

# **JAPAN'S ECO-TOWNS - INDUSTRIAL CLUSTERS OR LOCAL INNOVATION SYSTEMS?**

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## **ABSTRACT**

As part of policies to move towards a more sustainable model of regional industrial development, Japan introduced Eco-towns in 1997. Ten years later, experience is accumulating on how these are applying a systems approach to reducing wastes and energy use, and recycling materials. In 2001, Japan also launched an Industrial Cluster Policy following the international debate on Clusters and Systems of Innovation triggered by Michael Porter's work on clusters in the 1990s. Although Eco-towns are not generally referred to as Clusters, they share the latter's characteristics in requiring thinking in terms of systems and networks between the various parts and players in the system. This paper will thus look at Eco-towns as Industrial Clusters and consider what implications their experience has for the ongoing debate over the value of cluster theory. Since some of METI's Industrial Clusters relate to environmental themes, we can also see to what extent these differ from Eco-towns in the way they apply the systems approach. It appears that Eco-towns exhibit closer correspondence to cluster theory than do Industrial Clusters; but both are better characterized as local Systems of Innovation.

Keywords: eco-town, cluster, sustainable industry, vein industry.

## **PURPOSE OF THE PAPER**

Systems of Innovation have been a recurrent theme of innovation and technology policy in many countries since the 1990s; in particular, one variant (Porter's cluster theory) has attracted much attention with its vision of dynamic, innovative and successful local economies stimulated by linkages and synergies in the cluster "system". Japan joined many other OECD countries which have introduced a cluster policy when the Ministry of Economy Trade and Industry (METI) launched 17 Industrial Cluster Projects in 2001. However, since then an academic debate has intensified over the extent to which Porter's cluster theory is novel and capable of leading to enhanced innovation, competitiveness and economic performance.

A second strand of Japanese policy relevant to the current debate on clusters is the Eco-town policy, launched 10 years ago to create the framework conditions for a recycling industry to develop. Eco-towns represent agglomerations of recycle-oriented businesses aimed at developing a more sustainable industrial model, and thus possess at least some of the characteristics of clusters. With these two policies, Japan's experience may contribute to the broader debate on cluster theory. In this paper, we first summarise the debate on clusters, then describe the two Japanese cluster-relevant policies before discussing what light their experience sheds on this critical area of economic and technology policy.

### SPREAD OF THE CLUSTER MODEL

Porter introduced the concept of industrial clusters as a source of local innovation and competitiveness in his 1990 work on the competitive advantage of nations (Porter, 1990). His definition is (Porter, 1998):

*“ geographic concentrations of interconnected companies, specialised suppliers, service providers, firms in related industries, and associated institutions (for example universities, standard agencies, and trade associations) in particular fields that compete but also cooperate”*. He also points out: *“a cluster is a form of network that occurs within a geographic location, in which the proximity of firms and institutions ensures certain forms of commonality and increases the frequency and impact of interactions”*.

Clusters are said to offer a route to the “third generation” (innovation-driven) economy<sup>1</sup>. Specifically, it is argued that clusters increase productivity and efficiency (Porter 2001) by: *“providing efficient access to specialised inputs, employees, information, institutions and public goods such as training programmes and training institutions; ease of coordination across firms; rapid diffusion of best practice; and ongoing, visible performance comparison and strong incentive to improve versus local rivals”*.

They can stimulate innovation because of: *“better ability to perceive innovation opportunities; presence of multiple suppliers and institutions to assist in knowledge creation; and use of experimentation given locally available resources”*.

They may also facilitate commercialisation because: *“opportunities for new companies and new lines of established business are more apparent; and barriers to entry into cluster related businesses are lower because of available skills, supplies etc.”*.

According to Porter, the cluster mechanisms interact with his competitiveness diamond with its four interrelated influences (Porter, 1998). **Factor inputs** range from basic factors such as natural resources, to advanced factors such as infrastructure and skills. **Firm strategy and rivalry** refers to the rules, incentives and norms governing local competition. **Demand** conditions refer to whether local sophisticated customers provide a challenging and rewarding environment for innovative products. Finally, **related and supporting industries** refer to the connections with supplier or support industries which contribute to productivity and new business formation and innovation. Porter's thesis is that geographical clustering intensifies interactions within the diamond, increases competitive rivalry and knowledge spillovers thus stimulating innovative activity and raising productivity.

As a result of Porter's work, innovation clusters form a key part of policies to stimulate local and regional innovation and competitiveness in many OECD countries (OECD, 1999; OECD, 2001). In Japan, after studying international experience, METI launched its own Industrial Cluster Policy in 2001 with the objectives of improving productivity, spurring innovation, supporting autonomous development and international competition from regional economies, and fostering new business creation (METI, 2005). METI clusters emphasise the creation of links between companies and the local education and research base to carry out cooperative R&D, while providing expertise and finance for supporting innovation, entrepreneurship and venture businesses. A primary focus is to help regional SMEs and venture companies take advantage of research seeds from universities and research institutes, and to increase regional innovation through inter-firm collaboration networks. Priorities can be seen from FY2005's budget of ¥56.8Billion which was allocated to:

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<sup>1</sup> “First generation” was factor-driven in which the cost of inputs was dominant; the “second generation” was where efficiency and competitiveness was driven by substantial capital investment.

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- Industry-academic network formation (¥10.3B);
- Technical Development (¥41.3B);
- Incubator and related facilities for entrepreneurs (¥5.2B); as well as support for
- Market development and collaboration with financial institutions.

Of the 17 National Industrial Cluster projects currently proceeding (METI, 2006a), 4 are focused on environmental technologies (Box 1).

### BOX 1 INDUSTRIAL CLUSTER PROJECTS ON SUSTAINABILITY AND THE ENVIRONMENT

#### **Kyushu Recycle and Environmental Industry Plaza**

This aims to stimulate the local economy by creating new environment and recycling industries. The Cluster Project has created 177 collaborations between companies, 531 projects or commercial products, and 29 new or secondary businesses established. Examples of new products include:

- Dry powder moulding technology to make ceramics (e.g. ceramic tiles) by non-thermal process with the option of utilising waste ash from coal power stations.
- A new soil/irrigation system for reducing costs and improving effectiveness of rooftop gardens.
- A solar powered water aeration system.

#### **Tohoku Industry Promotion Project for a Recycling-oriented Society**

Tohoku's industrial cluster project is focused largely on manufacturing industry but includes a 'sub-cluster' on nonferrous metal recycling as one of its seven themes intended to contribute to a recycling oriented society: currently some 54 projects are under way under this part of the cluster project.

#### **Kansai Environment Business "Green Cluster" Promotion Project**

This project builds on the environment-related companies and universities already active in the Kinki Region. Its network and innovation support activities aim to develop new technologies, products and businesses particularly in technology and equipment to use organic resources and wastes, and in environment purification equipment, sensors and services. Two products/processes developed through the Cluster are:

- A recycling process for Hydrofluoric acid as a result of collaboration between companies.
- A treatment process for waste containing aromatics (developed through industry-university-government collaboration).

#### **Chukoku Cluster on a Recycling-Oriented Society**

The Chugoku region includes many companies in the automobile industry, petrochemical complex, plastic industry, and biological industries; this cluster will encourage further application of existing technologies, know-how, and human resources to recycling, energy, and environment purification innovation. 159 new businesses or products have been created. For example:

- To expand recycling options for glass bottles, a company mixed waste glass with seashells and developed a process to produce a high surface area porous material. This can be used for water purification and rooftop gardening, or as a security ground cover.
- A lake-regeneration, oxygen injection system which prevents dissolution of nutrients and heavy metals from the bottom of dams and lakes.

## CURRENT CRITIQUES OF THE CLUSTER MODEL

Since 2003, a debate among economic geographers has grown on the merits of Porter's cluster concept (Martin and Sunley, 2003; Asheim et al., 2006a). This has been critically dissected and actual outputs (as opposed to postulated effects) evaluated which are relevant to the twin pillars on which Porter's theory is based – the linkages between and the geographical proximity of the firms in the cluster<sup>2</sup>. Summarising this debate in the brief terms necessary for this paper carries with it the danger of oversimplification but, in essence, Porter's definition of clusters is seen as too broad and incoherent a concept

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<sup>2</sup> Firms are linked – e.g. by vertical (buying and selling chains) or by horizontal links (complementary products services, the use of similar inputs, technologies, labour, etc.). These linkages also involve social relationships or networks that are beneficial, so co-location encourages network formation and associated benefits of interaction between firms.

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to cover the variety of types of and reasons for clustering or agglomeration in industries - a phenomenon which was first observed by Marshall many years ago (Marshall, 1919). For instance, Gordon and McCann (2000) cited in Asheim et al. (2006b), see 3 main underlying economic drivers for industries to co-locate:

1. **Marshallian:** The benefits of co-location are primarily via Marshall's mechanisms whereby agglomeration delivers economic benefits from enhanced local skills supplies, cheap local infrastructure, specialized producer support services, and localized knowledge spillovers.
2. **Industrial Complex:** Firms are part of a regionalized or localized outsourcing system designed to generate 'Toyota-style' logistical and transaction costs reductions; these use preferred supplier interactions to enhance productivity and quality.
3. **Learning Networks:** Proximity may also allow local and regional innovation and learning networks to develop involving research institutes, industry associations, and local government, which in turn may deliver economic benefits.

As Asheim et al. (2006a) point out, much debate on the contribution of clusters to productivity and competitiveness has been on the basis of presumption or belief rather than founded on firm evidence of cause and effect. Malmberg and Power (2006) reviewed such evidence as exists on the impacts of clustering, and evaluated 3 hypothetical mechanisms by which clusters may contribute to innovation and competitiveness. They concluded:

Hypothesis 1: "*Knowledge in clusters is created through various forms of local inter-organizational collaborative interaction*". Thus firms that collaborate more on technology with firms and other actors (e.g. universities) should innovate more, firms that meet sophisticated local demand may innovate faster. The evidence suggested this is **not generally a major knowledge-creating mechanism**.

Hypothesis 2: "*Knowledge in clusters is created through increased competition and intensified rivalry*". The **evidence for this was weak** and it appears just as likely that various forms of collaboration will be as effective as rivalry in knowledge creation.

Hypothesis 3: "*Knowledge in clusters is created through spill-over effects following from the local mobility and sociability of individuals*". Here, evidence suggests that informal **knowledge exchanges do seem to occur across groups** of professionals and specialized individuals in clusters.

Academic debate has thus moved back towards the concept of National and Local Innovation Systems being an equally useful if not more useful guiding principle for regional innovation and development (OECD, 1997; Simmie, 2006). In this approach, regions are seen as having unique sets of 'relational assets' and the Region's strategy is to exploit and enhance these in order to:

- develop its attractiveness to investment and embed this into local supply chains;
- encourage indigenous SME development by improving links to sources of local knowledge (universities etc.), promoting university-industry links, technology transfer and spin-outs, as well as helping to improve the skills and capacities of small companies to develop innovative ideas;
- overcome systemic barriers to innovation from market failures (information, regulations, finance, etc.).

There is much common ground on many of the desirable attributes of both 'clusters' and 'innovation systems' – for example the importance of networks between firms and with sources of knowledge such as universities- so there are few objective tests which allow differentiation between the two concepts. However, Porter's cluster model places more emphasis on competition and markets driving the speed and direction of

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innovation within the specific cluster; the Innovation Systems approach places a greater emphasis on the role of national and local government in creating favourable background conditions in which firms can improve their innovation and competitiveness (see for example DTI (2003): p21).

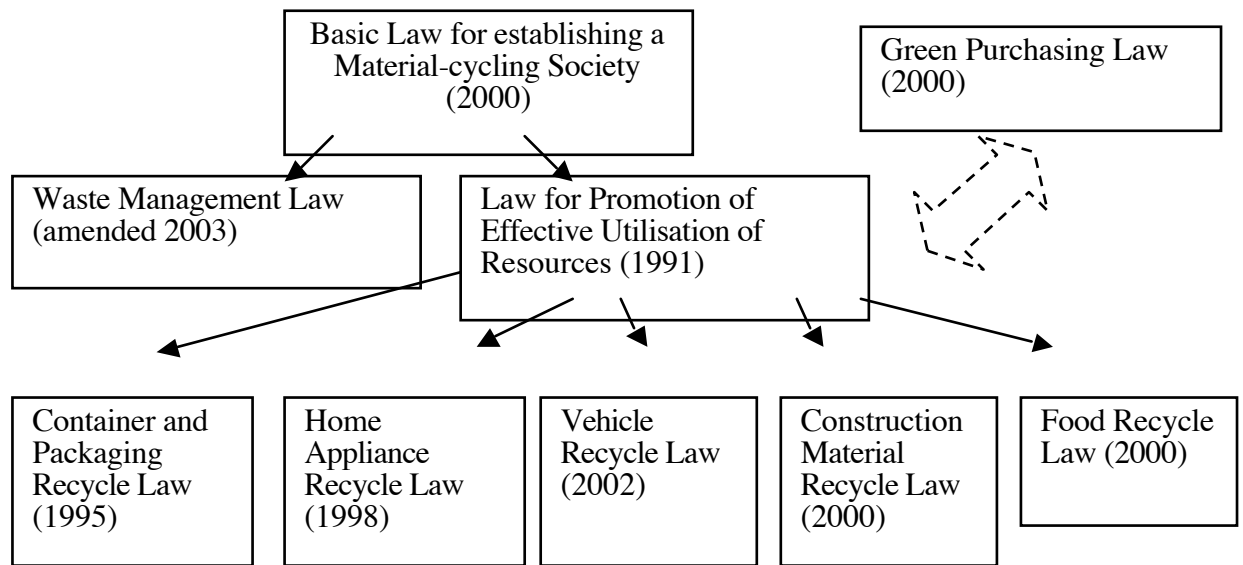
### BACKGROUND TO ECO-TOWNS

The material flow in traditional industrial processes, using raw materials and energy, can be likened to the arteries in the body which carry fresh materials (oxygen, sugars, etc) for consumption. The recycling industry can then be likened to the veins which return with waste products to be processed into substances which the body can re-use. In order to reduce the global environmental impact of product manufacturing and consumption, it is argued that these flows should (as is the case of the body) be more in balance. However, there are many market barriers to the spontaneous development of such a 'vein' industry. Raw material prices fail to reflect externalities such as future scarcity and the environmental impacts of extraction; traditional industries are still able to externalise many environmental costs (especially those related to greenhouse gas emissions). Meanwhile, the recycling industry is beset by barriers such as search and transaction costs, information failures etc. (OECD, 2007), so that a vein industry cannot develop through market forces alone. Governments address these market failures through legislation and regulation to some extent (e.g. laws requiring safe disposal, landfill taxes, recycling targets), but the Eco-town initiative takes more of a *systems* approach by using regulatory and financial tools in a coordinated way to create a more favourable environment within which a vein industry can develop (Norton and Higuchi, 2007). It does this by influencing both supply of raw materials (wastes) and markets for the products, and by also stimulating the necessary infrastructure investment and mobilising local initiative. The policy also integrates two separate strands of policy - the environmental strand focuses on resource conservation and emissions reduction, while the economic strand seeks to stimulate local economies and support the development of technology and businesses with a competitive advantage in global recycling markets (Higuchi, 2005).

The current regulatory system, summarised in Figure 1, provides a legal framework for creating a *supply* of materials for recycling. Eco-towns are part of the administrative and entrepreneurial system designed to effectively *utilise* this supply. Driving the system are government targets (GOJ, 2003) for 2010 to:

- halve the amount of waste disposed to landfill from 56mtons in 2000 to 28mtons:
- increased the cyclical use rate from 10% in 2000 to 14%:
- increase Japan's resource productivity from ¥280,000 to ¥390,000/ton by 2010.

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**Figure 1 Legislative Framework for Japan's Recycling-Oriented Society**

The eco-town project was launched via a competition between local administrations offering innovative approaches to developing sustainable industries. The first Eco-towns were decided in 1997, and the programme is now jointly administered by METI and Ministry of Environment (MoE). Designation as an Eco-town provided access to grants (1/3-50%) for both 'hardware' (such as recycling plant), and 'software' in the form of networking, support and promotional organisations. Grants were available up to 2005.

There are now 26 Eco-towns in Japan with a wide range of recycling related facilities. While each has its own focus, the range of activities can be illustrated by looking at two of the first eco-towns- Kitakyushu and Kawasaki.

### Kitakyushu

Kitakyushu's experience has been described by Sueyoshi (2003), GECF (2005) and Norton and Higuchi (2007). Local enthusiasm for developing environmental industries arose from competitive pressures on the local heavy industry to diversify, nearby available reclaimed land, and research expertise on recycling at Fukuoka University. After Eco-town approval was granted in 1997, the eco-town developed in three main areas:

1. **Kitakyushu Academic and Research City** includes the Research Center for Recycling Systems (Fukuoka University) and the University of Kitakyushu, and focuses on teaching and research into natural resources and environmental engineering.
2. **The Practical Research Area** is dedicated to scale-up and development of research ideas on recycling technologies, waste disposal, etc., using Fukuoka University's Institute for Resource Recycling and Environmental Pollution Control facilities. It also houses an Eco-Town Visitor Center to engage local citizens.
3. **Business development Areas.** There are two locations (the Comprehensive Environmental Complex and the Hibiki recycle area) which are allocated to recycling businesses and SME/venture businesses.

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Kitakyushu Eco-town has built up the most extensive range of recycling and environmental industries in Japan covering a wide range of materials and products. Current recycle businesses extend through PET bottles, office equipment, vehicles, fluorescent tubes, medical equipment, construction waste, solvents, paper, food residues, Styrofoam packaging, cans and metals etc. Total investment has been some ¥430 x10<sup>8</sup> (\$390m at ¥110/\$), of which ¥82 x10<sup>8</sup> came from national and ¥56 x10<sup>8</sup> from local public sources.

Aspects relevant to the systems approach include:

- **Supply.** Recycling depends on obtaining sufficient raw material of acceptable quality; this depends greatly on citizens' cooperation in separating waste. At the time of the eco-town's creation, pre-existing collection systems were not capable of delivering the required quantity and quality, and the city of Kitakyushu thus worked with neighbouring local authorities to establish a sufficiently large catchment area to supply Eco-town businesses.
- **Markets.** Although much of the recovered products are of low value (e.g. fuel), where higher added-value markets have potential, the City acts as a green purchaser (e.g. for clothes using PET derived fibre, recycled fluorescent lights).
- **Local Agglomeration.** The Eco-town demonstrates the importance of localisation. The local cement and steel industries allow low grade recycled plastics and other combustibles to be used for fuel locally thus avoiding significant transport costs. A local cluster related to vehicle recycling has developed spontaneously at the Hibiki site, where a group of car disposal companies have formed a Cooperative to provide common services to vehicle recycling businesses. This includes a "Joint Storage and Logistics Center" to store used parts, and a "Cooperative Organization Center" to manage joint tasks – for instance collection and sales/distribution of recovered parts, recovered metals etc. as well as joint research on automobile recycling.
- **Regulatory interaction.** Technology development in the Eco-town has interacted with national regulatory standards in a synergistic manner- for instance a shredder-less recycling process was developed for vehicles avoiding the associated air pollution problems of standard recycling processes. This allowed METI to incorporate this knowledge into a revision in the Auto recycle law then being drafted to set tougher standards for more efficient recycle (Sueyoshi, 2003).
- **Process innovation.** Process development (learning by doing) in office equipment disassembly has increased the recycle rate to 96% and halved the time needed to recycle each machine. High-quality recycled plastics are returned to the manufacturer to make new equipment, while low quality plastics are sent for fuel. Experience in disassembly allows feedback into materials selection and design so that the next generation of equipment can be designed to optimise resource efficiency over the whole life cycle.

### Kawasaki

Kawasaki also received its status as Eco-town in 1997 but put its initial focus on 'zero emissions' whereby companies use wastes and by-products from one industry as useful resources in another (Kato, 2006; KCEIRS, 2004). The first stage of the Kawasaki eco-town project (led by 15 companies which formed the "Zero Emissions Industrial Complex Association") focused firstly on action to reduce or eliminate emissions **within** each company, and secondly on cooperation **between** companies so that remaining wastes could be used or treated by others. This was soon followed by more general R&D towards a sustainable local economy, energy conservation and reuse by neighbouring areas, and investments in new recycle-oriented businesses. Since

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Kawasaki is the 9<sup>th</sup> largest city in Japan with many international connections, the project had the objective from the outset of becoming an international centre of expertise on sustainable industry and a source of technology to other countries. To date, grants have totalled around ¥250x10<sup>8</sup> for investment into recycling plant and necessary support organisations (GECF, 2005).

In addition to standard recycling businesses for cans, home appliances and fluorescent tubes, the eco-town has developed locally innovative solutions-these include: waste plastics processed into a coke substitute for blast furnaces, used in ammonia manufacture or to make boards for the construction industry; a waste paper recycle plant which is able to handle difficult-to-recycle waste paper, with residual metals and sludge recycled; plant which can recycle PET bottles into new PET bottles; and a process for metals recycling into stainless steel manufacture.

In terms of Kawasaki eco-town's properties as a system, the following points are worthy of mention:

- **Networks.** The Eco-town is supported by the 'Liaison Centre for Creation of Industry and Environment' – a City-supported network comprising university researchers, research Institutes, and over 70 companies. The group is working on improving waste heat and electricity recovery among industries and urban areas; redesigning the regulatory system to encourage energy and environmental improvement; and developing a 'Kawasaki eco-efficiency model'.
- **University links.** The eco-town links to Toyo University which maintains a database of wastes and by-products on a Geographical Information System; this is used to provide a matching service, identify possible technology and market opportunities, and model possible new cooperative relationships and their environmental and economic feasibility (Fujita et al., 2004).
- **Integration.** Kawasaki's industry and residential areas are intermixed and the eco-town was very much motivated by the need to introduce greater harmony between these areas. This provided a focus for public engagement and motivating the local population to involve itself in the project<sup>3</sup>.
- **Localisation** allows the use of low-grade waste materials locally in cement manufacture (this includes sewage sludge, waste wood, plastics, tires and oil as substitute for coal, and also incinerator ash and blast furnace slag).
- **Process synergy.** The paper recycling process illustrates synergy with the local authority which upgraded the Kawasaki waste treatment plant to provide the large quantities of water needed.

### Overall Eco-town Economic Viability

During the period when Government subsidies were available (1997 to 2005), over 62 installations have been built which either deal with the goods covered by the various recycling laws in Figure 1, process recyclable domestic wastes, or deal with difficult wastes (METI, 2006b). As of 2005, 29 of these facilities had a combined capacity of 534,000 ton/yr which were running at 85% of notional capacity during 2004. Investment in recycling/disposal facilities up to 2005 (by which time 21 eco-towns had been established) totalled ¥2023 x10<sup>8</sup> (\$1840m at ¥110/\$)<sup>4</sup>. Turnover related to 37 of the businesses totalled ¥521x10<sup>8</sup>/yr of which ¥266 x10<sup>8</sup> was the businesses' own turnover and ¥255 x10<sup>8</sup> triggered in related businesses.

<sup>3</sup> For instance, an environmental education programme in area schools includes an energy monitoring system to allow students to target specific reductions and measure their progress.

<sup>4</sup> Grants from METI totalled ¥345 x10<sup>8</sup>, from local government ¥7 x10<sup>8</sup>, and investment from private businesses ¥403 x10<sup>8</sup>. Other grants were by MoE (for 6 facilities). Spending by other businesses in the Eco-town areas created a further ¥1268 x10<sup>8</sup> investment.



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Ultimately, initial grants are designed to lead to a self-sufficient system where corporate social responsibility, extended producer responsibility (EPR) and the socially responsible investments of banks maintain the development of a locally sustainable recycle-oriented 'vein' industry. Particularly important is to guarantee a stable revenue stream and here the METI survey (METI, 2006b) revealed that while a number of recycle businesses were able to generate most of their income by sales of recycled products (cars, bottles, paper), some were entirely dependent on charging disposal fees (electrical appliances, fluorescent tubes, plastic packaging).

### ECO-TOWNS AS SYSTEMS

In terms of *principle*, eco-towns can be seen as a way of stimulating a more sustainable industrial model (the 'vein' industry). The system 'root definition' might be to overcome the deficiencies in the market which rule out the spontaneous development of such an industry through market forces alone. Because of the market failures mentioned above, the Government has chosen to intervene in the market for social and environmental reasons. In terms of *operations*, the system for recycling can be expressed as in Figure 2. It requires collection and supply of the waste material to be matched with the processing capacity and market for the recycled products, and for the revenue stream to cover the costs of recycling. Critical factors at each stage are summarised in Figure 2.

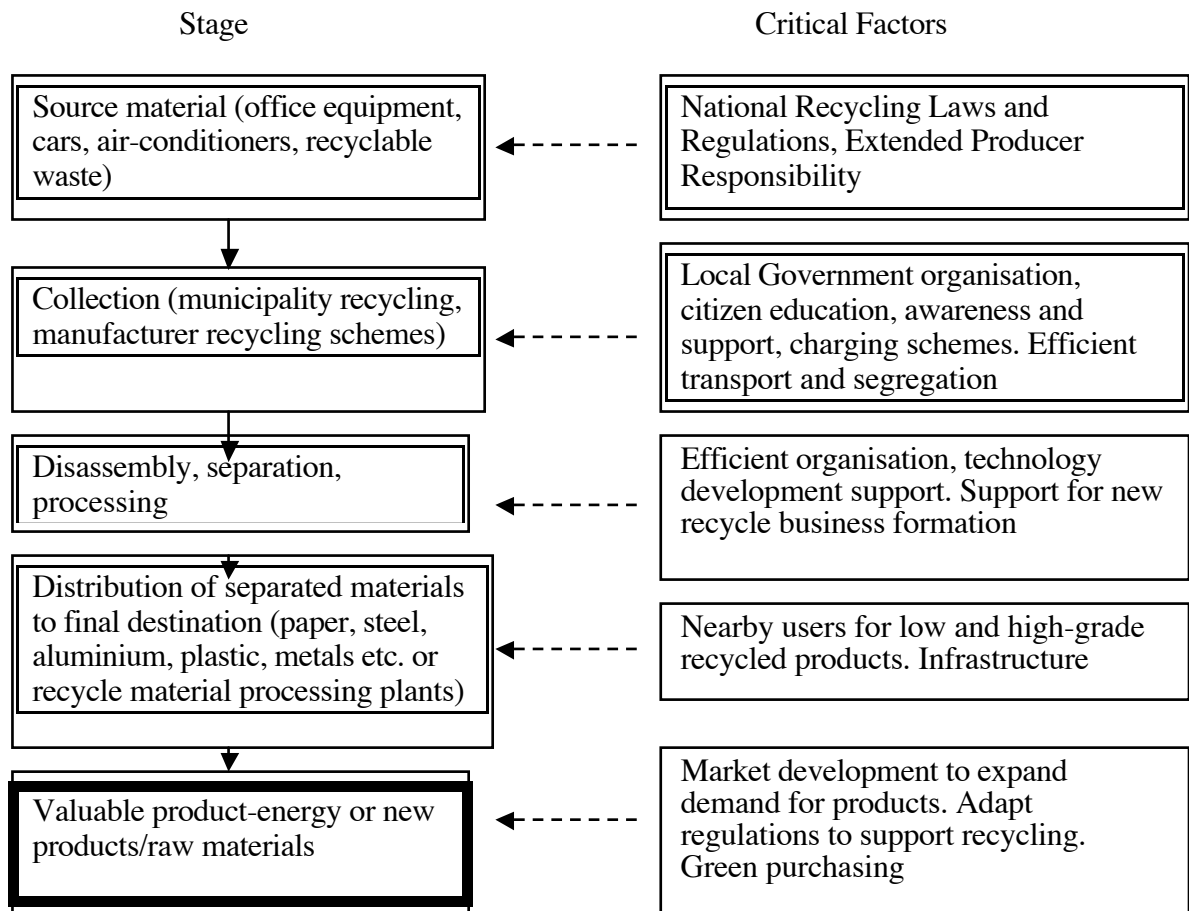
Figure 2 shows the critical role of Government. At the **national** level, Government:

- provides leadership on the need for recycling and creates a comprehensive legal and regulatory structure to support recycling- Japan now has recycling laws or guidance covering 35 categories of waste materials.
- provides grants for hardware and software which allows individual Eco-towns to develop their own versions of sustainable industries and communities.
- supports related basic research and education (e.g. in the examples given above, the Ministry of Education (MEXT) supports research groups at Toyo and Fukuoka Universities linked with Kawasaki and Kitakyushu respectively);
- supports environment-related innovation-oriented Industrial Clusters (METI).
- creates a revenue stream where recycled products cannot do so (e.g. household electric recycling fees).

**Local Government** plays a critical role in:

- ensuring a supply of materials for recycle, development of some markets for products and the essential area of extensive public awareness and engagement.
- in terms of the separate zero emission strategy at Kawasaki, local government also provides mechanisms through which one company can enjoy a symbiotic relationship with another even though they may be competing in their business.

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**Figure 2 Generic System for Recycling (Norton and Higuchi, 2007)**

As described in the previous section, eco-towns have achieved at least provisional viability in logistical and economic terms. However the motive is to stimulate the creation of a 'vein' industry which is viable in the long-term without government subsidy. In this context, a number of difficulties remain to be overcome (Norton and Higuchi, 2007). First is stability of revenues where viability remains highly dependent on disposal fees (and therefore consumer acceptance and cooperation with the fee-based system); raw material supply (many businesses are concerned over the adequacy of both quantity and quality); business environment (businesses report that overall economic performance is mostly more difficult than they expected) and innovation (whether the emphasis on collaboration between manufacturers, retailers and government may stifle innovation to achieve further reductions in recycling costs).

The system is already under some strain because of the export of collected waste<sup>5</sup> to neighbouring countries for cheaper 'recycle' by less technologically advanced and more environmentally damaging methods (Treazono, 2005). The danger of the economic viability of Eco-town recycling facilities being undercut by low-cost 'informal' recycling thus represents a serious systems externality which could threaten the long-term viability of Japan's attempts to develop sustainable industry (eco-towns) based on technologically advanced (and therefore capital-intensive and expensive) recycling

<sup>5</sup> In 2003, 681,000tons of plastics and 1,920,000tons of paper were exported from Japan (Kojima, 2005).

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systems. Recognising this danger, Japan has raised the issue of global trade in waste for recycle under the G8 process (MOE, 2006a) based on a vision of an "East Asia Sound Material Cycle Society". This proposes capacity building in developing countries to handle recycled materials in an environmentally appropriate manner. This could be combined with a regional certification system (Hotta et al., 2006) which would accredit recycling zones which met international standards, and provide a basis for regulating international trade in recyclable materials.

While there is support for the principle internationally that "*Promotion of an adequate recycling industry is considered important for economic development and job creation both for developed and developing countries*" (MOE, 2006b), there is no consensus on rules or restrictions on trade based on the technical adequacy of recycling systems in the recipient country. Many other problems also remain to be overcome, including (Hotta et al., 2006); problems of mis-labelling; harmonisation of definitions of waste and recyclables; export/ import regulation and enforcement; recycle vs second-hand use; trade barriers; and how to apply EPR across borders. Despite overall support internationally through the UN for the principle of more sustainable production and consumption<sup>6</sup>, such considerations do not override trading rules, and initiatives such as Japan's Eco-towns remain vulnerable to low-cost competition based on lower environmental standards and/or less efficient resource recycling.

The increasing demand from China for recyclable materials is having global effects- for instance UK plastic and paper recycling facilities have been unable to match the price paid by Chinese importing companies, and this has already led to plant closures and a growing dependence on export to meet the UK's own targets for recycling rate and reduction of waste for landfill (Corrin, 2006). Such trends reflect the operation of global markets- especially the shift in manufacturing (and therefore demand for raw materials) from the developed to the developing world- but the environmental sustainability of this trend is closely related to the recycling methods used. At present, much recycling makes use of environmentally damaging and labour-intensive 'informal' recycling and leads to accusations that the UK is 'dumping' its waste on developing countries (RICS, 2004). The EU Directive on recycling of Waste Electrical and Electronic Equipment (EU, 2003) requires exporters to prove that the recovery, re-use and/or recycling operation took place under conditions that are equivalent to the requirements within Europe (Article 7), and some argue a similar principle should apply to all waste exports for recycle (RGS, 2006).

Another critical part of the Eco-town 'system' is the public's role in separating domestic waste prior to collection. Costs of recycle processes increase with contamination, so inadequate separation leading to cross-contamination can affect the viability of eco-town businesses. For example, PET bottle recycling is improved where the bottle tops and labels (which are not PET) are removed- this needs a high degree of public awareness and cooperative commitment. In addition, home appliance recycling depends entirely on revenue flows from recycle fees and would be undermined if significant numbers of users sought to avoid paying a recycle fee at the end of a product's life. Public education and mobilisation thus remain critical components of the system.

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<sup>6</sup> The Johannesburg Earth Summit started a 10-Year Programme by the UN to support regional and national initiatives to promote sustainable consumption and production (the Marrakech Process).

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### RELEVANCE TO THE CLUSTER/SYSTEMS OF INNOVATION DEBATE

The current debate over whether clusters or systems of innovation are the more effective policy model for stimulating innovation and competitiveness was summarised above. How do Japan's eco-towns and industrial clusters fit within this debate - are they best viewed as clusters or a local system of innovation?

As described above, Gordon and McCann (2000) postulated three types of clusters. In terms of their first one (Marshallian agglomerations), Eco-towns display many of the features cited. The two examples in this paper rely on proximity to urban areas for sources of waste and proximity to local heavy industry for markets for low-value recycle residues. They rely on common infrastructure (for example separated waste deliveries from public collection services). The Eco-towns provide common services and support in the form of R&D support, public outreach and education, and shared facilities for development and validation. Within particular fields, there are examples of collaborative actions (e.g. storage and resale of car parts, common logistics). These attributes all conform to the Marshallian agglomeration model with its emphasis on access to common resources, raw materials, infrastructure, etc. Examples of constructive cooperation cited by Marshall (1919) also include cooperation to provide technical services, testing and standardisation, supply of raw materials etc. - the type of joint projects which exist in Eco-towns.

Regarding the second category (supply networks), the nature of the industry limits the potential for complex vertical horizontal links to develop; perhaps the most relevant example would be the interaction between the dismantling process in home appliance recycle businesses and the design process for new equipment by the manufacturer. Their third category (local innovation and learning networks) is paralleled in Eco-town networks which bring together government, academic and businesses interests; the benefits of links with universities (e.g. Fukuoka and Toyo) can also be seen. In short, Eco-towns seem to conform mostly to Gordon and McCann's type 1 cluster but also include elements of their other two types.

In contrast, the METI Industrial Clusters appear to be largely type 3- focused on improving local innovation and learning networks involving research institutes and industry, with the assistance of national and local government organisation and financial support in technological and market development.

A second aspect of the cluster debate concerns the three potential mechanisms evaluated by Malmberg and Power (2006). In both cases, Eco-town and Industrial Cluster networks are based on collaboration supported and guided by government, rather than placing emphasis on competition as is seen in Porter's cluster approach. This experience is thus consistent with those authors' conclusion regarding collaboration being as effective as competition in creating knowledge. In terms of knowledge generation, both tacit and codified knowledge can be identified. Efficient recycling of electrical appliances illustrates the importance of tacit knowledge-both in the disassembly process and in recycle-oriented design. On the other hand, some of the Eco-town innovations (e.g. using plastics in ammonia, steel or cement manufacturer) as well as innovations triggered by the METI cluster projects lead to intellectual property-and thus add to codified knowledge.

We conclude therefore that neither Eco-towns nor METI Industrial Clusters are a good fit with Porter's conceptual model of clusters. However it may yet be that his model may provide some useful insights for future development of Eco-towns. Amongst the factors affecting long-term viability listed above, we have already identified the need to address

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the international externalities which may adversely affect demand conditions. This highlights the urgency of the Japanese government's attempt to promote consideration of environmental sustainability into rules on trade in products for recycle. The second aspect mentioned above was the difficulty of maintaining pressure for innovation in the current system which is so heavily based on collaboration. Porter's thinking would suggest a greater role for competition to encourage innovation towards reducing recycling costs, as has been commented on in comparisons with overseas practice (DTI, 2005).

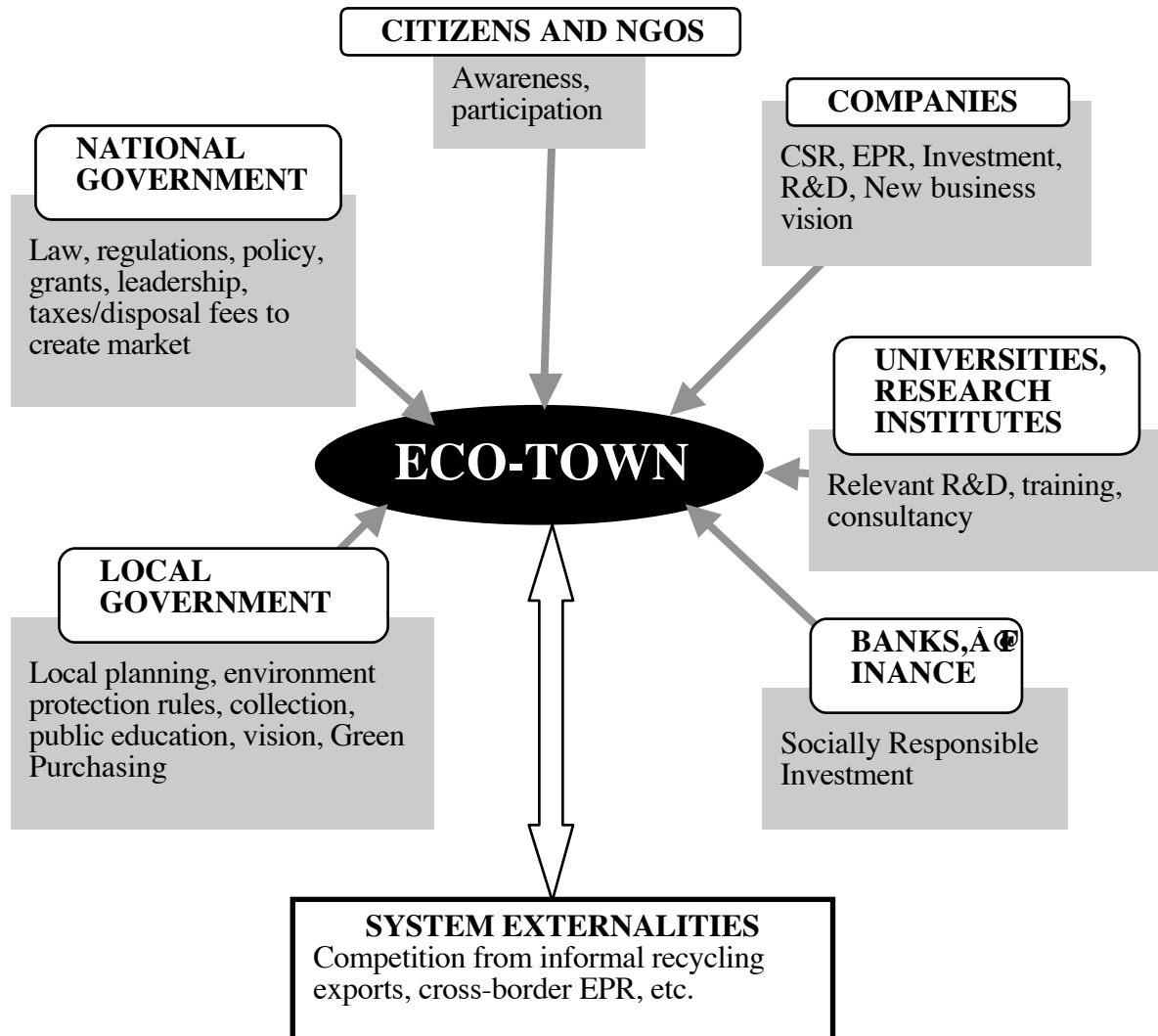
Finally we consider whether eco-towns are better seen as innovation systems. As described earlier, the term 'Systems of Innovation' generally refers to interactions between different elements in the economy that combine to promote innovation. These include firms, infrastructure, and institutions (including laws, regulations, rules and systems of finance, governance and education). Innovation performance is linked to inter-firm cooperation between firms, and between firms and other institutions, policy and cumulative learning processes. There are many definitions but an early one by Freeman (1987) was "*the network of institutions in the public and private sector whose activities and interactions initiate, import, modify, and diffuse new technologies.*". The approach thus focuses on factors such as industrial structure; institutions; the education and science system; the regulatory environment; finance and governance and the nature and extent of inter-linkages (e.g. that illustrated in DTI, 2003 p21). Innovation systems can thus be seen as a broader concept focusing on the environment within which companies operate and innovate. Cluster thinking is more focused on a particular industry or sector and its internal detailed links and knowledge flows; in the case of Porter's concept, the emphasis is also on competition especially in relation to interaction within his competitiveness diamond.

The prominent role of local and national government, and the emphasis on collaboration rather than competition suggests that eco-towns and METI clusters are better seen as local systems of innovation than clusters.

We can express the various Eco-town interactions as a 'LSI' in Figure 3. This represents the collaboration and networks between companies and other players in the system (national and local government, regulatory authorities, research and training centres, the financial system and markets). It summarises the diversity of roles of the various parts of the system-roles that are interlinked and interdependent. However, as already mentioned, the system resides within a larger regional and global system involving trading in recyclable materials, and the market distortions of different standards- particularly the competition between technologically advanced and informal recycling methods.

Simmie (2006) addresses directly the question of whether clusters or systems of innovation offer a generally more helpful analysis of innovation mechanisms and raises the question whether clusters merely reflect the result of companies moving to an area with (pre-cluster) high rates of innovation and opportunity. Eco-towns, insofar as they conform to the cluster model, have largely been created by government intervention. After having been formed, they could follow Simmie's model if the initial investment acted as a nucleus to attract innovative players to build a comprehensive national and international capability in the vein industry. This suggests a need for measures to boost innovation within the Eco-town LSI; one potential route would be through more explicit links to METI's environmental industry clusters which are currently administrated separately.

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**Figure 3 Eco-towns as Local Systems of Innovation**

## CONCLUSIONS

Thinking from the systems perspective sheds light not only on which type of agglomeration model Eco-towns and Industrial Clusters best conform to, but also brings into focus properties of the system which may be relevant for future development. Japan's objective for Eco-towns is to further improve its resource productivity and move towards more sustainable local economies, as endorsed by the 2002 Johannesburg Summit. However while it has constructed a system which functions well at a local level, its long-term viability is under threat from the wider global system, which creates incentives to divert collected materials from domestic recycle to export. This systems failure arises from the lack of any consideration of environmental quality in the competing recycling processes. This is a global trend and raises the key question whether trade should include consideration of environmental impacts applied to some licensing or certification scheme. A precedent may exist in European regulations on waste electronic equipment which require exporters to prove that exported materials are

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treated in an equivalent manner to those required within the EU. A similar requirement in Asia, combined with capacity building in other countries represents one potential policy goal to avoid Japan's effort to improve sustainability being undermined by the indifference of international markets to the core objectives of Japan's policies on sustainability and resource productivity<sup>7</sup>.

The systems approach also highlights that Eco-towns, while they undoubtedly include many innovative processes and approaches, have not been formed because of that- other factors (primarily government policy) have caused the localisation. The question now is whether, having been formed, they can realise some of the postulated benefits of localisation on innovation expressed in the traditional cluster model. Networks are already in place but it is notable that of the environmentally-oriented Industrial Clusters supported by METI, only one (Kyushu) has some geographical and organisational overlap and a degree of integration with an Eco-town (Kitakyushu). This raises the question whether the explicit innovative focus of the Industrial Clusters should be more purposefully integrated with Eco-towns; the latter could be a source not only of challenges and problems for R&D-focused Industrial Clusters, but also potential development path for ideas emerging from them.

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<sup>7</sup> Japan's resource productivity is already the highest among OECD countries and an order of magnitude higher than China (one ton of Direct Material Input generated GDP of \$2188 in Japan in 1996, \$730 in the EU in 2000 and \$178 in China in 2002 – Zu and Zhang, 2007).

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