ENVIRONMENT POLICY STATEMENT: 09/04

INDUSTRIAL ECOLOGY

Institution of MECHANICAL ENGINEERS

Long-term global economic growth is fuelling consumerist behaviours at an unprecedented scale. Add to this the continued increase in world population and it is clear that the growth in our collective demand for manufactured goods shows no signs of abatement[1]. If we are to continue to enjoy the benefits and pleasures of material goods on this scale, we must rethink the way we use Earth's material resources. It's time to adopt industrial ecology.

What is industrial ecology? Industrial ecology is the application of the principles of our natural environment to industrial processes. Natural ecosystems are often characterised by how little waste they produce and the many mutually beneficial relationships that exist within them. Applied to a human context, these principles can guide the way we plan our industrial and economic activity to ensure we are as efficient as we possibly can be.

Why do we need to adopt it? With established industrial processes and practices, only between 1 and 10% of the materials we mine or grow end up in the products we buy[2]; the rest contributes to our ever growing streams of waste. At the same time, known reserves of some critical material resources are becoming increasingly scarce. Measures have been introduced to attempt to minimise the environmental impact of our linear patterns of production and consumption. Whilst worthy exercises, such approaches do little to tackle the root cause of our waste. Only by adopting a radically different approach can humans hope to continue to enjoy the benefits of modern civilisation and flourish in harmony with the planet's ability to support us.

How would we go about implementing it? Adopting industrial ecology would require a complete rethink of the way we work as a society. To do so we would need to:

- Review the provision of information on, and support for, industrial ecology to ensure business support is prioritised to focus primarily on achieving industrial ecology outcomes and benefits rather than simply dealing with the negative environmental outcomes of industrial activity (end of pipe[3] mitigation);
- Revisit the instruments governing our current industrial system, from a whole system perspective to ensure these support the establishment and operation of industrial ecology;
- Educate and train all professionals charged with the responsibility to implement waste, emissions and materials approval legislation and guidance to ensure that policy and regulation enabling industrial ecology are implemented consistently.

INDUSTRIAL ECOLOGY

TRADITIONAL PATTERNS OF PRODUCTION AND CONSUMPTION

Traditional patterns of production, consumption and disposal are essentially linear. They involve obtaining usable materials from natural resources, transforming these materials into components which are then assembled into products for distribution, sale or other usage, after which they are disposed of. At every step a proportion of what we started with is lost and more heat, power and water used.

Numerous measures have been introduced in an attempt to minimise the negative environmental impact of production and consumption. Most of these address a particular point in the product lifecycle. In many cases this has the effect of encouraging manufacturers, distributors and users to focus on mitigating the negative symptoms of industrial activity, rather than the root cause. So, even as we focus on improving manufacturing efficiency and reducing emissions as well as increasing reuse and recycling, we are only scratching the surface. As the sheer quantity of goods we demand rises, established manufacturing practices and our efforts to minimise the environmental damage they cause can do no more than dampen the rate at which we deplete natural resources and reduce the earth's capacity to support us.

Whether as engineers, scientists, politicians, economists or business leaders, it is imperative that we rethink our relationship with manufactured goods and the resources we use to produce them. We should no longer behave just as consumers, but as custodians of Earth's material resources. Historically, when obtaining usable material resources required much greater effort, by-products and off-cuts were used imaginatively and goods were put to other uses once they had fulfilled their initial purpose. With advances in knowledge and understanding we should now have both the means and the motive to develop mutually supportive and beneficial industrial systems, borrowing concepts and approaches from nature to derive greater value whilst making fewer demands on diminishing primary resources. To sustain standards of civilisation indefinitely, linear patterns of production and consumption have to be replaced by cyclic systems, in which 'wastes' and by-products of one process become inputs to others. This is called Industrial Symbiosis[4] and the study, creation and management of interdependent industrial processes based on material (and other) resource symbioses is termed Industrial Ecology[5].

IS GOVERNMENT ADDRESSING THE RIGHT PROBLEMS?

Following the Earth Summit in 1992, national and local governments across the world increased their attention on reducing the negative impact of human activity on the environment and adopting and promoting more sustainable practices and technologies. Policies and legislation have followed including, among others, the WEEE directive, End of Life Vehicles Directive, Energy Using Products Directive, increasing land fill tax, reclassification and management of various wastes, emissions legislation, carbon footprinting and eco-labelling.

Whilst these are all well intentioned and individually address issues of actual or potential negative environmental impact of industrial activity, collectively the consequences have led to a focus on doing what we do less badly, rather than finding new and better ways to do things that deliver better overall outcomes. Focusing on minimising the negative environmental outcomes of industrial activity diverts our attention from where the real solutions lie.

Even if population growth could be halted, or even reversed, and emerging economies were denied access to the material benefits of economic growth (both of which being morally unacceptable), this would do no more than defer the time in which we run out of resources or damage our planet beyond its capacity to support human life. Likewise, even if we returned to levels of frugality that would dramatically reduce our use of materials and energy, the ultimate crisis would be merely delayed.

INDUSTRIAL ECOLOGY: A SUSTAINABLE APPROACH

The only long term approach that offers any potential for a highly populated, developed world to live indefinitely is to learn to live on the planets natural revenues and using its natural capital again and again in a cyclic economy of interconnected processes, deriving maximum value and producing no waste – Industrial Ecology.

In natural systems the concept of waste is completely alien: what seems to be waste from one creature or process, becomes an input to another process; natural ecological systems often comprise many species and mutually beneficial interconnected processes or symbiotic relationships. Symbiotic relationships are frequently created between and amongst organisms of vastly different size and lifespan[6]. For example, the Nile crocodile usually eats birds but allows some birds to walk around its mouth, cleaning harmful parasites from the crocodile's teeth whilst removing scraps of food for themselves.

For generations now, scientists have studied natural ecosystems and, recognising the depletion of non-renewable resources, have begun to translate some of these lessons into an industrial context. Industrial Ecology is the development and application of this knowledge or know how to industrial systems based on the mutually beneficial exchange of material resources. Critically, it is a **systems approach** that inherently derives the maximum value from material and energy resources, where the operation of each participant or process is improved through its relationship with others. Crucially, it offers the possibility of decoupling GDP from environmental damage[7], enabling a new paradigm for industries and allowing individuals to enjoy the material pleasures of modern civilisation whilst halting our erosion of, and potentially restoration, natural capital.

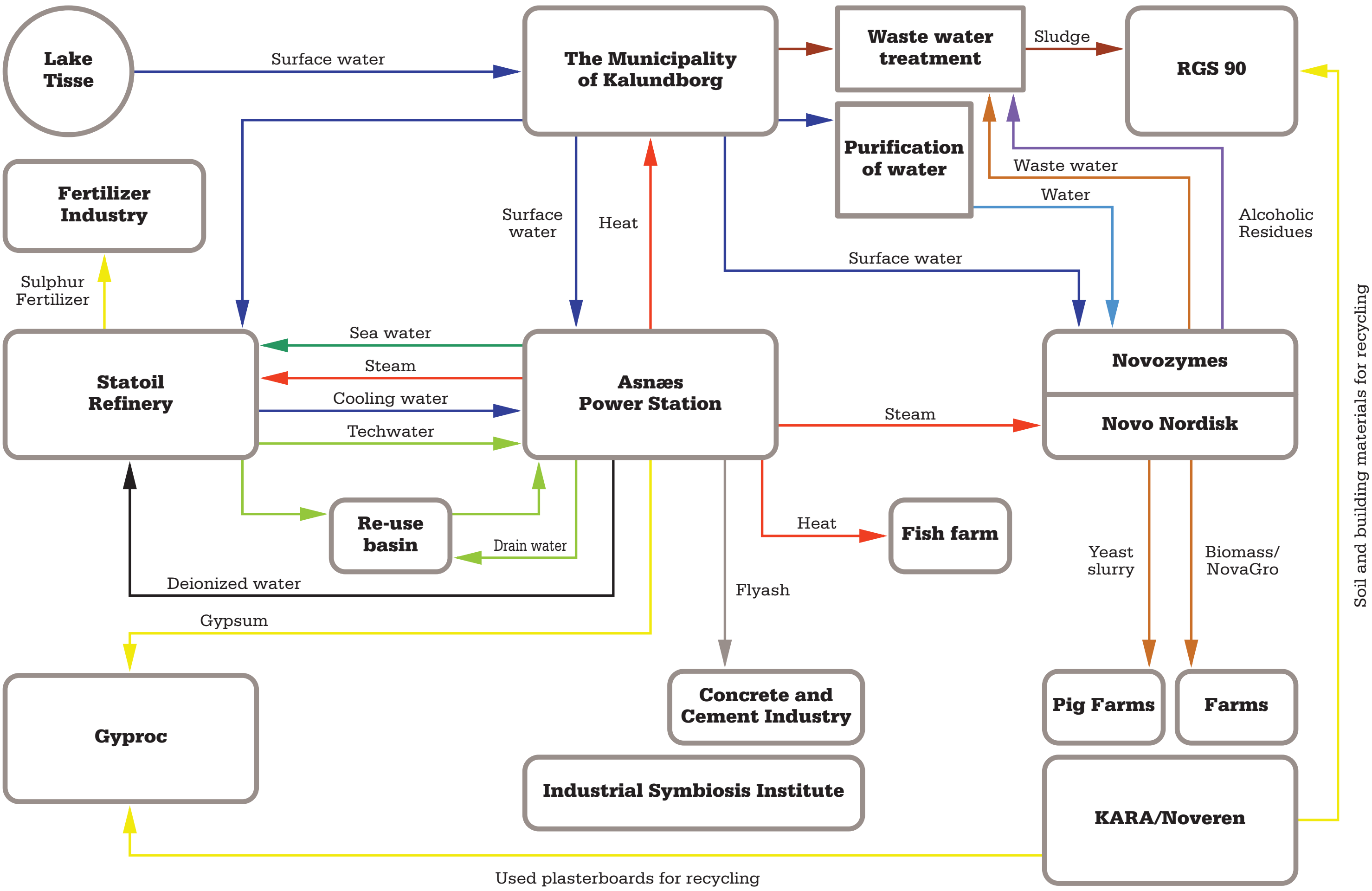
FOCUSING ON THE SOLUTION

One of the most well known and frequently cited examples of successful Industrial Ecology exists in Kalundborg, Denmark. In a process similar to natural systems, Kalundborg was not planned, but rather it evolved organically, with participants deriving benefits from the exchanges of material and energy resources[8]. Participating organisations include a power plant, oil refinery, pharmaceuticals manufacturer, cement factory, plasterboard manufacturer, a fish farm and the city of Kalundborg[9]. As shown in the box 1, the system at Kalundborg results in almost no waste. By developing and adopting more sustainable process technologies, creating mutually beneficial relationships of resource and energy exchanges as well as designing for eventual decommissioning, recovery and reuse, Kalundborg shows us how its done. The result: an extremely efficient closed-loop system approach to the way we use our natural resources.

Over the last fifteen years, attempts have been made in Europe, North America and Asia, to recreate the conditions and characteristics of Kalundborg with limited success. The design and implementation of such systems is a complex task spanning engineering and technology, management theory, business systems, economics and sociology and psychology. There are also many practical and contextual issues that constrain or distort the successful institution and operation of industrial ecology systems. Examples of these are:

- Barriers to co-location;
- Information on potential customers / suppliers of residuals;
- Uncertainty regarding regulatory changes affecting economic value of residuals;
- Competition and anti-trust legislation;
- Feed-in tariffs for electricity, ROCs etc;
- Carbon Reduction Commitments and their implementation;
- Metrics used as proxies for sustainability such as carbon footprint.

In spite of its evolutionary history the Kalundborg cluster has encountered and addressed many of these issues and thus still provides a rich pool of experience that planners and implementers of Industrial Ecology systems can draw upon.



Source: www.symbiosis.dk/industrial-symbiosis.aspx

CREATING THE RIGHT ENVIRONMENT

Since the Industrial Ecology paradigm is the logical approach to combining the benefits of modern civilisation whilst protecting natural capital, every effort should be made to create a favourable physical, commercial and regulatory context. To achieve this transformation, we need the skills and knowledge of engineers and scientists to develop better processes for transforming, shaping and assembling products. We also need market transformation and an enabling business, regulatory and policy context to encourage and support the formation and operation of companies and networks according to Industrial Ecology principles.

This requires a comprehensive review of all aspects of current thinking from this new systems perspective, to ensure that policies, regulations, legislative frameworks, fiscal conditions, business support, research, training, etc. act together to enable and reward industries and other actors adopting Industrial Ecology.

Companies' sustainability credentials are under increasing scrutiny. At the same time, the cost and security of energy supply and some material resources are uncertain. These market pressures provide a fertile climate for shifting to an industrial ecology paradigm.

For the UK, creating a fertile business environment for Industrial Ecology could mean becoming a location of choice for companies seeking a different, better way to do business – in turn improving their corporate credentials and enhancing competitiveness. Additionally, developing expertise in all aspects of Industrial Ecology, will itself be a valuable asset and contributor to UK's knowledge economy.

UK NATIONAL INDUSTRIAL SYMBIOSIS PROGRAMME

Since its inception in 2005, UK NISP[10] has brought together companies from all business sectors with the aim of improving cross industry resource efficiency. It has focused on facilitating residuals transactions of waste heat and power and of material resources that would otherwise probably have gone to landfill. So far NISP has diverted over 4.6 million tonnes[11] of industrial waste from landfill and reduced carbon emissions by over 4.7 million tonnes . NISP continues to build a growing database of members and material profiles and is working with government departments and regulators (DEFRA, EA) to address many of the barriers to resource exchange, most notably in terms of revision of waste protocols, for example enabling potentially useful wastes or by-products to be reclassified as primary materials, thus facilitating the sale, transport and use of those resources.

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FOCUSING ON MINIMISING THE NEGATIVE ENVIRONMENTAL OUTCOMES OF INDUSTRIAL ACTIVITY DIVERTS OUR ATTENTION FROM WHERE THE REAL SOLUTIONS LIE.

POLICY RECOMMENDATIONS

Given the urgency and severity of the situation we face, we advocate the introduction of industrial ecology at the earliest possible juncture. To do so, the UK would need to:

- **Review the provision of information on, and support for, industrial ecology** to ensure business support (delivered through NISP, Carbon Trust, MAS, WRAP, Envirowise and others) is prioritised to focus primarily on achieving industrial ecology outcomes and benefits rather than dealing with negative environmental outcomes of industrial activity;
- **Revisit the instruments governing our current industrial system**, including all regulations, policies, procedures, fiscal treatment, metrics and targets relevant to participants in industrial ecology systems, from a whole system perspective to ensure these support their establishment and operation;
- **Educate and train** all public and private sector professionals charged with the responsibility to implement waste, emissions and materials approval legislation and guidance to ensure that policy enables industrial ecology are implemented consistently. We also encourage Government to introduce a referral mechanism for areas of uncertainty to provide definitive guidance and identify perverse or contradictory circumstances.

REFERENCES

1 Limits to Growth: the 30-year update, Meadows, D., Raeders, J., & Meadows, D. (2005).

2 Natural Capitalism, Paul Hawken, Amory B Lovins, L Hunter Lovins, Earthscan Publications Ltd. ISBN 1-85383-763-6 p14–15 (and ref 16)

3 Process outflows such as atmospheric emissions and waste materials

4 Industrial Symbiosis and Eco-Industrial Development: An Introduction, David Gibbs, Department of Geography, University of Hull (June 2008) www.blackwell-compass.com/subject/geography/article_view?article_id=geco_articles_bpl123

5 Industrial Ecology: Policy Framework and Implementation, Braden R Allenby, Prentice Hall, ISBN 0-13-921180-2

6 Symbiosis – Examples Of Natural Symbioses

7 www.sd-commission.org.uk/presslist.php/18/getting-to-grips-with-consumption

8 Saving include 30% reduction in water consumption by cascading its use and reduction of oil consumption by 20,000 tonnes year (replaced by process steam from power generation), saving 250,000 tonnes CO_2 and 380 tonnes SO_2 annually. For more benefits see www.symbiosis.dk/benefits.aspx

9 www.symbiosis.dk

10 www.nisp.org.uk

11 For more NISP achievements see www.nisp.org.uk/about_us_approach.aspx

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