LUNDQUIST COLLEGE OF BUSINESS
University of Oregon

Center for Sustainable Business Practices

Industrial Symbiosis - Kalundborg

ResourceFull Use Workshop, Nov 17, 2011

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Industrial *Ecology*

- The study of material and energy flows in industrial and consumer activities
  - effects of these flows on the environment
  - and influences of *economic, political, regulatory, and social factors* on them

  (White, 1994)
- Tools for process and product evaluation
  - Lifecycle analysis, Materials flow analysis

Industrial *Symbiosis*

- A specific approach to industrial ecology
  - Exploits an ecosystem metaphor for industry

Industrial Symbiosis Defined

- The enlistment of *geographically proximate* facilities in the *physical exchange* of materials, energy, water, and by-products (Chertow, 2000)
  - "waste" to resource (product or process input)

A simple example

Spent brewer's yeast into…

Marmite!

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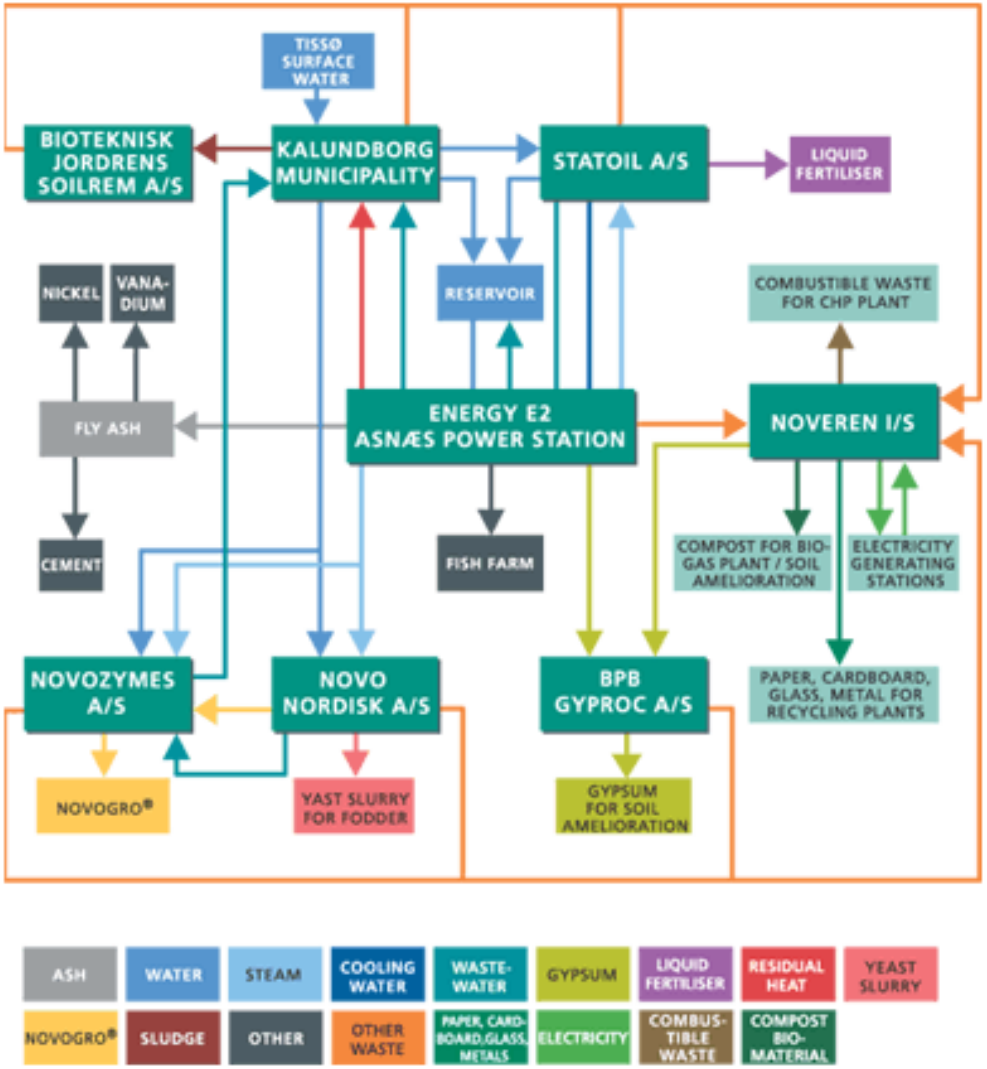
- Berndt Jespersen, Project Advisor, Kalundborg Industrial Symbiosis
- Jorgen Christensen, Advisor to Kalundborg Industrial Symbiosis

Kalundborg Exchanges



- 6 core firms + waste processor & municipality
- 20+ exchanges of by-products

Kalundborg Founding Conditions

- First 'link' in 1961 with surface water diverted from Lake Tisso for Asnaes power plant
- All links there-after
  - Spontaneously developed; bilateral business arrangements
  - Economic considerations first, then environmental
  - ONLY cash flow in system is to waste companies and payment for steam

Asnaes Power Plant (DONG energy)

Statoil Refinery

Lerchenborgvej
Lerchenborg
Asnæs
22
23

Keys to Success

- Awareness, willingness, feasibility
  - In that order!
    - "Starting with feasibility (e.g., mass balance) will never create action" (Berndt)
- Managers must have ownership over ideas
  - Failed to replicate even within Denmark, at 'sister' power plants!
- Those working on IS never had it as their principal roles in company
  - 'left hand' work

FAQs (Jorgen Christensen)

- Don't the companies become too dependent?
  - Has never in practice been a problem
- What kinds of subsidies do you get?
  - Keen interest, but no money (save small funding)
- Were there projects that failed?
  - Yes, dozens – didn't make money (e.g., central refrigeration, central compressed air, potato starch co.)
- Who decides?
  - Companies themselves
- Any other Danish IS?
  - Many attempts, none so far

New Developments

- DONG Energy (Asnaes Power Plant)
  - No longer Denmark's largest power station
  - Wind energy on the rise (also owned by DONG)
    - DK goal of zero fossil fuel combustion by 2050
  - New bioethanol demonstration project uses wheat straw + enzymes from Novo

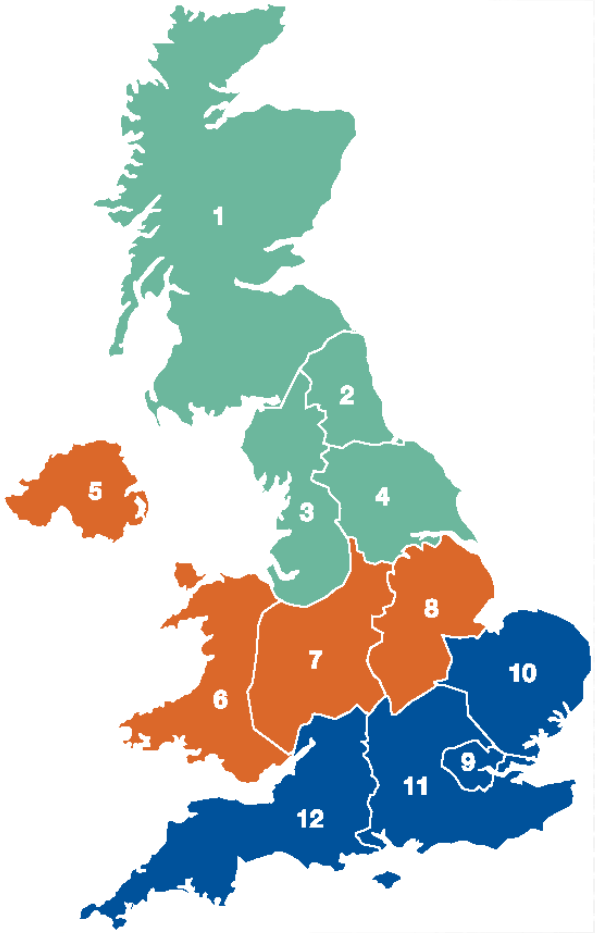
Are Berndt & Jorgen Worried?

- No!
- Steam (from Asnaes) can be sourced elsewhere
  - New fish oil (omega 3) plant built own steam plant
  - Novozymes plans a biodigester that could supply steam and heating
- The future is in microalgae…
  - Developing pilot reactor to grow microalgae
    - 2% of world's biomass is in microalgae, but produce 50% of world's biogas!
- AND – starting to facilitate IS in other regions!

Facilitated Industrial Symbiosis: UK National Industrial Symbiosis Programme

12 regions since 2005

Regional teams facilitate development of IS exchanges



Thank you!