The Western Cape Industrial Symbiosis Programme (WISP): An Innovative Approach to Resource Efficiency and Waste Minimisation for South African Businesses

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ABSTRACT

Industrial symbiosis is a resource efficiency approach where unused or residual resources (materials, assets, logistics and expertise) of one company are used by another in a manner that is beneficial to both parties involved. Industrial symbiosis was identified as an opportunity by the Western Cape Government, which led to the initiation of a pilot facilitated industrial symbiosis programme: the Western Cape Industrial Symbiosis Programme (WISP). The programme is delivered by GreenCape, the Sector Development Agency for the Green Economy, with the support of International Synergies Limited. Since its inception in 2013, WISP has developed a diverse network of businesses and under-utilised resources. This paper discusses the positive impact that the programme has had on businesses in the Western Cape, providing both environmental and economic benefits. Furthermore, this paper examines how WISP has contributed towards innovative waste management practices by creating new pathways for waste resources as well as creating the foundation for a national industrial symbiosis programme in South Africa.

1. INTRODUCTION AND BACKGROUND

1.1 Background to industrial symbiosis

Industrial symbiosis is based on the biological concept of symbiosis where two or more organisms interact in a manner that is beneficial to at least one of the organisms involved. Industrial symbiosis extends this to the industrial sector, using a resource efficiency approach where unused or residual resources (materials, energy, water, assets, logistics and expertise) of one company are used by another. The concept of industrial symbiosis was initially proposed by Frosch and Gallopoulos (1989) as part of a hypothetical industrial ecosystem where *"the consumption of energy and materials is optimized, waste generation is minimized and the effluents of one process … serve as raw materials for another process".* A more rigorous definition was later proposed by Chertow (2000) stating that industrial symbiosis *"engages traditionally separate industries in a collective approach to competitive advantage involving physical exchange of materials, energy, water and by-products. The keys to industrial symbiosis are collaboration and the synergistic possibilities offered by geographic proximity."* The delivery of a facilitated network model of industrial symbiosis has been shown to decrease the importance of geographic proximity (Jensen et al. 2011). Realising that the above definition could only be applied to companies which had production processes, Lombardi and Laybourn (2012) modified the definition of industrial symbiosis to include the exchange of assets such as land, warehousing space and factory space as well as that of less tangible resources such as technical expertise. In this way, the applicability of industrial symbiosis was extended beyond the manufacturing sector.

1.2 Industrial symbiosis and sustainability

Sustainable development is understood as *"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"* (World Commission on Environment and Development, 1987). Industrial symbiosis advances sustainability by promoting the development of circular systems within the industrial sector, where resource efficiency is promoted, clean technologies are adopted and businesses exchange under-utilised resources (Jacobsen, 2006). These resource exchanges (alternatively referred to as "synergies") use the principles of the waste hierarchy, reducing the amount of waste that is generated within industry, and creating new opportunities for materials to be re-used or reprocessed into new products. This results in mutual economic, environmental and social benefits for the

companies involved (Paquin et al. 2009). Table 1 summarises the economic, environmental and social benefits usually associated with industrial symbiosis networks.

Table 1: Economic, environmental and social benefits associated with industrial symbiosis networks*.

Economic benefits	Environmental benefits	Social benefits
Increase profits	Reduce CO_2 emissions	Create jobs
Increase sales	Divert material from landfill	Create opportunities for knowledge transfer and learning
Reduce waste disposal costs	Reduce use of virgin resources	
Create enterprise development opportunities	Reduce hazardous waste disposal	
Reduce raw material costs	Reduce production of pollution	
Create inward investment opportunities	Increase energy efficiency	
	Increased innovative waste management practice	

*Benefits that can be realised by a facilitated industrial symbiosis programme based on experience and information collected by ISL and collated by WISP (http://www.international-synergies.com/)

1.3 Two models of industrial symbiosis

Two models of industrial symbiosis exist. The first is a cluster of companies in a geographically confined space which exchange resources often called an eco-industrial park. The second model is a network of companies that has no strict requirement of geographical proximity, often spread over large areas (Agarwal et al. 2006).

1.3.1 The co-location model

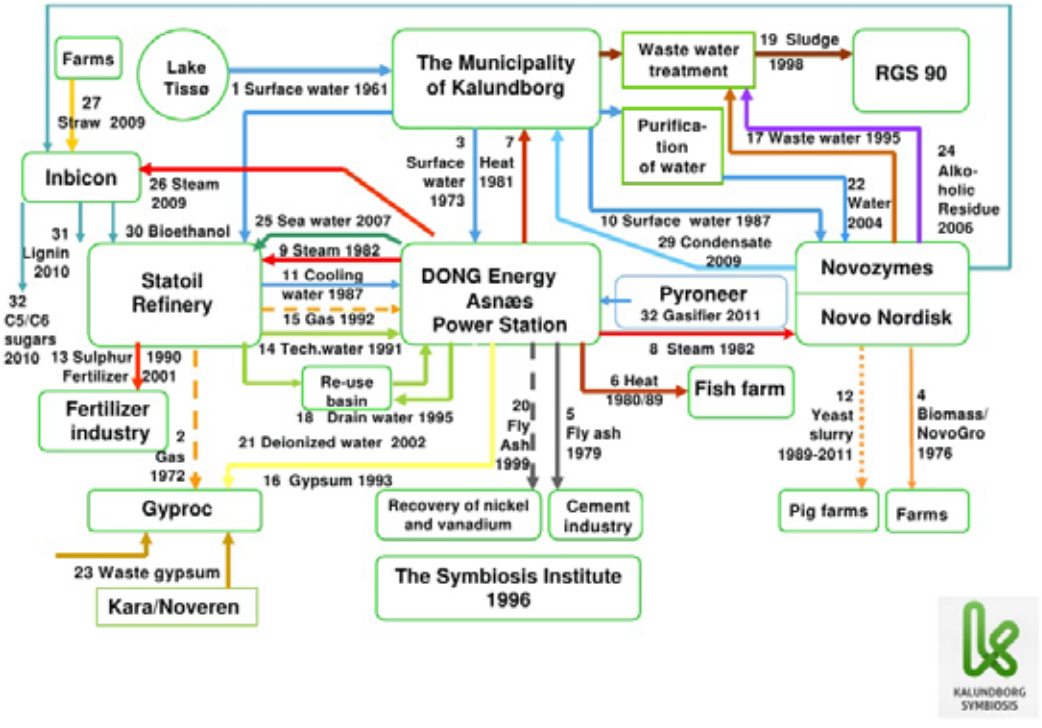

Figure 1: Illustration of the integrated system created in Kalundborg using industrial symbiosis *("Kalundborg Symbiosis", n.d.)*

The first successful industrial symbiosis system documented was in Kalundborg, Denmark (Chertow, 2000). As a result of market forces, a cluster of co-located companies had begun exchanging under-utilised materials and energy resources, creating an integrated system. The eco-industrial park revolved around a coal-fired power station that had several material and energy links with companies in the same location. The integrated system of Kalundborg is illustrated above in Figure 1. The environmental and economic benefits achieved at Kalundborg led to the development of number of eco-industrial parks (Paquin et al. 2009). An eco-industrial park may be defined as “a community of businesses that co-operate with each other and the

local community to efficiently share resources, leading to economic gains, gains in environmental quality and equitable enhancement of human resources for the business and local community" (Côté et al. 1998). Unlike Kalundborg, many of the planned complexes have not been successful in realising the benefits associated with industrial symbiosis (Paquin et al. 2009). This lack of success is largely attributed to the fact that many of the projects never evolved beyond the planning phase, and those that did failed to create lasting resource exchanges resulting in the project abandoning the ecology theme (Gibbs, 2009). Similarly, Jensen et al. (2012) states that the key to successful industrial symbiosis programmes is to build on existing opportunities in brownfield industrial systems since the level of diversification in these mature industrial systems create an environment where opportunities can be identified and facilitated more easily.

1.3.2 The wider network model

This model is based on the principle that companies do not have to be within the same location for resource exchanges to be viable. The networked model can take two forms, (i) self-organised or (ii) facilitated. It is common for companies that have dry-recyclables to already be engaging in self-organised industrial symbiosis; exchanging these materials with a recycler or waste management company would be a very simple form of industrial symbiosis. However, facilitated industrial symbiosis has gained significant attention over the last decade. This form of the networked model includes a third party that assists in the identification and implementation of mutually beneficial links for member businesses across large areas or regions. The first national facilitated industrial symbiosis pilot programme was launched in the United Kingdom in 2004, when the Landfill Tax was reintroduced, to assist industry to divert waste from landfill (National Industrial Symbiosis Programme, n.d.). The National Industrial Symbiosis Programme (NISP) was introduced in the West Midlands, Yorkshire and Humber regions and was so successful that a national programme was rolled out in 2006. Since the inception of the pilot programme in 2004, NISP has shown that facilitated industrial symbiosis has great potential as a practical means of reducing industrial and commercial waste, resulting in various economic and environmental benefits (Paquin et al. 2009). Altogether, between 2007 and 2013 NISP has:

- Achieved £1 billion cost savings for the member businesses involved
- Generated £993 million in additional sales
- Created or safeguarded over 10,000 jobs
- Recovered and reused 38 million tonnes materials
- Reduced 39 million tonnes industrial carbon emissions
- Saved 71 million tonnes of industrial water (NISP, 2013)

Because of the success of the NISP pilot program, International Synergies Limited (ISL) was established in 2005 as a vehicle to support the development of industrial symbiosis programmes globally. To date, ISL has developed facilitated industrial symbiosis programmes in 16 countries including the United Kingdom, the United States of America, China, Brazil and South Korea.

1.4 Supporting national and provincial legislation and strategies

The waste economy legislative framework supports the application of industrial symbiosis in the Western Cape. Table 2 below provides an overview of the relevant acts and strategies as well as their bearing on the development of industrial symbiosis programmes in the province.

Table 2: Summary of the acts and strategies that support the application of industrial symbiosis in the Western Cape

Act or Strategy	Overview of act or strategy	Assessment of impact on industrial symbiosis
National Environmental Management Act 107 of 1998	Sets ecological sustainable development as the framework for environmental decision making (Council for Scientific and Industrial Research, 2013)	Industrial symbiosis promotes resource efficiency and sustainable production processes.
National Environmental Management Act: Waste Act 59 of 2008	Sets the improved waste hierarchy as the basis for waste management decision making (Council for Scientific and Industrial Research, 2013)	Industrial symbiosis uses the principles of the waste hierarchy in decision making for resource exchanges.

Act or Strategy	Overview of act or strategy	Assessment of impact on industrial symbiosis
National Waste Management Strategy (GN 344 GG 35306 of 4 May 2012)	Sets eight goals which support the implementation of the Waste Act. Included is the promotion of waste minimisation, reuse, recycling and waste recovery. (Council for Scientific and Industrial Research, 2013)	As above, industrial symbiosis uses the principles of the waste hierarchy in decision making for resource exchanges. Industrial symbiosis is one of several methods that can contribute growing the waste sector within the green economy.
South African Green Economy Accord of 17 November 2011	Sets 12 commitments to address climate change and create jobs simultaneously. Commitment 5: "Government commits to finalise a Waste Innovation Programme that aims to promote reduced waste generation during production processes. Re-use will be promoted, as one waste stream can potentially be the raw material for a separate industrial process, leading to novel products. Waste can also be a feedstock for generation of energy". (South African Department of Economic Development, 2011)	The commitment supports the implementation of industrial symbiosis as a means to reduce waste generated during production processes.
National Development Plan: Vision 2013, Chapter 5: Transition to a Low Carbon Economy of 11 November 2011	Outlines the long term strategic plan for South Africa. States that by 2030, South Africa should be resource-efficient and have reduced its dependence on carbon, natural resources and energy without compromising job creation (National Planning Commission, 2011).	Industrial symbiosis has the potential to significantly contribute towards creating a resource efficient economy, while creating jobs simultaneously.
Green is Smart: Western Cape Green Economy Strategy Framework of 2013	Identifies the priorities to position the Western Cape as the lowest carbon province in South Africa and the leading green economic hub of the African continent (Western Cape Government, 2013)	WISP is referenced as a means to grow the commercial waste economy by developing a province-wide facilitated waste exchange network, which will result in lower greenhouse gas emissions for the businesses involved.
Western Cape Climate Change Response Strategy of February 2014	Sets the overall approach to mitigate climate change in the province, prioritising focus areas. Focus areas include energy efficiency, demand-side-management and renewable energy. The strategy promotes the development of the waste economy and opportunities to divert waste from landfill. (Western Cape Government Department of Environmental Affairs and Development Planning, 2014)	Industrial symbiosis is an appropriate tool to develop and encourage a waste economy, diverting material from landfill in the process.
OneCape 2040: From Vision to Action. The Western Cape agenda for joint action on economic development. October 2012	Outlines the long term strategic plan for economic development in the Western Cape. The strategy states that the Western Cape needs to reduce its dependence on carbon and change consumption patterns to reduce, reuse and eliminate wastage (Western Cape Economic Development Partnership, 2012)	Industrial symbiosis has the potential to contribute significantly to the reduction and reuse of waste. In addition, industrial symbiosis can help to implement less carbon intensive practise.

2. THE WESTERN CAPE INDUSTRIAL SYMBIOSIS PROGRAMME

The Western Cape Industrial Symbiosis Programme (WISP) is based on the facilitated industrial symbiosis programmes developed by International Synergies Limited. It is one of a number of Green Economy initiatives of the Western Cape Government (WCG), funded by the Department of Economic Development and Tourism and started in May 2013. The WCG has made known its intention to become the Green economic hub of South Africa and Africa, and approved a Western Cape Green Economy Strategic Framework in 2013. WISP was initiated in order to address challenges around the continued viability of businesses, as the cost of energy and other inputs rises, impeding economic growth and job creation. Furthermore, WISP is tasked to address landfill diversion as well as the need to reduce the carbon intensity of production processes and improve resource efficiency within production processes. WISP partnered with several government organisations and provincial departments in order to guide the programme and leverage existing networks to recruit members to the industrial symbiosis network. These stakeholders included: International Synergies Limited, The Department of Environmental Affairs and Development Planning, Department of Economic Development and Tourism, The Western Cape Economic Development Partnership, The Cape Chamber of Commerce, the National Cleaner Production Centre and The City of Cape Town. WISP had two facilitators during the pilot year, who worked full time to build an industrial symbiosis network, identifying under-utilised resources which could lead to business opportunities or "synergies" for the member companies. These synergies are identified in two ways:

- Business Opportunity Workshops – Business representatives attend a morning workshop where under-utilised resources are identified and matched with the needs of other businesses at the workshop. Two workshops were conducted during the pilot year.
- Business Meetings – Meetings are conducted with companies with the goal of identifying under-utilised resources and resources (virgin or alternatives) that are used in operations. The resource needs of businesses are then matched to those of other businesses in the network

As a result, an industrial symbiosis network containing 108 member companies, 529 under-utilised resources and 1205 potential synergies was created. This company and resource network was managed by WISP and the facilitators assisted companies with the implementation of synergies as well as developed business cases and completed synergy reports for member companies.

3. OUTCOMES OF THE PILOT PROGRAMME

3.1 Distribution of member companies within the Western Cape

Figure 2 shows the distribution of WISP's member companies within the Western Cape, where the majority of the programme's members are located in The City of Cape Town. This is a result of focussing the pilot programme on the greater Cape Town region, because of the pilot's small scale and structure. There is still significant potential to increase WISP's reach and diversify the network, increasing opportunities for collaboration and resource matching within an industrial symbiosis network.

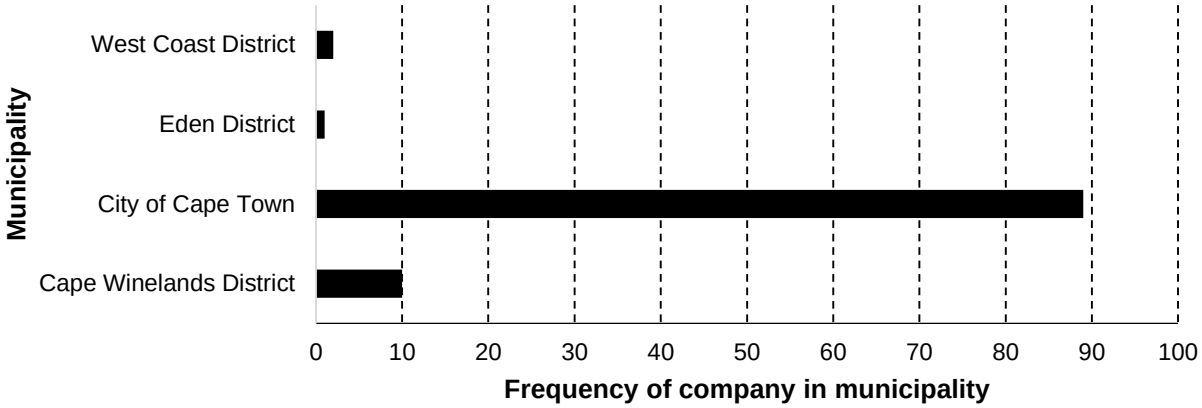

Figure 2: Distribution of WISP member companies by municipality

3.2 Overview of under-utilised resources identified at Business Opportunity Workshops

The under-utilised resources identified across the two workshops held in the pilot year are shown in Figure 3. The figure presents the frequencies for different categories of under-utilised resources, where the frequency is the number of times a company identifies a resource within that category. The resources are further disaggregated in “Haves” and “Wants”, where a “Have” resource is a resource that a company has that another company may want, and a “Want” resource is a resource that a company wants that another company may have.

The most common under-utilised resources that companies have are plastic and packaging, paper, wood, food and capacity. These resources are expected to be under-utilised for a number of reasons. Regardless of the industry, materials are always packaged for delivery resulting in plastic and packaging waste. However, the majority of these have existing markets and can be recycled; the workshops are usually used to find potential solution providers for these.

When the “Have” and “Want” frequency bars are analysed there appears to be a need for packaging and paper solution providers, even though the recycling market for these materials is well established (Figure 3). This may be the result of poor representation of packaging and paper solution providers at the workshops or because the solution providers that were present only wanted high grades of paper and cardboard that were not composite materials. However, situations such as these where the supply and demand are uncoupled create opportunities for innovation. In addition, the WISP team can leverage these insights to unlock niche markets or new businesses from these “abandoned” materials.

Bulk materials are typically delivered on wood or plastic pallets, which have no further functional use within the company. This is represented in the high frequency of wood “Haves” in Figure 3. Pallets can, however, be refurbished and reused. Therefore, the workshops allowed companies with used or broken pallets to find a pallet supplier willing to refurbish or buy the underutilised pallets. Wood pallets are not particularly durable and frequently break after two or three uses. Wood pallet refurbishers were invited to join the WISP network to ensure that there is also uptake of broken wood pallets. Although plastic pallets are far more durable than wood pallets, they also have a limited lifespan. Plastics recyclers and plastic pallet manufacturers within the network provided solutions for these materials. Apart from wood pallets, a wide variety of under-utilised wood has been identified at workshops. This includes saw dust and wood offcuts of varying quality and types. Finding solutions for these resources is complex as solution providers have been found to only want high quality large offcuts, whereas the waste wood at workshops is usually in the form of low quality, thin offcuts which are difficult to use. The saw dust generated is usually a mix of different wood types, making it undesirable for composting. These factors contribute to the difference between the “Haves” and “Wants” for wood (Figure 2).

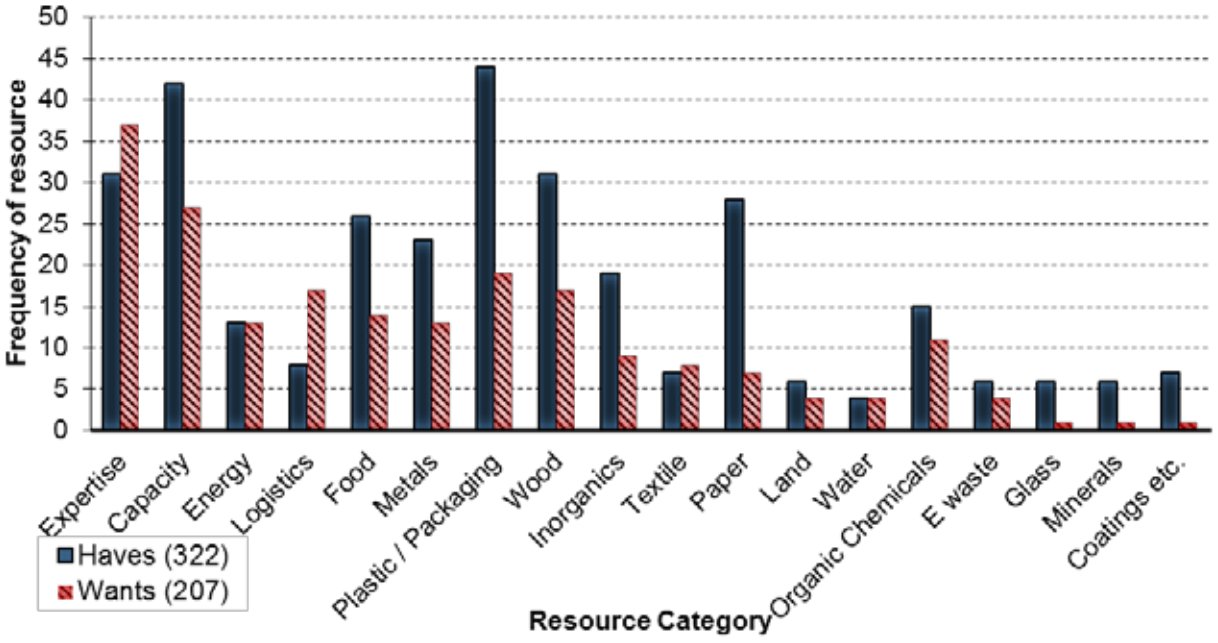

Figure 3: Frequency graph for resource “Haves” and resource “Wants” identified across two workshops.

In addition to wood, a great amount of organic material has been identified at workshops. Several WISP members are large retailers or part of large food groups and therefore generate a considerable amount of food waste (Figure 2). Few solutions exist for food waste in the Western Cape, resulting in the large gap between the frequency of "Have" and "Want" resources in this category. However, when challenges to implementation of solutions are encountered, WISP collaborates with other GreenCape projects and sectors to find potential solutions. It is expected that solutions for organic material will be resolved in the future by several anaerobic digestion and biofuel facilities that are currently in development.

Some members identified that they have warehousing space, land or other facilities that are under-utilised and could be used by other companies. Uptake of these "Capacity" resources is also fairly complex as they need to meet a number of specific requirements for companies looking for capacity, resulting in fewer "Wants" for "Capacity" resources.

Table 3: Summary of WISP synergies implemented during the 2013-2014 pilot year*

	Synergy Description	Benefits	Once-off/ Continuous**
1	Label Manufacturer's wood pallets returned to various suppliers for reuse	- Landfill diversion	Continuous
2	New Logistics Service Provider selected by Plastic Injection Moulding Company through increased networking opportunities	- Cost savings	Continuous
3	Pharmaceutical company and consulting company collaborate to increase the efficiency of waste management in a manner that benefits eight companies	- Landfill diversion - Additional sales - Cost savings - Additional investment	Continuous
4	Wood pallets exchanged* between Waste Management Company and Wood Pallet Refurbisher	- Landfill diversion - Additional sales - Cost savings	Once-off
5	Wood Pallet Refurbisher internally investing due to increased networking opportunities	- Additional investment	Once-off
6	Plastic pallets exchanged between a Wood Pallet Refurbisher and a Plastic Pallet Refurbisher	- Landfill diversion - Additional sales - Cost savings	Once-off
7	Broken fishing nets exchanged between a Marine Fishing Company and the City of Cape Town	- Landfill diversion	Once-off
8	Replacement of LED Lights at a Foundry by an Energy Efficient Lighting Company - following a relationship facilitated at a WISP workshop.	- Additional sales - Cost savings - Energy savings	Once-off
9	X-ray film and litho fixer exchanged between a Label Manufacturer and a Metal Recovery Company	- Additional sales - Cost savings	Once-off
10	Increased LDPE recycling by Label Manufacturer and Waste Management Company	- Landfill diversion - Cost savings	Once-off

** A synergy is described as the transaction or movement of materials between participating companies enabled by the active facilitation of WISP. This could be one way or two way flow between participating partners.*

*** In the case where the exchange is not once-off, the results from the synergies have been annualised to project the future outcome of the ongoing nature of the synergy.*

3.3 Completed synergy analysis

As indicated earlier (Section 1.3.2) a critical role of the industrial facilitator is to assist companies to implement synergies so that the companies can realise the benefits. Because of the small scale of the pilot programme for the duration of the year, the WISP facilitators focussed efforts on those member companies that showed a high level of commitment to the programme, in order to maximise the potential for synergy realisation. Table 3 presents the synergies that have been implemented to date (i.e. contracts signed and resource exchanges taking place). The benefits from realised synergies vary greatly. This can be attributed to the diversity of WISP's members and the opportunities identified. Synergy 1, 4, 5 and 6 (Table 3) involve the reuse or exchange of pallets. These are termed "quick wins" in industrial symbiosis because they can be

implemented and deliver benefits quickly once identified. WISP's Business Opportunity Workshops have the advantage of allowing companies that may not usually interact the opportunity to network and gain additional business contacts. As a result, a number of member companies secured contracts for additional work at the workshops. These are shown in synergies 2 and 8 in Table 3. Synergy 7 is an example of how facilitated industrial symbiosis model can increase collaboration between the public and private sectors. The City of Cape Town refurbished the discarded fishing nets into sports nets for various sports and recreation facilities that it manages; and the Fishing Company diverted its waste from landfill, eliminating disposal fees and contributing towards its Corporate Social Responsibility Initiatives. Synergy 6 indicates the private investment that a Wood Pallet Refurbisher has made toward expanding the business and altering the current business model to capitalise on the wood pallet recycling market following its engagement with WISP.

3.4 Performance of the programme and potential impact on waste management practice

The aggregated benefits achieved for implemented synergies by WISP members in 2013-2014 are shown in (Table 4).These benefits are aggregated using the data provided from the individual synergy reports which were signed off by companies when a synergy was completed. No particular indicators were prioritised for the pilot year, as this allowed for greater flexibility for the WISP facilitators to prioritise support to companies.

Table 4: Aggregated benefits of WISP in the 2013-2014 pilot year

Indicator	Total
Landfill diversion	59.2 tonnes
Additional sales	R 2.93 million
Cost savings	R 2.65 million
Private Investment	R100 000
Energy savings	1820 MWh 239 kW (demand)

The benefits indicate that industrial symbiosis as a waste management approach has economic and environmental merits for its participating member companies. In addition, WISP also supports the national and provincial acts and strategies (Table 2) by promoting the waste hierarchy, energy efficiency, landfill diversion and reducing the dependence on carbon, natural resources and energy without compromising job creation

The success of WISP can be attributed to several factors. Firstly, GreenCape, a not-for-profit organisation created by the Western Cape Government to support the growth of the green economy in the province, was used to deliver the programme. GreenCape has an established reputation in working to develop the green economy in the Western Cape with no vested interests. Secondly, establishing partnerships with key government stakeholders and industry which allowed WISP to leverage existing stakeholder networks to grow the industrial symbiosis network. And lastly, building on the foundation and experience of International Synergies Limited, who have experience in developing industrial symbiosis networks around the world. The success of WISP has indicated that companies in the Western Cape are interested in alternative waste management practices, beyond traditional waste management in South Africa, and are eager to join programmes like WISP that can provide business benefits. Based on the benefits achieved (Table 4), the Western Cape Government regards WISP as the successful demonstration of a tailored, but scalable approach for facilitated industrial symbiosis. As a result of the programme's success, WISP was granted funding for 2014-2015 to continue providing business in the Western Cape with the free service. In addition, the framework for a national South African industrial symbiosis programme will be developed in 2014-2015, with funding granted by the British High Commission's Prosperity Fund, with WISP serving as the foundation for the framework.

3.5 Barriers and challenges encountered during the implementation of synergies

Even though WISP has seen ten resource exchanges implemented between member companies, engagements with industry have revealed that there are several barriers and challenges limiting the programme reaching its full potential. These barriers and challenges include:

- Complex regulatory framework, especially around the reuse/recycling of waste materials
- High cost of transport and logistics services
- Poor appetite for the use of secondary and/or alternative materials
- Challenging and lengthy enterprise development process
- Poor appetite for additional capital investments
- Lack of large scale solutions for waste composite materials, organics, textiles and wood

The above have been communicated to the relevant stakeholders such as The City of Cape Town, the Western Cape Department of Environmental Affairs and Development Planning and the Western Cape Department of Economic Development and Tourism. Strong partnerships between WISP and its stakeholders have assisted to mitigate some of these barriers and challenges when implementing synergies. In addition, these challenges have been raised internally and are being addressed by the other functions within GreenCape.

4. CONCLUSION

The one-year WISP pilot progamme can be regarded as a success because of the positive impact it has had on Western Cape business in terms of financial benefits, landfill diversion, CO_2 equivalents emission reductions and the potential for enterprise development and job creation. It is clear that the facilitated industrial symbiosis model enables innovative waste management practices. By facilitating the delivery of industrial symbiosis, WISP is unlocking the carbon and resource-efficient targets stated in national and Western Cape policy frameworks, supporting the development of the waste economy in South Africa. The success of the pilot programme has indicated that there is potential for industrial symbiosis across South Africa, not only the Western Cape. WISP will therefore be used as the foundation for the development of a national industrial symbiosis programme in South Africa. Ultimately, a successfully delivered national IS programme could be used to shape innovative waste management and the waste economy on the African content.

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