S.W.A.N.
A digital Solid Waste reuse plAtform for BalkaN

Deliverable 3.1 Design and development of SWAN Platform

Functional and Technical Design & Guidelines for the Implementation of the SWAN Platform Prototype

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EXECUTIVE SUMMARY

The current European waste management framework defines waste as any substance or object which the holder discards or intends or is required to discard. Furthermore, effective material management and resource recovery are currently major components of the EU environmental policy. Towards that end, the development of novel business models based on industrial symbiosis (i.e. reusing unwanted waste streams of one industry as an input to another one) is highly promoted. However, the "end-of-waste" criteria should be taken into account to make sure that an output stream is no longer considered waste and can be reused as an input.

The SWAN platform hopes to be the facilitator in the development of such business models in the Balkan region, by (a) providing a detailed mapping of non hazardous solid waste sources and potential receivers and (ii) assessing the economic feasibility of all the technically feasible symbiotic schemes in the area. Different user groups (e.g. Public, Registered Users, Industry Managers, Industry Participants, Regional Authority Managers, Regional Authority Participants, and System Administrators) can be defined for the platform, each one with their specific user functionalities and permissions.

The SWAN Platform will be designed with a standard "look and feel" to facilitate ease of use, software design simplification, and branding. It will employ an N-Tier Application Architecture and will be a web application requiring only network access and a web browser for end-user access.

The database of the platform will be populated using the SWAN questionnaire, which will collect all the necessary information for the industrial (non hazardous) solid waste sources and potential receivers. Data will be collected from all four SWAN case studies/countries (Greece, Albania, Bulgaria and Cyprus). The questionnaire is split in five different parts: (a) General Characteristics; (b) Waste Data; (c) Input Data, (d) Supplementary Data; and (e) SWAN Industrial Ecosystem. The database will also include an inventory of the already implemented best practices towards industrial symbiosis, which will facilitate the matching functionality of the SWAN algorithm.

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1 INTRODUCTION

The overall aim of Work Package (WP) 3 is create the SWAN Digital Ecosystem, by developing the SWAN platform and gradually integrating the solid waste mapping and the sink-source matching algorithms. More specifically, WP3 is tasked amongst others with the development of a publicly available suite of tools and resources for the identification and assessment of novel solid waste reuse value chains, providing access to an integrated environment for the undertaking of similar analyses.

This report focuses on the initial steps of the tool development which will lay the foundation of the prototype development in later stages of the project. More specifically, the report includes:

- A brief discussion the current waste management and classification framework in Europe as well as a short review of existing industrial symbiosis models and algorithms (Section 2);
- The functional design of the SWAN platform, by providing a description of its internal design and its functionalities (Section 3);
- The technical design of the SWAN platform, by providing a description of its architecture and databased design (Section 4); and
- A set of guidelines towards the implementation of the SWAN platform prototype, including mock-up screens, the questionnaire that will be used to populate the database as well as some guidelines for the content of the solid waste reuse best practices database (Section 5)

2   WASTE MANAGEMENT AND CLASSIFICATION FRAMEWORK IN EUROPE

2.1   European and Balkan Solid Waste Management Framework

According to the Directive 2008/98/EC, the "waste" is defined as any substance or object which the holder discards or intends or is required to discard. On the contrary, an output stream is characterised as "by-product" and not "waste" when all the following criteria are met:

- Further use of the substance or object is certain;
- The substance or object can be used directly without any further processing other than normal industrial practice;
- The substance or object is produced as an integral part of a production process; and
- Further use is lawful, i.e. the substance or object fulfils all relevant product, environmental and health protection requirements for the specific use and will not lead to overall adverse environmental or human health impacts.

The same directive recognizes material management as a mean of decreasing impacts of waste and reducing raw material inputs to the economy. The EU economy currently loses a significant amount of potential secondary raw materials which are found in waste streams. In 2013, total waste generation in the EU amounted to approximately 2.5 billion tons of which 1.6 billion tons were streams that could be potentially reused or recycled. More specifically, only a limited share (43%) of the municipal waste generated in the Union was recycled, with the rest being landfilled (31%) or incinerated (26%) (Eurostat, 2015).In 2016 ten Member States still landfilled over 50% of their household waste and six of them incinerated 40% or more (EC, Circular Economy, 2018).

Towards that end, the Commission proposed to: a) ban the landfilling of recyclable plastics, metals, glass, paper and cardboard by 2025; b) increase the recycling rates for packaging waste by 80% until 2030; c) increase the reuse/recycle of municipal waste to at least 70%; and d) eliminate landfill by 2030 (COM 2014/398/EC). On 22 May 2018, the EU Member States approved an updated set of ambitious measures to make EU waste legislation fit for the future, as part of the EU's wider Circular Economy Policy. According to these rules, EU member states must: a) increase the recycling rates for packaging waste to 65% by 2025 and 70% until 2030; b) increase recycling of municipal waste to at least 60% by 2030; and c) eliminate landfill to 10% or less of the total amount of municipal waste generated by 2035. Thus, turning waste into a resource is an essential part of increasing resource efficiency and closing the loop in a circular economy. Even though several recycling initiatives have been implemented in existing product cycle, there are various key waste streams and materials that need to be further addressed.

This challenge is stressed in the Balkan Med region, with the economic crisis being pertinent, and cost should be kept in an absolute minimum and new growth options for the regional economies and societies are sought after. An added challenge is the lack of national or regional strategies for effective solid waste management, the category with the largest increase in terms of annual generation over the last decade (EEA, 2015). In this region, efficient waste management schemes, might not implemented because the directly involved stakeholders do not possess a clear view of the available opportunities (e.g. industrial symbiosis schemes) and indirect gains (e.g. climate mitigation potential).

However, a waste stream has to achieve end-of-waste status, in order to be able to be reused in a production line as an input. According to the Directive 2008/98/EC, a waste shall cease to be waste when it has undergone a recovery, including recycling, operation and complies with specific criteria to be developed in accordance with the following conditions:

(a) The substance or object is commonly used for specific purposes;

(b) A market or demand exists for such a substance or object;

(c) The substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products; and

(d) The use of the substance or object will not lead to overall adverse environmental or human health impacts.

In order to facilitate this process, European Union has published various technical reports to avoid confusion about the waste definition and to clarify when certain waste that has undergone recovery ceases to be waste:

- End-of-waste Criteria for Iron and Steel Scrap: Technical Proposal (2010)
- End-of-waste Criteria for Aluminium and Aluminium Alloy Scrap: Technical Proposals (2010)
- End-of-waste Criteria for Copper and Copper Alloy Scrap: Technical Proposals (2011)
- End-of-waste Criteria for Waste Paper: Technical Proposals (2011)
- End-of-waste Criteria for Glass Cullet: Technical Proposals (2011)
- End-of-waste Criteria for Biodegradable waste (compost/digestate): Technical Proposals (2014)
- End-of-waste criteria for waste plastic for conversion (2014)

2.2   The role of the SWAN Platform in the European Waste Framework

Having in mind the European Waste Management framework, as well as the specific characteristics of the Balkan region, the main objective of SWAN platform is to host an innovative Balkan Med ecosystem that will develop locally and potentially manage novel national and transnational value chains based on solid waste reused. In Industrial Symbiosis Re-use has the following definition «RE-USE : waste streams and energy within and between different sectors, including recovery, recycling and re-use of post-consumer waste».This will be performed through the solid waste mapping and matching platform.

The role of this platform will be thus two-fold. On one hand it can be used by local industries (forming the SWAN Industrial Ecosystem) in order to reveal all the appropriate recycling opportunities (even the ones that may not be economically viable locally but make financial and social sense in the wider scale or even transnationally). In such way, the SWAN platform will attempt to eliminate the "lack of knowledge" barrier that is prevalent in the Balkan region.

On the other hand, regional and national authorities will be able to have a holistic view regarding the waste reuse opportunities. Thus, the SWAN platform will act as the facilitator towards the development of relevant strategies, quality protocols and policy instruments for savings and profit opportunities.

2.3   Waste Classification

2.3.1   European Waste Classification

European Commission Decision 2000/532/EC has introduced the European Waste Classification (EWC), which creates a European List of Waste (LoW) and classifies waste based on two different parameters, the type of waste and the process that produces them. This classification scheme is nowadays well established and widely used as the official classification in the EU for administrative and reporting purposes, i.e. transport of waste, installation permits, supervision in the field of waste generation and management and even as a basis for waste statistics.

The classification is divided into 20 main categories (which are referred to as chapters), mostly referring to the type of industry/activity that produces the waste. Each chapter is divided into various subchapters and each subchapter is divided into various waste types produced. As a result, each type of waste, using this taxonomy, is assigned a six-digit code (the first two digits referring to the chapter, the following two to the subchapter and the final two to the waste type). The EWC also provides information regarding whether a type of waste is hazardous or not. The EWC code of all hazardous (special) wastes is marked by an asterisk (*). Hazardous waste entries can also have a non-hazardous 'mirror entry'.

According to the Decision 2000/532/EC, the LoW should be also revised regularly on the basis of new knowledge and, in particular, of research results. The last amendment is Commission Decision 2014/955/EU. The LoW currently defines 839 waste types which are structured into 20 chapters. The main categories - chapters of the EWC are presented in Appendix 2.

In order to properly categorize a waste, the following six steps should be followed (Commission Decision 2001/118/EC):

1. Identify the field of activity to which the waste producer belongs, i.e. chapters 1 to 12 or 17 to 20.
2. Identify the sub-chapter within the chapter which best characterises the source of the waste.
3. Within the sub-chapter, identify the waste category which best characterises the waste. The specific is always to be identified over the general.
4. If no appropriate waste category can be found in chapters 01 to 12 or 17 to 20, chapters 13, 14 and 15 should be examined as described above in steps 2 and 3 before resorting to waste categories XX YY 99.
5. If only one waste category XX YY 99 comes into question, the waste should be identified with a waste category in chapter 16, in accordance with steps 2 and 3 above.
6. If a suitable waste category cannot be found in chapter 16, then XX YY 99 is to be used in the chapter and sub-chapter corresponding to the most appropriate source producing the waste.

2.3.2   EWC-Stat Categories

Parallel to the EWC, a relevant classification has been introduced by the Regulation (EC) 2150/2002 on waste statistics, which obliges the EU member states to report statistical data on waste generation and waste treatment according to the statistical waste nomenclature EWC-Stat.

The EWC-Stat is a technically a substance-oriented aggregation of the waste types presented in LoW. This results in a 1-to-many relationship between the entries of EWC-Stat and those of the List of

Wastes which allows for the unambiguous conversion of the waste types classified according to the List of Wastes into the EWC-Stat waste categories. As of reference year 2010, data on waste generation and waste treatment will have to be broken down by 51 EWC-Stat categories (up to 2008: 48 categories). The 51 EWC-Stat categories are presented in Appendix 3.

However, member states are free to use any waste classification as long as they can produce the defined formats in the required quality and report back to Eurostat using the EWC-Stat categories. In practice, most of the countries collect their data using the List of Waste and subsequently convert it into the required EWC-Stat-categories, whereas the direct use of the EWC-Stat for data collection is applied only by a few countries.

2.4 Existing Industrial Symbiosis Management/Optimization Tools

In the early 2000s, several Information and Communication Technology (ICT) tools have been developed in an attempt to support and facilitate the implementation of Industrial Symbiosis (IS) schemes. Grant et al. (2011) have listed the most important of them (Table 1), stating that these were developed at an early period of IS development. Thus, the applicability and the results of these efforts were ambiguous.

Table 1. *ICT Systems for IS (Grant et al., 2011)*

Systems Studied	Geographic Scale	Status	Availability
Knowledge-Based Decision Support System (KBDSS)[a]	Industrial park	Completed	None
Designing Industrial Ecosystems Toolkit (DIET)[b]	Industrial park	Canceled	Public, reportedly unusable, requires MS Office 95
Industrial Materials Exchange Tool (IME)[c]	City	Canceled	None
Dynamic Industrial Materials Exchange Tool (DIME)[d]	Region	Completed	None
MatchMaker![e]	City	Completed	None
Industrial Ecology Planning Tool (IEPT)[f]	Industrial park	Completed	Source code available, requires ArcView GIS
WasteX[g]	Nation	Canceled	None
Industrial Ecosystem Development Project (IEDP)[h]	Region	Canceled	None
Residual Utilization Expert System (RUES)[i]	City/state	Completed	Available to the original project funding organizations, requires Level5 software shell
Institute of Eco-Industrial Analysis Waste Manager (IUWAWM)[j]	Region	Operational	Reporting software—purchase and demo available over the web; analysis and optimization systems under development
Industrie et Synergies Inter-Sectorielles (ISIS) and Presteo[k]	Region	Operational	In use by the developer
SymbioGIS[l]	Region	Operational/ continuous development	In use by the developer
Core Resource for Industrial Symbiosis Practitioners (CRISP)[m]	Nation	Operational	In use by the developer and select partners

Sources: [a]Boyle and Baetz (1997). [b]Industrial Economics (1998); Dubester (2000); Vigon et al. (2002). [c]Young (1999); Burnham et al. (2001). [d]Shropshire et al. (2000). [e]Brown et al. (1997). [f]Nobel (1998); Nobel and Allen (2000). [g]Clayton et al. (2002). [h]Kincaid (1999); Kincaid and Overcash (2001). [i]Fonseca et al. (2005). [j]Sterr and Ott (2004). [k]Adoue and Bouzidi (2004); Massard et al. (2006). [l]Massard and Erkman (2009). [m]NISP (2006).

In recent years, more elaborate methods have been used in the development of such ICT tools. The most important of these tools are the following:

a) e-Symbiosis; An online platform that introduced the use of ontology engineering in the field of IS. It focused on involving Small and Medium Enterprises (SMEs) in IS schemes, and has been validated using real-life data. The waste classification proposed by e-Symbiosis is presented in Appendix 4 (Cecelja et al., 2015);

b) Looplocal; A generic heuristic visualization tool, with an objective the identification of regions that could potentially be an appropriate candidate for IS implementation. Moreover, alternative strategies to promote IS schemes were assessed. (Aid et al., 2015);

c) SymbioSyS; An online tool that implemented a waterfall model with a dynamic knowledge base in order to identify and visualize suggested IS in a given region, validated in an existing industrial park with 25 SMEs (Alvarez & Ruiz-Puente, 2017);

d) By-product Exchange Network (BEN) model; An agent-based optimization tool with an objective function maximizing the transaction value of the model. It has been validated using real-life data from Singapore (Raabe et al., 2017).

Two other approaches should be also mentioned; the Core Resource for Industrial Symbiosis Practitioners (CRISP) portal system, which acted as the support system for the UK's National Industrial Symbiosis Programme (Jensen et al., 2011), and the very recent application of an emerging technique, such as big data analytics (Song et al., 2017).

The SWAN Platform will be a mapping and matching simulation tool and will be built by incorporating key characteristics from all the different tools that have been previously developed. So far, in this first part of the platform development, the main focus has been on two key aspects: (i) the waste classification schemes and (ii) the data requirements from the different components of an IS scheme. The way these findings have been incorporated in the functional and technical design of the SWAN platform is presented in the following sections.

3   SWAN PLATFORM FUNCTIONAL DESIGN

In this document, the functional design is synonymous to a first deepening of user requirements into functionalities and finally into mock-ups that implement the functionalities. The technical design will further detail the data specifications and requirements.

3.1   User Requirements – User Groups

The user requirement(s) document (URD) or user requirement(s) specification is a document, usually used in software engineering, which specifies the requirements the user expects from software to be constructed in a software project. Once the required information is completely gathered, it is documented in a URD, which is meant to spell out exactly what the software must do and becomes part of the contractual agreement.

User groups are used by the platform to control the access to the functionalities provided. Seven suggested system-wide user groups as presented in Table 2. The same table also provides a short description of the role of each user group in the platform.

Table 2. User groups and their role in the platform

No	User Group	Description / Role
1	Public (All Users)	All users that visit the web platform. They are able to view basic in-formation about the platform and request registration to the system.
2	Registered Users	The users that have been registered and logged into the platform. They are able to view general, regional and industry specific information. They are not allowed to enter any information other than comments.
3	Industry Managers	The users who are responsible for registering an industry in the platform. They are also responsible for documenting the industry resources (input and waste solid streams).
4	Industry Participants	The users who are allowed to search for possible synergies for a specific industry registered to the platform.
5	Regional Authority Managers	The users who are responsible for managing the information concerning the industrial region where the platform has been deployed.
6	Regional Authority Participants	The users who are allowed to view all existing synergies between all industries registered to the platform and to search for possible synergies based on holistic/regional objectives.
7	System Administrators	The users who are responsible for setting up and maintaining the platform. They are responsible for managing user accounts and authorizing users to enter/edit information to the system.

3.2   Platform Functionalities

The services provided by the platform have been organized into divided into eight categories. Table 3 provides information on indicative functionalities that may be supported for each functional category. The same table also provides the permissions assigned to each user groups presented in paragraph 3.1. An 'X' indicates that a user has some rights to take an action. The 'X' marks are indicative, as detailed use-cases with all user interaction go beyond the scope of this document.

Table 3. User functionalities and permissions

No		Description	Public	Registered Users		Industry Managers	Industry Participants	Regional Managers	Regional Participants	System Administrators
1		**General access**								
1.1		The platform will be accessed via a web browser.	X							
1.2		Information can be viewed and exported in printable and storable form.		X						
2		**User registration management**								
2.1		Public Users shall be able to request a registration to the platform.	X							
2.2		The Registered Users shall be able to unregister themselves (delete account).		X						
2.3		The System Administrators shall be able to accept a request for registration.								X
2.4		The System Administrators shall be able to delete accounts of other users.								X
3		**Industry management**								
3.1		The Registered Users may request to add an Industry.		X						
3.2		The System Administrators shall be able to accept / deny requests for adding an Industry.								X
3.3		The Industry Managers are allowed to insert an Industry.				X				
3.4		The Industry Managers may invite others to contribute.				X				
3.5		The Industry Managers can withdraw rights from the Industry Participants.				X				
3.6		The Industry Managers can publish parts of the Industry data to be viewed by all registered users.				X				
4		**Industry information**								
4.1		The Industry Managers shall be able to alter the general information of the Industry.				X				
4.2		The Industry Managers shall be able to				X				

No	Description	Public	Registered Users		Industry Managers	Industry Participants	Regional Managers	Regional Participants	System Administrators
	insert/update/delete input solid streams for their Industry.								
4.3	The Industry Managers shall be able to insert/update/delete waste solid streams for their Industry.				X				
5		**Build Industry synergies**							
5.1	The Industry Participants shall be able to use the algorithms of the platform to search for a provider of a specific input stream.					X			
5.2	The Industry Participants shall be able to use the algorithms of the platform to search for a provider of a specific waste stream.					X			
5.3	The Industry Participants shall be able to request the calculation of economic and environmental indicators after establishing one or more synergies for the Industry.					X			
6		**Regional authority management**							
6.1	The Registered Users may request to become Regional Authority Managers.		X						
6.2	The System Administrators shall be able to accept / deny requests for Regional Authority Managers.								X
6.3	The Industry Managers may invite others to contribute						X		
6.4	The Regional Authority Managers can withdraw rights from the Regional Authority Participants.						X		
6.5	The Regional Authority Managers can publish parts of the regional data to be viewed by all registered users.						X		
7		**Regional information**							
7.1	The Regional Authority Managers shall be able to alter the general information of the region.				X		X		
8		**Build regional synergies**							
8.1	The Regional Authority Participants shall be able to use the algorithms of the platform to search for regional synergies based on holistic/regional objectives.						X	X	
8.2	The Regional Authority Participants shall be able to request the calculation of eco-efficiency indicators after establishing one or more regional synergies.						X		

3.3 Functional Design Specifications – Mock-Ups

The requirements in the previous sections have been detailed to a level almost reaching functional specifications. In this section, first mock-ups for some of the functionalities are provided. Please note that the mock-ups in this document are not an indication of the look and feel (colours, location of buttons) of the final version of the platform.

3.3.1 Mock-up and functionality for editing an Industry

Figure 1 presents a mock-up for editing the information concerning an Industry. This mock-up implements the Functionalities 3.3 (The Industry Managers are allowed to insert an Industry) and 4.1 (The Industry Managers shall be able to alter the general information of the Industry) presented in Table 3.
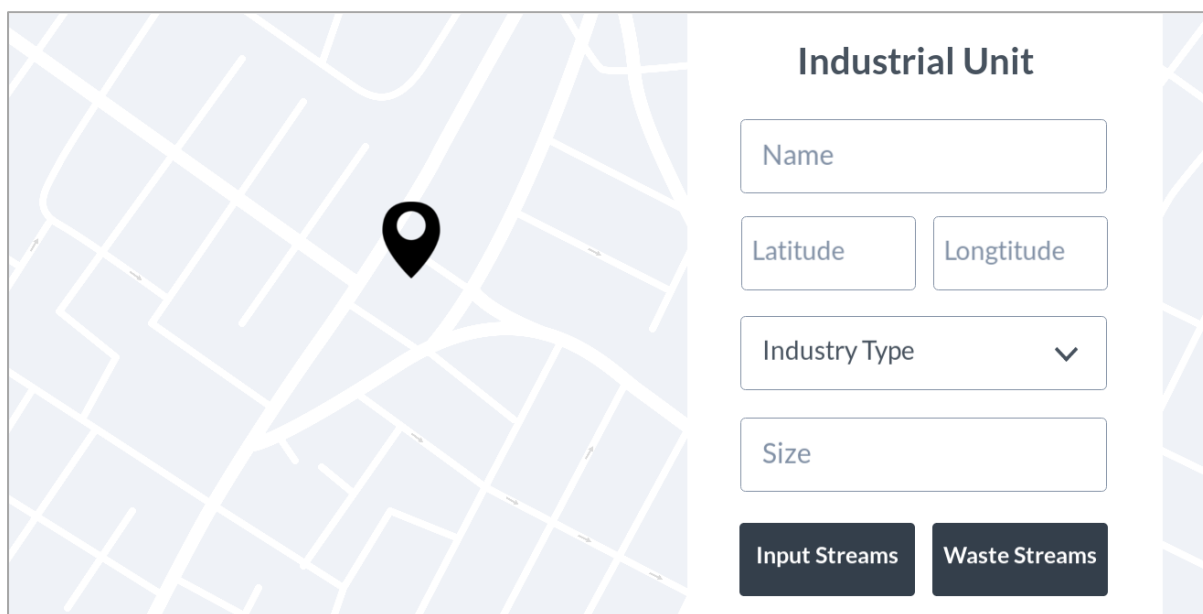
Figure 1. Editing an Industry

3.3.2 Mock-ups and functionalities for managing the Input Streams of an Industry

Figure 2 and Figure 3 presents a set of related mock-ups for managing the Input Streams of a specific Industry. These mock-ups implements the Functionality 4.2 (The Industry Managers shall be able to insert/update/delete input solid streams for their Industry) presented in Table 3.

Figure 2. Managing the list of Input Streams of an Industry

Figure 3. Editing the information concerning a specific Input Stream of an Industry

3.3.3 Mock-ups and functionalities for managing the Waste Streams of an Industry

<u>Figure 4</u> and <u>Figure 5</u> presents a set of related mock-ups for managing the Input Streams of a specific Industry. These mock-ups implement the Functionality 4.3 (The Industry Managers shall be able to insert/update/delete solid waste streams for their Industry) presented in Table 3.

Figure 4. Managing the list of Waste Streams of an Industry

Waste Stream

Description

Type ⌄

EWC Type ⌄

Management Cost

Unit ⌄

Amount

Save Stream   **Add Stream**

Figure 5. Editing the information concerning a specific Waste Stream of an Industry

4 SWAN PLATFORM TECHNICAL DESIGN

4.1 Application Architecture

4.1.1 Standard Look and Feel

The proposed solution will be designed with a standard "look and feel" to facilitate ease of use, software design simplification, and branding. As with other layers of the architecture, the presentation layer will make use of standardized, reusable components that will provide the application with a common, consistent end-user interface. The benefits of this approach are similar to those in other architecture layers: it allows for the upgrade, exchange, and reuse of products with minimal retooling or disruption to the overall environment.

4.1.2 N - Tier Application Architecture

The proposed solution will employ an N - Tier Application Architecture. At minimum, it should have a three-tiered architecture consisting of the following:

1. Presentation Tier - This is the topmost level of the application. It communicates with other tiers by outputting results to the browser/client tier and all other tiers in the network.
2. Application Tier (Business Logic/Logic Tier) - The logic tier is pulled out from the presentation tier and, as its own layer, it controls an application's functionality by performing detailed processing.
3. Data Tier - This tier consists of Database Servers where information is stored and retrieved. This tier keeps data neutral and independent from application servers or business logic. With data having its own tier also improves scalability and performance.

4.1.3 Web Application

The proposed solution will be a web application requiring only network access and a web browser for end-user access. Through the use of web applications, organizations can reduce the cost and complexity of all IT functions, making it easier to implement, deploy, manage, and monitor applications and information resources. Web application architecture provides the ability to rollout new applications and upgrades to the entire organization simultaneously.

The architecture of the proposed solution is shown in the figure below.
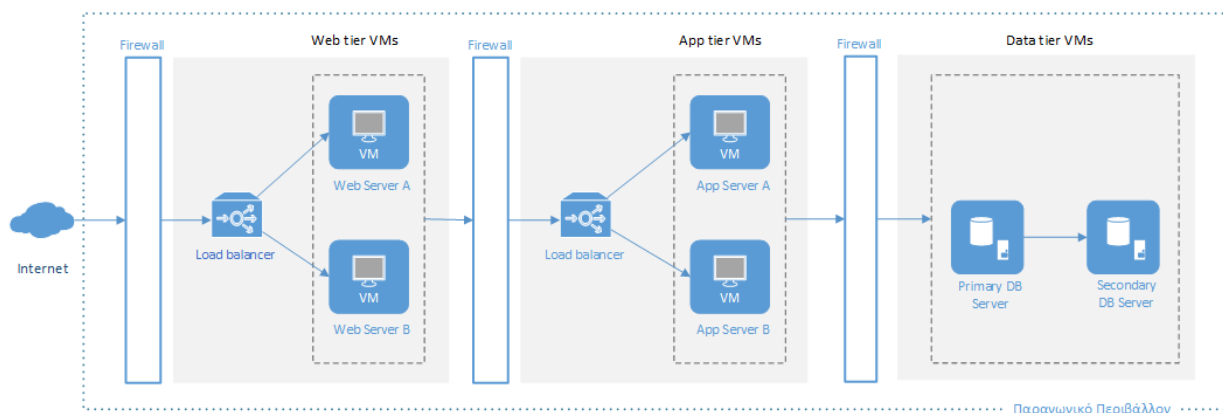
Figure 6. Three tier architecture

4.2   Entities in the industrial region

In order to conform to the requirements presented in section 3, the SWAN Platform is required to be structured around the model representation of a typical industrial region. This maps the actors as well as other entities and their hierarchical or other relations and attributes. Figure 7 presents the entity–relationship model for the SWAN Platform Database, which classifies the main entities-classes involved (industrial unit and material stream, either input, waste or product) and specifies relationships that can exist between instances of those entity types.
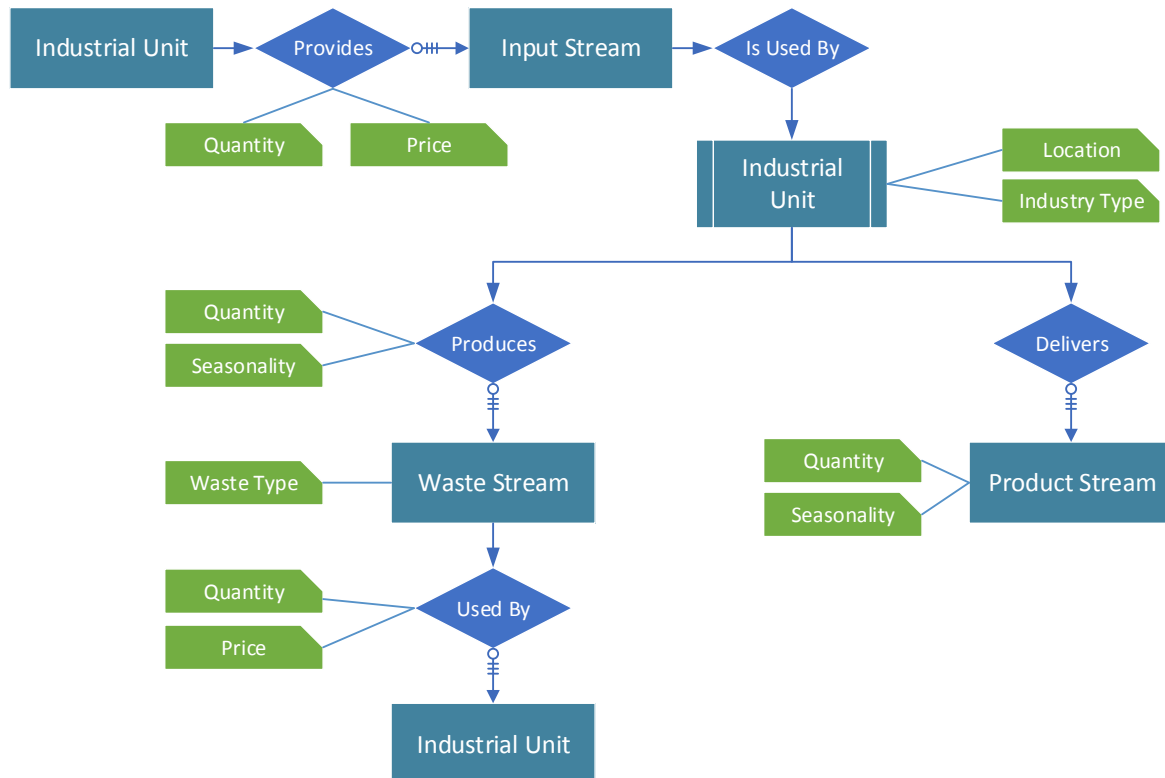
Figure 7. *SWAN Platform Database Entity–Relationship Model*

4.3   SWAN Platform Database Structure

Managing information is one of the most important aspects of the SWAN platform toolbox, as on one hand it helps structuring the data for a case study, towards the implementation of the algorithm. Thus, the structure of the data/information and their relationships is a key feature in the design. Figure 8 provides the database schema of the SWAN database system; a high level overview of the different components/tables of the database, which describes how the database is constructed and divided into various database tables. The following tables provide some more detailed insight into the database tables included in the Database Schema. The meaning of each column of these tables is as follows:

- FieldName: Represents the name of the data field
- FieldType: Provides the type of data contained in the field.
- LinkedTo: Where appropriate, the field is mentioned that is uniquely listed in one of the other tables and can be found in the column FieldName.
- Description: Provides, where appropriate, additional information.
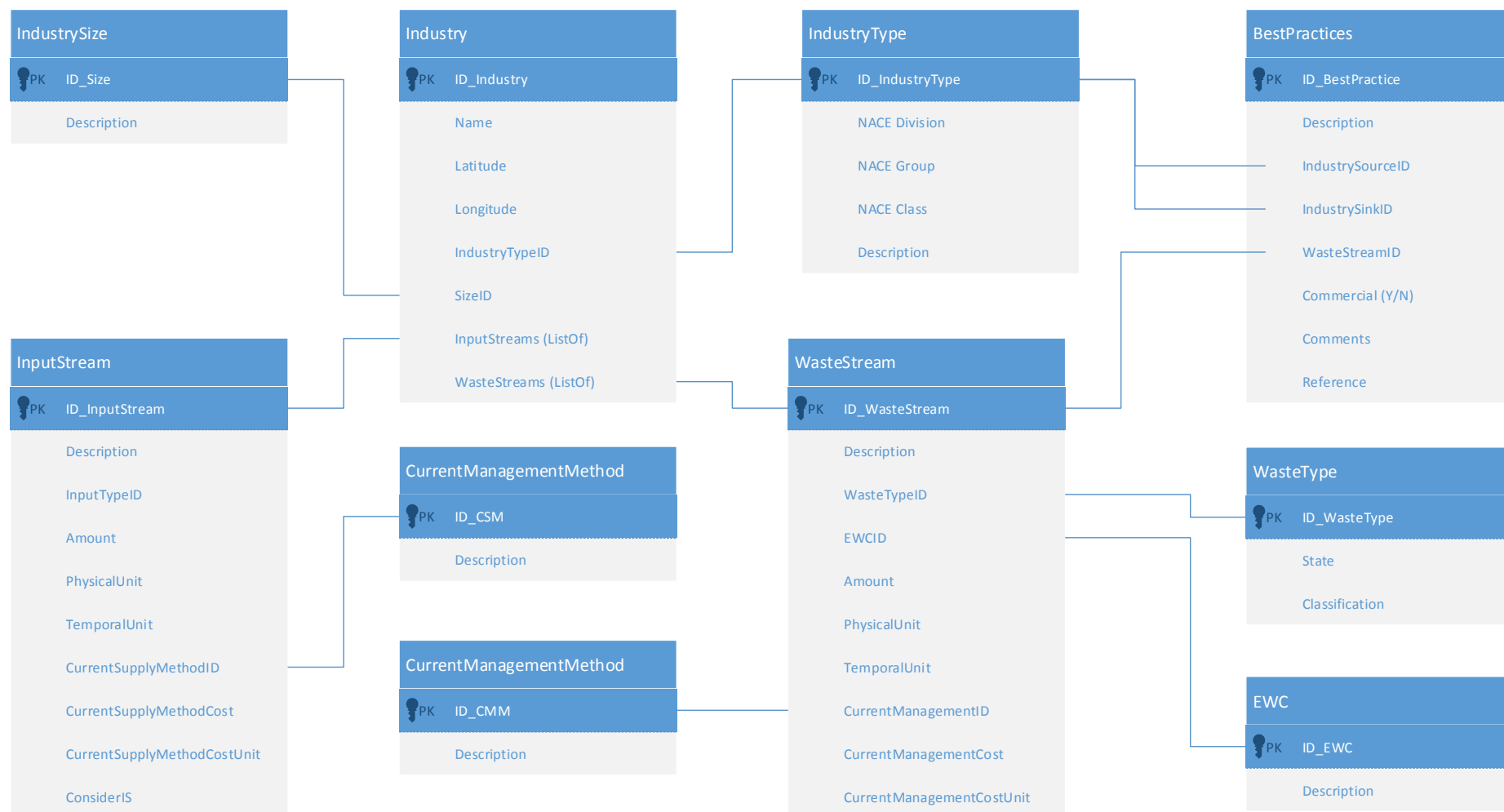
Figure 8. *SWAN Platform Database Schema*

Table 4. Properties of DB Table "Industry"

FieldName	FieldType	LinkedTo	Description
ID_Industry	String/GUID		A unique ID for each industrial plant (which could be either a solid waste source or potential receiver).
Name	String		The name of the industrial unit
Latitude	Real		The latitude of the industrial plant.
Longitude	Real		The longitude of the industrial plant.
IndustryTypeID	Integer	ID_IndustryType	The type of the industrial unit, based on the NACE classification code.
SizeID	Integer	ID_Size	The size of the industrial unit based on the number of employees
InputStreams	ListOf	ID_InputStream	A list of all the inputs that are consumed by the industrial plant and can be potentially replaced by a solid waste stream.
WasteStreams	ListOf	ID_WasteStream	A list of all the solid waste streams that are produced by the industrial plant

Table 5. Properties of DB Table "WasteStream"

FieldName	FieldType	LinkedTo	Description
ID_WasteStream	String/GUID		A unique ID for each industrial solid waste stream.
Description	String		A brief description of the solid waste stream.
WasteTypeID	String	ID_WasteType	An identifier for the type of the solid waste stream based on the SWAN waste classification.
EWCID	String	ID_EWC	An identifier for the type of the solid waste stream based on the European Waste Catalogue classification.
Amount	Real		A numerical value describing the amount of solid waste for this stream.
PhysicalUnit	String		The physical unit in which the amount of solid waste is measured. Options should include kg, t, kt, Mt, L and m^3.
TemporalUnit	String		The temporal unit in which the amount of solid waste is measured. Options should include per day, week, month and year.

CurrentManagementID	String	ID_CMM	An identifier for the current management method applicable for the solid waste stream.
CurrentManagementCost	Real		A numerical value indicating the cost of the current management for the solid waste stream.
CurrentManagementCostUnit	String		The unit of the current management cost, expressed either "per physical unit" or "per temporal unit".

Table 6. Properties of DB Table "InputStream"

FieldName	FieldType	LinkedTo	Description
ID_InputStream	String/GUID		A unique ID for each industrial solid input stream.
Description	String		A brief description of the solid input stream.
InputTypeID	String	ID_WasteType	An identifier for the type of the solid input stream based on the SWAN classification.
Amount	Real		A numerical value describing the amount of this solid input stream.
PhysicalUnit	String		The physical unit in which the solid input stream is measured. Options should include kg, t, kt, Mt, L and m^3.
TemporalUnit	String		The temporal unit in which the solid input stream is measured. Options should include per day, week, month and year.
CurrentSupplyID	String	ID_CSM	An identifier for the current supply method applicable for the solid input stream.
CurrentSupplyCost	Real		A numerical value indicating the current supply cost for the solid input stream.
CurrentSupplyCostUnit	String		The unit of the current supply cost, expressed either "per physical unit" or "per temporal unit".
ConsiderIS	Boolean		A Boolean (Yes/No) indicating whether the company would consider changing the current supply with a suitable waste stream.

Table 7. Properties of DB Table "IndustrySize"

FieldName	FieldType	LinkedTo	Description
ID_Size	String/GUID		A unique ID for each industrial size category.

Description	String		A brief description of each size category

The four size categories to be included in the corresponding table are the following:

- Large enterprises >250 employees
- Small and medium-sized enterprises 21-250 employees
- Small firms 11-50 employees
- Micro-enterprises <10 employees

Table 8. Properties of DB Table "Industry Type"

FieldName	FieldType	LinkedTo	Description
ID_IndustryType	String/GUID		A unique ID for each industrial type category.
NACESection	String		A letter (A to U) identifying the sector of economic activity.
NACEDivision	String		A two-digit numerical code (01 to 99) identifying the division.
NACEGroup	String		A three-digit numerical code (01.1 to 99.0) identifying the group
NACEClass	String		A four-digit numerical code (01.11 to 99.00) identifying the class
Descirption	String		A brief description of each size category

The various industrial type to be included in the corresponding table are presented in Appendix 1

Table 9. Properties of DB Table "EWC"

FieldName	FieldType	LinkedTo	Description
ID_EWC	String/GUID		A unique ID for each category of the European Waste Catalogue.
Description	String		A brief description of category of the European Waste Catalogue.

The twenty categories to be included in the corresponding table are presented in Appendix 2.

Table 10. Properties of DB Table "Waste Type"

FieldName	FieldType	LinkedTo	Description
ID_WasteType	String/GUID		A unique ID for each category of the SWAN Waste Classification.
Description	String		A brief description of the category.
State	String		The physical state of the waste

The eight categories to be initially included in the corresponding table are presented in Appendix 4. More categories might be added after the collection of the questionnaires from the SWAN Case Studies.

Table 11. Properties of DB Table "Current Management Method"

FieldName	FieldType	LinkedTo	Description
ID_CMM	String/GUID		A unique ID for each waste management method.
Description	String		A brief description of waste management method.

The six categories to be initially included in the corresponding table are the following:

- On-site Treatment and Disposal
- Management by Private Company
- Management by Public Company (municipal/regional)
- Sale
- Landfill
- Incineration

More categories might be added after the collection of the questionnaires from the SWAN Case Studies.

Table 12. Properties of DB Table "Current Supply Method"

FieldName	FieldType	LinkedTo	Description
ID_CSM	String/GUID		A unique ID for each solid input supply method.
Description	String		A brief description of solid input supply method.

The three categories to be initially included in the corresponding table are the following:

- Commercial purchase of raw material
- Waste stream purchase from another industry
- Supply from another industrial plant of the same company

More categories might be added after the collection of the questionnaires from the SWAN Case Studies.

Table 13. Properties of DB Table "Best Practices"

FieldName	FieldType	LinkedTo	Description
ID_BestPractice	String/GUID		A unique ID for each best practice.
Description	String		A short text describing the application of this technology.
IndustrySourceID	String		The type of the industrial plant supplying the waste stream.
IndustrySinkID	String		The type of the industrial plant receiving the waste stream.
WasteStreamID	String		The type of the waste stream.

Commercial	Boolean		A boolean (Y/N) indicating whether this technique is commercially applied in large scale.
Comments	String		A short text including any other relevant comments (e.g. amount of waste exchanged, location of application)
Reference	String		A short text describing the scientific reference for this technique.

5 GUIDELINES FOR THE IMPLEMENTATION OF THE SWAN PLATFORM PROTOTYPE

The final section of Deliverable presents some other guidelines towards the implementation of the SWAN Platform prototype. These include:

- A first draft of the SWAN survey questionnaire, which is based on the SWAN Platform Technical Design (presented in Section 4) and will help to populate the platform DB with data for all the regional case studies; and
- A first of the Database of Best Practices for Industrial Symbiosis, by indicating the main information that should be collected for each DB entry.

5.1 SWAN Questionnaire

The SWAN questionnaire will be used to collect all the necessary information for the industrial solid waste sources and potential receivers. Data will be collected from all four SWAN case studies/countries (Greece, Albania, Bulgaria and Cyprus). The questionnaire is split in five different parts, as described in the sections below.

5.1.1 Part 1. General Characteristics

Table 14 should be filled in with all the general characteristics of the industrial plant. Please, note that:

- For the "Type", the Statistical Classification of Economic Activities in the European Community (NACE) and the corresponding NACE code for the main activity of the plant in terms of waste production should be used, as presented in Appendix 1.
- For the "Size", the following classification should be used:
  - Large enterprises >250 employees
  - Small and medium-sized enterprises 21-250 employees
  - Small firms 11-50 employees
  - Micro-enterprises <10 employees
- For the "Electronic Waste Registry" and the corresponding number, the Greek participants should use their HMA number. For the other countries, please fill in as appropriate.

Table 14. General Characteristics of the Industrial Plant

Name	
NACE Type	
NACE Code	
Description	
Size	
Latitude	
Longitude	
Electronic Waste Registry	
Registration Number	

5.1.2 Part 2. Waste Data

As many rows of Table 15 as possible should be filled in based on the solid waste output streams of the industrial unit. Please note that:

- For the EWC Type (2 digits), the European Waste Classification/List of Waste presented in Appendix 2 should be used. However, please note that the waste type is fully defined by the six-digit code (see the full Consolidated European Waste Catalogue) so where possible the full six digit code should be given.
- For the EWC-Stat Type, the EWC-Stat Categories presented in Appendix 3 should be used.
- For the Quantity, specify the amount of industrial waste available and highlight the units that the quantity is measured in. Include both the physical units (e.g. kg, tonnes) and the temporal units (e.g. per day, per month, per year).
- For the Seasonal Availability, please determine if the waste is produced during the whole year or is it limited to a certain period of the year. In the latter case, please specify when.
- For the Current Management Method, the options are presented in Appendix 5, according to European Legislation.
- For the Current Management Method Owner, it should be specified iφ the company is managing the waste themselves, or if the treatment is done by an external stakeholder (private or public)
- For the Current Management Method Cost: Management by licensed operator include the cost of the currently used waste management method and specify the units (e.g. € per kg of waste, € per day/month/year)
- For the "Permit", the following question should be answered: "Is permit required for the collection and transport of waste, granted by the competent authority. If yes, which authority?" (e.g. government, regional administration)
- Any other information

Table 15. Solid Waste Streams

Name	EWC Type (2 digit)	EWC Type (6 digit)	EWC-Stat Type	Quantity	Seasonal Availability	Current Management Method	Current Management Owner	Current Management Method Cost	Permit

5.1.3 Part 3. Input Data

As many rows of Table 16 as possible should be filled in based on the solid input streams of the industrial unit that could be potentially replaced by a waste stream produced from another industrial unit. Please note that we are not interested in the entire inventory of flows of the industrial unit, but only those which could be a part of a waste reuse scheme. Furthermore:

- For the Type, you should use the Solid Resources Classification presented in Appendix 4.
- The Description should offer any extra detail to clarify the type of the solid input stream.

- For the Quantity, specify the amount of solid resources required available and highlight the units that the quantity is measured in. Include both the physical units (e.g. kg, tonnes) and the temporal units (e.g. per day, per month, per year).
- For the Seasonal Availability, please determine if the solid resources are consumed during the whole year or is it limited to a certain period of the year. In the latter case, please specify when.
- For the Current Supply Method, the options are:
    o Commercial purchase of raw material
    o Waste stream purchase from another industry
    o Supply from another industrial plant of the same company
    o Other (Please Specify)
- For the Current Management Supply Cost include the cost of the currently used resource supply method and specify the units (e.g. € per kg of waste, € per day/month/year)
- For the "Consider Industrial Symbiosis" determine with a Yes or a No, if the company would consider or not to implement a waste reuse scheme for this specific resource. If no, specify why.

Table 16. Solid Input Streams

Name	Type	Description	Quantity	Seasonal Availability	Current Supply Method	Current Supply Method Cost	Consider Industrial Symbiosis

5.1.4 Part 4. Supplementary Data

The following questions should be answered:

- Are you familiar with the concept of circular economy? If yes, which do you consider to be the main objectives of circular economy and the main sector of its application?
- Are you familiar with the concept of industrial symbiosis?
- Are there any existing Symbiotic Links implemented at this industrial units? The answer should not be limited to solid industrial waste.
- Is there availability of on-site waste treatment infrastructure?
- Is there availability of on-site solid waste storage facility?
- Are there any Environmental Related Initiatives in place?
- Is there availability of solid waste transportation and cost estimation?

5.1.5 Part 5. SWAN Industrial Ecosystem

The SWAN industrial ecosystem (SWAN IE) will be a network of industries in the Balkan region, which produce and use solid waste, with an aim to develop and promote cost efficient, transnational solid waste reuse value chains, within the frame of circular economy. The ecosystem will also involve policy makers and government stakeholders which will ensure common development and local adaptations, towards growth and job creation.

- Would you be interested in being involved in the SWAN-IE? (Yes or No)
- Would the company be interested in participating in symbiotic value chains?
- What are the details of the contact person?

5.2 Best Practices

This section presents a very first draft of the already implemented best practices towards industrial symbiosis. It is definitely not exhaustive and will be further populated during the SWAN platform development. Moreover, input might be provided through the SWAN questionnaire from the responses collected by the industries in the study areas.

For each IS practice/technology, the following characteristics should be collected:

- The type of the industrial plant supplying the waste stream;
- The type of the industrial plant receiving the waste stream;
- The type of the waste stream exchanged between source and sink;
- An indication about the technology readiness level of this option; and
- A scientific reference.

Table 17. Indicative list of IS schemes from literature

	Waste Stream	Source Type	Sink Type	Reference
1	Brines	Soda Plant	Bromine Plant	Liu et al. (2015)
2	Crude Salt	Salt Field	Soda Plant	Liu et al. (2015)
3	Waste Soda	Soda Plant	Silica Plant	Liu et al. (2015)
4	Waste Soda	Soda Plant	Saleratus	Liu et al. (2015)
5	Fly Ash	Thermal Plant	Cement Plant	Liu et al. (2015)
6	Fly Ash	Lime Industry/Plaster Industry	Cement Plant	CECP (2007)
7	Barley Ash	Brewery	Cement Plant	Kykia (2015)
8	Used Oil	Lime Industry/Plaster Industry	Cement Plant	CECP (2007)
9	Construction Rubble	-	Filling Material for construction	CECP (2007)
10	Used Tyres	-	Carbon Fibre manufacturing	Teng et al. (1995)
11	Used Tyres	-	Asphalt for Roads	Francois et al. (2009)
12	Glass Waste	Glass Industry	Fibreglass manufacturing	Mirata and Emtairah (2005)
13	Food Waste	Juice Industry	Animal foods manufacturing	Mirata (2004)
14	Residual PVC	-	Rubber manufacturing	Yang and Feng (2008)
15	…	…	…	…

6   REFERENCES

Aid, G., Brandt, N., Lysenkova, M. and Smedberg, N. (2015). "Looplocal – A heuristic visualization tool to support the strategic facilitation of industrial symbiosis", *Journal of Cleaner Production* **98**: 328-335.

Alvarez, R. and Ruiz-Puente, M.C. (2017). "Development of the tool SymbioSys to support the transition towards a circular economy based on industrial symbiosis strategies", *Waste and Biomass Valorization* **8**(5): 1521-1530.

Cecelja, F., Raafat, T., Trokanas, N., Innes, S., Smith, M., Yang, A., Zorgios, Y., Korkofygas, A. and Kokossis, A. (2015). *"e-Symbiosis: technology-enabled support for industrial symbiosis targeting SMEs and innovation" Journal of Cleaner Production* **98**: 336-352.

CECP (2007) Regional Resource Synergies for Sustainable Development in Heavy Industrial Areas: an Overview of Opportunities and Experiences, CECP-Centre of Excellence in Cleaner Production, Curtin University of Technology, Perth.

EC (2000) Commission Decision 2000/532/EC replacing Decision 94/3/EC establishing a list of wastes pursuant to Article 1(a) of Council Directive 75/442/EEC on waste and Council Decision 94/904/EC establishing a list of hazardous waste pursuant to Article 1(4) of Council Directive 91/689/EEC on hazardous waste, European Union, Brussels.

EC (2001) Commission Decision 2001/118/EC amending Decision 2000/532/EC as regards the list of wastes, European Union, Brussels.

EC (2002) Regulation 2150/2002/EC of the European Parliament and of the Council of 25 November 2002 on waste statistics, European Union, Brussels.

EC (2008) Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Waste Framework Directive), European Union, Brussels.

EC (2014a) Communication (COM 2014/398/EC) from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions - Towards a circular economy: A zero waste programme for Europe, European Union, Brussels.

EC (2014b) Commission Decision 2014/955/EU amending Decision 2000/532/EC on the list of waste pursuant to Directive 2008/98/EC, European Union, Brussels.

EEA (2015) "SOER 2015 - The European environment - State and outlook 2015", European Environment Agency, Copenhagen.

Eurostat (2015) Online database available at http://ec.europa.eu/eurostat

François D., Jullien A., Kerzreho J.P. and Chateau L. (2009) Full-scale experimentations on alternative materials in roads: analysis of study practices, *Waste Management*, **29**: 1076-1083

Grant, G.B., Seager, T.P., Massard, G. and Nies, L. (2010). "Information and communication technology for industrial symbiosis", *Journal of Industrial Ecology* **14**(5): 740–753.

Jensen, P.D., Basson, L., Hellawell, E., Bailey, M. and Leach, M. (2011). "Quantifying geographic proximity: Experiences from the United Kingdom's National Industrial Symbiosis Programme", *Resources, Conservation and Recycling* **55**(7): 703-712.

Kykia F. (2015). "Industrial Symbiosis: A Methodological Framework for Analysing and Assessing Alternative Actions", MEng Final Year Thesis, School of Chemical Engineering, NTUA, Greece.

Liu, C., Côté, R.P. and Zhang, K. (2015). "Implementing a three-level approach in industrial symbiosis", *Journal of Cleaner Production* **87**: 318-327.

Mirata, M. (2004) "Experiences from early stages of a national industrial symbiosis programme in the UK: determinants and coordination challenges", *Journal of Cleaner Production* **12**: 967-983.

Mirata M. and Emtairah T. (2005). "Industrial symbiosis network and the contribution to environmental innovation: the case of the Landskrona industrial symbiosis programme", *Journal of Cleaner Production* **13**: 993-1002.

Raabe, B., Choong Low, J., Juraschek, M., Herrmann, C., Bestari Tjandra, T., Ting Ng, Y., Kurle, D., Cerdas, F., Lueckenga, J., Yeo, Z. and Shee Tan, Y. (2017). "Collaboration Platform for Enabling Industrial Symbiosis: Application of the By-product Exchange Network Model" *Procedia CIRP*, **61**: 263-268.

Song, B., Yeo, Z., Kohls P, and Herrmann, C. (2017). "Industrial Symbiosis: Exploring Big-data Approach for Waste Stream Discovery", *Procedia CIRP* **61**: 353-358.

Teng H., Serio M.A., Wójtowicz M.A., Bassilakis R. and Solomon P.R. (1995). "Reprocessing of used tires into activated carbon and other products" *Industrial and Engineering Chemistry Research*, **34**:3102-3111

Yang S. and Feng N. (2008). "Case study of industrial symbiosis: Nanning Sugar So., Ltd. in China", *Resources, Conservation and Recycling*, **52**:813-820

Appendix 1. Statistical Classification of Economic Activities in the European Community

The Statistical classification of economic activities in the European Community, abbreviated as NACE, is the classification of economic activities in the European Union (EU); the term NACE is derived from the French "Nomenclature statistique des activités économiques dans la Communauté européenne". It is a four-digit classification providing the framework for collecting and presenting a large range of statistical data according to economic activity in the fields of economic statistics (e.g. production, employment and national accounts) and in other statistical domains developed within the European statistical system (ESS).

The current version of NACE (NACE Rev.2) uses four hierarchical levels:

- Level 1: 21 sections identified by alphabetical letters A to U;
- Level 2: 88 divisions identified by two-digit numerical codes (01 to 99);
- Level 3: 272 groups identified by three-digit numerical codes (01.1 to 99.0);
- Level 4: 615 classes identified by four-digit numerical codes (01.11 to 99.00).

(Source: http://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Statistical_classification_of_economic_activities_in_the_European_Community_(NACE)&oldid=280177)

A detailed list of all the relevant levels, divisions, groups and classes is presented below.

(Source: http://ec.europa.eu/competition/mergers/cases/index/nace_all.html)

A - Agriculture, forestry and fishing

No relevant sub levels for this section

B - Mining and quarrying

B5 - Mining of coal and lignite

B5.1 - Mining of hard coal

B5.1.0 - Mining of hard coal

B5.2 - Mining of lignite

B5.2.0 - Mining of lignite

B6 - Extraction of crude petroleum and natural gas

B6.1 - Extraction of crude petroleum

B6.1.0 - Extraction of crude petroleum

B6.2 - Extraction of natural gas

B6.2.0 - Extraction of natural gas

B7 - Mining of metal ores

B7.1 - Mining of iron ores

B7.1.0 - Mining of iron ores

B7.2 - Mining of non-ferrous metal ores

B7.2.1 - Mining of uranium and thorium ores

B7.2.9 - Mining of other non-ferrous metal ores

B8 - Other mining and quarrying

B8.1 - Quarrying of stone, sand and clay

B8.1.1 - Quarrying of ornamental and building stone, limestone, gypsum, chalk and slate

B8.1.2 - Operation of gravel and sand pits; mining of clays and kaolin

B8.9 - Mining and quarrying n.e.c.

B8.9.1 - Mining of chemical and fertiliser minerals

B8.9.2 - Extraction of peat

B8.9.3 - Extraction of salt

B8.9.9 - Other mining and quarrying n.e.c.

B9 - Mining support service activities

B9.1 - Support activities for petroleum and natural gas extraction

B9.1.0 - Support activities for petroleum and natural gas extraction

B9.9 - Support activities for other mining and quarrying

B9.9.0 - Support activities for other mining and quarrying

C - Manufacturing

C10 - Manufacture of food products

C10.1 - Processing and preserving of meat and production of meat products

C10.1.1 - Processing and preserving of meat

C10.1.2 - Processing and preserving of poultry meat

C10.1.3 - Production of meat and poultry meat products

C10.2 - Processing and preserving of fish, crustaceans and molluscs

C10.2.0 - Processing and preserving of fish, crustaceans and molluscs

C10.3 - Processing and preserving of fruit and vegetables

C10.3.1 - Processing and preserving of potatoes

C10.3.2 - Manufacture of fruit and vegetable juice

C10.3.9 - Other processing and preserving of fruit and vegetables

C10.4 - Manufacture of vegetable and animal oils and fats

C10.4.1 - Manufacture of oils and fats

C10.4.2 - Manufacture of margarine and similar edible fats

C10.5 - Manufacture of dairy products

C10.5.1 - Operation of dairies and cheese making

C10.5.2 - Manufacture of ice cream

C10.6 - Manufacture of grain mill products, starches and starch products

C10.6.1 - Manufacture of grain mill products

C10.6.2 - Manufacture of starches and starch products

C10.7 - Manufacture of bakery and farinaceous products

C10.7.1 - Manufacture of bread; manufacture of fresh pastry goods and cakes

C10.7.2 - Manufacture of rusks and biscuits; manufacture of preserved pastry goods and cakes

C10.7.3 - Manufacture of macaroni, noodles, couscous and similar farinaceous products

C10.8 - Manufacture of other food products

C10.8.1 - Manufacture of sugar

C10.8.2 - Manufacture of cocoa, chocolate and sugar confectionery

C10.8.3 - Processing of tea and coffee

C10.8.4 - Manufacture of condiments and seasonings

C10.8.5 - Manufacture of prepared meals and dishes

C10.8.6 - Manufacture of homogenised food preparations and dietetic food

C10.8.9 - Manufacture of other food products n.e.c.

C10.9 - Manufacture of prepared animal feeds

C10.9.1 - Manufacture of prepared feeds for farm animals

C10.9.2 - Manufacture of prepared pet foods

C11 - Manufacture of beverages

C11.0 - Manufacture of beverages

C11.0.1 - Distilling, rectifying and blending of spirits

C11.0.2 - Manufacture of wine from grape

C11.0.3 - Manufacture of cider and other fruit wines

C11.0.4 - Manufacture of other non-distilled fermented beverages

C11.0.5 - Manufacture of beer

C11.0.6 - Manufacture of malt

C11.0.7 - Manufacture of soft drinks; production of mineral waters and other bottled waters

C12 - Manufacture of tobacco products

C12.0 - Manufacture of tobacco products

C12.0.0 - Manufacture of tobacco products

C13 - Manufacture of textiles

C13.1 - Preparation and spinning of textile fibres

C13.1.0 - Preparation and spinning of textile fibres

C13.2 - Weaving of textiles

C13.2.0 - Weaving of textiles

C13.3 - Finishing of textiles

C13.3.0 - Finishing of textiles

C13.9 - Manufacture of other textiles

C13.9.1 - Manufacture of knitted and crocheted fabrics

C13.9.2 - Manufacture of made-up textile articles, except apparel

C13.9.3 - Manufacture of carpets and rugs

C13.9.4 - Manufacture of cordage, rope, twine and netting

C13.9.5 - Manufacture of non-wovens and articles made from non-wovens, except apparel

C13.9.6 - Manufacture of other technical and industrial textiles

C13.9.9 - Manufacture of other textiles n.e.c.

C14 - Manufacture of wearing apparel

C14.1 - Manufacture of wearing apparel, except fur apparel

C14.1.1 - Manufacture of leather clothes

C14.1.2 - Manufacture of workwear

C14.1.3 - Manufacture of other outerwear

C14.1.4 - Manufacture of underwear

C14.1.9 - Manufacture of other wearing apparel and accessories

C14.2 - Manufacture of articles of fur

C14.2.0 - Manufacture of articles of fur

C14.3 - Manufacture of knitted and crocheted apparel

C14.3.1 - Manufacture of knitted and crocheted hosiery

C14.3.9 - Manufacture of other knitted and crocheted apparel

C15 - Manufacture of leather and related products

C15.1 - Tanning and dressing of leather; manufacture of luggage, handbags, saddlery and harness; dressing and dyeing of fur

C15.1.1 - Tanning and dressing of leather; dressing and dyeing of fur

C15.1.2 - Manufacture of luggage, handbags and the like, saddlery and harness

C15.2 - Manufacture of footwear

C15.2.0 - Manufacture of footwear

C16 - Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials

C16.1 - Sawmilling and planing of wood

C16.1.0 - Sawmilling and planing of wood

C16.2 - Manufacture of products of wood, cork, straw and plaiting materials

C16.2.1 - Manufacture of veneer sheets and wood-based panels

C16.2.2 - Manufacture of assembled parquet floors

C16.2.3 - Manufacture of other builders' carpentry and joinery

C16.2.4 - Manufacture of wooden containers

C16.2.9 - Manufacture of other products of wood; manufacture of articles of cork, straw and plaiting materials

C17 - Manufacture of paper and paper products

C17.1 - Manufacture of pulp, paper and paperboard

C17.1.1 - Manufacture of pulp

C17.1.2 - Manufacture of paper and paperboard

C17.2 - Manufacture of articles of paper and paperboard

C17.2.1 - Manufacture of corrugated paper and paperboard and of containers of paper and paperboard

C17.2.2 - Manufacture of household and sanitary goods and of toilet requisites

C17.2.3 - Manufacture of paper stationery

C17.2.4 - Manufacture of wallpaper

C17.2.9 - Manufacture of other articles of paper and paperboard

C18 - Printing and reproduction of recorded media

C18.1 - Printing and service activities related to printing

C18.1.1 - Printing of newspapers

C18.1.2 - Other printing

C18.1.3 - Pre-press and pre-media services

C18.1.4 - Binding and related services

C18.2 - Reproduction of recorded media

C18.2.0 - Reproduction of recorded media

C19 - Manufacture of coke and refined petroleum products

C19.1 - Manufacture of coke oven products

C19.1.0 - Manufacture of coke oven products

C19.2 - Manufacture of refined petroleum products

C19.2.0 - Manufacture of refined petroleum products

C20 - Manufacture of chemicals and chemical products

C20.1 - Manufacture of basic chemicals, fertilisers and nitrogen compounds, plastics and synthetic rubber in primary forms

C20.1.1 - Manufacture of industrial gases

C20.1.2 - Manufacture of dyes and pigments

C20.1.3 - Manufacture of other inorganic basic chemicals

C20.1.4 - Manufacture of other organic basic chemicals

C20.1.5 - Manufacture of fertilisers and nitrogen compounds

C20.1.6 - Manufacture of plastics in primary forms

C20.1.7 - Manufacture of synthetic rubber in primary forms

C20.2 - Manufacture of pesticides and other agrochemical products

C20.2.0 - Manufacture of pesticides and other agrochemical products

C20.3 - Manufacture of paints, varnishes and similar coatings, printing ink and mastics

C20.3.0 - Manufacture of paints, varnishes and similar coatings, printing ink and mastics

C20.4 - Manufacture of soap and detergents, cleaning and polishing preparations, perfumes and toilet preparations

C20.4.1 - Manufacture of soap and detergents, cleaning and polishing preparations

C20.4.2 - Manufacture of perfumes and toilet preparations

C20.5 - Manufacture of other chemical products

C20.5.1 - Manufacture of explosives

C20.5.2 - Manufacture of glues

C20.5.3 - Manufacture of essential oils

C20.5.9 - Manufacture of other chemical products n.e.c.

C20.6 - Manufacture of man-made fibres

C20.6.0 - Manufacture of man-made fibres

C21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations

C21.1 - Manufacture of basic pharmaceutical products

C21.1.0 - Manufacture of basic pharmaceutical products

C21.2 - Manufacture of pharmaceutical preparations

C21.2.0 - Manufacture of pharmaceutical preparations

C22 - Manufacture of rubber and plastic products

C22.1 - Manufacture of rubber products

C22.1.1 - Manufacture of rubber tyres and tubes; retreading and rebuilding of rubber tyres

C22.1.9 - Manufacture of other rubber products

C22.2 - Manufacture of plastics products

C22.2.1 - Manufacture of plastic plates, sheets, tubes and profiles

C22.2.2 - Manufacture of plastic packing goods

C22.2.3 - Manufacture of builders' ware of plastic

C22.2.9 - Manufacture of other plastic products

C23 - Manufacture of other non-metallic mineral products

C23.1 - Manufacture of glass and glass products

C23.1.1 - Manufacture of flat glass

C23.1.2 - Shaping and processing of flat glass

C23.1.3 - Manufacture of hollow glass

C23.1.4 - Manufacture of glass fibres

C23.1.9 - Manufacture and processing of other glass, including technical glassware

C23.2 - Manufacture of refractory products

C23.2.0 - Manufacture of refractory products

C23.3 - Manufacture of clay building materials

C23.3.1 - Manufacture of ceramic tiles and flags

C23.3.2 - Manufacture of bricks, tiles and construction products, in baked clay

C23.4 - Manufacture of other porcelain and ceramic products

C23.4.1 - Manufacture of ceramic household and ornamental articles

C23.4.2 - Manufacture of ceramic sanitary fixtures

C23.4.3 - Manufacture of ceramic insulators and insulating fittings

C23.4.4 - Manufacture of other technical ceramic products

C23.4.9 - Manufacture of other ceramic products

C23.5 - Manufacture of cement, lime and plaster

C23.5.1 - Manufacture of cement

C23.5.2 - Manufacture of lime and plaster

C23.6 - Manufacture of articles of concrete, cement and plaster

C23.6.1 - Manufacture of concrete products for construction purposes

C23.6.2 - Manufacture of plaster products for construction purposes

C23.6.3 - Manufacture of ready-mixed concrete

C23.6.4 - Manufacture of mortars

C23.6.5 - Manufacture of fibre cement

C23.6.9 - Manufacture of other articles of concrete, plaster and cement

C23.7 - Cutting, shaping and finishing of stone

C23.7.0 - Cutting, shaping and finishing of stone

C23.9 - Manufacture of abrasive products and non-metallic mineral products n.e.c.

C23.9.1 - Production of abrasive products

C23.9.9 - Manufacture of other non-metallic mineral products n.e.c.

C24 - Manufacture of basic metals

C24.1 - Manufacture of basic iron and steel and of ferro-alloys

C24.1.0 - Manufacture of basic iron and steel and of ferro-alloys

C24.2 - Manufacture of tubes, pipes, hollow profiles and related fittings, of steel

C24.2.0 - Manufacture of tubes, pipes, hollow profiles and related fittings, of steel

C24.3 - Manufacture of other products of first processing of steel

C24.3.1 - Cold drawing of bars

C24.3.2 - Cold rolling of narrow strip

C24.3.3 - Cold forming or folding

C24.3.4 - Cold drawing of wire

C24.4 - Manufacture of basic precious and other non-ferrous metals

C24.4.1 - Precious metals production

C24.4.2 - Aluminium production

C24.4.3 - Lead, zinc and tin production

C24.4.4 - Copper production

C24.4.5 - Other non-ferrous metal production

C24.4.6 - Processing of nuclear fuel

C24.5 - Casting of metals

C24.5.1 - Casting of iron

C24.5.2 - Casting of steel

C24.5.3 - Casting of light metals

C24.5.4 - Casting of other non-ferrous metals

C25 - Manufacture of fabricated metal products, except machinery and equipment

C25.1 - Manufacture of structural metal products

C25.1.1 - Manufacture of metal structures and parts of structures

C25.1.2 - Manufacture of doors and windows of metal

C25.2 - Manufacture of tanks, reservoirs and containers of metal

C25.2.1 - Manufacture of central heating radiators and boilers

C25.2.9 - Manufacture of other tanks, reservoirs and containers of metal

C25.3 - Manufacture of steam generators, except central heating hot water boilers

C25.3.0 - Manufacture of steam generators, except central heating hot water boilers

C25.4 - Manufacture of weapons and ammunition

C25.4.0 - Manufacture of weapons and ammunition

C25.5 - Forging, pressing, stamping and roll-forming of metal; powder metallurgy

C25.5.0 - Forging, pressing, stamping and roll-forming of metal; powder metallurgy

C25.6 - Treatment and coating of metals; machining

C25.6.1 - Treatment and coating of metals

C25.6.2 - Machining

C25.7 - Manufacture of cutlery, tools and general hardware

C25.7.1 - Manufacture of cutlery

C25.7.2 - Manufacture of locks and hinges

C25.7.3 - Manufacture of tools

C25.9 - Manufacture of other fabricated metal products

C25.9.1 - Manufacture of steel drums and similar containers

C25.9.2 - Manufacture of light metal packaging

C25.9.3 - Manufacture of wire products, chain and springs

C25.9.4 - Manufacture of fasteners and screw machine products

C25.9.9 - Manufacture of other fabricated metal products n.e.c.

C26 - Manufacture of computer, electronic and optical products

C26.1 - Manufacture of electronic components and boards

C26.1.1 - Manufacture of electronic components

C26.1.2 - Manufacture of loaded electronic boards

C26.2 - Manufacture of computers and peripheral equipment

C26.2.0 - Manufacture of computers and peripheral equipment

C26.3 - Manufacture of communication equipment

C26.3.0 - Manufacture of communication equipment

C26.4 - Manufacture of consumer electronics

C26.4.0 - Manufacture of consumer electronics

C26.5 - Manufacture of instruments and appliances for measuring, testing and navigation; watches and clocks

C26.5.1 - Manufacture of instruments and appliances for measuring, testing and navigation

C26.5.2 - Manufacture of watches and clocks

C26.6 - Manufacture of irradiation, electromedical and electrotherapeutic equipment

C26.6.0 - Manufacture of irradiation, electromedical and electrotherapeutic equipment

C26.7 - Manufacture of optical instruments and photographic equipment

C26.7.0 - Manufacture of optical instruments and photographic equipment

C26.8 - Manufacture of magnetic and optical media

C26.8.0 - Manufacture of magnetic and optical media

C27 - Manufacture of electrical equipment

C27.1 - Manufacture of electric motors, generators, transformers and electricity distribution and control apparatus

C27.1.1 - Manufacture of electric motors, generators and transformers

C27.1.2 - Manufacture of electricity distribution and control apparatus

C27.2 - Manufacture of batteries and accumulators

C27.2.0 - Manufacture of batteries and accumulators

C27.3 - Manufacture of wiring and wiring devices

C27.3.1 - Manufacture of fibre optic cables

C27.3.2 - Manufacture of other electronic and electric wires and cables

C27.3.3 - Manufacture of wiring devices

C27.4 - Manufacture of electric lighting equipment

C27.4.0 - Manufacture of electric lighting equipment

C27.5 - Manufacture of domestic appliances

C27.5.1 - Manufacture of electric domestic appliances

C27.5.2 - Manufacture of non-electric domestic appliances

C27.9 - Manufacture of other electrical equipment

C27.9.0 - Manufacture of other electrical equipment

C28 - Manufacture of machinery and equipment n.e.c.

C28.1 - Manufacture of general-purpose machinery

C28.1.1 - Manufacture of engines and turbines, except aircraft, vehicle and cycle engines

C28.1.2 - Manufacture of fluid power equipment

C28.1.3 - Manufacture of other pumps and compressors

C28.1.4 - Manufacture of other taps and valves

C28.1.5 - Manufacture of bearings, gears, gearing and driving elements

C28.2 - Manufacture of other general-purpose machinery

C28.2.1 - Manufacture of ovens, furnaces and furnace burners

C28.2.2 - Manufacture of lifting and handling equipment

C28.2.3 - Manufacture of office machinery and equipment (except computers and peripheral equipment)

C28.2.4 - Manufacture of power-driven hand tools

C28.2.5 - Manufacture of non-domestic cooling and ventilation equipment

C28.2.9 - Manufacture of other general-purpose machinery n.e.c.

C28.3 - Manufacture of agricultural and forestry machinery

C28.3.0 - Manufacture of agricultural and forestry machinery

C28.4 - Manufacture of metal forming machinery and machine tools

C28.4.1 - Manufacture of metal forming machinery

C28.4.9 - Manufacture of other machine tools

C28.9 - Manufacture of other special-purpose machinery

C28.9.1 - Manufacture of machinery for metallurgy

C28.9.2 - Manufacture of machinery for mining, quarrying and construction

C28.9.3 - Manufacture of machinery for food, beverage and tobacco processing

C28.9.4 - Manufacture of machinery for textile, apparel and leather production

C28.9.5 - Manufacture of machinery for paper and paperboard production

C28.9.6 - Manufacture of plastics and rubber machinery

C28.9.9 - Manufacture of other special-purpose machinery n.e.c.

C29 - Manufacture of motor vehicles, trailers and semi-trailers

C29.1 - Manufacture of motor vehicles

C29.1.0 - Manufacture of motor vehicles

C29.2 - Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers

C29.2.0 - Manufacture of bodies (coachwork) for motor vehicles; manufacture of trailers and semi-trailers

C29.3 - Manufacture of parts and accessories for motor vehicles

C29.3.1 - Manufacture of electrical and electronic equipment for motor vehicles

C29.3.2 - Manufacture of other parts and accessories for motor vehicles

C30 - Manufacture of other transport equipment

C30.1 - Building of ships and boats

C30.1.1 - Building of ships and floating structures

C30.1.2 - Building of pleasure and sporting boats

C30.2 - Manufacture of railway locomotives and rolling stock

C30.2.0 - Manufacture of railway locomotives and rolling stock

C30.3 - Manufacture of air and spacecraft and related machinery

C30.3.0 - Manufacture of air and spacecraft and related machinery

C30.4 - Manufacture of military fighting vehicles

C30.4.0 - Manufacture of military fighting vehicles

C30.9 - Manufacture of transport equipment n.e.c.

C30.9.1 - Manufacture of motorcycles

C30.9.2 - Manufacture of bicycles and invalid carriages

C30.9.9 - Manufacture of other transport equipment n.e.c.

C31 - Manufacture of furniture

C31.0 - Manufacture of furniture

C31.0.1 - Manufacture of office and shop furniture

C31.0.2 - Manufacture of kitchen furniture

C31.0.3 - Manufacture of mattresses

C31.0.9 - Manufacture of other furniture

C32 - Other manufacturing

C32.1 - Manufacture of jewellery, bijouterie and related articles

C32.1.1 - Striking of coins

C32.1.2 - Manufacture of jewellery and related articles

C32.1.3 - Manufacture of imitation jewellery and related articles

C32.2 - Manufacture of musical instruments

C32.2.0 - Manufacture of musical instruments

C32.3 - Manufacture of sports goods

C32.3.0 - Manufacture of sports goods

C32.4 - Manufacture of games and toys

C32.4.0 - Manufacture of games and toys

C32.5 - Manufacture of medical and dental instruments and supplies

C32.5.0 - Manufacture of medical and dental instruments and supplies

C32.9 - Manufacturing n.e.c.

C32.9.1 - Manufacture of brooms and brushes

C32.9.9 - Other manufacturing n.e.c.

C33 - Repair and installation of machinery and equipment

C33.1 - Repair of fabricated metal products, machinery and equipment

C33.1.1 - Repair of fabricated metal products

C33.1.2 - Repair of machinery

C33.1.3 - Repair of electronic and optical equipment

C33.1.4 - Repair of electrical equipment

C33.1.5 - Repair and maintenance of ships and boats

C33.1.6 - Repair and maintenance of aircraft and spacecraft

C33.1.7 - Repair and maintenance of other transport equipment

C33.1.9 - Repair of other equipment

C33.2 - Installation of industrial machinery and equipment

C33.2.0 - Installation of industrial machinery and equipment

D - Electricity, gas, steam and air conditioning supply

D35 - Electricity, gas, steam and air conditioning supply

D35.1 - Electric power generation, transmission and distribution

D35.1.1 - Production of electricity

D35.1.2 - Transmission of electricity

D35.1.3 - Distribution of electricity

D35.1.4 - Trade of electricity

D35.2 - Manufacture of gas; distribution of gaseous fuels through mains

D35.2.1 - Manufacture of gas

D35.2.2 - Distribution of gaseous fuels through mains

D35.2.3 - Trade of gas through mains

D35.3 - Steam and air conditioning supply

D35.3.0 - Steam and air conditioning supply

E - Water supply; sewerage; waste managment and remediation activities

E36 - Water collection, treatment and supply

E36.0 - Water collection, treatment and supply

E36.0.0 - Water collection, treatment and supply

E37 - Sewerage

E37.0 - Sewerage

E37.0.0 - Sewerage

E38 - Waste collection, treatment and disposal activities; materials recovery

E38.1 - Waste collection

E38.1.1 - Collection of non-hazardous waste

E38.1.2 - Collection of hazardous waste

E38.2 - Waste treatment and disposal

E38.2.1 - Treatment and disposal of non-hazardous waste

E38.2.2 - Treatment and disposal of hazardous waste

E38.3 - Materials recovery

E38.3.1 - Dismantling of wrecks

E38.3.2 - Recovery of sorted materials

E39 - Remediation activities and other waste management services

E39.0 - Remediation activities and other waste management services

E39.0.0 - Remediation activities and other waste management services

F - Construction

F41 - Construction of buildings

F41.1 - Development of building projects

F41.1.0 - Development of building projects

F41.2 - Construction of residential and non-residential buildings

F41.2.0 - Construction of residential and non-residential buildings

F42 - Civil engineering

F42.1 - Construction of roads and railways

F42.1.1 - Construction of roads and motorways

F42.1.2 - Construction of railways and underground railways

F42.1.3 - Construction of bridges and tunnels

F42.2 - Construction of utility projects

F42.2.1 - Construction of utility projects for fluids

F42.2.2 - Construction of utility projects for electricity and telecommunications

F42.9 - Construction of other civil engineering projects

F42.9.1 - Construction of water projects

F42.9.9 - Construction of other civil engineering projects n.e.c.

F43 - Specialised construction activities

F43.1 - Demolition and site preparation

F43.1.1 - Demolition

F43.1.2 - Site preparation

F43.1.3 - Test drilling and boring

F43.2 - Electrical, plumbing and other construction installation activities

F43.2.1 - Electrical installation

F43.2.2 - Plumbing, heat and air-conditioning installation

F43.2.9 - Other construction installation

F43.3 - Building completion and finishing

F43.3.1 - Plastering

F43.3.2 - Joinery installation

F43.3.3 - Floor and wall covering

F43.3.4 - Painting and glazing

F43.3.9 - Other building completion and finishing

F43.9 - Other specialised construction activities

F43.9.1 - Roofing activities

F43.9.9 - Other specialised construction activities n.e.c.

G - Wholesale and retail trade; repair of motor vehicles and motorcycles

No relevant sub levels for this section

H - Transporting and storage

No relevant sub levels for this section

I - Accommodation and food service activities

No relevant sub levels for this section

J - Information and communication

No relevant sub levels for this section

K - Financial and insurance activities

No relevant sub levels for this section

M - Professional, scientific and technical activities

No relevant sub levels for this section

N - Administrative and support service activities

No relevant sub levels for this section

O - Public administration and defence; compulsory social security

No relevant sub levels for this section

P - Education

No relevant sub levels for this section

Q - Human health and social work activities

No relevant sub levels for this section

R - Arts, entertainment and recreation

No relevant sub levels for this section

S - Other services activities

No relevant sub levels for this section

T - Activities of households as employers; undifferentiated goods - and services - producing activities of households for own use

No relevant sub levels for this section

U - Activities of extraterritorial organisations and bodies

No relevant sub levels for this section

Appendix 2. European Waste Catalogue

1. Wastes resulting from exploration, mining, quarrying, and physical and chemical treatment of minerals
2. Wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing, food preparation and processing
3. Wastes from wood processing and the production of panels and furniture, pulp, paper and cardboard
4. Wastes from the leather, fur and textile industries
5. Wastes from petroleum refining, natural gas purification and pyrolytic treatment of coal
6. Wastes from inorganic chemical processes
7. Wastes from organic chemical processes
8. Wastes from the manufacture, formulation, supply and use (MFSU) of coatings (paints, varnishes and vitreous enamels), adhesives, sealants and printing inks
9. Wastes from the photographic industry
10. Wastes from thermal processes
11. Wastes from chemical surface treatment and coating of metals and other materials; non-ferrous hydro metallurgy
12. Wastes from shaping and physical and mechanical surface treatment of metals and plastics
13. Oil wastes and wastes of liquid fuels (except edible oils, 05 and 12)
14. Waste organic solvents, refrigerants and propellants (except 07 and 08)
15. Waste packaging; absorbents, wiping cloths, filter materials and protective clothing not otherwise specified
16. Wastes not otherwise specified in the list
17. Construction and demolition wastes (including excavated soil from contaminated sites)
18. Wastes from human or animal health care and/or related research (except kitchen and restaurant wastes not arising from immediate health care)
19. Wastes from waste management facilities, off-site waste water treatment plants and preparation of water intended for human consumption and water for industrial use
20. Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions

Appendix 3. EWC-Stat Categories

No	Code	Description	Hazardous
1	01.1	Spent solvents	Hazardous
2	01.2	Acid, alkaline or saline wastes	Non-hazardous
3	01.2	Acid, alkaline or saline wastes	Hazardous
4	01.3	Used oils	Hazardous
5	01.4, 02, 03.1	Chemical wastes	Non-hazardous
6	01.4, 02, 03.1	Chemical wastes	Hazardous
7	03.2	Industrial effluent sludges	Non-hazardous
8	03.2	Industrial effluent sludges	Hazardous
9	03.3	Sludges and liquid wastes from waste treatment	Non-hazardous
10	03.3	Sludges and liquid wastes from waste treatment	Hazardous
11	05	Health care and biological wastes	Non-hazardous
12	05	Health care and biological wastes	Hazardous
13	06	Metallic wastes, ferrous	Non-hazardous
14	06	Metallic wastes, non-ferrous	Non-hazardous
15	06	Metallic wastes, mixed ferrous and non-ferrous	Non-hazardous
16	07.1	Glass wastes	Non-hazardous
17	07.1	Glass wastes	Hazardous
18	07.2	Paper and cardboard wastes	Non-hazardous
19	07.3	Rubber wastes	Non-hazardous
20	07.4	Plastic wastes	Non-hazardous
21	07.5	Wood wastes	Non-hazardous
22	07.5	Wood wastes	Hazardous
23	07.6	Textile wastes	Non-hazardous
24	07.7	Waste containing PCB	Hazardous
25	08	Discarded equipment	Non-hazardous
26	08	Discarded equipment	Hazardous
27	08.1	Discarded vehicles	Non-hazardous
28	08.1	Discarded vehicles	Hazardous
29	08.41	Batteries and accumulators wastes	Non-hazardous
30	08.41	Batteries and accumulators wastes	Hazardous
31	09.1	Animal and mixed food waste	Non-hazardous
32	09.2	Vegetal wastes	Non-hazardous
33	09.3	Animal faeces, urine and manure	Non-hazardous
34	10.1	Household and similar wastes	Non-hazardous
35	10.2	Mixed and undifferentiated materials	Non-hazardous
36	10.2	Mixed and undifferentiated materials	Hazardous
37	10.3	Sorting residues	Non-hazardous
38	10.3	Sorting residues	Hazardous
39	11	Common sludges	Non-hazardous
40	12.1	Mineral waste from construction and demolition	Non-hazardous
41	12.1	Mineral waste from construction and demolition	Hazardous
42	12.2, 12.3, 12.5	Other mineral wastes	Non-hazardous

43	12.2, 12.3, 12.5	Other mineral wastes	Hazardous
44	12.4	Combustion wastes	Non-hazardous
45	12.4	Combustion wastes	Hazardous
46	12.6	Soils	Non-hazardous
47	12.6	Soils	Hazardous
48	12.7	Dredging spoils	Non-hazardous
49	12.7	Dredging spoils	Hazardous
50	12.8, 13	Mineral wastes from waste treatment and stabilised wastes	Non-hazardous
51	12.8, 13	Mineral wastes from waste treatment and stabilised wastes	Hazardous

Appendix 4. Solid Resources Classification

This appendix presents the resources classification for an IS scheme according to Cecelja et al. (2015). A resource is defined as any component can be involved in an exchange between two industrial units and can a solid material, liquid/aqueous material or energy.

The solid materials can be divided into the following categories:

- Polymers; range from synthetic plastics and elastomers to natural biopolymers
- Metals; solid material including ferrous and non-ferrous metals and alloys.
- Ceramics; inorganic, non-metallic materials.
- Chemicals; any material with a definite chemical composition.
- Minerals; naturally occurring inorganic solids.
- Composites; naturally occurring or engineered solid material.
- Organic Matter; solid material coming from a once living organism.
- Rocks; solid mineral material

Appendix 5. Waste Recovery and Disposal Methods

As defined in the in the EU Waste Framework Directive 2008/98:

Recovery Operations

R1*   Use principally as a fuel or other means to generate energy (***** not considered recovery to a final product)

R2   Solvent reclamation/regeneration

R3   Recycling/reclamation of organic substances which are not used as solvents (including composting and other biological transformation processes)

R4   Recycling/reclamation of metals and metal compounds

R5   Recycling/reclamation of other inorganic materials

R6   Regeneration of acids or bases

R7   Recovery of components used for pollution abatement

R8   Recovery of components from catalysts

R9   Oil re-refining or other reuses of oil

R10   Land treatment resulting in benefit to agriculture or ecological improvement

R11   Use of wastes obtained from any of the operations numbered R1 to R10

R12* Exchange of wastes for submission to any of the operations numbered R1 to R11 (***** not considered recovery to a final product)

R13* Storage of wastes pending any of the operations numbered R1 to R12 (excluding temporary storage, pending collection, on the site where it is produced) (***** not considered recovery to a final product)

Disposal Operations

D1   Deposit into or onto land, e.g. landfill

D2   Land treatment, e.g. biodegradation of liquid or sludgy discards in soils

D3   Deep injection, e.g. injection of pumpable discards into wells, salt domes or naturally occurring repositories

D4   Surface impoundment, e.g. placement of liquid or sludgy discards into pits, ponds or lagoons

D5   Specially engineered landfill, e.g. placement into lined discrete cells which are capped and isolated from one another and the environment

D6   Release into a water body, except seas/oceans

D7   Release into seas/oceans, including sea-bed insertion

D8   Biological treatment resulting in final compounds or mixtures which are discarded by any of the operations numbered D1 to D12

D9   Physico-chemical treatment resulting in final compounds or mixtures which are discarded by any of the operations numbered D1 to D12, e.g. evaporation, drying, calcination

D10   Incineration on land

D11   Incineration at sea

D12   Permanent storage, e.g. emplacement of containers in a mine

D13   Blending or mixing prior to submission to any of the operations numbered D1 to D12

D14   Repackaging prior to submission to any of the operations numbered D1 to D13

D15   Storage pending any of the operations numbered D1 to D14 (excluding temporary storage, pending collection, on the site where it is produced)