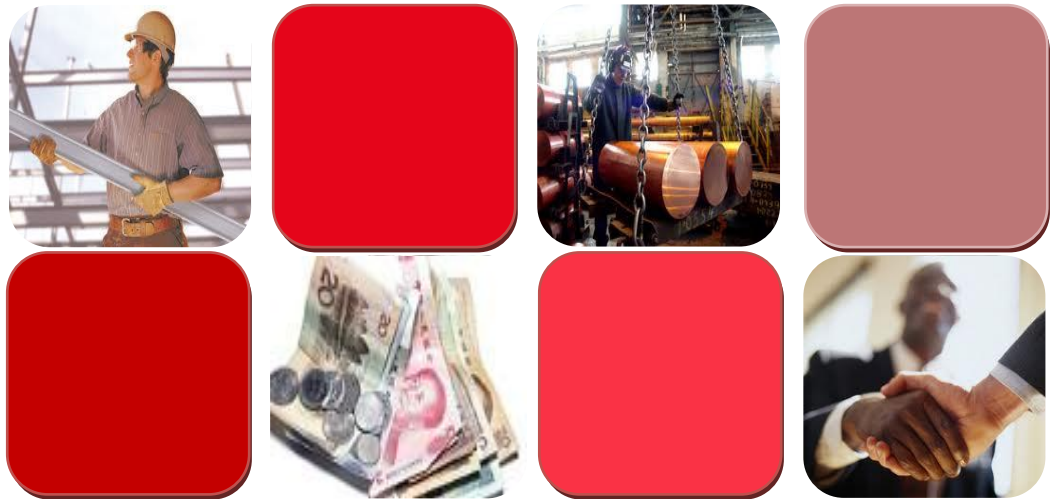


# Towards Industrial Symbiosis in Jiangsu, China

Demonstrating the value of industrial symbiosis in Jiangsu and beyond



Report prepared for Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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On behalf of

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für Internationale  
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## Executive Summary

This report follows a visit from staff from International Synergies to the province of Jiangsu. The visit was organised by GIZ in conjunction with Jiangsu Development and Reform Commission and comprised visits to a number of Eco-Industrial Parks (EIP) and attendance of a Workshop on Industrial Symbiosis in Industrial Parks.

Centred on positioning **a facilitated Industrial Symbiosis (IS) programme within the context of Circular Economy (CE)** in China the report examines

- the current position with regards to implementation of CE in China;
- different types of industry park in operation;
- how the key aim of extending the industry chain can effect green growth and CE
- the mechanisms of a facilitated IS programme
- how such a programme could assist in implementing CE
- risks associated with implementing a programme

There are a number of **conclusions reached with regards to the advantages of implementing a programme**. While EIPs have been developed and the concept of extending the industry chain has been introduced and implemented, a number of areas of improvement have been highlighted. These include

- Extending the industry chain beyond what has currently been achieved
- Increased engagement with small and medium sized companies (SMEs)
- Energy consumption per GDP can be high in some instances
- Data management with regards to available resources and their potential uses
- Increased integration of new technology and incubator companies
- Increase collaboration between companies within and between parks
- The management ability for implementing CE could be improved in some areas

A facilitated IS programme such as the one proposed that holds a database of resource information that can be searched based on multi-criteria and uses practitioners to work alongside the membership to identify and progress synergies can address all the points highlighted during the discussions.

Before implementation, however, it would be important to decide what would show as success for such a programme. Typically, environmental benefits such as landfill diversion of solid waste have been used as benchmarks against success.



Within the industry parks this may be regarded as a rather crude measure that would keep a programme focussed only on heavy, solid waste. If a programme were to be predicated on the introduction of innovative, new technology that enabled the extension of the industrial chain, then the type of resources that could be exploited within a programme would be extended beyond the solid waste while still keeping those resources open to be included.

Thought should be given to policies that aid IS such as the definition of waste and waste protocols that would enable resources to be classified as by-products rather than waste, removing any potential stigma associated with their use.



## Introduction

The purpose of this report is to position a facilitated Industrial Symbiosis programme in Jiangsu, within the context of Circular Economy (CE) and the development of EIPs in the province. The report looks at the history of CE in China, highlighting the seven pillars of current implementation; how the concept of extending the industrial chain can lead to increased resource efficiency; how a facilitated programme could impact EIPs in China and what risks may be associated with introducing such a programme.

## History of Circular Economy in China

Throughout history China has been an industry powerhouse. During more recent times China's impact has been somewhat reduced, to the point where in 1949, its contribution to the global economy was estimated to be just 3%. There has been a gradual increase since that date, with a more marked increase during the last decade such that China now contributes around 10% to the global economy. A key result of this increase is an ever greater requirement for resources, coupled with increased stresses on the environment. What makes China slightly unique from past examples of increased development is that while previously developing nations may have phased their development, China is experiencing industrialisation, urbanisation, commercialisation and internationalisation all at the same time.

Prior to the early 1990s, industry location was based on the availability of resources which had the consequence of scattering development depending on what was required. This gave way to the formation of clusters of industry in EIPs which then led to the introduction of the Circular Economy (CE) model in the year 2000.

Introduced during the 11<sup>th</sup> 5 year plan, the Circular Economy law led to the introduction of the concept on a much wider scale but now, as we enter the 12<sup>th</sup> 5 year plan we see a more formalised methodology being introduced to ensure a greater success.

EIPs are seen by the national Development and Reform Commission (NDRC) as being pilot locations where the practical application of CE can be developed. Within this view, the plans have moved from enabling policies to finding ways to further develop parks given the current challengers. To that end within the plan **there are seven tasks or pillars which are seen as being key to this success.**



### 1) Optimise spatial layout

EIPs should be removed from residential areas and the production units of the park should be organised such that material flow costs are minimised. Resources such as water, heat and waste recycling should be distributed in an efficient manner with clearly delineated areas for production and waste treatment.

### 2) Optimise industrial structure

There is some debate as to how best to implement this part of the plan. The current thinking appears to be to discourage or remove the more heavily polluting industries or industries that do not fit the 'mix' of the park. For instance, if a park is more concerned with the chemical industry, then non-chemical companies may need to be relocated to make space available for new chemical companies.

While in many ways this could be seen as a beneficial move by a park it could lead to a number of areas of conflict. For example, if too many similar companies are co-located market forces may break down and the companies begin to compete with their neighbours, creating a risk for the long term stability of the park. In addition, in the context of industrial symbiosis, a diverse industry mix may lead to a higher number of opportunities with regard to extending the industry chain in that different industry sectors would be able to work together to find maximum uses for the identified resources.

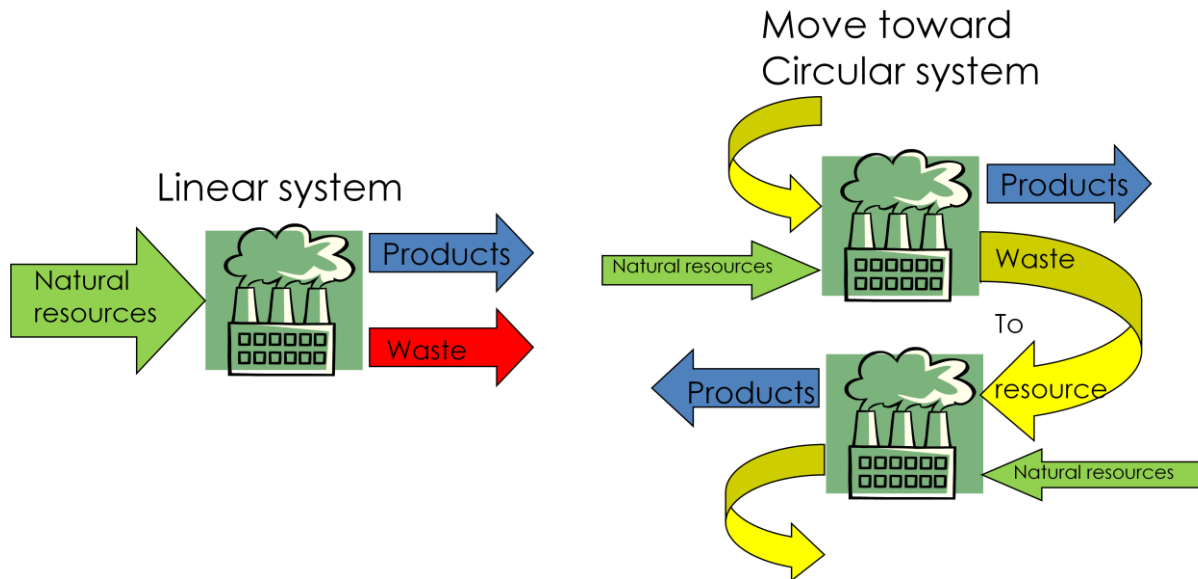
Having said that, this obstacle may be able to be overcome provided EIPs increase their joint working patterns, something a facilitated IS programme would be able to make a significant contribution to.

There is also a will to move heavier, more polluting industries from the East of China to the West. While the principles behind this can be seen as being sound, thought should be given to the potential effects this may have on the industry chain as companies that could make use of resources or provide feedstocks to other companies may move away from their partners.



### 3) Realise zero emissions through chain optimisation

Traditionally, the industry chain ceases at packaging – a product is shipped and anything that remains is discarded as waste. In more recent times there has been a shift in emphasis regarding these resources whereby new opportunities are sought to maintain their beneficial use. Essentially one person's waste becomes another person's feedstock and the production chain moves from a linear cycle to a circular cycle.



Comprehensive industrial parks present an interesting methodology for the realisation of this aim in that if processes and chains can be mapped, taking in to account cross sector connections then parks can be planned based on which industry sectors can work together – either within the same park or between neighbouring parks.

### 4) Efficient utilisation of resources

In many ways this aim overarches the preceding and succeeding aims. The aim is decrease the impact of industry on the environment through the efficient use of resources. While many of the keys to this aim will be related to technology, many of the solutions are already in existence and policy relating to those solutions becomes important as to their effectiveness. For example, the definition of waste – at what point does a resource become a waste and how does one counter this through tools such as waste protocols (as in Europe), or financial stimuli such as financial assistance to instigating new technological solutions or penalising companies that dispose of waste in a non-useful manner.



#### 5) Centralised treatment of pollutants

Many options exist with regard to the treatment of pollutants. Centralised treatment facilities can always offer economies of scale but can be subject to incompatibilities between pollutants. However, by having centralised facilities, some resources may be treated in a manner that makes them economically viable when compared to single site treatment. This may require infrastructure or may present a business opportunity for a company prepared to fulfil the service of visiting companies to bulk up wastes and transporting them to a centralised treatment facility. This latter is something that a facilitated programme has been shown to contribute to in that it can aid in the identification of resources together with when those resources are available.

Thought may also be given to what treatment facilities are already available such as municipal wastewater treatment facilities. In many cases, domestic sewage can act as a buffer to the shocks that can be experienced from industrial discharges.

#### 6) Green infrastructure

There are many ways in which this aim can be and is being achieved. Energy generation, LED street lighting can play a major part but in addition the infrastructure relating to heat, steam and grey water distribution can be a key game changer in the take up of these resources throughout an industrial park. For example, water is bulky and expensive to transport but a grey water distribution system removes many of the negatives to increased use within a park. Quality considerations remain in that the quality of the grey water must meet the requirement but the ability of companies to take and use lower grade water that has not been subject to the expensive and resource hungry processes to bring it to potable standards cannot be overstated. Many industries, especially within the high tech sectors will produce water that is of good quality and could be used by other companies. Without the infrastructure to distribute that water, the resource goes to waste.

#### 7) Standardisation of administration, operation and management of parks

It is important for the best performing parks to pass on their knowledge to the less well performing parks. In addition good performing waste



management companies, that meet the ethos of CE, can be used to implement the consolidation and pre-treatment of wastes prior to reuse.

China has implemented a number of policies that target resource efficiency and the reduction of pollutants. These policies can be categorised as being a mixture of legislation, guidance, and tax and fundraising projects.

<b>Instrument type</b>	<b>Policy</b>
Regulation	Catalogue of restricted and eliminated techniques, equipment and material ( <b>Restriction Catalogue</b> )
Stimulus	Preferential taxes (Corporate income tax and Value added tax)
Guidance	Catalogue of promoted CE technology technique and equipment ( <b>Promotion Catalogue</b> ) List of technically innovative pilot CE projects
Funding	Funding pilot projects (e.g. individual energy / water conservation, EIP / agricultural industry park development, waste disposal, utilising large solid waste streams)

Table of Chinese key policy instruments from Wang, Q et al (2012) policy contents of Industrial Symbiosis (IS) implementation in the UK and China: if the UK's IS initiative is adaptable to the Chinese policy context? [18<sup>th</sup> Annual International Sustainable Development Research Conference](#)

One of the key challenges for any policy implementation remains, however, the low cost of landfill in China. The current level is around 40 RMB per tonne which remains lower than many technological solutions. In the United Kingdom, the landfill tax, first introduced in 1996, has had a marked effect on the economics of industrial symbiosis solutions to resource utilisation. It is important that the benefits out way the costs so that companies are prepared to be enthusiastic towards IS and the extension of the industrial chain.





## Industrial park concept in China

China currently has four different categories for industrial parks.

- 1) Development and processing of resources  
The primary aim of such parks is the provision of resources to feed industry. Such parks depend on the geographical location of the resources to determine their nature.
- 2) Main or anchor sector complimented with different supporting sectors  
One main sector will act as an anchor and be supported by different sectors which can make use of the resources from or supply resources to the main sector. The main industry is likely to be from the metals or chemical sector while the park as a whole will have a comprehensive mix of industries including agriculture.
- 3) Recycling parks  
These parks are fed from other parks and act as a place where resources are collected and recycled in to forms where they can be reused, usually within other parks.
- 4) Comprehensive parks combining producers and recyclers  
These parks combine both producers and recyclers who can process waste resources in to usable forms. Tinajin Economic and Technological Development Zone (TEDA) in the Binhai New Area would be a good example of such a park.

## Key concept: Increase Circular Economy and Green growth through extending the industry chain

Extending the industrial chain impacts many areas of how EIPs are managed. Important aspects of industrial chains are that not all solutions will come from new technologies and not all solutions will come from within the same industry sector. For instance, in the Yangzhou Economic and Technical Development Zone (YETDZ) examples were shown of solutions for silicon resources which match the main ethos of the park. However, the area has a large amount of agricultural land which producers waste straw. A solution has been found for the straw within the paper industry, which while not within the remit of the park, which is to focus on new technology, presents a solution for a resource that was previously being



sent to Taiwan. The solution is currently at pilot scale but could have a large impact when commercialised. Yangzhou Chemical Industry Park Administration Commission mentioned that they are seeking to produce ethylene ( $C_2H_4$ ) from waste straw which would again upscale the waste through the waste hierarchy through new technology. A facilitated IS programme would be able to link these two ideas together through the sharing of knowledge.

Again, from the YETDZ, the construction period was over a long period of time and it is recognised that the layout may not be optimal. The platform for collecting, transporting and usage of similar wastes is not seen as being ideal. An IS programme would be able to aid this platform by identifying and collating the information relating to the underutilised wastes, enabling a cohesive solution to be implemented.

Cooperation between companies on the same park is not the only solution available. Cooperation between parks can yield results as well. Parks mentioned that they would be willing to move companies to their park if they presented an opportunity to extend the industry chain within the park. A more environmental solution may be to increase inter park collaboration and connect the companies together in their current locations. This may also align more closely with the indication from NDRC that they wish parks to focus on key sectors rather than be multi-sector.

Parks mentioned that they would like to engage with small and medium sized companies (SMEs) more. CE aids this as the small companies could be presented with opportunities that could increase their business or even lead to a transformation of their business. An example of this from the UK involves a company that started as an animal renderer but has recently transformed to become a power generation company through the installation of an anaerobic digester which treats the high organic strength waste from the rendering process.

CE provides opportunities for innovation and the realisation of technology developed in incubator companies on a commercial basis. By identifying which resources have not been fully exploited in the industry chain, new technology and innovation can be brought to bear that will close that loop, allowing the resource to find new life further down the chain. The aim would be to raise a solution further up the waste hierarchy from energy recovery to reuse.



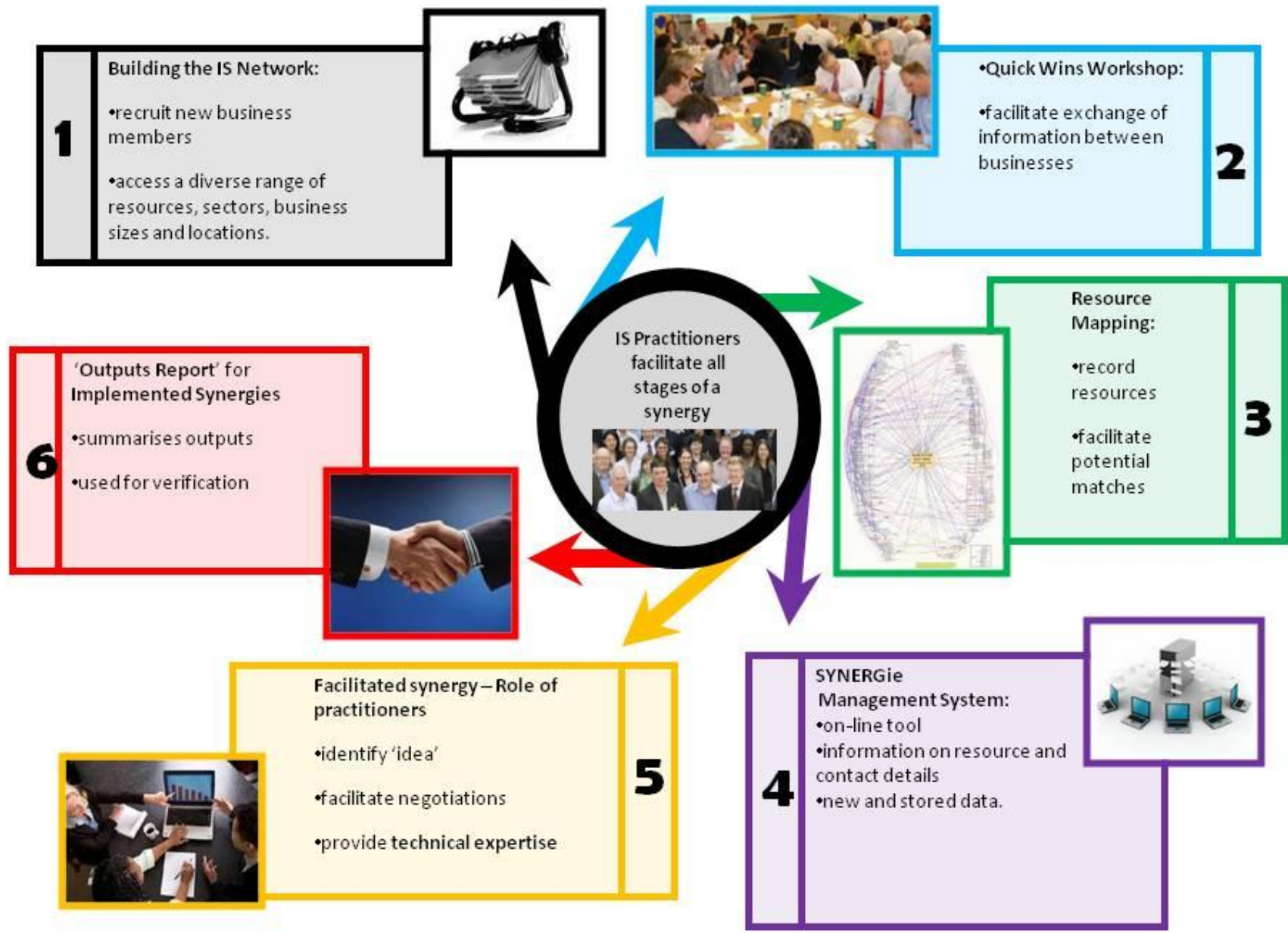
Furthermore, CE provides opportunities with regards to older technologies and companies. Often these are seen as polluting and indeed that may often be the case. Consideration should be given as to whether the solution is to simply move those companies from the parks, to another part of the country or whether CE can be brought to bear on the company and issues can be resolved in their current location by connecting companies through their resource chain.

### **Introduction to a facilitated IS programme**

A facilitated industrial symbiosis programme uses practitioners to assist member companies to identify business opportunities for waste resources. While there are a number of models in operation throughout the world, ranging from lone practitioners to fully fledged, managed teams, the most widely distributed model is one based on the UK National industrial Symbiosis Programme (NISP).

NISP has been in operation since 2002 when it started as a pilot programme, becoming fully national in 2005. The basic concept is one where the assistance to members is free to the member at the point of delivery. Initially the programme was funded through revenue raised by the landfill tax but in more recent years has been funded through general taxation and delivered under contract. The basic tools and methodology of the programme has been exported to a number of countries including China, Brazil, South Africa, Turkey, Romania, Hungary, Slovakia and Belgium. No two programmes are exactly the same as each programme will adapt to the requirements of the local country and the implementing organisation. For instance, if the overriding factor that concerns the implementers is landfill diversion, then the programme would concentrate on heavier industries such as construction. But if the overriding concern was innovation then the programme would concentrate on working with new technologies and incubator companies, helping them bring their new products to market.

The basic steps and methodology of a programme can be illustrated below:



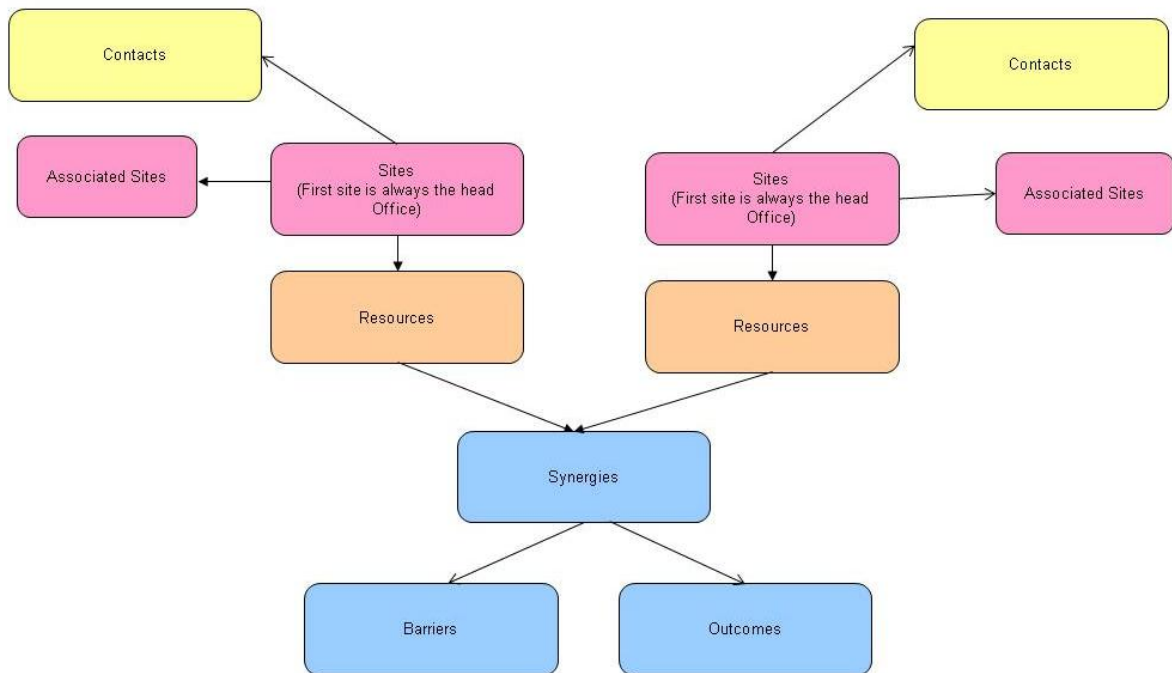


Within a programme, members are recruited to the programme through a number of means including workshop, direct site visit and collaboration with other industry bodies such as trade associations. Workshops are the melting pot for ideas as they allow members to see each other's resources. A typical workshop would consist of around 50 to 60 members and result in around 200 to 300 potential synergies being identified. Resource 'haves' and 'wants' are logged on the programme's proprietary information system – SYNERGie – and solutions are found from complimenting members who could either supply or make use of the resources. The key to the programme is that the practitioner helps in the identification of solutions as opposed to the company taking time out to search for the solutions. Relationship and trust are imperative for the success of the programme. As identified solutions progress, the practitioner works closely with the companies involved to help with the progression while also looking to identify additional synergies that could be progressed with the companies. Once a synergy is completed, the practitioner works with the members to identify and calculate the outputs achieved – environmental, economic and social.

Access to data and management of that data is an important pillar of the programme. Data can be sourced from a number of locations including but not limited to, workshop data, company visit data, environment body data and industry body data. Data in itself however is of no use without the ability to manipulate that data. International Synergies have developed over a number of years a proprietary synergy management system called SYNERGie.

SYNERGie is a secure, web based system accessible worldwide via a username and password. The system uses Microsoft .NET platform and SQL database technology for reporting. Designed to allow for local configuration, including country specific coding and wording, the system can be translated in to the host country language should this be required. The system incorporates a highly flexible and powerful multi-criteria search engine that enables data to be found quickly and easily. Hyperlinks allow fast transition between screens and data, increasing the efficiency of the system. A front end loading system allows for the fast entry of bulk amounts of data without the need for repartition of said data between sites, contacts and resources.

This system structures data according to the following criteria:



Within the site screen it is a simple process to move between contacts, resources and synergies as can be seen in the tabs illustrated below.

Site	Associations	Contact	Resources	Synergies
<b>Site</b>				
Short Name:	A&A		Owner:*	Derek Sear
Site Classification:*	1444: FMCG			
<b>Location</b>				
Country:*	UK		Region:*	West Midlands
Sub Region1:				
<b>Address</b>				
Address 1:*	Coleshill Road		Address 2:	Log lane
Address 3:				
City:*	Rugely		Postal Code:*	RU1 7IT
<b>Contact Details</b>				
Phone:*	09123481282		Fax Number:	
Email:				
Skype ID:				
Website:	<a href="http://www.aandarecycling.com">http://www.aandarecycling.com</a>			
<b>Site Details</b>				
Site Type:*	Head Office		Associated Sites:	1
Site Status:*	Member		Site Function:*	Wood Chopper
Employee Count:	27		Turnover:	2000000 GBP
Site Size:	Medium		Source:	Email
Solution Provider:	<input checked="" type="radio"/> Yes <input type="radio"/> No		Solution Type:*	Environmental
Notes:	Also takes broken pallets for recycling			
Make Site Unavailable:	<input type="checkbox"/>		Membership Date:	

Resources can be searched according to multi-criteria with synergy creation being possible direct from the returned results. Selecting the resource from the results adds it to the create synergy section in the example below:



Search Resource

Home >> Resource Management >> Resource Search

**Resource Search**

Resource:  Site:  Status:

Supply Type:  Type:  Keyword:

Valid From:  Valid To:  Region:

Category 1:  Classification 1:  Sub Region 1:

Category 2:  Classification 2:  Sub Region 2:

Category 3:  Classification 3:  Resource contact:

Availability:

**Synergy Resources**

Have Resources:  Want Resources:

Have Resources  Want Resources

View	Edit	Delete	Resource	Supply Type	Type	Site	Region	Valid From	Valid To	Quantity	Unit of Measure
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<a href="#">Wood shaves</a>	Continuous	Have	<a href="#">EAA Sanayi ve Ticaret Ltd. Sti.</a>	Northern Ireland	01/06/2011	01/06/2012	36	Tonnes
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<a href="#">Pallets</a>	Continuous	Have	<a href="#">Tigerturf</a>	West Midlands	08/04/2011	08/04/2012	25	Tonnes
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<a href="#">Benban Pallets</a>	Continuous	Have	<a href="#">Freudenberg Maschinenbau I.S.</a>	South West	11/03/2011	11/03/2012	0	Tonnes

Resources can be categorised by whatever criteria is required by the host country be that a defined waste catalogue or descriptions. Once created the progression of a synergy can be tracked through the synergy screen as it moves from an idea to a completed synergy.

Search Synergies Barriers

Home >> Synergy Management >> Add Synergy

Synergy ID: 167 Title:

Current Stage Resources Notes Outcome Barrier History Documents Audit

Current Stage:

Synergy Description:

Supply Type:  Synergy Create Date:

Forecast Completion Date:  Actual Completion Date:

Owner:

**Case Study**

Case Study Status:  Confidential  Case Study Not Required  Case Study Sign Off

Outcomes for a synergies can be captured against the individual synergy. The outcomes can be configured to reflect the aims of the programme. For example outcomes can relate to environmental, social or economic benefits. In addition, outcomes can reflect innovation and numbers of businesses assisted.



View Save Back

Synergy ID: 167      Title: China Woodcock - China Marvel - Test resource

Current Stage   Resources   Notes   Outcome   Barrier   History   Documents   Audit

**Outcome**

Outcome Start Date:

Stage:

Notes:

20

Outcome Name	Outcome	China Woodcock Limited - TEDA(%)	China Marvel Limited(%)
Additional Sales (£ (Pounds))	0	0	0
Businesses Assisted (Numbers)	0	0	0
CO2 Reduction (Tonnes)	0	0	0
Cost Savings (£ (Pounds))	0	0	0
Hazardous Waste (Tonnes)	0	0	0
Jobs Created (Numbers)	0	0	0
Jobs SafeGuarded (Numbers)	0	0	0
Landfill Diverted (Tonnes)	0	0	0

Reports can be produced along a number of criteria and exported in to other packages such as Excel for manipulation. The system also contains a knowledge management database of previously completed synergies. This is a key aspect in that it allows the user to research resources and industry sectors and apply that knowledge to their own programme. For example, if a practitioner has a resource they can search which industry sectors have been able to make use of that resource in other programmes and then search as to whether they have a company from those sectors in their programme. If they do not they know that they could look to recruit members from that sector and be able to present a business opportunity during the initial discussions.

An example of the knowledge management database results is shown below. Each of the links presented links to a document analysis of a completed synergy.





SYNERGIE Quick Links: Select a page to go to... NISP

Home Members Actions Resources Synergies Reports Subscriptions Administration

Search Subscriptions

Basic Search Search by Outcomes Search by Filter Search by Code

**Search Blueprints**  
Search words: wood Search

Your search returned 36 results  
Page: 1 2 3

[2079 Various Wood Waste](#)  
 '20 01 38 wood n.e.s'  
 '...Four different grades of wood which they would accept (clean-virgin wood...'  
 'Industry Standard as there are lots of people bidding to provide the same products (i.e.) wood chip products.'  
 '...Most o...'  
 '...Primarily landfill diversion for companies who had the wood...'  
 '...Sales ...'  
 '...The wood...'  
 '...This synergy involves a variety of different companies with wood...'  
 'Various Wood Waste'  
 'Wood...'  
 'Wood Recycler and Produce Products from wood (chipped wood) ...'

Finally, the system can be configured to the local circumstances from a geographical and language aspect. The location structure can reflect provincial

SYNERGIE Quick Links: Select a page to go to... NISP

Home Members Relationships Resources Synergies Administration Licenses

Search General Location Category Classification Outcome User Search Add User Rights Delegation

Home >> System Administration >> Location Master Welcome Mr. XYZ

Location Master Management

- Locations
  - U.K.
    - West Midlands
      - Birmingham
        - Kings Norton
        - Soli Hull
      - East Midlands
        - Soli Hull
        - Kings Norton
    - India
      - Gujarat
        - Ahmedabad
        - Khadia

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and industrial park structure and be translated in to Chinese should that be required. The example below shows a Portuguese language version of the system.

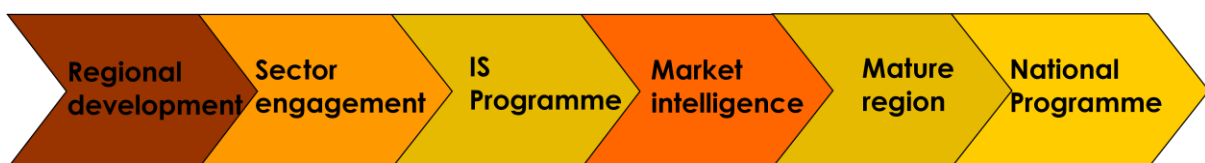


## Where could a facilitated IS programme assist in Circular Economy

Historically, the view regarding the implementation of a facilitated industrial symbiosis programme has been to deliver a pilot programme that grows to maturity as the practitioners and coordinators gain experience, and then to expand that pilot across a greater area. Coupled with this expansion has been the increased integration of the programme within other areas such as sector specialisation and regional economic development. The diagram below illustrates this typical view. In reality, the aspects of the final three chevrons occur concurrently, particularly with regard to sector engagement and market intelligence.



China presents a new opportunity in that the integration of CE within EIPs has enabled the integration of industrial symbiosis in to regional development from the outset, through the co-location of industries and the extension of the industrial chain. A facilitated industrial symbiosis programme, delivered along the main principles described earlier could be used to identify and resolve gaps in the industry chain. Market intelligence could then be integrated in to the programme to increase effectiveness, with this methodology being used as a launch pad towards a national programme.



With the introduction of any programme there are a number of methods available. 1) The direct copying of a programme without adaptation; 2)



emulation – adoption with adaptation to certain contextual factors; 3) hybridisation or synthesis – the elements of the transferred programmes are combined if more than one programme is to be introduced; 4) inspiration – experiences elsewhere stimulate new ideas about how programmes could be reshaped, without necessarily utilising any parts of the programmes examined.

Throughout the introduction of facilitated IS programmes across the world, there has been a high regard to emulation with no two programmes being exactly alike. Indeed, the first introduction to the UK was in the form of emulation in that the initial idea came from a facilitated, commercial model that operated in the United States of America. That commercial model, at the time, had a relatively low number of members and focussed on a number of synergies with each member. By making the programme free at the point of delivery to the members the UK model was able to recruit a greater membership (over 14,000 as at 2012) which led to a greater number of resources identified which in turn led to a greater number of synergies identified. In the first instance we would recommend implementing a free at the point of delivery programme that could be transferred in to a charging model at a later date once the membership had been established and results obtained.

If we consider each of the seven tasks or pillars that have been introduced with regards to implementing CE across China we can see how a facilitated IS programme may impact and add value to the process.

1) Optimise spatial layout

A facilitated programme would enable the collection of large amounts of resource data, enabling analysis to be carried out with regards to which resources are not being used efficiently or effectively. Clustering of resources, both main and secondary, could be identified which would enable new opportunities with regards to treatment and processing to be exploited. This analysis could be integrated in to the planning process as parks develop beyond their initial phases, enabling the co location of beneficial industries that may not initially be obvious partners.

2) Optimise industrial structure

Referring back to the two strains of thought regarding this area we see that a facilitated IS programme would be beneficial regardless of which method is progressed. If parks develop along single industrial sectors then a facilitated IS programme would be able to analyse those resources for which the solution falls outside of the incumbent industrial sector. By pooling data from many parks, the programme would be able to identify solutions within other parks through gap analysis.

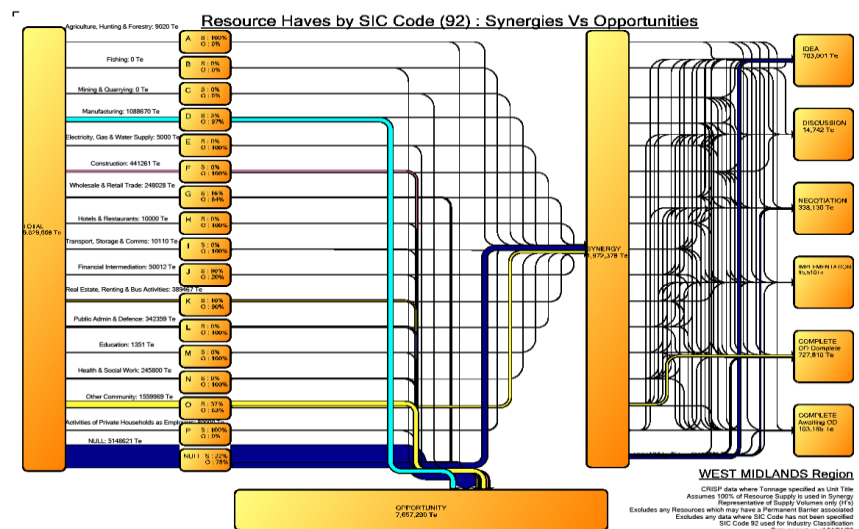
If parks develop along the lines of co-existence of industries (something NDRC appear not to encourage based on their presentation during the workshop on Industrial Symbiosis in industrial Parks, Nanjing, 28 June 2012) then gap analysis could be carried out with regards to which industrial





- 3) Realise zero emissions through chain optimisation  
China has done great work in identifying ways to optimise the industrial chain as exemplified by the Catalogue of promoted CE technology, techniques and equipment (the Promotion Catalogue). It has also produced a catalogue of restricted and eliminated techniques, equipment and material (Restriction Catalogue) that works with the former to identify those processes that are beneficial and those processes that are detrimental to the environment. A further document, the List of Technically Innovative Pilot CE Projects aims to compile good technical practices working on building production chains for resource utilisation in heavy industrial networks and in industrial parks (Notice about Organising and Recommending Technically Innovative Pilot CE Projects cited in Wang, Q et al (2012) policy contents of Industrial Symbiosis (IS) implementation in the UK and China: if the UK's IS initiative is adaptable to the Chinese policy context? 18th Annual International Sustainable Development Research Conference).

Through the pooling of data from numerous sources (workshops, site visits, publicly available waste data) a facilitated IS programme would be able to identify the resources that have no solutions but also identify potential solutions that may be available but may not have been implemented. In addition the programme would be able to identify solutions that had been implemented but could be expanded based on the amount of resource that is available. An example of this type of analysis is shown below where a Sankey diagram has been used to analyse a resource pool, identifying the fate of the known resources. Resources not involved in synergies, that are being sent to landfill can be seen as an opportunity for new businesses.



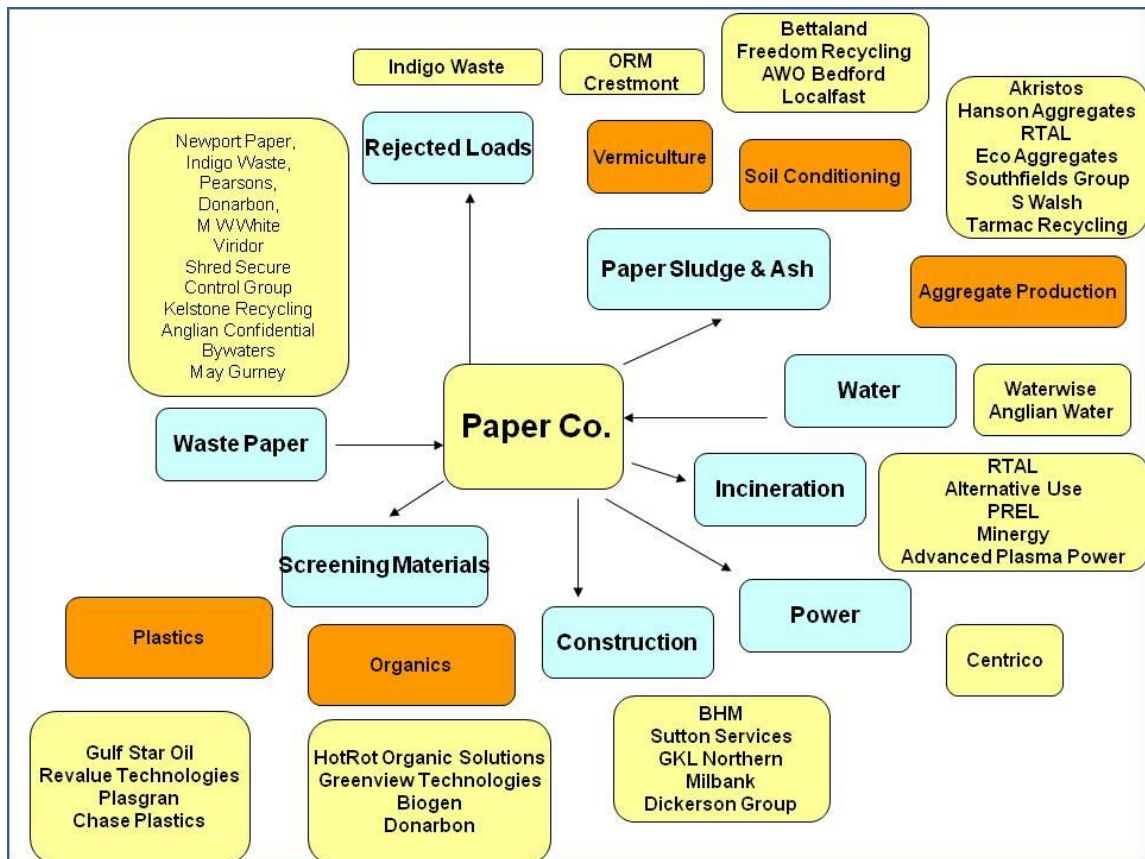
The bar on the left represents the total known pool of resources being investigated. The second set of bars splits these resources in to type. The bars on the left represent the resources from this pool that are involved in synergies within the programme while the bar along the bottom



represents resources that are known to not be involved in any beneficial use – these present an opportunity for companies.

The issue therefore becomes how does a company with new technology or process that could find a beneficial use for a resource where such use previously did not exist bring that process or technology to market against this background? A facilitated IS programme would be able to identify the scale of opportunity for the process together with where the best location to site that technology would be, based on the analysis of collected data. Furthermore, the practitioners within the programme would be able to present opportunities to promote the existence of that technology through the workshops etc. An example of this has occurred in Romania where the programme delivered a workshop around a specific, large scale issue. A company that could deliver a solution was invited to present and the programme used its member database to identify companies that would benefit from the solution. The practitioners invited the members and arranged the workshop, all things that the company with the solution were unable to organise as they had not established a client base.

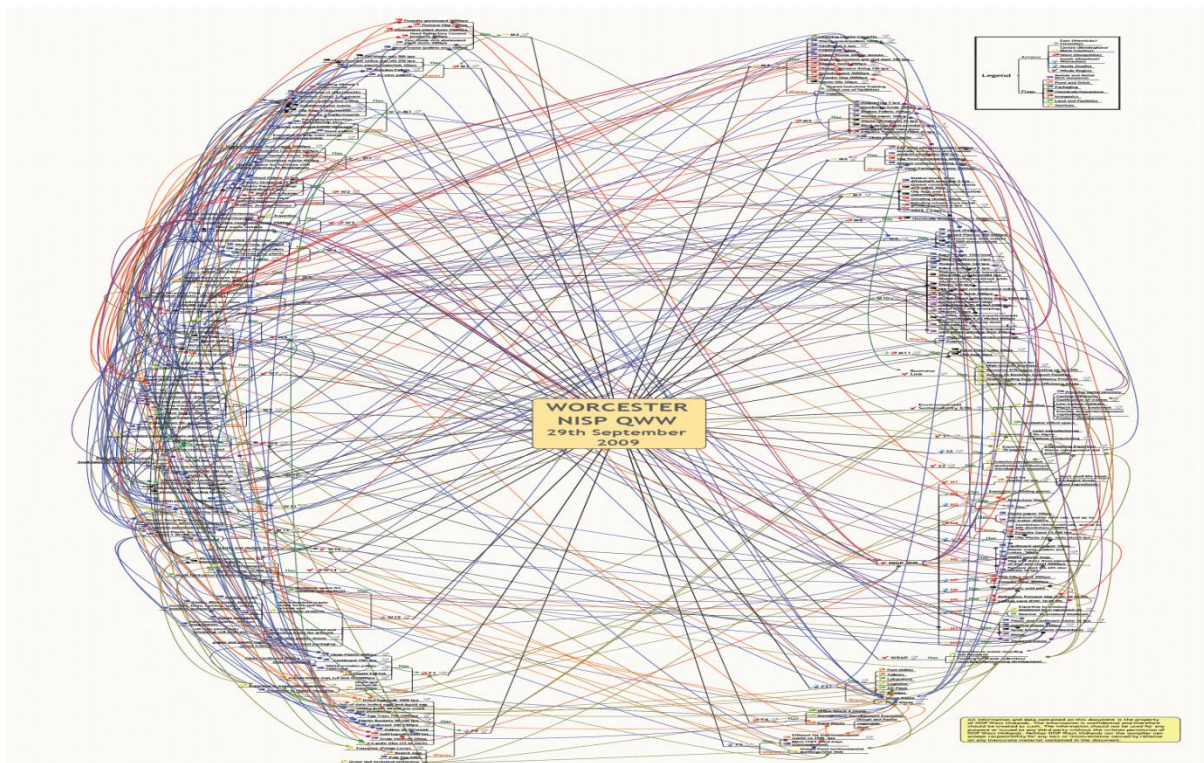
Similar work has been carried out in other programmes such as the example below. The example refers to a paper company that were looking to build a new facility in the UK. They initially approached the UK programme to identify feedstocks for the recycled paper process. NISP were also able to look at the whole production process, looking at resource feeds and waste resources. The programme identified solutions to a large number of areas within their business.



#### 4) Efficient utilisation of resources

Through many of the processes described in the previous tasks a facilitated IS programme can aid this area. China has implemented CE in a number of ways of which the EIPs are a chief example. It is recognised however that getting companies to talk to each other has been an issue. It is further recognised that getting parks to talk to each other is also an issue.

A facilitated IS programme would be able to break down many of these barriers as practitioners, skilled in relationship management, would be able to act as go betweens for the companies and parks. Many of the solutions to increase the utilisations of resources would be available within a park, whether the park is concentrated on a single industry sector or is based on multi sectors. However, the companies need to be aware of where those solutions are located. A Business Opportunities Workshop presents the ideal platform for companies to network and understand each other's resource wants and haves. This enables ideas to be generated and captured which can then be progressed, with the aid of the practitioner, to completion. The use of a system such as ISL's SYNERGie enables data from multiple workshops, and indeed, other data migration techniques, to be cross referenced in a number of ways, so that inter-park solutions could be identified and presented to companies that were unaware of each other. The diagram below illustrates the typical results from a workshop where each line represents a potential synergy between two companies.



5) Concentrate treatment of waste and pollutants

The key to any treatment process is knowing what is to be treated and in what quantities and frequency. Often, while a company may know this data for itself, it is often difficult to obtain data in a manner that enables a holistic approach to be developed, particularly with regards to treating the wastes with a view to them being reused. Often a company may well be under the impression that there is no alternative to final disposal as the amount of waste resource that they possess makes it economically unviable for them to arrange any alternatives. By having access to pooled data, a facilitated IS programme is able to identify concentrations of resources among groups of companies. The practitioners can then work with the companies and a solution provided to arrange alternative collections that increase the economic viability for reutilising that resource. This is often referred to in the west as a 'milk round' as it alludes to the practice of a single vehicle visiting a number of companies in turn, at a pre-arranged date so that small amounts of resources are concentrated up through the day's collection. The analysis results as exemplified under task 2, optimising industrial structure, can play a large part here.

6) Green infrastructure

Often, the key to reusing resources remains their availability. For some key resources such as water, heat and steam this remains difficult for a single company to organise due to economies of scale. That China has recognised this and is building the necessary distribution infrastructure within its EIPs is of great benefit. This opens the door for companies to either make use of this infrastructure or to contribute through the provision





of waste heat, steam or grey water to the system. However, on many occasions it may be that a company is unsure of what is available or the quality aspects of the resource. A facilitated IS programme can work with the companies and the EIP management to bridge this knowledge gap – both in terms of availability and beneficial use.

- 7) Standardisation of administration, operation and management of parks  
As IS becomes more integrated in to EIPs, each will find better ways to utilise the programme for their advantage. Sharing that knowledge between parks will aid all parks to move forward towards their goal of achieving zero waste through extending the industry chain. Co-operation between parks, using one park to provide the solution to another park's chain need, would become easier as there would be a single source of cross referenced data.

## Introduction of facilitated IS in China

Tianjin Economic and Technological Development Area (TEDA) has been delivering a facilitated IS programme with the assistance of ISL since 2010. The programme has been funded through the European Union's Switch Asia programme and seeks to introduce and adapt the methodologies developed by ISL.

Liu Guoguo, manager of the programme, is quoted as saying that initially businesses were not that interested in the programme as they believed they had their own business connections. China's landfill tax was low and private waste handlers offered to make the waste disappear at a good price (whether these were licensed waste handlers or not is not stated). What turned the programme around was a suggestion to green existing business connections with the companies picking up extra government subsidies as a result. The incoming carbon price will provide fresh economic incentive to look for synergies that link industrial development with emission reduction (Sonja van Renssen (2012) Waste not want not, Nature Climate Change volume 2)

This illustrates the importance of setting the correct goals for a programme from the outset. The main goals of the TEDA programme are environmental with landfill diversion being a key metric. This leads to a bias in activity towards heavy wastes such as construction. However, if the goals reflect a different set of priorities then the programme can focus on different activities and success can be measured by different parameters.

Within the context of this report there would be less of an emphasis on landfill diversion per se and more of an emphasis on extending the industry chain and introducing new technologies to industrial parks. Success therefore becomes less



about weight and big synergies and becomes more about innovation, new business start ups and increased utilisation of resources. In many ways this fits the Chinese situation better as alternative incentives need to be highlighted against the background of cheap landfill disposal costs. Jiangsu has a number of Technical parks such as Zhengjiang Technical Park with incubator areas for new technologies and companies. If the some of the parameters of a programme were focussed on driving innovation and introducing technologies, this presents good opportunities for these parks to be involved in the programme as the practitioners work with the companies to identify both existing and new markets for their innovations. An example of this from the UK would be where the programme is working with research institutes to promote pyrolysis to a number of different industries including agriculture (compost oversize which cannot be broken down within the compost process), plastics companies, the metals industry to recover precious metals and the bio fuels markets. NISP in the UK have good member details for each of these sectors and understand what their members are looking for in the way of solutions. By discussing with the Pyrolysis researchers, they are helping to identify more and more markets that the technology may be applied to.

Supporting policies are also important in the implementation of an IS programme. For instance, the financial incentives available that have been mentioned above. Europe is in the process of reviewing its waste legislation and is introducing a number of protocols, similar to those introduced in the UK, that seek to define the conditions that a waste can be produced that would lead to that waste no longer being defined as a waste. Information on the UK protocols project can be found at <http://www.environment-agency.gov.uk/business/topics/waste/32154.aspx> . The implementation of any IS programme should have regard for Chinese policies in its goals.

## **Risks associated with implementing facilitated IS programme**

There are a number of risks associated with the implementation of an IS programme and we have reviewed them below. The main risk is associated to member participation as without members the programme would fail to identify resources and thereby fail to identify synergies to meet the goal. The experience gained in TEDA and elsewhere suggests that if the programme is framed in the correct manner, such as a gateway to government subsidies or a method of promoting new technologies and increasing the industrial chain, then many of these risks are reduced. Of further importance is the consideration regarding longer term operation of a programme and what format such a programme would take – would it remain free to members at the point of delivery or would there be a need to convert the programme to a fee based model once a membership had been established and a resource databank had been identified.



The table below highlights a risk and looks at the probability and importance of that risk, together with suggesting some options for controlling that risk.

Risk Description	Prb	Imp	Control
<b>Company Engagement – Industrial Symbiosis</b>			
Lack of buy-in by business	L	H	Ensure project is perceived as a business support initiative, ensure business participation and ownership from start, extensive promotion, convincing case studies
Project unable to demonstrate added value to business	L	H	Structure aims of the project to reflect CE aims such as introduction of innovation, extending the industry chain
Demand beyond capacity of project	M	L	Support the development of private sector capacity; focus project resources on priority areas;
Limited reliability of local data	M	M	Make do with available data, increase face-to-face contact with industrial symbiosis companies. Build good relationships based on trust to increase the accuracy of data.
Availability of data between partners	M	H	From the outset there will be understanding between partners regarding the parameters they would operate and how data would be shared
<b>Institutional Development</b>			
Difficult to find qualified staff to man the IS Network	M	M	GIZ have qualified staff with industry background that can work with ISL to implement a programme
Staff turnover or decreasing motivation of team over time due to long implementation period	M	M	Include some recreational and team-building activities, set fair performance indicators and bonus system, ensure staff are not overloaded with other activities, assign clear duties and job descriptions. Important that staff can be focussed on IS programme so as to minimise disruption by other projects
<b>Policy Development and Dissemination</b>			
Policy does not support IS implementation	L	H	China has implemented many policies that support IS implementation and shows a will to extend its successes. Some policies do overlap but structure of programme should take in to



			account policy aims
Difficult to secure funding sources for the sustainable operations (and future expansion) of the IS Network	L	M	Early identification of potential sources of funding – be that continued subsidies or charging model, active engagement throughout project period with potential funders or membership, demonstrating beyond doubt the value of continued programme

### Main Pre-conditions and Assumptions:

- Encouraging policies for utilization of secondary resources (waste) will remain in place
- Promotion of circular economy will remain a high priority for China

### Financial Sustainability:

**IS Network:** The exchanges initiated through the IS Network are profitable to the businesses involved, and are sustainable as such. Once the network is established, the operational maintenance of the network will be relatively low. It is envisioned operational financing will be secured through either municipal government or fee based membership

**Investments in Recycling / Reprocessing:** Experience from the UK has shown that the waste data collected through the development of the industrial symbiosis database can serve as an excellent basis for investment in recycling or reprocessing activities. Such investments obviously have a lasting impact.

**Net Contributor to Treasury:** Taking the UK's NISP as an example, in terms of value for money to Defra, its principal funder, NISP has demonstrated delivery on a range of government policy agendas. Apart from extensive environmental objectives, benefits have been generated in the areas of productivity, employment, regeneration and private sector investment and NISP continues to be a net contributor to the UK's Treasury. This is a result of the additional tax paid by companies enjoying higher profits, new solutions creating business start-ups, and by taxes paid by those people whose jobs have been saved/created by the programme.

Econometrics from the ongoing funding for the UK programme (as at 2010) are:

- Gross Value Added: £472,000,000
- Total Economic Value Added: £1,660,000,000
- Return to Treasury: £257,000,000
- NISP Tax multiplier: 14.5 to 1 (i.e. every £1 spent on the programme returns £14.5 back to the UK Treasury through corporation tax, personal taxation, VAT, etc)
- JOBS: £11,800 / job



*Based on an initial study by the London School of Economics, covering the period of 2005 - 2008*



## About International Synergies

International Synergies devises and manages industrial symbiosis programmes around the world and provides capacity-building support to in-country partners to develop their own programmes. Our programmes enable industry and governments to make the transition to an environmentally sustainable economy by facilitating innovative resource synergies that stimulate economic growth whilst protecting the natural environment.

Established in 2005, International Synergies is a dynamic company with offices in Birmingham (UK), Brussels (Belgium) and Belfast (Northern Ireland). The company is widely acknowledged as a world leading expert in the practical application of industrial symbiosis; having developed a global network of leading government, business and innovation partners at the forefront of the green economy.

To date, International Synergies has supported the implementation and development of industrial symbiosis-based projects in the UK, México, Brazil, China, South Africa, Hungary, Romania, Slovakia, Turkey, Australia and the United States. Projects are scheduled to launch in 2012 in Poland, Italy, Germany and Spain.

The chart below summarises our global project activity.





## Our People

To provide pioneering but practical solutions to industry, International Synergies employs the highest calibre of personnel. All are experts in the respective fields of aerospace, chemistry, engineering, environmental management, metallurgy, minerals, and research and technology. We believe the people who work for International Synergies share a passion and commitment towards achieving a low carbon sustainable economy. International Synergies is committed to complying with legal, environmental and ethical standards, and is accredited with ISO 14001:2004 and ISO 9001:2008 standards.

We have a wealth of knowledge and expertise in applying industrial symbiosis tools and techniques to projects around the world. We provide a 'turn-key' service of information, support and systems tailored to enable clients (both private and public sector) to successfully set-up, implement and develop an industrial symbiosis programme, either in a designated geographic area or within an organisation and its supply chain.

Owing to our world-leading knowledge and expertise in industrial symbiosis, we contribute to a number of influential, international institutions focussed upon the transition to a sustainable economy:

- A member of the European Climate Knowledge and Innovation Community
- Expert for the United Nations Asia Pacific Low Carbon Road Map
- Member of the Tianjin Economic-Technology Development Area (TEDA) Low Carbon Economy International Cooperation Committee
- Expert for DG Enterprise: Environmental Technologies and Services and Green Business Models.
- Expert for DG Enterprise: INNO GRIPS: combating global warming and resource scarcity