

The Eco-Park: Green Nirvana or White Elephant?

Sam Goss, Gareth Kane, Graham Street, Clean Environment Management Centre, University of Teesside, United Kingdom.

Summary

The concept of co-locating businesses involved in the recovery of materials and the manufacture of recycled products has been around for a number of years. In the United Kingdom the Eco-Park (aka Resource Recovery Park) concept has for some time been seen as part of the answer to stimulating economic growth and enterprise in regions that have seen a decline and depression of the more traditional core industries. However, despite all of the discussion and planning that has gone into their development, there are no operating examples in the UK and very few examples across the world. This paper looks at the theory behind this form of eco-industrial development and seeks to discover why their development has been so slow.

1. Introduction

This paper has emanated from a feasibility study into a potential 'Recycling Eco-Park' to be located in Teesside, which is a heavily industrialised area of the North East of England. The Clean Environment Management Centre (CLEMANCE) at the University of Teesside was subcontracted to distribute a questionnaire and carry out a desk survey of similar developments around the world. The questionnaire was distributed to people believed to be involved in the operation of eco-industrial sites and also those concerned with the development and research of eco-industrial development.

The response to the first questionnaire was very disappointing and although it gave some insight, it didn't allow any proper analysis of the results. Subsequently another questionnaire was distributed, but in a much reduced form, while the response was better than the first, it remained insufficient to allow any accurate analysis. The majority of respondents to the survey were involved in research; there were very few responses from anyone actually involved in the operation of eco-industrial parks. As a result of the disappointing survey response, a survey analysis is not provided in this paper. The focus will therefore be on case studies and literature, whilst also using some quotations from the surveys to contribute to the paper.

2. Industrial Ecology and Eco-Industrial Development

The 1990s saw new ways of thinking in relation to industrial development and the environment. Much can be attributed to industrial ecology, which is notion of aligning industrial systems in a similar way to the processes taking place in nature; of viewing industry as a closed loop system, as opposed to a series of individual processes with only a linear linkage. The well-cited work of Frosch and Gallopoulos (1989) is often seen as the initial conceptualisation of industrial ecology.

Built upon the principles of industrial ecology came the notion of eco-industrial development, whereby industry would seek to minimise its environmental impacts,

whilst improving business performance and competitiveness. Schlarb (2001) describes the roots of eco-industrial development as having an ‘emphasis on fostering networks among businesses and communities to optimize resource use and reduce economic and environmental costs.’

The idea of eco-industrial parks has stemmed from the notion of eco-industrial development. Lowe and Warren (1996) defined the idea, describing it as:

‘A community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environmental and resource issues including energy, water, and materials . . . the community of businesses seeks a collective benefit that is greater than the sum of the individual benefits each company would realise if it optimised its individual performance.’

The US President’s Council on Sustainable Development produced another well used definition, similar to the above, but also indicating the local community to be central in both collaborating and benefiting from an eco-industrial park (PCSD 1996).

3. Resource Recovery Parks

There are a number of different titles given to eco-industrial developments based around clustered recycling businesses. In addition to Resource Recovery Parks, other terminology includes Eco-Park, Recycling Eco-Park or Sustainable Growth Park. For the purpose of this report they will generally be referred to as Resource Recovery Parks, which appears to be the most widely used definition for this form of development.

The resource recovery park concept is an evolution of early thinking on eco-industrial development. Lowe (1997) of the Indigo Development Research Centre in conjunction with Urban Ore provided the first real description of theory, describing how an eco-industrial park, anchored by a diverse cluster of resource recovery companies could become part of a regional resource recovery system.

There is much debate as to what exactly defines an eco-industrial park, this then leads to some question as to whether the resource recovery park model can be defined as an EIP. Martin et al. (1996) made an early attempt to define what should be classified as an eco-industrial park:

‘Some developers and communities have used the term EIP in a relatively loose fashion. We encourage applying this term to developments that are more than:

- a single by-product exchange pattern or network of exchanges;
- a recycling business cluster (e.g., resource recovery, recycling companies);
- a collection of environmental technology companies;
- a collection of companies making “green” products;
- an industrial park designed around a single environmental theme (i.e., a solar energy-driven park);

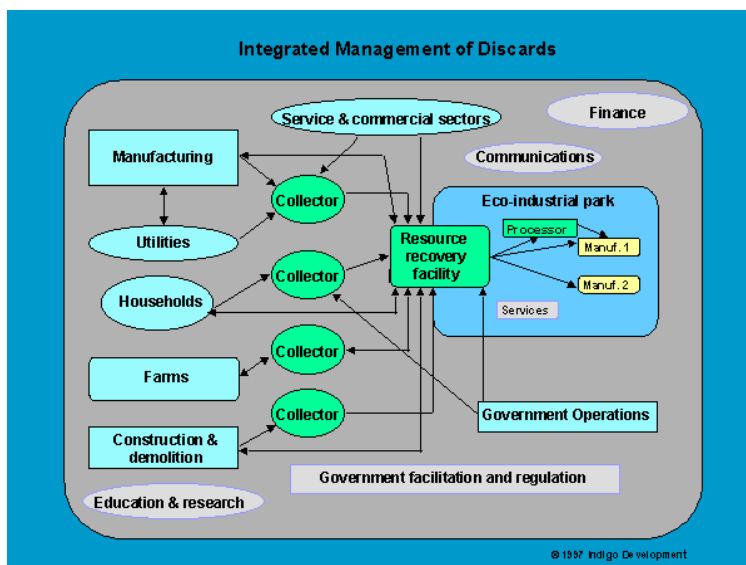
- a park with environmentally friendly infrastructure or construction; and a mixed use development (i.e., industrial, commercial, and residential).

An EIP may include any of these features. But the critical element in defining an EIP is the interactions among its member businesses and between them and their natural environment.’

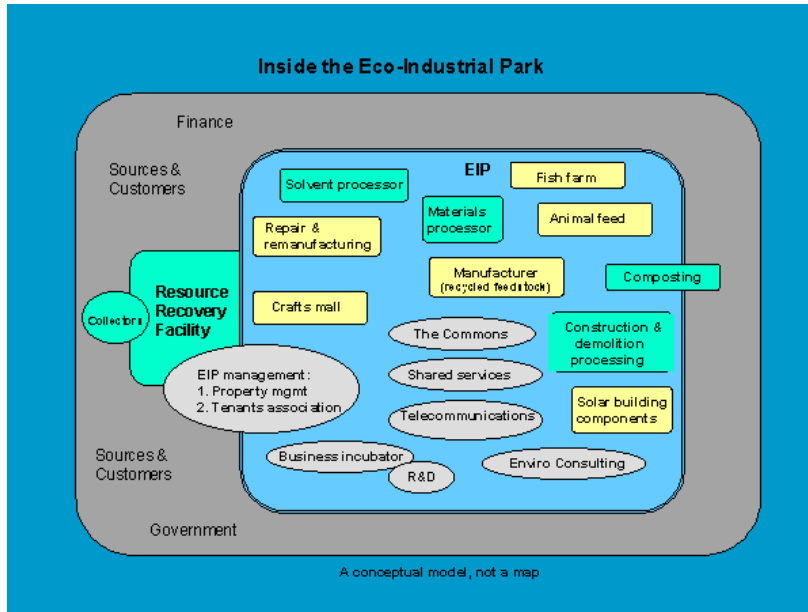
This widely used definition is supported by others (Lowe 2001; Cohen-Rosenthal 2003). A resource recovery park would fit with this definition depending on its particular make up and level of member interaction. It is however very questionable based on this classification, whether many of the self-defined eco-industrial parks can justifiably name themselves as such.

There has been very little in the way of literature which focuses on the resource recovery park concept. The vast majority of eco-industrial literature tends to focus on the many other aspects of eco-industrial development. A great deal of effort has been spent looking at the example of the symbiosis taking place at Kalundborg in Denmark and the potential for its replication. Kalundborg is the world’s prime illustration of how contrasting industries can feed from each other’s by-products. However, the symbiosis at Kalundborg occurred spontaneously and was by no means the result of planning (Grann 1997).

A resource recovery park as theorised by Lowe would include recycling, re-use, remanufacturing and composting operations. These would be complemented by companies involved in the collection, sorting and processing of industrial materials, along with dismantling, wholesale and retail activity. Lowe (1997) states: ‘The unifying concept is that discarded materials, goods, and by-products are turned into saleable materials and products.’ An integrated system such as this would have strong links into the local municipality, with materials collected from households in addition to those sourced from local industry. It is envisaged that the resource recovery park would become the hub of a diverse regional network of companies and communities.



The Regional Resource Recovery System (Lowe 1997)



A conceptual model of the Resource Recovery Park (Lowe 1997)

The success of such a resource recovery system would surely be dependent on the ability to develop a diverse regional industrial network, complemented by an appropriate blend of companies based in the resource recovery park. The system would also rely on linkages into the local community, especially in terms of the municipal material flows.

There is great complexity to developing such a system, requiring the involvement of development agencies, local governments, local communities, regulatory bodies and a diverse number of private sector industries. Such a level of interdisciplinary organisation poses one of the greatest challenges as argued by Martin et al. (1996) 'A new standard of communication and cooperation between key stakeholders is critical to the realization of EIP development.'

4. Case Studies

This section will look at case examples of developments which relate to the resource recovery park model. Some of these developments never made it past the planning stage; others are still planned, whilst a few have actually been created. Some of the examples were indicated through the surveys, others have been discovered through literature and internet searches. The case studies have a particular focus on the United Kingdom as the work was initially aimed towards a feasibility study for a development on Teesside.

4.1 The United Kingdom

Recent years have seen a growing awareness in the UK over the need to find more sustainable solutions for industrial and household waste. The last two decades have also seen a sharp decline in many of the traditional industries, coal mining, shipbuilding and car manufacturing are prime examples. Policymakers have identified a synergy between these two issues as they seek to combine economic development

with social and environmental aims (Deutz & Gibbs 2003). Such policy initiatives have led a number of local authorities to view the resource recovery park / eco - park concept as having the potential to solve waste problems, whilst stimulating new economic growth.

4.11 The Genesis Project Consett

Possibly the earliest eco-industrial park to be planned in the UK, and one of the earliest in the world took place in a small industrial town in the North East of England named Consett. This initiative has received very little attention other than the work of Stone (2002), who looked at how industrial ecology was seen as an answer to regenerating a town in which an industrial legacy had ended.

Consett was once one of the world's main steelmaking towns, in an unlikely setting on the edge of the North Pennine hills in County Durham. The complex was state owned by British Steel, and by the time it closed in 1980, had a 150 year history of steelmaking. Its closure led to the redundancy of 3,700 workers, leaving the town with a 27% unemployment rate (BBC 1999). Stone (2002) partly attributes the decline of the plant to competition from better placed sites, in particular the nearby Teesside complex with a deep sea port.

At the turn of the 1990s, as part of a long – term regeneration strategy named ‘The Genesis Project’, it was planned for the former steel site to become an eco – industrial park (Stone 2002). The park would have a focus on the recycling based industries, creating opportunities for companies processing and using secondary materials. In addition it was planned for renewable energy generation to provide the power for the development, with biomass seen as central to this. Overall it was hoped that Consett could become the recycling hub of North East England.

This is certainly one of the earliest examples of the planning for a recycling based eco – park, in reality Consett is a small town with a limited transport infrastructure. There were considered too many uncertainties and the plans were largely laid to rest. Since this time, development with an environmental theme has been encouraged on the site; unfortunately there has been very limited success in attracting any industry, a recent visit by the author found a food manufacturer to be the only notable occupant.

In his work, Stone (2002) concludes that ‘some of the basic ideas behind the Genesis project may be becoming feasible’, he also remarks that ‘there may be prospects for other locations to examine the feasibility of the idea—particularly, similar locations suffering the physical and environmental consequences of mine and heavy-industry closures.’ He does however accept that there are still many uncertainties with the idea, in particular issues around planning, clustering and scale.

4.12 Sustainable Growth Park, Castleford

The Sustainable Growth Park concept has been developed by Urban Mines, a charity with a focus on finding sustainable waste solutions. The design is similar to the resource recovery park concept put forward by Indigo Development (Lowe 1997), which was described previously. The park would be broken into three main sections. The first would include a materials handling facility, through which a range of

different wastes would be accepted and sorted, complemented by a community drop off point. The second section would provide facilities for companies involved in the reprocessing of materials and the manufacture of new products. The third section would be based around education, research and business incubation.

A sustainable growth park is being planned on the site of a former coal mine in Castleford, West Yorkshire. The project is being funded through public and private sector finance. The aim of the project is to provide sustainable waste solutions, whilst fostering economic growth through the creation of new business.

Although the site has been planned for a number of years, building work has not yet commenced on the site. The latest update states that 'It is anticipated that the construction will start later in 2005. A planning application and environmental impact assessment is being prepared and will be submitted to Wakefield MDC for approval in the near future' (Urban Mines 2005)

A respondent to our initial survey indicated in relation to the viability of the Sustainable Growth Park (Res. A 2004) 'They are viable. Cost models prove this. The first "Sustainable Growth Park" being built this year at Castleford will prove this!!'. However, there would appear to be some development problems, as the start date for construction has been put back from 2004 until late 2005.

Although much time and effort has been spent in the planning and developing of this project, there are still a number of unknowns which are crucial to its success. Can it get through the planning process? Can it foster new businesses alongside major waste management companies? Can it attract the right kind of business? Will the material flow forecasts prove to be correct? These are key questions which are crucial to its success.

4.13 Other UK developments

There has been a considerable amount of interest shown in resource recovery parks in the UK. A number of local authorities have undertaken feasibility studies and produced reports on the potential to improve recycling performance, whilst stimulating economic growth.

Two feasibility studies have been undertaken to look at the potential for a 'Recycling Eco Park', on an area of brownfield land once occupied by the Corus steel manufacturing complex. This proposal has striking similarities to the development which was planned in Consett over ten years earlier: The development would be on a site formerly occupied by steelworks in an area with high unemployment deprivation. The capital cost of this project based on the original plans is likely to be in the region of 25 million pounds (Entec, 2003).

Interest has also been shown in a number of other areas within the UK; studies have taken place in Hampshire, South Tyneside, Sandwell and Doncaster. The 'eco-park' concept was put forward by the Wales Environmental Trust in the late 1990s as a means of providing a sustainable answer to local waste problems (WET, 2000). A Zero Waste Strategy has been published by Doncaster Metropolitan Council (2004) with the creation of a resource recovery park as central to this plan.

Despite the interest and planning behind the recycling eco park / resource recovery park concept in the UK, there is no operating example. The wider notion of eco – industrial development has received attention in the UK with a number of other developments being defined as such (Gibbs, 2003).

4.2 Europe

Built largely upon the achievements of Kalundborg, the concept of eco–industrial development has grown popular in parts of Europe. The Netherlands have adopted the creation of eco–industrial parks as national policy (Eilering & Vermeulen, 2004). Other examples of eco–industrial development can be found in Germany, France and Italy (Gibbs, 2003).

It has not been possible to identify any developments based around the resource recovery park model of co–located recycling and manufacturing industries within Europe. That is not to say they do not actually exist, but neither the survey responses nor the surveyed literature have identified any examples.

The failure to find any illustrations of the concept in Europe by no means indicates a lack of progress in the field of recycling. In fact the opposite is true if you consider that Germany, the Netherlands, Austria and Switzerland are all achieving domestic waste recycling rates of above 46%. (FOE 2002). Similarly the most well documented cases of Industrial Symbiosis take place at Kalundborg in Denmark and also within the Styrian Region of Austria. The latter being a perfect example of how the inter–firm networking of waste can spontaneously take place over a whole region, with economics providing the stimulus (Schwarz and Steininger, 1997).

4.3 North America

In the United States during the 1990s there were numerous planned eco–industrial developments. In reality their success has been very limited as indicated by Chertow (2003) ‘Few of approximately 20 projects discussed at the seminal Cape Charles meeting of the PCSD on October 1996, for example, are still under consideration’. These projects were diverse in nature and covered a range of geographical locations, but the high attrition rate clearly indicates problems with eco–industrial development.

In terms of the resource recovery park concept, the Cabazon RRP in California is one of the most well known. Operated by the Cabazon Band of Mission Indians, it covers a 640 acre site but, despite existing for over ten years, it only has two tenants - a biomass power station and a tyre crumbing facility. There are a number of incentives in place to attract more tenants (CRRP 2005). This development would appear not to fit the standard resource recovery park model of a central facility feeding a cluster of enterprises, it is however intended to attract companies involved in the recovery and recycling of waste. The fact that the Cabazon RRP has been open for over 10 years with only two tenants must surely raise questions regarding its ultimate success.

Elsewhere within California there are recycling parks located at Monterey and San Leandro, these have largely evolved around materials recovery facilities (MRFs). Materials are received from both commercial and public sources, some of which are

processed on site. These parks are controlled by district governments with recycling operations contracted out to private companies (CIWMB, 2003). Although these have been described as resource recovery parks, they do not appear to fit the model of private enterprise and development as they are district government controlled facilities which incorporate some private operations.

There are further planned developments in the United States although the progress of these is unknown. There is a proposed 'industrial ecosystem' development to be based around a recycling facility in Northwest Louisiana (Tosteson, Guadagno, 2001); and a proposed resource recovery park development in the US Commonwealth state of Puerto Rico (Lowe, 1999).

4.4 Asia and Oceania

The concept of eco-industrial development has been received positively within Asia; with many developing nations attempting to apply the industrial ecology concept by avoiding the errors made in Europe and North America (Lowe 2003). The belief is that by catching industry at its development stage, there will be significant advantages over the attempts to retrofit the principles of industrial ecology to the industry of developed nations. The idea of co-locating recycling industries into a resource recovery park has also gained consideration, with such developments being mooted in Thailand and the Philippines (Lowe 2003). Other more general eco-industrial development is planned for Sri Lanka, India and China (Chui & Yong 2004).

There has been considerable development in Japan – as was pointed out by a respondent to the survey (Res B, 2005):

‘There are currently more than 20 ecotowns in Japan. Many of these ecotowns are geared toward accommodating the recycling-oriented business entities. This is due to the Recycling Oriented Economic Society Law that was enacted few years ago in Japan.’

The eco-town projects in Japan have largely been government funded and promoted through the Ministry of International Trade and Industry. As Morikawa (2000) indicates:

‘The central government provides both technical and financial support to local governments that wish to establish eco-towns as areas where regional zero emissions are promoted through various recycling and industrial symbiosis efforts.’

Possibly the best example of a recycling based eco-town within Japan is located in Sapporo. It features a recycling complex on a 57 acre site containing 10 private and semi-private companies dealing with a range of waste materials. Operations include the manufacture of polyester sheets from PET bottles, the treatment of waste tyres and the recycling of waste oils. The complex is said to be run as a public / private partnership and is claimed to be the 'first city-led concentration of industrial waste recycling and treatment facilities in Japan and the only such conglomeration of waste reduction facilities in one centralized location in the world.' (Sapporo Ambassador 2000). This statement would not appear to be true based on the following example.

Elsewhere in Asia, the only other example of a recycling based eco-industrial development which was found is in Singapore. The Sarimbun Recycling Park is located adjacent to a former landfill site on the island of Sarimbun. The National Environment Agency (NEA) of Singapore made the land available at a subsidised rate to companies within the recycling industry. They were successful in encouraging 12 businesses to locate there (NEA 2002). The circumstances surrounding this park are fairly unique in that Singapore is an island-city state with very little available land for development. The benefits of co-location under these conditions are likely to be far greater than to the vast majority of other proposed developments.

Within New Zealand consideration is being given to the creation of resource recovery parks as part of a waste strategy for communities (Envision, 2003). A resource recovery centre is being built in the Australian capital Canberra. This is a government funded development which aims for a cluster of recycling businesses to develop around a central MRF (No Waste 2003). The progress of this development is unknown.

4.5 Summary of Studies

The first identified example of a proposed resource recovery park / recycling eco-park within the UK was at Consett in County Durham, since then there have been several other proposals, none of which have come to fruition. The proposals for the Sustainable Growth Park at Castleford appear to be further advanced than any other planned development. However, this development appears to be suffering from delays during the planning stage. If it is finally constructed, its level of success is likely to influence other proposals around the world.

Elsewhere in the world there are only a few operational examples of resource recovery parks; it may well be the case that there are similar developments which have not been identified, but it is unlikely that there will be significantly more than those listed. Those that do exist vary quite markedly in design and operation. It could also be argued as to whether they can actually be defined as Resource Recovery Parks or recycling based Eco - Parks. Those examples that have been identified are:

- Monterey Recycling Park, California, USA.
- San Leandro Recycling Park, California, USA.
- Cabazon Resource Recovery Park, California, USA.
- Sapporo Recycling Complex, Japan.
- Sarimbun Recycling Park, Singapore.

The recycling parks at San Leandro and Monterey are district government controlled waste facilities which have incorporated some private recycling operations. The Cabazon RRP differs and has developed from scratch; aiming to attract a number of different operators, but currently only has two tenants. In contrast the developments in Sapporo and Sarimbun have been more successful in attracting tenants and contain a cluster of recycling industries using feedstock from both industrial and household sources. However, the Sapporo complex has received heavy government subsidisation to enable its creation and survival (Morikawa 2000). The Sarimbun complex has unique circumstances in that Singapore is an island-city state.

5. Discussion

There are several key issues that may help indicate why there are so few examples of resource recovery parks, they may also indicate why development has been so slow and in many cases has failed.

A key requirement for the creation of a resource recovery park is a continuous and diverse inward material flow received from industrial, commercial and household sources. Without this material flow it would simply not be possible for the park to function in any form. In order to achieve this material flow it can be assumed that a great deal of cooperation is required between public authorities, industrial organisations and of course those companies within the park itself. Moreover the material flowing inwards must also be matched by that flowing outwards in the form of new products or materials that are readily saleable; there must then be a market for these products and materials. This then indicates that a great deal of planning must be involved in the conception and development of a resource recovery park, not just in the physical aspects but the virtual aspects of developing relationships and effective material flows.

The most successful examples of by-product material flows and recycling networks such as those at Kalundborg and Styria have occurred spontaneously based on clear economic advantages. It is argued that the unplanned evolution of networks based on market forces will always achieve better results than the centralised attempts of planners at creating such networks (Desrochers 2001, Posch 2004). The relevance of this lies in the fact that the resource recovery park is a model development based around centralised planning and not an evolution based on the results of market forces. This certainly raises issues concerning how material flows and networks can be developed to foster growth and ensure survival.

Intrinsically related to the concerns surrounding material flows are the issues involved in the co-location of businesses. Without the ability to guarantee or predict material flows, it may prove very difficult to attract companies to relocate, or to find a niche in the market for a start up business to prosper. There may also be the risk of overdependence on particular waste streams as indicated by Gibbs (2003) 'over time, individual firms may wish to reduce their waste associated with particular products to the detriment of those firms relying upon such wastes as inputs', this is certainly a risk posed to both start up companies and those who may seek to relocate to a resource recovery park.

There needs to be clear and tangible economic benefits for a company to relocate to a resource recovery park. It may be the case that there are simply too many risks involved in a company uprooting its business and relocating to a development which is unproven. This then raises the questions: can subsidies or financial incentives drive businesses to relocate? What are the longer-term implications of this? Subsidies and economic incentives may certainly provide encouragement in the short-term, but surely the fact that subsidies may be required in the first place raises questions over the longer-term viability. Moreover subsidies and incentives may well have a negative effect on the competitive market as a whole, leading to unfair competition and putting other businesses at risk. If the resource recovery park model is to prove viable it must

be capable of supporting itself, without the need for long-term subsidies and market interventions.

It is no real surprise that the development of the resource recovery park concept has been so slow when you consider the number of uncertainties involved. The lack of proven success is seen by many as a barrier to attracting investment in eco-industrial developments (Martin et al 1996, Giannini-Spohn & North 1999). The lack of successful examples of the resource recovery park model will make it very difficult to obtain the necessary development funds, especially when costs as high as 25 million pounds are being quoted (Entec, 2003).

6. Conclusions

Despite numerous proposals and studies dating back nearly fifteen years, there remains no operational recycling based eco-industrial park or resource recovery park in the United Kingdom. Furthermore through surveys and literature studies it has only been possible to locate five examples of similar developments across the world.

The only detailed conceptualisation of the resource recovery park idea appears to have been undertaken by Indigo Development in conjunction with Urban Ore (Lowe 1997). This model has attracted considerable interest and provides the basis upon which many proposals have been made. None of the five identified examples can really be described as successful working models of this particular concept. They differ considerably in make up and circumstance, it could also be argued as to whether they can actually be termed 'Eco-Parks' or 'Resource Recovery Parks'.

Many developers view the resource recovery park concept as almost being a 'win win' situation whereby economic development is combined with the development of sustainable waste industries. Many proposals rely on the assumptions that companies will somehow be attracted there; with new start up businesses fostered and developed alongside. In reality this may prove to be very difficult as there are some very complex issues at stake regarding material flows, co-location, economics and long-term viability.

The uncertainties surrounding the resource recovery park concept have led many proposals to be dropped. Moreover until there is a successful working model, many more proposals will fall by the wayside as decision makers become sceptical over the many untested assumptions. Similarly, attracting the relevant and necessary funding for such an unproven development is likely to prove difficult.

Whilst it may be unfair to describe the notion of a resource recovery park as a 'white elephant', based on available evidence it most certainly appears not to be the 'green nirvana' that many people hope for. Some very successful examples of regional recycling and symbiotic linkages take place without the need for resource recovery parks, so it certainly should not be seen as a prerequisite for a thriving recycling industry. It would therefore be wise to urge caution towards any future plans for this form of development as its underlying principles remain untried and untested.

References

- CCRP, 2005. Cabazon Resource Recovery Park. Website accessed at: <http://www.cabazonresourcerecoverypark.com/> in March 2005.
- Chiu, SF & Yong, G. 2004. 'On the industrial ecology potential in Asian Developing Countries', *Journal of Cleaner Production*, 12, 1037–1045.
- CIWMB, 2003. California Integrated Waste Management Board, Case Studies. <http://www.ciwmb.ca.gov/LGLibrary/Innovations/recoverypark/CaseStudies1.htm>. Accessed in April 2004.
- Cohen-Rosenthal, E. 2003, A Case study of the Louisiana Army Ammunition Plant Re-use. In Cohen-Rosenthal, E. and Musnikow, J. *Eco-industrial Strategies Unleashing Synergy between Economic Development and the Environment*, Greenleaf Publishing Ltd., Sheffield, pp.330–340.
- Desrochers, 2001. Eco – Industrial Parks: The Case for Private Planning. *The Independent Review*, v.V, n.3, winter 2001, ISSN 1086-1653, pp. 345-371.
- Doncaster MBC, 2004. A Draft Zero Waste Strategy 'An opportunity not to be missed'. Produced by Zero Waste Associates Ltd.
- Eilering, J.A.M. and Vermeulen, W.J.V. 2004. 'Eco-industrial parks: toward industrial symbiosis and utility sharing in practice', *Progress in Industrial Ecology*, Vol. 1, Nos. 1/2/3, pp.245–270.
- Entec, 2003. Presentation on a potential Eco – Recycling Park for Teesside. At Redcar and Cleveland Borough Council offices, by Entec UK Ltd. July 2003.
- Envision, 2003. 'Resourceful Communities – A Guide to Resource Recovery Centres in New Zealand' Envision New Zealand. <http://www.zerowaste.co.nz/assets/Reports/ResourcefulCommunities-lowres.pdf>
- FOE, 2002. So why does UK languish at bottom of euro-recycling league? , Press Release, Friends of the Earth. 28 May 2002. Available at: http://www.foe.co.uk/resource/press_releases/20020528000102.html
- Frosch, Robert A., and Nicholas E. Gallopoulos. 1989. "Strategies for Manufacturing," *Scientific American*. September, pp. 144-152.
- Giannini-Spohn, S and North, J. 1999. "Strategies for Financing Eco-Industrial Parks." Economic Development Commentary.
- Gibbs, D.C., and Deutz, P., 2003. Eco-industrial development and regional restructuring: industrial ecology or marketing tool? Paper presented to the Business and Industrial Ecology Symposium, Business Strategy and the Environment Conference, University of Leicester, 16 September 2003.

Gibbs, D.C, 2003. Trust and Networking in Inter-firm Relations: the Case of Eco-industrial Development. *Local Economy*, August 2003, Vol. 18, No. 3, 222–236.

Grann H, 1997. “The Industrial Symbiosis at Kalundborg” in ‘The Industrial Green Game: Implications for Environmental Design and Management’, National academy Press, Washington DC, pp117-123

Lowe, E. A. and Warren, J. 1996. The Source of Value: An Executive Briefing and Sourcebook on Industrial Ecology, Richland, Washington, Battelle Pacific Northwest Library.

Lowe, E. A. 1997. Regional Resource Recovery, and Eco-Industrial Parks: An Integrated strategy. Prepared for the Symposium, Verwertungsnetz Obersteiermark Innovation durch regionale Recycling-Netzwerke at Karl-Franzens-Universität Graz. April 28-29, 1997. Available at: <http://www.indigodev.com/Eipresrecov.html>

Lowe, E. A. 1999. Evaluation of the Sustainable Development Benefits of the Proposed Resource Recovery Park at Arecibo, Puerto Rico. Indigo Development Working Paper # 8.

Lowe. E.A. 2001. Eco-Industrial Park Handbook for Asian Developing Countries. A report for the Environment Department, Asian Development Bank. Emeryville, California. RPP International.

Lowe. E.A. 2003. Eco – Industrial Development In Asian Developing Countries. In Cohen-Rosenthal, E. and Musnikow, J. Eco-industrial Strategies Unleashing Synergy between Economic Development and the Environment, Greenleaf Publishing Ltd., Sheffield, pp.342–352.

Martin, S.A., Weitz, K.A., Cushman, R.A., Sharma, A., Lindrooth, R.C., et al. 1996 Oct. Eco-Industrial Parks: A Case Study and Analysis of Economic, Environmental, Technical, and Regulatory Issues. Research triangle Institute <http://www.rti.org/pubs/case-study.pdf>

Morikawa, Mari. 2000. Eco-Industrial Developments in Japan. Indigo Development Working Paper # 11. RPP International, Indigo Development Center, Emeryville, CA

NEA, 2002. ‘Sarimbun Recycling Park - Wasteland Returns to Useful Life’. National Environment Agency of Singapore. Available at: <http://app.nea.gov.sg/cms/htdocs/article.asp?pid=982>

No Waste, 2003. ‘ACT NOWaste The Waste Management Strategy for Canberra - No Waste by 2010’ ACT NOWaste. Available at: <http://www.nowaste.act.gov.au/text/rwcentres/humeresourcerecoveryestate.html>.

PCSD (President’s Council on Sustainable Development) 1996. Eco-industrial Park Workshop Proceedings, Cape Charles, VA, 17-18 October 1996.

*Res.A. 2004. Respondent to the initial survey, pers comm., April 2004.

*Res.B. 2005. Respondent to the second survey, pers comm., March 2005

Posch, A. 2004. 'Industrial recycling networks: results of rational decision making or 'organised anarchies'?', *Progress in Industrial Ecology*, Vol. 1, Nos. 1/2/3, pp.112-129.

Sapporo Ambassador, 2000. 'City's Zero Waste Initiative, Sapporo Recycling Complex Completed'. Sapporo Ambassador, Summer 2000. Available at: <http://www.city.sapporo.jp/somu/ambassador/amb1/2.htm>. Accessed in March 2005.

Schlarb, M. 2001. *Eco-industrial Development: A Strategy for Building Sustainable Communities*, Cornell University/Washington DC: United States Economic Development Administration.

Schwarz, E.J. and Steininger, K.W. 1997. 'Implementing nature's lesson: the industrial recycling network enhancing regional development', *Journal of Cleaner Production*, Vol. 5, Nos. 1-2, pp.47-56.

Stone, C. 2002. 'Environmental consequences of heavy-industry restructuring and economic regeneration through industrial ecology' *Mining Technology: Transactions of the Institute of Mining and Metallurgy, Section A*, December 2002, vol. 111, no. 3, pp. 187-191(5)

Tosteson, Guadagno, 2001. in Cohen-Rosenthal, E. and Musnikow, J. *Eco-industrial Strategies Unleashing Synergy between Economic Development and the Environment*, Greenleaf Publishing Ltd., Sheffield, pp.163-185.

Urban Mines, 2005. Sustainable Growth Park, Urban Mines Ltd. Available at: <http://www.resourcerevolution.com/>. Accessed in April 2005.

WET, 2000. The Eco – Parks Concept – 'The sustainable alternative to landfill'. The Wales Environment Trust. Available at: <http://ww.cwmre.org.uk/site/index.php>. Accessed in April 2005.

*When distributing the surveys it was stated that the details of respondents would remain confidential.