INSA INSTITUT NATIONAL DES SCIENCES APPLIQUÉES LYON

Ecologie industrielle et économie circulaire

GI-4-EIE-S1 2024-25

6&7. Eco-Industrial parcs (Industrial and territorial ecology) : Kalundborg

membre de UNIVERSITÉ DE LYON

Today and next session

Objectives :

- Knowing another way of circularizing flows
  = ITE (Industrial and Territorial Ecology)
  = symbiosis
- Compare an eco-industrial park to Kalundborg

Plan :

1. *In the Loop Game Debrief*

2. Principles of industrial ecology

3. Kalundborg

4. Eco-industrial parks compared to Kalundborg
   - Reading in sub-groups of 4 people
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     (last half hour of the next session)

In the Loop Game Debrief: discussion

It's not just a game, because !

- The game shows
  - The interest and importance of circularizing flows
  - which mineral resources are not infinite, but scarce (PMGs, REEs, W, Mg...) => frustration
  - conflicts of use between products (settled by auction rather than by need)
  - The impact of unforeseen events

- Money = Means (to reach 7 points of progress)
  ≠ objective

- Reminder : What is better between re-use (ré-emploi), reuse (réutilisation) and recycling?

- What other insights do you take away from the game?

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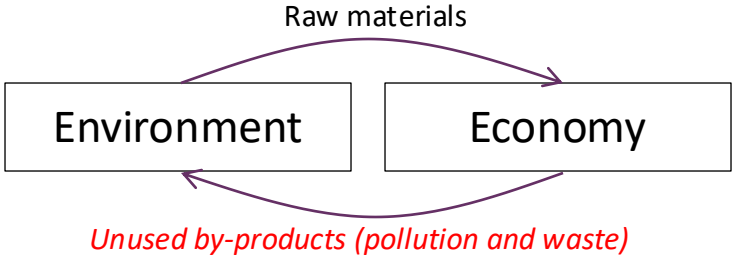
General principle

- Reminder: Current Pb = Linear/Open Loop Economics



- Industrial ecosystem
  - = Industrial symbiosis
  - Main feature: Exchange of waste, co-products and energy between geographically close firms

- "In the end, we found agreement around the idea that to achieve our vision of sustainability some things must grow (jobs, productivity, wages, profits, capital and savings, information, knowledge, education) and others (pollution, waste, poverty, energy and material use per unit of output) must not."
  [President's Council for Sustainable Development (1996) des Etats-Unis]

[Ehrenfeld J. & Gerder N. (1997) « Industrial Ecology in Practice – The Evolution of Interdependence at Kalundborg », J. Industrial Ecology 1(1):67-79]

A few simple principles

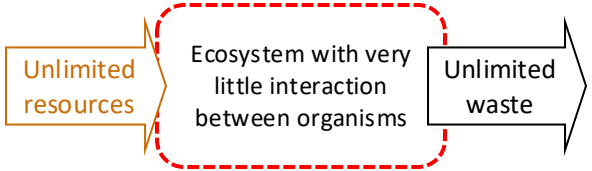
1. *Loop*
   Closing material cycles + Recycling and recovering waste as a resource
2. *Avoiding upheavals in the metabolism of the natural system*
   Eliminate toxic substances and avoid pollution
3. *Waterproof/Seal*
   Minimize dissipative emissions
4. *Food Chain/Food Webs*
   The rejections of some are the resources of others
5. *Dematerialize* (intensify)
   Reduce resource and energy consumption
6. *Cascading energies*
   Using energy in a thermodynamically efficient way
7. *Balance (Decarbonize)*
   Producing + energy with – fossil carbon (Developing renewable energies + reducing consumption)

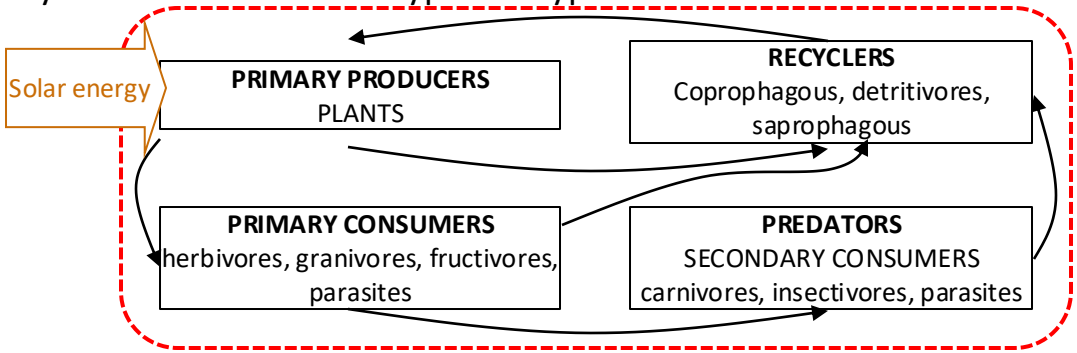
   => Creation of links between companies to improve the efficiency of the material and energy flows of the business system, even if some companies, seen individually, seem inefficient.

[Ehrenfeld J. & Gerder N. (1997) « Industrial Ecology in Practice – The Evolution of Interdependence at Kalundborg », J. Industrial Ecology 1(1):67-79]
[Vincent F. « Symbioses industrielles et parcs éco-industriels : la symbiose de Kalundborg », https://youtu.be/39nbiVcGdNc]
[Surren Erkmann cité dans Vincent F., 2015, « Genèse de la notion d'écologie industrielle », MOOC UVED « Economie circulaire et innovation », https://www.uved.fr/fiche/parcours/economie-circulaire-et-innovation/13/approfondi#sequence]

Types of Ecosystem

Industrial ecology = imperfect analogy with the evolution of Life
Objective for industrial ecosystems = to move from type 1 to type 2





Type 1 Ecosystem
Juvenile ecosystem
(Ex. : intensive agriculture)

- Low material recycling
- Open material flows
- Few interactions between species
- Competition between species
- Simple food chains
- High productivity

Type 2 ecosystem

- Beginning of complex interactions between individuals

Type 3 Ecosystem
Mature ecosystem
(Ex. : Mature forest)

- High element recycling rate
- Quasi-cyclic material flows
- Complex interactions between species: symbiosis, parasitism, etc.
- Complex food chains
- Low productivity

[Braden Allenby cité dans Vincent F., 2015, « Genèse de la notion d'écologie industrielle », MOOC UVED « Economie circulaire et innovation », https://www.uved.fr/fiche/parcours/economie-circulaire-et-innovation/13/approfondi#sequence / www.youtube.com/watch?v=AeE2Ki99bfM]

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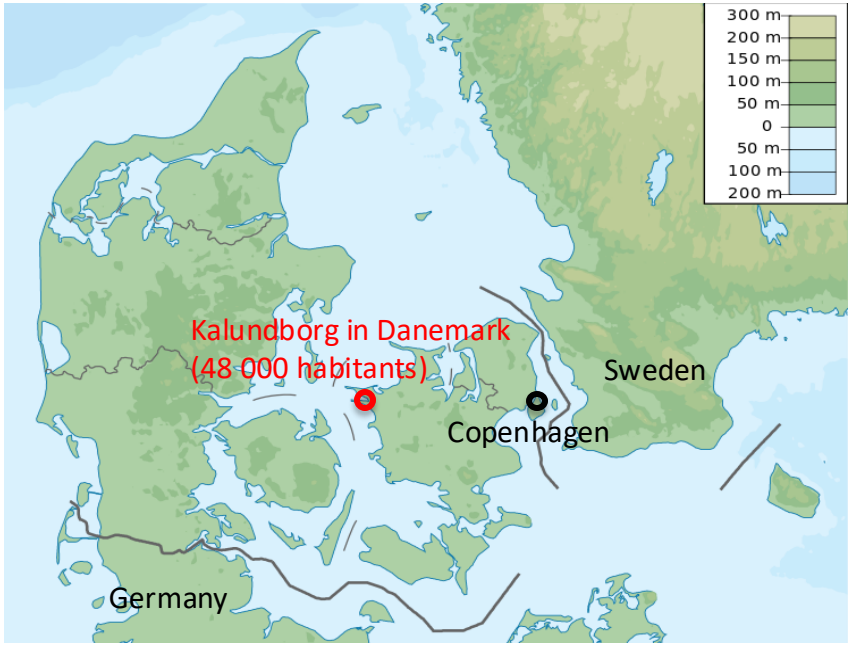


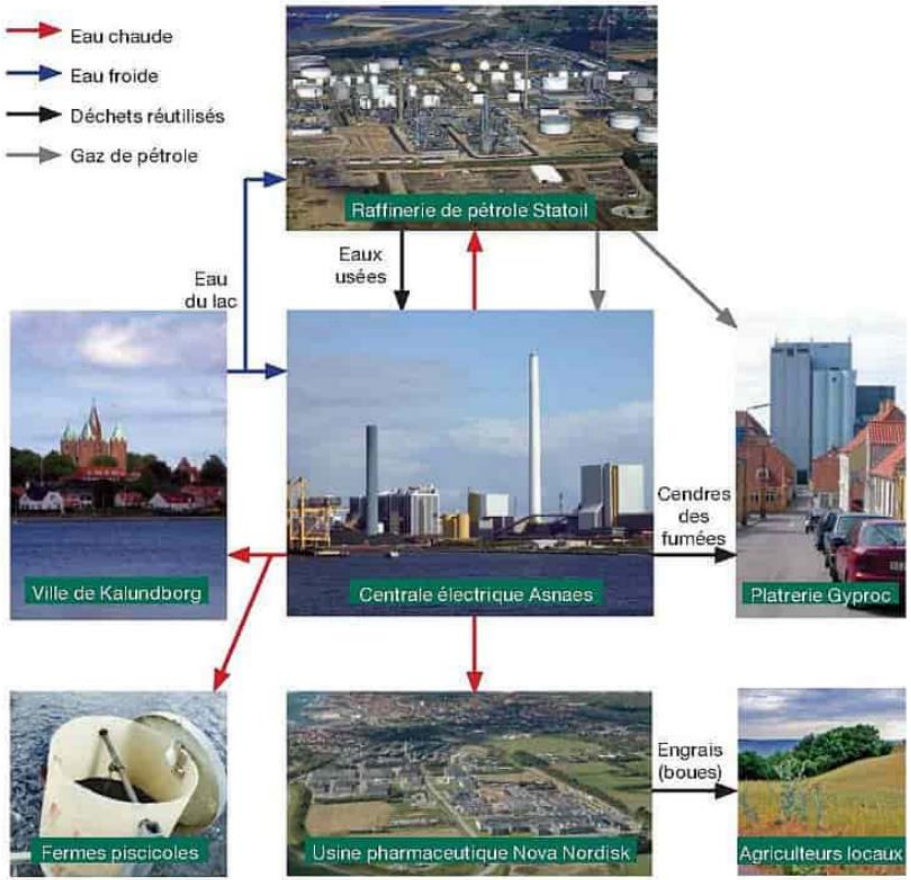
[https://commons.wikimedia.org/wiki/File:Denmark_physical_map.svg]

Kalundborg

Eco-Industrial park website:

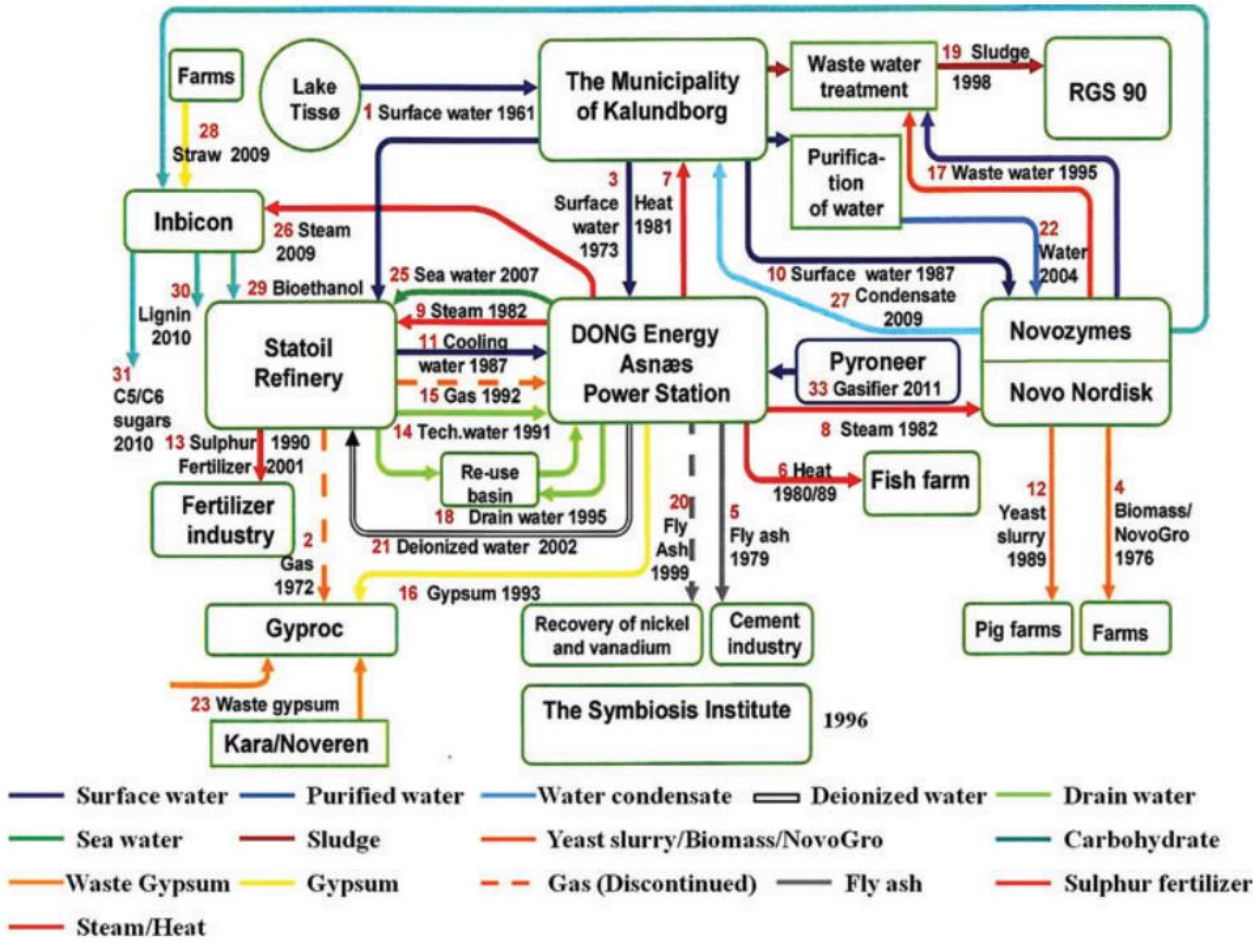
www.symbiosis.dk/wp-content/uploads/2022/01/sitemap_1920x1080_uk.mp4

[www.symbiosis.dk/en/partnerne-bag]



Exemple d'économie circulaire à l'éco-parc de Kalundborg au Danemark.http://lewebpedagogique.com

[Royer M. (2017) « Limites technologiques de l'économie circulaire », In « Le développement durable à découvert », Chap. IV-19]



[Chertow M. & Ehrenfeld J. (2012) « Organizing Self-Organizing Systems – Toward a Theory of Industrial Symbiosis », J. Industrial Ecology 16(1):13-27]

History of Kalundborg

1959 : Asnaes power station commissioned

1961 : Statoil refinery commissioned; water piped from Lake Tissa

1972 : Gyproc A / S built; gas piped from Statoil
1973 : Asnaes expands; draws water from pipeline

1976 : Novo Nordisk begins shipping sludge to farmers

1979 : Asnaes begins to sell fly ash to cement producers

1981 : Asnaes produces heat for Kalundborg Kommune
1982 : Asnaes delivers steam to Statoil and Novo Nordisk

1987 : Statoil pipes cooling water to Asnaes

1989 : Novo Nordisk switches from Lake Tissa to wells
1990 : Statoil sells molten sulfur to Kemira in Jutland
1991 : Statoil sends treated waste water to Asnaes for utility use
1992 : Statoil sends desulfirized waste gas to Asnaes
1993 : Asnaes supplies gypsum to Gyproc

[Ehrenfeld J. & Gerder N. (1997) « Industrial Ecology in Practice – The Evolution of Interdependence at Kalundborg », Table 1, J. Industrial Ecology 1(1):67-79]

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- La suite de l'histoire : [Vincent F., 2015, « Symbioses industrielles et parcs éco-industriels : la symbiose de Kalundborg », MOOC UVED « Economie circulaire et innovation », www.uved.fr/fiche/parcours/economie-circulaire-et-innovation/9#sequence / https://youtu.be/39nbiVcGdNc]

[?]

Kalundborg : Keys to success

- Eco-industrial park organically designed = bottom-up approach to save money by buying other people's waste
- No deliberate institutional mechanisms
- Instead, inter-company trust
  (But brokers and planning agencies can create these business-to-business links)
- Each link was created by seeking economic benefits, i.e. the right thing for the environment was obtained for economic reasons
  - Profitable symbiosis if (waste management supplier costs) + (customer costs of buying a new one)

    >

    (Supplier and customer costs of processing by-products)
- Technical needs for a symbiosis:
  - *Geographical proximity* (otherwise transport costs and energy loss)
  - Seems to work better when there is a lot of waste

[Ehrenfeld J. & Gerder N. (1997) « Industrial Ecology in Practice – The Evolution of Interdependence at Kalundborg », Table 1, J. Industrial Ecology 1(1):67-79]

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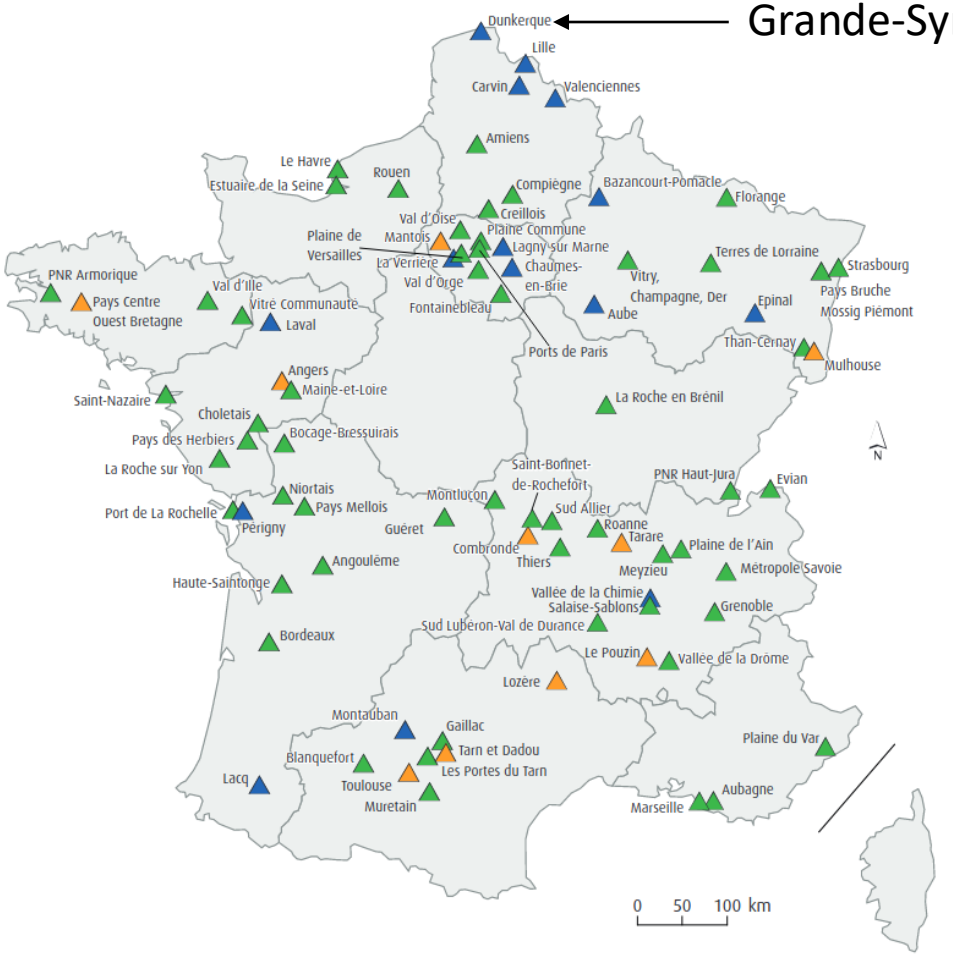
Projets d'écologie industrielle et territoriale répertoriés

Grande-Synthe: the most known in France



[C. Magnier *et al.* (2017) « 10 indicateurs clés pour le suivi de l'économie circulaire », https://www.statistiques.developpement-durable.gouv.fr/sites/default/files/2018-10/datalab-18-economie-circulaire-edition-2017-c.pdf]

Sources : *Orée, Le recueil des démarches d'écologie industrielle et territoriale, mars 2016. Traitements : SOeS, 2016*

Exercise

- *Choose an eco-park from*:

1.	Ecopal à Dunkerque/Grande-Synthe	France
2.	CEIA/Club d'Ecologie Industrielle de l'Aube at Troyes	France
3.	Club des Entreprises du Parc Industriel de la Plaine de l'Ain	France
4.	LISP/Landskrona Industrial Symbiosis Program	Sweden
5.	NISP/National Industrial Symbiosis Progamme	UK
6.	AGUM/Inter-Industrial Materials Flow Management Rhine-Neckar Experience	Germany

- *Describe your eco-park on the A2*:
  - Perimeter : Size in number of enterprises/employees/km² and sectors of activity
  - Methodology and tools: Sharing information. (Prestéo software)
  - Synergies : Pooling and substitution (use of waste)
  - Results : Profits and difficulties

- When the info is available, *Compare your eco-park to Kalundborg* on the A2

- *Present your A2 orally*

[Maltais-Guibault M. (2011) « L'écologie industrielle au Québec : Identification de pistes pour développer ce modèle d'innovation pour les entreprises », Mémoire de maîtrise, Uni. de Sherbrooke, PQ, Canada & Mémoire de Master, UTT, Troyes, France]