

# 10<sup>th</sup> IWAACP

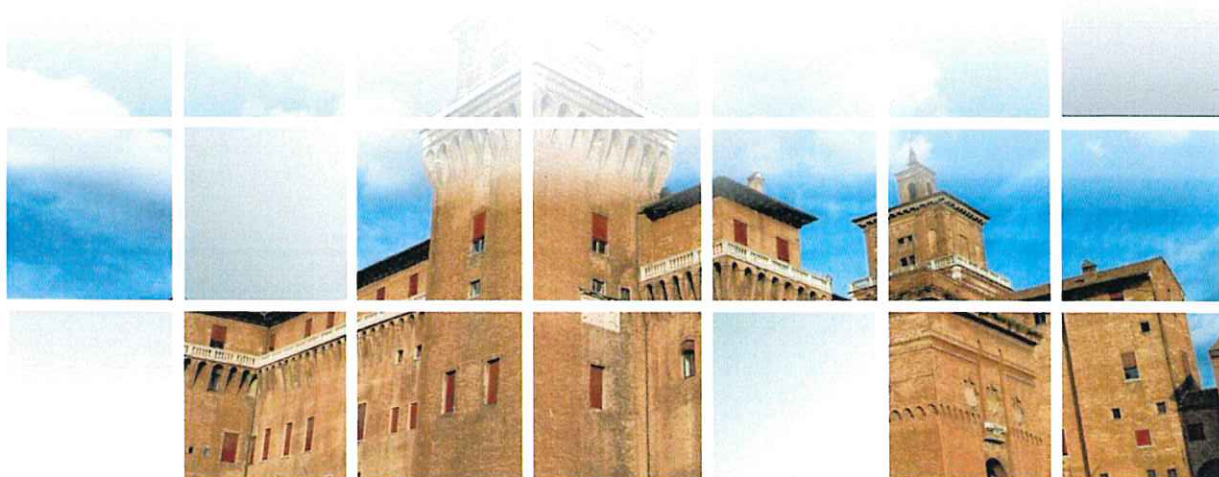
“A RESILIENT AND SUSTAINABLE WORLD:  
CONTRIBUTIONS OF  
CLEANER PRODUCTION, CIRCULAR ECONOMY  
AND ECO INNOVATION”

Advances in Cleaner Production

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## The Evolution of Local Economic Systems towards Circular Economy: The ALYCE project

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### Abstract

The main purpose of this abstract is to present ALYCE (*An Analytical model for the evolution of Local Economic sYstems towards Circular Economy*), a research project founded by the "G. d'Annunzio" University, under the Program named "Search for Excellence", that aims to define an analytical model to investigate the evolution of Local Economic Systems (LESes) towards Circular Economy (CE).

As widely recognized, CE is progressively establishing as a new socio-technical paradigm. It is well known that paradigmatic jumps require an "adaptation" of the system in which they apply, from both a structural-morphological (e. g. roles, technologies) and functional-operational point of view (e. g. rules and routines). However, on a global scale, there is a still open issue related to operational complexity, geographical disparities, difficulties in supply chains traceability and control and impacts related to transportation activities, which make fully circular principles and models less applicable. In this sense, local-scale systems have greater potential of reevaluation.

The theoretical background of this project is based on Industrial Ecology (IE) principles and approaches for the development of economic systems taking inspiration from the *biological systems*. This research field was definitively established at a global level in the late 1980s and proposed a new concept in which an industrial system is viewed not in isolation from its surrounding systems but in concert with them. IE seeks to optimize the total materials cycle from virgin material to finished product and to ultimate disposal moving from the natural ecosystem's metaphor, which starts from a certainty: in the natural world, no waste is produced; waste is essentially a social or human construct. In this perspective, the most effective IE-based approach relies on the concept of Industrial Symbiosis (IS).

Theoretical contributions and empirical evidences emerged in the preliminary phases of the project, indicate some important limitations in the implementation of IE tools and approaches in local systems; some are of a contextual nature, and are difficult to eliminate, while others are intrinsic, and can be addressed by an integrated interdisciplinary perspective. A first limitation is due to the fact that the main current approaches are static and generic, i.e. they are not "context based" (which actors, which processes, which technologies to include or exclude) and have no prospective vision to define paths for the circular development of the systems analyzed; ii) a second important limitation is related to the possibility of measuring and communicating the economic, environmental and social effects of CE initiatives.

The ALYCE project, starting from the biological paradigm, wants to contribute to fill these practical and scientific gaps by developing an integrated model capable of representing and studying the evolution of local systems and their surroundings towards the CE paradigm. In particular, the ALYCE project pays attention to local systems characterized by the presence of multiple dimensions, the so-called *hybrid systems*. Examples may include industrial contexts developed within existing urban handcraft and rural substrates; large plants giving rise to satellite industrial activities and urban settlements; agro-rural contexts (multi-functional) housing industrial plants for biomass processing or energy generation (Fig.1).

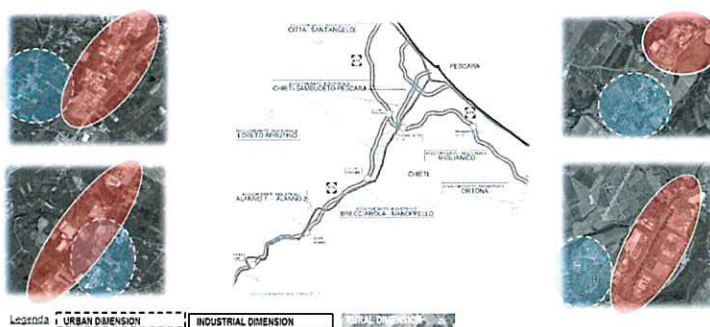


Fig. 1. Examples of LESes including multiple dimensions.

The final objective is facilitating the representation of the potential actors and the variables involved in the development of CE practices at local level, and to create a framework for the integrated application of IE-based and other technological (e. g. Industry 4.0) solutions and tools (e. g. for systems representation; network relations;

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materials/energy inventory; impact assessment; dynamic modelling; communication). The model so far developed considers three structural-morphological dimensions (industrial, urban, and agro-rural) for the representation of the LESes and four functional-operational dimensions (economic, socio-relational, environmental, and technological-innovative) to investigate their evolution towards CE.

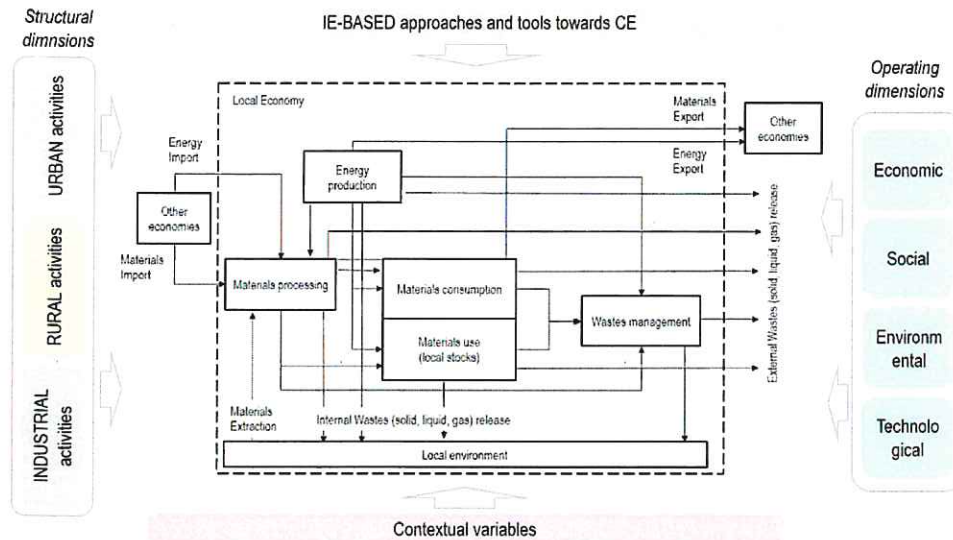


Fig. 2. A general scheme of the dimensions and the variables included in the analytical model.

Figure 2 describes a graphical representation of the dimensions and the variables included in the analytical model; the grey depicts a general model of a linear LES, highlighting material and energy flows in a linear approach; around the system the representative elements of the analytical model proposed are reported: the three contextual dimensions characterizing the hybrid systems; IE-based approaches and tools; the contextual variables; the four aspects/levels investigated (economic, social, environmental, and technological). The adoption of IE-based approaches and tools to the entities belonging to the three dimensions will be used to redefine the roles (inspired to biological systems) and the relations (social and physical) capable of establishing a new trajectory of development, towards CE, taking into account the effects of external variables and the potential effects.

**Keywords:** *Industrial Ecology, Local Economic Systems, Industrial Symbiosis, Circular Economy, Analytical Model.*