

INVESTIGATING THE ADEQUACY OF THE INSTITUTIONAL FRAMEWORK FOR IMPLEMENTING INDUSTRIAL SYMBIOSIS IN PRACTICE: THE CASE OF GREECE

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Abstract

Industrial Symbiosis ambition is to couple industrial development and environmental protection, through conservation of energy and resources, waste and by-products utilisation. The promotion and implementation of Industrial Symbiosis highly depends on the institutional framework at local, national and EU level. In particular, while the adopted policies provide opportunities they also impose restrictions in order to achieve a shift towards eco-industry. To determine the institutional framework needed, it is necessary to define the Industrial Symbiosis itself. The present study is focused on investigating the sufficiency of the current institutional framework applied in Greece so as to implement industrial symbiosis in practice. For the needs of this study, the Industrial Symbiosis concept is not confined within the spatial entity of an Industrial Zone, detached from the surrounding environment. Instead, it is a spatial network of human activities, a sustainable flow of energy and matter. The very first finding of the study is that there is enough legislation and competent authorities for the environmental protection, both in the EU and Greek legal system. What is hard to be done is its effective implementation of it, which is most of the times inefficient and fragmented. The absence of comprehensive and specifically designed legislation as well as the difficulty in uptake existing funding programs and incentives were also identified as major problems for putting into practice Industrial Symbiosis. Considering the above, the present legislative and institutional framework needs to be further integrated while better coordination and more simplified procedures shall be applied by the permitting authorities so as to implement Industrial Symbiosis in Greece.

Keywords

Industrial Symbiosis; Greece; Institutional Framework; Ecological Park; Industrial Park

1. Introduction

Industrial Symbiosis is the sharing of services, utility, and by-product resources among industries in order to add value, reduce costs and improve the environment [1]. Industrial Symbiosis is based on the concepts of industrial ecology (IE) and eco-industrial development (EID) and refers to the network of product, by-product and waste exchanges that reduce the ecological footprint of industrial areas [2]. Sharing costs between companies, value chains and sectors in an open innovation community aim to have an energy and resource efficiency impact. These potentials can be identified by considering industries not in isolation, but as part of a broader value- chain that contains future economic opportunities. As a result Industrial symbiosis can help companies: reduce raw material and waste disposal costs; earn new revenue from residues and byproducts; divert waste from landfill and reduce carbon emissions and open up new business opportunities [3]. *Chertow (2007)* proposed that there are three primary opportunities for resource exchange: a) By-product reuse - the exchange of firm-specific materials between two or more parties for use as substitutes for commercial products or raw materials. The materials exchange component has also been referred to as a by-product exchange, by-product synergy, or waste exchange and may also be referred to as an industrial recycling network. b) Utility/infrastructure sharing - the pooled use and management of commonly used resources such

as energy, water, and wastewater. c) Joint provision of services - meeting common needs across firms for ancillary activities such as fire suppression, transportation, and food provision [4].

As mentioned above, the concept of Industrial Symbiosis is based on the principle of Industrial Ecology where the objective is the net production for environmental protection [5]. The instruments or tools to be used for the implementation of Industrial Symbiosis in practice must lead to Industrial Sustainability, which aims at achieving environmental sustainability, but also constitutes a challenge in terms of optimal financial and administrative development of the companies.

Industrial symbiosis includes not only the secondary sector, but also extends to both primary (e.g. livestock and agriculture) and tertiary sectors (e.g. tourism services, commerce). Although the term 'Industrial Symbiosis' can theoretically be applied in a wider concept and must not limit itself to sectoral boundaries and / or geographical restrictions, it is believed that Industrial Symbiosis networks shall primarily be organised in geographic proximity so as to develop tangible economic and social benefits to local communities. The success depends on many factors including but not limited to the legislative framework, the private initiative, the use of advanced technologies, the financial incentives and the market value of products and businesses.

The present study aims at investigating the adequacy of the Greek institutional framework in implementing the concept of Industrial Symbiosis. Aiming at the above, relative European legislative framework (Directives, Regulation, policies etc.) as well as the institutional tools related to raw materials and energy savings and pollution prevention in air, soil and water were examined and are presented below. Moreover, the policies conducted by the Special Framework for Regional Planning and Sustainable Development for the Greek Industry and the current and past Laws for Industrial Parks are also summarised. Finally, financial incentives provided by the Greek government and their adequacy for business relocation to existing and future Industrial Parks were also investigated.

2. The institutional framework for waste management and environmental protection

2.1 EU principles and tools encouraging Industrial Symbiosis

The fundamental principles of environmental protection are: (a) the "precautionary principle" and the preventive action, (b) the principle of rectifying environmental damage at source and (c) the "polluter pays principle". In line with these principles, the EU waste management policy sets as a first priority the prevention of waste generation, which is expressed both by reducing the quantity, and by reducing the danger of waste. Following prevention, reuse and recycling of different "waste streams" such as packaging waste, vehicles at the end of life, used batteries, electrical and electronic waste etc is foreseen. Finally, recovery and safe disposal are proposed if the previous mentioned waste management options are exhausted. The waste hierarchy is often represented by a pyramid in which the more desirable options are found towards the top of the pyramid while the less favored on its foundations. In **Figure 1**, the waste management pyramid and the relative official definitions derived from Article 3 of Directive 2008/98/EC are illustrated.

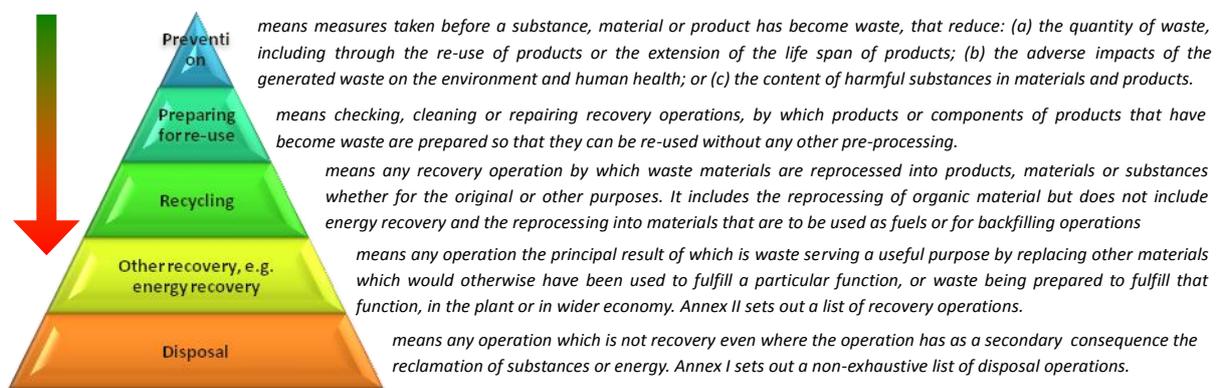


Figure 1: Waste hierarchy under Directive 2008/98/EC

The main tools used by the EU to achieve its objectives towards a greener industry are as follows: (1) LCA - Life Cycle Assessment, (2) Eco-Labeling, (3) EMAS - Eco-Management and Audit Scheme, (4) IED – BAT: Industrial Emissions Directive - Best Available Techniques and (5) EoW: End of Waste Criteria.

2.2 Existing Legislative Framework in Greece

In Greece the basic environmental legislative act was introduced with Law 1650/86 (Government Gazette A160) *on the protection of the environment*, based on which ground rules, criteria and mechanisms for the protection of the environment were established. The question as to whether or not the Industrial Symbiosis may be an option or a commitment of the competent authorities and/or businesses, must be considered in the light of international protocols and EU directives which requires specific policies to achieve a satisfactory level of environmental protection. Under Directive 2004/35/EC *on environmental liability*, incorporated in Greek law by the Presidential Decree 148/2009, industries are most economically and administratively accountable for environmental damage. Under these provisions the polluter is liable to pay the cost of restoring the environmental damage, although according to paragraph 2d of Article 9 of Presidential Decree 148/2009 " *The competent authority may at any time take itself against the operator liable, the necessary remedial measures ...* ". Considering the obligation of those commitments, Industrial Symbiosis can be seen as a tool that can highly contribute towards the achievement of Community objectives.

2.2.1 Solid Waste Management in Greece

Directive 2008/98/EC "*Revised Waste Framework Directive (rWFD)*" defines key concepts and sets the essential requirements for the management of waste and the criteria to be met in order for a waste to cease to be waste (End-of-Waste) or to be considered as by-product. Moreover, through Decision 2000/532/EC as amended, the European List of Waste (LoW) has been established.

The Greek Legislative Framework was harmonized with Directive 2008/98/EC with the introduction of Law 4042/2012. This Law also includes provisions in order to achieve conformity with the Directive 2008/99/EC "*on the protection of the environment through criminal law*" as well as specific arrangements of issues related to the Ministry of Environment, Energy and Climate Change. Law 4042/2012 aimed at resolving many problems and started a systematization of management actions that should be performed in order to achieve the objectives of the EU waste management. At the moment, the National Waste Management Plan, which sets guidelines for the integrated management of waste and suggest appropriate measures, is under revision while the studies for the Special Waste Management Plans for specific waste streams, in national level, have been accomplished. National and the Regional and Special Management Plans have no binding force unless they are officially adopted by ministerial decision.

Following some indicative provisions concerning industrial and agricultural waste as well as issues related to EoW criteria and by-products are discussed. Industrial and agricultural waste are quite important but not so frequently studied, however it should not be considered that only these waste streams contribute to the goals of industrial symbiosis. For instance, Municipal Solid Waste (MSW) and the sludge produced from wastewater treatment plants can be also considered so as to promote the eco-industrial concept.

2.2.1.1 Industrial Waste

Producer Liability

Article 11 of the Joint Ministerial Decision (JMD) 50910/2727/03 "*Measures and terms for the management of solid waste*" had specified that any holder of waste must either deliver waste to the waste management operator or to approve alternative management systems, or to ensure the recovery or disposal. In continuity, with Articles 14 and 24 of Law 4042/12 it is clearly established that the waste producer or the waste holders are responsible to manage the waste in a way that guarantees a high level of protection of the environment and human health. Also, for the first time in this legislation the principle of extended producer responsibility

(EPR) is expressed. In particular, in Article 25 it is clearly stated that any natural or legal person who professionally develops, manufactures, processes, treats, sells or imports products (producer of the product) has extended producer responsibility.

Networks and co-management infrastructure

Industrial waste production is about ten times higher than that of MSW. In 2011, 17.700.000 t of industrial waste was produced in Greece [6]. However, industrial waste management is very limited and adequate facilities for the treatment, recovery or disposal do not exist. In the fourth deliverable plan which was put up for public consultation on specific waste streams [6] specific provisions are foreseen for industrial waste. It is obvious from all documents under consultation that a strong effort has been made to create networks and infrastructure that will serve the shared management of industrial waste while taking into account the proximity principle. The proposal and application of proximity principle but also the provisions about common waste management systems and networks are a positive step for the promotion of industrial symbiosis. Therefore each design should aim to meet the above two requirements. Further, another action to be implemented in order to allow co - management, is to enable joint processing of industrial waste with other waste streams (eg MSW) given that are not dangerous. At the same time, it is necessary to create the appropriate landfill sites so as to reassure the safe disposal of hazardous substances. The Greek Ministry of Environment, Energy and Climate Change (YPEKA) has recently established the criteria for selecting the location of hazardous waste disposal facilities (Circular 134365/7002/2011).

Register of waste producers

According to Law 4042/2012, Annual Reports of Waste Producers which will be the basis for an electronic registration system via internet, while, in a second stage, the responsible authorities will be allowed to execute their inspections based on these data. YPEKA has launched an electronic environmental registry of waste producers; however, there are still a lot to be done in order the efforts to be completed.

Approval of environmental terms

JMD 36060/1155/E.103 was issued in order to transpose into national legislation Directive 2010/75/EU on industrial emissions bringing major changes to existing environmental legislation. In the context of this JMD, the term 'emissions' means *the direct or indirect release of substances, vibrations, heat or noise from individual or diffuse sources in the installation into air, water or land*. In Article 10 it is clearly stated that for issuing environmental conditions, each emission source, quantities and technologies that will be used for the prevention, recovery and recycling of waste generated by the installation, must be determined. However, a problem that occurs in practice is that the potential environmental problems are not clearly defined in the Environmental Impact Studies (EIS) and as a result the proposed measures and techniques cannot ensure the effective protection of the environment. Moreover, Article 11 says that the "*Decisions of Approval of Environmental Terms*" should include complementary and necessary measures on the basis of best available techniques (BATs).

2.2.1.2 Agricultural and Livestock Waste

As mentioned above, Industrial Symbiosis does not only refer to the secondary sector but to the primary as well. Based on the proposals for the revision of the National Waste Management Plan, for agricultural waste of biodegradable origin, prevention measures and optimum valorization techniques are proposed, either through direct disposal or after been processed (composting, energy recovery in biogas plants or thermal treatment facilities). To this end, the relevant departments has proposed the update of the criteria for the specifications of compost, the annual mandatory submission of the waste producer report and the imposition of sanctions for non- implementation of these directions [7].

An excellent example of locational and functional unity towards industrial symbiosis is the establishment of livestock zones based on Law 4235/14 in which there will be adequate infrastructure, electricity networks, water and waste management facilities.

2.2.1.3 List of Waste, By-products and End-of-Waste criteria

As mentioned above, the European Commission adopted the European List of Waste (LoW) by Decision 94/3/EC, while today it has been amended and is in force the Annex of Decision 2002/532/EC. LoW is a non-exhaustive list of waste, which must be reviewed at regular intervals. LoW is an extremely useful tool, as it provides a common terminology for EU waste, while those considered as hazardous waste are marked with an asterisk. It should be noted that according to Article 7 of the rWFD the inclusion of a substance or object in the list shall not mean that it is waste in all circumstances. As is clear from relative articles of the Directive, Member States shall, upon scientific evidence, may have different approaches, and it is possible that these positions conflict with those lists. As specifically defined in Article 7, the list of waste shall be binding only as regards determination of the waste to be treated as hazardous [8].

Although the definition of waste itself remains unchanged in Directive 2008/98/EC, there are two provisions which may have an impact on what is or is not classified as waste. These provisions are: By-Products and End-of-waste criteria [9] which are defined and clarified in Articles 5 and 6 of rWFD, respectively, corresponding to Articles 12 and 13 of Law 4042/12.

In particular, according to Article 5 par. 1: "a substance or object, resulting from a production process, the primary aim of which is not the production of that item, may be regarded as not being waste but as being a **by-product** only if the following conditions are met: (a) further use of the substance or object is certain; (b) the substance or object can be used directly without any

further processing other than normal industrial practice; (c) the substance or object is produced as an integral part of a production process; and (d) further use is lawful." Nevertheless, the European Commission has not yet made extensive research, classification and recording for by-products. In particular, although EC refer to specific examples and technical specifications of products, however it has not proceeded to systematize them through the conduction of relevant lists. However, based on paragraph 2 of Article 5 of the rWFD measures may be adopted to determine the criteria to be met for specific substances or objects to be regarded as a by-product and not as waste referred to in point (1) of Article 3. In **Figure 2**, the decision tree for waste versus by-products decisions presented in COM(2007)0059 is illustrated [10].

Moreover, the revised WFD contains specific provisions to define end-of-waste (EoW) criteria. In particular, according to Article 6 "...certain specified 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" [8]. The Commission has already enacted the establishment of end-of-waste criteria for a number of specific recyclable materials including metal scrap of copper, aluminium and iron, waste glass and compost. To this end, a series of

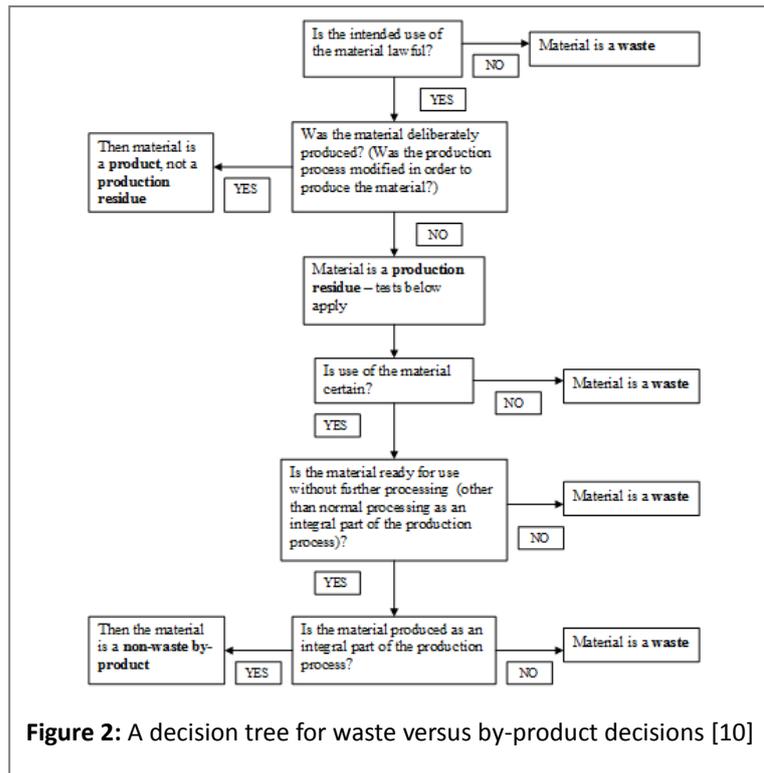


Figure 2: A decision tree for waste versus by-product decisions [10]

technical studies proposing end-of-waste criteria on these materials have been prepared. Based on the results of these studies, specific regulations have been adopted and enforced. In the following table (**Table 1**) accomplished studies as well as adopted Regulations on end-of-waste criteria are presented.

Table 1: Accomplished Technical studies and Adopted Regulations on EoW criteria

	Waste Stream	Technical Study EoW	Regulation
1.	<i>Category I.1:</i> Iron and Steel Scrap	«End-of-waste Criteria for Iron and Steel Scrap: Technical Proposals» (2010)	<i>EoW Regulation (333/2011)</i>
2.	<i>Category I.1:</i> Aluminium and Aluminium Alloy Scrap	«End-of-waste Criteria for Aluminium and Aluminium Alloy Scrap: Technical Proposals» (2010)	Commission Regulation on EoW for copper scrap (715/2013)
3.	<i>Category I.1:</i> Copper and Copper Alloy Scrap	«End-of-waste Criteria for Copper and Copper Alloy Scrap: Technical Proposals» (2011)	<i>Expected Regulation</i>
4.	<i>Category I.1:</i> Paper	«End-of-waste Criteria for Waste Paper: Technical Proposals» (2011)	<i>Commission Regulation on EoW for glass cullet (1179/2012)</i>
5.	<i>Category I.1:</i> Glass	«End-of-waste Criteria for Glass Cullet: Technical Proposals» (2011)	<i>Expected Regulation</i>
6.	<i>Category I.2:</i> <i>Biodegradable waste (compost/digestate)</i>	«End-of-waste Criteria for Biodegradable waste (compost/digestate): Technical Proposals» (2014)	

At the same time, ongoing relevant studies for end-of-waste criteria for plastic and paper waste are in progress [11]. Once end-of-waste criteria are set at Community level, these are binding for Member States. If they have been set as an EU Regulation, they are also binding for stakeholders. Member States cannot apply different end-of-waste criteria for the same material. However, since the WFD is based on Article 175 of the Treaty, they may establish 'more stringent protective measures' [12]. Moreover, where criteria have not been set at Community level, Member States may decide on a case by case basis, whether certain waste has ceased to be waste taking into account the applicable case law and notify the Commission of such decisions [8].

Considering the above it is obvious that Member States, aiming at complying with EU legislative framework, can determine their own end-of-waste criteria given that no relative list have been adopted in EU level. Moreover, no limitations exist to Member States to conduct its own list of by-products. This is very important and highlights the possibility and necessity of creating such a list so as to draw the line between waste and by-products and reintroduce the latter in the production cycle. In line with this direction the competent authorities shall conduct a dynamic database of potential uses and users (other industries or recycling/recovery centers) per category of by-product taking into account the current industrial technologies and the orientations given by the European Commission.

Implementation of Directive 2008/98/EC and procedures that will support the industrial symbiosis, is not in any way via the dogmatic insistence on lists established by EC or by waiting for concrete directives for all waste from Commission, something neither provided nor recommended by the Directive, which is strongly characterized by the spirit of initiative and participation in discussion and scientific data with the Member States. Finally, it should be noted that there is a need to update the European List of Waste.

2.2.2 Solid Waste Management Bodies

The regional Solid Waste Management Bodies (FOSDA), have recently been established by Article 7 of the Law 4071/2012, as a Public Entity and consists of the municipalities of the Prefecture. While municipalities are responsible for the collection and transportation of municipal waste, including separation at source, FOSDA

has to propose and implement a Regional Waste Management Plan (PESDA). Despite the fact that the Article 35 of the Law 4042/2012 states clearly that FOSDA are obliged to deal with all the waste produced (industrial, agricultural, etc.), a later legislation, Article 13 of the Law 4071/2012 says that the proposed PESDA will only be applied to Municipal Solid Waste. This contradictory provision runs counter both with earlier predictions of legislation and the EU Directives, and therefore, it should be reconsidered.

Additionally, the legislation for FOSDAs has not been implemented so far, both administratively and practically. There are currently only a few fully functional bodies, a fact that delays the implementation of regional plans made. Hence, municipalities strive to manage their waste, without always having the expertise needed.

2.2.3 Air Protection

"Industrial Emissions Directive (integrated pollution prevention and control)" 2010/75/EU relates to highly polluting activities such as energy industries, metal production and processing, mineral industry, chemical industry, waste management, animal husbandry and more. It also includes special provisions for combustion, incineration and co-incineration plants. The objectives of the Directive shall be pollution prevention by adopting adequate precautionary measures, the implementation of best available techniques (BAT) and maximization of energy efficiency. As mentioned above, the Greek Legislative Framework is harmonized with JMD 36060/1155/E.103/2013, which configures a program for combustion and incineration plants in order to reduce their emissions gradually.

2.2.4 Water Protection

The EU Water Framework Directive 2000/60/EC (WFD), as last amended by Directive 2008/105/EC, suggests the measures needed for water protection and preservation. Both Directives have been incorporated in Greek Law by the Ministerial Decision (MD) 51354/2641/E103/2010. Groundwater is protected by Directive 2006/118/EC. The respective Greek JMD 39626/2208/E.103/2009 aims to reach higher levels of groundwater protection. As for the nitrate pollution caused by agricultural activities, the EU adopted the Directive 91/676/EEC. Article 3 says that Member States shall, within a two-year period, designate as vulnerable zones all known areas of land in their territories which drain into polluted water. Nitrate directive was transposed into national legislation with JMD 161890/1335/1997 and MD 85167/820/2000 (OJG 477/B/2000) which established the "*Code of Good Agricultural Practices related to the protection of water bodies against nitrate pollution caused by agriculture*".

JMD 145116/2011 "*Specifying measures, conditions and procedures for the reuse of treated wastewater and other provisions*" made the wastewater reuse possible for the first time. This process is for agricultural (irrigation), urban and industrial use as well as for aquifers' replenish. It was last amended by JMD 191002/2013 which accelerate authorisation process for certain treatment and disposal facilities of recovered water.

The reference to all the instructions above shows that the solution for managing industrial - agricultural entries can not be assigned to individual industries and where feasible to be jointly managed by creating treatment plant. In addition, the re-use of water is another way to reduce water consumption. Imposing sanctions classified according to the degree of water consumption could be a convincing way to avoid incurring further.

Considering all the above, industries shall treat produced wastewater and as a result the joint management of wastewater produced from more than one industries in a shared wastewater treatment plant will be for the benefit of both industries and the environment due to minimisation of capital and operating costs and to reduction of resource use, respectively. Besides, proper water reuse can contribute to further decrease of water consumption and thus of resource use.

2.2.5. Soil Protection

The European Commission adopted a Soil Thematic Strategy (COM(2006) 231) on 2006, in order to protect soil from degradation, which hasn't been turned to a Directive so far. According to that "... the European

Parliament urged the Commission to draw up by 2007, in cooperation with the Member States and the competent regional authorities, a scientific soil catalogue which should include the nature of the soil, its biography, health and vulnerability, degradation and erosion processes and contaminated areas..." [13].

At the Greek Legislative Framework, a draft document regarding the protection and sustainable use of soil has recently been tabled. This is the first time that legislation for soil protection is formed in a uniform and consistent manner. By the time that it comes into force, industries will have to collaborate in order to exercise a common and proper environmental policy and restore the occupied land. Unfortunately, the existing legislation for soil protection consists of fragmented prohibitions of activities that cause soil degradation.

3. Industrial Symbiosis and Industrial areas

Under industrial Symbiosis, industries are entering a new era as there is a significant change in their function and the way they interact with each other. These new relationships are definitely spatial relationships where all distribution networks and services are included. In this section, the rules governing these spatial relationships between industries will be studied by the evaluation of the Greek institutional framework and applied policies for the establishment and operation of Industrial Areas all round the country. According to Brunner and Rechberger [14], one of the four basic requirements for effective implementation of Industrial Symbiosis is the existence of regional planning. This is because planning significantly affects the time and cost of transport system for materials, by-products and waste.

3.1. The established policies of the past: 1960-2000

The installation and operation of Industrial Areas (IA) in Greece was established formally in the 1960s by Law 4458/1965 "*On Industrial Areas*". The Management Body was the Greek Bank for Industrial Development (ETBA). At 1975, the protection of the environment is institutionalized by the Article 24 of the Constitution of Greece. At the same year, Law 360/1975 "*On regional planning and the environment*" enforces the preparation of regional plans and programs at three levels: national, regional and special. Unfortunately this Law had never been applied. Few years later, is the first time that regional planning is set as a prerequisite for the establishment of an Industrial Area, by Law 742/1977 "*Amending and supplementing the Law 4458/65 [...]*". However the same Law says that until the approval of the plans, Industrial Areas can be established by Presidential Decree.

The regulations above were followed until 2003, when the Council of State asked for the establishment of a regional plan for the installation of any productive activity. The point siting process does not replace the lack of planning any more. On the contrary, planning is necessary in order an industrial Unit or Area to be approved. In general, legislators have been particularly concerned about the issue of dispersed point siting, however it has never been addressed systematically so far.

On 1997, Law 2545/1997 "*Industrial and Business Areas and other provisions*" defines four types of Industrial Areas according to the level of noise they produce or the technology they use and their efficiency in terms of ecological footprint. It also separates the IA's Foundation Body from the IA's Management Body, which both are private entities (limited companies) instead of public.

3.2. Special Framework for Regional Planning and Sustainable Development for Industry

The inclusion of Industrial Areas in the regional development designing process is something that has already occurred several years ago in other European countries [15]. The basic idea is to put on the same table all spatial, environmental and economic parameters in order to come up with the optimal industrial policy for the country [16]. In Greece, this happened at 2009 with the Special Framework for Regional Planning and Sustainable Development for Industry. The first think that the framework does is to accurately describe the current state of industrial activity in Greece. It also notes the necessity to deal with widespread point siting of industrial units, particularly in outer ring areas. It highly proposes the establishment of organized Industrial Parks and incentive measures for the (re)installation of industries at them.

3.3. Current legislation for Industrial Areas - Law 3982/2011

Shifting from Law 2545/1997 to Law 3982/2011, the name for Industrial Areas changes from Industrial and Business Areas (V.E.PE) to Business Parks (E.P). However, the essential difference is that these new Business Parks also include areas of informal concentration of industrial activities in order those to be rehabilitated. In addition, the new Law provides incentives for individual industrial units to be established or relocated in Business Parks.

Despite the fact that Law 3982/2011 came recently into force, it doesn't incorporate the concept of Industrial Symbiosis. There is just a hint of it in Article 46, saying that "[...] *A technical organisation study for the proposed site showing: aa)the layout of business activities in the business park, in the aim of grouping categories or types of activities, so that the development of one does not obstruct or hamper the development of the other and so as to foster the creation of utilisation of common infrastructures and cooperation and networking between businesses.*" However, apart from this statement, there is no other provision to facilitate collaboration and business networking.

3.4 Incentives for the establishment and relocation of Industrial Units in Industrial Areas.

3.4.1 Law 3982/2011

According to this law, the company to be established in Industrial Areas exempt from setup, donation and income taxes. In addition, all industrial and manufacturing units, professional workshops and ancillary facilities, defined in Paragraph 1-5, Article 1, also exempt from permit requirements for establishment activities in Industrial Areas established under Laws 4458/1965, 2545/1997 and 3982/2011.

In fact, companies that settle in Industrial Parks are covered by the general authorization of the parks. More specifically, if an already existing Industrial Park has an operation approval, it applies to all individual industrial units inside that park. At the same time, those companies are exempt from the process of preliminary environmental assessment and evaluation. Finally, industrial units of low disturbance exempt from the obligation to get Environmental Approval, if the Rules and Regulations of the Park they are in include environmental conditions for these activities.

3.4.2 Subsidized Program "Relocation of companies in Industrial Parks"

This program is part of a larger Operational Programme called "*Competitiveness and Entrepreneurship 2007-2013*" created by the Ministry of Development, Infrastructure, Transport and Networks. The main objective was to create economies of scale in order to improve competitiveness for businesses who are willing to move inside organised Industrial Areas. The first priority was the relocation of manufacturing businesses which are situated inside or outside the urban fabric and have to be removed according to Paragraph 1, Article 6 of Law 3982/2011, in order to address the nuisance created by their operation [17]. Suitable Industrial Areas are those established by Laws 4458/1965, 2545/1997 and according to the third part of Law 3982/2011.

3.4.3 The new "National Strategic Reference Framework", Category: Environment

The new National Strategic Reference Framework (ESPA) 2014-2020 [18] aims to support innovation and entrepreneurship of products and services for environment upgrading. Special attention is given to "*green business*" and Industrial Symbiosis.

3.5. Assessment of the Institutional Framework for Industrial Parks on the basis of IS

A major problem for Industrial Symbiosis is the fact that according to the existing institutional framework for Industrial Areas, the categorization depends on the level of disturbance they cause. According to that, industrial units that belong to a different level of disturbance are not allowed to be together, in the same Industrial Area.

It goes without saying that the division made serves the need to separate different land uses in order to avoid conflict. However, it doesn't seem to take into account either the relationships needed or the flows of matter, energy and water in order to develop synergy [19]. The legislation would be more favourable if there was a

provision for Thematic Industrial Parks that include units based on flow analysis and potential synergies, including the existing Park activities, as well as the future ones.

Another important issue is the high establishing cost of an Industrial Park. It's expensive either for the Management Body or for the companies that plan to settle in them. As mentioned by the Special Framework for Regional Planning and Sustainable Development for Industry, the point siting choice has direct economic benefits for industrial units because of the comparatively cheaper land and the favourable terms and conditions of siting and building, mostly in outer ring areas. This is the reason why it is hard for areas of informal industrial concentration to be turned to Industrial Parks, fact that requires owners to contribute with land and money for the creation of public spaces and infrastructure. Despite tax incentives that 3982/2011 gives, the establishment and relocation of industrial units inside Industrial Parks remains expensive. Industrial Park's Managing Bodies face difficulties too, as the share capital of the company can't be less than 10% of the approved budget for infrastructure.

There is also a raising concern about the nature and composition of the body tasked with establishing and running the Industrial Park, as, according to the Law, the initiative goes to private entities with the possible participation of public ones. The question is whether the public sector could take the initiative to start up a Park, as it could offer lower parcel prices and more favourable conditions for the establishment of the units. At the same time, the ETBA example shoes that, regardless of the cost, public sector bodies are oriented towards the environmental protection and the creation of all facilities needed for that purpose.

Besides, past experience so far indicates that the establishment of Industrial Parks is absolutely necessary in order to gradually diminish the point siting phenomenon of industrial units. This will definitely lead to land use conflict reduction, improving production activities and the environmental protection. Hence, taking into account the importance of the issue, it is recommended that the public sector must not only have the possibility to create such Parks but the obligation. At the same time, all future units should be forced to relocate inside these Parks.

4. Conclusions

It goes without saying that the EU and National Institutional Framework guide the actions and formulate the plans in order to adopt Industrial Symbiosis. The current legislation and policies provide both opportunities and tools, while imposing restrictions in order to achieve a shift towards eco-industry.

Industrial symbiosis should not be limited to a production chain or an Industrial Park, detached from the surrounding environment. On the contrary, the term "*symbiosis*" refers to a spatial network of sustainable energy and material flow between human activities, related both to production and consumption. This means that there is a strong interdependence between the features of production process and the development policies taken.

It is worth mentioning that the Greek institutional framework has to overcome two fundamental barriers towards Industrial Symbiosis: a) the lack of a unique legislation dedicated to promotion and implementation of industrial symbiosis and b) the lack of vision towards industrial symbiosis which is reflected to the unwillingness of the competent authorities to undertake specific measures such as determination of national end-of-waste criteria given that no relative list have been adopted in EU level and conduction of a national list of by-products. The Industrial Symbiosis concept has not been addressed as an individual goal yet by the government and the legislature. This is demonstrated by the lack of secondary objectives that should be set in relation to, for example, the exchange of matter between companies and the infrastructure needed.

In conclusion, the implementation of Industrial Symbiosis has not been put into practice mainly because of the absence of a clear governmental vision, the lack of a clear legislation dedicated to industrial symbiosis and the poor implementation of the existing legislation.

5. References

1. Agarwal A. and Strachan P. (2008), *Is Industrial Symbiosis only a Concept for Developed Countries?*, The Journal for Waste & Resource Management Professionals, The Chartered Institution of Wastes Management; 42
2. Agarwal A. & Strachan P. (2006), *Literature review on eco-industrial development initiatives around the world and the methods employed to evaluate their performance / effectiveness*, Consultancy Report prepared for Databuild Ltd. and National Industrial Symbiosis Programme, 7th May 2006
3. WRAP (2014), *What is Industrial Symbiosis?*, last retrieved at 9-4-2014 <<http://www.wrap.org.uk/content/what-industrial-symbiosis>>
4. Chertow M., Marian R., Ashton W., and Espinosa J. (2008) *Industrial Symbiosis in Puerto Rico: Environmentally Related Agglomeration Economie'*, Regional Studies, vol. 42:10, pp. 1299-1312
5. Miller G. (1999), *Βιώνοντας στο Περιβάλλον II - Προβλήματα Περιβαλλοντικών Συστημάτων*, Εκδόσεις Ίων
6. ΥΠΕΚΑ/ΕΙΔΙΚΗ ΥΠΗΡΕΣΙΑ ΔΙΑΧΕΙΡΙΣΗΣ Ε.Π.ΠΕΡ.Α.Α., *Παραδοτέο Μελέτης Αναθεώρησης Εθνικού Σχεδιασμού Διαχείρισης Αποβλήτων - 2^ο Παραδοτέο*, last retrieved at 28-5-2014 <www.ypeka.gr>
7. ΥΠΕΚΑ/ΕΙΔΙΚΗ ΥΠΗΡΕΣΙΑ ΔΙΑΧΕΙΡΙΣΗΣ Ε.Π.ΠΕΡ.Α.Α. *Παραδοτέο Μελέτης Αναθεώρησης Εθνικού Σχεδιασμού Διαχείρισης Αποβλήτων - 4^ο Παραδοτέο*, last retrieved at 28-5-2014 <www.ypeka.gr>
8. Directive 2008/98/EC of the European Parliament and the Council of 19 November 2008 on waste and repealing certain Directives, Official Journal of the European Union L 312/11 22/11/2008, last retrieved at 25-5-2014 <<http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:312:0003:0030:EL:PDF>>
9. DEFRA (2012), *Guidance on the legal definition of waste and its application*, last retrieved at 23-5-2014 <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69590/pb13813-waste-legal-def-guide.pdf>
10. Document COM/2007/0059, *Communication from the Commission to the Council and the European Parliament on the Interpretative Communication on waste and by-products*, European Commission
11. EC (2008), *End of Waste Criteria - Final Report*, Joint Research Centre of the European Commission, last retrieved at 20-5-2014, <<http://susproc.jrc.ec.europa.eu/activities/waste>>
12. EC (2012), *Guidance on the interpretation of key provisions of Directive 2008/98/EC on Waste*, last retrieved at 20-5-2014 <http://ec.europa.eu/environment/waste/framework/pdf/guidance_doc.pdf>
13. Document COM/2006/0231, *Communication from the Commission to the Council and the European Parliament, the European Economic and Social Committee and the Committee of Regions - Thematic Strategy for Soil Protection*, European Commission
14. Brunner P., Rechberger H. (2004), *Practical Handbook of material flow analysis*, The International Journal of Life Cycle Assessment, vol. 9, pp. 337-338.
15. Βασενχόφεν Λ. (1993), *Χωροθέτηση Βιομηχανικών Εγκαταστάσεων και Περιοχών στην Ελλάδα*, επιστημονικό διήμερο του Τεχνικού Επιμελητηρίου της Ελλάδας: Βιομηχανικά Κτίρια, Αθήνα: 10-11 Μαΐου.
16. Γιαννίτσης Τ., Καλογήρου Γ., Δενιόζος Δ. (1993), *Βιομηχανική και τεχνολογική πολιτική στην Ελλάδα*, Εκδόσεις Θεμέλιο, Αθήνα.
17. ΕΣΠΑ 2007, *Μετεγκατάσταση επιχειρήσεων σε Βιομηχανικές Επιχειρηματικές Περιοχές (Β.Ε.ΠΕ) και Επιχειρηματικά Πάρκα*, Ε.Π. Ανταγωνιστικότητα και Επιχειρηματικότητα 2007-2013, Υπουργείο Ανάπτυξης, Ανταγωνιστικότητας, Υποδομών, Μεταφορών & Δικτύων, last retrieved at 26-5-2014, <<http://www.espa.gr/el/pages/proclamationsfs.aspx?item=2301>>
18. ΕΣΠΑ 2014, *Νέα Προγραμματική Περίοδος για την Πολιτική της Συνοχής 2014-2020*, Υπουργείο Ανάπτυξης και Ανταγωνιστικότητας, last retrieved at 26-5-2014, <<http://www.espa.gr/el/pages/staticNewProgrammingPeriod.aspx>>
19. ECOSIND (2006), *Οδηγός συστάσεων για το σχεδιασμό και τη διαχείριση Βιομηχανικών Ζωνών Οικολογικής Βιομηχανίας*, Ευρωπαϊκό Πρόγραμμα ECOSIND.