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PROJECT FINAL REPORT

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4.1 Final publishable summary report

The following section will persist out of the five parts:

1. An executive summary
2. A summary description of project context and objectives
3. A description of the main S&T results/foregrounds
4. The potential impact and the main dissemination activities and exploitation of results
5. Miscellaneous

An executive summary

'ZeroWIN' (*Towards Zero Waste in Industrial Networks* - www.zerowin.eu) was a five year project running from 2009 to 2014, funded by the European Commission (EC) under the 7th Framework Programme (FP7). It had 29 academic, research and industrial partners across Europe, and one partner in Taiwan, who integrated their expertise and enabled chosen strategies to be trialled in 9 practical and 1 conceptual case study. The aim of the project was to move from the traditional industrial model, in which waste is considered the norm, to integrated systems in which everything has its use. Therefore it was based on the concept of industrial symbiosis — that is, regional collaboration among companies from traditionally separate sectors, which exchange by-products, energy, water and materials in such a way that waste from one industry becomes raw material for another.

The project pursued the goals of (I) developing of innovative technologies, waste-prevention methodologies, strategies and system tools exportable into other European and worldwide contexts, (II) developing of a structured and innovative production model based on industrial symbiosis for resource-use optimisation and waste prevention, also taking residues as secondary raw materials and finally (III) demonstrating the innovative approach in practical demonstrators.

Hereby laid the focus on two key waste types in four industry sectors:

- High-tech, electronics waste from three industry sectors:
  - Waste from Electrical and Electronic Equipment (WEEE)
  - Automotive sector
  - Photovoltaic (PV) sector
- Construction and Demolition (C&D) waste and waste from Refurbishment activities (referred to in short as the construction sector)

ZeroWIN's huge success and importance based on the demonstration that the approach, adopted by the ZeroWIN consortium, can enable industrial networks in targeted sectors in Europe to meet at least two of the following stringent objectives:

- 30% reduction of greenhouse gas emissions
- 70% overall re-use and recycling of waste
- 75% reduction of fresh water use

The ZeroWIN project led, amongst others, to the following selected results:

- Literature review fed into ZeroWIN Wiki online
- Individual Producer Responsibility (IPR) applied to the 4 sectors (position papers)
- Technology roadmap for RFID in waste management
- Enabling technologies for re-use (identification and smart condition monitoring)
- Various papers on innovative waste prevention methods and strategies in the different sectors
- Analysis, improvement and practical application of assessment tools
- ZeroWIN Production Model
- Online Guide on Zero Waste Entrepreneurship and Waste Prevention in Industrial Networks
- Resource Exchange Platform (RXP) online
- Development of policy recommendations (policy briefs …)

- Practical Demonstrators in the 4 sectors with quantitative assessments

A summary description of project context and objectives

Project Context

Waste prevention has been assigned the highest priority under European waste management law. However, the initiatives which have been taken so far have not reduced the regular annual increase in total waste arising across Europe. With a rising level of prosperity in industrialized countries, an increasing number of products and services are being produced and consumed. This development is reflected in the amount of waste generated. According to Eurostat, the EU27 is annually generating about 4 billion tons of agricultural, domestic and industrial waste.

The problem here is not only the quantity of waste but also the quality, i.e. the intrinsic hazardous nature of some types of waste, especially industrial waste. In general industry today is using a wider range of materials and is producing more complex products than in past decades. There has also been an overall increase in the quantity and variety of products and services and a continuous creation of new products.

The Zero Emissions / Waste concept represents a shift from the traditional industrial model in which wastes are considered the norm, to integrated systems in which everything has its use. It advocates an industrial transformation whereby businesses emulate the sustainable cycles found in nature and where society minimizes the load it imposes on the natural resource base and learns to be more efficient with Earth’s resources.

The concept of "zero waste" requires a targeting of the various environmental media aspects:

1. Zero Waste of Resources (100% efficiency): Energy, Materials and Human
2. Zero Emissions: Air, Soil, Water, Solid Waste, Hazardous Waste
3. Zero Waste in Activities: Administration, Production
4. Zero Waste in Product Life: Transportation, Use, End-of-Life
5. Zero Use of Toxics: Processes and Products

The key guiding principles for zero waste industrial networks have to be:

1. Commitment to the triple bottom line: social, environmental and economic performance standards
2. Use of the Precautionary Principle
3. Minimising waste to landfill or incineration
4. Use of the Producer Responsibility regime: taking back products & packaging
5. Seeing re-used, recycled & composted materials as resources
6. Preventing pollution and reducing waste, and thereby maximising resource efficiency
7. Highest and best use of resources
8. Use of economic incentives for customers, workers and suppliers
9. Selling products or services that are not wasteful or harmful to the environment
10. Use of non-toxic production, re-use and recycling processes

Idea and objectives of ZeroWIN

The main idea of ZeroWIN is that waste prevention has to be seen from a holistic perspective to make it work efficiently and effectively.

Therefore the first Work Package (WP1) of the ZeroWIN project defined a common vision on zero-waste entrepreneurship and sustainable industry. The mythos Individual Producer

Responsibility (IPR) was investigated if it can become the all-healing-solution in electronics industry as well as how this concept can be applied to other industrial sectors. Work Package 2 (WP2) concentrated on new technological developments (such as RFID), dematerialisation and decarbonisation (reduction of material variety and intensity), as well as enabling technologies for re-use (such as life-cycle units for quality control, as well as necessary hard- and software modifications). Work Package 3 (WP3) concentrated on waste prevention methodologies and strategies. In particular ZeroWIN investigated the specifics of high-tech products (laptop and PV system) and of the construction sector. Whereas the major focus was put on the so-called D4R (Design for Recycling, Repair, Refurbishment and Re-use) of high-tech products, the focus in the construction industry was broader (waste prevention at the production stage, reduction of greenhouse gas emissions and fresh water utilisation in the production and use phase as well as increasing the re-use and recycling ratio of construction and demolition waste in the End-of-Life phase). Work Package 4 (WP4) compared existing software tools supporting waste prevention. All available tools were analysed if they are applicable to industrial networks and the best available identified. All the previously gathered knowledge was then formalised into an innovative and structured production model for resource-use optimisation and waste prevention in Work Package 5 (WP5) which shifts the focus from traditional models to integrated models where all by-products are regarded as valuable resources. The production model was tested under real life conditions in 9 case studies and then translated into an online guide which is available on the ZeroWIN website. The preparatory work enabled the 9 industrial case studies in Work Package 6 (WP6) that forms the core of the ZeroWIN project with more than half of the total budget. These case studies were used to prove that the ZeroWIN approach can meet at least 2 of the 3 stringent targets of the call (decrease of at least 30% greenhouse gas emissions, at least 70% of overall re-use and recycling of waste and a reduction of at least 75% of fresh water utilisation). Those targets were verified in:

- CS1: a prototype of a D4R laptop
- CS2: a prototype of a D4R photovoltaic system
- CS3: a regional ReUse network for ICT products around Berlin
- CS 4 and 5: new buildings in Portugal and UK
- CS6: the revitalisation of the Deutsche Bank Headquarter in Frankfurt, Germany
- CS 7 and 8: demolition of End-of-life buildings in Portugal and the UK
- CS 9: Automotive

Work Package 7 (WP7) closely monitored and validated the improvements by a quantitative assessment. For this reason WP 7 ran in parallel over the whole period in order to give early feedback on what has been already achieved and what needs to be improved. Work Package 8 (WP8) followed the development by investigating the implications to policy and based on that formulated recommendations. It delivered directions on how to implement the main EU policy initiatives in this area (ELV Directive, WEEE Directive, Waste Framework Directive, EMAS, …) in a coherent, integrated and sustainable oriented way, inter alia by identifying and assessing policy measures that could be taken at EU, national or regional levels to favour the development and the update of industrial networking and zero-waste entrepreneurship and achieve waste prevention. Work Package 9 (WP9) disseminated the results of ZeroWIN to a broad and diverse audience of industrial clusters, individual entrepreneurs, policy makers, public authorities, NGOs and academia. It used a Knowledge Management Platform similar as Wikipedia and organised around 10 dissemination events and one policy workshop. Furthermore it included additional interested parties as corresponding members. Finally, Work Package 10 (WP10) ensured the efficient operation of the proposed ZeroWIN project. It provided the basic infrastructure needed to operate such a comprehensive project with a rather large number of partners. What's more it delivered the necessary progress reports, cost statements, quality management, communication inside and outside the consortium and milestone reviews.

At the beginning of the project the partners defined a common vision on "zero waste entrepreneurship". The mythos Individual Producer Responsibility was investigated if it can become the all-healing-solution in electronics industry as well as how this concept can be applied to other industrial sectors. The work in the ZeroWIN project was also concentrated on new technological developments, waste prevention methodologies and strategies and adapted existing software tools supporting waste prevention. All this knowledge was then formalised into an innovative production model for resource-use optimisation and waste prevention. This preparatory work paved the way for the 9 industrial case studies that form the core of the ZeroWIN project.

These case studies were used to prove that the ZeroWIN approach can meet at least 2 of the stringent targets of the call:

- A decrease of at least 30% greenhouse gas emissions
- At least 70% of overall re-use and recycling of waste
- A reduction of at least 75% of fresh water utilisation

Goal

The ZeroWIN Project will examine and develop new and innovative approaches and effective strategies for the prevention of waste in industries based on industrial symbiosis. Industrial symbiosis is concerned with regional collaboration of companies from traditionally separated sectors which exchange by-products, energy, water and materials in such way, that the waste from one industry becomes the raw material for another.
To find innovative approaches and effective strategies for the prevention of waste in industrial network based on industrial symbiosis:

- The development of innovative technologies, waste-prevention methodologies, strategies and system tools (e.g. eco-design, local industrial clusters, and resource exchange) exportable into other European and worldwide contexts, shall represent the main focus of this action

- The goal is to develop a structured and innovative production model for resource-use optimisation and waste prevention, also taking residues as secondary raw materials and test it in real cases of sustainable industrial networks.

Results will translate the vision of sustainable development into elements of a sustainable entrepreneurship, focusing at enhancing business opportunities according to a "towards zero waste" approach.

Expected Impacts

The assessment of the life cycle benefits and costs for achieving the main EU environmental resource-related targets (in the context of the industrial networks assessed) will be a measure of the outcomes of this action.

Target Group

By concentrating on industrial networks in the automotive, construction, electronics and photovoltaic industries ZeroWIN will address:

- Nearly 3 million companies (of which 80% are SMEs)
- More than 2,8 trillion € turnover and a value creation of more than 800 billion €
- With more than 20 million employees
- Creating about 40% or more than 400 million tons of industrial waste
- Using as much as 50% of all materials extracted from the earth´s crust
- Generating about 40% of all energy use and about 35% of all greenhouse gas emissions

A description of the main S&T results / foregrounds

The scientific and technical objectives of the project ZeroWIN are:

A. Development and conceptual work on selected innovative technologies, which are essential to overcome dedicated barriers for waste prevention

Within ZeroWIN the hypothesis was presumed that **waste is material without sufficient related knowledge**. Knowledge in this context refers to information regarding material quantity, quality, ageing and handling.

Waste can only be used as an input for industrial processes if specific details and information regarding its state is readily available. This new hypothesis allows industrial partners to view waste as a material resource or product rather than waste. In a production context, increasing the availability of explicit and implicit information about materials from the manufacturer(s) involved creates the opportunity for other manufacturers to use these materials as inputs for their respective production processes. This information could comprise of static and dynamic data (e.g. Bill of materials (BoM), remaining residual life etc.) specifically related to the secondary production resources (by-products) but also spatially referenced data (e.g. location information). Information pertaining to production resources includes:

- End of life estimation
- History and ingredients
- Material condition and contamination
- Actual geographic position
- Amount and weight
- Handling and Transportation

Making information readily available regarding the current state of materials / by-products aims to achieve environmentally and economically and even socially positive cultural effects. This new hypothesis serves to enhance materials management and delivers a means to prevent waste occurring in the primary instance.

Based on that hypothesis ZeroWIN specifically dealt with product identification for Individual Producer Responsibility (IPR) within the context of industrial networks.

Extended producer responsibility (EPR) as a means of waste recovery and green design was first proposed in the academic literature in 1993 and Individual Producer Responsibility (IPR) has now emerged as a more developed refinement. The adoption of IPR strategies by producers is widely believed to be the last measure required before achieving the tipping point to the emergence of low waste entrepreneurship. Although the most obvious implementation route is through the use of producers' dedicated own infrastructures. Shared infrastructures among groups or networks of producers are more realistic in the immediate term. Indeed the use of shared infrastructures with their associated larger collection volumes increases the probability of industrial networking creating new use for waste and thus turning wastes into by-products. However, regardless of the route to IPR, the concept itself presents many technical challenges in order to ensure smooth operation and guarantee that the benefits of such low waste entrepreneurship are feedback to the producer. If reduction, recycling, remanufacture, or re-use are endeavours, which are to become an integral part of a producers operations, then efficient technical means of their facilitation are imperative to ensure a positive economic feedback in addition to the environmental gains. The concept and the operational mechanisms by which IPR can take place, its role in industrial networks across a range of sectors and the technical barriers and opportunities that may exist were explored in detail within ZeroWIN.

One of the key aspects to the facilitation of IPR is the ability to identify individual products and assign them to individual producers. Different IPR models can see this occur at places such as the initial point of return by the consumer, at points of aggregation and separation, or indeed at the recovery facility itself but each requires a reliable and robust means of achieving this if producers are to benefit from their D4R efforts. ZeroWIN investigated different technical means of achieving this (specifically Radio Frequency Identification (RFID) but also bar codes and green ports) and identified which technologies suit different IPR models best. A technology roadmap for RFID and alternative technologies for waste management were developed, which was fed into the production model (WP5), where individual producer responsibility pays for those companies, which follow a zero waste entrepreneurship strategy.

As the WEEE Directive stressed IPR in the first legislative framework the technical investigations in ZeroWIN were focused on electrical and electronic products. The findings in this sector were then transferred into the other sectors (photovoltaic, automotive and construction).

Radio frequency identification (RFID) can play a role in facilitating the transition to zero waste for the electrical and electronic (EEE), photovoltaic (PV), automotive and construction sectors. The concepts applicable for ZeroWIN for these product domains have been elaborated and include:

1. Sorting of products / parts / materials by brand for return to the OEM (facilitation of individual producer responsibility (IPR))
2. Design of more durable remanufacturable or recyclable products / installations / automobiles / buildings
3. Reuse of viable products / parts / materials within an industrial network
4. Breakdown of products / automobiles / buildings for parts for new products repair and refurbishment
5. List of hazardous materials contained in the product / installation / automobile / building
6. Breakdown for recycling / material recovery
7. Industrial Networks in the manufacturing supply chain
8. Uses for construction / demolition waste
9. Delivery Route planning

ZeroWIN showed that RFID architectural frameworks can support many of the concepts listed above for elimination of waste and help achieve environmental targets through increasing the visibility of by-products in industrial networks. While the EPCglobal approach is deemed most appropriate for EEE sector industrial networks, the DIALOG / PROMISE approach is considered more suitable for the PV and automotive domains.

In addition to the technology configuration, informational requirements for exchange between members of the industrial network are described. The right information can ensure that partners within the industrial network have full visibility of appropriate data, optimising efficiency in the context of sourcing materials / products for their desired applicdation. ZeroWIN has demonstrated that RFID technology, taking a number of considerations into account, can achieve reliable EOL identification and ultimately facilitate brand identification for Individual Producer Responsibility (IPR) for the four ZeroWIN sectors. Suitable tags and also optimal transponder placement to enable reliable identification for products were determined through an investigation of a series of EOL use case scenarios. A novel technology configuration concerning the tagging of skips was demonstrated at a pilot level for the construction sector. The concept was applicable for all sectors and enabled identification of resources to increase resource visibility to members of the industrial network. In addition to RFID technology, the proposed concept takes advantage of global positioning system (GPS) and Global System for Mobile (GSM) communications technologies. The results of a business to business (B2B) asset management case study conducted for the EEE sector indicates that organisational barriers exist to the adoption of innovative technologies and also obstacles remain that obstruct the future implementation of IPR. These include the varied approaches to asset management within similar organisation size categories, the apparent lack of visibility of end-of-use processes by those responsible and the low uptake of free take-back schemes probably due to the informal redirection of equipment for secondary use activities.

It has clearly been shown in the technical demonstrations that from a physical perspective (assuming the correct tag choice and positioning of tag on products / components) RFID is technically feasible for implementation in industrial networks. For example, a pallet of 80 desktops / 56 laptops, or under the hood vehicle transmission mounted parts, or in-situ PV panels can be inventoried in less than 10 seconds using a handheld reader, products / parts / vehicles passing through a control portal / point can be automatically read with 100% accuracy using the appropriate tag, tag placement and reader configurations. Special rugged transponder types are suitable for tagging of containers and can in conjunction with GPS and GPRS technologies play a role in tracking of production and demolition resources. These validated use cases represent the ability to facilitate product identification for IPR but also considerable time and cost savings opportunities for EOL processing. A summary of the experiments summarising the cases where technical feasibility has been demonstrated is given in the table below.

Table: Summary of experiments

	Stationary Inventory in Situ	**Entry / Exit identification (ID) at EOL Site**	**Inventory at EOL Site**	**Material Tracking**
EEE	Office Inventory	Pallet Inventory	Pallet Inventory, WEEE cage Inventory	Container tracking
PV	PV panel inventory (demount scenario)			
Automotive	"Under the hodd" Inventor	Stationary Vehicle ID, Moving Vehicle	Compartment ID	

		ID		
Construction				

ZeroWIN showed that the following aspects must be observed before initial deployment of RFID:

Tag pre-testing and selection is very important
Tag placement, including orientation and material, is very important in determining whether tags can be read or not. Not all metal mount tags perform as effectively on both metal and plastic, so it is necessary to choose the appropriate tag depending upon the product / part being identified. In addition it is necessary to pre-test the tags before application to products. A small number (approximately 2%) of metal mount tags used in the experiments seemed to be working fine prior to application to products but were unreadable when applied to metal substrates.

Form factor of tags must be taken into account
Although smaller tags can be used for the products / parts of interest to the four ZeroWIN sectors, they provide diminished performance when compared with their larger counterparts. RFID tags become more orientation sensitive as they decrease in size. The orientation sensitivity of tags has implications when it comes to handheld inventory. This was demonstrated in the EEE, PV and automotive experiments by the need to rotate the handheld reader in order to inventory smaller tags for pallet and component / parts inventory cases. When choosing a tag the manufacturer must keep in mind the product and also the EOL scenario as well as the use case environment.

False positive reads must be addressed
If pallets of EOL equipment to be inventoried are placed side by side / one after the other, spurious reads from adjacent pallets will be the result. This is not an issue for inventorying at a room or compartment level, but pallet level inventory requires specialised software to accurately associate tags to pallets and filter false positive tag data captured from an adjacent pallet. Alternatively the use of metallic shielding can be employed to ensure pallets are inventoried on an individual basis. The same principle applies to component level inventory.

Certain identification scenarios are not feasible due to technical limitations
Components / parts within metal enclosures cannot be read due to reflection / absorption effects caused by the metallic materials. This was demonstrated in the "under the hood parts inventory" test (Deliverable 2.2: Report on the impact of emerging micro- and nanotechnologies on waste prevention), when the car bonnet was closed, vehicle parts could not be read. However, with the bonnet open reliable identification of parts was achieved. The same outcome would result for primary computer system components tagged within a sealed aluminium laptop chassis. This is a fundamental technical limitation of the RFID technology itself.

Performance standards are required for the technology

Constant variations in tag cost, performance and form factor necessitates an objective measure of performance to facilitate communication between tag manufacturers and EEE / PV / automotive / construction manufacturers. A tag performance standard can provide manufacturers with guidance regarding tag placement and its required performance level.

Apart from EOL benefits, ZeroWIN also demonstrated that there is no question that RFID brings considerable benefits to the value chains of all ZeroWIN sectors. This is particularly the case for logistical tracking & tracing, production monitoring, and also providing product safety and quality information. A summary where RFID can be used to increase efficiency in these areas for all the ZeroWIN sectors is revisited in the table below.

Table: Additional benefits RFID brings to ZeroWIN sector Supply chains

Operation	Description
Distributed Inventory	A manufacturer with products distributed throughout his / her assembly / warehouse facilities can utilise RFID technology to complete an inventory of total products. As inventory information is collected, the product database is automatically updated with the latest location data for each component / product / part.
Equipment Tracking within Distribution Centres	System component / part manufacturers can use RFID to track movements of equipment / components / parts within their facilities and ascertain whether components / equipment is brought outside their facility / facilities. A strategically implemented RFID infrastructure can automatically capture movement data which can be recorded in the company's product / component database.
Equipment Location	During the course of a lease agreement between a manufacturer and a business consumer technical staff will be on site to carry out routine maintenance operations and upgrading and also decommission of certain systems / parts / vehicles altogether. The location of specific product / assemblies / parts / vehicles / skips can be quickly determined by RFID technology.
Product / Component Receipt	In the manufacturing supply chain, RFID facilitates automated components receipt between the component / part manufacturer and the system / vehicle manufacturer with no manual data input required by company personnel to their product / component database. On arrival at the manufacturer's premises, the pallet / component tag data is interrogated by RFID reader infrastructure. The arrival data is linked to an electronic Advanced Shipping Notice (ASN) from the manufacturer, loading all relevant information into the manufacturer's component database.
Equipment Tracking	When company equipment approaches EOL (in the case of a non lease agreement

	between an enterprise and a manufacturer / retailer) RFID could be used to prevent leakage of equipment from 'proper' EOL recovery systems. Intel and HP have already identified RFID as a potential technology to track inventory in the return process. Moreover, RFID could contribute to the precise distribution of costs among producers and the possibility for automatic sorting of products.
Delivery Route Planning	RFID could play an integral role in a system that could allow the efficient delivery of materials / products / parts to production / construction sites. For example in the construction industry, it is the norm that each individual building site orders materials etc. from manufacturers and the materials are individually delivered to each construction site. This often causes the situation where many trucks travel back and forth between manufacturers and building sites carrying a fraction of the vehicles load capacity. A logistics service can act as the conjugate between the manufacturer and construction sites and allows multiple construction sites to share the delivery network.

Further benefits that can arise from using RFID in production (for all sectors) include provision of information of the environmental status of the materials / by-products / final products. For example, if dangerous materials / by-products have been used in production that should be treated in a specific environmental way at the EOL.

Conclusion:

- RFID means significant efficiency gains in increasing visibility of products, components and materials for industrial networks and for possible IPR.
- RFID is already being deployed across the EEE, automotive and construction domains and providing return on investment for distribution and use phase asset management alone for these sectors. It is highly probable that the same will prove true for the PV sector. The experiments demonstrated in ZeroWIN have shown that applicability extends to industrial networking as covered in the ZeroWIN case studies**.**

B. Development of waste-prevention methodologies and strategies

Under this objective the following deliverables were accomplished:

- **Summary paper: EOL impacts under appropriate and uncontrolled treatment**

Within ZeroWIN a sound basis for product-related waste prevention strategies for high-tech products, covering Liquid Crystal Display (LCD) products, such as television sets, monitors and laptops, and photovoltaic (PV) systems and modules was provided. Although LCD products and PV systems have some aspects in common, there are important differences with significant impacts on Design-for-Recycling strategies:

- LCD products are a consumer market with moderate lifetimes of few years. Manufacturing of these products is mainly happening outside Europe
- PV systems are a business-to-business market with lifetimes up to few decades. Manufacturing and systems design is largely done in Europe

Consequently, the analysis looked at end-of-life implications of LCD products observed under the various end-of-life practices on a global level, whereas for PV systems end-of-life does not play a major role currently and related recycling processes are just under development. For PV systems the aspect of manufacturing waste, given the huge growth rates of this sector, is much more of interest for any design related improvement strategy, including aspects of industrial symbiosis. Therefore, the analysis looked in particular at the manufacturing processes and technologies for photovoltaic systems as a starting point to investigate measures for enhanced product technologies and designs to foster high-level recycling of production waste but also in the mid-term future end-of-life waste photovoltaic systems.

The analysis of LCD recycling in particular identified a broad spectrum of applied end-of-life technologies, ranging from deep level dismantling in both, Europe and Asia, to high-throughput technical treatment processes. The various approaches also led to a different perception of environmental impacts: Whereas the content of hazardous materials (mercury in particular) is critical regardless of the recycling technology, resource recovery related matters highly depend on applied recycling technology – only if the technology is able to care for a high level of separation, design should take into account easy separation as a product development criterion. Reuse of parts and components furthermore are an important aspect, which needs to be addressed with Design-for-Recycling measures as the analysis identified not only a large potential for reuse, but also critical components, which fail frequently and should be designed either for easy replacement or longer lifetime.

The analysis of the different sources of wastes associated to a typical photovoltaic (PV) installation identified possible wastes that can be treated as possible raw materials. Specifically two different waste sources were analysed regarding the PV installation components, namely (i) waste rising from its production and (ii) waste rising from the use and end of life (EOL) phases. In the first case it was found that the current practices in industry already reuse most of the produced waste. On the other hand, regarding the use and EOL phases different trends were found regarding each component and the disposal under controlled and uncontrolled conditions. In the case of PV arrays it seemed that current initiatives regarding recycling could cope with most of this type of waste. Similarly batteries, specifically lead-acid which are commonly used in PV installations, were already manufactured using recycled lead, and networks of recyclers were in place. There is an improvement potential regarding wastes related to the electronic components of the PV installation as well as for the supporting structure. In this sense different aspects regarding the design of the electronic part could influence the overall generation of wastes.

The analysis also identified a couple of examples for industrial symbiosis in the life cycles of LCDs and PV systems, including the usage of lignin based plastics for computer components, use of silicon scrap from micro-electronics production in the PV industry and recycling of LCD production waste in e.g. the construction sector.

- **Guidance document on D4R for PV systems and flat panel products (incl. R&D needs)**

D4R (or DfR) is a subordinate term and a specific aspect of the broader Eco-design / Design for the Environment approach. Both take the product life cycle into consideration, but D4R follows the primary target to reduce impacts at end-of-life, which includes also a "first end-of-life" and to bring back a product into a second life cycle or to postpone the date of time, when a system, product or part thereof finally reaches end of life. The design guidance of ZeroWIN is a compilation of suitable design measures in general and guides more specifically the D4R specification for the Case Studies 1-2, i.e. the D4R laptop and D4R Photovoltaic systems. The guideline document lists 50 measures for LCD products and 47 measures for photovoltaic systems, each as a fiche of up to one page each, in the following categories:

Design...
... for minimised production waste
... for production waste recycling / downcycling
... for lifetime extension
... for reuse
... for repair
... for disassembly
... for refurbishment
... for depollution
... for material recycling / high recovery ratio
... in low-impact materials
... out materials and components
... for collection
... for upgradeability

All these categories are relevant on both levels, at production waste generation and product end-of-(first-) life. The publication of the design recommendations was made through the ZeroWIN wiki as this was deemed the most appropriate format to search easily among options, to provide a sound structural framework and to allow a swift update and extension of the catalogue of measures, keeping pace with the fast technological progress in the target sectors.

- **Database on LCA-oriented evaluations for C&D materials and components**

One aspect of ZeroWIN was to gain a better understanding of what product directories are available, the scope of information presented and how the information is collated. Therefore information on sustainable construction product directories from throughout Europe, North America, Asia and Australia were collated.

This objective helped partners in the ZeroWIN Programme to understand the status quo that existed in relation to Life Cycle Assessments (LCA) products available across Europe in this specific time. The methodology of that study identified significant environmental aspects associated with the LCA of construction products. Results from that study were used by ZeroWIN partners to provide an indicator of the best environmental options for products used on sites involved in accreditation schemes such as BREEAM or LiderA. The value of this work provided an understanding of the systems currently in use and enabled partners to target more efficiently those materials and products that produce waste or have an effect on fuel, water and energy usage.

Information was compiled on the following directories:

European

i. GreenSpec (UK)
ii. Green Book Live (UK)
iii. German Building Materials Association (Germany)
iv. RT Environmental Declarations (Finland)
v. Nordic Ecolabel (Pan-Scandinavian countries)
vi. PE International (Germany)

North America

vii. Oikos Green Building Source (USA)
viii. Green Building Pages (USA)
ix. Eco Structure (USA)
x. Environmental Design and Construction Magazine: The Green Book Sustainable Product and Resource Guide 2009 (USA)
xi. Environment Protection Agency Comprehensive Procurement Guidelines (USA)
xii. MDBC (USA)
xiii. BuildingGreen.com (USA)
xiv. California Integrated Waste Management Board Recycled Content Product Directory (USA)
xv. Ecologo (Canada)

Asia and Australia

xvi. Eco-products (Japan)
xvii. Australian Green Procurement (Australia)

For each directory a summary table was produced containing the following key information:

- Name of directory
- Website details
- Background information on the website/directory
- The scope of information presented each product in the directory
- The process for collating information in the directory
- The type of products listed in each directory
- If the directory was freely available to the construction industry
- If the directory had national or international accreditation or recognition
- Whether the directories had minimum entry standards (e.g. Green Seal, Forest Stewardship Council, BSEN)
- Contact details for directory managers

- **Paper on the certification practices in different countries**

One main objective of the project ZeroWIN was the identification and analysis of methodologies and strategies that can contribute to significantly reduce emissions in the construction sector. Under the umbrella of Sustainable Construction, a large diversity of initiatives has been launched at different levels in the past decades to promote better environmental standards. Legislation, standardization and voluntary certification schemes have provided instruments for the implementation of good practices in the construction sector.

Within ZeroWIN the focus was set on the role of voluntary building certification systems for environmental improvements in the construction sector and, in particular, their contribution to the implementation of the ZeroWIN approach, which assumes that industrial symbioses allow industries to achieve zero-waste standards.

Several building certification systems were analysed in what concerns their scope and methodology: BREEAM (U.K.), HQE (France), LEED (USA), LiderA (Portugal) and DGNB (Germany). The objective was to understand how the concept of sustainable construction is implemented in those certification schemes, giving especial attention to the way they address the environmental impacts during the construction phase and the end-of-life of buildings, on which the ZeroWIN project has its main focus. The analysis also integrated the results of some practical certification experiences.

The study showed that most certification systems focus on measures taken in the planning phase. They mostly assess the extent to which such measures will induce a reduction of environmental impacts during the use-phase. They regard the materials and features that actually will influence energy and water consumption by the users, the inside air quality and also the land-use aspects related with the integration of the building in the surrounding area. Insofar, all certification schemes contribute to promote the overall environmental performance in the construction sector. However, the core issues of the project ZeroWIN are hardly addressed. Although industrial networking is a must for the success of certification, the evaluation procedures do not emphasize the potential contribution of industrial symbioses for waste prevention. Moreover, construction and demolition are neglected in all certification systems, although these phases are responsible for an important share of the global environmental impacts in the life-cycle of buildings.

- **Paper on R&D needs in the C&D sector**

Within ZeroWIN the research and development – needed of the construction and demolition sector – was reviewed (in particular of current research activities and feedback from industry professionals in Portugal, Germany and the United Kingdom).

The recommended research and development needs are summarised below:

R&D need 1: Case study use of sustainable products and materials
R&D need 2: Economic downturn effect on Sustainable Product and Material Certification schemes
uptake
R&D need 3: Economic downturn effect on Sustainable Building Certification scheme uptake
R&D need 4: Retrofit implications
R&D need 5: Construction value in 2011/12
R&D need 6: Implications of Energy and Climate Change Policy on Case Study activities
R&D need 7: Case study reference to the Vision 2030 document
R&D need 8: Case study opportunities to disseminate findings
R&D need 9: Case study opportunities to disseminate findings
R&D need 10: Monitor progress of UK Low Carbon Construction strategy
R&D need 11: Case study opportunities to disseminate findings
R&D need 12: Case study opportunities to disseminate findings
R&D need 13: Review findings of SB11 in November 2011
R&D need 14: Case study use of modern lightweight products and materials
R&D need 15: Research on lightweight products
R&D need 16: Case study applications of nanotechnology
R&D need 17: Life cycle implications of nanotechnology (future project)
R&D need 18: Case study examination of retrofitting

- **Construction waste prevention strategy: Consideration of waste prevention in materials certification**

Historically product, material and component certification schemes were developed to ensure the technical quality of the constructed product met a specified legal standard. Criteria referring to the environmental performance of materials and components during the complete life cycle are generally missing. The rise of sustainable construction has encouraged development of environment friendly products, materials and components. Certification schemes which take into account the product, material and components life-cycle have grown out of the need for architects and designers to specify items with certified improved environmental performance during its life-cycle. Assessing the life-cycle of a product, material or component involves making detailed measurements during the manufacture of the product, from the mining of the raw materials used in its production and distribution, through to its use, possible re-use or recycling, and its eventual disposal. Building certification schemes have also stimulated the development of environmentally focused product, material and component certification schemes. Since their introduction many designers seeking to adhere to the building certification requirements are specifically seeking products with improved environmental performance through the life-cycle evidenced through a product, material or component certification scheme. The majority of environment certification schemes researched for this paper examined the entire life cycle of the product during the certification process (with ranking unique to the individual scheme). Where accreditation is awarded through the environment certification scheme or standard, information will be provided in relation to greenhouse gas emissions, waste arising and water consumption. Where a manufacture chooses to invest in environment certification, they will seek to achieve a good rating which encourages them to minimise waste during manufacture, use and deconstruction. Market forces will stimulate manufacturers to minimise waste where they wish to become eco-certified supporting the ZeroWIN project objectives. A methodical list of recommendations for zero-waste strategies in the construction and demolition sector in Europe has been produced to reflect the findings of ZeroWIN Work Package 3. The recommendations and conclusions are summarised below and are general / strategic recommendations for zero-waste strategies in the construction and demolition sector in Europe.

Recommendation 1: Maintaining an up-to-date industrial network map
Recommendation 2: Documenting industrial network establishment
Recommendation 3: Regulating energy consumption during construction and demolition activities
Recommendation 4: Design for disassembly
Recommendation 5: Material and waste management

The design phase of a construction project offers the greatest opportunity to establish an industrial network. At this point the materials specified, energy and water consumption in use, maintenance and design for disassembly can maximise sustainability through the building lifecycle. During the design phase the introduction of zero-waste strategies can exert influence on the choice of products and services used throughout the building lifecycle. After this point any changes will be reactive, as a change in product selection during the build phase will have a knock-on effect on the industrial network members and possible industrial symbiosis activities. The approach taken by the architect and / or designer during the design phase in terms of specification of sustainable products will have consequences on the environmental performance of the building for many years after (influencing use, maintenance and demolition). This applies to a lesser extent in demolition projects where the zero-waste strategies are more limited and are influenced by the demolition method which will affect the waste arisings, end products and dictate potential re-use outlets. The desire to assess the sustainability of a building has seen an increasing number of independent verification schemes develop globally. Building certification schemes give a verified measure of eco-efficiency and have stimulated the development of material and product environmental certification schemes providing important independent valuation of a products 'greenness' allowing for comparison between brands. One drawback is the difficulty experienced when comparing similar products accredited to different schemes with different rating methods as well as the fact that these schemes do not necessarily meet the ZeroWIN aims for the reduction of resource use. This may be addressed by the development of a European Ecolabel Criteria for Office Buildings which embodies many of the ZeroWIN principles influencing environmental performance at all stages of a construction projects life cycle.

- **Paper on waste prevention measures of non-production industrial waste**

With a rising level of prosperity in industrialised countries, an increasing number of products and services are being produced and consumed. This development is reflected in the amount of waste generated. By 2020, the OECD estimates, we could be generating 45% more waste than we did in 1995. Obviously this trend has to be reversed. In 2008, industrial waste accounted for around 55% of waste generated in the EU-27.

Concerning waste prevention in general a differentiation in quantitative and qualitative waste prevention is made. In the ZeroWIN project the main focus is laid on quantitative waste prevention. In addition to this differentiation, there are also several options for classifying waste prevention activities. The known classification of waste prevention lead to the fact that waste prevention measures in the municipal sector focus on activities on household and public administration level and waste prevention measures in the industrial sector focus on the waste directly linked to the production or manufacturing process.

A therefore often neglected issue (and not specifically displayed in waste statistics) is that waste streams originating from industry arising from activities that are not directly linked to the production process. These wastes are coming from administrative, research or shipment activities. Especially packaging wastes show a potential for waste prevention activities. Until now, these waste streams were often not considered on the whole extent on company level.

The analysis of 625 small and medium sized enterprises out of 15 industry branches showed that the fraction of branch specific waste may be very low depending on the specific industry. As mean value concerning the rate of branch specific wastes 14% were calculated. The range was between zero and almost 70% of branch specific waste.

The development of innovative waste-prevention methodologies as planned within ZeroWIN therefore also included those non-production related industrial wastes. Therefore after detecting relevant prevention measures together with the Case study partners those measures were also tested within their pilot cases.

Out of an abundance of different waste prevention measures, taken from an extended literature review, desktop research, EcoBusinessPlan Vienna and European best practice initiative 20 waste prevention measures were selected according to their waste prevention potential. Industry partners of the ZeroWIN project were asked to do a ranking of the proposed measures concerning the prevention potential and the feasibility in their specific company. Six prevention measures were selected for further implementation.

Almost all participating case study partners agreed that double sited printing and the use of re-fillable toner cartridges has a very high potential of waste prevention and could be implemented very easy in their personal business environment.

To enforce the use of e-mails instead of faxes and letters and to print products catalogues only on demand or offer it as CD or DVD was also seen as to be implemented easily but not all industry partners that high potential of environmental savings in this case. The reuse of electronic equipment and the common use of newspapers or journals were also only partly seen as relevant for waste prevention and some partners also saw the possibility of implementation not too easy.

Together with the implementation of the pilot cases it was planned that the case study partners also implement the above chosen prevention measures additionally to their product related prevention activities. They documented their savings to estimate the effect within the midterm as well as the final assessment.

C. Development of system tools

Another result of the project ZeroWIN is the collection of available tools and methods for the measurement of sustainability aspects from the life cycle perspective in order to support the quantification of impacts as well as the identification of feasible improvement measures.

A structured search has been carried out in order to identify tools that may support the establishment of strategies enhancing Zero-waste entrepreneurship. In this context, the tool/method compilation has been focused on the identification of analytical tools and methods (E.g. LCA, MFA, etc.), but it has been extended to include other potential aids like, for example, procedures for pollution prevention or software to enhance industrial metabolisms. This search has lead to the compilation of more than 100 tools and methods.

In order to perform an effective classification/characterization a two-step approach has been performed.

- In a first step the tools/methods have been classified according to the level of fulfilment of the requirements of the project.

- In a second step, a smaller group of tools/methods has been identified (excluding the ones that clearly do not comply with the requirements identified in the previous step), and they have been characterized according to additional criteria.

The work has led to an extensive matrix including key information about the tools analysed, and their characterization according to the potential for the ZeroWIN project.

The task has concluded with the identification of the tools that better answer the established requirements, identifying their strengths and weaknesses, and also their level of applicability for the project.

For economic and social issues both simplified and exhaustive approaches have been considered potentially suitable. In case of simplified tools, the data requirement is lower, but the results are approximations and are not exhaustive. On the other hand, there are several professional tools that offer predefined calculation procedures for economic assessment, but few that incorporate methodologies for social assessment, although much LCA software present adaptable structure that enable the user modelling self-defined indicators. Databases with economic and social information are not widespread.

As far as environmental impacts in Life Cycle Assessment are concerned, only tools enabling ISO 14044 compliant analyses are suitable for the current study. Several professional tools are available on the market with flexible features to incorporate and even adapt methodologies as needed.

At the same time, the task has lead to the identification of a number of tools that even if they do not comply with all requirements, can provide additional support for specific issues.

D. Development of a production model for zero waste entrepreneurship

Within the project ZeroWIN a production model was developed which pays attention on how to promote and optimize the physical exchange of by-products (materials, energy, water) within companies in industrial networks. Existing production models for companies and usual environmental strategies were assessed. The ZWPM was derived after expanding the scope of production models and environmental practices from the individual company level ("meso level") to the industrial network level ("macro level"). The industrial symbiosis concept and the translation into "macro level" of "the five prevention practices" (modification of the product, substitution of materials, modification of technology, maintenance of facilities, and recycling and reuse), that can improve the "five areas of resource productivity" (resource efficiency, preventing and giving value to waste, reducing energy demands and greenhouse gas emissions, reducing water consumption and impact on water, and the control of critical and toxic substances), normally defined at the "meso level", are the essence of the ZWPM.

The most challenging activity of this task was to find an efficient way for adjusting the slightly theoretical ZeroWIN production model with the practical case studies. The expected outcome was a model in closer connection with the case studies.

The ultimate step was to translate the concept of the ZeroWIN Production Model (ZWPM) into a guideline (web guide) that can be accessed easily by a wide audience. For this reason the aim was to develop an online tool that gives practical advice regarding waste prevention and resource-use optimization in industrial networks in a simple and useful manner. Design, navigation and texture settings were intensely discussed within the consortium. The partners agreed on a design that should facilitate the navigation and encourage the audience to use the site. The idea was to establish the guide like a menu where the user chooses the topic he or she is interested in. The menu allows the user to narrow down the list of recommendations according to his/her interest.

The core of the guideline is represented by a list of recommendations which is based on several questions leading to a list of DO and DO NOTs dealing with waste prevention and resource-use optimization in industrial networks. The web guide hereby considers the implementation of the five resource productivity themes and prevention practices and thus represents the practical implementation of the ZWPM. The site is accessible under www.zerowin.eu.

E. Pilot Applications for the production model in Industrial Networks and real cases

The concepts addressed in the case studies are coherent with the ZeroWIN vision:

"ZeroWIN envisions industrial networks that have eliminated the wasteful consumption of resources."

Zero Waste represents a shift from the traditional industrial model in which wastes are considered the norm, to integrated systems in which everything has its use. It advocates an industrial transformation whereby businesses emulate the sustainable cycles found in nature and where society minimizes the burden it imposes on the natural resource base and learns to do more with what the earth produces.

The main aim of the ZeroWIN case studies remains (as stated in the Description of Work) to show that the approach adopted by the ZeroWIN consortium can enable industrial networks in targeted sectors to meet at least two of the following targets:

- 30% reduction of greenhouse gas emissions
- 70% overall re-use and recycling of waste
- 75% reduction of fresh water use

According to the methodology which was developed within the ZeroWIN project the core element of the ZeroWIN vision is a successful collaboration and exchange of resources within industrial networks. The case studies should test and validate the methodologies which were developed within the project with the main focus towards more resource efficiency. The case studies should demonstrate how the ZeroWIN vision can be implemented within 10 real industrial networks which were formed around 10 different cases:

- CS1: prototype of a D4R laptop
- CS2: prototype of a D4R photovoltaic system
- CS3: regional ReUse network for ICT products around Berlin
- CS4 and CS5: new construction projects in the UK and Portugal
- CS6: the refurbishment and new construction projects in Germany
- CS7 and CS8: demolition projects of End-of-Life buildings in the UK and Portugal
- CS9: the automotive case study in Germany

An additional tenth case study was initiated at a later time:
- CS10: Business to Business Information Technology Industrial Networks

The main emphasis of each case study was concerned with the development and exploitation of various potential interactions between industrial entities, with a main focus on resource exchange. Achieving the direct exchange of by-products between industries is one of the main challenges of the ZeroWIN project. However, it was not always easy to develop such kind of cooperation between enterprises, due to existing barriers, for instance the quality of a secondary material is a key factor determining its application and suitability for various manufacturing processes. This information flow has to be improved in order to achieve a higher level of resource efficiency and in order to prevent down cycling. The

Resource Exchange Platform has thus been developed to facilitate information flow and ultimately higher resource efficiency.

Case Study 1: The Design for Reuse (D4R) laptop is presented by MicroPro Computers, a Dublin based computer manufacturer. In this case study MicroPro have formed an industrial network with end-of-life IT asset management firms, IT refurbishers, component manufacturers and local industries to create a new design that has created a new use for their waste and thus turning wastes into by-products.

The focal point of the network is the D4R laptop. MicroPro has successfully been able to manufacture a universal shell composed of a universal motherboard and a 6 cell lithium battery, encapsulated in a wooden housing structure. The shell is capable of accepting new primary system components and also has the ability to integrate various diverse parts and components (and parts and components of different specifications). All by-product parts to populate the D4R shell can be sourced from industrial network partners. The resource exchange platform serves to increase the availability of quality used components which reduces quality, timing, and quantity uncertainties.

An equally important part of the D4R industrial network is the take back business model. This ensures MicroPro and industrial network partners receive return on investment for their eco-design efforts and more importantly that primary laptop parts (including the universal chassis) are made available to other members of the industrial network for future D4R generations. This creates further environmental savings especially in respect of reuse of the universal motherboard part.

<u>ZeroWIN Targets:</u> Final life cycle assessment results illustrate that considerable environmental savings are achievable through adoption of the concept proposed. According to the final numbers a 66% reduction in greenhouse gas emissions is achievable when compared to the baseline scenario of a standard laptop. The closed loop manufacturing scenario in conjunction with the lease based business model allows all but defective parts to be replaced, and given defect parts are recycled according to WEEE schemes, this indicates nearly 87% reuse or recycling is possible. Further a 65% reduction of fresh water utilisation is reached while using a D4R laptop instead of a new one, so two out of the three ZeroWIN targets can be reached.

Case Study 2: The main aim of CS2 was to design and demonstrate two complete PV systems with lower environmental impact for the two most representative applications within the sector: grid-connected and stand-alone.
The demonstration of the PV case study has been divided into three phases: the first phase covered the elaboration of a detailed PV complete system concept; the second phase consisted in the development of a D4R power conditioning prototype, and the third phase has been the installation and start-up of the two complete PV systems.

Within the first phase, two typical PV systems have been assessed and the possible improvements have been identified (such as reuse of EoL PV modules; reuse of structural elements from demolition in the structure supporting PV modules or the consideration of the D4R criteria defined within the project). Within the second phase, the D4R power conditioning for both installations was designed and manufactured. Its main objectives were the increase of the performance ratio (PR) and the increase of the PV system lifetime. Using the concepts and prototypes developed in phases 1 and 2; two PV systems have been demonstrated. The PV case studies have been built on the principle of industrial network (the PV systems use off-spec PV modules, the array structures are made of elements originated as waste in construction or demolition, part of the cabling and protections has been reused, etc.).

The PV systems were installed in two different sites, within 150 km of Barcelona city:

- Grid-connected PV system at Electra Caldense in Caldes de Montbui, Spain: an electricity utility, which enabled the industrial symbiosis with electrical components and the electricity generated.

- Stand-alone PV system at Sersall in Castelló d'Empúries, Spain: a recycling facility, which enabled the industrial symbiosis with structural elements from dismantled installations.

In order to improve the performance of the system and its lifetime, lead-acid batteries in the PV system have been replaced by a prototype of a Li-ion battery. Both installations have the same size (2,76kWp and 4kWh of storage capacity). The main difference between both systems is how the components are connected and the strategy of use.

By considering the improvements identified within the ZeroWIN project and thanks to some market improvements, the PV system lifetime increased up to 25 years (for the baseline it was 20 years); and the PR of the demonstration systems have increased by 11% compared to the baseline. Therefore the energy generated by the system will increase up to a 40% during the whole lifetime compared to the baseline installation. The quantitative assessment of the PV systems demonstrated the achievement of reduction of GHG emissions goal.
ZeroWIN Targets: According to the final assessment both PV systems in Spain are reaching at least two of the stringent targets of ZeroWIN. The stand-alone PV system achieves a 45% reduction in greenhouse gas emissions and 91 % rate of reuse and recycling. The grid-connected PV system reaches all three targets; more than 100% reduction of greenhouse gas emissions and fresh water utilisation and a 91% rate of re-use and recycling. This CS reaches more than 100% for two targets because of the credits given by savings of conventional fossil energy through using the energy produced with the PV system.

Case Study 3: Considerable resource consumption and severe impacts of the high-tech sector on the environment, the economy and society have been investigated and documented in detail over the last years by a global scientific community. One fact is that the high-tech waste stream is growing rapidly, damaging the earth's ecosystems.

Against this background an holistic approach has been chosen in Case Study 3 (CS3), that aimed at enhancing value-conservation and reuse in the ICT sector based on the existing ReUse ICT network "ReUse-Computer e.V." in the region of Berlin / Germany. Greenhouse Gas (GHG) emissions, fresh water use and waste can thereby be minimised. To make the improved scenario measurable in comparison to the baseline, three indicator products have been selected: one PC, one laptop and one data logger system.

The main goals of CS3 were:
1. Increase the re-use stream of ICT equipment; and

2. Extend the activities of the ReUse-Computer network from a regional to the European level.

ZeroWIN Targets: Two out of three ecological targets of ZeroWIN project have been met with respect to the baseline, where new equipment is produced and used ICT appliances are collected and recycled:

Goal of 30% reduction of GHG emissions: The percentage of the reached goals is influenced by deciding, if parts of the computer/laptop are exchanged or upgraded. A re-use with exchange or with upgrading reduces the GHG reduction potential of PCs, while on the other side a laptop with re-used parts has a higher GHG reduction potential. Anyway, the goal of a 30% reduction of GHG emissions can be reached for all three indicator products: a desktop computer of 4 years, a laptop of 4 years and a 10 years old data logger. They reach a reduction rate of 46% to 69%.

Goal of 70% reduction of re-use and recycling rate: This goal can also be fulfilled by all three indicator products. The re-use rate for the PC and the laptop is of course higher when no parts are exchanged or upgraded. In any case the 70% re-use and recycling rate can be accomplished and reaches 87% to 100%.

Goal of 75% reduction of fresh water savings: The target for fresh water savings of 75% can only be reached, when the market value of the device reaches 10% (compared to the original value of the product), which is an unlikely low value for product re-use.

The results of this case study are directly incorporated into the network's daily businesses. Furthermore, RXP offers two opportunities for marketing:

1. RXP serves as a tool for establishing and / or enhancing the competiveness of zero waste networks.
2. RXP offers business opportunities for start-up companies based on product re-use and material recycling.

Based on the results of CS3, further development of re-use ICT networks in Europe is possible and preferable under ecological, social and economic considerations. A resolute European re-use and recycling strategy would help to save resources – primarily raw materials but also water and energy. The European waste hierarchy provides an adequate resource utilization and recovery framework for the consideration of ICT products. It will be necessary to overcome technological as well as economic barriers by concerted measures such as establishing regional and international re-use networks and introducing financial incentives for re-use businesses. The RXP can serve as a technological basis for future development of ICT product re-use.

Case Study 4: Case Study 4 (CS4) aimed to develop a construction resource efficiency stakeholder network that adopts the concept of sustainable construction in the UK. As part of CS4, work was carried out on three construction sites operated by Wilding Butler. Each of these sites is known as Phases 1, 2 and 3 respectively. Wilding Butler is a medium-sized construction contractor, based near Winchester, Hampshire and is also a ZeroWIN project partner.

Data from Phase 1 (Crimea Road) has been collected to establish baseline data which was used to assess Wilding Butler's greenhouse gas emissions, reuse and recycling rates and fresh water consumption during the construction process. The sites in Phases 2 and 3 were focused on implementing improvements to reduce resource use in the construction process by working with different actors in the industrial network. The Phase 2 industrial network of CS4 has improved upon the Phase 1 network by separating more waste on site (concrete, brick, metal, wood and plasterboard), reusing the concrete and brick work generated from the demolition of the toilet block on-site and specifying two material improvements with 98% recycled content structural steel and the 80% recycled content Futurepanel plasterboard product. The Phase 3 construction was the design and build of 13 flats in Southampton. Unlike the Phase 1 and 2 sites having input into the design, rather than being a 'build' only contract, enabled Wilding Butler to specify further improvements. The client (Talisman Homes (Solent) Ltd) was open to 'sustainable' alternatives and the creation of a sound business and environmental case helped win agreement of the client to specify materials with reduced impact on resources.

Performance against the ZeroWIN targets, to be reported in WP7, was assessed for the improvement scenarios, compared to the baseline, by calculating the GHG, fresh water usage and recycling rates for the following elements of construction:

- The main input materials and products used to manufacture the building: The structural frame, secondary aggregate, reinforcement, block work, brick work, external framework, insulation, plasterboard, carpet, carpentry and joinery (timber), electricity used on-site, water used on-site, diesel used on-site and distances travelled to deliver the input materials.
- The main output (waste) materials generated by manufacturing the building: Demolition materials, concrete, bricks, blocks, paper, cardboard, timber, plastics, metals, plasterboard, mixed waste and distances travelled to haul the output material.

<u>ZeroWIN Targets:</u> According to the final assessment CS4 reached the goal "decrease of 30% GHG emissions" with 58% and "70% overall rate of re-use and recycling of waste" with 93%.
Most challenging was the reduction of fresh water utilization for all construction and demolition (C&D) case studies, CS4-8. Direct on-site water consumption has negligible influence on the life cycle water consumption. Thus, improvements can only be achieved through material exchange or very thorough selection of products. EOL related case studies could achieve the goal of reduced fresh water utilization due to the avoided primary production caused by recycling and reuse.

Case Study 5: CS5 focused on the development of industrial networks around a construction site, including producers of materials and components, owners or promoters, architects, waste managers and other eventual players. The research team was expected to guide a construction project in Portugal; in particular the energy, water and material flows should be monitored, in order to analyse the opportunities and limitations of zero waste strategies in the construction sector. The construction project selected for the implementation of the CS was the Construction of an Environmental Education Center in Torres Vedras (west region in Portugal), with around 1220m^2 of gross area.

The main objective of the CS, towards the ZeroWIN environmental targets were the reduction of fuel consumption, improvement material and waste management, replacement of fresh water with treated wastewater / reused water, achieve 80% of waste reuse and recycling, replacement some input materials for more "environmentally friendly" ones. To achieve these objectives a methodology was designed, that included the development of a baseline scenario and selection of appropriated site; establishment of objectives and responsibilities with the actors involved; development of guidance document with general measures to implement; analysis of data about the construction project, development of a list of specific measures to the actors involved and monitoring the processes implemented within the ZeroWIN schedule.

Considering the implementation stage of the site would not be finished within the ZeroWIN schedule (due to delays), a realistic but theoretical scenario was developed. Concerning material flows, some interesting results were obtained, mainly related to substitution of primary materials (like aggregates, insulation plastics and 100% Portland cement) with secondary ones (recycled aggregates, recycled cork and cement including ashes). Concerning waste management a higher segregation on-site and avoidance of landfill were positive results.
Objectives fixed were generally achieved with the implementation of the CS. However, it was observed that actors on a construction site have usually no predisposition for establishing industrial networking other than the traditional supply-chain. In these conditions, a facilitator (in the CS, the research team) was crucial for the identification of networking potentials and the promotion of the industrial network.

The concept of industrial networking towards zero waste would enjoy better acceptance in the construction sector in Portugal if:

- Their implementation is required by law or by contractual obligations;
- Information and guidance on the potential benefits of working in symbiosis with other industries, or forming bespoke industrial networks would be promoted and spread by trusted entities (in particular sectorial associations).

Environment was verified not to be a driving force for the sector, so this concept has only a real chance if enterprises can expect it to induce immediate benefits (image improvement, economic gains).

Several barriers were identified that influenced the obtained results. Most of them require political intervention to be properly overcome, namely:

- Legal clarification of by-product concept and its implementation in practice;
- Promotion of the use of recycled and secondary materials;
- Instruments to overcome the gap between the planning/ design and the execution stages of construction projects.

<u>ZeroWIN Targets:</u> In CS5 at least two targets of the project could be reached. A 35% reduction of GHG emissions and a 97% rate of overall re-use and recycling of waste were the goals which were accomplished.

Case Study 6: The concept was based on the idea of implementing an industrial network around two selected construction projects in Germany - one refurbishment of a commercial building and one new construction – by establishing a logistic service provider for planning and securing an efficient material management on-site:

- Project I: Refurbishment of Deutsche Bank's Head Office (located in Frankfurt / Main, Germany)
- Project II: New Construction Schwabinger Tor (located in Munich, Germany)

The selection of building materials and products was not considered in this case study, as Bauserve acted to facilitate the co-operation of industrial companies and main actors (owner, architects, general planer and contractors, sub-contractors, logistic service providers, etc.).

The CS focused on the analysis of material management on-site within the logistics of delivery as well as regarding the logistics of disposal. The motivation of the research was twofold: first, to introduce an approach for an efficient construction logistics which can ensure the successful implementation of an industrial network in construction industry and which at the same time ensures resources efficiency. Second, to examine how and why the implementation of an approach for logistics has an environmental and economic impact on material management on-site. Specifically, two real case studies were used to measure the efficiency of logistic processes of delivery and disposal and to examine how construction logistics can decrease environmental impacts as well as increase potentials for economic benefits through industrial network design.

<u>ZeroWIN Targets:</u> As a result of the analysis of the two building projects in Germany, it was shown that project II, the new construction of the Schwabinger Tor, can reach all three goals (38% decrease of GHG emissions, more than 100% reduction of freshwater utilisation and 85% of overall re-use and recycling of waste).
Only project I could achieve just one goal, which was not the fault by the case study partners. This project was best investigated and applied most measures but had the disadvantages of huge mass flows, a high quantity of considered materials and well developed baseline technologies. The highest impact in this case study comes from aluminium for which baseline recycling rates are very hard to improve. This case study gave also the unique opportunity of a detailed view on transport and on-site impacts. The result on transport impact shows that sophisticated separate collection causes significantly higher transport burdens.

Case Study 7: Herein it was intended to demonstrate continuous improvement towards resource efficiency in UK demolition projects by tracking progress towards sustainable best practice on six individual demolition sites. This case study has been divided into two delivery stages:

- Gathering baseline data from practical examples of demolition practices
- Implementing improvements that will meet the ZeroWIN targets though innovative best practice

For each stage data was intended to be collected from three building eras: pre 1950s, 1950s to 1980s and 1980s to present day.

Data for the baseline scenarios for pre 1950s and 1950s to 1980s has been collected and analysed. In practice it was not possible to identify 1980s to present demolition projects due to the long life span of buildings. Improved scenario projects have been identified for the pre 1950s and 1950s to 1980s eras. BioRegional was appointed to undertake a pre-demolition audit for each of the sites. The audit identified the types and quantities of materials and end markets, and produced a time plan of when specific demolition activities should be undertaken on site. This process is key to planning when materials will be produced, when raw materials like diesel and water will be required and when vehicle movements are necessary to collect waste materials. The industrial network provided outlets for the segregated materials and supply of raw material supplements like waste water and biodiesel.

The aim for the phase 2 projects was to implement an efficient industrial network to allow higher resource efficiency at the site. The main improvement potential for the phase 2 sites was achieved by:

- developing the opportunities for reuse and recycling of the output material, such as clean brick, plasterboard (gypsum), metals, hardcore (brick, block and concrete), carpet, insulation, canteen waste, office waste, ceramics, furniture, mortar, plastics and glass;
- To a much lesser extent, by selecting alternative input materials. The main input materials used on site to undertake the deconstruction of the building include the electricity, fresh water and diesel consumed.

<u>ZeroWIN Targets:</u> The final assessment for CS7 analysed two building eras in the UK in detail: the pre 1950s and the phase between 1950 and 1980. Both could reach the ZeroWIN targets, in doing so the pre 1950s era reached all of the three targets. The GHG emissions could be reduced by more than 100% as well as the fresh water utilisation. The re-use and recycling rate of waste was nearly 100% (99%).
The phase between 1950 and ’80 could reach two out of the three targets. A reduction of more than 100% GHG emissions as well as a 99% re-use and recycling rate of waste were achieved.

Case Study 8: The main aim of Case Study 8 was to build industrial networks around a planned demolition site in order to optimise global resource management.

For this purpose, the methodology outlined for the ZeroWIN case studies was adapted to this case, specifying the concepts that are expected to help with achieving its main targets, namely a decrease of greenhouse gas (GHG) emissions, increased overall reuse and recycling of waste, and reduction of fresh water use. It was necessary to have in mind that in demolition projects the outputs flows are much more significant than the input ones.

According to the Project Description of Work, CS8 was expected to implement the CS in three demolition sites. The selected sites were:

- Site 1 – School building in "Escola Secundária de Paços de Ferreira" (demolition works to be implemented in January – February 2010)
- Site 2 – School building in "Escola Secundária da Maia" (schedule for August – September 2010)

- Site 3 – Demolition of industrial pavilions in Amadora, to be performed from January to March – April 2013

The main aspects of the developed methodology were the selection of appropriate demolition sites, development of the baseline scenario (established by Site 1, implemented with no intervention of the research team); pre-demolition audit and selective demolition plan; analysis of data; development of a list of specific measures; monitoring the implementation of the CS and development of an electronic tool to support the planning of zero waste sites.

On both Sites 2 and 3 there was a significant improvement in reference to the baseline established by Site 1. On Site 3, there was a more systematic implementation of the selective demolition procedure. However, the advanced state of degradation of the building did not allow direct reuse of arising materials. In both cases, the main materials were deviated from landfill, which was the principal destination for waste on the baseline Site 1. The overall recycling rate was approximately 89%, while the remaining 11% of generated waste was landfilled.

Concerning water and energy, one of the greatest difficulties was to determine the consumptions related to on-site activities. Only a qualitative analysis was possible for the material and energy flows and no substitutions or industrial networking measures were implemented.

<u>ZeroWIN Targets:</u> Overall the all targets of the ZeroWIN project and the objectives of CS8 were achieved for 100% (only the rate for overall re-use and recycling of waste was achieved for 99%). However, industrial networking directly involving productive industries (direct reuse of materials / resource exchange) was found to be difficult in demolition projects. The high recycling rate achieved was more related to the implementation of waste prevention strategies on the site, in particular the selective demolition approach and the rational material management (separation of materials on the site), than to direct industrial networking activities. Similarly to CS5, the role of the facilitator was determinant for the search for industrial networking potentials. The role of the proximity principle became evident on several occasions during the implementation of this case study.

Several barriers were also detected, related to deficient planning, lack of records on water and energy consumption per process and resistance to proper selective demolition and waste sorting. Measures were suggested to overcome these barriers.

Case Study 9: The automotive sector is one of the most important sources for value creation and employment within the European Union. This sector is facing the challenge to become more resource efficient. The industrial network of Case Study 9 covers this sector. The focus was a security relevant component, and high-tech primary plastics material was substituted by recyclate. CS9 described the links of product development, production processes and the set-up of an appropriate industrial network under the lead of the Tier1-supplier Continental.

Today's passenger vehicles consist of approximately 40% recyclate (calculated on the weight of all materials). When considering only the thermoplastics, which are addressed by this case study, the share is usually about 15%. The further extended use of recycled plastics in automotive components offers potentially significant environmental improvements, conserving resources via substitution of primary materials. The employment of recyclate in the automotive industry is also a strategic means to offset rising raw material prices. In today's industry practice, plastics recyclate is employed for components with low technical or functional requirements, e.g. bumpers or underbody panelling.

In order to raise the share of recyclate and unlock new applications for recycled plastic materials, this case study aimed at producing a security relevant part of the braking system with recyclate, respectively a mixture of recyclate and virgins materials. The control housing is a safety-to-life component: If the control housing fails, the vehicle will not brake. This makes the case study a 'flagship project' for recycled materials for Continental. The control housing consists of short glass fibre enforced polyethylene terephthalate (PET) plastics with a share of 35% glass fibres (PET-GF35). The approach of this case study is innovative in terms of both the security relevant application for recycled materials and the recycling of a glass fibre enforced composite plastic which otherwise would be incinerated / downcycled.

In the baseline scenario, the component was manufactured fully with virgin glass fibre enforced PET with a moulding process creating 10-20% of the weight as waste (sprues). In the improved scenario, this waste is now recycled in a plastics mill and mixed with virgin materials. This mixture is then used for producing control housings by a changed production process, also enabled by major effort in the product development.

The case study had set four specific goals which contribute to the practical implementation of the industrial network and to being able to handle recyclate as material for the security relevant component control housing:

- Goal A: development of a control housing with plastics recyclate (product concept)
- Goal B: elaboration of material testing processes, specifications and identification critical process parameters for the recyclate
- Goal C: establishment and design of a recycling process and changes in the production process of the control housing
- Goal D: design and establishment of an industrial network and start mass production of this control housing

Since all these four goals are interdependent, all of them were successfully reached by CS9.

Regarding the technology and market uptake, this case study was a great success for the involved partners. Continental has a market share of about 25% of the worldwide production of control housings. The technology uptake into serial production and market entry was very successful: Serial mass production started in October 2012 with a volume of 600.000 control housings with a recyclate share of 33% per year of production for a first automotive pilot customer original equipment manufacturer (OEM).

Two out of the three overall ZeroWIN goals were met with the prototypes of the practical demonstrator. The ZeroWIN goals regarding waste prevention by recycling were met by serial production and prototypes. Prototypes with recyclate share over 40-45% – which are technical feasible and planned for serial production – also successfully reach the greenhouse gas emission (GHG) reduction goal. Only the water reduction goal could not be reached due to the additional electricity consumption of the recycling process for milling of sprues.
This case study with its serial production components and prototypes of the practical demonstrator showed the significant environmental improvements which can be reached by

the implementation of an industrial network in automotive, as well as the financial and social benefits by preserving the value of a former waste material thus saving material costs and securing employment by being technically on the competitive edge. Industrial networks are seen as a tool to secure secondary materials supply over a long time and controlling / tracing the sources of the recyclate which is a requirement for the security relevant use case.

ZeroWIN Targets: In the pilot project of the Eco control housing one out of three ZeroWIN targets could be reached. In the final scenario the outcome was improved. At status quo 100% recycled material is used for the brake booster. According to this circumstance two out of three ZeroWIN targets were reached. Greenhouse gas emissions were reduced by 47%, as well as a re-use quota of 100% was achieved.

Case Study 10: ZeroWIN Case Study 10 was developed to describe the current situation of used Business to Business (B2B) EEE collection and treatment in EU member states and propose improvements, including policy recommendations. B2B EEE includes the equipment used by Small-to-Medium sized Enterprises, large and public sector organisations. According to the latest EU reporting figures, 7,189t of end-of-life B2B IT equipment were collected in 2008 in the UK, i.e. a mere 6,3% of that put on the market a year later. The context, approach, findings, analysis and conclusions from ZeroWIN Case Study 10, B2B EEE industrial networks are presented. Data were collected from five EU member states: UK, Austria, Germany, Romania and Spain. Methods used were semi-structured interviews and surveys of relevant literature. The aims were to explore the operations of, and the market for materials from, organisations which exploit the value of used B2B EEE. The goal of the case study was to learn from existing practice, then make recommendations to increase throughput and improve collection and treatment operations to provide evidence in support of the ZeroWIN vision. Results showed that the treatment options for used B2B EEE, including reuse, were highly driven by the end market for the resulting product. Reuse rarely occurred in Austria and Spain, but was common in the UK and prevalent in Germany. It was concluded that a solution is needed to account for used B2B EEE to avoid negative sustainability impacts, which did not place such a burden on the industry that it made the practice unattractive. The decision-making around used EEE processing was highly sensitive to economic barriers and stimuli.

The potential impact (including the socio-economic impact and the wider societal implications of the project so far) and the main dissemination activities and exploitation of results (not exceeding 10 pages)

The potential impact given in the project ZeroWIN is as follows:

- General:

"The assessment of the life cycle benefits and costs for achieving the main EU environmental resource-related targets"

- Specific:

"Looking at the whole process chain of industrial networks, results should contribute to at least two of the following goals:
(a) a decrease of at least 30% greenhouse gas emissions
(b) at least 70% of overall reuse and recycling of waste
(c) a reduction of at least 75% of fresh water utilisation

ZeroWIN contributed substantially to all expected impacts. By using the whole system approach developed in Work Package 1, a range of strategies, approaches, technologies and practical tools to aid waste prevention were developed in Work Packages 2 to 5 that addressed the general impacts. Work Package 3 and 4, in particular, built upon previous EU activities and provided evidence and direction on how the whole life cycle approach can be used to achieve EU environmental resource-related targets as well as providing additional data to directly support strategies / initiatives (**impact on legislation**) such as:

- Kyoto Protocol on Climate Change
- European Emissions Trading Scheme
- European Sustainable Development Strategy
- Thematic Strategy on Sustainable Use of Natural Resources
- Thematic Strategy on Waste Prevention and Recycling
- Thematic Strategy on Sustainable Consumption and Production (SCP)
- Integrated Product Policy (IPP)
- Eco-Management and Audit Scheme (EMAS)
- Eco-label Scheme
- Environmental Technology Action Plan (ETAP)
- Green Public Procurement
- Eco-design of Energy Using Product Directive
- Waste Framework Directive
- End-of-Life Vehicles Directive
- Directive on Waste from Electrical and Electronic Equipment (WEEE)
- Battery Directive
- European Compliance Assistance Programme – Environment & SMEs

The specific impacts were addressed and quantified in Work Packages 6 and 7, and converted into policy recommendations in Work Package 8. The call specifically requested for substantial participation of industrial partners, including SMEs. ZeroWIN ensured the involvement of SMEs at all stages of the project, from vision to assessment studies to management and dissemination activities. This integrated approach ensured "ownership" of the modules, tools, technologies and approaches developed as well as allowing focus on achievement of the specific targets for reduction of emissions and resource utilization. ZeroWIN deliberately chose to work with sectors that are large and energy and resource-intensive, so that the impacts can be maximised as quickly as possible.

In more detail the ZeroWIN went beyond the targets and set itself the following goals:

1. Lifetime extension of ICT products from in average 4 years to 6 years resulting in e-waste reductions of 50% and 50% reductions of related CO_2 emissions of avoided waste generation at production of such devices
2. Design for recycling measures coupled with IPR in place leading to predicted increased reuse and recycling rates of ICT products of more than 85%
3. Providing inputs concerning existing national legislation for construction materials and components with a view to establishing a minimum standard of a 10% increase in recycled and recyclable products being specified by construction enterprises
4. Evaluate arrangements that characterize actors' networks involved in the C&D waste sectors of Europe with a view to encouraging a minimum of 10% overall standard reduction of waste generated on construction sites, a decrease of at least 30% decrease of greenhouse gas emissions and a 70% increase in re-use and recycling of the remaining waste
5. Regarding photovoltaic systems it is expected that a 35% reduction can be achieved in greenhouse gas emission and at least 75% of overall re-use and recycling by enhanced design and measures for longevity of the system by a cooperative approach of the supply chain

The research in ZeroWIN addresses:

- nearly 3 million companies (of which 80% are SMEs)
- with more than € 2,8 trillion turnover and a value creation of more than € 800 billion
- with more than 20 million employees
- creating about 40% or more than 400 million tons of industrial waste every year
- using as much as 50% of all materials extracted from the earth's crust
- generating about 40% of all energy use and about 35% of all greenhouse gas emissions

Improved health of the EU's citizens
Avoiding the use of hazardous substances, processing of hazardous waste, reducing contamination of soil, air and water resources by organic and inorganic pollutants will improve the life-support systems of mankind.

Impact on individual ZeroWIN partners

GAIA	GAIA benefits by additional knowledge that they can transfer to their 170 members within the Basque electronics cluster. In addition, they can offer additional services as well as consulting to their member companies.
Bauserve, W-B	Both benefits from the experiences gained in the pilot applications. Through the savings in the waste disposal they can increase their competitiveness. In addition, they also profits from the increased publicity and the better environmental image gained by the ZeroWIN project.
Greentronics, tricom, UP	All companies from the re-use and recycling sector will increase their direct market share because of the valuable experiences within the case study. In addition, they will also indirectly benefit as the total market of re-use and recycling of EOL electronics and automotive equipment will rise because to the project findings. In the end they will also improve their environmental image as well as their name recognition.
HP	HP will benefit by practical experiences about product identification technologies for IPR that they can incorporate into their future products. By that they can become the major driver of this topic and lead the market because of this competitive advantage.

MicroPro	MicroPro will have a prototype for a D4R laptop after the project. The major findings can be transferred into a green laptop and by that they can become market leader in a niche market.
Saft, TTA	On the basis of the D4R prototype for photovoltaic systems they can incorporate their experiences into the new product line and become market leader as they will have a considerable price advantage against their competitors.
PE	As a developer of software tools in this area they can use the results to improve their existing products, create new tools as well as use the case studies as references.
BIOIS, CEIFA, Remade, WAMECO	These companies can use the knowledge gained during the ZeroWIN project to better serve their customers in traditional areas as well as extend their services into new areas.
WIFI-IKT, REC	As they are dissemination partners within the ZeroWIN project representing large groups of customers they can offer additional topics in their training courses.
All universities and research centers	Finally the universities and research centres have gained valuable knowledge as well as practical experience that they can use for teaching, follow-up research as well as consulting.

Major dissemination activities

ZeroWIN Vision Conference
Date: July 6, 2010
Location: Southampton, UK
Partners present: All ZeroWIN partners (lead by SCEE)

Going Green – Care Innovation 2010
Date: November 8-11, 2010
Location: Vienna, Austria
Partners present: Majority of partners (lead by SAT)

Green Electronics 2011- Resource Efficiency in the Electric and Electronics Industry
Date: November 8-10, 2011
Location: Bucharest, Romania
Partners present: GAIA

ZeroWIN Webinar
Date: June 12, 2012
Location: Internet
Partners present: SAT, REC, PE, LBP, SCEE, MicroPro, TTA, Bauserve

Electronics Goes Greem 2012+
Date: September 9-12, 2012
Location: Berlin, Germany
Partners present: SAT, MicroPro, TTA, TUB, LBP, WRUT, UNU, University of Surrey

Green Electronics 2013 Workshop
Date: November 4-6, 2013
Location: Budapest, Hungary
Partners present: SCEE, UL, TUB, CONI, WRUT, TTA, MicroPro, SAT

ZeroWIN Bilbao Dissemination Event
Date: November 28, 2013
Location: Zamudio, Spain
Partners present: SCEE, SAT, UP, TTA

ZeroWIN Farnham Dissemination Event – “Circular Economy & Industrial Networks”
Date: March 24, 2014
Location: Farnham, UK
Partners present: UCA, SAT, MicroPro, UP, UNU, Remade

ZeroWIN Lisbon Dissemination Event
Date: April 3, 2014
Location: Lisbon, Portugal
Partners present: CEIFA, SCEE, Wilding-Butler

Series of ZeroWIN Webinar Presentations
Date: April 9, 2014
Location: Internet
Partners present: All partners (lead by REC)

For further dissemination a youtube channel has been created where all recorded presentations of the project are clustered. The channel can be found at:
https://www.youtube.com/user/ZeroWINProject

Exploitation of project results

- 5 peer reviewed publications
- a special edition of the peer-reviewed journal Waste and Resource Management based upon the ZeroWIN project
- 10 major international dissemination events
- 4 short films on the results of the ZeroWIN project
- several awards for the project (Bronze Zero Waste Award for ZeroWIN in the UK; ZeroWIN shortlisted as finalist for UK’s National Recycling Awards 2014)
- ZeroWIN was promoted at more than 140 national and international conferences and events
- Altogether more than 90 project publications were issued on ZeroWIN
- A software tool for production estimation has been developed
- Two different types of computers have been developed
- Expertise has been gained

For a more detailed description of the exploitable foreground see section 4.3 of this document. The two tables (template B1 and B2) provide a structured overview of the exploitation of the project results.

Miscellaneous

<u>Name of the scientific representative of the projects co-ordinator, Title and Organisation:</u>

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http://www.zerowin.eu/

<u>Project logo:</u>

<u>List of beneficiaries:</u>

Beneficiary Number	Beneficiary Name	Beneficiary short name	Country	Date enter project	Date exit project
1(coordinator)	Austrian Society for Systems Engineering and Automation	SAT	AT	M1	M60
2	Asociacion de Industrias de las tecnologias Electronicas y de la Informacion del Pais Vasco	GAIA	ES	M1	M60
3	Bauserve GmbH	Bauserve	DE	M1	M60
4	BIO Intelligence Service	BIOIS	FR	M1	M60

5	Centro de Estudos, Informação e Formação para o Ambiente	CEIFA	PT	M1	M60
6	Flection Germany GmbH	Flection	DE	M1	M24
7	Fundacion GAIKER	GAIKER	ES	M1	M60
8	S. C. Greentronics Srl	Greentronics	RO	M1	M60
9	Hewlett-Packard Ltd	HP	UK	M1	M60
10	INSEAD – Institute European d´Administration des Affaires	Insead	FR	M1	M60
11	Wirtschaftskammer Oesterreich	WIFI-IKT	AT	M1	M60
12	Multimedia Computer Systems Ltd	MicroPro	IE	M1	M60
13	PE INTERNATIONAL GmbH	PE	DE	M1	M60
14	Remade South-East Ltd	Remade	UK	M1	M60
15	Saft SAS	Saft	FR	M1	M60
16	Technische Universitaet Berlin	TUB	DE	M1	M60
17	Regional Environmental Center for Central and Eastern Europe	REC	HU	M1	M60
18	Trama TecnoAmbiental SI	TTA	ES	M1	M60
19	Tricom GmbH	Tricom	DE	M1	M60
20	United Nations University	UNUN	DE	M1	M60
21	University College for the Creative Arts	UCA	UK	M1	M60
22	University of Limerick	UL	IE	M1	M60
23	Universitaet fuer Bodenkultur Wien	BOKU	AT	M1	M60
24	University of Southhampton	SCEE	UK	M1	M60
25	UP Umweltanalytische Produkte GmbH	UP	DE	M1	M60

26	VfJ Werkstaetten GmbH	VfJ	DE	M1	M18
27	WAMECO S.C. Ryszard Szpadt, Wojciech Gornikowski	WAMECO	PL	M1	M60
28	Wilding-Butler Ltd	W-B	UK	M1	M60
29	Politechnika Wroclawska	WRUT	PL	M1	M60
30	Universitaet Stuttgart	LBP	DE	M1	M60
31	AU Optronics Corporation	AUO	TW	M9	M60
32	Continental Teves AG & Co. OHG	Continental	DE	M20	M60