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A zero waste vision for industrial networks in Europe

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ABSTRACT

'ZeroWIN' (*Towards Zero Waste in Industrial Networks* – www.zerowin.eu) is a five year project running 2009–2014, funded by the EC under the 7th Framework Programme. Project ZeroWIN envisions industrial networks that have eliminated the wasteful consumption of resources. Zero waste is a unifying concept for a range of measures aimed at eliminating waste and challenging old ways of thinking. Aiming for zero waste will mean viewing waste as a potential resource with value to be realised, rather than as a problem to be dealt with. The ZeroWIN project will investigate and demonstrate how existing approaches and tools can be improved and combined to best effect in an industrial network, and how innovative technologies can contribute to achieving the zero waste vision.

1. Introduction to zero waste

1.1. Zero waste philosophy

Zero waste is a whole-system approach that aims to eliminate rather than 'manage' waste. As well as encouraging waste diversion from landfill and incineration, it is a guiding design philosophy for eliminating waste at source and at all points down the supply chain. It rejects current one-way linear resource use and disposal culture in favour of a 'closed-loop' circular system modelled on Nature's successful strategies – see Fig. 1. Zero emissions/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 minimise the load they impose on the natural resource base and learn to do more with what the Earth produces.

Targeting the whole system means striving for:

- Zero waste of resources: Energy, Materials, Human;
- Zero emissions: Air, Soil, Water;
- Zero waste in activities: Administration, Production;
- Zero waste in product life: Transportation, Use, End of Life; and
- Zero use of toxics: Processes and Products.

The zero waste approach envisions all industrial inputs being used in final products or converted into value-added inputs for other industries or processes. In this way, industries will be reorganised into clusters such that each industry's wastes/by-products are fully matched with the input requirements of another industry, and the integrated whole produces no waste. From an environmental perspective, the elimination of waste represents the ultimate solution to pollution problems that threaten ecosystems at global, national and local levels. In addition, full use of raw materials, accompanied by a shift towards renewable sources, means that utilisation of the Earth's resources can be brought back to sustainable levels.

For business, zero waste can mean greater competitiveness and represents a continuation of its inevitable drive towards efficiency. First came productivity of labour and capital, and now comes the productivity of raw materials – producing more from less. Zero waste in industrial networks can therefore be understood as a new standard for efficiency and integration.

1.2. Project ZeroWIN

'ZeroWIN' (*Towards Zero Waste in Industrial Networks* – www.zerowin.eu) is a five year project running 2009–2014, funded by the EC under the 7th Framework Programme. It has 30 academic and industrial partners across Europe (and one partner in Taiwan) who will integrate their expertise and enable the chosen strategies to be trialled in real case studies. The consortium will investigate and demonstrate how the closed-loop philosophy can contribute to achieving zero waste by adopting a network approach, and using a combination of methods and tools, use of technology and design innovations and policy measures.

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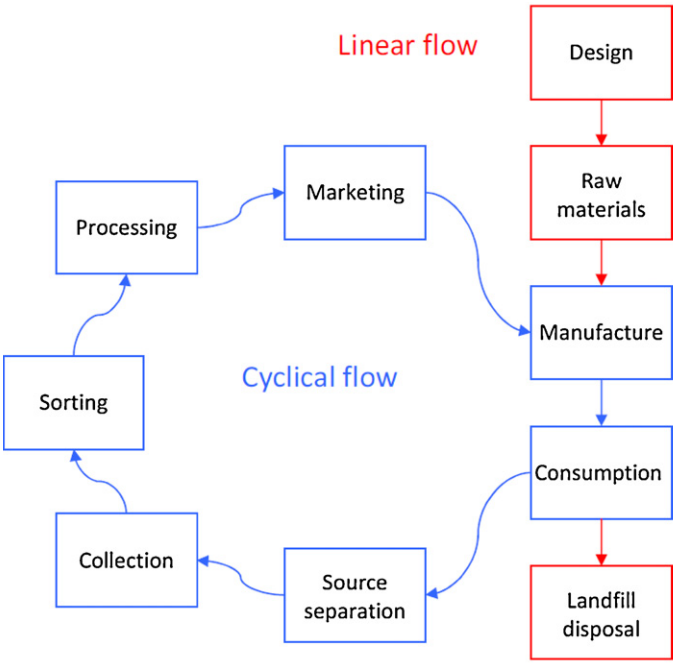

Fig. 1. Linear and cyclical resource flows.

The ZeroWIN partners worked up the project proposal from a shared view that the zero waste goal was necessary and achievable, a clear and identified need for research in this area and recognition that such an ambitious study required a consortium of research institutions and industrial partners with the required research expertise and practical capability to deliver on the project objectives. The project is divided into distinct work packages. Some elements of work are sequential, for example developing the zero waste vision before deciding on which new technologies and waste prevention methods to apply and which tools to use, and in turn agreeing on these before developing a production model for resource-use optimisation and waste prevention. Other elements run in parallel: the production model will be trialled in 9 real case studies – these form the core of the project. Quantitative assessment will be conducted throughout the project to evaluate success. The policy implications of the ZeroWIN approach will be reported, and extensive dissemination of results is planned. Overall management and coordination is formally written into a work package to ensure the project operates efficiently.

ZeroWIN will focus on two key waste types in four industry sectors:

- Construction and Demolition waste
- High-tech, electrical/electronic waste; from three sectors:
  - Electrical and Electronic Equipment (EEE)
  - Automotive sector
  - Photovoltaic (PV) sector

The ZeroWIN project will determine how existing approaches and tools can be improved and combined to best effect in an industrial network, and how innovative technologies can contribute to achieving the zero waste vision. The specific environmental targets are:

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

1.3. Defining zero waste

The ZeroWIN consortium has defined zero waste as:

> "*A goal that is both pragmatic and visionary, to guide people to emulate sustainable natural cycles, where all discarded materials are resources for others to use. Zero waste means designing and managing products and processes to reduce the volume and toxicity of waste and materials as close to zero as possible, conserve and recover all resources and not burn or bury them. Successful Implementation of zero waste will eliminate all discharges to land, water or air that may be a threat to planetary, human, animal or plant health. In industry the goal of zero waste will be accomplished with the aid of industrial symbiosis and new technologies.*"

This definition of zero waste describes a so-called 'whole-system' approach to redesigning resource flows to minimise harmful emissions and waste of resources. It is also a unifying concept for a range of measures aimed at eliminating waste and challenging old ways of thinking. It is envisaged that zero waste to landfill or incineration in Europe can be achieved over a 10–30 year timescale, although a co-ordinated and concerted effort focused on waste prevention, minimisation and re-use will be necessary. It is important to recognise that zero waste is a target to be strived for, not an absolute, and it is possible that landfill or incineration may ultimately be the best option for a very small number of wastes.

2. Zero waste system

There are many approaches, methods, tools and principles that have been used to tackle different problems in the field of business waste and resource efficiency. Many of these have sub-specialised across space, time and industry sector or material type, and some hybrid solutions have emerged. Fig. 2 presents those that were accepted as relevant to the project's vision, after being thoroughly reviewed and discussed in turn within the ZeroWIN consortium [1]. The zero waste philosophy and closed loop approach described above are at the core of the 'whole system' for preventing, rather than managing, waste [2]. Zero waste can be informed by the substantial body of reporting of research and application of precursor approaches [3] – industrial ecology [4–8], cleaner production/pollution prevention [9,10], zero emissions [11,12] and natural capitalism [13].

It is not possible to discuss all of the concepts and influences in Fig. 2, but the key strategies identified for applying zero waste in industry are:

- Eco-design – designing waste out of the system is acknowledged to be of particular importance to achieving real improvements in waste reduction across the system. This is illustrated in Section 3 (also see Fig. 3). For ZeroWIN this principle incorporates the concepts of prolongation of product use, de-materialisation and green chemistry [selected references: 14–21].
- Industrial symbiosis – this is a part of the industrial ecology concept. It is particularly relevant for ZeroWIN, which seeks to reach zero waste by promoting networks across industries. Industrial symbiosis is the theoretical rationale and methods for sharing information and resources across different industries; eco-industrial parks are real world applications of industrial symbiosis [selected references: 22–26].
- (Closed-loop) supply chain management – ZeroWIN will develop its own version of this established management strategy, incorporating reverse logistics to close the loop and optimise the flows of materials, products and wastes in the procurement, distribution and recycling functions. This will improve the efficiency (and

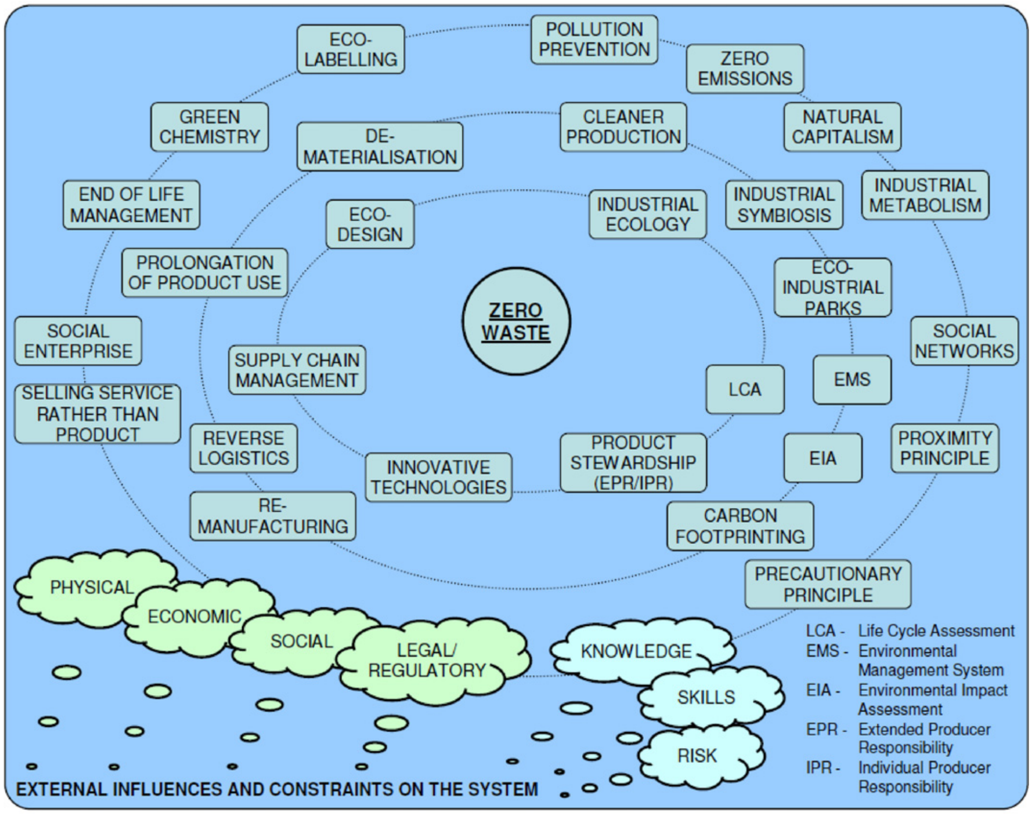

Fig. 2. The zero waste system proposed for ZeroWIN.

so economic performance) and the sustainability of the industrial network [selected references: 27–35].

- Use of new technologies – innovative technologies in new products and industrial processes can have powerful environmental as well as economic impacts. In ZeroWIN RFID (Radio Frequency Identification) technology and a D4R – Design for Re-use, Recycling, Refurbishment, Repair – laptop and grid-connected and stand-alone photovoltaic systems will be investigated, designed and trialled
- Product stewardship – extended producer responsibility (EPR) methods, and particularly individual producer responsibility (IPR), are regarded as important tools to enforce producers to take full responsibility for their products, especially at their end of life. IPR approaches are relevant to 2 of ZeroWIN's 4 sectors: electronics and automotive. Linking with the potential for the use of RFID technology or other innovative technologies, ZeroWIN will explore how IPR can be more successfully encouraged and enforced than it has been to date [selected references: 36–38].

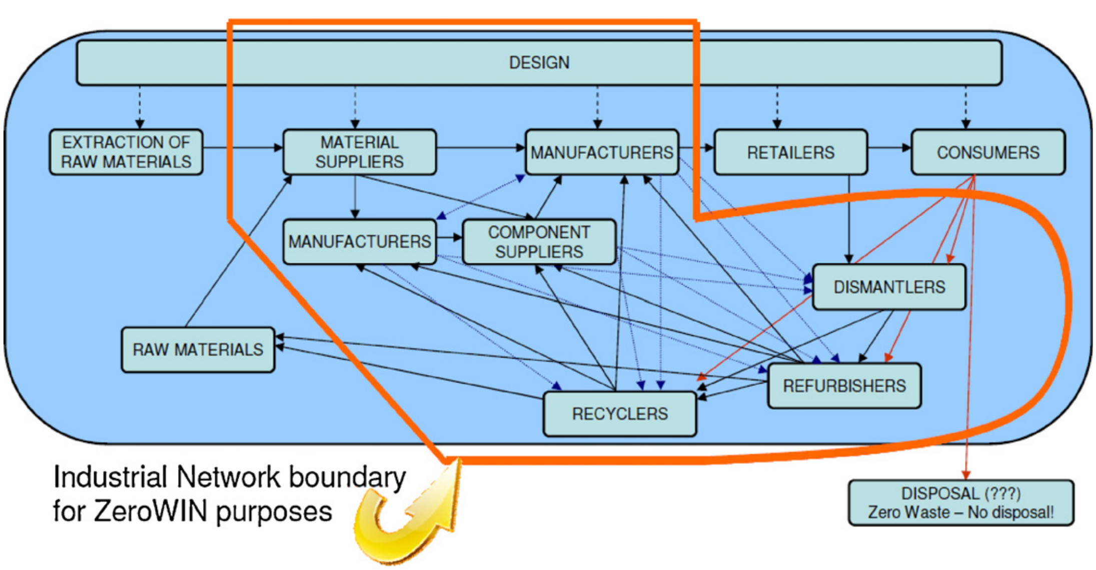

Fig. 3. The scope and boundary of an industrial network for ZeroWIN.

- Life Cycle Assessment – it is now accepted that obtaining the true environmental impact of products requires measuring the impacts across the whole physical life cycle from raw materials through production and use phases to end of life, and that consideration in this way can lead to more sustainable patterns of production and consumption. Carbon footprint measurement has also been identified as being important with the future increase in use of carbon targets and budgets in Europe. LCA and carbon footprinting methods will be used to measure how successful the different waste prevention techniques and case studies of ZeroWIN have been, in relation to the targets of greenhouse gas emissions, waste and water use [selected references: 16, 39–48].
- An Environmental Management System (EMS) plans, schedules, implements and monitors those activities aimed at improving environmental performance. It is a problem identification and problem solving tool that provides organisations with a method to systematically manage their environmental activities, products and services and helps to achieve their environmental obligations and performance goals. There are a number of standards available around which EMS can be modelled. The most widespread ones are ISO14001 on the international scene and the Eco-Management and Audit Scheme (EMAS) at the EU level. EMS is of moderate relevance to ZeroWIN because although it can be considered as an adequate support for better managing sustainability-oriented industrial activities, it is not a key issue itself for their development. Recently, a number of projects and pilot initiatives have tackled the issue of EMS implementation in industrial networking. Several EU funded projects have explored applicability of EMAS to industrial networking. For instance, LIFE03 ENV/IT/000421 project "Paper Industry Operating in Network: an Experiment for EMAS Revision – PIONEER" in an industrial area of the province of Lucca, Italy; LIFE04 ENV/IT/000526 project "Sustainable EMAS North Milan – SENOMI"; ESEMPLA and EMAS projects for the cooperative management of existing industrial networks (under the Regional Framework Operation (RFO) ECOSIND stemming from the INTERREG III C programme). However, no specific evidence for successful implementation of an EMS in an industrial network has been previously reported.

The influences and constraints indicated at the bottom of Fig. 2 represent all the factors which affect businesses, which are generally beyond the scope of a research project, and often the businesses themselves, to target and change. This covers the physical infrastructure including that of transport and waste management, prevailing market conditions and the general economic climate, and social and political factors including the legal and regulatory framework. The knowledge, skills and propensity to take risks also constrain the actions and development of a business or industrial network.

3. An industrial network

There is no universal definition of an industrial network. Industrial networks historically have developed over time, depending on a number of factors including the type of industries present, local natural conditions and physical infrastructure and human factors such as the ethos and drive of the local entrepreneurs and the prevailing regulatory framework. Some good examples are the Kalundborg municipality in Denmark [7,12], the Kwinana industrial area in Western Australia [26,49] and Fujisawa eco-industrial park in Japan [11,50].

The scope and boundary of an industrial network for the ZeroWIN project is shown in Fig. 3 as a network of potentially diverse industries working together in symbiosis; note the cross-cutting influence of design. The transport of materials, products and wastes between actors are implied by the arrows. The scope and boundary must be general enough to be applicable to all of the ZeroWIN-related sectors, e.g. by taking construction activities to be thought of as 'manufacturers' (something is produced), and using non-specific terms for dismantling (to encompass Material Recycling Facilities, demolition and automotive dismantling) and refurbishing (to encompass remanufacturing, re-use and repair) activities. However, a distinction is also required between what can be considered the boundary of an industrial network for the purpose of what ZeroWIN wants to influence and improve and what ZeroWIN must look at, collect data on and assess in order to evaluate the full impact of the project.

Thus, the thick orange line in Fig. 3 represents what will be regarded as the boundary of the industrial network under the ZeroWIN vision. It is clear that the primary sector functions, mainly supplying raw materials, and the tertiary sector functions that interface with the consumer, are outside of ZeroWIN's scope. So too is the 'use' phase of the product, and the end of life of the product until the point where the materials re-enter the industrial network to be used again, whether by means of repair/remanufacture or to be recycled and used as raw materials. An "industrial network" does not need to involve all players in the depicted boundary, but could be a sub-set of key actors across the supply chain.

A second, larger boundary will be used to enable a full assessment of the network, using Life Cycle Assessment methods, and will include all necessary upstream and downstream processes to perform the assessment according to International Reference Life Cycle Data System Guidelines [48].

4. A vision for zero waste in industrial networks

The first step of the ZeroWIN project has been the development of a common approach – a vision for how all project partners will operate and what they aim to achieve [51]. The ZeroWIN vision statement is:

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

This statement, designed to be memorable and appealing, is underpinned by the concepts, scope and boundary that have been described in this paper, and set within the context of the zero waste philosophy, industrial networks and the whole-system approach. This vision for ZeroWIN may continue to evolve as internal project findings and external stakeholder input contribute further information and real-world experience. The creation of the ZeroWIN vision is dual purpose: it is an aspirational description of what the consortium would like to achieve in the medium- and long-term future, and it also serves as the consortium's commonly agreed inspiration and framework for all strategic planning and future courses of action.

5. Conclusions

Working towards zero waste in industry will require a network approach, and all involved to aspire to a common vision for achieving this, making best use of a range of existing waste prevention approaches, tools and technologies and to develop new ones to make improvements throughout the system.

This activity has never been undertaken previously by such a large group of international experts and industrial organisations with such a range of different viewpoints and perspectives. As a consequence, the outputs and conclusions from this project will be of international interest and significance. ZeroWIN is an ambitious project set with difficult goals, but meeting these challenges will be necessary if society is to solve the pollution and resource problems of current industrial practices in a sustainable way.

Acknowledgement

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