Port cities and Industrial Ecology

by Kate Royston

Ports and cities are major hot spots for industrial activity, metabolising vast flows of resources in, through and out of the area. This brings not only economic wealth but growing environmental challenges such as congestion, waste and emissions. These challenges are set to intensify as the cost of resources increase and their availability diminishes. However there is good news. There are growing opportunities to transform the ecology of industrial centres through optimising resource use and reducing carbon impact through co-operation, collaboration and exploiting new technologies. In fact ports and cities have an opportunity to be drivers for change and become models for sustainable industrialisation.

This was Suren Erkman’s message in his key note speech during the opening session of AIVP’s 2012 conference – The Port’s New Era. This isn’t just a pipe dream. There are growing numbers of ports and cities embracing collaborative approaches and new technology to rejuvenate and transform their economies for the future. AIVP considers this as an important development in port and urban planning to be embraced. Hence a platform was provided and international research (by M-Atome and Ecole des Mines d’Alès) is being supported.

Introduction to Industrial ecology and Ports

Industrial ecology examines the way in which industrial systems can mimic natural systems, and in so doing reduce their impact on, and increase their harmony with, the natural environment. In natural systems materials are part of closed cycles or circular systems. Industrial ecology seeks to
take a systematic approach to the “management of materials and energy flows through the human economy, including beneficial use of waste”.

Understanding the materials, energy, water and other resources being consumed to produce products and services is an important start point for systematically looking at how the industrial systems and processes can be re-designed, costs reduced and new opportunities grasped. Importantly this will also support pro-active management of the risks and vulnerabilities we face from reducing resource availability.

Industrial Ecology Thinking
Suren Erkman identified four important approaches for industrial ecology in his presentation which can benefit port/city industries, their environment and economies.

Circularising. More than just recycling, much can be gained by seeking ways to re-use resources as many times as possible. This might be, for example, through product end of life disassembly and component re-use; through sharing residual resource flows between one business and another such as pipelines for steam; or through exchange of by-products such as surplus CO2 supporting horticultural businesses (see OCAP).

De-toxification. Products and services can be redesigned to reduce harmful components within production processes and end products, reducing environmental and health impacts, reducing risk and leading to new ‘Green Chemistry’.

De-materialisation. Decoupling economic activity from resource use i.e. producing more with less. Examples include reducing product size through granulation or concentration; or using recycled materials. The development of Product Service Systems – selling performance rather than the product – could be a business model of the future. For example a seller of ‘heat’ to a specified service level rather than a ‘heating system’ is incentivised to ensure that the heat is produced as efficiently as possible.

De-carbonisation. Seeking ways to decouple energy use from fossil fuel sources. An example might be development of a district heating and cooling system such as the Geneva-Lake-Nations project using water from Lake Geneva to air condition and heat the offices of many international organisations.

The Geneva-Lake-Nations project Source: SIG

Research Projects and Practical Examples
From the work in Kalundborg (Denmark), where inter-firm co-operation began in the early 1980s, a growing body of research and practical projects have developed across the world.

China provides a valuable case study where developments towards a circular economy have been supported by leading edge government legislation. This involves multi-scale efforts from
promotion of cleaner production at the individual firm level to a more circular society (see diagram).

**Multi-scale efforts to promote circular economy**

![Diagram of circular economy](image)

Source: Professor Lei Shi

Professor Lei Shi from Tsinghua University explained to AIVP delegates how the rapid increase in China’s industrial development has put pressure on twenty-five of China’s portal cities. These have developed into large industrial bases and the accompanying resource and environmental burdens have highlighted the need for more sustainable approaches. “It has been recognised that enhanced performance can be achieved in the management of environmental and resource issues, where communities of manufacturing and service businesses are located together”.

There are **four key strategies**: **industrial clustering** through enterprise recruitment, **waste and/or by-products exchanging**, **utility networking and infrastructure sharing**; and experimental pilots for **urban mining**.

Examples of **industrial clustering** include the Tianjin Binhai New Area with an important electronics cluster and Ningbo with a chemicals cluster. Clusters are also evident elsewhere. In Zeeland Seaports Dow Chemicals is at the centre of Valuepark Terneuzen*, a centre for chemical production and distribution. Dow actively seeks new businesses which can benefit from its by-products, expertise and facilities and support its supply chain. This brings local benefit and reduces risk for the businesses involved.

Industrial clustering is an important element of spatial planning across many port areas including Rotterdam, Amsterdam and Moerdijk. It enables businesses with compatible land use requirements to flourish within designated areas, reduces potential land use conflicts and supports co-operation and collaboration.

**Residual resource (or waste) exchange networks** are vital in supporting the circular economy. A very large project is underway in China’s Tianjin Binhai Economic Development Area (TEDA). Businesses are being supported in getting to know potential exchange partners and developing synergies through knowledge exchange as part of the EU Switch-Asia Project†.
An example from TEDA is the development of a polystyrene industrial chain. A company able to use waste polystyrene (known locally as the ‘white pollution’) as a material to manufacture insulation products for construction has been introduced to Foqiang, a company able to collect and transport waste polystyrene.

Across Europe, resource exchange networks are in various stages of development. Kalundborg may be the earliest (see figure). There are many examples across Dutch port areas, including OCAP (see below) and several developments are underway in France. In the UK the National Industrial Symbiosis Platform\textsuperscript{vii} (NISP) has supported the development of waste exchange between businesses in the UK since 2005. Their work has led to changed business practice, new opportunities and significant diversion of waste from landfill.

**OCAP – Organic Assimilation of CO\textsubscript{2} by plants**

Organic CO\textsubscript{2} for Assimilation of Plants (OCAP) is a JV between Linde Gas Benelux and Volker Vessels supplying CO\textsubscript{2} to 500 horticultural businesses over an area of 1300 hectares via a dedicated pipeline. The project took ten years to come to fruition but is now successfully supplying 160 tonnes of CO\textsubscript{2} per hour to the glasshouse complexes yielding annual savings of 95 million m\textsuperscript{3} in natural gas consumption and 170,000 tons in emissions. The CO\textsubscript{2} is a by-product of Shell Pernis’ production processes. Further regional CO\textsubscript{2} providers are expected to join the network.

Work on the CO\textsubscript{2} distribution network

Utility networking and infrastructure sharing.
Significant gains can be achieved where utility networks and infrastructure can be shared between businesses. In China, Zhuhai Port is an example where retro-fitting a shared steam network has enabled the replacement of 36 boilers in 18 companies, saving 582 tonnes of fuel oil per hour and reducing SO₂ emissions by 22,000 tons annually.

In Rotterdam, Stedin (an energy infrastructure company) is working with the businesses and the port authority to retro-fit a multi-utility pipeline in the Botlek area of the port. AVR, a waste to energy plant with excess steam, will be supplying into the network. With an initial customer now on board (EKC – an industrial chemicals company) the Botlek steam loop is expected to be operational in Q1, 2013. Potential savings include 200-400 ktons of CO₂ per annum and 180 ktons of NOx.

Similar networks are being installed across the Moerdijk port area in the Netherlands; and a feasibility study is underway at Zeeland Seaports supported through the EU PATCH project.

These investments can reduce costs and environmental impact, stabilise supplies and improve the attractiveness of a port industrial area offering ‘plug and play infrastructure’.

It can be much simpler and less expensive to plan in the potential for shared infrastructure and utilities at the beginning of a new development. Whilst this should be an important consideration in any new project it requires new ways of thinking about development and the ‘service offer’ to potential occupants.

**Experimental pilots for urban mining.**

Our urban environments are full of surplus, increasingly scarce resources with significant value. Technologies and processes are being developed to enable these to be recovered, paving the way for new businesses as pilots are scaled up. There are 22 pilots in place in China. In Qingdao there is a facility able to recycle 20 million units of end-of-life TVs, fridges, washing machines, air conditioning units and computers. All the valuable and recyclable components are extracted for reprocessing e.g. metals, plastics and refrigerant gases. The residues are safely disposed of.

In Europe Sims Metals facility located on Newport Docks in Wales includes one of the world’s most technologically advanced electrical and electronics waste reprocessing units (see picture). Phosphorus is an increasingly scarce but vital resource for the future which can be recoverable from bio-wastes. The Greenmills bio-refinery at the Port of Amsterdam is supplying recovered phosphorus to a neighbouring ICI Fertilisers facility.
Collaboration and long term development

Collaboration and co-operation vital to the success of industrial ecology will evolve and mature over time. An element of all of the strategies mentioned above may be relevant across a particular port city industrial area or, for example, an Eco-Industrial Park (EIP).

In Korea the development of EIPs in coastal areas has been part of a national programme since 2005. Linkages have been actively encouraged between businesses across five parks. Best practice is now being shared with a further eight parks and plans are underway to develop a further two to three parks built upon IE principles from the bottom up.

The well developed relationships and exchanges in Kalundborg, Denmark continue to evolve today (see picture). Relationships between the different enterprises have matured over the 40 years of developing co-operation and mutual benefits embedded within their operations (approx $250m savings to 2005). Supported by the Kalundborg Institute work is now ongoing to look at the opportunities for optimising water and energy cycles across the area.
In the Netherlands developments spread from the Rotterdam area from the late 1980s have been influential. They have led to many Dutch port areas integrating the concepts of industrial ecology into their strategic and spatial planning. Numerous examples of co-operation are in place or are being developed in the drive to help ‘green’ existing businesses and attract new ‘green’ technologies to complement existing businesses. The port of Moerdijk featured in the last edition of GreenPort. Another example is the developing bio-based economy between Zeeland Seaports and its neighbour the Port of Ghent (http://www.bbeu.org/) also providing welcome diversification from traditional industry and cargoes.

The development of industrial ecology across French port / cities is less well known outside France. It has been in progress at the Port of Marseille-Fos since 2003, the Port of Le Havre since 2006 and the Port of Paris since 2008. The port of Dunkirk is also an important centre with many opportunities identified through resource mapping. In many cases this is sponsored by local government in partnership with port authorities and supported by a growing network of practitioners including EcoPal, Ecole des Mines d’Alès and SOFIES.

In Dunkirk Arcelor Mittal provides residual heat into the cities heat network. Work is ongoing, supported by EcoPal, to identify further industries to supply the network with residual heat.
The developing heat network in Dunkirk

Source: Dalkia

The Cities and Ports of Dunkirk and Ghent are also involved in an innovative European project ACE (Answers to the Carbon Economy). This is exploring practical and economic solutions to support business to business, across business parks and for individual businesses.

How to move forward – mobilising opportunities

Research and practical experience have highlighted a number of important enablers to help move opportunities forward. These include a champion and facilitator, one or more ‘anchor tenants’, a collaborative business organisation such as a business association and ideally a multi-stakeholder forum bringing the businesses together with government and other supporting agencies. An infrastructure for knowledge sharing and information exchange and the availability of technical support to help assess the viability of exchanges are also important. Of paramount importance is an economic business case.

Major barriers include a low level of social interchange between businesses and stakeholders, a lack of trust, a poor business case or technical constraints.

Eamonn O'Reilly, Chief Executive, Dublin Port Company “At the AIVP conference I was struck by the “obviousness” of the industrial ecology approach or philosophy which I was hearing for the first time. This is still my view. To date, much of the environmental approach of ports is based on reduction and efficiency. Whilst there is no problem with this, the question is whether this is sufficient or can more be done. Industrial ecology’s focus on reuse provides a more complete approach where, at the industrial level, the consumer mantra of “reduce, reuse, recycle” can be applied. The biggest challenge [for someone like me] is likely to be trying to get an initiative or initiatives going in the area of the port and beyond. This clearly needs the support of Sponsors and/or Champions; and building upon successful case studies from elsewhere”.
A good way of finding out if there is interest across a port estate and surrounding area can be to bring together a few pilot businesses, ideally opinion leaders with resource exchange potential, for an initial workshop or meeting. If this sparks interest and potential opportunities a more structured approach can be developed to engage with a wider group of businesses supported by facilitation and technical support to help progress connections. Regular networking opportunities will be vital for building relationships and trust. Where feasible an area wide resource mapping exercise can be invaluable.

This is not just for big industrialised port cities. Research undertaken in South West England has suggested opportunities exist to better exploit resources across small and medium sized port areas and their vicinities. This might include provision of shared facilities such as waste provision and exchange of resources between organisations. Key is gaining a working knowledge and understanding of the businesses and organisations within the area and sharing information about needs, requirements and residual resources.

**Thomas Marchant, Environmental Officer, Port Nelson Ltd.** “Industrial ecology practice is, as yet, limited at Port Nelson. With large scale fish processors and clusters around marine engineering there is no doubt that there must be opportunities for integrated solutions across companies and industries which could bring benefit to the port and city. The city is developing a sustainability strategy and a number of the challenges identified could be partly addressed with an industrial ecology framework. However there is limited expertise and resource locally to raise awareness, improve the level of social interchange between businesses and stakeholders and enable identification of opportunities. This in itself would require a strong business case.”

Research undertaken by Kate Royston comparing practice in the Netherlands with that in the UK has led to a demonstration project across the Bristol port estate area (see picture). Since its beginning in 2009 over 100 businesses have been brought together to exchange ideas and best practice, and investigate opportunities for further co-operation. The core businesses involved have benefitted from learning from each other and. significant cost savings have been achieved. Through its involvement, for example, Toyota GB at Portbury has been able to achieve zero waste to landfill in 2012; and the businesses recognise that there is a lot more that can be achieved!
Conclusions

Ports and their cities face increasing pressure to find new ways of managing the challenges of intensification, congestion and spiralling resource costs. This also presents a great opportunity to embrace alternative approaches. Industrial ecology is increasingly being demonstrated across the globe as a practical response, ideally suited to port city environments, leading to improved resource effectiveness, reductions in cost and environmental impact, and the emergence of ‘greener’ industry and economic diversification.

To take advantage of these opportunities requires new ways of thinking and acting for business, getting to know each other, building trust and working co-operatively and collaboratively. Getting started may not always be easy. It requires a champion(s), facilitator and willingness for stakeholders to begin a process of positive engagement. Ideally, reaping the benefits also necessitates industrial ecology thinking to be embedded within strategic and spatial planning and new developments. AIVP (see box) believes this offers real opportunity for the future and we encourage you to have a go!

If you would like to know more about this, have any questions or would like support please contact Kate Royston (kate.royston@robbeesmole.com; www.robbeesmole.com).

Jean Pierre Lecomte, AIVP President of the Board: “The Charter of the AIVP for sustainable development of port cities adopted in Sydney in 2006, reaffirmed in 2010 by the Buenos Aires Declaration encourages stakeholders in port cities to innovate and to be exemplary in the implementation of new strategies of sustainable development. As such, it seems to me quite necessary to seek to involve industrial competitiveness, saving resources and preserving the environment and the standard of living of our fellow citizens. Development of industrial ecology and the circular economy in the port cities is a particularly appropriate response to these issues. That is why, within the framework of the world events which we organise, we gave the floor to the experts and actors of circular economy projects in the port cities and actively support initiatives in this way. An example is the international study “Port cities and the circular economy” created by M-Atome and The Ecole des Mines d'Ales (French Institute for Engineering...
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1 Suren Erkman is a Professor at the Institute of Land Use Policies and Human Environment at the University of Lausanne in Switzerland.

ii AIVP (www.aivp.org) brings together urban and port stakeholders in the development of cities and ports as well as their partners.

iii The international study ‘Ports and the Circular Economy’ is authored by Nicolas Mat and Juliette Cerreau of the Ecole de Mines d’Alès. The study has been supported by l’ADEME and AIVP. The report will be available shortly.


vii http://www.nispnetwork.com


ix Working together on sustainable connections, Jacco Rentrop (GreenPort Autumn 2012)

x http://www.sofiesonline.com/index_eng.html

xii Application of Industrial Ecology across Ports Areas: the potential to leverage commercial advantage and support sustainable development in SW England. Kate Royston, 2011

See also: www.ellenmacarthurfoundation.com