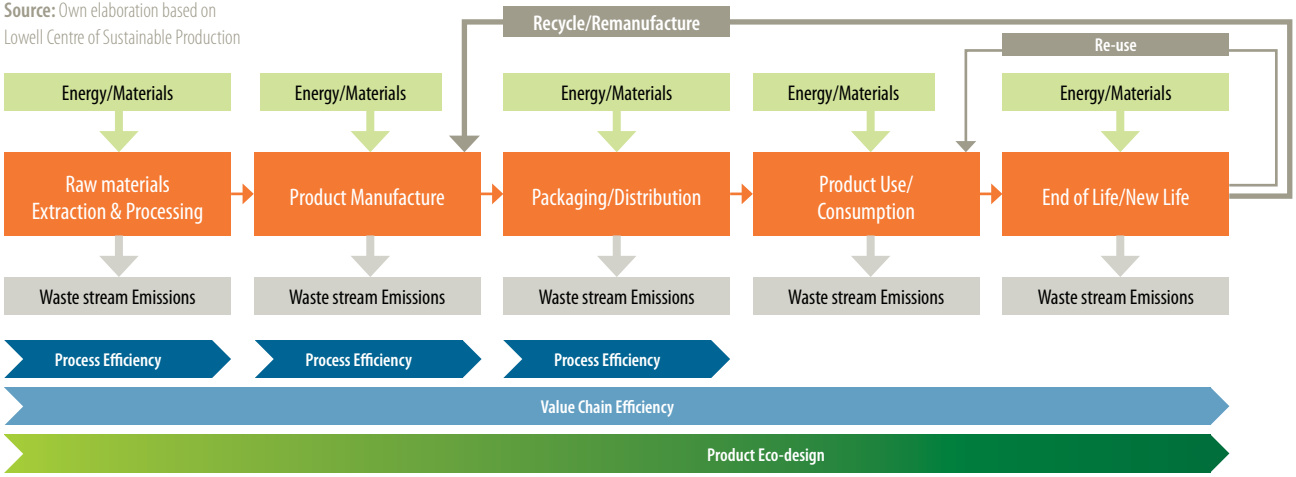
A new way of thinking

At each point along the value chain the use of valuable resources can be optimised. "More integrated product design and manufacturing engineering that takes into account the factor of resource-efficiency will make those products more environmentally sustainable during their complete life-cycle, including the manufacturing phase. [Also], environmental sustainability is a driver for new product and markets. Manufacturing technologies are a prerequisite for realising these resource-efficient next-generation products".[7]

Hence, the potential of resource efficiency in the manufacturing sector is clear, as is the urgency of the challenge to European industry. However, manufacturing SMEs have difficulties in adopting resource efficiency measures, despite the clear environmental and economic advantages that can be achieved. This has been the reason for developing solutions within the REMake project to support manufacturing SMEs in taking-up and accelerating eco-innovation towards resource efficiency optimisation.

Life-cycle optimisation strategies

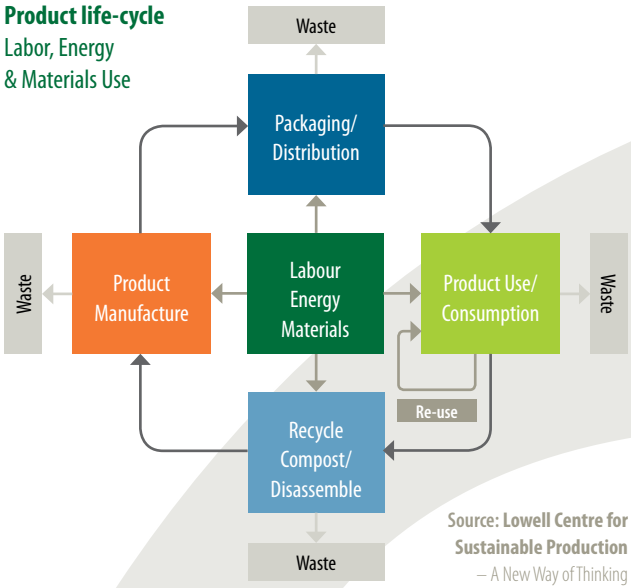
Source: Own elaboration based on Lowell Centre of Sustainable Production



[7] **Organisation for Economic Cooperation and Development** – Sustainable Manufacturing and Eco-Innovation: Towards a Green Economy (2009)

Levels of innovation

There are three main levels where resource efficiency can be improved to cover the whole value-chain of a product: eco-efficient product design, resource efficient manufacturing processes at factory level and integrated optimisation of the manufacturing value chain. In a typical manufacturing SME such eco-innovation measures often start with an improvement of the company's manufacturing efficiency.



Source: **Lowell Centre for Sustainable Production** – A New Way of Thinking

❶ Manufacturing efficiency

Manufacturing processes transform raw materials and other inputs into finished products and in most factories there is still ample opportunity for energy and material efficiency improvements.

Relatively small changes to the manufacturing process can have a large impact on resource use. Identifying 'low hanging fruit' – low cost measures that can reduce both the environmental impacts ***and*** costs of manufacturing – is a win-win situation. Typical improvement measures may include:

- Optimised operating parameters;
- Reduction of cuttings and rejects;
- Reduction of the use of operating fluids and supplies, including water;
- Improvement of cleaning and conditioning processes;
- Recycling of production wastes;
- Improved storage and logistics.

Larger changes are also highly profitable: while they may require some investment these typically pay off within less than a year. Changes that can be made include measures such as:

- Minimising tool wear by using advanced tool materials;
- Implementing near-net-shaped manufacturing concepts or near zero-waste concepts through advanced recovery, remanufacturing and recycling;
- Use of advanced or renewable resources, and;
- Implementing improved process control and inline-inspection systems with pre-processing prognosis.[8]

[8] **EFFRA** – Factories of the Future 2020 Roadmap, Working Document, May 2012

❷ Product design

The design of a product determines its life-cycle, starting with the selection of materials and finishing with recyclability at end-of-life. It has been shown that 70%[9] – 80%[10] of a product's environmental impact throughout its life-cycle is determined at the design stage. Design decisions thus have a huge impact on resource consumption and environmental footprint, and in turn on the profits of the producer.

Efficient product design also has a logic that extends beyond reducing production costs; consumers are increasingly aware of the environmental impact of the products they purchase and respond accordingly. Eight out of ten EU citizens state that environmental impacts are either very or rather important to them when making decisions on what to buy.[11]

Determining the product life-cycle

Eco-design introduces environmental criteria to the design of products or services (in the same way as technical and economic criteria) in order to reduce the environmental impact during the product's life-cycle, whilst maintaining its functionality. It uses Life-Cycle Assessment (LCA) to analyse a product's environmental footprint and identify priority areas of improvement.

Measures typically include: optimisation of resource consumption during use phase; optimised product design to increase manufacturing efficiency; weight and component reduction and use of alternative (preferably renewable) materials; and design optimisation enabling a high degree of reuse or recycling at the end of product life (vision of 'closed loop' production).

A deeper understanding of the relationship between design features (such as aesthetics, and characteristics like corrosion protection) and related manufacturing process efficiencies should be the focus of future developments. This will result in the availability of advanced product eco-design options and guidelines for the manufacturing of new high added value products with tailored properties. Specific design tools could aid the selection of basic materials with minimal environmental impact and support the minimisation of resource use during manufacturing. Future development in this field should include:

- Advanced manufacturing information systems for informed product design to monitor and improve resource efficiency of products throughout their life-cycles, and;
- Advanced solutions for product value and impact simulation.[12]

REMake has tested a number of eco-design tools, and has demonstrated the potential of a comprehensive understanding of a product's life-cycle in making efficiency savings and reducing environmental impact.

[9] **Lowell Centre For Sustainable Production** – A New Way of Thinking (2009)
[10] **European Environmental Bureau** – Designing Greener Electronic Products: Building Synergies Between EU Product Policy Instruments or Simply Passing the Buck? (2010)
[11] **Eurobarometer** – Attitudes of Europeans to Resource Efficiency (2011)
[12] **EFFRA** – Factories of the Future 2020 Roadmap, Working Document May 2012

Resource Savings Potential of the Manufacturing Industry:
Analysis of company data from Germany

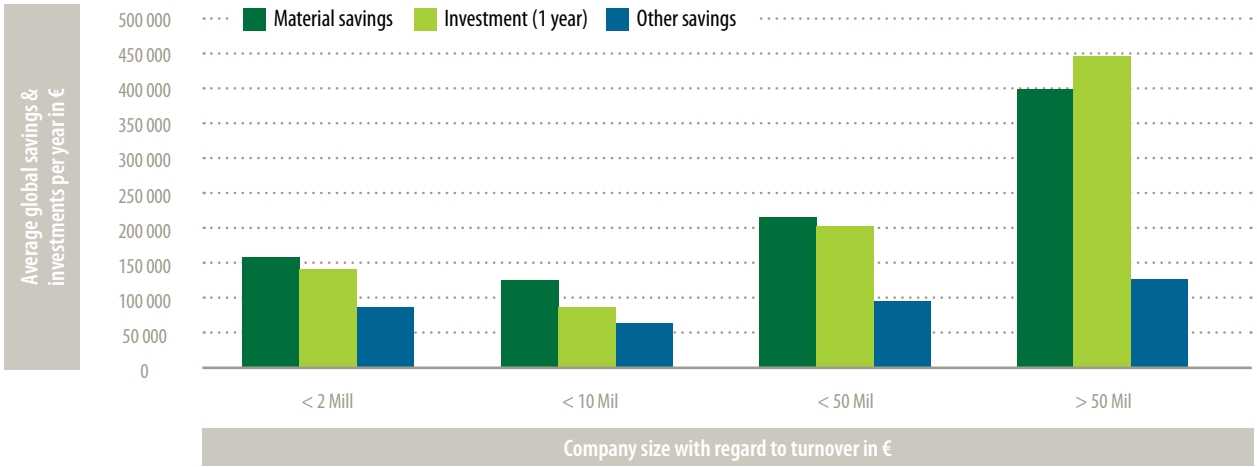
Within the scope of the REMake project, case studies have been analysed which were performed under the German Materials Efficiency Programme (now 'go-effizient') to improve the resource efficiency of manufacturing companies. The sample contained 100 case studies from different sectors with a focus on metal processing, machine building and automotive suppliers.

These case studies were mainly focused on achieving material savings, though measures also contributed to savings in energy use, labour costs, or production capacity.

Figure 1 shows average yearly savings (in Euro) and the average investment costs required to achieve these results. In most of the case studies only needed a one-off investment, and these paid off within less than one year.

Across all case studies, average material savings in the manufacturing processes reached 6.7% of the related material input. Although total amounts of savings and investments increased with company size as expected, when related to materials input the savings are highest for small companies

Fig.1 Resource savings and investments in dependency on company size



where they reach up to 9% of input. One reason for this is that most of the larger companies are from metal processing or related sectors and deal with expensive input materials like steel or aluminium. This gives some indication that these companies have already implemented efficiency measures in the past in order to reduce their materials costs.

Figure 3 shows the optimisation measures that were implemented. Most of them cover either the optimisation of manufacturing technologies and processes, or the optimisation of manufacturing organisation. The next most prevalent group of measures was dedicated to optimisation of other processes such as stock-keeping and logistics, with training of employees following closely behind (mostly implemented by larger companies).

Fig.2 Material savings in dependency of company size

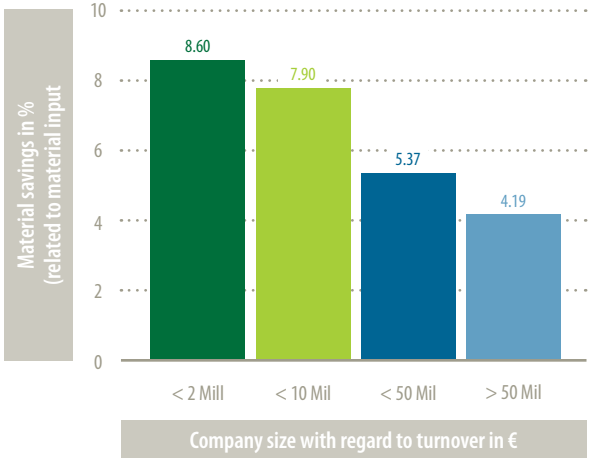
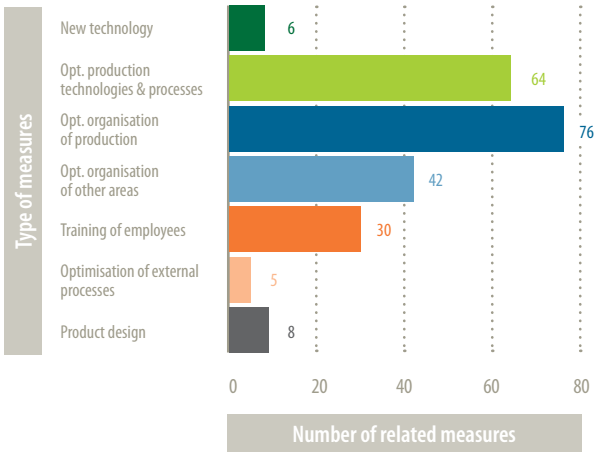


Fig.3 Categorisation of measures implemented



❸ Value chain optimisation

Looking across entire manufacturing value-chains, high overall savings can be achieved by applying best available technologies (reaching up to 20% of total abiotic resource consumption). While process optimisation at individual company level at best reaches 10% of the firms' resource consumption (see Fig.2 and Fig.3), value chain optimisation can tap the large savings potential that is locked at the interface between different companies involved in increasingly complex supply chains.

This is the most complicated route to resource efficiency, but also the one that gives the greatest rewards in long-term environmental and economic savings. There are very few companies who manage their whole production line. One company's output is another's input, requiring a great deal of cooperation and communication to achieve efficiency gains. From obtaining natural resources to a final product being sold, there are many steps to be coordinated to ensure the efficiency of resource use. If inputs do not meet exact output specifications, then large quantities of resources are wasted.

Hence, addressing the overall production chain in an integrated way should lead to substantial advances in overall process efficiency and sustainability. In order to prove this potential and to improve on available estimations, a recent study initiated by REMake has analysed three typical manufacturing value chains through life-cycle simulations.[13] The aim was to calculate the savings potentials achievable by applying best available technologies and optimising interfaces compared to optimisation at single company level only. The results demonstrate very substantial savings reaching up to 50% of total non-regenerative material resources over the life-cycle!

[13] **Greenovate! Europe EEIG** – "Study on potential resource efficiency savings locked in typical process chains of the manufacturing industry" (June 2012). Study performed by i.con. innovation GmbH together with LCS Life-Cycle Simulations GmbH and CTECH Innovation Ltd., with financial support from Defra (UK).

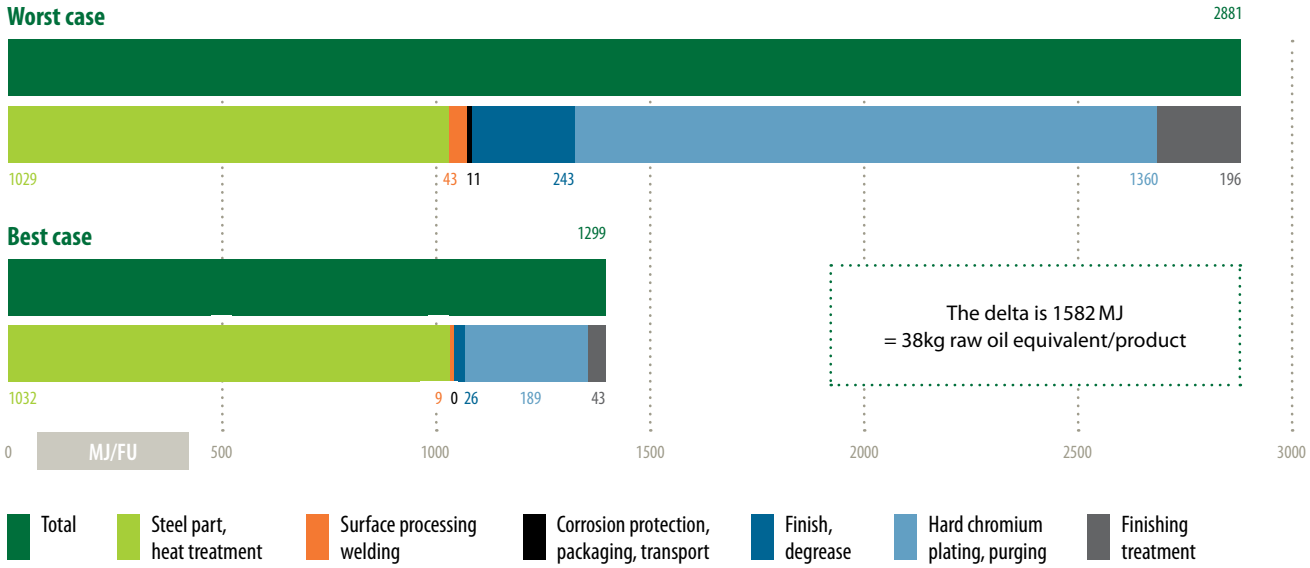
Value chain optimisation of hydraulic piston rod production

Hydraulic piston rods are widely used in machinery such as lifting devices, material handling equipment and construction machines. They are produced from steel that is subsequently treated to obtain maximum corrosion protection and hardness as well as a flawless surface ensuring optimal functionality of the machinery. The key process used for surface treatment is hard chromium plating that results in a high-quality, shiny chromium surface of the hydraulic piston rod.

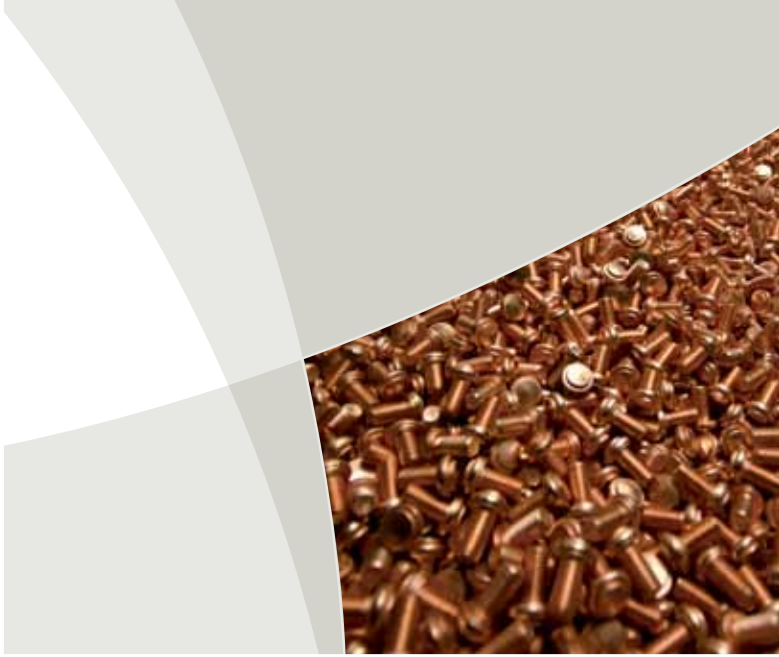
In order to maximise the efficiency of the production value chain, an in-depth life-cycle simulation has been carried out based on two different scenarios using a| low quality steel or b| high quality steel as point of departure for the production of hydraulic piston rods used in diggers.

For both scenarios, each single production step has been examined to find the primary energy need of pre-production resources; the greenhouse gas emissions as CO_2 equivalent; material resources that are not regenerated such as minerals and all energetic resources used during the life-cycle of the product.

The life-cycle simulation has clearly shown that producing high quality steel requires more effort but results in important savings at the level of surface treatment where the production process can be optimised and a significant amount of scrap is avoided thus minimising the overall steel demand. For each hydraulic piston rod, the primary energy demand can be reduced by 1582 MJ which corresponds to 38kg of crude oil, and a reduction in total non-regenerative material resources used for manufacturing of roughly 400kg (including raw materials extraction).



Boosting resource efficiency with REMake



With the support of REMake experts, companies have been assessing their savings potential in a simple, hands-on manner and discovering how material efficiency and life-cycle approaches increase their profitability.

Since 2009 the REMake project has been designing and testing policy instruments and practical tools to support manufacturing eco-innovation across Europe. REMake is a public-private partnership that brings together national and regional agencies and technical centres, together with industrial associations and innovation experts, from six countries.

Eco-innovation support consulting tools

Based on existing solutions and approaches, a repository of validated eco-innovation support tools has been developed for SMEs to assess savings and profits from innovative approaches to resource efficiency. The tools offer potentiality analysis, implementation support to recycling and resource efficiency measures, life-cycle approaches, eco-design and innovation management support. The selected tools and concepts may be used in the framework of ongoing and further voucher schemes, or as stand-alone tools by intermediaries.

REMake Recycling and Resource Efficiency Self-Assessment Tool (RRE-SAT)

The tool allows SMEs to quickly and easily evaluate their eco-innovation performance in recycling and resource efficiency through an online self-assessment. On completion of a qualitative questionnaire, the user receives a detailed report with recommendations of areas for potential improvement and a benchmark of manufacturing resource efficiency.
(©REMake consortium)

REMake Guidebook on standards and regulations

This database enables manufacturing SMEs to assess their level of compliance with regulations and standards existing at European and national level. It may be filtered using multiple categories: life-cycle steps (e.g. production, packaging, transport, use, end of life); topic (e.g. waste, energy, emissions, materials, workers, equipment); and by sector or keywords.
(©REMake consortium)

PIUS®

Framework for potentiality analysis
(©EfA Effizienzagentur NRW, Duisburg)

STAN

Free material flow analysis software used for potentiality analysis in process optimisation
(©Research Centre of Waste and Resource Management, Vienna University of Technology; Wien)

EAMA

Environmental Alternative Assessment for process optimization
(©AIMME - Instituto Tecnológico Metalmecánico, Valencia)

ATEP
Software tool for potentiality analysis in product eco-design (©CETIM – Centre Technique des Industries Mechaniques, St. Etienne)

Ecotriz
Optimisation methodology for product eco-design (©A.I.M. – Active Innovation Management, Palaiseau)

eVerdEE, CCaLC
Free, simplified life-cycle analysis tools for product eco-design (eVerdEE ©ENEA, Rome; CCaLC ©School of Chemical Engineering and Analytical Science, University of Manchester)

Resource Efficiency Network
Learning network for eco innovation management (free).

Expertise in the specific industry sector is absolutely necessary for advice on improving resource efficiency, and being familiar with a set of tools supporting these highly complex processes is an asset. The REMake partners have a deep understanding of these tools, illustrating their potential and providing training to manufacturers all over Europe. All tools and related case studies are available at **www.ecomanufacturing.eu**

REMake voucher schemes

Green vouchers allow companies to assess savings potential and quickly discover how material efficiency measures and life-cycle approaches can increase their profitability. The REMake partners are testing two-stage voucher schemes with European manufacturing SMEs in France, Germany, Italy, Spain and the UK. The first voucher is used to conduct a resource efficiency audit, or a potentiality analysis, identifying the most promising areas for saving resources. The second voucher is used to implement specific measures.

What is a green innovation voucher?

Innovation vouchers are a user-friendly way of financing external expertise to solve small innovation issues. Green innovation vouchers focus on areas with positive environmental impact. They are highly flexible and non-bureaucratic, designed with SMEs in mind. The voucher schemes are usually handled by national or regional agencies and are financed through regional, national or European funds, including the ERFD.
To learn more about green voucher schemes contact: **katharina.krell@greenovate.eu**

The French REMake voucher scheme

In France, REMake vouchers are managed by OSEO, the French innovation agency.

Vouchers can be used to fund half the costs of a project, with the SME contributing the other half. They are available up to the value of €15,000. Three main eligibility criteria have been set out:

- Less than 2000 employees (although most of the applications come from companies with less than 10 employees);
- Evidence of sufficient equity to fund their share of the project;
- Cannot be a "profession libérale" – i.e. self-employed without a payroll.

When a proposal is accepted, the SME is given a list of experienced consultants to choose from. Half the payment of an approved voucher is made up front, and half paid after the consultant has submitted a report at the end of the project. This ensures that SMEs do not face any cash liquidity problems when implementing their innovation project.

Eco-design means business

A small manufacturer of metallic components for building sites produces a novel system that improves both the construction process and worker safety. Together with the French Technical Centre for the Mechanical Industry (CETIM), it has employed the eco-design methodology Maieco to create an environmental profile of the product. Using this life-cycle assessment, the company understood where the greatest impact was made and defined clear priorities for improvement. As a result, the environmental performance of the product was increased, including a 10% reduction in raw material use and CO_2 emissions during transport, and a 30% gain with respect to its reusability. In addition to cost reduction, for the SME it had the added-value of a greener product to present to clients without any further cost.

INTERVIEW

Jacques Gautray
OSEO

What was the rationale for creating an innovation voucher scheme?

We established the innovation voucher scheme to stimulate economic activity, contribute to job creation and support SMEs to become more competitive. Vouchers have become increasingly common in Europe, and the Europe INNOVA programme is an interesting platform to test these pilot schemes.

Why did you choose to focus on resource efficiency in manufacturing?

With the rapid growth of emerging countries, resource efficiency has become a key driver in fostering European competitiveness. The way Europe currently uses resources and disposes of waste promotes resource dependency and contributes to economic vulnerability and price fluctuations. As Europe faces scarcity, the real challenge in creating smart and sustainable growth is to learn to use, reuse and never waste. In other words; doing more by using less resources. Hence, we need more innovation, recycling processes, training and education to tackle this issue. With REMake we are supporting SMEs to learn how to innovate, get access to external expertise and become greener and more competitive.

Eco-design business success

Bourgeois, a Savoy based oven manufacturer, has been working with Cetim and Maieco eco-design methodology to optimise the design of its new range of ovens. This allowed the company to profile the environmental impact of the product throughout the different phases of its life-cycle: raw materials, manufacturing process, packaging, transport, product usage, recyclability, etc. The SME was able to identify the high impact of the usage phase, as well as of the raw materials used and their recyclability, which allowed them to prioritise areas for improvement in the design process. The result was an oven that consumes around 35% less energy than the previous model, weighs 10% less, has an energy content that is 14% lower and a recycling rate that now passes 90%. Another benefit was that the new oven will be ready for the implementation of future European energy standards and directives on the elimination of hazardous substances.

By employing Maieco methodology, Bourgeois has been able to bring to the market an environmentally-friendly product that stands out from the competition. After working alongside Cetim in implementing the new methodology, Bourgeois will now also be able to use it to design future products.

Resource-efficient design of refrigeration trucks

With the help of a REMake voucher, Aubineau Constructeur ventured into a re-design of the body of a refrigerated truck to optimise the energy loss of the cooling vehicle, reduce fuel consumption and decrease CO_2 emissions. The potential benefits are impressive:

- A decrease in the fuel consumption of the refrigeration unit by 3.6% due to a performance improvement of 19% to the floor insulation;
- A 16% reduction of material weight (i.e. 150kg per truck and 235kg per semi-trailer);
- A fall of 0.5% in fuel consumption by the truck engine due to the weight of the floor being reduced by 16%;
- 50% of the plywood plates previously bought in Finland are now bought in the west of France, close to the factory;
- Production cost savings on each floor of 5%.

jacques.gautray@oseo.fr

What are the main challenges and opportunities you have encountered?

One of the challenges we have faced is communicating to manufacturing companies what eco-innovation is, which has not always been easy, but the voucher pilot schemes that we are testing in REMake, as well as in previous voucher projects, have given us an insight into their workings and potential. One of their greatest advantages is their flexibility, allowing us as innovation agencies to shape them to our own country's needs.

Resource efficient manufacturing in Germany

In Germany the voucher pilot scheme is run in the framework of the Impulse Programme for Material Efficiency, set up in 2006. This provided a pool of experienced consultants, about 600 strong, from which 23 were chosen for the REMake pilot scheme.

A consultant is responsible for ensuring that the company meets eligibility criteria, before helping them to fill in a Self-Assessment Tool on the demea website. This consists of 13 questions that allow the company to assess its material efficiency. After completion, the consultant can generate and print out a voucher and begin their work in the company immediately.

The vouchers cover part of the costs of consultancy up to the value of €30,000. Two funding rates were set:

- 67% funding up to €15,000
- 50% funding up to €30,000

INTERVIEW

Mario Schneider
demea

Why was resource efficiency in manufacturing chosen for a voucher scheme?

There is a high potential in the manufacturing industry to reduce material costs. In 2009, the manufacturing industry in Germany spent €625 billion on materials compared to €35 billion on energy. With such a large amount of resources being used, it is a sector that is very well suited to a public support programme involving the identification of potential material savings.

What are your experiences of the scheme so far?

SMEs have been satisfied with the smooth performance of the project and the easy access to public funding that it provides. Companies find initially reduced costs more attractive than a reimbursement after the consulting project. Cutting costs spent on materials will raise a company's competitiveness on the global market, and that's a strong incentive for taking part in the voucher project. Another key aim is the reduction of environmental burdens that material savings can achieve. On the other hand, consultants were charged with a great deal of responsibility, including checking all the pre-requirements (e.g. eligibility, project aims) before the project started and leading it to a successful end. Therefore, professional training for consultants is essential.

Each SME is only eligible for one voucher, and responsible for paying the remainder of the costs directly to the consultant. The project should start no later than one month after the voucher is printed, and finish within two months of the start. The consultant then submits a final report to demea, who evaluates the project and pays the consultant as long as it meets the specified criteria.

Metal fabricator

A German steel manufacturer was losing material during processing and some product deficiencies were leading to customer complaints. With the help of REMake, a consultant analysed the company's production process and material flow. By optimising purchasing in terms of fitting steel lengths and by introducing quality criteria for the inspection of incoming goods, as much as 9% of steel could be saved. Training courses for employees were also suggested in order to implement new quality standards and the incoming goods inspection successfully. By implementing a few simple measures, the company could realise an annual material saving of €50,000 with minor investments.

Metal refining

Electroplating processes require huge amounts of resources. One German company was using 79 tonnes of metal, 420 tonnes of chemicals and 7,500m^3 of water per year. With the help of a REMake voucher, a consultant found significant potential for resource savings by installing a circulation system of process solution and rinsing water in order to reduce evaporation losses. Increasing the dwell time of the work piece over the process bath also reduced water consumption. Altogether, an annual saving potential of about €70,000 has been identified, which corresponds to a 10% increase in the company's rate of return.

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Will voucher schemes continue in Germany?

Since 2011, Germany has based its material efficiency programme entirely on a voucher scheme (a module of BMWi-Innovationsgutscheine, called 'go-effizient'). The scope of 'go-effizient' has been enlarged to include measures on raw materials and recycling aimed at improving resource efficiency in SME production processes and product design.

What was the most unique aspect of your voucher scheme?

The voucher pilot scheme was embedded into a programme for material efficiency run by the German Federal Ministry of Economics and Technology, which has been performing very well. This helped us generate a high amount of vouchers; the consultants already knew the programme and were able to recruit SMEs from their prior experiences.

The Welsh REMake experience

In Wales more than £250,000 (€300,000) worth of support has been made available for manufacturing SMEs interested in finding out more about using recycled materials in their products or packaging. Up to 30 Welsh companies were offered the opportunity to apply for expert technical advice to the value of £17,500 (€20,000).
The scheme, run by Waste and Resource Action Programme (WRAP Cymru), offers two types of voucher:

- A first package (with up to six day's support) where SMEs can assess the feasibility of using less raw material in their products or packaging. This includes site visits and help with research and planning.
- A second package (with up to 15 days support) for SMEs which have already decided to use recycled materials but need help with implementation

Consultants are selected on the basis of experience, technical capability, added value and cost, and SMEs have the chance to select the experts themselves.

INTERVIEW

Bettina Gilbert
WRAP Cymru

Why did you decide to establish an innovation voucher scheme?

WRAP Cymru offers grant support for SME manufacturers to off-set the capital costs of incorporating recycled content into their products. The REMake voucher scheme complements this grants scheme and allows us to offer businesses a full range of support mechanisms, potentially accelerating the 'greening' process of the region's SMEs.

Why did you choose the manufacturing sector as a target?

The policy objectives of the Welsh Government are strongly geared towards achieving zero waste to landfill and a closed loop economy. Key to achieving these policy objectives is giving support to manufacturing businesses so they can become more resource efficient through methods such as incorporating eco-design into product development, decreasing the use of primary resources with recycled material use, and undertaking lifecycle assessments.

High-quality tiles from building waste and recycled material

With a REMake voucher of €20,000, Nexiform was able to finalise the first un-fired, energy-free copy of the ceramic tile, made entirely from building waste and recycled material. The business had spent several months trialling and testing the tile, but needed support to finalise the product 'recipe', identify key target markets, and increase production. After reviewing the production process, an action plan was drawn up to ensure that production included the maximum percentage of recycled content possible. Nexiform and REMake have developed a unique product: one that is made from 85% recycled materials and created using a low-energy, environmentally friendly production method. The company estimate that 700 tonnes of recycled materials will be used in the production of tiles. So far the company has created 12 new jobs, but hopes to expand that to 45 in the near future.

Surgery company reducing packaging costs

A manufacturer of high-specification medical equipment, specialised in state-of-the-art clinical instruments for use in brain surgery, wants to increase its use of recycled materials. The nature of the company's products means that it is not able to use recycled materials in their manufacture, but it is using REMake voucher support to explore the use of recycled materials in its packaging. The high value equipment needs quality packaging to ensure that it does not become damaged during transit, meaning that the company pays up to €14 packaging costs per unit sold. Incorporating more recycled materials into the packaging while retaining the quality will help reduce costs.

For more information, please contact: Bettina Gilbert, WRAP Cymru **bettina.gilbert@wrap.org.uk**

In what ways have SMEs been using REMake vouchers?

WRAP has awarded vouchers to help businesses reduce their packaging costs, undertake life-cycle assessment, replace virgin plastics with recycled materials, and save money by recovering valuable metals from the surface finishing process and reducing water consumption. Particularly in a difficult economic environment, many businesses are more risk averse and will prioritise growth or stability over less concrete concepts such as 'resource efficiency', which is difficult to understand, or changing their product specifications unless deemed necessary.

What is the future of voucher schemes in Wales?

In Wales, 99.2% of businesses are SMEs and over 94% are micro sized businesses. In order to help Wales meet aggressive policy targets, we recognise the need to offer expert support to manufacturers in order to increase their levels of recycling and resource efficiency. Moving forward, and having gained experience from the REMake voucher scheme, we are looking at how we can continue to offer a similar service in the future.

REMake in Valencia Region

In Valencia, while innovation vouchers were already used for horizontal actions, REMake offered the opportunity to test a voucher scheme in a single specific topic.

The Network of Technological Institutes of the Comunitat Valenciana (REDIT) is playing a key role in designing and implementing the whole scheme, being responsible for publishing calls for proposals and raising the scheme's profile. The whole process (call publication, submission, evaluation and communication) took no more than 6 weeks. 95% of proposals received were eligible and 25 vouchers were granted to companies. They covered 100% of external service costs up to €10,000.

Optimising performance

A Spanish start-up manufacturer of coffee mills sought to reduce environmental impact throughout the entire lifetime of its products, from product manufacturing and distribution to use and final disposal. The REMake voucher was used to identify ways to reduce energy consumption during the product use phase, which represents 80% of total energy consumption in the product lifecycle. The experts proposed different options to optimise the performance of the product components, including a different engine and a new configuration of the control electronics. The company is currently evaluating the alternatives proposed.

INTERVIEW

Eduardo Tomás Dolado
Government of Valencia

Why did you establish an innovation voucher scheme?

Industrial SMEs in Valencia are generally on the small side. Although they are sometimes able to undertake complex Research and Development projects, the size of their productive units is best fitted to implementing innovation actions. For SMEs, easy access to innovation support is paramount. Vouchers are a great way of linking the needs of companies in terms of innovation with adequate support, both economic and technical.

Cutting the cost of waste

An organic coating SME in Spain used the external expertise provided by the REMake voucher to investigate reducing the amount of waste they were producing. The company generates 35 tonnes of hazardous sludge per year, which represents a significant waste management cost. An initial analysis showed that by installing a sludge-dryer system the company could half the amount of water in their sludge and reuse what was recovered. This represents significant savings in waste treatment and water consumption. The voucher was also used to analyse the company's equipment, where the experts suggested substituting certain elements with more efficient equipment in order to reduce overspray in the coating processes.

Reducing waste in metal production

A Spanish company used the REMake voucher to evaluate the potential to reduce material losses in the processes of cutting, bending, and punching metal sheets. The analysis revealed that a significant part of the material losses were due to inadequate handling of metal coils. Several measures were proposed which eventually led to a 20m reduction in loss per coil. The consultants also recommended changing the cutting and punching software to minimise the amount of scrap produced. Finally, a new coreless packing solution was identified that eliminates the need for a mandrel and saves 240kg of cardboard per pallet.

For more information, please contact: Eduardo Tomás Dolado, Government of Valencia **tomas_edu@gva.es**

What are the main challenges and opportunities you have faced?

Companies' mainly saw opportunities in two areas: energy savings and water consumption. The main concern in energy savings is based on the economic situation that forces companies to reduce expenses. Regarding water, companies that make efforts in implanting wastewater treatment systems want to profit from this treated water by recycling it in their processes, while at the same time reducing consumption.

Was there a unique aspect to your voucher scheme?

The most unique aspect was matching the voucher offer to the needs of the companies. SMEs do not usually view public administration as a natural counterpart, and in our case REDIT played a key role in finding companies and talking to them in the right language. If part of the scheme can be run by intermediate agents with the trust of these companies that understand research, innovation, markets, and supporting SMEs, then the chances of success are clearly higher.

REMake in Navarra Region

The region of Navarra joined the REMake project to assess the viability of the voucher mechanism, an area where the region had no prior experience.

Navarra has simplified the application procedure to reduce administrative barriers and encourage SME participation. A two page application form is submitted electronically and there is a continuous evaluation process.

The vouchers cover 100% of external service costs up to €20,000, provided that the targeted measures are among those defined by REMake: resource savings potential, product life-cycle assessment, eco-design, eco-innovation management, eco-innovation financing, etc.

Priority is given to manufacturing SMEs belonging to one of the following sectors: metal products, plastic products, surface finishing, mechanical engineering and electrical and electronic equipment. SMEs from other sectors showing interest and potential in resource efficiency and recycling measures were offered the chance to apply for a voucher during the second call.

INTERVIEW

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Rafael Muguerza Eraso

Government of Navarra

Why did you feel an innovation voucher scheme was right for the Navarra region?

Navarra's manufacturing industry has historically been based around the automotive sector, but our focus is now turning to renewable energy, and this needs new support actions to stimulate growth. This project is helping us learn more about the eco-innovation capacities of Navarra's industries, and particularly its SMEs.

Did you face any challenges, and if so, how were they overcome?

The greatest challenge has been reaching SMEs. Companies are reluctant to apply for a voucher scheme that includes diagnostic processes and audits; they are afraid of being punished afterwards for not meeting environmental standards. The success of such initiatives depends on a dissemination effort to demonstrate the advantages of participating in terms of competitiveness improvements.

What was the most unique aspect of your voucher scheme?

The most unique aspect of our scheme was the decision to use a restricted pool of service providers. SMEs are directly recruited and audited by CEMITEC, a multidisciplinary technological centre selected to work in the programme.

The Hungarian REMake experience

The Hungarian Scientific Society for Mechanical Engineering (GTE) is the REMake partner for Hungary. It includes hundreds of engineers and dozens of factories and companies as members.

Resource efficiency is a key factor for growing the Hungarian economy, yet SMEs are reluctant to engage in this field. But things are now changing. National laws and European regulations will shortly come into effect placing economic burdens on companies that have not adapted to produce less waste, consume less gas and electricity and use less water and other resources. Besides, complying with CO_2 targets will also put pressure on factories to initiate change themselves.

During the project GTE has raised awareness of resource efficiency and has been assessing the potential of implementing the REMake voucher scheme in Hungary. "Until 2 years ago there was a National Office for Technology Development that provided support, grants and loans for product or service development, research and the exchange of scientific know-how. A kind of voucher system called INNO-CHECK was also in place dedicated to the implementation of innovative ideas and solutions. INNO-CHECK could be the ideal platform to continue the REMake programme in Hungary. We hope that the Government will look into this possibility given the high interest in resource efficiency REMake has raised," explained Mr. Heidegger, senior CIM engineer at GTE.

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REMake in Lombardia Region

Innovhub is the Italian agency for innovation of the Chamber of Commerce of Milan (CCIAA), offering consultancy services to SMEs on European issues with special interest in innovation, technology transfer, grants and loans.

Implemented at regional level, REMake is encouraging synergies between Lombard SMEs and international providers, fostering the competitiveness of beneficiary companies and local service providers. The scheme offers grants to cover 50% of the costs of private consultancy services to support SMEs in areas such as monitoring, analysis and measurement of energy consumption, Life-Cycle Assessment, eco-design, process innovation, product and system innovation.

Implementing the voucher scheme is being made more difficult by the financial challenges currently facing many companies, according to Mara Tumiati of Innovhub. SMEs tend not to consider eco-innovation as a priority. However, business opportunities can be created by pursuing greater resource efficiency.

"Win-win opportunities exist if manufacturing industries pursue life-cycle approaches and introduce resource efficiency and productivity improvements to get more useful output from resource inputs. Repair, reconditioning, remanufacturing and recycling are fairly labour-intensive activities, requiring relatively little capital investment. Innovation that fosters resource efficiency in manufacturing is therefore essential and should be accompanied not only by regulatory reform and new policies but also by suitable economic instruments," Mara Tumiati, project manager at CCIAA, concluded.

Environmental Management System

An Italian company specialising in the design and development of new car components is using the voucher scheme to implement an innovative Environmental Management System. The service is delivered in three phases:

- Analysis: examine the business model and its environmental aspects and identify improvements.
- Implementation: put into practice the improvements and innovations to environmental management.
- Audit and Review: verify the correct implementation of the Environmental Management System and measure results.

With the support of the REMake voucher, the company will make a 20% electricity saving by producing renewable energy itself. Better roof insulation will lead to a 15% energy saving, and a new painting process will cut emissions by 10%.

For more information, please contact: Mara Tumiati, CCIAA **mara.tumiati@mi.camcom.it**

Life-Cycle Assessment for chemical company

A chemical company has explored eco-innovation possibilities in the production processes of cosmetics. Firstly, a Life-Cycle Assessment study was carried out to calculate the environmental burden associated with the production of the company's chemical products. The environmental analysis identified several possible technological improvements and process solutions. Thanks to the voucher (and to the use of 'Eco Bio Cosmetic' certified formulations) a 10% reduction in water and crude oil consumption was possible, which translated into valuable cost-savings for the company. Finally, a strategy on how to benefit most widely from the LCA study was identified, using the best dissemination channels to increase company awareness.

SICMAT: LCA for high performance tooling machine

SICMAT, a Turin-based developer and manufacturer of precision mechanics for the automotive sector tested two new eco-design tools with the support of Active Innovation Management (AIM). The company wanted to redesign a cogwheel device: a complex and costly tooling machine composed of more than 5000 metallic parts. Two LCA tools were used together to integrate the environmental aspects into the product design while exploring cost savings. The potential benefits and cost savings of the redesigned machine are impressive: a 20% reduction in mass and energy and a 50% reduction in materials and chemicals use. This substantial reduction of resources also lead to major cost savings for the company.

Outlook for the future

A better understanding of resource efficiency

For European manufacturing enterprises, resource efficiency is not only a critical environmental issue; it already plays a decisive role for their competitiveness. To tackle this issue well, it is important to understand the four dimensions which the term 'resources' encompasses: these are all **raw materials, energy sources, operating supplies** required for manufacturing a product (i.e. the value generation) and the **waste streams** which need to be recovered and reused or recycled as far as possible.

All four resource dimensions – raw materials, energy, supplies and wastes – **are strongly interlinked** across the life-cycle of a product. Hence, increasing resource efficiency in manufacturing, product use and recycling requires an integrated optimisation of all four resource dimensions. Addressing one dimension separately will lead to suboptimal results.

Resource efficiency can be improved at three (also interconnected) levels of innovation

1. Resource efficient manufacturing and recycling processes at single factory level,
2. Eco-efficient product design enabling low resource consumption during product use as well as efficient manufacturing and recycling,
3. Integrated optimisation across the various interfaces (e. g. between factories) of the complex manufacturing value chains, including waste recovery and recycling / re-use.

This complexity needs to be better understood and accounted for when:

- Designing resource efficiency policies and implementation strategies;
- Developing meaningful indicators and performance benchmarks for resource efficiency, as intended as a first key measure in the EU Resource Efficiency Roadmap, and;
- Setting up RDI programmes and defining projects to develop advanced technologies and measures for resource efficiency such as for HORIZON 2020.

Hence, resource efficiency is *not just about energy consumption or critical raw material* substitution; it is about the most intelligent way of using all our natural and residual resources.

The needs of manufacturing companies

Manufacturing SMEs have been slow to adopt resource efficiency measures, despite the clear environmental and economic advantages that can be achieved. Lack of information and critical knowledge have been identified as main reason for this failure by various studies[14] as well as experience from REMake. This concerns in particular:

- A lack of **awareness** of SME decision-makers on the relevance of resource efficiency (scarcity of resources) and the opportunities related to optimising manufacturing processes (cost savings potential);
- Insufficient **data** such as benchmarking of production processes and alternative technologies, lifecycle data and impact of different materials, products and applications, and reliable recycling data in Europe (end of life statistics);
- **Knowledge gaps** concerning access to technologies and innovative solutions, the opportunities of industry cooperation such as networks of good practice exchange and joint RTD as well as for enhancing cooperation within supply and production chains and across industry sectors.

[14] **Ecorys** – Study of the Competitiveness of the European Companies and Resource Efficiency (2011), p. 7.
VDI Zentrum Ressourceneffizienz – Umsetzung von Ressourceneffizienz-Maßnahmen in KMU

Insufficient incentive to invest in resource efficient technology is another major barrier in view of the risks and costs involved with new technology integration. This is particularly due to the complexity of integrating new technology into existing processes, while maintaining absolute production quality as a condition *sine qua non*.

Moreover, **sector specific issues** need to be considered such as different priorities on optimising product eco-design, manufacturing process efficiency or recycling approaches. In many sectors, manufacturing SMEs are also increasingly **trapped between large suppliers and large customers** so that options to introduce innovative resource efficient solutions are limited (e.g. manufacturing standards set by a large automotive company).

At the same time there are many opportunities to promote resource efficiency which may be related to customer demand, environmental labels which have growing importance, and increased competitiveness which is the strongest driving force for SMEs. Based on these opportunities, making more use of industrial associations as well established intermediaries is a key to involving manufacturing SMEs in resource efficiency on a broad scale.

Focusing European policies and support measures

With the Resource Efficient Europe Flagship Initiative, the Roadmap for a Resource Efficient Europe and the Eco-Innovation Action Plan, the European Commission has launched substantial measures towards a sustainable, resource efficient economy. HORIZON 2020 will also contribute to this objective by providing targeted funding for key RTD projects related to the development of innovative resource efficient technologies.

The following **recommendations** are aimed at focusing these policy measures better on industry needs to implement resource efficiency at a broad scale.

- **Unclear and conflicting policy signals coming from a lack of coordination and correlation** between different EU policies need to be avoided.[15] Examples are energy and climate policy vs. the drive for recycling; biomass-related policies; waste prevention vs. waste recycling; uncorrelated approaches for energy efficiency and raw materials efficiency, or a main focus on energy when addressing resource efficiency in the Roadmap.
- Better **integrate RDI efforts on resource efficiency to avoid fragmentation** – an integrated approach of materials and energy efficiency is critical and should be raised to a more important research theme. Today the different dimensions of resource efficiency are addressed separately, missing the synergies of an integrated approach.
- **Up-to-date information** on life-cycle impact of materials, products and processes is limited or only available from proprietary databases. Resource efficiency benchmarks for technologies rarely exist. Indicators and impact assessment measures in general are lacking sector specific adaptation to become easily applicable for SMEs. These are urgent issues for broad scale deployment of resource efficiency. Similarly, broader **dissemination of knowledge and information** and **awareness raising** are required.

[15] Compare for instance results from EC Sustainable Industry Forum

- **Environmental standards and regulations can be a key driver** for resource efficient manufacturing innovation. But in order to accelerate implementation of eco-efficient processes, they need to be better defined, harmonised and implemented at national level, enabling SMEs, in particular, to work along such standards and regulations. **Regulatory measures must be flexible** and not impose restrictions on development and implementation of innovative products and processes.
- There is an opportunity to build on the so-called **Best Available Techniques (BAT) Reference Documents** developed by industry sectors in support of the **IPPC Directive**. These BATs are setting *de facto* standards for technologies and industrial installations. Further development towards integrated resource efficiency objectives with clear defined technology benchmarks would allow companies to innovate within well-defined windows of regulations.
- Finally, there is a need for **SME-friendly support instruments** to implement resource efficient products and processes at a broad scale:
  - A flexible fast-track resource efficiency program for SMEs tackling their diverse needs e.g. through resource efficiency vouchers for technology and business expertise;
  - A specific program for labour qualification on resource efficiency;
  - New financing solutions for more resource efficient equipment;
  - Co-ordinating European and national initiatives, including best practice exchange.

Emphasis on research, development and innovation

Resource efficiency is indeed high on the agenda of Europe's manufacturing industry. In its preparation of the Factories of the Future (FoF) 2020 Roadmap, EFFRA is addressing 'Scarcity of resources' as one of seven megatrends critically influencing manufacturing industries.[16] A number of priority measures are proposed which would be **important to be considered by the EC** in the present NMP programme as well as in the future. These include for example:

- Material efficient manufacturing processes such as near-net-shaped concepts, better use of waste streams, improved process control as well as processes for renewable raw materials, biomaterials and materials from waste;
- Product life-cycle management for advanced materials;
- ICT solutions for modelling and simulation tools such as product value and impact simulation for informed product design, energy-efficient product life-cycles etc.;
- ICT for energy monitoring and management in future manufacturing enterprises.

From the experience of the REMake project even more emphasis could be placed on integrated optimisation of resource efficiency such as:

- Better understanding the potential of resource efficiency through R&D and analysis of materials and energy flows, product properties, waste recovery and recycling methods;
- Easy-to-handle life-cycle analysis methods adapted to specific sector needs and sector specific performance benchmarks for SMEs;
- Inclusion of life-cycle performance and resource efficiency information in simulation tools, design tools and manufacturing information systems
- Integrated optimisation of energy and material efficiency;
- Dedicated R&D projects to improve resource efficiency across entire value chains.

[16] European Factories of the Future Research Association, Brussels, established by the MANUFUTURE Technology Platform

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