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The decline of eco-industrial development in Porto Marghera, Italy

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ABSTRACT

Establishment of an eco-industrial park is influenced by numerous internal and external factors. The evolution of an eco-industrial park is path-dependent acknowledging that both choices made in the past as well as the current context of the industrial sector are very important in determining its success. We study the industrial area of Venice, namely Porto Marghera, as a center of chemical industry activity in Italy, in order to understand two sets of factors that determine its destiny: the endogenous ones which emerge from local siting and decision making, and the exogenous ones, that are principally more regional and global in scope. The motivation in studying the Porto Marghera industrial park derives from its long and articulated history, its important economic role both at national and European levels, the complexity of the industries involved, the heavy environmental burden, and the high social conflict in the area. The aforementioned factors motivates our interest and indicates reasons for areas' eventual decline. We conclude that since 2004, had, either the endogenous factors or the exogenous ones – that influence the European or even global chemical industry, been favorable at the same time, there may have been an opportunity to stem the decline of the area. But without a strong basis the eco-industrial park faces a bleak future. We contribute to the literature a case study of the failure of a particular location to sustain its previously successful eco-industrial activity. Whether the fate of Porto Marghera should be seen as the natural outcome of a confluence of events over time, or as an outright failure, is discussed as a means of informing other industrial symbiosis projects.

1. Introduction

In principle, industrial symbiosis, in the form of eco-industrial parks, offers a way to combine local economic development with favorable environmental outcomes. Eco-industrial parks have been seen as the concrete realization of the concept of industrial symbiosis at the inter-firm level where loop closing increases reuse of physical resources through the return of by-products back to production processes. As a result, they increase economic benefits and improve environmental performance of industrial areas, thus promoting their sustainability.

Yet, loop closing represents only one of a list of factors that combine to make for successful eco-industrial parks. Optimization of energy and material consumption, minimization of waste generation, and the exchange of by-products are all necessary, but not sufficient, conditions for the survival and development of eco-industrial parks (EIP). The context in which they are embedded is of utmost importance: the presence of a community, inter-firm cooperation, proximity and adaptability of participating organizations all play a major role for effective, sustainable, and functional eco-industrial parks. In addition, the relevant literature highlights a set of technical and context related factors that favor the development of industrial symbiosis. Among those, we may cite the existence of *synergies* among the firms, the availability of *infrastructure*, the presence of a *flexible regulatory framework* and *favorable policies*, the existence of some *information management systems*, of *facilitators* and the presence of a *coordinative function.* More broadly, most industrial parks face other local, national, regional and global constraints such as the evolution of the international division of labor, globalization processes, and financial volatility, that have not yet been extensively considered in the literature. All of these factors affect the possibility of successful

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development of eco-industrial parks and its resilience, i.e. the system's ability to maintain its functionality under shock.

This paper aims to study the industrial park of Venice, namely Porto Marghera, Italy and its development over time as an eco-industrial park employing industrial symbiosis even though this designation was not explicit in the organizational history of the region. It also aims to identify and explain the set of local, national, regional and international contextual drivers that, over time, promoted or hindered the development and evolution of Porto Marghera. The paper contributes a study of eco-industrial decline to the industrial symbiosis literature and of triggering factors for eco-industrial park development, with a special focus on endogenous vs. exogenous ones.

The paper is structured as follows: in Section 2, on the basis of a literature review, we discuss the major factors favoring the development of an EIP; a brief history of Porto Marghera and its evolution over time is presented in Section 3; in Section 4 we discuss whether Porto Marghera ever showed the relevant characteristics of an EIP; the recent evolution and the causes of Porto Marghera's decline are discussed in Section 5, while Section 6 concludes.

2. Structure and context: enhancing the development of an eco-industrial park

The variety of structural and contextual factors supporting the development of an industrial park as an EIP is stressed in the relevant literature. Some, like the existence of *synergies* among firms, are a necessary condition; in Chertow (2000) three mechanisms that can foster or propel industrial symbiosis are described: 1) a single material or energy exchange, 2) pre-existing organizational relationships, and 3) the anchor tenant model. To expand on this, the single exchange would show a clear, relevant and identifiable environmental and economic benefit which would become a stimulus for the development of further exchanges (Ehrenfeld and Chertow, 2002). Examples of this kind include, in the case of a power plant, the co-generation of steam and electricity, the use of recirculated water, or the inclusion of ash in making building materials. More recently these have been referred to as “kernels” or “precursors” of industrial symbiosis (Chertow, 2007).

Industrial symbiosis can also evolve from existing organizational relationships or networks; these organizational relationships are the result of a shared need to solve common necessities, such as accessing natural resources, dealing with natural disasters or hazards, or jointly addressing new environmental regulations (Costa et al., 2010). For instance, in Kalundborg, Denmark, the most famous case of industrial symbiosis, the partnership among the firms was stimulated by the need to solve the common need for a surface water resource (Ehrenfeld and Gertler, 1997). A third enabling mechanism for EIPs is offered by the anchor tenant model, where the large scale throughput of the anchor – such as a power plant or brewery – may attract the co-location of other industries and businesses, according to the model of up-stream or down-stream vertical integration, supplying raw materials or using by-products (Lowe, 1997; Korhonen, 2001).

The exchange of by-products can be a solid base for the development of an EIP among firms, but it often requires updated *infrastructure*, calling for dedicated investments, and, therefore, introducing a relevant constraint to the economic viability of specific symbiosis initiatives (Cohen-Rosenthal, 2003; Baas and Huisingh, 2008). For this reason, the existence of appropriate infrastructure has long been recognized as a fundamental element of industrial symbiosis whereas its lack is a relevant obstacle, considering the costs of implementation and the difficulty in finding the needed funds to realize it (Côté and Hall, 1995; Jacobsen, 2006).

The role of environmental regulation in supporting industrial ecology is ambiguous (Wenting and Boons, 2014). For industrial ecology the notion of waste is crucial, since IE considers all materials either as resources or by-products that can be exchanged through industrial symbiosis mechanisms. For environmental regulation, however, especially in the majority of European countries, most by-products are considered to be waste originated within a single production process, and, as such, their transport and storage is strictly ruled within waste management policy (Costa et al., 2010).

These limitations are even more restrictive when dealing with hazardous substances, and regulations may become a barrier to development of industrial symbiosis. Iacondini et al. (2014) identify regulation as one of the main factors limiting a systematic development of industrial symbiosis in Italy. Accordingly, a *flexible regulatory framework* and *favorable policies* are supportive of Industrial Symbiosis (IS) development (Chertow, 2000; Côté and Hall, 1995; Lowe and Warren, 1996; Côté and Smolenaars, 1997; Gertler, 1995; Desrochers, 2002; Boons et al., 2013; Costa et al., 2010; Lethoranta et al., 2011). This is one of the lessons learned from Kalundborg, where the flexibility of the Danish regulatory framework, that asks firms to submit detailed plans of their efforts for continuous environmental performance improvement, instead of imposing technology standards, has encouraged the evolution of industrial symbioses (Ehrenfeld and Chertow, 2002).

Chertow (2000) underscores the matching of inputs and outputs in order to create links across industries as a further key element that promotes symbiosis. To support and enhance the links that develop symbiosis, an *information management system*, fed by a systematic collection of information about inputs and outputs of the different entities, is an enabler, facilitating the flow of materials and energy within the system (Côté and Hall, 1995; Lowe and Warren, 1996; Côté and Cohen-Rosenthal, 1998; Mirata, 2004; Grant et al., 2010).

Organizational factors, such as the presence of *facilitators* and of a *coordinating entity,* support the establishment and maintenance of the momentum of symbioses (Côté and Cohen-Rosenthal, 1998; Mirata, 2004; Behera et al., 2012; Chertow and Ehrenfeld, 2012; Paquin and Howard-Grenville, 2012; Park and Park, 2014), also by facilitating the involvement of different stakeholders, the exchange of information, the opening of new and larger flows. Some scholars have begun to write about the organizational dynamics of industrial symbiosis and how it influences eco-industrial outcomes (Boons et al., 2011). It is important to notice that all successful innovations have a systemic component: to be sustainable in time they must open new markets, but also support the strengthening of interrelation among firms. This seems specifically true for clean(er) technologies where innovation is identified with superior ecological performance. Sustainable innovations are rooted in systemic relations among firms, customers and the capacity to create value for a constellation of actors, connecting to several suppliers and acquiring resources in a profitable manner for all, pointing to the need for new business models (Boons and Lüdeke-Freund, 2013; Boons et al., 2013). Summing up, twenty years of practice and reflection around the model of industrial symbiosis have identified favorable factors for the development of an EIP: the presence of a facilitator is acknowledged because its actions shape and develop network processes contributing to IS. Facilitators can contribute to create a context that can favor the development of IS initiatives, in terms of social, economic, political, spatial and temporal embeddedness (Costa and Ferrão, 2010). Embeddedness implies the local capacity to create networking among firms and individuals in particular exchanges, even culturally, and developing trust and shared norms in support of IS has also been observed (Boons and Howard-Grenville, 2009).