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INDUSTRIAL ECOLOGY AND REGIONAL DEVELOPMENT: ECO-INDUSTRIAL DEVELOPMENT AS CLUSTER POLICY

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11 ABSTRACT

12 Aspects of industrial ecology fit closely with work in regional development
13 investigating clustering, networking, and local economic development. However,
14
15 there has been limited cross fertilisation between these bodies of literature. This
16
17 paper uses an empirical focus on eco-industrial developments in the USA to postulate
18
19 that industrial ecology can be viewed as a distinct cluster concept and to consider the
20
21 implications of this for both industrial ecology and regional development policies.
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25

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27 Key words

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29 Industrial ecology eco-industrial parks industrial symbiosis regional
30
31 development clusters networking
32
33

34 JEL L14 R38 R58

35
36 L'écologie industrielle et l'aménagement du territoire:
37 le développement industriel écologique comme politique d'agglomération.
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41 Deutz & Gibb
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43

44
45 Des aspects de l'écologie industrielle sont en corrélation étroite avec des recherches
46 dans le domaine de l'aménagement du territoire qui examinent l'agglomération, la
47 connexion et le développement local économique. Cependant, il y a eu peu de
48 synergie entre ces faisceaux de documentation. Cet article porte de façon empirique
49 sur les développements industriels écologiques aux E-U afin de postuler que l'on peut
50 envisager l'écologie industrielle comme une notion indéniable d'agglomération et en
51 considérer les retombées à la fois pour l'écologie industrielle et les politiques
52 d'aménagement du territoire.
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54

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56 Ecologie industrielle / Parcs industriels écologiques / Symbiose industrielle /
57 Agglomérations régionales / Connexion
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Classement JEL: L14; R38; R58

Industrieökologie und Regionalentwicklung: öko-industrielle Entwicklung als Cluster-Politik

Pauline Deutz and David Gibb

ABSTRACT

Die Aspekte der Industrieökologie sind eng mit der Arbeit der Regionalentwicklung verzahnt, was die Untersuchung von Clusterbildungen, Netzwerken und lokaler Wirtschaftsentwicklung anbelangt. Die gegenseitige Befruchtung zwischen diesen Literaturkörpern fiel jedoch bisher eher begrenzt aus. In diesem Beitrag wird anhand eines empirischen Fokus auf den ökoindustriellen Entwicklungen in den USA postuliert, dass sich die Industrieökologie als eigenständiges Cluster-Konzept betrachten lässt, und es werden die Auswirkungen auf die Politiken für Industrieökologie und Regionalentwicklung untersucht.

Key words

Industrieökologie
Öko-Industrieparks
Industriesymbiose
Regionalentwicklung
Cluster
Netzwerke

JEL L14 R38 R58

Ecología industrial y desarrollo regional: desarrollo ecoindustrial como política de aglomeración

Pauline Deutz and David Gibb

ABSTRACT

Los aspectos de la ecología industrial están estrechamente vinculados al trabajo en el desarrollo regional que estudia la aglomeración, las redes y el desarrollo económico local. Sin embargo, la mutua hibridación entre estos organismos de literatura ha estado limitada. En este artículo usamos un enfoque empírico sobre los desarrollos ecoindustriales en los EE.UU. para postular que la ecología industrial puede considerarse un concepto distintivo de aglomeraciones y para considerar qué efectos tiene esto en la ecología industrial y las políticas de desarrollo industrial.

Key words

Ecología industrial
Parques ecoindustriales
Simbiosis industrial
Desarrollo regional
Aglomeraciones
Redes

JEL L14 R38 R58

INTRODUCTION

Over some fifteen years the industrial ecology (IE) and regional development (RD) literatures have shared an interest in the theories and practices of industrial agglomeration, interfirm networking and their potential contribution to regional development. Academic interest in agglomeration relates to the apparently paradoxical persistence of regional economic disparities in the age of the 'knowledge economy' and electronic communications (CUMBERS and MACKINNON, 2004). Policy interest in industrial agglomeration, largely derived from PORTER'S work on clusters (e.g., 1998) (MARTIN and SUNLEY, 2003) lies in its perceived potential as an engine for regional development through the attempted transfer of features from successful to lagging regions. Some writers have debated whether regional success can be duplicated, and indeed whether the region is an appropriate scale of analysis, given for example, the interdependence of regions, the importance of national policies and historic contingencies (LOVERING, 1999; RACO, 1999; MORGAN, 2004). Nevertheless, cluster-based policies remain firmly entrenched in many national and regional economic development strategies (CUMBERS and MACKINNON, 2004).

Industrial clusters have been defined as 'loose networks of independent economic agents in the same or related market segment and restrictive geographic locality' (HENDRY and BROWN, 2006; p. 708). Cluster approaches to regional development observe that clustering confers an economic advantage on participants over non-participants and that these advantages can have beneficial spill-over effects on the host community. The regional development literature on clusters incorporates a range of theoretical perspectives offering different explanations for regional economic disparities. The ambiguities of the term 'cluster' and consequent limitations on its usefulness as either a source of theory or as a policy tool have been

1
2
3 widely discussed (e.g., MACKINNON et al., 2002; BATHELT, 2005). Following
4
5 BENNEWORTH and HENRY (2004) we use the term 'clusters' as an umbrella
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7
8 concept for agglomerations of interlinked businesses and institutions, rather than a
9
10 precisely, but variously, defined term.
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13 An emerging theme in regional development in theory and practice is the need
14
15 to address environmental issues (HAUGHTON and COUNSELL, 2004; GIBBS,
16
17 2006), which have received relatively little attention in the regional development
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19 literature (RACO, 1999). In the UK, the regional level of government has been given
20
21 an enhanced planning role, with the advent of the requirement for Regional Spatial
22
23 Strategies (RSS) (HAUGHTON and COUNSELL, 2004). The RSS covers a large
24
25 range of issues, with the environment, including waste and energy, being amongst
26
27 them. A comparable national drive to promote an integrated approach to regional
28
29 planning does not exist in the US. However, ideas such as New Regionalism and
30
31 Smart Growth do promote consideration of the environment in US regional and urban
32
33 development (e.g., JONAS and PINCETL, 2006; SCOTT, 2007). These movements
34
35 as 'bottom up' approaches are distinct from the 'top down' policy driven New
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37 Regionalism that LOVERING (1999) and others refer to in the UK context (JONAS
38
39 and PINCETL, 2006).
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46 One way to address these environmental concerns is through the adoption of
47
48 ideas from industrial ecology which propose that industry can learn from the example
49
50 of natural ecosystems and can be reorganised to form 'industrial ecosystems'. More
51
52 specifically, industrial ecologists envisage such industrial ecosystems as involving a
53
54 dense network of material interchanges between proximate firms. While some
55
56 industrial ecologists have viewed eco-industrial developments as a form of cluster
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58 (GERTLER, 1995; COHEN-ROSENTHAL and MCGALLIARD, 1998; BAAS and
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2
3 BOONS, 2004), research work in industrial ecology has paid little attention to either
4
5 theoretical or policy debates in the regional development literature. Similarly, those
6
7 working in the regional development field have largely ignored developments in
8
9 industrial ecology (GIBBS, 2003).
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13 Bringing the regional development and industrial ecology literatures together
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15 can have benefits for researchers in both fields. Drawing upon the lessons of cluster
16
17 development may help to explain the difficulties of policy implementation for
18
19 industrial ecology projects, as well as providing a more rigorous theoretical context to
20
21 a predominantly normative literature. Conversely, for those involved with regional
22
23 development policy, industrial ecology provides guidelines as to how the
24
25 environmental impact of economic development can be ameliorated, a key
26
27 consideration in an age of concern over climate change. However, in order to
28
29 consider the potential for a fruitful cross fertilisation of ideas from IE and RD, it is
30
31 first imperative to situate them in a common framework. Thus the primary research
32
33 question for this study is to investigate on the basis of theoretical arguments and
34
35 empirical evidence whether IE is simply an environmentally explicitly version of an
36
37 existing approach to RD, or should it be seen as a distinct perspective? Given the
38
39 multiplicity of approaches to clusters within RD (e.g., BENNEWORTH and HENRY
40
41 (2004), the basis for our comparison of IE and RD cluster perspectives will be the
42
43 theoretical and empirical treatment of the three meta-themes of external economies of
44
45 scale, networking and policy. As we will show below, these themes are important in
46
47 varying ways to all the recognised cluster perspectives and are also prominent in the
48
49 IE literature. We will argue that IE should be seen as a distinct cluster perspective,
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51 which generates the second research question: what are the policy implications for IE
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53 and RD of recontextualising IE as a cluster perspective?
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3 The structure of the paper is as follows. In the next section we outline the
4 main features of industrial ecology and its implementation in the form of eco-
5 industrial parks. We then turn to a review of the clusters literature to examine its
6 approaches to the three meta-themes, in order to provide the context for the
7 subsequent examination of how eco-industrial developments can be (re)conceived as a
8 clustering strategy. The paper then draws upon empirical work on nine US eco-
9 industrial parks (EIPs), representing a range of developmental stages, to present EIPs
10 as a cluster-based, yet distinctive perspective, on regional development. In the
11 conclusions, we present policy implications for both regional development and
12 industrial ecology arising from this contextualisation.
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29 INDUSTRIAL ECOLOGY AND ECO-INDUSTRIAL DEVELOPMENT

30 Industrial ecology is a business-oriented initiative aiming to decrease the impact of
31 business on the environment by promoting the 'win-win' of eco-efficiency i.e. that
32 environmental savings (e.g., reducing material and energy consumption) can also
33 bring cost savings. IE is characterised by its promotion of 'industrial ecosystems',
34 involving inter-company co-operation, derived from a metaphor with natural
35 ecosystems (e.g., FROSCHE and GALLOPOULOS, 1989; AYRES, 1989; WELLS,
36 2006). A number of principles can be derived from this metaphor. KORHONEN
37 (2001) refers to these as roundput; diversity; locality and gradual change. Roundput
38 is the recycling and cascading of matter and/or energy between either natural or
39 industrial ecosystem members. Diversity relates to biodiversity in natural ecosystems
40 with interdependency and co-operation between different species and/or different
41 organisms of the same species. In industrial terms this concept implies
42 interdependency and co-operation between companies potentially engaged in different
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3 industrial sectors as well as other actors (e.g., government or non-governmental
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5 bodies). Diversity is important, so the range of inputs required may match the range
6
7 of outputs offered. Locality in both ecosystem and industrial systems relates to
8
9 awareness of, and respect for, local resources and local limiting factors and also the
10
11 spatial scale of interdependences (networks of industrial symbioses in economic
12
13 terms). Gradual change for ecosystems relates to change through evolution and use of
14
15 resources at a rate at which they are replenished. KORHONEN (2001) contrasts this
16
17 with the rate of change in industrial systems and calls for a use of renewable resources
18
19 within their rate of replenishment. In essence, in an industrial ecosystem one
20
21 company's by-products or surplus heat become another's raw material or energy -
22
23 essentially the concept of 'waste' is replaced by one of 'residuals' (ALLENBY, 1999).
24
25 Thus, IE takes a systems rather than firm-oriented view to eco-efficiency, with the
26
27 expectation that this will increase the possibilities for eco-efficiencies at the system,
28
29 or regional, scale.
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36 Industrial symbiosis (IS) is a place-based approach to IE, which concerns
37
38 networks of companies exchanging by-products. Much of the industrial ecology
39
40 perspective on clustering is derived from observations of the symbiosis network
41
42 developed around the Danish town of Kalundborg. As widely described (e.g.,
43
44 GERTLER, 1995; CHERTOW, 2000; DESROCHERS, 2002; CHERTOW et al., this
45
46 volume), over approximately 25 years a complex web of interchanges evolved at
47
48 Kalundborg including the transfer of fly ash from the power station to a cement plant,
49
50 use of excess heat from the power station for district heating, and transfer of waste-
51
52 water from the oil refinery to the power station. Despite a backdrop of environmental
53
54 regulations that encouraged firms to seek alternatives to traditional waste disposal
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56 options, the emerging network and its environmental benefits was not noticed until
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3 some 15 years after the initial exchanges were agreed on the basis of mutual financial
4 interest (CHERTOW, 2000). Other IS networks have since been identified e.g., Styria,
5
6 Austria and the petrochemical complex at Sarnia, Ontario, Canada (DESROCHERS,
7
8 2002).

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12 A growing policy interest in applying the lessons of Kalundborg in other
13
14 locations has led to the development of eco-industrial initiatives. In some cases these
15
16 have been organised on a regional scale, in others around co-located firms in an eco-
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18 industrial park, or a mixture of both. An eco-industrial park (EIP) has been defined as
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25 ...community of businesses that co-operate with each other and with the local
26
27 community to efficiently share resources (information, materials, water, energy,
28
29 infrastructure and natural habitat), leading to economic gains, gains in
30
31 environmental quality and equitable enhancement of human resources for
32
33 business and local community. (PCSD, 1997: 6).

34
35 Industrial ecology initiatives frequently display an imbalance between ideals
36
37 and practice (CHERTOW, 1999; HEERES et al., 2004; GIBBS and DEUTZ, 2005).
38
39 With respect to the operational parks, there is a debate on the defining characteristics
40
41 of an EIP (see GIBBS et al., (2005) and CHERTOW (2007) for a review of the IE
42
43 literature; and PELLENBARG (2002) for a review of the Dutch policy-oriented
44
45 debate). Similar components to EIPs are identified in either case, with symbiosis
46
47 being the ultimate, but elusive, goal. VAN LEEUWEN et al. (2003) define a three-
48
49 fold classification of 'eco-cooperation options' (p. 153). The most ambitious of these
50
51 is symbiosis, with its concomitant environmental and economic benefits, but also
52
53 technological, organisational and social barriers (i.e., principally the need to build
54
55 trust). We have previously stated that some evidence of symbiosis should be present
56
57 for a park to be considered an EIP, though accomplishing that may be a long term
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59 goal (GIBBS et al., 2005). CHERTOW (2007) further states that an IS network (not
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1
2
3 necessarily park based) at a minimum should comprise 3 companies exchanging at
4
5 least 2 different by-products. VAN LEEUWEN et al.'s intermediate option is utility
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7 sharing. This includes joint purchase of energy or waste services. It involves less
8
9 interfirm co-operation but also offers fewer environmental benefits than IS. The third
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11 option they refer to as 'spatial planning' (p. 154), i.e., the collective design of park
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13 features, such as the location and landscaping of open spaces. This brings the least
14
15 environmental benefits of the three options.
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19
20 A number of authors have identified industrial symbiosis as a potential area
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22 for public sector intervention, in that it could provide a means to both implement
23
24 environmental regulations and promote economic development. However, whereas
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26 some (e.g. ANDREWS, 1999) have simply called for more environmentally sensitive
27
28 economic development and urged caution as to the potential for planned EIPs, others
29
30 (e.g., LOWE, 1997; SCHLARB, 2001) have seen a major role for the active
31
32 promotion of eco-industrial development as a tool for local and regional economic
33
34 development. Although the links are not made explicit, the implementation of IE as a
35
36 policy initiative is effectively an environmentally-based variant of the types of cluster
37
38 policy that have been widely applied in economic development initiatives in recent
39
40 years (see below). Thus, EIP developers are striving for not just an agglomeration of
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42 businesses (i.e., a standard industrial park), but an agglomeration with links between
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44 the businesses, i.e., a cluster. We now turn to a review of the clusters literature in
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46 regional development to provide some more detailed context.
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56 CLUSTER PERSPECTIVES IN REGIONAL DEVELOPMENT

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58 The purpose of this section is to present our three key meta-themes of external
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60 economies of scale, networking and policy, which we will use to review both the IE

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3 literature and our case studies. There is an extensive regional development literature
4 offering a range of theoretical perspectives on the cluster concept. A comprehensive
5 review is not possible here (see STORPER (1997), NEWLANDS (2003) and
6 BENNEWORTH and HENRY (2004) for overviews) but six main perspectives can be
7 identified:
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9

- 10 1. Industrial districts: agglomeration economies (co-located small companies
11 enjoying the economies of scale otherwise confined to larger operations)
12 originating with Alfred Marshall (MARSHALL, 1890); the benefits relate to
13 access to a common pool of labour, shared services, and trade between companies
14 within the agglomeration.
15
- 16 2. New industrial districts (NID): Small companies exploit a market niche by
17 specialising, but gain flexibility by co-operating with co-located companies with
18 compatible interests. Co-operation is founded on social and business related
19 contact between individuals (PIORE and SABEL, 1984); based on observations of
20 the Third Italy and southern Germany. The concept of ‘untraded
21 interdependencies’ (STORPER, 1997) emphasises the benefits of inter-firm co-
22 operation founded on trust and exchange of tacit knowledge.
23
- 24 3. Transaction cost theory: in the era of post-Fordist vertical and horizontal
25 disintegration companies face a potentially costly increase in the number of
26 external transactions. However, trust built of personal contact with proximal firms
27 reduces the complexity and thus costs of transactions (e.g., SCOTT, 1988).
28
- 29 4. Innovation and high technology: seeks to explain location of high-technology
30 industries, which are considered a driver for regional development (e.g.,
31 SAXENIAN, 1995); includes the concept of *innovative milieu* in which a
32 network of local businesses and institutions (e.g., of learning and policy making)
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3 provide a supportive environment for innovation (e.g., PERRIN, 1993, in
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6 STORPER, 1997).

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5. Institutional and evolutionary economics: technological developments are part of the drive for competitiveness characteristic of capitalism; development is 'path dependent' with present-day agglomerations the result of historical events. 'Institutional thickness' emphasises the role of extra-firm organisations (AMIN, 1999; SYDOW and STABER, 2002).
6. Porter's 'strategic management' concept of clusters: draws on agglomeration economies, but emphasises interfirm networking (PORTER, 1998). Businesses within a cluster may share a common value chain, or alternatively comprise competitors in a common industry (BATHELT, 2005).

Whilst each perspective is distinctive, they substantially overlap and the boundaries between them debatable (NEWLANDS, 2003). Therefore, rather than elaborate on each perspective in detail, we distil three key meta-themes: external economies of scale; networking; and policy, where the first two relate to explanations for the benefits of clustering. Our description of these meta-themes cannot provide a full picture of the nuances of each perspective, but we subsequently use these here to provide a basis to reanalyse eco-industrial initiatives from the perspective of the clusters literature.

External economies of scale

This meta-theme is the essence of agglomeration theories and refers to the shared access to factors of production and supporting institutions. In all the perspectives on clustering, a central theme is that companies have access to benefits that they cannot provide internally and for which they would not by themselves constitute a sufficient market to support an external provider. Deriving from the original work of

1
2
3 MARSHALL (1890) on industrial districts, this meta-theme displays varying degrees
4
5 of prominence in all the other perspectives. The notion of external (to the firm)
6
7 economies of scale concerns not just the relationships between manufacturers
8
9 themselves, but emphasises the potential for firms to benefit from shared access to
10
11 goods and services, such as a pool of suitably qualified and/or experienced labour, or
12
13 financial and legal firms. In PORTER'S (1998) conceptualisation of clusters,
14
15 agglomeration economies are central to the competitive advantage afforded to
16
17 participating businesses. The new industrial districts approach also draws on
18
19 Marshall's ideas, but in addition stresses the benefits to business of social cohesion
20
21 and personal contact (AMIN, 2000). A parallel can also be drawn between
22
23 MARSHALL'S work emphasising agglomeration benefits, such as a shared labour
24
25 pool, and other research emphasising the importance of institutions in catalysing
26
27 potentially innovative collaborations (STORPER, 1997). The involvement of
28
29 institutions such as universities is part of the explanation for success for regional
30
31 development based on innovation and high technology approaches (SAXENIAN,
32
33 1985).

40 41 Networking

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43 This meta-theme relates to opportunities for face-to-face contact between
44
45 representatives of different companies and organisations, which helps to generate
46
47 benefits most succinctly summed up as 'untraded interdependencies', as well as
48
49 reducing the cost of monetary-based transactions between firms. Given the ability of
50
51 firms to source goods (and services) globally, locational advantages are assumed in
52
53 part to reflect the dynamics of personal contact (e.g., AMIN, 1999, MORGAN, 2004).
54
55 The importance of personal contact and familiarity came originally from the new
56
57 industrial districts conceptualisation of agglomeration benefits (PIORE and SABEL,
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3 1984; AMIN, 2000). The institutionalist perspective emphasises that economically
4 successful agglomerations may be differentiated from others by the presence of key
5
6 institutions mediating interfirm collaborations (STORPER, 1997).
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10 Personal contact, be it institutionally mediated, purely social, or the result of
11 an employee moving between companies helps generate trust between individuals
12
13 (PIORE and SABEL, 1984; STORPER, 1997). The resulting benefits fall into two
14
15 categories as exemplified by two of the perspectives on clusters. First, the transaction
16
17 cost perspective emphasises the benefits of a greater willingness to do business with a
18
19 firm with which there is a personal link. This is particularly true in complex
20
21 circumstances, as opposed to a straightforward buyer-seller relationship (STORPER,
22
23 1997). Thus if trust is present, time and money are saved by avoiding having to draw
24
25 up a water-tight contract or build a personal relationship. Second, the concept of
26
27 'untraded interdependencies' captures the benefits of contact not related to formal
28
29 monetary transactions. One such is the exchange of tacit knowledge - knowledge
30
31 which cannot be readily written down, or 'codified' (HOWELLS, 2002). Knowledge
32
33 and its exchange are significant precursors to innovation, itself a key determinant of a
34
35 firm's competitiveness (e.g., MORGAN, 1997). The concept of innovative milieu
36
37 also draws on the importance of personal contact and tacit knowledge (CAMAGNI,
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39 1991).
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48 Policy

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50 Policy makers have displayed, and continue to display, substantial interest in cluster
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52 formation as a regional development initiative worldwide (MARTIN and SUNLEY,
53
54 2003; CUMBERS and MACKINNON, 2004; ST. JOHN and POUDER, 2006). One
55
56 inspiration is the evident economic growth stemming from the innovations emerging
57
58 from successful clusters such as the IT industry in Silicon Valley. However, the
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3 academic literature on regional development is far more ambivalent about the role for
4 policy initiatives in cluster formation and the necessity of 'institutional thickness'.
5

6
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8 Much of this literature advises against attempting to create clusters de novo as
9
10 opposed to nurturing clusters based on existing local/regional potential (MARTIN and
11
12 SUNLEY, 2003). Thus, the role for policy in cluster initiatives is confined to
13
14 providing assistance where the market has failed and where, despite some form of
15
16 agglomeration, the expected benefits have not emerged (NEWLANDS, 2003).
17
18

19
20 Policies may consist of providing opportunities or encouragement for one of the other
21
22 meta-themes above, e.g., for external economies (joint marketing, shared business
23
24 services); targeting to recruit the types of firms/organisations that are missing (e.g.,
25
26 from the supply chain); or providing opportunities for contact between firms, i.e.,
27
28 networking activities (MARTIN and SUNLEY, 2003). In the US context, some of
29
30 the literature on high tech development credits the development of successful clusters
31
32 to the impact of government investment, e.g., in the defence industry, although critics
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34 have pointed to enough exceptions to suggest that other factors must be critical to the
35
36 success of these regions (STORPER, 1997).
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40
41 ST. JOHN and POUDER (2006) caution that development agencies should be
42
43 realistic in the type of cluster they pursue, according to their particular geographic and
44
45 economic strengths. Studies of policy-driven efforts at network building in the UK
46
47 have indicated that successful networks, i.e. ones that generate lasting inter-firm co-
48
49 operation, are very difficult to generate without favourable preconditions such as an
50
51 identifiable issue of common interest or culture of co-operation (ATHERTON, 2003).
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54 Therefore intervention in pre-existing informal networks is more successful at
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56 generating lasting co-operation than attempting to establish new networks (HUGGINS,
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58 2001).
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ECO-INDUSTRIAL PARKS AS A CLUSTER DEVELOPMENT

We suggest that by their nature as an agglomeration of businesses with inter-linkages and the expectation of a competitive advantage for participants and economic development benefits for the host community, EIPs can be conceived as a type of cluster policy. In this section we will examine the issue more closely by reviewing the literature on EIPs from the perspective of these three meta-themes.

External economies of scale

Some of the benefits suggested for locating in an EIP are resonant with references in the clusters literature to external economies of scale (e.g., skilled labour supply, shared marketing, and specialist advice) (MARTIN et al., 1998). Some such benefits may relate to environmental issues, such as park-level regulatory compliance, or on-site recycling, but there is nevertheless an awareness of the potential economic benefits (LOWE, 1997; MARTIN et al., 1998). Indeed, in a study of Dutch eco-industrial parks, PELLENBARG (2002) found that external economies relating to non-environmental activities (e.g., parking facilities or safety systems) were more common than environment-related ones (e.g., utility sharing or heat cascading).

DESROCHERS (2002) points out that an industrial symbiosis network (in which he includes EIPs) is an example of urbanisation agglomeration economies, given that it comprises businesses from a variety of industries, and is not in this respect a novel phenomenon (DESROCHERS, 2002). However, the potential environmental benefits of agglomeration economies are not prominent in the clusters literature (CHERTOW et al., this volume). Industrial ecology features such as shared access to water supply or energy can bring about not only financial savings to the business involved, but also environmental savings (e.g., reductions in total

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3 water/energy usage) that are of public benefit (CHERTOW et al., this volume).
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6 Furthermore, there are significant distinctions between EIPs and other clusters,
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8 especially when the cluster is planned. For example, institutional support can be
9
10 important in the IE context as with other clusters and university based groups, public
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12 agencies or a combination of both are commonly involved (e.g., MARTIN et al.,
13
14 1998). However, in the IE context, these institutions tend to be more than simply
15
16 facilitators of collaboration. Rather, they are more likely to be playing a key policy
17
18 role leading the cluster formation initiative (see under 'policy' below).
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22 Thus there is a significant overlap between the IE and RD literature in the area
23
24 of external economies of scale, which supports the identification of IE as a cluster
25
26 perspective in RD terms. Explicit reference to economies accruing from
27
28 environmental initiatives is distinctive, especially the awareness of those benefits as a
29
30 public good.
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33 Networking

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35 One of the distinctive elements of IE amongst eco-efficiency initiatives for business is
36
37 its emphasis on interfirm co-operation. IE advocates the attempted optimisation of
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39 environmental issues on a sectoral or regional scale, rather than at the individual
40
41 company level. Thus the advantages of clustering accruing from opportunities for
42
43 face-to-face contact between representatives of different companies and organisations
44
45 could be of great importance in the context of an EIP. However, we will show that
46
47 there are critical differences in the expectations placed on networking between IE and
48
49 RD clusters.
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54
55 There is appreciation in the IE literature for the social networks highlighted by
56
57 the New Industrial District (NID) literature. The community of Kalundborg has been
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59 compared to a NID in terms of the density of interconnections of social networks
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2
3 between representatives of companies involved in the IS network (e.g., GERTLER,
4 1995; CÔTÉ and COHEN-ROSENTHAL, 1998; STERR and OTT, 2004; D'AMICO
5 et al., 2007). The importance of such links in implementing IE is underscored by
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7
8 D'AMICO et al.'s (2007) study of the policy-initiated formation of an IS network in
9
10 the Italian Industrial District of Murano, Venice. However, as both RD and IE
11
12 literature acknowledge, this type of setting is exceptional and certainly cannot be re-
13
14 created on a policy-relevant time scale.
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20 The networking and trust building that goes into making interfirm
21
22 relationships possible are not always appreciated in the eco-industrial literature
23
24 (GIBBS, 2003). There is frequently a more normative concern for matching inputs
25
26 and outputs (e.g., MARTIN et al., 1998; KINCAID 2003). This concern arises from
27
28 the premium that the IE literature puts on physical (i.e., material, energy and/or water)
29
30 exchanges between companies. Whereas in much of the clusters literature the benefits
31
32 of clustering relate to the potential for personal contact and the generation of untraded
33
34 interdependencies, in the industrial ecology literature the focus is more firmly on
35
36 benefits relating to *physical* transactions (e.g., CÔTÉ and COHEN-ROSENTHAL,
37
38 1998; MARTIN et al., 1998). Thus, the focus in IE clusters is not on the benefits of
39
40 reduced transaction costs in RD terms, but on the financial rewards of the transactions
41
42 themselves. In the transaction cost literature the assumption is that a company is
43
44 achieving economic savings and/or operational flexibility by outsourcing certain of its
45
46 activities (STORPER, 1997). The cost savings from agglomeration come from the
47
48 ability to more easily set up arrangements with companies with whom one has a
49
50 personal connection; it is not any savings in the transactions themselves that are
51
52 fundamental to the theory (albeit transportation costs may be reduced). By contrast,
53
54 the economic savings in IE come from the physical transactions themselves, e.g., the
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3 buying of another company's by-product as opposed to a virgin material. For the
4
5 company selling the by-product the arrangement is even more beneficial - the cost of
6
7 disposal of a by-product has become an income through its sale.
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11 However, transactions involving waste materials or energy are often well
12
13 outside the core interests of a company. This means that many companies are grossly
14
15 under-informed about the amount and composition of waste they produce, the costs of
16
17 disposal, and the costs of the raw materials, energy and labour that went into
18
19 producing their 'waste' (LANDER, 2006). Thus they may have little incentive to
20
21 explore waste minimisation or more imaginative disposal routes. Moreover, even
22
23 when the full cost of waste is apparent, it will seldom be a sufficient proportion of a
24
25 company's expenses to be a significant factor in decisions about where to locate - a
26
27 significant handicap for planned EIPs (STERR and OTT, 2004). Furthermore, what
28
29 was once a simple market relationship with a waste disposal company could become a
30
31 far more complex and collaborative venture with a symbiosis partner. Regulatory
32
33 issues such as duty of care also make trust a particular concern in the trading of waste
34
35 (STERR and OTT, 2004). Thus in effect the direct and indirect costs of an industrial
36
37 symbiosis transaction are likely to be greater than those associated with the alternative.
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44 The volume and frequency of supply as well as its precise composition is
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46 likely to be highly significant to a company relying on a by-product as an input to
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48 production (SCHLARB, 2001). Since the items in question are by-products,
49
50 companies cannot readily modify production rate or composition to suit a potential
51
52 user, in the same manner as they would consider accommodating a new customer for
53
54 their core products. STERR and OTT (2004) argue that whilst increasing the scale of
55
56 an industrial symbiosis network from being park-based to that of a region will
57
58 increase the potential for input-output matches, the difficulty of achieving personal
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3 contacts is increased. While increasing the scale of search for input-output matches
4
5 increases the chance of success, there is clearly a distance-decay effect on the
6
7 economic viability of transporting materials, especially relatively low value ones such
8
9 as by-products. Furthermore, for energy (heat or steam) transfers, there are
10
11 technological limitations, such that physical proximity is a necessity (KORHONEN,
12
13 2002).
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16
17 Whilst interfirm co-operation is a central theme of the IE literature, the focus
18
19 is more on the benefits that would accrue from establishing relationships than on the
20
21 networking necessary to establish them. Furthermore, we argue that resemblance to
22
23 the transaction cost perspective is superficial, since the 'costs' of IE 'transactions' are
24
25 likely to be more expensive than those of more standard options.
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28 29 Policy

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31 The benefits to business of external economies and interfirm exchanges have been
32
33 argued to make eco-industrial development useful as an economic development tool
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35 (LOWE, 1997; COHEN-ROSENTHAL, 2003). In the US the implementation of
36
37 industrial ecology in the form of EIPs received federal backing from the
38
39 Environmental Protection Agency and the President's Council for Sustainable
40
41 Development. The latter was discontinued in 2000, but the Economic Development
42
43 Administration (EDA) still offers financial support for eco-industrial developments
44
45 through its Public Works and Economic Development Investments programme (EDA,
46
47 2006). Eco-industrial development as a policy has also been adopted in Europe
48
49 (notably the Netherlands) (e.g. VAN LEEUWEN et al., 2003; MIRATA, 2004); parts
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51 of Asia (e.g., YANG and LAY, 2004) and Australia (ROBERTS, 2004).
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58 There is an on-going debate within the industrial ecology literature as to
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60 whether implementation of its principles would be better achieved by planned EIPs or

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3 evolving IS projects (i.e., self-organising systems) (e.g., CÔTÉ and COHEN-
4 ROSENTHAL, 1998; CHERTOW, 2007) and much of the early optimism for the
5 development of EIPs has given way to pragmatism (CHERTOW, 1999; 2007).
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9
10 DESROCHERS (2002) develops a similar argument to those regional development
11 researchers who argue that clusters cannot be created de novo. However, it is more
12 widely considered that there is a role for the public sector in supporting EIP
13 development (e.g., VAN LEEUWEN et al., 2003; GIBBS and DEUTZ, 2005). There
14 are some similarities between the kinds of limited intervention recommended by
15 regional development analysts regarding cluster policy and those proposed in eco-
16 industrial developments. CÔTÉ and COHEN-ROSENTHAL'S (1998)
17 recommendations for developing an EIP, for example, include establishing links
18 between on-site companies and suppliers/customers in the community, establishing a
19 joint training facility, and seeking to attract companies to fill niches. LOWE (1997:
20 59) urges policy-makers not to 'over-plan'. He sees the public sector role as setting
21 the conditions for businesses to negotiate exchanges. Preparatory activities could
22 include investigating the existing mix of industries in a region to assess potential by-
23 product flows. COHEN-ROSENTHAL and MCGALLIARD (1998) saw this type of
24 activity as an application of Porter's cluster approach to economic development, i.e.,
25 looking for nascent clusters and seeking to develop them. HEERES et al. (2004)
26 compared the experiences of private sector-led EIPs in the Netherlands with those of
27 public sector-led EIPs in the US. They concluded that public sector involvement in
28 EIP development can be a positive hindrance- the privately-led parks they examined
29 had more success at attracting private sector participation.

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As with the RD literature, the IE literature identifies economic benefits to
communities of hosting a successful cluster. IE-related clusters (i.e., EIPs) have been

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3 seen as an attractive proposition for sustainable local economic development.
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6 However, the IE literature is divided on the role of policy in cluster establishment
7
8 between some authors taking an approach akin to the RD literature (favouring cluster
9
10 evolution). A more widely held view is that there is a role for policy intervention
11
12 (which varies from facilitation to detailed planning), which distinguishes the IE
13
14 approach from RD perspectives.
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18 We now turn to an investigation of the issues raised so far through an analysis
19
20 of empirical data derived from nine US EIPs. Our two aims in this study are to 1)
21
22 investigate whether IE is simply an environmentally explicitly version of an existing
23
24 approach to RD, or should it be seen as a distinct perspective; and 2) to derive policy
25
26 implications for IE and RD of recontextualising IE as a cluster perspective. So far on
27
28 the basis of our reviews of the treatment of the meta-themes in the IE and RD
29
30 literature, we have argued that IE-based clusters can be seen as a distinct form of
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32 clusters in the RD tradition. We will now investigate that argument further with the
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34 data from our case studies. This will also enable us to address our second aim.
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38 RESEARCH METHODS

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41 The research on which the remainder of this paper is based was conducted in two
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43 phases. The initial, extensive, phase of the project identified eco-industrial
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45 developments and obtained background information on the characteristics of each
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47 initiative through web-based research. We identified over 60 sites worldwide in 2002.
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49 However, as sites were predominantly in the U.S.A. (35) and Europe (26), we
50
51 confined further study to those locations. We attempted to contact a representative of
52
53 each US and European site in order to validate the Internet data. An email, fax and
54
55 telephone survey was conducted between January and March 2002. A total of 19
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57 surveys were returned (9 from the USA and 10 from Europe) - see GIBBS et al.
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3 (2005). We found that many EIPs included on prominent web-lists (e.g., Cornell
4 University Work and Environment Initiative and University of Southern California's
5 Centre for Eco-industrial Development) were either at early stages of development, or
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10 already been abandoned; relatively few were operational.
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13 The second, intensive, phase of the research was an in-depth study of selected
14
15 EIPs involving face-to-face interviews, as well as analysis of secondary materials.
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17 Limiting the number of cases examined allowed a far more in-depth approach than
18
19 could be applied to all cases on a feasible time and expense scale. We concentrated
20
21 on the US, where there has been a concerted policy drive to establish EIPs and the
22
23 largest concentration of EIPs in one country. Furthermore, the US sites more
24
25 explicitly identify themselves with the concept of industrial ecology than the
26
27 European ones. Projects were selected to represent the range of stages of
28
29 development (planning to operational) that the EIPs had reached, however none was
30
31 engaged in by-product exchange at the time of interview. Specific site selection was
32
33 controlled by their willingness to participate and also 'snowballing' (as in
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35 LONGHURST, 2003, p. 124) where the director of one site arranged a visit to one in
36
37 which he had formerly been involved. In total, we included nine sites, which whilst
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39 not a randomly selected sample, covered 50 % of the then active US sites.
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46 At each site up to 8 interviews were carried out with individuals selected from:
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48 the park manager, project developer, local authority representative, consultants,
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50 participating firms, environmental organisations, community representatives, and the
51
52 local chamber of commerce. Interviewing multiple representatives of each site
53
54 enabled a 'triangulation' of factual information and to explore differing perspectives -
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56 for example, tenants tended to have a less idealistic view of EIPs than developers.
57
58 The interviews were semi-structured, open-ended and conversational in style (see
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3 LONGHURST, 2003). We prepared a list of questions appropriate for each type of
4 person to be interviewed, which covered both the development and operational phases
5 of EIPs. Questions addressed both subjective issues such as the motivations behind
6 setting up the EIP, where the idea for an EIP had come from, and what the
7 interviewees' understood by sustainable development, as well as more factual areas
8 such as how funding was obtained or being sought; and what attempts were being
9 made to, or anticipated for, encouraging networking between site occupants.
10 Interviews were transcribed in full and analysed using the approach that CRANG
11 (2005) terms 'analytic induction' (p. 224). The texts were coded as themes emerged,
12 and re-analysed as new themes emerged and/or our appreciation of existing ones
13 became more nuanced. The use of secondary materials from and relating to the sites
14 provided additional information as well as another form of 'triangulation' to back-up
15 the information from multiple interviewees. We subsequently communicated by
16 email and telephone with park representatives to update park status. Table 1 shows
17 the main features of the case studies used herein based on secondary data. As primary
18 data were collected on the understanding of anonymity, sites have been arbitrarily
19 numbered from 1 to 9 for reference in the main empirical section below. Secondary
20 data are referred to by the name of the park.

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Table 1 about here

EIP PROJECTS IN THE U.S.A.

In this section we review interview, survey and secondary data from each of the sites with respect to the three meta-themes: external economies of scale; networking; and policy. We analyse what the parks envisage(d) and their strategies for implementation, as well as what has so far been achieved in practice.

External economies of scale

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3 In this section we consider the role that external economies of scale have played in the
4 case study EIPs in order to compare this to their role in the RD concepts of clusters.

5
6 External economies of scale are an important feature of the advantages that the case
7 study EIPs consider themselves to offer to tenants. For example, the Town of
8 Londonderry website proclaims that the EIP ‘allows businesses to save money and
9 work more efficiently through collective environmental management’ⁱ. Some
10 economies relate to the location of the park in a manner that would apply to any
11 economic development. In this category are economies of scale beyond the park
12 boundary. For example, the location of the Cape Charles EIP was selected for its
13 access to road, rail and port facilities. Economies of scale within EIPs may include
14 shared management and maintenance of building(s) and/or grounds (e.g., Devens,
15 PEEC, Cape Charles, Front Royal, Londonderry). In some cases facilities such as
16 conference and meeting rooms, eating and washroom facilities are shared between
17 tenants (e.g., PEEC). Environmental economies of scale come from communal waste
18 disposal and/or recycling, and utility sharing in the form of renewable energy (e.g.
19 solar energy at Cape Charles, a ground source heat pump at PEEC). These types of
20 features are referred to in promotional material, implying that the EIPs are aware of
21 their economic appeal to potential clients.

22
23 One of the primary external economies is access to a shared labour pool. All
24 the EIP case studies have job creation as one of their aims; some have explicitly
25 referred to this as an opportunity for employers. The Cape Charles’ web siteⁱⁱ
26 boasted ‘an ample labour pool’, which is ‘keen to work’. Conversely, Londonderry
27 boasts that New Hampshire has a highly educated citizenry with the highest
28 concentration (per 1000 population) of high-tech workers in the USⁱⁱⁱ. Three of the
29 EIPs have had a significant involvement with local universities. This engagement has
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3 taken various forms including park development, research into industrial symbiosis
4 and as potential tenants, while the development team for Ecolibrium is partly based at
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6 the University of Texas, Austin. At EIP 4 collaboration took the form of research into
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8 potential use of waste heat in aquaculture. At EIP 1 a local university had agreed to
9
10 use the educational facility that is the centrepiece of the park. Delays in establishing
11
12 the park have resulted in the university pulling out.
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17 The case study EIPs were all aware of the financial benefits of economies of
18 scale. These include a mix of environmentally focused economies (collective waste
19 removal/recycling) and standard ones, as in the Dutch examples explored by
20 PELLANBURG (2002). The three active sites all offer external economies, including
21 both environmental and more standard ones. In VAN LEEUWEN et al.'s terms all the
22 projects exhibit at least spatial planning and the active ones some form of utility
23 sharing. Thus EIPs fit closely with this aspect of the clusters literature, both in theory
24 and practice, with environmental awareness being an additional distinctive feature.
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36 Networking

37 Here we consider the approach that the case study EIPs have taken to networking in
38 order to make a comparison with the RD approach. The goal in all the case study
39 EIPs has been to achieve an agglomeration of interlinked firms. In almost all cases
40 these were envisaged as including energy and/or material exchanges (i.e.,
41 transactions). However, some sites are attempting to recruit to a pre-conceived
42 symbiosis network, while others have an open recruitment policy. In the latter case
43 the aim is to promote networking between tenants with a view to assist the evolution
44 of IS on a medium to long time scale. The EIPs attempting to recruit to a symbiosis
45 network are Dallas, Red Hills, and Ecolibrium. EIP 1 is based around a dual
46 recycling and educational theme. The EDA funding that helped develop the site was
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3 conditional on the recruitment of tenants from a specified range of environment-
4 related activities (e.g., recycling, solid waste management, and research into wetlands
5 and waste water treatment). The Red Hills developers have identified a number of
6 potential synergies that would fit with by-products of the operational mine and power
7 station, though other types of businesses would be considered.
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15 The operational and pre-operational US EIPs studied have at least partially
16 separated the processes of attempting to form an initial physical agglomeration of
17 businesses from subsequent attempts to establish a symbiosis network (Cape Charles,
18 Devens, PEEC, Londonderry). Bassett Creek Valley was also envisioned as
19 following this approach. At Front Royal, notwithstanding its identification with the
20 EIP movement, the aim was to establish an office park. In these parks the tenant
21 recruitment phase resembles a standard economic development exercise in attracting
22 inward investment.
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34 The second development phase for these EIPs is building links between
35 tenants. Co-location is only one step towards establishing interfirm linkages:
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39 We realised that we needed to figure out a way to improve communication
40 among the businesses here...[for] the concept of industrial ecology to work that
41 one thing that helps is having businesses in proximity to each other. But
42 another aspect that is really important is that the businesses know what each
43 other is about and that formally or informally linkages can happen.
44 (Environmental Programme Organiser, EIP 8).
45
46

47 A number of strategies have been adopted to encourage networking amongst
48 site occupants. The Londonderry by-laws require occupants to participate in social
49 functions, such as supporting an educational centre to promote the EIP and its
50 practices to the community (TF MORAN INC, undated). At Cape Charles
51 networking, including transactions, was encouraged by a system that rewards socially
52 or environmentally beneficial activities (including working with other companies on
53 how best to meet the environmental goals of the park) by a reduction in rent
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3 (MCGUIRE et al., undated). Devens has developed a peer recognition scheme (the
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5 EcoStar Program) for environmental and/or social accomplishments including by-
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7 product exchange^{iv}.
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10 EIP organisers appreciate that they cannot force linkages, certainly not in
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12 terms of materials exchanges, for which there needs to be a match of supply and
13
14 demand in terms of quantity and quality of material. However, networking events can
15
16 help to set the pre-conditions for exchanges:
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20 It could build some of these relationships. It is already starting to do that with
21
22 the steering committee, build some relationships among the businesses here so
23
24 that they're more likely to do the exchanges if the exchanges make economic
25
26 sense for them. (Environmental Programme Organiser, EIP 8).

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28 However, there is little evidence of industrial symbiosis at our case studies - none of
29
30 our case studies meet CHERTOW's (2007) definition of an industrial symbiosis
31
32 network, although only Front Royal has dropped its networking aspirations altogether.
33
34 Devens is a modest example of symbiosis, but is actively encouraging more. The
35
36 power plant at Londonderry uses waste water for cooling purposes and the ash from
37
38 the power station at Red Hills is recycled into cinder blocks off-site. PEEC is
39
40 involved in neighbourhood scale efforts; although the current mix of tenants makes
41
42 this unrealistic within the building itself. At Dallas recruitment has been too slow to
43
44 make industrial symbiosis feasible yet. The sites that have been most successful at
45
46 recruiting tenants have not been restrictive in their recruitment policy. However, the
47
48 consequently diverse and unplanned mixture of tenants has contributed to the
49
50 difficulties in establishing symbiosis beyond a token level. For example, tenants at
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52 EIP 8 claimed particular circumstances militate against participating in by-product
53
54 exchanges. One firm, carrying out pharmaceutical R&D is banned by the Food and
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56 Drug Agency from using recycled goods. That company's by-products are classified
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58 as hazardous waste and are sent for incineration. Another company manufactures
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3 parts for aircraft and claim quality as their priority in sourcing materials to ensure
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5 product performance.
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8 The tenants who were interviewed were not well informed on the principles of
9
10 industrial ecology. In every case they had moved only because the company was
11
12 looking to relocate or expand and the location suited: 'Initially [an EIP] wasn't what
13
14 we were looking for when we moved up here... we were looking for a new facility, a
15
16 place to build, and something that was centrally located to access our customers'
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18 (Company Representative, EIP 8). However, aside from the locations, aspects of the
19
20 parks were attractive, such as links between Devens and the state Environmental
21
22 Protection Agency (EPA), which smoothed the permitting process. At Red Hills a
23
24 new tenant will use coal from the mine to research and demonstrate a technology for
25
26 converting coal into a liquid fuel^y. The locational decision appears to have included a
27
28 very traditional concern to minimise the transportation costs of the major raw material,
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30 aided by grants from the Mississippi Development Agency.
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36 Devens' pro-active approach to bringing firms together has resulted in
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38 collaborations, albeit so far only minimal symbiosis. Interviewees from two firms
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40 participating in the steering group setting up Devens' incentive scheme have
41
42 established a functional relationship with each other and a third firm. Collaborations
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44 between these firms include purchase of safety equipment, investigating joint
45
46 recycling of waste, and exchange of information on safety procedures. At EIP 3
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48 networking initiatives have been less pro-active and less successful. One tenant had
49
50 been attracted by the spirit of the enterprise and the environmental standards of the
51
52 building. He and another tenant at the same park had both expected more networking
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54 opportunities than have materialised. The park has an e-newsletter as well as a variety
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3 of shared facilities, but this appears to have had a limited effect on communication, let
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5 alone collaboration.
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8 To a variable extent, the active parks are promoting networking between
9
10 existing tenants not unlike more conventional clustering activities (BENNEWORTH
11
12 et al., 2003)). Spatial proximity and commitment to sustainability required by some
13
14 of these sites means they are starting the cluster formation process with potentially
15
16 favourable pre-conditions. A newly formed park is an agglomeration of businesses
17
18 somewhere between the level of 'potential' and 'emerging' cluster (ATHERTON,
19
20 2003): that is, common interests and need or opportunity for co-operation has been
21
22 identified, but is at a preliminary level regarding trust building. Potentially, an EIP
23
24 already has 'the development of mutual awareness and a local common enterprise'
25
26 (RACO, 1999: 956) regarded as necessary for the formalisation of clusters. This is
27
28 supported by the willingness of tenants to participate in networking activities,
29
30 notwithstanding that they had located in an EIP largely for non-environment related
31
32 reasons. The choice of location may also indicate a preparedness to engage in
33
34 networking activities outside core company activities (c.f., MORGAN et al., 2000).
35
36 However, the tenants interviewed were environmental managers of multinational
37
38 companies. Therefore, environmental issues are core to their own interests, even if
39
40 not to the company as a whole.
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48 Networking related ideas and activities have been fundamental to the sites
49
50 studied. However, recruitment is a necessary precursor to networking and the
51
52 regional setting appears to be a stronger determinant of recruitment success than
53
54 variations in the approach of the parks. The difficulty of exploiting interfirm
55
56 relationships to achieve physical flows between firms is evident from the lack of a
57
58 significant IS network at any of these EIPs. The experience of the case study EIPs
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1
2
3 also cautions against seeing EIP status as a factor likely to promote efforts at creating
4
5 a cluster de novo. Several parks have had to downgrade or abandon their
6
7 environmental aims, suggesting an initial under-appreciation of the challenges they
8
9 faced.

10 11 Policy

12
13 In this section we consider the role of policy in the development of the case study
14
15 EIPs, in order to compare this to the role of policy in RD clusters. All of the EIPs
16
17 studied are planned initiatives, chiefly aimed at re-developing specific
18
19 brownfield sites, but with no pre-existing tenants. In all cases (based on survey,
20
21 interview and secondary data) there is an expectation that the development would
22
23 generate benefits for the communities in which they are situated. Indeed, most are
24
25 public sector initiatives led by economic development agencies (see Table 1). Cape
26
27 Charles, Devens, Londonderry, and Bassett Creek Valley were initiated as part of
28
29 larger sustainability agendas, whereas others (e.g., Front Royal, Dallas, Red Hills) are
30
31 more isolated sustainability initiatives for agencies whose primary function is
32
33 economic development. Londonderry was initiated by the town's Planning and
34
35 Economic Development Department, but the town's inability to afford to develop the
36
37 site itself has meant that it was sold to a private developer and is the only site to be
38
39 developed by private sector funding (LOWITT, 2003). Nevertheless, the site was
40
41 sold on the condition that vision of the planners was implemented via a strict set of
42
43 covenants (LOWITT, 2003). The PEEC is exceptional in that it is a community-led
44
45 initiative. However, it is aimed precisely at attracting economic benefits in an
46
47 environmentally-friendly context to a deprived neighbourhood^{vi}.

48
49 As stated, all the EIPs studied were planned, and all but two were public
50
51 sector-led. The three that have been the most successful at tenant recruitment so far
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3 are Devens and both of the exceptions to public sector status: PEEC is community-led
4 and Londonderry was privately developed following a public sector initiative. Red
5
6 Hills and Dallas remain at early stages of development. The Dallas Eco Business
7
8 Park is an on-going development project for the City of Dallas. Front Royal is
9
10 actively recruiting companies, but the environmental theme has been played down.
11
12 The Avtex Fibres website currently refers to 'eco-friendly office space'^{vii}, a step
13
14 removed from the previous planned 'eco-office park', which was already a step back
15
16 from the earlier interest in an 'eco-industrial park'. Eco-industrial principles could yet
17
18 be an element of the redevelopment of Bassett Creek Valley, but the City-led
19
20 redevelopment is still at the planning stages. The Austin EIP does not appear to have
21
22 progressed beyond conceptual stages. The Cape Charles EIP has closed as a result of
23
24 difficulties in recruiting tenants.
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31
32 Whilst the IE literature is divided on the possibilities for implementation of its
33
34 principles via the planned formation of EIPs, this is precisely what has been attempted
35
36 by each of the case studies. Furthermore, although the net result of the difficulties in
37
38 establishing symbiosis is that EIPs in practice resemble standard clusters far more
39
40 than EIPs in theory, the distinction is still important. Labelling themselves as EIPs
41
42 does make EIPs distinct. This can either help or hinder recruitment, but means that
43
44 they are judged by additional criteria for success compared to standard local
45
46 development projects. Furthermore, whilst EIP status may open up alternative
47
48 funding sources, these may limit recruitment options (as at EIP 1). In other words, in
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50 being more ambitious than more conventional development projects, EIPs may
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52 compromise their ability to succeed on any level.
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CONCLUSIONS

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3 The main aim of this paper has been to examine whether EIPs can be conceptualised
4 as an environmentally-based variant of a cluster strategy and to consider the policy
5 implications of such a re-conceptualisation. We have argued that whilst EIPs have
6 important features in common with more mainstream conceptualisations of clusters,
7 there are significant differences in economic as well as environmental terms.

8
9
10 Common features include the use of EIPs as economic development initiatives as well
11 as an appreciation of the economic significance of both external economies of scale
12 and networking. A major distinguishing feature of EIPs is that development agencies
13 are typically trying to build clusters de novo, rather than enhance existing ones.

14
15 However, more significant differences between EIPs and other clusters are an
16 awareness of the environmental benefits of agglomeration (CHERTOW et al., this
17 volume), awareness of economic benefits in environmental practices, the nature of the
18 envisaged transactions between cluster members and the sources of cost savings if
19 those transactions were realised. The physical exchanges characteristic of an
20 industrial symbiosis cluster are not a trivial variation on the clustering theme.

21
22 Symbiosis transactions by their very nature involve by-product material and energy
23 exchanges. These will be of lower value and less interest to a firm than its products,
24 but may nonetheless involve issues of confidentiality. It is the need for, and the
25 nature of, the transactions that make EIPs a highly ambitious cluster strategy. Neither
26 localisation economies from companies in a given sector (all with similar input needs
27 and by-products to each other), nor urbanisation economies from companies in a
28 broad collection of industries will necessarily offer potential material or energy
29 exchanges. Thus whilst EIPs have commonalities with other cluster perspectives in
30 terms of their engagement with the three meta-themes, they do not fit comfortably
31 into any of the recognised cluster perspectives.

Policy implications of EIPs as a cluster perspective

The second aim of the study was to derive the policy implications of conceptualising EIPs as a distinct cluster perspective. This is especially pertinent in the light of the significant gap between EIP aspiration and achievement that we have highlighted.

Implications for regional development

Some of these initiatives are being led by economic development agencies (Table 1); others can learn from these attempts to infuse IE principles into RD initiatives. The shortfall in IE results compared to expectations sends a clear cautionary signal that attempting to implement the principles of IE will not provide a simple, economically advantageous means to address environmental issues in a local or regional development strategy. The practical difficulties of IE implementation are best understood if it is acknowledged that EIPs are 'clusters' and will share the common difficulties and uncertainties of other cluster approaches in terms of transferring the successful features from one location to another. Some of the case study EIPs are in locations where attracting other forms of economic development generally has proved difficult. Opting for an IE approach has not therefore been a way to transcend economic and geographic realities. It is also necessary to understand the distinctiveness of EIPs in cluster terms in order to appreciate the economic realities of the beguiling simplicity of the ecological metaphor. The distinctive features of EIPs as clusters include the need for physical exchanges, which can involve complex negotiations/technical arrangements pertaining to items which for potential symbiosis partners are low priority items. For many firms these may simply be items they wish to dispose of without incurring excessive costs or uncertain liabilities. Such factors significantly add to the challenges involved.

Implications for IE

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4 Importantly, the clusters literature indicates the uncertainty of defining what is
5
6 generating the success of successful regions and, therefore, what policy makers should
7
8 be attempting to emulate (MARTIN and SUNLEY, 2003). Most of the cluster
9
10 concepts, such as New Industrial Districts, or transaction costs approaches apply to
11
12 specific, limited circumstances (STORPER, 1997). The recognition of the importance
13
14 of institutions in economic development could suggest a possible pathway for policy,
15
16 but is no guarantor of success: 'while in some circumstances different places can learn
17
18 from each other, in general there are few easy opportunities to borrow institutions.
19
20 Instead there is the complex task of institution building appropriate to the social,
21
22 economic, legal and cultural norms of different localities' (NEWLANDS, 2003: p.
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27 530).

28
29
30 Significantly, for EIPs, economic success and ability to construct a symbiosis
31
32 network do not necessarily go together. Whether the environmental theme of the case
33
34 study developments sets a higher hurdle for tenant recruitment compared to other
35
36 cluster initiatives, or acted as a useful tool for market differentiation, their economic
37
38 success ultimately reflects factors beyond the control of developers. However, the
39
40 experiences of the active EIPs, and Devens in particular, indicates what can be
41
42 achieved when developers focus first on the characteristics of EIPs that they can
43
44 control and second on providing the pre-conditions for more elusive ones to evolve.
45
46 The environmental achievements of both EIPs that are financially viable and those
47
48 that are less so are dominated by 'economy of scale' features such as environment
49
50 award-winning premises and environmentally sympathetic landscaping. These may
51
52 be desirable ends in their own right, but represent at best a partial success as an EIP.
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55 However, these types of initiatives can be precursors to closer co-operation. The
56
57
58 clusters literature suggests that generating successful networks, i.e. ones that generate
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3 lasting inter-firm co-operation, requires favourable preconditions such as an
4
5 identifiable issue of common interest or culture of co-operation (GERTLER, 1995,
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7 HUGGINS, 2001). Location within an EIP may provide the proximity to overcome
8
9 the largest problem for small companies, i.e., time (HUGGINS, 2001). The EIP
10
11 setting helps to provide organisational as well as geographical proximity (TORRE and
12
13 GILLY, 2000; BOSCHMA 2005). However, the case study interviews indicate that
14
15 this organisational proximity is not yet well developed. There is a lack of social depth
16
17 to the contacts at present, compared to those characteristic of new industrial districts
18
19 (AMIN, 2000). Devens has been more successful than the other active sites at
20
21 building on successful spatial planning or utility sharing (c.f., VAN LEEUWEN et al.,
22
23 2003) to achieve inter-firm networking, albeit that symbiosis has yet to develop. The
24
25 difference between Devens and PEEC and Londonderry EIPs in this regard is the
26
27 EcoStar programme, which provides both incentives for collaboration and
28
29 opportunities for contact. Thus for any policy-driven network a high level and
30
31 protracted period of intervention is required to crystallise the potential for apparently
32
33 spontaneous inter-firm co-operation to come about. For those EIPs that have
34
35 struggled to achieve financial sustainability, an appreciation of the clusters literature
36
37 might have helped to guide their expectations and approach to tenant recruitment.
38
39 EIPs 3 and 7 both expressed disappointment that whilst they had initially identified
40
41 tens of potential tenants, very few would even consider relocating. The would-be
42
43 tenants had good reasons to be where they were already. Having a clear theme to EIP
44
45 developments was not in and of itself a magnet to tenants, even those whose business
46
47 fitted squarely into the theme. Local authorities should not abandon their economic
48
49 development objectives simply because there are clear challenges to achieving them.
50
51 They should also not abandon their environmental principles, indeed a number of the
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2
3 case study sites have selected eco-industrial development in reaction to environmental
4
5 problems generated by former activities. However, they should be realistic as to the
6
7 strengths and weaknesses of their locality, and should be cautious in their decision to
8
9 aim for this specialised and distinct type of clustering represented by EIPs. This
10
11 realism can only be aided by the awareness that EIPs are one of a number of forms of
12
13 cluster and an appreciation of the mainstream perspectives on clustering.
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Table 1. Main Features of Eco-industrial Developments in Interview Survey (developed from Gibbs and Deutz, 2005)

Park	Location	Developer and Funding	Objectives	'Greenness'	Status
Devens Planned Community, MA	Former army base, rural area	Public - including Federal	Balancing economic development, environmental performance and social values	Developing Eco Star Program to promote environmental achievements including IS; green building incentives	Opened 1996; 75 tenants; 4,000 jobs; EcoStar programme in place
Phillips Eco Enterprise Center, MN	Urban area, deprived neighbourhood	Community group; public (state, county and city) & private	Living wage jobs, clean industries	Architecture, some 'green' tenants; links with the community and planning CHP plant	Opened 1999; no IS on site, but involved in neighbourhood projects
Port of Cape Charles Sustainable Technology Park, VA	Rural location in transition from agriculture and food processing to service economy	County economic development agency; public (county, federal and state)	Creation of living wage jobs in context of sustainable development	Architecture, covenants, points system	Opened 2000 but limited recruitment; offered for sale for private development in 2004
Londonderry Eco-industrial Park, NH	Small community with 2 superfund sites, adjacent to airport and freeway to Boston	Commercial developer; private	Strengthen local economy, reduce environmental impacts	Covenants, architecture, gas fired power plant as anchor tenant, uses treated wastewater from near-by town	Opened 2003; limited recruitment, covenants still in place now overseen by local authority
Red Hills Ecoplex, MS	Rural location, next to lignite mine and power plant, high job losses	County economic development foundation; public (State)	Job creation in sustainable context	Recruiting for loop closing, power plant as anchor tenant	Anchor businesses in place 2003, tenant recruitment ongoing, now less focused on prescribed symbioses.
Dallas Eco-industrial Park, TX	Adjacent to landfill in underdeveloped neighbourhood, South Dallas	City economic development and brownfield development departments; public (Federal and city)	Job creation, neighbourhood redevelopment	Environmental education, recycling	Educational building open 2003; recruitment slow

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Ecolibrium, Computer and Electronic Disposition, Austin, TX	Outskirts of Austin on major landfill site	Consortium - university based, private sector and federal economic development agency; public (Federal)	Reduced waste to landfill, job creation	Recycling computers & electronic equipment	Planned; grant from EDA
Front Royal, Eco Office Park, VA	Washington DC commuter belt, superfund site	Town/county economic development authority; public (Federal), private (company liable for clean-up)	Jobs for residents, reduce commuting outside town	Architecture, networking	Major progress in clean up, historic building restored as main office, but 'eco' credentials now dropped
Bassett Creek, MN	Industrial/commercial site north of downtown Minneapolis	Consultants; public (city)	Creating labour intensive businesses	Networking - energy, materials, personnel	The neighbourhood redevelopment initiative still in planning stages

Notes

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