Overview of the most developed instances of Eco-Industrial Parks in Italy

Sara Tessitore, Tiberio Daddi, Francesco Testa

Abstract—The literature presents a gap related to Italian experiences with Eco-Industrial parks (EIPs). Although this approach is distributed throughout many regions of Italy, particularly in the northern and central regions. This paper describes the dissemination of EIPs in Italy and the “Key Elements” of this model in Italian experiences. The study introduces 5 of most important Italian case studies of EIPs and describes the environmental infrastructure and services implemented in those cases. The research compares the main international features of EIPs with the characteristics of these 5 case studies and highlights the differences and similarities between Italian and international EIPs.

Keywords—Eco industrial park, industrial ecology, case study, sustainable development, case study, Italy.

I. INTRODUCTION

Industrial ecology is a new approach to more sustainable production that supports companies in implementing sustainable development strategies. The concept of industrial ecology evolved from environmental management paradigms and springs from interests in integrating notions [1] of sustainability with environmental and economic systems [2]. Industrial ecology can be applied to eco-industry development at three levels. The boundaries can be defined at the micro-level (firms), the “meso level” (eco-industrial parks), and the macro-level (regional and wider global networks of manufacturing activity centers) [3]. This article focuses on the concept of eco-industrial parks (EIPs). The research investigates the spread of EIPs in Italy and their distinctive features. An industrial park is defined as “a large tract of land, sub-divided and developed for the use of several firms simultaneously, distinguished by its shareable infrastructure and close proximity of firms” [4]. Other definitions of EIPs were introduced in other studies. Coté [5] was the first author to cite the issue of economic and natural resource conservation. This author defined the eco-industrial park (EIP) as “an industrial system which conserves natural and economic resources; reduces production, material, energy, insurance and treatment costs and liabilities; improves operating efficiency, quality, worker health and public image; and provides opportunities for income generation from the use and sale of wasted materials". This concept affects worker health as well, which is not included in the other definition of the EIP. The definition of an EIP was discussed during the 1990s by authors such as Lowe [6] and Ayres [7]. The interest in the development of EIPs is relevant especially in the USA. The USEPA (United States Environmental Protection Agency) defined EIPs as A community of manufacturing and service businesses seeking enhanced environmental and economic performance by collaborating in the management of environmental and reuse issues. By working together the community of businesses seeks a collective benefit that is greater than the sum of the individual benefits each company would realise if it optimised its individual performance only. In the most recent years the concept of the EIP has been globally popularized and has attracted interest in less developed, industrializing, as well as developed countries [8]. From the 1990s onwards, a number of local and regional projects were initiated to plan and actively develop EIPs. As Heeres [9] states: “attention for eco-industrial park (EIP) development projects has grown enormously among national and regional governments and industries in many countries. It is believed that a well planned, functioning EIP has the potential to both benefit the economy and substantially relieve environmental pressure in and near the location of its development”.

II. INTERNATIONAL EXPERIENCES OF EIPS

The EIP approach has been developed at the international level and the experiences of EIPs have disseminated in many industrial areas that have adopted industrial ecology solutions. Many national institutions supported the dissemination of EIPs by programmes and policies. In the USA the dissemination of EIPs was encouraged by the federal government through the President’s Council for Sustainable Development, which identified and promoted four demonstration sites [10] [11]. EIPs have been similarly encouraged in Europe, particularly in the Netherlands [12], Denmark [13] and Finland [14]. Experiences with EIPs have increased and the literature has been enriched by many case studies. Some studies describe the International EIPs and the most
famous experience in Europe and in other countries. Looking at the European experiences we note Kalundborg as one of the most interesting case studies of EIPs. Kalundborg Park in Denmark was developed in the 1960s. The industrial district at Kalundborg is labeled as an “industrial ecosystem” or “industrial symbiosis” because of the many links between the firms [10]; [13]; [15].

This approach was developed in Canada [16] and Australia [17]. We also found EIPs in Germany, the UK and other countries, especially in Northern Europe [18].

Examples of EIPs in Asia are mainly concentrated in China and Korea [19]; [20], but the development of EIPs is attracting interest in India [21], the Philippines, Thailand and Sri Lanka [22] as well.

There are many studies that describe the EIP experiences of China, where there are now over 100 EIP projects [23]. The SEPA (State Environmental Protection Agency of China) categorized industrial parks in China into three groups in this new regulation, namely the sector-integrated group, the venous group, and the sector-specific group, each with slightly different criteria and indicators. The sector-integrated group refers to those parks with multiple industrial sectors, the venous industrial grouping particularly refers to those resource recovery parks where environmental technology companies and firms making “green products” coexist and the sector-specific group refers to those main sectors [24]; [25]. One of the most important Chinese case studies is that of the Tianjin Economic-Technological Development Area (TEDA). The emergence of an environmental institution in TEDA is used as a backdrop to assess how TEDA has transformed itself into one of the top three national eco-industrial parks in China. Following two years of field research, a network of 81 symbiotic inter-company relationships formed in TEDA during the past 16 years. These relationships involve utilities, automobiles, electronics, biotechnology, food and beverage, and resource recovery clusters [26]. Another famous Chinese EIP is Guigang. The Guigang Group (GG), which operates one of China’s largest sugar refineries, has been developing and implementing an internal and external industrial symbiosis strategy for more than four decades. The GG first invested in developing its own collection of downstream companies to utilize nearly all by-products of sugar production. This strategy has generated new revenues and reduced environmental emissions and disposal costs, while simultaneously improving the quality of sugar [27].

Singapore’s Jurong Island is developing three EIP projects in the form of mini ecological parks and alternative fuel infrastructures, created through long range planning [28]. The first Korean EIP is the Daedok Technovalley (DTV) Development Project. The Korean EIP focused on symbiotic industrial network construction, energy and material flow planning, externally and internally built environmental design and cultural identity creation [29]. The experience of Ulsan city is also notable. The Ulsan industrial complex has been continuously evolving from conventional industrial complexes to eco-industrial parks by spontaneous industrial symbiosis.

A project by the Technology Development Foundation of Turkey to disseminate cleaner production and EIPs also began in Turkey in 2009 [30].

The Queensland State Government in Australia developed the first eco-industrial park in 1994, Synergy Park, a site 22 km west of Brisbane. The park aims to support several key scale economies. The first is the central warehouse, which will allow for shared logistics and the controlled movement of vehicles. The second is the sophisticated logistics management system. The third level of economy arises from the energy supply infrastructure (a co-generation plan for the park’s business). The EIPs in Australia are built on “the importance of an industrial catalyst, a synergy trust, coordination of key industries and utilizing players, the need for strategic planning that has foresight and flexibility and developing community oriented development” [17].

Another important case study is the idea of the West Midlands Industrial Symbiosis programme (WISP). West Midlands, which is located some 200 km Northwest of London and covers the areas around Birmingham. One plan has already become operational, providing economic, environmental and social benefits. This consists of the conversion of 5000 t/year of waste edible oils into bio-diesel [18].

Many other studies [31] describe some EIP case studies in the Netherlands and Canada, analyzing their key elements (Material/energy networks, Process integration) and management.

The following table summarizes some of most famous EIPs at the international level.
Despite the national Italian law issued in 1998 mandating the spread and application of EIPs and despite Regional Governments who are actively applying EIP concepts in their local policies, there is currently no literature related to Italian EIPs. There are just a few surveys and studies that cite Italian EIPs, and often the ones mentioned are not the country’s most important ones. For instance a recent survey of EIPs in the USA and Europe [34] investigated 53 EIPs and only 3 are Italian case studies. Coté and Cohen-Rosenthal [35], cited the EIP experiences in Emilia-Romagna without providing data or technical information on the EIPs developed there. The Turin Environment Park is mentioned in an article by Gibbs in 2003 [36] and the experience of Montagna-Energia Valle di Non [37].

### III. INTERNATIONAL CHARACTERISTICS OF EIPS

There are many studies identifying the main features of EIPs. Many authors focus on industrial symbiosis and others on landscape ecology or networking. From our review of the literature we have selected the “key elements” of the EIP concept. The initial characteristics of EIPs were essentially the industrial symbiosis initiatives and the “by-product exchange”. These aspects characterized the first EIP experiences. The by-products exchange is influenced by geographic proximity of firms and especially since transport costs will eventually limit the spatial boundaries over which certain by-product exchanges remain economically viable [38]. In a preview publication Chertow [38] suggested three criteria to develop EIPs: building on existing types of material and energy exchange, building on pre-existing organisational relationships and networks and the anchor tenant model. Another authors [39] build their EIP conceptual framework on the model of natural ecosystems. They argue that increased diversity (of the actors involved) enhances connection and opens up new possibilities for cooperation, although increasing the number of actors can also lead to conflicting interests, thereby acting as a decisive factor in preventing the development of an EIP.

In recent years Chertow [40] identified many types of collaborative arrangements for businesses that can lead to the development of industrial symbiosis. In addition to by-product exchanges there are other typical approaches to EIP development such as the sharing of utilities and joint service provision. Utility sharing includes shared access to public goods and services. An example of utility-sharing initiatives is the collective use of a geothermal exchange system in the Phillips Eco-Enterprise Center in Minneapolis, Minnesota, which improved energy efficiency by 35% in its office building facility [41]. “Joint service provision” provides for the creation of common services for firms. These tools create economies of scale and benefit sources of both urbanization and localization of economies [42]; [43]. “Policy programs from governmental agencies are usually referred to as a major conditioning factor. The Chinese policy on circular economy is one of the central factors of influence on Chinese industrial symbiosis development [44]; [45]. In the United Kingdom the influence of public policies is also evident, as a result of the NISP and of waste management policies[18].The importance of a comprehensive legal framework in order to move towards a recycling-based society is confirmed by Japan’s experience in which the Government implemented a programme that involves societal actors in shaping the initiatives [46]. Tudor [47] defined the three main elements of EIPs as IE (industrial ecology), biological ecology, and the spatial perspectives provided by landscape ecology. IE relates to industrial and ecological systems that are based on optimal circulation of materials and energy. Regarding biological ecology, EIPs seek to mimic natural ecosystems where ‘waste’ products from one process are incorporated into another process, just as carbon dioxide and oxygen in the processes of photosynthesis and respiration [47]. Landscape ecology aims to reduce the ‘negative’ ecological effects of urban and industrial development. In a survey of European and USA EIPs [34] the key features of IE and EIPs were investigated: the cycling of materials and energy as industrial symbiosis initiatives, or closed cycle, networking and cluster building concerning networking among firms, sustainable development and collaboration with local stakeholders.

The following table summarizes the key elements of the most cited EIPs in the international literature.

### IV. GOALS AND METHOD

During our review we noted a gap in the literature. There are very few articles that describe Italian case studies of Eco-Industrial Parks. However, in Italy there is a strong interest in EIPs and many policy makers are stimulating the establishment of them or the

---

Table I: Case studies of International EIPs

<table>
<thead>
<tr>
<th>EIPs</th>
<th>Country</th>
<th>Industrial sector</th>
<th>Dimension (ha)</th>
<th>N. of companies</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Devens</td>
<td>USA</td>
<td>mixed</td>
<td>1780</td>
<td>not available</td>
<td>Miners, 2004</td>
</tr>
<tr>
<td>Kalundborg</td>
<td>Denmark</td>
<td>mixed</td>
<td>not available</td>
<td>not available</td>
<td>Many authors</td>
</tr>
<tr>
<td>West Midlands</td>
<td>UK</td>
<td>mixed</td>
<td>not available</td>
<td>20</td>
<td>Miners, 2004</td>
</tr>
<tr>
<td>Colangang/Guangtung group</td>
<td>China</td>
<td>sugar</td>
<td>not available</td>
<td>not available</td>
<td>Zhu et al. 2007</td>
</tr>
<tr>
<td>Synergy Park</td>
<td>Australia</td>
<td>food, milk and bevereage</td>
<td>37</td>
<td>not available</td>
<td>Roberts, 2004</td>
</tr>
<tr>
<td>Burmit Industrial Park</td>
<td>Canada</td>
<td>many</td>
<td>570</td>
<td>1300</td>
<td>Jazet al. 2004</td>
</tr>
<tr>
<td>Udon Industrial Park</td>
<td>Korea</td>
<td>petrochemical, nonferrous, metal, ship building and automobile industries</td>
<td>5504</td>
<td>700</td>
<td>Park et al. 2008</td>
</tr>
</tbody>
</table>

---

Table II: Case studies of International EIPs

<table>
<thead>
<tr>
<th>Key Elements</th>
<th>Tudor et al. 2007</th>
<th>Gibbs and Donts 2007</th>
<th>Chertow et al. 2008</th>
<th>Booms et al. 2011</th>
</tr>
</thead>
<tbody>
<tr>
<td>By products and energy exchanges</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Sharing service</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landscape ecology</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Common infrastructures</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Networking</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Involvement of local stakeholder</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---
reconversion of existing industrial areas into areas based on the key concepts of industrial symbiosis.
To achieve this objective we will use the following method:
First we will describe the main drivers of the dissemination of EIPs in Italy. Then we will focus on the description of the characteristics of five of the most important experiences developed in Italy. Finally, in the discussion section we will compare the key aspects of international EIPs identified in the literature review with the distinctive features identified in the Italian cases.
The main source of information on the Italian case studies is a report issued by the regional government of Emilia-Romagna, issued in 2010 [49]. It describes 14 highly developed experience examples of EIPs. We selected the five case studies presented in this paper from these, according to the following criteria: maturity and degree of development of the EIP, geographical distribution, and relevance of the experiences in terms of results achieved.

V. RESULTS: DRIVERS OF THE DISSEMINATION OF EIPS IN ITALY

Italy is witnessing a growing interest in EIPs among policy makers on all administrative levels. Usually, four "visions" can be identified, which have emerged gradually in the Italian experience.
The "technocratic vision" considers the EIPs to be a result of production and location choices made by the companies. These choices are linked to the advantages of building industrial plants close together and to the synergies obtained from a mere "technical" point of view. For example, businesses may find it convenient to combine and share the management of some environmental facilities. This view explains the development of the EIPs as a result of the enterprises' (usually SMEs) need to share the management of the most significant environmental aspects (waste water treatment, power generation, waste collection) through the construction of common structures and facilities [34]. Their aim is to increase environmental efficiency, as well as economic efficiency through cost savings, thanks to the sharing of collective facilities or structures in the area, obtaining advantages from geographic proximity [51].
The "managerial vision" is more directly based on the opportunity to stimulate and promote management and organizational coordination among the environmentally relevant business activities undertaken by the already established enterprises or businesses that are going to settle in an area. In this case, scale economies are improved not only in technical terms but they also achieve benefits linked to more "intangible" variables such as the management and organisation of environmental issues. The objective is to optimize and prevent environmental impact related to the productive activities located in the area by focusing on aspects that can facilitate proper and effective management [52].
The "governance vision" exceeds the boundaries of technical and management efficiency of enterprises and sees the development of EIPs as the response to a problem of "governance". The systemic approach of EIPs can indeed be seen as a policy trend, and as an opportunity for institutions to promote local development geared towards sustainability. This vision treats the EIP as a lever for local policies and as a technical and managerial solution for the local production system [50]. Many Italian experiences have shown that over time the role of institutions can be crucial in stimulating and strengthening the development and functioning of EIPs.
Taking the categorization of the literature studies presented in the previous section into account, we may note that the effects of the policies of the three groups of drivers described above are more oriented toward the Command and Control approach than toward voluntary tools [53].
In contrast, in the Italian experience we observe another kind of driver that follows more “holistic” methods, and which are linked to voluntary policy tools. In this case, the process leading to the creation of an EIP is no longer just a matter of technical drafting and territorial planning of the area. It becomes a decision-making process, in which enterprises are involved, along with their representatives, local institutions and even the social partners in the territory. Right from the planning stage, the common goal is to coordinate the choice of location and the technical and managerial solutions that are most effective from an environmental point of view. To sum up, the "holistic" vision is able to increase the benefits for the different stakeholders, provided that they are capable of operating within the framework of a true "industrial policy for the territorial production systems" which is voluntarily oriented towards sustainability.

VI. RESULTS: ITALIAN EIPS KEY EXPERIENCES

The study published by the Regional Government of Emilia-Romagna in 2010 (ERVET and Emilia Romagna Region, 2010) defined 84 experiences in which there was an attempt to experiment with the EIP approach and an interest in carrying out localized solutions that favour sustainable development. These 84 experiences are located in only 5 Italian regions (Emilia-Romagna, Friuli-Venezia Giulia, Liguria, Marche, Piedmont and Tuscany) and are distributed as follows:

- 30 in Emilia-Romagna
- 21 in Friuli-Venezia Giulia
- 15 in Liguria
- 7 in Marche
- 1 in Piedmont
- 9 in Tuscany

The study selected 14 case studies whose characteristics were most strongly linked to the EIP approach, namely the productive areas that had adopted managerial and infrastructural solutions inspired by the concept of industrial ecology and also had a management body, which is a fundamental element of Italian EIPs.
This paper will present the following EIPs:

1) Macrolotto of Prato (Tuscany),
2) Industrial Area of Ponterosso (Friuli-Venezia Giulia),
3) Industrial Area of Ponte Rizzoli (Emilia-Romagna),
4) Industrial Area of Padova (Veneto),
5) Industrial Area of Ancona (Marche).

“Macrolotto di Prato” is located in Prato, Tuscany, which is one of the most important productive districts of Italy and specialize in textiles. Macrolotto is the first EIP in Italy and it is the most advanced in eco-innovation technologies and services.

Macrolotto is an industrial area of 150 hectares. There are about 380 companies in the district with over 3,000 employees. The environmental initiative originates from the need to provide this industrial area with centralized environmental services (such as recycling the waste water for production use and for firefighting, reducing the use of private vehicles for employee transportation, etc.). The nonprofit consortium CONSER managed the common environmental services introduced in the Macrolotto productive area.

The following centralized environmental infrastructures and services are present in Macrolotto:

1) Management and maintenance of the centralized waste water recycling plant and of the industrial aqueduct, and the provision of a centralized firefighting service;
2) Promotion and provision of centralized services for the industrial area that can create scaled economies to reduce production costs while also respecting the surrounding environment and society;
3) Training and environmental education initiatives;
4) Mobility management (carpooling, car sharing and freight);
5) Other centralized services for workers (laundry, pharmacy, post office, nursery).

In 1975, following the depletion of ground water resources due to the presence of textile companies with a high demand for water, the town of Prato pushed the industrial area to build an industrial aqueduct fed by wastewater from the treatment plant which was under construction at the time. However, the water could not be used and therefore it was necessary to build a refining and pumping station as well as 12 km of water pipes. Planning began in 1985 to define a design that, after the usual treatment, reduces the suspended solids using sand and anthracite filters. The process also removes color through an activated charcoal treatment. An economic calculation showed that the centralized solution was cheaper for the companies than paying a water supplier.

The system began operating in 1990 and currently the plant in Prato is able to provide 5 million cubic meters of water per year, which is why other companies outside the Macrolotto area that have a high demand for water have joined the system. The Industrial Area of Ponterosso is located in the Municipality of San Vito al Tagliamento, near Pordenone, in the lowlands of Friuli. There are 120 companies (with a total of approximately 3,150 employees) which are very diversified both in products and in size. The sectors range from chemicals to food products, from glass to machinery and components, and from woodworking to services.

The area has a double collecting system where wastewaters goes into a sewage treatment plant for the exclusive use of the industrial zone. This EIP is managed by the Consortium for the Industrial Area of Ponterosso.

From the energy supply standpoint, the Consortium operates combined production plants, and self production of electricity and heat distribution plants.

The Consortium provided the industrial area with a railway that is linked with the national network, offering each company the opportunity to have terminals in their area and manage the distribution of goods as an alternative to road transport.

Among the consulting services offered indirectly through an agreement with third parties, there are also services that can lead the company to greater environmental sustainability, such as advice on quality, environment and safety. The environmental monitoring system managed by the Consorzio Ponterosso that periodically monitors some indicators. The Ponterosso area is equipped with other services and infrastructure for all companies operating in this EIP including the following:

1) Rail access
2) Natural gas pipeline
3) Street management
4) Cafeteria for workers
5) Other services for workers

“APEA Ponte Rizzoli” is an industrial zone of about 105 hectares and approximately 170 companies in the region of Emilia-Romagna. The area is characterized by the predominance of production activities in the sectors of manufacturing and business services. The Province of Bologna has implemented a pilot project to promote the Environmentally Equipped Areas, involving the production area of Ponte Rizzoli as a pilot project.

The plan to design the area and its services and infrastructure was the result of a survey conducted in 2004. The companies suggested creating a plan for energy production and waste management. The design of APEA Ponte Rizzoli includes three projects:

1) Heating plant and cogeneration plant powered by methane and biomass;
2) Network for rainwater recovery;
3) Bicycle paths for productive area employees.

The area will be also equipped with many services for workers such as a cafeteria, parking and others.

This project is not yet concluded but the local institutions are working to create all of the infrastructure and services for the companies provided for in the plan.

The Industrial Area of Padova is located in Friuli-Venezia Giulia. It is composed of 1,500 companies operating in different manufacturing fields. The area is one of the biggest in northern Italy and starting from 1956 has been managed by a consortium of local public institutions (Municipality, Province and Chamber of Commerce). The area is served by a railway with 7 km of tracks, 2 toll booths, 5 service centers with post
offices, hotels, restaurants, banks, professional offices, business services, and a fiber optic ring of 30 km. 18% of its territory is dedicated to green areas. The main infrastructures in this area relate to mobility management since approximately 50,000 people (workers, suppliers, consultants and other stakeholders) travel to the productive area every day. Mobility management was the main problem presented by the industrial area for the workers and the local community. The consortium invested in this problem and organized services and infrastructures to reduce the pressures connected with road traffic. There is a mobility manager that identifies some solutions and improvements. The area also invested in training activities on sustainability and planned for the new plant to increase energy production from renewable energy sources.

The productive area of Ancona is the first EIP in the Marche region. This area began to develop in the 1980s and is located around Ancona’s harbor. The area is composed of about 90 companies operating in various sectors (industry, services, craftsmen) linked to maritime activities such as shipbuilding, mechanical repairs, electrical systems, nautical decor, food supplies, logistics, shipping agencies, seafood processing, etc. ZIPA manages the productive area and four other productive areas in the Marche. The shared services relate to training activities, consulting and company support of infrastructure for water discharge and waste. ZIPA aims to develop “area management” based on a high level of company involvement in the improvement of environmental performance.

VII. DISCUSSION: A CROSS COMPARISON OF THE CHARACTERISTICS OF ITALIAN EIPS AND INTERNATIONAL EIPS

The development of EIPs in Italy was mandated in the national Legislative Decree 112/1998, which introduced the APEA production model. The APEA model is linked to the EIP concept. The law has decreed that every region has the job of regulating the criteria and the system requirements of EIPs (APEA).

The fundamentals elements of Italian EIPs (APEA) are the presence of unified area management (management body) and of common environmental services and infrastructure for the companies that operate the EIPs.

Italian EIPs were characterized by the presence of a management body, which exists in all 5 cases examined above. The “management body” is an organism (a public-private company or consortium) that coordinates the development of the productive area and promotes the adoption and implementation of services and infrastructure to reduce the environmental impact of companies that operate within EIPs.

The management body of an EIP has numerous abilities. It can coordinate the management of environmental aspects such as waste and water resources, organize services such as transportation, as well as education and communication initiatives. They can also create infrastructure and develop relationships and transactions with local stakeholders. The latter task is another element that stands out about Italian EIPs (APEA). The collaboration between companies and institutions is considered a very relevant element to the adoption of managerial and infrastructural solutions that foster the creation of EIPs. Much of the collaboration therefore begins with participation in decision-making processes related to the adoption of widely shared solutions that allow companies to implement more sustainable production methods. The presence of shared services and infrastructure is provided for in the national regulation and is therefore an essential criteria for all EIPs (APEA) developed in Italy. This relates to various types of services such as transportation, waste collection, lighting, etc. The legislations of many regions address the infrastructure of purifying areas, energy production plants, and rain water collection systems, which are strongly encouraged through funding and incentives. Objectives of the analysis of Italian EIPs and the key elements of international EIPs is to reveal how much these aspects are present in the Italian experience and to discover similarities and differences in the implementation of the methodologies and instruments for more sustainable production.

Already in the legislation’s definition of APEA, some similarities and differences emerge with respect to the experiences of the EIPs cited in numerous international studies. The APEA concept recalls the definition of EIP given by USEPA, “A community of manufacturing and service businesses seeking enhanced environmental and economic performance by collaborating in the management of environmental and reuse issues”. Also in much regional legislation the APEAs are described as a sustainable approach to production, whose goal is both improvement of environmental performance of businesses and increasing their competitiveness.

In summary, Italian EIPs (APEA) have three main characteristics: the management body, the shared environmental services and infrastructure and the tight collaboration between public and private entities. The shared services and infrastructures and the collaboration between the various stakeholders emerge as essential characteristics of international EIPs, as shown in the literature analysis, in contrast with the management body that results as an essential Italian aspect. Reference is made to a coordinating entity in the EIP in only a few other case studies, such as the British case study of WISP, described by Mirata (2004). This aspect, particularly because it is rarely cited in the international literature on EIPs was not a part of the comparative analysis. The comparative analysis focused on the 6 characteristics which emerged from the articles that were analyzed. The characteristics defined in table 2 were searched for in the 5 case studies described, which are representative of the national EIP scenario. Each of these Key Elements was verified to have been implemented in the case studies and the level of implementation was distinguished as one of the following:

(-) not implemented
(+)+) poorly implemented
(+++) implemented
(++++) strongly implemented

Table III Comparative analysis of the Key elements of the international concept of the EIP and Italian EIP features
Table 3 Comparative analysis between Key elements of International concept of EIP and Italian EIP features

<table>
<thead>
<tr>
<th>Italian EIPs</th>
<th>Exchange of materials and Energy (industrial symbiosis)</th>
<th>Sharing service</th>
<th>Landscape ecology</th>
<th>Common infrastructures</th>
<th>Networking</th>
<th>Involvement in local stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macrolotto di Prato</td>
<td>+++</td>
<td>++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
<td>+++</td>
</tr>
<tr>
<td>Pontecorvo</td>
<td>-</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>APEA Ponte Rizzardi</td>
<td>-</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>I.Z. of Padova</td>
<td>-</td>
<td>+++</td>
<td>++</td>
<td>+</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Productive area of Ancona</td>
<td>-</td>
<td>++</td>
<td>++</td>
<td>+</td>
<td>+++</td>
<td>+++</td>
</tr>
</tbody>
</table>

Table 3 clearly shows the substantial differences between Italian EIPs and the international approach, highlighting for example the minimal attention to the solutions related to industrial symbiosis. Today, experimentation with symbiosis initiatives at the area level has been applied minimally in this country, while there is instead a strong presence of shared infrastructures. The aspect of shared services and infrastructure is strongly developed in Italian EIPs, both because it is encouraged and outlined in the APEA legislation and because many national experiences exist that were economically and environmentally significant. The most notable case is certainly that of the industrial aqueduct of Macrolotto di Prato, which resulted in a significant reduction of industrial impact on local water resources. In fact, that installation made it possible to re-use 5 million MC of purified water per year in the productive processes of the Macrolotto companies. Shared services were one of the strong points of Italian EIPs and were present in all 5 case studies. Instances of shared services are numerous and are not limited to the environmental services of waste collection, transportation, energy supply, etc., but also include services for workers such as cafeterias and childcare.

Attention to “Landscape ecology” is present in all 5 case studies presented, although initiatives for landscape improvement are all fairly recent. Only Padova’s Industrial Zone is strongly engaged in this aspect, inasmuch as the company is located near a park where it has launched numerous projects and initiatives for the protection of the landscape, bio-monitoring of the area and educational projects on subjects such as renewable energy sources and sustainable development.

Networking among companies is mainly characterized by 4 of the 5 experiences examined. In the APEA of Ponte Rizzoli this aspect is minimally implemented because the EIP is still in the startup phase in which few companies are located there and they have not yet activated the mechanisms of cooperation. The networking is manifested in different ways among the various cases considered, including through information exchange, the organization of and participation in projects and initiatives for the development of the EIP and improvements in sustainability.

The involvement of the stakeholders, namely public institutions, sector organizations, etc., has a high level of development in 4 of the case studies. Only Macrolotto limits stakeholder involvement mainly to private entities, reducing interactions with public institutions.

Also, the involvement of the stakeholders, like networking, is implemented in different ways across the Italian case studies. For example, in the Ancona area, there is strong participation in the decision making path, especially in defining the development plans and initiatives for the EIP. On the other hand, Padova’s IZ collaborates with organisations and foundations for the execution of educational projects.

The 5 Italian case studies can therefore be considered partly different from the many examples of international EIPs, both with regard to the limited spread of industrial symbiosis initiatives and for the presence of the management body that was rarely found in the international EIP scenarios. These differences are emphasized when one compares Italian experiences with those of Asian countries, such as the EIP of Guiyang City and Lubei or the Korean case of Ulsan Industrial Park, in which the principle element mainly consists of the presence of technological solutions that allow for the exchange of materials and energy between the various businesses. Italian examples of EIPs are therefore shown to be more similar to some European and American cases, such as the case study of Humber in the UK which refers to the presence of a management body, as well as the case of Denves in the USA, where there is coordination between enterprises, sector organizations, institutions and representatives of the local community.

VIII. CONCLUSION

This paper gives a contribute in the bridging the gap linked with the experiences on Italian EIPs. From our overview emerges clearly that Italy is not a Country without interesting case studies to describe even if these are partially different by the cases identified at international level. Some peculiarities can be pointed out.

Firstly, as aforementioned, the initiative of industrial symbiosis declined in its form of by-products and energy exchange are not so disseminated. One of the reason can be identified in the fragmentation and the characteristics of the Italian industrial sector. In our Country the industrial areas are mainly composed by small and micro enterprises. The large presence of these kind of firms reduce the possibility to have relevant quantity of by-products and energy to recover from one hand and on the other hand increase the difficulty to manage in an integrated way the industrial area due to the necessity to coordinate too many subjects.

Secondly, Italy has chosen a policy approach based on national legislation to stimulate the diffusion of industrial ecology concepts among the industrial areas. Among the different approach adopted in other Countries this seems as an Italian peculiarity.

Thirdly, the Italian EIPs are based on a strong presence of the manager of the industrial area as a subject capable to involve private and public actors to pursue the common objective of the sustainable development of the industrial areas. In the carrying out this phase at the beginning we can assist to some tensions among stakeholders. For example the industrial associations can identify the Management Body of the area as a hypothetical competitor in the providing of environmental service and assistance to the tenant companies. In any case after this initial phase the fact to have on board of the initiative
both private as well as public actors can give an added value to its effectiveness.

According to the results described in this paper possible future research topics can be identified. One of these is the focus on the role and power assigned to the Management bodies of the different Countries. Which functions? How they get financial resources for its functioning? Do they benefit from the economic synergies realized in the area or are they funded by public resources?

A second research aim could investigate the environmental performance of the Italian industrial areas comparing them with the performance of areas of other Countries where industrial symbiosis initiatives are wider adopted. Strictly referred to this, the measurement of the environmental performance of the industrial area as a whole instead of the effectiveness of a singular initiative in our opinion can be considered a further topic to be investigated by scholars in this field.

REFERENCES

Sara Tessitore is graduated at University of Pisa in 2005 attended the Master in Environmental Management and Control at Sant’Anna School of Advanced Studies in 2006 Starting from 2009 is a PhD student in Management, Innovation, Sustainability and Healthcare. Since 2007 she collaborates with the “Istituto di Management - Scuola Superiore Sant’Anna” on National and European projects on sustainability. She specializes in the environmental management tools and policies to improve the performance of companies especially small and medium.

Francesco Testa is Assistant Professor -at the Institute of Management, Sustainability Management area, and senior consultant in Environmental and H&S management in ERGO srl (a spin-off company of Sant’Anna School). He is graduated in environmental economics at the University of Florence in 2001 and had an M.Sc. in Environmental Management and Audit in 2002. Since 2002 he’s research officer at S.Anna School of Advanced Studies with participation in many European and national projects related to the environmental management issues in industrial enterprises and territorial areas (clusters). He worked in projects promoted by European Commission - DG Environment, DG Enterprise, DG Research. Since 2010 he is in chief of a VII Framework Programme project promoted by DG Research (BAT4MED) dealing with the impact of introduction of the EU Integrated Pollution Prevention and Control approach to the participating Mediterranean Partner Countries (Tunisia, Morocco, Egypt) and the implementation of Best Available Techniques.

Tiberio Daddi is Assistant Professor -at the Institute of Management, Sustainability Management area, and senior consultant in Environmental and H&S management in ERGO srl (a spin-off company of Sant’Anna School). He has specialized in the economics and management of innovative environmental policy instruments and their relationship with the economy fundamentals and competitiveness. He is lecturer in Environmental Management at the international PhD in Management (Innovation, Sustainability and Healthcare), at the Master of environmental Management and Audit –efficient management of resources held at Sant’Anna School and in the ordinary course at SSSA. He has been working on many pilot projects promoted by EC in the field of environmental management, impact assessment of IPPs and analysis of the relationship between environmental management and competitiveness. He has distinctive competences in the field of environmental product policies, GPP and SCP and environmental management having published several papers in International journals.