

## Efficiency measures of industrial symbiosis network using enterprise input-output analysis

Topic: Productivity and Efficiency Analysis

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An important challenge that firms should be able to sustain regards mitigating the environmental impact of their production processes. Industrial symbiosis is a way that allows firms to approach this goal and, at the same time, to obtain economic benefits in terms of cost reduction (Chertow, 2000). The topic of industrial symbiosis networks (ISNs) has been addressed in the industrial ecology literature (Chertow and Ehrenfeld, 2012; Romano et al. 2012) but efficiency measures need to be more explored in order to drive the ISN design and development. Park and Behera (2014) provide some insights about the methodological aspects related to the use of eco-efficiency indicators for ISNs.

In this paper we propose a measure of efficiency at the level of each specific symbiosis relationship based on the exchange of materials and energy. Then, based on the enterprise input-output (EIO) approach, we extend the definition of efficiency at the level of the entire ISN.

We analyse several types of network in terms of topology, number of firms, and technical coefficients. In particular, ISN efficiency can be strongly affected by the network topology and technical coefficients. Then, various ways to improve efficiency of a symbiotic network have been recognized, resulting in policy recommendations.

This approach has been applied to a couple of ISN, the conversion of biomass and exhausted tyres into energy, getting information about the most efficient balance between waste production and primary input requirements.

Keywords: Industrial symbiosis, Network efficiency, Enterprise input-output

### References

- Chertow, M. (2000). Industrial Symbiosis: Literature and Taxonomy, *Annual Review of Energy and Environment*, Vol. 25, pp. 313-337.
- Chertow, M., Ehrenfeld, J. (2012). Organizing Self-Organizing Systems. Toward a Theory of Industrial Symbiosis, *Journal of Industrial Ecology*, Vol. 16, pp.13-27.
- Park, H.-S., Behera, S.K. (2014). Methodological aspects of applying eco-efficiency indicators to industrial symbiosis networks, *Journal of Cleaner Production*, Vol.64, pp.478-485.
- Romano, V.A., Yazan, D.M., Albino, V. (2012). How far is an input-output production system from perfect industrial symbiosis?, 20th International Input-Output Conference, Bratislava, Slovakia, June 25-29.