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Panel 2. Sustainable production towards a circular economy

Assessing the geographical aspects of regional Industrial symbiosis for European regions

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Geographic Challenge of Providing Sustainable Energy

There are three main challenges about energy in European regions[1]:

- Increasing the share of renewable energy sources in total energy consumption
- Increasing efficiency by heat integration technologies among industrial processes
- Increasing efficiency by better land use policies for industrial sites (agglomeration)

Industrial symbiosis (IS) can play a role as a an innovative solution for moving from linear production toward circular economy and territorial efficiency. Two or more dissimilar industrial processes exchange the residues as resources (material, energy, or services)[2]. It involves several aspects regarding energy related problems:

- Cascaded waste-heat recovery
- Exchange of material residues as alternative fuels[3]
- Utility sharing (wastewater treatment, waste and wastewater combined treatment, etc.) which can reduce the total energy consumption, and relevant emissions

[1]Eurostat, 2018. Shedding light on energy in the EU. https://ec.europa.eu/eurostat/cache/infographs/energy/

[2]Fraccascia, L., Giannoccaroc, I., Albinoc, V. 2019. Business models for industrial symbiosis: A taxonomy focused on the form of governance. Resources, Conservation & Recycling 146, 114–126. DOI: 10.1016/j.resconrec.2019.03.016

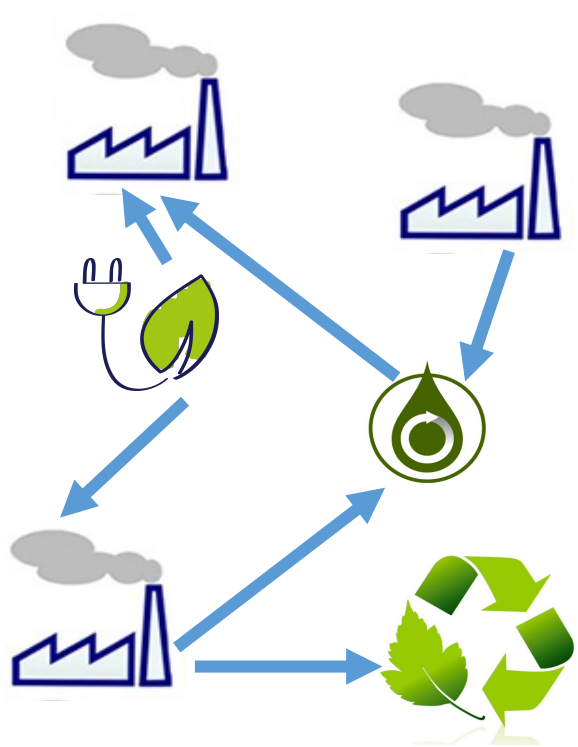
[3]Albino, V., Garavelli, A.C., Romano, V.A., 2013. A Classification of industrial symbiosis networks: A focus on materials and energy recovery. IFIP Advances in Information and Communication Technology, 397 (PART 1), pp. 216-223. DOI: 10.1007/978-3-642-40352-1_28

Scaling up Industrial Symbiosis Networks to Regional Level

Industrial symbiosis at regional scale is usually considered as a planned (or facilitated) approach which relies on the central role of an organization for connecting the network members (nodes) by regulation, providing information and incentives.

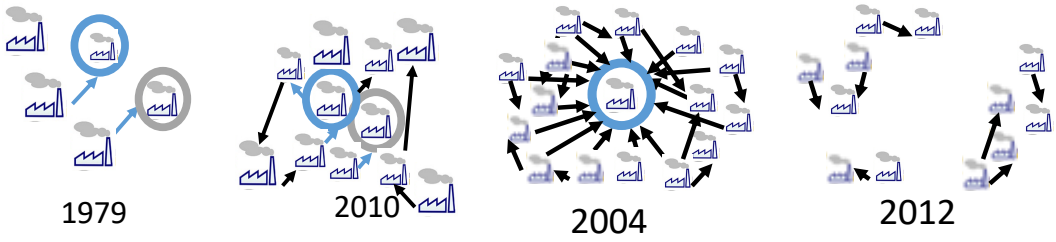
The importance of Industrial Symbiosis Network (ISN) characterization

Various models for industrial symbiosis have been introduced to the industrial ecology discussions, based on different degrees of centralization in the collaboration networks.



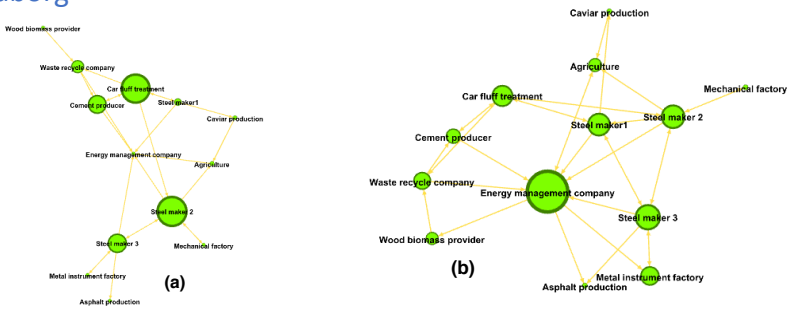
Network Analysis Approach

- Social network analysis (SNA) has been applied in many fields, including resource utilization.
- It is a quantitative method to analyze social interactions, such as economic transactions.
- The network structures may be characterized by graphs made of nodes and edges.
- Special metrics are developed for characterizing the networks such as density, structural holes, the average shortest path, etc.



Development of IS network in Kalundborg[1]

Critical state in an industrial area[2]



	nn	ne	APL	AvCC	D	N.D.
a	13	27	2.446	0.081	0.173	6
b	13	35	2.023	0.087	0.191	6

Visualization and analysis of the performance of an ISN in Brescia

[1]X. Zhang, L. Chai (2019). Structural features and evolutionary mechanisms of industrial symbiosis networks: Comparable analyses of two different cases. Journal of Cleaner Production 213 (2019) 528-539

[2]Mannino, I., Ninka, E., Turvani, M., Chertow, M. (2015). The decline of eco-industrial development in Porto Marghera, Italy. Journal of Cleaner Production, 100, pp. 286-296

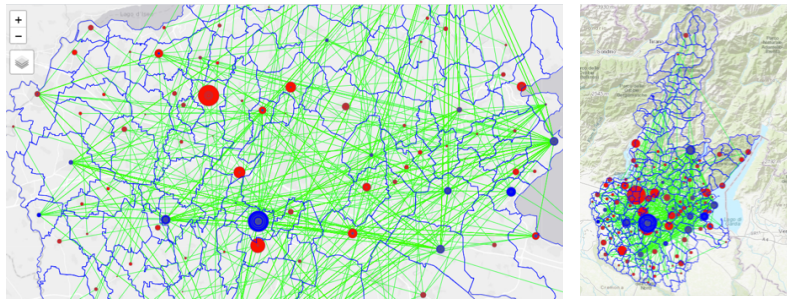
Geographical dependencies in network assessment and the possibility for a combined approach

The geographical proximity and system boundaries were considered as crucial factors in formation of industrial symbiosis in the earlier studies. More recent definitions paid less attention to such features. The hypothesis of this research is that the geographical (contextual) conditions can result in different categories of regional symbiotic networks.

Mapping the Symbiosis Networks in European Regions

- Documentations for 47 industrial symbiosis projects were analysed for this study.
- The comparative studies between pairs of regions were common in IS literature. However, the impacts of geographical dependencies have been rarely considered.

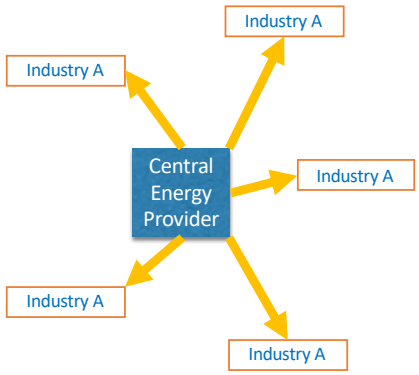
Positioning of an industrial district, the province of Brescia, Italy (Google Map), below the network visualized by GIS



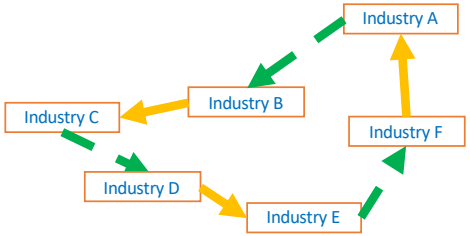
The geographic distribution of industrial areas as nodes in the output-input network, visualized by GIS

Main Types of Networks

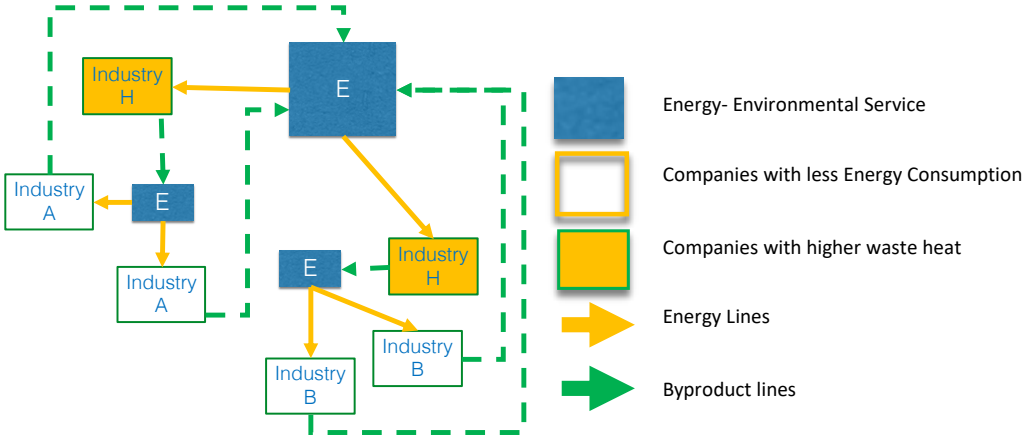
Centralized Closed System



Decentralized Closed System



Semi-centralized open system



Regional Characteristics and Potentials

Centralized Closed System

- Lower Industrial Diversity
- Lower Innovation Potentials
- Development of shared utilities (e.g., solar energy)

Decentralized Closed System

- Vast geographical lands
- Diversity of industrial sectors
- Higher Innovation Potentials
- Presence of well-developed environmental management companies (waste-energy)
- Presence of Companies with higher amount of waste heat

Semi-centralized open system

- Highly industrialized districts (ports, islands, etc.)
- Connection to urban texture and public services
- Presence of Leading Energy and Chemical Companies
- Transfer from some sorts of circular but not sustainable connections to more renewable and green ones

Conclusions

- The geographical (contextual) conditions can result in different categories of IS networks.
- Three main patterns were identified for regional energy symbiosis networks. However, each of these main groups are divided into important sub-categories.
- The physical geography of regions can control the process of IS development in areas with low innovation potentials. Otherwise, regional characteristics such as regulative frameworks and ecological conditions would have higher impacts.
- These features should be included in the process of planning or evaluation of possible scenarios prior to undertaking practical steps toward implementation of IS programs.

THANK YOU!

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