Deliverable 3.6

CONSTRUCTION WASTE PREVENTION STRATEGY: CONSIDERATION OF WASTE PREVENTION IN MATERIALS CERTIFICATION

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1 EXECUTIVE SUMMARY

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
• Recommendation 6: Regulating water consumption during construction and demolition activities
• Recommendation 7: Mandatory eco-product specification at design phase
• Recommendation 8: Documenting the use of sustainable products and materials
• Recommendation 9: Zero-waste strategy applications on lightweight products including nanotechnology
• Recommendation 10: Building certification schemes application
• Recommendation 11: Building certification schemes improvement
• Recommendation 12: Matching ZeroWIN strategy to the building lifecycle
• Recommendation 13: Education and awareness raising activities
• Recommendation 14: Stimulating industrial networks through planning requirements at macro level
• Recommendation 15: Establishing reuse and recycling route during planning and development phase (pre-construction/demolition) at micro level.

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,
2 INTRODUCTION

As part of the EU Seventh Framework funded ZeroWIN (Towards Zero Waste in Industrial Networks) project (Grant Agreement number 226752), Remade South East was commissioned to consider waste prevention strategies within material and component certification schemes (work package 3, deliverable 3.6).

The aim of deliverable 3.6 is to review established construction product accreditation schemes with a view to identifying opportunities for waste prevention in material certification.

Sustainable construction takes a holistic approach which addresses and develops solutions for the environmental impacts of construction activities, materials and products throughout their entire life-cycle. Present construction legislation is limited to direct environmental impacts such as water body protection, waste savings, preserving soil quality and biodiversity, and to promote waste prevention and energy efficiency.

Environmental certification schemes identify the indirect impacts of construction considering the lifecycle of the building, product, component or materials and as such are key building blocks in the move towards zero waste within industrial networks.

Legislation is not currently a driver in developing environmental certification schemes since neither building nor product accreditation schemes have associated legislation (either at national or European level).

Industry could be considered the driving force in developing tools that standardise building practice which include:

- ISO 15392:2008 – principles for sustainability in building construction (materials, products, services, buildings and construction works)
- ISO/TS 21929-1:2006 – sustainability indicators for buildings
- ISO 21930:2007 – specification and requirements for environmental declarations of building products
- ISO/TS 21931:2006 – assessing the environmental performance of buildings

Other non-legislative drivers include building certification schemes. The longest established schemes are BRE Environmental Assessment Method (BREEAM) and Haute Qualité Environnementale (HQE) from the UK and France with more recent additions of the Portuguese LiderA and German Sustainable Building.

2.1 Methodology

To produce the “Construction waste* prevention strategy: consideration of waste prevention in materials certification” report the following methodology has been applied:

- Review and inclusion of relevant information from former research task report 3.2.4/D3.4 “Integrating Waste Prevention Strategies in Materials and
Components Certification”, task report 3.2.5 “Analysis of Industrial Networks” and task report 3.2.6 “Conclusions and Recommendations”.

- Review of current international market trends in construction materials certification
- Review of current international market trends in building certification schemes
- Review of recent trends in the construction and demolition sector which influence waste prevention strategy development
- Consider certification schemes in the UK, Portugal and Germany

* For the purpose of this report the term ‘waste’ was considered in line with the ZeroWIN expected results to include reduction in greenhouse gas emissions, increase in reuse and recycling of solid waste, reduce consumption of fresh water.

2.2 Similarities in eco-label and environmental certification scheme

When considering the differences between eco-labels and environment certification schemes it is useful to observe the Oxford dictionary definition as:

- Eco-label: the practice of marking products with a distinctive label so that consumers know that their manufacture conforms to recognised environmental standards
- Certificate: an official document attesting a fact

In environmental terms, both consider the life cycle aspects however the many different environment certification and eco-labels place varying importance on raw materials, energy consumption in use criteria based on rating systems unique to the scheme.

For the purposes of the ZeroWIN waste prevention in materials certification task, both schemes could be considered equally relevant towards achieving zero-waste strategies in Europe.
3 IMPORTANCE OF CERTIFICATION SCHEMES IN SUSTAINABLE CONSTRUCTION

3.1 Background
Certification schemes for materials and components were originally established to prove the performance of a product to national health and safety standards (during usage) by guaranteeing performance through testing. Certification to a national standard means that architects, designers and specifiers are assured that the material or component will function within its chosen application to a guaranteed legal standard.

Generally materials and components are certified to national and/or European standards. However some product-led specifications are recognised world-wide. Plasterboard is a good example of an international standard which is accepted by companies such as Knauf and British Gypsum as being the industry standard (British Gypsum Sustainability Statement, 2011).

3.2 European and National Certification Schemes

Construction products that comply with the national standards and harmonised technical specifications are eligible to bear the "CE" mark. The basic requirements are:

- Mechanical strength and stability
- Safety in the event of fire
- Hygiene, health and the environmental
- Safety in use
- Protection against noise
- Energy saving and thermal insulation

Harmonisation of materials and product standards was explored in ZeroWIN Activity Report 3.2.1 “Status Quo Description” where the Construction Products Directive was explored in detail.

United Kingdom
In the UK the British Standards Institute (BSI) assesses the quality of a huge variety of industrial and consumer products including construction materials and components assigning products that meet the standard with British Kitemark and the European “CE” mark (British Standards Institute, 2011).
Since its foundation in 1901 as the Engineering Standards Committee, BSI Group has grown into a leading global independent business services organisation providing standard-based solutions in more than 140 countries. The BSI Group:

- develops private, national and international standards;
- certifies management systems and products;
- provides testing and certification of products and services;
- provides training and information on standards and international trade;
- provides performance management and supply chain management software solutions.

In 2008 the Construction Products Association (representing the UK's manufacturers and suppliers of construction products, components and fittings) asked BSI for help with identifying sustainable building materials. Aside from the well-established Forestry Stewardship Council scheme for timber, there was a lack of trusted and consistent information to help procurers distinguish between sustainable and less sustainable products. Moreover, the industry needed something that would allow it to comply with government legislation (Construction Products Association, 2007).

In 2009 BSI published BS 8902 a specification for responsible sourcing sector certification schemes for construction products. The standard covers construction materials and products, everything from timber, concrete and steel to PVC window frames (SGS Group, 2011).

**Portugal**

In Portugal the National Laboratory of Civil Engineering (LNEC) assesses the quality of new construction products and has the authority to assign the European “CE” mark (different to LNEC approval). Every new product must have LNEC approval before it can be marketed in Portugal (National Laboratory for Civil Engineering, 2011).

LNEC is a member of EOTA (European Organisation for Technical Approvals), of UEAtc (The European Union of Agrément) and of WFTAO (World Federation of Technical Assessment Organisations).

LNEC is the only Portuguese approval body for construction products and to date has issued about 900 Approval Documents. LNEC works in the various domains of civil engineering, giving it a unique multidisciplinary perspective in this field with the goals to carry out innovative research and development and to contribute to the best practices in civil engineering. LNEC also plays a key role in advising the government in technical and scientific matters of civil engineering, as an unbiased and independent body.

Based on the research literature available it would seem that LNEC has no dedicated environmental agenda.

**Germany**

In Germany the Deutsches Institut für Bautechnik (DIBt) assesses the quality of new construction products and has the authority to assign the European “CE” mark
DIBt is the only German approval body for construction products and grants *allgemeine bauaufsichtliche Zulassungen* ('national technical approvals') for construction products and types of construction; it also grants European technical approvals (ETA) for construction products and kits. Every year approx. 2000 national technical approvals are granted. At European level DIBt is competing with the European approval bodies and it takes a leading position when granting European technical approvals. The institute is working for companies which have their product markets in Germany, in Europe as well as internationally.

### 3.3 Summary of component and material accreditation schemes

Certification of building materials, components and products can be very different throughout the EU countries, depending upon the nature of materials or products.

The characterisation of each certification scheme examined within this report is based on the following criteria (presented in tables 1-5):

- Country of origin
- European affiliations
- Date of introduction
- Number of certificates issued
- Product categories
- Costs
- 3rd party accreditation
- Information on Life Cycle Assessment (LCA)
- Key indicators of environmental sustainability
- Comparison with other schemes
- ZeroWIN industrial networks links

**United Kingdom**

Within UK two principle schemes exist to certify construction materials and components and have been compared below. BRE Global run the Environment Profiles Certification scheme and British Board of Agrément (BBA) and has a similar scheme with additional Environment Information requirement.

**Portugal**

Within Portugal certification schemes focus more generally on environmental, quality and RDI (research, development and innovation) for management systems. Information has been included on APCER (The Portuguese Association for Certification) which is the closest equivalent to the UK and German schemes in
Portugal and market leader in Portugal for certification activities. It is clear that the scheme focuses on management systems and limits product testing to CE marking.

There is an initiative in Portugal for the implementation of a registration system of Environmental Product Declarations (EPD) for Construction Materials according to international standards - DAPHabitat. This system will be managed by Platform for Sustainable Construction, manager of the cluster Sustainable Habitat. Contacts are being designed to achieve mutual recognition of EPDs developed in Portugal under DAPHabitat and EPDs developed under the German system BAU. While not formally a certification system, this will be a positive move for environmental information (including waste prevention) related to construction materials in Portugal.

Germany
Germany has one of the first and oldest environment-related label for products and services in the world, the Blue Angel which contains a significant number of construction materials and components (although the scheme categorises products by health, climate, water and resources rather than commercial factors).

### 3.4 Environment Profiles Certification Scheme (BRE – UK)

<table>
<thead>
<tr>
<th>Certification scheme name</th>
<th>BRE Global - Environment Profiles Certification Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Website</td>
<td><a href="http://www.breglobal.com">www.breglobal.com</a></td>
</tr>
<tr>
<td>Country of origin</td>
<td>United Kingdom but wider recognition</td>
</tr>
<tr>
<td>Affiliate in Europe</td>
<td>BRE Global, CSTB (France) and CERTIVEA have signed a</td>
</tr>
<tr>
<td></td>
<td>Memorandum of Understanding for the development of a</td>
</tr>
<tr>
<td></td>
<td>Pan-European building environmental assessment method</td>
</tr>
<tr>
<td></td>
<td>BRE Global is a member of EOTA (European Organisation</td>
</tr>
<tr>
<td></td>
<td>for Technical Approvals</td>
</tr>
<tr>
<td>Date of introduction</td>
<td>1999</td>
</tr>
<tr>
<td>Number of certificates</td>
<td>687 listed in the Green Book live across all environment profiles</td>
</tr>
<tr>
<td>issues</td>
<td></td>
</tr>
<tr>
<td>Product categories</td>
<td>• Ceiling finish</td>
</tr>
<tr>
<td></td>
<td>• Domestic internal foundation</td>
</tr>
<tr>
<td></td>
<td>• External wall</td>
</tr>
<tr>
<td></td>
<td>• Floor finishes</td>
</tr>
<tr>
<td></td>
<td>• Ground floor construction</td>
</tr>
<tr>
<td></td>
<td>• Insulation</td>
</tr>
<tr>
<td></td>
<td>• Internal wall</td>
</tr>
<tr>
<td></td>
<td>• Party wall</td>
</tr>
<tr>
<td></td>
<td>• Roofing</td>
</tr>
<tr>
<td></td>
<td>• Upper floor construction</td>
</tr>
<tr>
<td>Costs</td>
<td>A typical project cost is £8,000 - £12,000</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td><strong>Background to the scheme</strong></td>
<td>The BRE Global provide independent, third party assessment and certification of materials and components for their environmental performance under the “Environment Profiles Certification Scheme”</td>
</tr>
<tr>
<td></td>
<td>The products and services approved by the “Environment Profiles Certification Scheme” are listed in the online database “Green Book Live” free of charge.</td>
</tr>
<tr>
<td><strong>Background to Organisation</strong></td>
<td>BRE Global is responsible for the internationally renowned BRE Environmental Assessment Method (BREEAM) family of schemes for assessing the environmental performance of buildings.</td>
</tr>
<tr>
<td><strong>Accreditation</strong></td>
<td>Independently verified by United Kingdom Accreditation Services (UKAS)</td>
</tr>
<tr>
<td><strong>Information on LCA</strong></td>
<td>Environmental Profiles measure environmental performance throughout a product's life:</td>
</tr>
<tr>
<td></td>
<td>• in manufacture (including impacts from virgin and recycled inputs)</td>
</tr>
<tr>
<td></td>
<td>• in use in a building (taken over a typical building life and including maintenance and replacement)</td>
</tr>
<tr>
<td></td>
<td>• in demolition (the waste produced, allowing for recycling and reuse)</td>
</tr>
<tr>
<td><strong>Key indicators of environmental sustainability</strong></td>
<td>Considered within the LCA stages</td>
</tr>
<tr>
<td></td>
<td>• Climate change - from CO2 and other greenhouse gases especially associated with energy use</td>
</tr>
<tr>
<td></td>
<td>• Ozone depletion - from gases affecting the ozone layer</td>
</tr>
<tr>
<td></td>
<td>• Acidification - from acid gases reacting with rain (acid rain) or water in the soil</td>
</tr>
<tr>
<td></td>
<td>• Consumption of minerals and water</td>
</tr>
<tr>
<td></td>
<td>• Emission of pollutants to air and water - including toxicity to humans and ecosystems</td>
</tr>
<tr>
<td></td>
<td>• Quantity of waste sent to disposal</td>
</tr>
<tr>
<td><strong>Comparison with other schemes</strong></td>
<td>The scheme is independent but is comparable with the BBA Environment Profiles</td>
</tr>
<tr>
<td></td>
<td>Environment Profiles allows specifiers to compare one type of element with another by considering all component parts of a product. A construction product is likely to be made up of several materials and components therefore environmental profiling takes this into account by adding together the contribution of all the component parts.</td>
</tr>
<tr>
<td><strong>Consider manufacturer environmental declaration</strong></td>
<td>Not considered within the assessment criteria</td>
</tr>
<tr>
<td><strong>ZeroWIN industrial networks links</strong></td>
<td>This research assists case study four partners to select products which will improve reduction of environment impact.</td>
</tr>
<tr>
<td></td>
<td>It also allows partners to compare one element of waste with another by configuring all component parts of a product.</td>
</tr>
</tbody>
</table>
Table 1: Summary of the key characteristics of BRE Global Environment Profiles Certification Scheme

### 3.5 Environment Profile Certification (BBA – UK)

<table>
<thead>
<tr>
<th>Certification scheme name</th>
<th>British Board of Agrément (BBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Website</td>
<td><a href="http://www.bbacerts.co.uk">www.bbacerts.co.uk</a></td>
</tr>
<tr>
<td>Country of origin</td>
<td>United Kingdom but wider recognition</td>
</tr>
<tr>
<td>Affiliate in Europe</td>
<td>BBA is a member of EOTA (European Organisation for Technical Approvals), of UEAtc (The European Union of Agrément) and of WFTAO (World Federation of Technical Assessment Organisations).</td>
</tr>
<tr>
<td>Date of introduction</td>
<td>1966</td>
</tr>
<tr>
<td>Number of certificates issues</td>
<td>200</td>
</tr>
<tr>
<td>Product categories</td>
<td>• Concrete</td>
</tr>
<tr>
<td></td>
<td>• Floor</td>
</tr>
<tr>
<td></td>
<td>• Roads/bridge products and materials</td>
</tr>
<tr>
<td></td>
<td>• Ventilation</td>
</tr>
<tr>
<td></td>
<td>• Wall</td>
</tr>
<tr>
<td></td>
<td>• Roof</td>
</tr>
<tr>
<td></td>
<td>• Drainage</td>
</tr>
<tr>
<td></td>
<td>• Windows and doors</td>
</tr>
<tr>
<td></td>
<td>• HAPAS</td>
</tr>
<tr>
<td>Costs</td>
<td>Costs range from £5,000 - £50,000 depending on nature of testing</td>
</tr>
<tr>
<td>Background to the scheme</td>
<td>The British Board of Agrément (BBA) provide independent, third party assessment and certification of materials and components for their environmental performance under the Environmental Profile Certificates which consists of two sections</td>
</tr>
<tr>
<td></td>
<td>• ‘Environmental Profile’ calculated from BS EN 14040 series of Standards and BRE environmental profiles methodology and results can be linked to the Green Guide</td>
</tr>
<tr>
<td></td>
<td>• ‘Additional Environmental Information’ includes manufacturer’s environmental declarations</td>
</tr>
<tr>
<td>Background to Organisation</td>
<td>Since 1966 Agrément Certificates have been providing invaluable information on the performance of new construction products and materials.</td>
</tr>
<tr>
<td>Accreditation</td>
<td>Independently verified by United Kingdom Accreditation Services (UKAS)</td>
</tr>
<tr>
<td>Information on LCA</td>
<td>Scheme is comparable with BRE Global Environmental Profiles which measure environmental performance throughout a product’s life:</td>
</tr>
<tr>
<td></td>
<td>• in manufacture (including impacts from virgin and recycled inputs)</td>
</tr>
</tbody>
</table>


in use in a building (taken over a typical building life and including maintenance and replacement)
• in demolition (the waste produced, allowing for recycling and reuse)

Key indicators of environmental sustainability

Considered within the LCA stages:
• Climate change - from CO2 and other greenhouse gases especially associated with energy use
• Ozone depletion - from gases affecting the ozone layer
• Acidification - from acid gases reacting with rain (acid rain) or water in the soil
• Consumption of minerals and water
• Emission of pollutants to air and water - including toxicity to humans and ecosystems
• Quantity of waste sent to disposal

Scheme is comparable with BRE Global Environmental Profiles.

Comparison with other schemes

The scheme is independent but is comparable with the BRE Global Environment Profiles.

Consider manufacturer environmental declaration

Additional environmental information is verified by the BBA’s environmental experts which can include:
• Recycled content
• Environmental benefits in use phase
• Carbon balance
• Recyclability and manufacturer’s responsibilities,
• Environment Management Systems
• Responsible Sourcing

Table 2: Summary of the key characteristics of British Board of Agrément (BBA) scheme

3.6 APCER (2009) (Portuguese Association for Certification Portuguese Scheme – Portugal)

<table>
<thead>
<tr>
<th>Certification scheme name</th>
<th>APCER (2009) Portuguese Association for Certification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Website</td>
<td><a href="http://www.apcer.pt">www.apcer.pt</a> (English translation available)</td>
</tr>
<tr>
<td>Country of origin</td>
<td>Portugal but wider recognition</td>
</tr>
<tr>
<td>Affiliate in Europe</td>
<td>Certified organisations in Spain, Morocco, Mozambique, Angola, Brazil and China; IQNet (The International Certification Network)</td>
</tr>
<tr>
<td>Date of introduction</td>
<td>1996</td>
</tr>
<tr>
<td>Number of certificates issues</td>
<td>Information not available</td>
</tr>
<tr>
<td>Product categories</td>
<td>Information not available</td>
</tr>
<tr>
<td>Costs</td>
<td>Information not available</td>
</tr>
<tr>
<td>Background to the scheme</td>
<td>The Portuguese Association for Certification (APCER) provide independent, third party assessment and certification of materials and components primarily to the CE standards</td>
</tr>
<tr>
<td></td>
<td>Presently there is not a division dedicated to Environmental Product or Services Certification and the construction Sector Certificates</td>
</tr>
</tbody>
</table>
consists of
• ISO 9001 - Quality Management Systems Certification
• ISO 14001 Environmental Management Systems Certification
• Environmental Verification (EMAS)
• Occupational Health and Safety Management Systems Certification (OHSAS18001:1999 / NP4397)
• CE Marking

Background to Organisation
APCER is a private Portuguese organisation dedicated to the certification of management systems, services, products and people as a method of guaranteeing quality and promoting the competitive advantage of organizations, whether public or private, national or international.

Accreditation
Credibility is ensured by thorough control processes and recognized through accreditation from IPAC - Instituto Português de Acreditação, ENAC – Entidade Nacional de Acreditação Espanhola and SAI - Social Accountability International.

Information on LCA
Information not available

Key indicators of environmental sustainability
Information not available

Comparison with other schemes
The scheme is independent and not comparable with other certification schemes

Consider manufacturer environmental declaration
Information not available

Table 3: Summary of the key characteristics of APCER (2009) Portuguese Association for Certification scheme

3.7 Blue Angel (Germany)

<table>
<thead>
<tr>
<th>Certification scheme name</th>
<th>Der Blaue Engel (The Blue Angel)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Website</td>
<td><a href="http://www.blauer-engel.de">www.blauer-engel.de</a> (English translation available)</td>
</tr>
<tr>
<td>Country of origin</td>
<td>Germany</td>
</tr>
<tr>
<td>Affiliate in Europe</td>
<td>Scheme recognised Europe wide</td>
</tr>
<tr>
<td>Date of introduction</td>
<td>1978</td>
</tr>
<tr>
<td>Number of certificates issues</td>
<td>Information not available solely for Construction Products. 1050 licensees use The Blue Angel for about 11,500 products</td>
</tr>
<tr>
<td>Product categories</td>
<td>• Construction machinery</td>
</tr>
<tr>
<td>Costs</td>
<td>From €270-€6000 per annum</td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>Background to the scheme</td>
<td>The award criteria are developed by the Federal Environment Agency in close consultation with product manufacturers, testing bodies and consumer associations. After certification, the products are able to use then the eco-label logo.</td>
</tr>
<tr>
<td>Background to Organisation</td>
<td>The Blue Angel is a large German organization owned by the Federal Ministry for the Environment Nature Conservation and Nuclear Safety. It certifies a large range of consumer products that are ecologically sound and a high-quality ecological alternative.</td>
</tr>
<tr>
<td>Accreditation</td>
<td>Information not available</td>
</tr>
<tr>
<td>Information on LCA</td>
<td>Specific life cycle analysis information not available on website</td>
</tr>
<tr>
<td>Key indicators of environmental sustainability</td>
<td>Key indicators of environment sustainability information is not available on the website</td>
</tr>
<tr>
<td>Comparison with other schemes</td>
<td>The scheme is independent and not comparable with other certification schemes</td>
</tr>
<tr>
<td>Consider manufacturer environmental declaration</td>
<td>Not considered within the assessment criteria</td>
</tr>
</tbody>
</table>

Table 4: Summary of the key characteristics of Der Blaue Engel (The Blue Angel) scheme

### 3.8 Seal of Approval (Institut für Baubiologie – Germany)

<table>
<thead>
<tr>
<th>Certification scheme name</th>
<th>IBR Institut für Baubiologie</th>
</tr>
</thead>
</table>

- Website: [www.baubiologie-ibr.de](http://www.baubiologie-ibr.de) (English translation available)
- Country of origin: Germany
- Affiliate in Europe: Yes
- Date of introduction: 1982 (revised July 2010)
- Number of certificates issues: 300
- Product categories:
  - Bricks and brick products
  - Ceramic products
- Limestone, gypsum, cement and derived products
- Wallpapers, home textiles, flooring
- Wood and wood materials

**Costs**

Vary depending on component or material

**Background to the scheme**

The Institut für Baubiologie (IBR) provide independent, third party assessment and certification of materials and components for their environmental performance under the Seal of Approval scheme.

**Background to Organisation**

The Institut für Baubiologie Rosenheim GmbH (IBR) was founded in 1978 with the objective to enrich residential environments with ideals from human ecology and to develop and promote ecologically compatible practices among planners, architects and building contractors.

**Accreditation**

Information not available

**Information on LCA**

Not considered within the assessment criteria

Scheme focuses on promoting non-polluting building products in situ, no reference to life cycle analysis

**Key indicators of environmental sustainability**

Scheme focuses on pollutants to air, land and water

No reference to climate change, ozone depletion, acidification, consumption of minerals and water or quantity of waste sent to disposal

**Comparison with other schemes**

The scheme is independent and not comparable with other certification schemes

**Consider manufacturer environmental declaration**

Not considered within the assessment criteria

**ZeroWIN industrial networks links**

Table 5: Summary of the key characteristics of Seal of Approval (Institut für Baubiologie – Germany) Scheme

### 3.9 Changing focus of certification schemes

The increasing importance of material, product and component certification schemes can be illustrated by examining the changes that have taken place in the window manufacturing and installation industry. By comparing traditional practice where certification focused on windows in their usage phase with modern sustainable construction practice influenced by life cycle analysis driven building certification schemes illustrates the evolution of certification schemes.

As an example, historically domestic and commercial windows pre-1950 consisted of single glazed panes with wooden framed units. These offered limited thermal efficiency and required regular maintenance of the wooden frames. In the early 1950s low production costs saw a rise in single glazed metal frame units which offered improved thermal efficiency and reduced maintenance relative to wooden framed units. The 1970s saw the emergence of double glazed units with aluminium frames which offered far superior thermal and acoustic insulation properties. The move to UPVC when extrusion technology resulted in a more cost effective
manufacturing process frames saw further improvements in thermal efficiency and far reduced maintenance requirements.

Until this point it is clear that development of windows was driven by the product in use which is illustrated by the benefits (short term) of UPVC frames but with little regard to the material and component life cycle particularly at end of life.

More recently there has been an increased demand for timber framed double or triple glazed units driven partially by customer preferences but primarily by the sustainable construction influence of life cycle analysis focused building certification schemes which actively promote products with a reduced environmental impact across the life cycle. For example, the UK Code for Sustainable homes awards points when timber frames manufactured from FSC approved timber are used but no points were awarded for UPVC frames. Table 1 shows a summary of the features of timber and UPVC window frames at key stages of the life cycle.

<table>
<thead>
<tr>
<th></th>
<th>Timber Frame</th>
<th>UPVC Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Raw materials</strong></td>
<td>Timber sourced from sustainable materials</td>
<td>UPVC sourced from non-sustainable materials (oil)</td>
</tr>
<tr>
<td><strong>In use</strong></td>
<td>Window offer equivalent benefits in use as conventional product Requires regular maintenance</td>
<td>Window offer equivalent benefits in use as conventional product Requires minimal maintenance</td>
</tr>
<tr>
<td><strong>End of life</strong></td>
<td>Component parts have established recycle and reuse routes</td>
<td>Emerging market for UPVC frames to be recycled very much in its infancy</td>
</tr>
</tbody>
</table>

Table 6: Summary Life Cycle comparison of Timber and UPVC Window Frames

### 3.1 Waste Prevention in material and component certification

Former research in ZeroWIN work package 3 has identified that mandatory material certification has no great focus on environmental aspects. Neither has it had intervention at waste prevention level in materials nor at components design.

However, there is a trend for more restrictive specifications of materials in what regards mandatory material certification. Namely, Regulation (EU) no 305/2011 of the European Parliament and of the Council (9 March 2011). This refers specifically to environmental aspects and suggests the use of EPD to assess sustainability of resource use and the environmental impacts of buildings.

This is demonstrated in Point (55) of the Regulation: “The basic requirement for construction works on sustainable use of natural resources should notably take into account the recyclability of construction works, their materials and parts after demolition, the durability of construction works and the use of environmentally compatible raw and secondary materials in construction works.”

Annex 1, section 7 ‘sustainable use of natural resources’ further states:
“The construction works must be designed, built and demolished in such a way that the use of natural resources is sustainable and in particular ensure the following:
(a) reuse or recyclability of the construction works, their materials and parts after demolition;
(b) durability of the construction works;
(c) use of environmentally compatible raw and secondary materials in the construction works.”

These guidelines imply the obligation to avoid resources depletion and prevent waste generation in distinct stages of a material or a building life cycle.

3.2 Eco-labels and environment certification
Eco-label and environment certification schemes are becoming increasingly prominent in international symposiums and research papers globally illustrating an increased knowledge and understanding of the relevance when selecting construction materials and components.

Evaluating Eco-Labels
For the past 18 years the International Symposium on Sustainable Systems and Technology (IEEE ISSST) has been a centre for international debate considering innovative solutions to sustainability challenges. The program covers the spectrum of issues for assessing and managing products and services across their life cycle, and the design, management, and policy implications of sustainable engineered systems and technologies. The 2011 IEEE ISSSST programme included 18 sessions on a diverse set of topics, from nanotechnology to large scale infrastructure, authored and presented by an international mix of speakers. Of particular interest to the ZeroWIN goal for waste prevention in construction materials certification was a seminar on using an LCA approach to evaluate green labels. The research paper commented that “while the green building materials industry has flourished, the labelling of green materials is disparate, confusing, and complex” which supports comments made in earlier research papers in ZeroWIN Work Package 3 (Rajagopalan, Bilec, Landis, 2011).

Eco-LCA evaluation tool (relevant to ZeroWIN case studies)
The American Society of Civil Engineers (ASCE) considered the issue of sustainable assessment tools at their annual 2011 ASCE International Workshop on Computing in Civil Engineering. During a session on Sustainability and Resilient Infrastructure the Ohio State University Centre for Resilience presented a paper on “Evaluation Eco-Efficiency of Construction Materials: A Frontier Approach” alongside their free evaluation tool ‘Eco-LCA’ (funded by the National Science Foundation and the U.S. Environmental Protection Agency). The Eco-LCA assessment tool has been 10 years in development and uses data envelopment analysis to rank life cycle assessment and life cycle cost including ecosystem services such as soil erosion, pollination, flood prevention and cropland. Eco-LCA aims to complement existing LCA tools by showing how different products and materials impact on nature (Tatari, Kucukvar, 2011). This research tool provides further analysis on materials used in the construction and demolition sector and is free to access (Eco-LCA, 2011).
3.3 Delivering Zero-emission buildings

Addressing energy consumption during building use has been considered during the review of building certifications in former research conducted by CEIFA. A short summary of the most recent trends is presented below linking to analysis tools and building certification schemes.

During the course of ZeroWIN Work Package 3 research for deliverable 3.6 “Consideration of Waste Prevention in Materials Certification” it has become clear that while selection of building materials and components which optimise sustainable characteristic contributes to zero-waste strategies, considering the design element of energy consumption/wastage in building use should also be included in the goal to deliver zero-emission buildings.

Residential Building EU Eco-Label

The European Commission has tasked the Italian Ministry for Economic Development with defining criteria for the proposed EU eco-label for residential, office and school buildings taking into account the new European Performance of Buildings Directive. Separate requirements will be applied for existing and new building stock. Within the industry there has been concern the potential for duplication given the successful building certification schemes that already exist and are well recognised (Franzitta et al., 2010).

The European Commission's Directorate General for the Environment has instructed the Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS) to carry out a pilot study on developing an EU Ecolabel for “Buildings”. The environmental impacts associated with energy consumption have made establishing the “Ecolabel for new and major renovated office buildings” the first in the series. The proposed weighting criteria for the Ecolabel allows designers freedom to develop buildings suitable for the local area while ensuring that the most significant environmental aspects are addressed. Table 7 compares the proposed weighting criteria to established building certification schemes such as BREEAM and HQE and is based on the harmonization of existing environment labels in the Member States and on scientific results obtained in the LCA studies (Larriba, Dodd, Wolf, 2012).

Importance of design interface in achieving zero emission buildings

The International Symposium on Sustainable Systems 2011 included a seminar on the role of product and systems interfaces in designing zero emission buildings. Through the lifecycle of a building it has been shown that the greatest energy consumption occurs during the occupation phase (not the build or demolition phase) through use of the building and its integrated energy consuming products. The design of a product interface has been shown to strongly influence how an individual...
user interacts with a product. Considering how the design interface will affect tenant’s behaviour will strongly influence the emissions generated (or avoided). Therefore, super energy efficient products and buildings which have a human oriented design approach based on real users’ behaviour will be a key factor in delivering zero emission buildings (Wigum, Zacharson, Boks, 2011).

Assessing building design with life cycle analysis dynamically
During the 2011 ASCE International Workshop on Computing in Civil Engineering Stanford University presented a paper on “Dynamic Life Cycle Assessment of Building Design and Retrofit Processes”. The Dynamic Life Cycle Assessment is a tool which uses real-time data to examine tradeoffs between design and construction/operation decisions providing a vital link between these two previously disparate areas.

Zero emission buildings (in use)
A very recent review of “Europe’s buildings under the microscope, a country-by-country review of the energy performance of buildings” documented that some of the most significant greenhouse gas emission sources in Europe are a result of the energy consumed in buildings. This is particularly evident in older buildings (the majority of European building stock) which predominantly require renovation to improve their energy performance, “with their potential to deliver high energy and CO$_2$ savings as well as many societal benefits, energy efficient buildings can have a pivotal role in a sustainable future” (BPIE, 2011).

The review does not make reference to solutions for existing building stock that is not suitable for energy performance renovations. For example a recent scheme in the UK by the Energy Saving Trust’s Home Insulation Scheme identified that around half the houses on the island of Uist, Scottish Outer Hebrides, were unsuitable for the scheme. The older stone-build properties are classed as ‘hard to treat’ as they do not have wall cavities or the roof space that could be insulated under the Energy Savings Trust project. The scheme recognized that some of the issues which made properties ‘hard to treat’ were unique to Uist (including being off the gas grid) and
additional funding has been invested to run four pilot projects to test innovative insulation ideas. The results of these will be published in early 2012 and could be very informative in the move towards refurbishing residential properties which are off the gas grid throughout Europe (Sustainable Uist, 2011).

A similar experience by Radian (a social housing provider in the south east of England, UK) identified that undertaking retrofit measures to improve energy efficiency in ‘hard to treat’ properties also provided opportunities and generate energy through solar PV and solar water heating (Radian, 2011).

### 3.4 Country wide approach to ZeroWIN principles
During the research process it was identified that Singapore has been making significant steps towards sustainable construction embodying the ZeroWIN project aims with four of the ten key eco-labels relating directly to sustainable construction (Tay, 2011). The combination of four eco-labels which deliver the ZeroWIN principles would collectively deliver the ZeroWIN waste prevention goal during production, build, use and decommissioning.

<table>
<thead>
<tr>
<th>Certification Scheme (eco-label)</th>
<th>Description</th>
</tr>
</thead>
</table>
| **Green Mark** | The [BCA Green Mark Scheme](#) was launched in January 2005 by the Building and Construction Authority (BCA) to encourage more green buildings and sustainability in the built environment.  

The Green Mark is a green building rating system to evaluate a building for its environmental impact and performance based on five key criteria: Energy Efficiency, Water Efficiency, Environmental Protection, Indoor Environmental Quality, Other Green Features and Innovation.  

Under the Green Mark assessment system, buildings are awarded the Platinum, Gold Plus, Gold or Certified rating depending on the points scored. |
| **Singapore Green Building Product Certification** | The [Singapore Green Building Product Certification Scheme](#) was launched by the Singapore Green Building Council (SGBC) in September 2010 to support the BCA Green Mark Scheme, and help the building industry move towards sustainability.  

The certification provides consumers, building industry stakeholders, and government procurement system a listing of assessed and certified green building products in the following categories: Mechanical, Electrical, Facade and Roof System, Concrete and Structural, Interior System, Finishes, Recycled Material, and |
Renewable Energy.

The products are assessed on: Energy efficiency, Water efficiency, Resource efficiency, Health and Pollution Control, and other requirements such as environment quality management system, technical performance, and innovation.

Energy Label

The **Energy Label** is issued by the National Environment Agency (NEA) and is mandatory for registered suppliers of air-conditioners, refrigerators and clothes dryers to affix the Energy Label on their appliances.

The Energy Label shows the [energy efficiency rating and the energy consumption](#) of the appliance (appliances with more ticks are more energy efficient).

The public can check the green ticks for different brands and types of appliances from this [database of registered goods](#).

Water Efficiency Label

There are 2 types of **Water Efficiency Label** for water-efficient water fittings and appliances under the Water Efficiency Labelling Scheme (WELS).

The Mandatory WELS includes shower taps and mixers, basin taps and mixers, sink/bib taps and mixers, flushing cisterns, urinals and urinal flush valve. The Voluntary WELS showerheads and clothes washing machines.

The Water Efficiency Label shows the water consumption and water efficiency of the appliances and fittings (the more ticks shaded on the Label, the more water-efficient a product is).

Table 8: Summary of sustainable construction certification schemes in Singapore
4 CURRENT THINKING ON EMERGING MARKETS FOR REUSE AND RECYCLED CONTENT PRODUCTS & ANALYSIS OF REUSE AND RECYCLING MARKETS

4.1 Background information
A review of construction and demolition treatment methods was undertaken by the European Environment Agency, A Review of Selected Waste Streams (EEA, Technical Report no 69, 2002a). The ZeroWIN Activity Report 3.2.1 “Status Quo Description” examined the waste amounts arising per capita as a base line indicator in great detail to draw comparisons between Portugal, German and the UK.

In the context of the EEA Technical report, the definition of recycling includes the use of crushed concrete and bricks as both fill material in new construction and fill to void space (instead of virgin material). Denmark, Germany and the Netherlands would appear to recycle the greatest volume of construction and demolition waste with over 80% being recycled. The majority of waste arising in Scandinavian countries is wood waste due to the nature of their construction methods (majority of construction is timber framed). Finland, Ireland and Italy recycle 30–50 %, while the recycling percentage in Luxembourg is 10 %.

4.2 Implications of recession
In the UK the recession has affected all aspects of the economy and by December 2008 the construction sector had sector shrank at its fastest pace since records began. House building had the most significant decline, while the civil engineering and commercial sub-sectors also fell at record rates during that month (Stiff, 2009).

The UK Coalition Government published “The Spending Review” in October 2010 to identify savings across all government departments. Reduced departmental budgets has resulted in planned public sector spending programme have been put on hold such as construction of roads, schools and other public buildings (Boughton, 2010).

Germany has experienced the recession across of their economy with the quarter-on-quarter contraction in Europe’s biggest economy, accounting for a third of euro zone output, even steeper than the 2.2-percent fall recorded in the final three months of 2008 (Eubusiness, 2009).

Portugal has experienced the recession across their economy and recently introduced a stringent budget cuts across public sector spending which are likely to have a knock on effect on public-sector construction (Eubusiness, 2010)
4.3 National organisation position

Baseline Data
Baseline construction data from the Environment Agency is very out of date. The most recent published national document is “Construction and Demolition Waste Survey 1999-2000” (Environment Agency, 2001) although several regions have carried out research independently for example East of England. The publications the Environment Agency produce are generally focused at helping business mitigate the risk of legal non-complicate.

In March 2009 a three-year partnership programme “Pathway to Zero Waste” was launched to reduce waste to landfill with founding partners WRAP, SEEDA and the Environment Agency.

The Portuguese Environmental Agency (APA) also has no up to date information available regarding the production and management of construction and demolition waste. For 2005, around 7.5 tons were produced and a significant volume of this was illegally managed (APA, 2011). However this situation is now inverted with the application of specific legislation (2008) and a better supervision from competent authorities.

Waste Arisings
In England, construction, demolition and refurbishment activities produce around 33% of all waste, with inert waste alone being 90 million tonnes. About half of this waste is recycled from the demolition and excavation sectors and parts of the construction sector. On top of that, construction and demolition waste is responsible for more hazardous waste than any other industry sector.

Around 380 million tonnes of resources are consumed by the construction industry each year, suggesting that there is greater scope for waste reduction, reuse and recycling. The government’s Sustainable Development Strategy (Securing the Future, 2005) recognises that the construction sector has a particularly strong influence on the sustainability of UK consumption, through use and management of resources. But we cannot hope to address the industry’s mounting waste problem in isolation. Everyone agrees that, in order to minimise waste, we must work within the wider sustainability and production agenda – where waste issues are just one part of an overall life cycle assessment (DEFRA 2008) (DEFRA, 2010).

This reality is extended to Portugal and to other European countries. Despite the economical crisis, the construction sector is still responsible for significant amounts of European waste production and resources consumption (Communication from the Commission: Towards a thematic strategy on the prevention and recycling of waste, 2003), including soil occupation.

Summary on market growth
Recent quotes in the UK trade journals focus on the need to reduce legislation and allow freedom to reuse and recycle left-over and waste materials.

One such quote attributed to Richard Jenkins, Director of Master Builder described site waste management plans as “a bit of a sledgehammer to crack a nut” and further commented on the Proposed Waste (Wales) Measure Bill that proposes a ban on recyclables such as glass, metals, plastics and wood from landfill saying “Builders that want to recycle, believe in it and think it may even have a business case would find there are no options for them if there was a complete ban on landfill” (Reynolds, 2010).

Similarly, recent research from the Wood Recyclers Association has found that whilst half of the waste wood is reprocessed into panel board, the remainder is either incinerated, mulched for landscaping or used as animal bedding or used as equine surfacing with very little being reused. Peter Butt of the Wood Recyclers Association called on the Environment Agency to exempt wood reprocessors from current legislation so that they are able to accept both treated and untreated wood (Anon, 2010)

Andrew Hartley, Operations Director for CO2sense commented that markets need to complement each other and not compete directly such that all waste is perceived for the value it has. With regard to wood waste in particular he drew attention to the percentage of wood being reprocessed for panel board manufacture. He states that only ten years ago some 90% of waste wood was used for panel board whereas today only 50% is reprocessed with the vast majority of the remainder being incinerated for energy (Hartley, 2010)

Although in Portugal this is not a theme often reported by the press or technical/scientific publications, specialists and actors from the sector of waste management feel that there is no market for recycled materials. Some of the causes pointed are:

- the low price of competitor natural materials, mainly on aggregates
- the lack of confidence of the construction technicians
- very strict regulations for certification (CE mark) of recycled and secondary materials and
- heavy licensing processes for an agent to become a recycler and be able to sale the recycled material

4.4 The Importance of Quality Protocols in the UK

Quality Protocols have an important role to play in material and component accreditation schemes as they allow products formerly deemed as ‘waste’ to be treated in the same manner as virgin materials.

In the UK, the Quality Protocols Project is a joint Environment Agency and WRAP initiative in collaboration with industry, funded by the Department for the Environment, Food and Rural Affairs (Defra), the Welsh Assembly Government (WAG) and the Northern Ireland Environment Agency (NIEA) as a business resource efficiency activity. The purpose of the Quality Protocol is to provide a uniform
control process for producers from which they can reasonably state and demonstrate that their product has been fully recovered and is no longer a waste. It also provides purchasers with a quality-managed product to common aggregate standards increasing confidence in performance. Furthermore the framework created by the Protocol provides a clear audit trail for those responsible for ensuring compliance with Waste Management legislation.

A Quality Protocol gives guidance on how to recover waste, remove it from the regulatory regime and unnecessary regulations. It will assist in identifying the point at which the inert waste used to produce recovered aggregates has been fully recovered, ceases to be a waste and becomes a product and it will give adequate assurance that recovered aggregate products conform to standards common to both recovered and primary aggregates.

For example, for aggregates the protocol seeks to ensure that recovered materials meet the quality and conformity requirements for European Standards for Aggregates. If they do then they are likely to be regarded as having been completely recovered and having ceased to be waste at that point. However, whether a substance or object is waste, in any particular situation, must still be determined in the light of all the circumstances, having regard to the aims of the Waste Framework Directive (75/442/EEC as amended by 91/156/EEC and 2008/98/EC) and the need to ensure that its effectiveness is not undermined.

Quality Protocols exist for:
- Gypsum from waste plasterboard
- Paper sludge ash
- Anaerobic digestate
- Blast furnace slag
- Compost
- Flat glass
- Plastic waste
- Processed fuel oil
- Pulverised fuel ash and furnace bottom ash
- Soils
- Rubber materials
- Waste vegetable oil

4.5 The Importance of the Waste Hierarchy
Article 4 of the Waste Framework Directive 2008/98/CE outlines the new waste hierarchy as a guide which should act as a "priority order of what constitutes the best environmental option in waste legislation and policy".

The European waste hierarchy refers to the 5 steps included in the article 4:
1. Prevention – preventing and reducing waste generation.
2. Reuse and preparation for reuse – giving the products a second life before they become waste (without mechanical pre-processing).
3 Recycle - any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes composting and it does not include incineration.

4 Recovery – includes some waste incineration facilities where energy recovery meets legal specification

5 Disposal - processes to dispose of waste by land filling, incineration (not meeting energy recovery requirements), pyrolisis, gasification and other finalist solutions.

The European waste hierarchy supports industrial symbiosis by making the treatment of waste materials no longer principle economically driven but instead by adopting the best environmental option.

4.6 Industrial network opportunities and challenges

ZeroWIN Work Package 3, Activity Report 3.2.6 considered the analysis of industrial networks in the construction and demolition sector as a mechanism to minimise waste through industrial symbiosis. The construction and demolition sector has traditionally been wasteful with resources therefore there has great potential for improved resource efficiency through industrial symbiosis. In practical terms, making the savings through industrial networks will be more challenging as the construction and demolition sector has a short term transient nature meaning that just as networks are established the build is coming to an end. However there is the potential to accumulate networks from one build to the next build as an ongoing strategy to deliver long-term zero waste initiatives. This approach has been illustrated in both demolition case studies undertaken by CEIFA and has been documented in the work package 6 reports.

The construction and demolition industry generates a significant variety of materials which cumulatively result in the sector being one of the most wasteful. The heterogeneous nature of the waste types, as illustrated through the case studies in WP 6, makes industrial network development and industrial symbiosis more difficult as achieving a critical mass of materials of the same type and quality can be challenging.

However in its favour, the construction and demolition sector is well able to accommodate design deviations at the build stage so flexibility and co-operation are well established features of the sector.

Most successful industrial networks are suited to a ‘fixed’ chain of actors/companies both in space and time. This allows for changes in the supply chain to be integrated into the network to deliver industrial symbiosis. Accommodating this within the shifting nature of the construction and demolition sector will be a challenge for the case study activities. This factor should therefore be taken into account during the development of zero-waste strategies within the ZeroWIN project.

The limitations on the development of industrial networks in the construction and demolition sector include the geographical logistics for moving materials and the short-term nature of the activities involved. The build or demolition element has a
relatively short window of activity in the overall timeline for a demolition project (design and planning permission often take much longer). Therefore the greatest opportunity for significant industrial network development is in larger/longer term project such as CEIFA’s airport case study documented in WP6.

Previous reports by CEFIA have identified the point of intervention as a limiting factor for the development of a ZeroWIN case study. Several of the construction and demolition case studies have begun after the project design and planning stage. At the construction/demolition phase only slight changes to materials, equipment and techniques can be made.

During the research phase of task 3.2.6 organisations were approached to share their experience of industrial networks and symbiosis in the construction and demolition sector. Generally organisations (not directly involved in the ZeroWIN case studies) had very limited awareness and understanding of the terminology and were reluctant to participate in the survey activities. There was no apparent understanding of what industrial networking or symbiosis meant in practice. This lack of understanding was also found where contractors could not identify themselves as active members of an existing industrial network. Therefore, lack of recognition could be a barrier to the wider implementation of the ZeroWIN project goals by engaging businesses to participate in industrial networks to deliver the “towards zero waste” approach. The knowledge gap in understanding industrial networks and industrial symbiosis is a significant limiting factor in the development of zero-waste strategies.
5 CONCLUSIONS

Harmonisation of products, materials and components at a European level has been driven through the CE Marking Directive (93/68/EEC) to ensure products are ‘fit for purpose’ but does not consider the environmental impacts of a product through its life-cycle, and recent Regulation (EU) No 305/2011, laying down harmonised conditions for the marketing of construction products. **Product, material and component certification schemes** which consider the whole life-cycle of products vary from country to country making pan European comparisons (where baseline data is not available in a consistent and comparable format) very difficult. With relation to Zero Waste Strategy development, industrial networks can have very different influences depending on geographical location.

Where building certification schemes are well established and required as part of the planning process they act as strong drivers for product certification schemes. Since introduction of building certification schemes many designers seeking to adhere to the building certification requirements are specifically seeking products with increased sustainable content e.g. use less embodied energy, manufactured from sustainable materials, and are eminently reusable at end of life. Building certification schemes can be seen to stimulate the development of product, material and component certification schemes.

When considering opportunities for waste prevention in materials and component certification it is useful to look at the increasing awareness of eco-efficiency in the construction and demolition sector illustrated by the increasing profile of certification schemes and efficiency at international sector conferences (not dedicated to sustainable issues)

A globally recognised product certification scheme which uses a standard life cycle analysis would provide a level playing field when assessing construction products and materials

The move towards zero emissions buildings (in use) has highlighted the complexity of some technologies (i.e. solar thermal heating systems, combined heat and power, etc). Appropriate guidance, training and user manuals need to be provided to occupants to ensure they understand how to best use the equipment and maximise the savings new technologies can offer. This is an area that designers, architects and construction companies must focus on when buildings are handed over to occupants.

Training should be provided to designers, architects and construction contractors to understand the environmental benefits of using low impact materials. The industry makes most of its material and product choices based on cost but understanding the importance of life cycle analysis could persuade behavioural change towards the most sustainable option.

Trends in research are focusing greatly on more holistic approaches where the most significant/environmental damaging aspects of the building life cycle can be considered. This includes the early-stage development of a European Commission Eco-Label for buildings, findings on the tenant interface with the building and latest
research on the energy performance of buildings in Europe published in October 2011.

During the course of ZeroWIN Work Package 3 research for deliverable 3.6 Consideration of Waste Prevention in Materials Certification it has become clear that while selection of building materials and components which optimise sustainable characteristic contributes to zero-waste strategies, considering the design element of energy consumption/wastage in building use should also be included in the goal to deliver zero-emission buildings.
6 CONSTRUCTION AND DEMOLITION SECTOR
CONCLUSIONS AND RECOMMENDATIONS

6.1 Industrial network development
The construction and demolition sector traditionally works on the basis of ad hoc networks where several enterprises work together, each one contributing with specific skills, materials and equipment to the achievement of a project. Each building incorporates a high diversity of materials and components and therefore, in addition to acting directly on site, the network may integrate enterprises involved in the upstream and downstream supply chains. Enterprises from other sectors may also be involved if they have an influence on the reuse and recycling of materials.

Historically a ‘fixed’ industrial network (both in space and time) has been the established approach for industrial network development allowing changes in the supply chain to be integrated into the network without compromising associated industrial symbiosis activities. Limitations of construction and demolition sector related industrial networks include geographical constraints and the short-term nature of projects. The build or demolition element has a relatively short window of activity in the time frame of the whole project duration.

**Recommendation 1: Maintaining an up-to-date industrial network map**
In projects with identified networking improvement potential, reviewing the changes in to the industrial network map, from the design phase to project completion, will provide a useful insight into the many changes which take place from project inception to final handover to the client/owner. This process will also allow for a gap analysis to take place where important areas of potential e.g. for industrial symbiosis have not been addressed.

**Recommendation 2: Documenting industrial network establishment**
Construction and demolition sector projects using an industrial network approach should document the duration of the construction or demolition project relative to the development stage of the industrial network and any consequential industrial symbiosis. This provides a useful tool for assessing whether the network has longevity and a long-term use that can be applied to other initiatives after the building project has been completed.

*The ZeroWIN case studies can support this activity acting as a useful resource and template for other organisations documenting industrial networks. The ZeroWIN research will explain in great detail the establishment of industrial networks including where existing networks have been adopted by the project and if they are likely to continue after the activity is completed.*

6.2 Reduction in greenhouse gas emissions
In Europe 40% of the total energy demand is consumed in buildings and legislation
to address this is relatively well established however, it applies only to the use phase of buildings.

There are no specific regulations which apply to the phases where industrial networks may be established within the scope of the ZeroWIN project (construction, maintenance or refurbishment and demolition), and there is an absence of information relating to average consumption and total consumption limits.

However it is possible to observe (in the field) the electricity and fuel consumption of a building project (for example, in foundations). To start planning interventions on energy consumption, leading to a reduction in greenhouse gas emissions, requires knowledge on energy consumption both in the average and superior-efficiency circumstances.

Considering a sustainable transport strategy would benchmark greenhouse gas emissions from equipment usage during construction and demolition sector works. This is an area which has not specifically considered in the ZeroWIN work package 3 activities but could be an area of interest for future zero-waste strategy development.

Recommendation 3: Regulating energy consumption during construction and demolition activities
Further research is needed concerning energy consumption during construction, demolition and refurbishment and it is recommended that actors undertaking these activities document and report on energy consumption during the works to establish energy consumption “ratings”

The “ratings” could be used in two ways, first for consideration when granting construction / demolition / refurbishment permits. Secondly, financial rewards could be issued to recognise improved efficiency. For example, works which reported lower consumption per square meter of intervened area could benefit from lower taxes.

6.3 Increase in reuse and recycling of waste
The European Union has provided a legal framework along with recommendations which are aimed at the whole waste cycle from generation to disposal placing the emphasis on recovery and recycling in line with the waste hierarchy. In order to increase both the conditions and the benefits from reuse and recycling, it is important to design for disassembly.

During the use phase of the building, maintenance often accounts for a considerable share of material consumption. By extending the lifetime of materials/components with short maintenance intervals and using materials/components with low environmental impacts can greatly reduce the requirement for maintenance.

Recommendation 4: Design for disassembly and maintenance
Design and implementation actors in the construction sector should highlight where (if any) special measures have been taken to design for maintenance and disassembly.
**Recommendation 5: Material and waste management**

Based on the design and materials specifications, main material flows should be identified prior to each project identifying the potential for reuse and recycling. Additionally this would allow measures to be taken to eliminate or minimise hazardous wastes and to mitigating for the production of very high amounts of certain wastes.

*The ZeroWIN case studies can support this activity acting as a useful resource for other organisations highlighting where design for maintenance and disassembly has taken place.*

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**6.4 Reduction in fresh water consumption**

Targets for reduction in the consumption of fresh waste in buildings are generally linked into building certification schemes (mostly for the use phase of the building).

There are no mandatory requirements to set flow limits for the construction and demolition sector phases within the ZeroWIN scope where industrial networks may be established. Further, there is an absence of information relating to average consumption and total consumption limits.

*Recommendation 6: Regulating water consumption during construction and demolition activities*

Information is needed concerning water consumption during construction, demolition and refurbishment and it is recommended that actors undertaking these activities document and report on water consumption during the works to establish water consumption “ratings”.

The “ratings” could be used in two ways, first for consideration when granting construction / demolition / refurbishment permits. Secondly, financial rewards could be issued to recognise improved efficiency. For example, works which reported lower consumption per square meter of intervened area could benefit from lower taxes.

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**6.5 Product specification and certification**

Besides the enterprises that are directly involved in the construction/demolition processes, there are other actors that play a decisive role in the implementation of waste reduction strategies.
• **Upstream supply chain.** In the upstream supply chain both the service suppliers and the materials and component suppliers influence the waste arising (fresh water, greenhouse gas and waste by-products).

• **Importing materials.** As a significant portion of materials and components are often imported from other counties, material suppliers may have little decision-making capacity concerning the characteristics of the products they sell.

• **Materials selection.** The owner and/or the architect may be more important actors in this context as they normally select the materials and components to be incorporated in the building.

Prevention of waste at the design phase illustrates the importance of the informed decision-making processes in the building planning phase coupled with the need to enhance eco-design principles in the selection of materials and components.

Environmental certification schemes identify the indirect impacts of construction considering the lifecycle of the building, product, component or materials and as such are key building blocks in the move towards zero waste within industrial networks.

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.

In the UK BRE Global run the Environment Profiles Certification scheme and British Board of Agrément (BBA) have a similar scheme with additional Environment Information requirement. Germany has one of the first and oldest environment-related labels for products and services in the world, the Blue Angel which contains a significant number of construction materials and components (although the scheme categorises products by health, climate, water and resources rather than commercial factors).

There is a strong trend for developing new lightweight materials which can be seen both at European and National Government level and through findings of international conferences (Schwarz, E ed, 2010) (European Commission 2, 2010). There is a great opportunity to integrate zero-waste strategies in the development of resource efficient products (both in product and use) and potential for innovative products to be used in the construction sector.

The potential for nanotechnologies to bring positive environmental benefits through improved resource and energy efficiency is very strong with examples including remediation of contaminated land and waste water treatment. However this must be considered in context against the harm to human health with the potential for minute nano-particles to penetrate the cells of living organisms. Further the effects of nano-particles at end of life on reuse and recycling options must also be considered. This
may give rise to additional positive alternative end markets as well as reducing options.

**Recommendation 7: Mandatory eco-product specification at design phase**
Selecting materials which embody the ZeroWIN principles is likely to be best achieved by the architect/owner.

Setting targets at EU level for a proportion of eco-products which meet the ZeroWIN principles would be a measurable target allowing monitoring of sustainable product usage.

**Recommendation 8: Documenting the use of sustainable products and materials**
Monitoring the uptake of sustainable products and materials through the project is recommended. A short national review of the key products used in the construction process would be useful for material specifiers.

*The ZeroWIN case studies can support this activity acting as a useful resource for other organisations documenting considering substitution of sustainable products and materials.*

**Recommendation 9: Zero-waste strategy applications on lightweight products including nanotechnology**
It would be useful for the construction actors to have a brief matrix summarising key lightweight products which could be substituted easily for traditional materials including advantages, disadvantages during use and installation. This matrix could compliment the sustainable product review mentioned in recommendation 8.

*Where applicable the ZeroWIN case studies will document any applications of lightweight products including nanotechnology and the implications of the product selections.*

### 6.6 Building Certification schemes
The global drive towards sustainable construction has seen the emergence of building and product certification schemes to provide independent verification of ‘greenness’. The certification schemes are intended to promote more sustainable design, construction, operation, maintenance and deconstruction. Certification schemes have varying perspectives concerning building rating and certification but generally share the same approach in viewing the building through life cycle performance of site, energy, water, materials and indoor environment. The majority of schemes consider new build (domestic and commercial) rather than the performance of existing buildings.

In general, the evaluated systems show strong focus on environmental protection but they are not close to the concept of Zero Waste or Zero WIN, once the ZeroWIN...
vision is to use a whole-system approach to redesigning resource flows to minimise emissions, waste and resource. However, the implementation of such instruments may be determining to achieve a better performance in what regards materials and waste management.

In the phases of construction, maintenance and demolition, a building has a great impact in resource consumption and waste production. Therefore, it would be important that in a near future the certification systems could give stronger attention to resource and material management. This should refer to measures that promote rational and more sustainable materials, as well as water and energy use; waste prevention should be set prior to waste management; when it is not possible to prevent waste, the management of the generated waste should be done according to the hierarchy

**Recommendation 10: Building certification schemes application**
Better dissemination of certification schemes so that their application becomes generalised.

**Recommendation 11: Building certification schemes improvement**
It is recommended that existing certification systems increase the prominence given to resource and material management and its impacts during the construction / refurbishment / demolition stages to align more with the ZeroWIN project goals.

### 6.7 Matching ZeroWIN strategy to building lifecycle

Broadly research and development needs can be categorised directly in terms of construction inputs, process (including demolition and retrofit) and outputs. Additionally there are overarching categories of legislation and to a lesser extent the approach of Life Cycle Assessment (LCA). After consultation with actors in the construction industrial networks involved in the ZeroWIN project case study activities (CS4 and CS7) it can be concluded that, in the new construction projects, waste is one of the more significant aspects, whereas in maintenance and retrofitting activities energy and water are key aspects with waste playing a less significant role. During the demolition phase, waste and the opportunities for recycling and reuse again become the most significant impacts.

**Recommendation 12: Matching ZeroWIN strategy to building lifecycle**
It is recommended that zero-waste strategies are tailored to the stage in the building lifecycle to match the waste arisings where possible, i.e. Site Waste Management plans are an efficient tool to control the direct waste arisings from the build process. The zero-waste strategies must also address water and energy emissions (with potential to include mechanism such as sustainable transport plans).
6.8 Importance of educated workforce (in environmental matters)

Several projects (e.g. the Leonardo da Vinci project Wambuco) showed that workers’ training may have important impacts in the reduction of construction and demolition sector waste.

While this recommendation is not a direct result of work package 3 research activities, its merits inclusion because awareness raising activities ought to be integrated into strategy development and implementation.

**Recommendation 13: Education and awareness raising activities**
A comprehensive approach to education will be a key measure of success. If the workforce is not aware of sustainable construction practices they will be equally wasteful regardless of material and component selection.

6.9 The important of planning requirements for the success of zero-waste strategies

The research undertaken in ZeroWIN (both in the Literature review and WP3) clearly showed the important of planning requirements for the success of zero-waste strategies in the construction/demolition sector. These planning requirements address to levels of the decision-making process:

1. the macro level (e.g. regional and regional planning)
2. the micro level (concerning the design phase of buildings and other construction objects)

**The macro level**
In England the Town and Country Planning Agency’s measures to strive for sustainable construction practice by:

- **Building Certification Schemes.** Setting high building design standards to achieve maximum points in the Code for Sustainable Homes and for non-residential buildings achieve maximum points for waste and materials under BREEAM (Building Research Establishment Environmental Assessment Method);
- **Move towards zero construction waste.** Eco-towns should exceed the [UK] Government’s target of at least a 50% reduction in construction, demolition, and excavation waste to landfill (compared with 2008), and achieve the 70% target in the Waste Framework Directive;
- **Capturing data.** Tools for sustainable construction should be used by constructors, including the ‘SMARTWaste’ suite of tools and advice service – see [www.smartwaste.co.uk](http://www.smartwaste.co.uk) (note that SMARTWaste is simply the chosen brand name, it is not an acronym);
- **Specification.** Construction Resources and Waste Roadmap – [www.crwplatform.org.uk](http://www.crwplatform.org.uk), incorporating the green guide to choosing A-rated construction elements – [www.thegreenguide.org.uk](http://www.thegreenguide.org.uk);

**The micro level**
During the planning and development stage of construction and demolition activities the framework conditions for reuse and recycling practices can be established to maximise waste prevention potential. In England the Site Waste Management Plan Regulations 2008 make this a legal requirement for construction projects valued in excess of £300,000. It was hoped that SWMPs will help industry to maximise waste efficiency, while simultaneously bolstering existing regulations to combat waste crime. A Site Waste Management Plan (SWMP) is simply a plan that details the amounts and types of wastes that will be produced on site and how they will be reused, recycled or disposed of. SWMPs provide a good opportunity to streamline site activities and realise a number of business benefits including:

- Cost savings and income realisation through reduced requirements for materials, storage & handling and better management for recovery or disposal
- Demonstration of good environmental performance, supporting the requirements of environmental management systems
- Risk management - ensuring compliance with regulation and contractual requirements of public and private sector clients
- Improved company performance allowing differentiation from competitors

Also in Portugal a similar scheme was implemented in 2008 by law, but only for public works: every public works need to have a Waste Prevention and Management Plan, developed at the planning / design stage, before public tender. The owner or promoter is responsible for the production of such plan. In practice, usually the design team develops it. The Waste Prevention and Management Plan intents to promote waste prevention by reuse on site or off site, as well as optimise waste management through planning and quantities estimation.

**Recommendation 14: Stimulating industrial networks through planning requirements at macro level**

National planning stipulations can influence sustainable construction as seen through the English Town and Country Planning Agency measures. Adopting a consistent method Europe wide would strengthen the results and lead to development of inter-country industrial networks.

Exchange of waste over long distances would not be the most sustainable solution; however the national agencies can promote such exchanges at a regional level.

**Recommendation 15: Establishing reuse and recycling route during planning and development phase (pre-construction/demolition) at micro level**

Advance planning to identify reuse and recycling routes for likely waste arisings will stimulate markets for these materials and increase the establishment of industrial networks.

6.10 **Recommendations outside the ZeroWIN scope**

During the research process of ZeroWIN work package 3 it became clear that addressing construction, maintenance and demolition construction and demolition sector would deliver only a partial zero-waste strategy for zero emission buildings.
To date activities on the ZeroWIN project Work Package 3 have been dominated by reduction of waste as a by-product of the construction and demolition process as this is the area which is predominantly controlled by legislation in Member States. Emerging legislation around carbon savings resulting from energy reduction will see retrofitting of existing building stock become the focus of research in the next decade.

Considering energy and water consumption when the building is in use as well as the growing importance of retrofit is necessary to provide a fully rounded zero-waste strategy.

**Recommendation A (outside the scope): Applying energy certification scheme across all ZeroWIN target areas**

Construction and demolition works should generally ensure that energy certification is clearly documented and where possible highlighting the balance between consumption from appliances and heating sources.

**Recommendation B (outside the scope): Freshwater flow limits**

There is great potential in new build for reducing fresh water consumption in buildings. Addressing existing building stock is more difficult to regulate and requires a review of European water regulations to set flow limits on water fittings through refurbishments.
## 7 SUMMARY OF RECOMMENDATIONS

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Description</th>
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Construction and demolition sector projects using an industrial network approach should document the duration of the project relative to the development stage of the industrial network and any consequential industrial symbiosis.  
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## 8 REFERENCES


COMMUNICATION FROM THE COMMISSION: Towards a thematic strategy on the prevention and recycling of waste


9 LIST OF FIGURES

Figure 1: European Building Stock at a glance (Source: Europe’s Buildings under the microscope, BPIE, 2011)

10 LIST OF TABLES

Table 1. Summary of the key characteristics of BRE Global Environment Profiles Certification Scheme

Table 2. Summary of the key characteristics of British Board of Agrément (BBA) scheme

Table 3. Summary of the key characteristics of APCER (2009) Portuguese Association for Certification scheme

Table 4. Summary of the key characteristics of Der Blaue Engel (The Blue Angel) scheme

Table 5. Summary of the key characteristics of Seal of Approval (Institut für Baubiologie – Germany) Scheme

Table 6: Summary Life Cycle comparison of Timber and UPVC Window Frames

Table 7: Comparison of Building Certification Scheme environmental weightings (Larriba, Dodd, Wolf, 2012)
Table 87: Summary of sustainable construction certification schemes in Singapore

<table>
<thead>
<tr>
<th>Scheme Name</th>
<th>Description</th>
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<tbody>
<tr>
<td>BCA Green Mark</td>
<td>Certification for green buildings in Singapore</td>
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<td>BCA Green Label</td>
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<td>GBC</td>
<td>Green Building Council of Singapore</td>
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<tr>
<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
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<tr>
<td>WMB</td>
<td>Waste Management Board</td>
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... (Continue with more schemes)
SOME NOTES:
- The manufacturers produce the final product but also they also origin waste materials/sub products that shall be considered (blue dotted arrows).
- It was decided in the Bilbo meeting that there should not be a distinction between upstream and downstream clusters, seen as before and after the consumer.
- In the next slides there is a suggestion for the appliance of this scheme to the construction sector (construction and demolition case-studies).
ZEROWIN SCOPE AND BOUNDARIES 5 – Adapted to the DEMOLITION case studies

SOME NOTES:
- It is important to define either the recycling facility, refurbisher and recycler represented in this scheme are in-site or off site, because in construction sector both scenarios are possible. Shall we consider that these are represented the off-site actors and the on-site operations will be treated as internal networks??

DISPOSAL??
Zero Waste – No disposal!