

## A methodological framework for Eco-Industrial Park design and optimization

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### Abstract

Eco-Industrial Park (EIP) is an industrial system, whose conceptual structure is inspired from biological concept of an Industrial Symbiosis (IS). IS are established for energy/material exchanges among the different industrial enterprises (or Individual Actors, IA), to improve their economic and environmental performances, e.g., by reducing expenses for energy purchase, industrial waste, and water treatment, pollution taxes. The EIP design and management must account for the business core differences of the IA, with their possibly conflicting objectives on energy/material management and those of the additional players that may be involved for facilitating infrastructure operation, under the typical characteristics of a complex engineered system. For this, it is necessary go beyond classical energy/material processes integration and to bring new perspectives for the decision makers to create a sustainable and robust EIP design. This paper provides an analysis of EIP from the point of view of system complexity, drawing a parallel with other complex engineering systems such as Smart Grids (SG) for electric power transportation and distribution. The biologically inspired concept of IS in EIP is formulated and a methodological framework is developed for modelling and optimization, taking into account EIP specificities, and integrating uncertainties and risks in future EIP operation, e.g., due to unexpected major changes in the regulatory context and IA operational strategies, failures of interconnections among IA, interruption or shutdown of IA operation.

**Keywords:** Circular Economy, Eco-industrial Park, Industrial Symbiosis, industrial interconnected system, complex system, modelling and optimization under uncertainty.