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Briefing: Demonstrating the circular resource economy – the Zerowin approach

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Zerowin is an ambitious European Union funded project researching and trialling methods and strategies to eliminate the wasteful consumption of resources in key industrial sectors in Europe, primarily by way of the formation of industrial networks. The project has run from 2009 to 2014. This paper reports on the completion of the project, which through demonstration activities has shown that society can solve its current industrial pollution and resource problems in a sustainable way if it is willing to change its business practices and culture.

1. Introduction

The global economy has evolved with little consideration towards the residuals of production and consumption and their impacts on the environment, which include resource depletion; air, water and land contamination; and the deterioration of related ecosystem goods and services. The waste society generates is enormous: in 2008, the total generation of waste in the member countries of the European Union (EU-28) amounted to 2·62 Gt (5·2 t per capita), with 98 Mt classified as hazardous waste (Eurostat, 2011).

The most important sectors in terms of waste generation are construction, mining and manufacturing industries. By comparison, households contributed just 221 Mt (8·5%) (Eurostat, 2011). These wasted materials represent valuable resources that we can no longer afford to discard. As demand for key resources such as metals and minerals increases, competition for resources is growing. Policy makers, industry and consumers are concerned about supply risk, the need to diversify supply from the Earth's resources and the environmental implications of burgeoning consumption. There is a clear need for effective closed-loop resource management systems, especially within industry.

2. The 'Zerowin' approach?

Project Zerowin – 'Towards zero waste in industrial networks' (see www.zerowin.eu) – is an ambitious European Union funded project researching – and trialling by means of case studies with industrial partners – methods and strategies to eliminate the wasteful consumption of resources in key industrial sectors in Europe, primarily by way of the formation of industrial networks. The project has run from 2009 to 2014, so it is nearing the end phase. It has 30 academic, research and industrial partners across Europe, and one partner in Taiwan. The companies involved range from small charitable organisations to multi-nationals like Continental and Hewlett Packard.

The Zerowin project has reported on how existing approaches and tools can be improved and combined to best effect in an industrial network and how innovative technologies and design innovations can contribute to achieving the project's zero waste vision. It focuses on two key waste types in four industry sectors, as follows

- high-tech waste, from three sectors
  - electrical and electronic equipment (EEE)
  - automotive sector

- photovoltaic (PV) sector
- construction and demolition (C&D) waste.

The main aim of the project was 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 stringent targets

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

A key part of the project was to make a comprehensive review of literature, current practice and policy so that a common vision could be created as a foundation for the demonstration activities in each industry sector. The key concepts, guiding principles, technologies, methods and tools have been distilled into the key strategies that underpin the Zerowin approach: these are designing waste out of the system; industrial symbiosis and closed-loop supply chain management; use of effective waste prevention methods and new technologies; application of individual producer responsibility (IPR); and accurate monitoring and assessment of results (Curran and Williams, 2012).

The zero waste concept underpins the Zerowin vision. Zero waste envisions all industrial inputs being used in final products or converted into value-added inputs for other industries or processes. In this way, industries are 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 (Suzuki, 2000). The zero waste concept requires industries to re-engineer their manufacturing systems so that they can fully utilise the resources within the industries.

These key concepts formed the foundation of the demonstration case studies presented in this journal. The crucial Zerowin concept is an 'industrial network' – a physical framework for cooperation between network members aimed at zero waste and resource conservation. Figure 1 presents the scope and the boundaries of an industrial network, according the Zerowin definition.

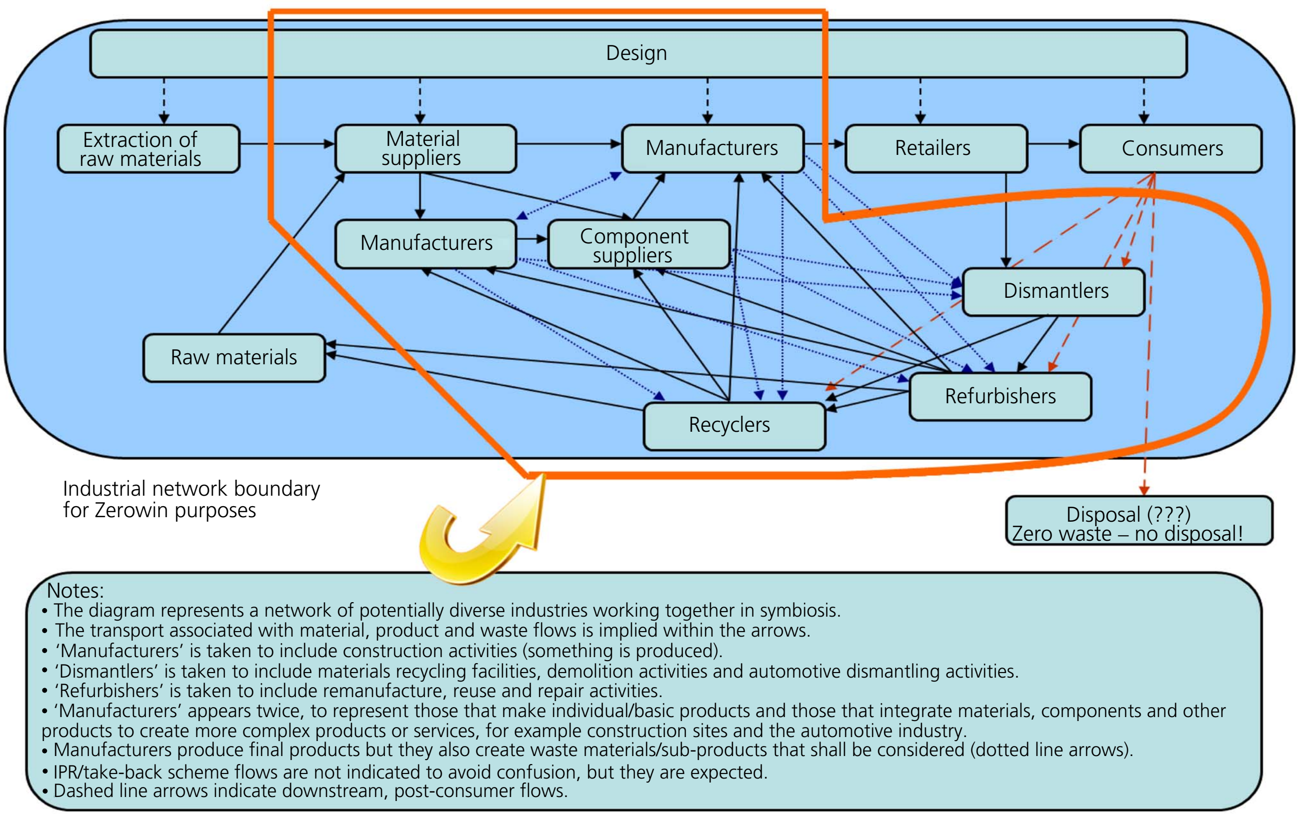

Figure 1. The scope and boundary of an industrial network for Zerowin

In the economy a number of industrial networks, often referred to as industrial symbioses, exist. Some of them evolved spontaneously, if there were enough economic or political incentives. The Zerowin networks evolved as a targeted process. The development of an industrial symbiosis is a long-term process requiring extensive data collection, data analysis, facilitating contacts between various non-related industries and overcoming various barriers.

For the Zerowin case studies the following methodology was proposed and followed.

(*a*) Identification of own input streams by the case study manufacturers (resources used in production processes), both product related (feedstock materials) and process related (auxiliary).
(*b*) Identification of the required quality of the input streams in order to identify tolerance of the manufacturing process to recovered (non-virgin) substitutes.
(*c*) Identification of potential network partners, both Zerowin industries and non-Zerowin industries.
(*d*) Identification of own output streams and their current destination.
(*e*) Identification of the quality of the output streams.
(*f*) Identification of potential application of the output streams, both at Zerowin and non-Zerowin industries.

Brainstorming sessions were conducted at Zerowin meetings in order to identify potential co-operations and resource exchange possibilities within and outside the Zerowin consortium.

Quality tolerance has been determined as a crucial parameter for industrial networking. If the quality requirements are very high, so that only virgin materials can fulfil them, the potential for industrial networking is low. Another crucial parameter is the supply of resources in the required quantity and the guarantee of its continuity. Industrial symbiosis can only be successfully implemented if it is viable economically. Ideally, all participants should benefit from such symbiotic relations – the company which delivers by-products does not have to bear the costs of waste treatment and disposal, and the company which utilises by-products has lower production costs due to cheaper raw materials.

The methodology for the development of industrial symbiosis is shown in Figure 2.

The industrial networks have not been limited to the classical symbiosis only. The main goal is to prove high resource efficiency through the combination of all of the mentioned possible strategies, involving processing of secondary materials at designated recycling plants or other recovery options. The role of recycling companies in the industrial network can be multifold, with various degrees of intervention in the secondary material composition and quality. The extent of the operations that will be required at the recycling plant is strongly related to the quality of the secondary material provided, as it is necessary to match the supplied to the demanded qualities. In addition, 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. A resource exchange platform has been developed to facilitate information flow and ultimately higher resource efficiency.

3. Zerowin outputs

Many outputs are expected over the duration of the project – there are almost 40 project deliverables in total, ranging from tangible outputs such as a prototype D4R* (i.e. design for reuse, recycling, refurbishment, repair) laptop, to reports and guidance documents on new methods and systems, to the

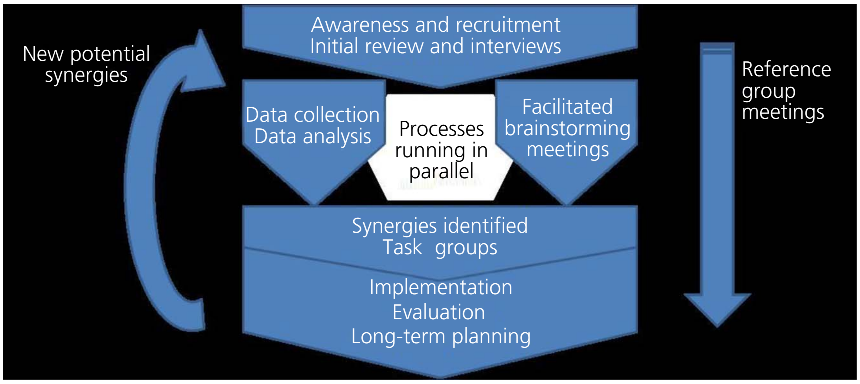

Figure 2. Methodology of the development of industrial symbiosis (adapted from Starlander (2003))

development of a production model for resource-use optimisation and waste prevention. Ultimately, the key results will be the quantitative assessment of the performance of the Zerowin approach by ten case studies applying the production model. These form the core of the project, and will each be measured against the three environmental targets outlined earlier.

Other outputs will be recommendations for policy making, the creation of a knowledge management platform on zero waste, and the delivery of education, training and support services on this new sustainable approach in industry. More general outcomes of the project will include the impact on research and industrial practice externally and secondary impacts on employment, the economy and health of EU citizens. The ten case studies (and their associated industrial networks) are

(*a*) the design for reuse (D4R) laptop
(*b*) the D4R photovoltaic system
(*c*) a reuse network and the resource exchange platform
(*d*) resource efficiency construction networks (UK)
(*e*) resource efficiency construction networks (Portugal)
(*f*) refurbishment and new construction projects (Germany)
(*g*) demolition of end-of-life buildings (UK)
(*h*) demolition of end-of-life buildings (Portugal)
(*i*) automotive part recycling
(*j*) business to business EEE industrial networks.

This special issue of *Waste and Resource Management* showcases 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 and indeed a significant challenge for achieving a global closed-loop economy. Barriers to this kind of cooperation between enterprises will be discussed on a case-by-case basis.

4. Conclusion

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.

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