Industrial Symbiosis, a dynamic strategy to a Bio-based Economy

Manuel E. MORALES
NEOMA Business School, Industrial Bio-economy Chair
Clermont Auvergne University, Research Center of International Development Studies

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OUTLINE

• Introduction
• Literature Review
  – Industrial Ecosystem
  – Bio-based economy
  – Industrial symbiosis
• Empirical Approach
  – Systems dynamics
• Results
  – Norrköping Causal Loops Diagram
  – Key regional actors and the sectors of society they represent
• Mechanisms/Discussion
• Conclusions
INTRODUCTION

WHAT ARE THE CAUSAL STRUCTURAL PATTERNS THAT DRIVES THE TRANSITION TO A BIO-BASED ECONOMY?

Do we need to deal with the structural patterns in a dynamic way to understand and figure out the leverages and key mechanisms to influence the system?

What is the role of the actors and stakeholders in the industrial ecosystem?

How do we should assess sustainability of the bio-based economy in the industrial ecosystem?
INDUSTRIAL ECOSYSTEM

THEORETICAL FRAMEWORK

Ecosystem Metaphor

Ecosystem

Organizational
Innovation

Human
technology
organization
symbiosis

Convention
theory

Stakeholders
theory

Industriel
Ecology

Industrial
clusters

Hybrid
organizational
forms

Industriel
Ecosystem

Introduction | Literature Review | Empirical Approach | Results | Mechanisms/Discussion | Conclusions

Ehrenfeld, Gertler, 1997
Hess, 2009

Marshall, 1903
Baas, Boons, 2004

Williamson, 1975, 1976,

Mitchell, 1997
Brullot, Buclet, 2011

Shumpeter, 1912, 1951
Di Maggio, Powell, 1981,
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Shumpeter, 1912, 1951
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2011

Brangier, Hammes-Adele,
Bastien, 2010

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INDUSTRIAL ECOSYSTEM
BIO-BASED ECONOMY

Is a development leading to an increasing and novel use of biomass in society, with the aim of substituting fossil-based sources of energy, materials and chemicals.
Cooperative process settled by stakeholders that seeks to enforce the circularity within a shared territory, organizational and institutional proximity, where institutions and firms willingness fosters synergies, motivated by eco-efficiency and resilience (Diemer & Morales, 2016).
This approach can be used to perform scenario runs and policy testing, exploring potential future development patterns, risks factors and opportunities to further expand bio-based economy activities in the area.
MUNICIPALITY SECTOR
The desired capacity is based on expected future energy demand, rather than on available production inputs.
The higher the outtake, the larger the negative impact of growth (due to limitations in nutrients availability)

If the outtake fraction is above 85% of the residues, the growth rate will be negatively affected

The loss in growth rate is compensated by the increasing productivity
### 4 stages in the Industrial symbiosis evolution process

<table>
<thead>
<tr>
<th>Dynamic Phases</th>
<th>IS type</th>
<th>Motivations</th>
<th>Initial actors</th>
<th>Overall storyline outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergence – 1980</td>
<td>Facilitator brokerage</td>
<td>Interfirms organization and transparency</td>
<td>Wood and paper industry</td>
<td>The early stages of an forestry cluster</td>
</tr>
<tr>
<td>Regional efficiency – 1992</td>
<td>Facilitator collective learning</td>
<td>Eco-efficiency and environmentally friendly practices</td>
<td>Municipality</td>
<td>Combined heat and power construction</td>
</tr>
<tr>
<td>Regional learning – 2000</td>
<td>Facilitator collective learning</td>
<td>Resilience</td>
<td>Partnership between public and private actors</td>
<td>Investment in the CHP (2.6 million euros)</td>
</tr>
<tr>
<td>Sustainability of industrial District - 2017</td>
<td>Eco-cluster development</td>
<td>Adaptability and flexibility</td>
<td>External participants and local authorities</td>
<td>Decreasing marginal efficiency of environmental investments, development of an eco-cluster necessary to foster sustainability</td>
</tr>
</tbody>
</table>

Source: modified from (Morales & Diemer, 2018)
MECHANISMS

• We identify public-private partnership as a key driver for the Eco-industrial cluster

• We found the empirical evidence of an historical transition validated by the causal relationship of energy behavior patterns.

• We identify the Residue outtake rate as one of the mechanisms of sustainability of the forestry ecosystem

• Model validation and sensitivity analysis is a necessary to build confidence in the model
FURTHER RESEARCH QUESTIONS

- **Energy demand** could be modelled endogenously because in the model is taken as exogenous.
- Include in the model other uses of **waste**, reductions in the model, potential resources and market dynamics.
- **Socio-economic constraints** would be considered and may entail the addition and interaction of **other sector in the model**.
CONCLUSIONS

• The dynamic analysis of Norrkoping IS let us understand the feedback and spillover effects in the reproduction of an economy of waste in the market, entailing a possible transition to a bio-based economy.

• To accomplish the structural patterns identification in a industrial symbiosis, the local and historical analysis is necessary in order to identify the mechanisms that figure out the leverages and to influence the system.

• There is a negative feedback from the outtake of forest residues to the growth rate, that could not be identified by the cost-benefit analysis and econometric forecasting, because the investments were based on future energy demand, rather than on available production inputs. Mainstream economic analysis only take into account flows variables (demand, supply, price, etc.) disregard the stocks involved in the system.
Thank you

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