Industrial Symbiosis as an Enabler of Resource Efficient Regional Development

S. Smout. GreenCape, Cape Town, South Africa. Sam@greencape.co.za
S. O'Carroll. GreenCape. Sarah@greencape.co.za
L. Basson. GreenCape. Lauren@greencape.co.za

ABSTRACT
Using its tailor made methodology, the Western Cape Industrial Symbiosis Programme was able to document the outward flow of underutilised resources from 46 companies across sectors within the Atlantis area, and synthesised that data into resource availability, ascertain problem waste streams, and subsequently identify potential opportunities embedded in those problem wastes.

A number of waste streams were identified as problem streams, of which wood, textiles, inorganics, and paper / cardboard were the four largest, and subsequently became focus streams for diversion. Through its understanding and local knowledge, fifteen potential opportunities were identified that, if implemented, could divert over 73,000 tonnes of waste to landfill and have an economic spinoff amounting to over R28million, create jobs and foster regional development through resource efficiency and enterprise development.

1. INTRODUCTION TO A RESOURCE EFFICIENT ECONOMY AND THE ROLE OF INDUSTRIAL SYMBIOSIS IN RESOURCE EFFICIENT REGIONAL DEVELOPMENT

The 2016 United Nations Environmental Programme (UNEP) report "Resource Efficiency: Potential and Economic Implications" highlights that effective resource efficiency policies and an ambitious global action on climate change could reduce global resource extraction by approximately 28% by 2050, compared to a reference scenario based on current trends; reduce global greenhouse gas emissions by 74% by 2050 compared to 2015 levels; and increase the global economic output by 1% (UNEP, 2016).

To achieve this ambitious forecast, a shift in the way society manages its linear, take-make-waste, economy to a more resource efficient, circular economy is required. A circular economy is one that is "restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times." (Ellen McArthur Foundation, 2016). The World Economic Forum, in collaboration with the Ellen MacArthur Foundation and McKinsey & Company, indicated that by the year 2025, an economy adopting the circular economic principles could generate over US $1 trillion a year for the global economy, and 100,00 jobs in the next five years (Ellen McArthur Foundation, 2014).

Such a fundamental change in the economy draws on, amongst others, the principles of industrial ecology, and more specifically Industrial Symbiosis (IS). IS a resource efficiency approach that enables the increased utilisation of manufacturing by-products and excess materials previously considered waste streams to reduce material waste and dependency on virgin materials. Industrial symbiosis enables unused or residual resources (materials, energy, water, waste, assets, logistics, expertise) from one company to be used by another company typically leading to financial, social and environmental benefits.

IS can occur directly through the interactions of businesses, often in response to local resource constraints. Facilitated industrial symbiosis programmes typically provide support to companies to identify and realise IS opportunities. The Western Cape Industrial Symbiosis Programme (WISP) is one such programme. It provides a free facilitation service, funded by the Western Cape Government and City of Cape Town, to enable the implementation of IS in the Western Cape. WISP uses an IS facilitation methodology developed by the International Synergies Limited (ISL)[1] adapted to the South African context. The programme identifies companies that could benefit from IS and facilitates the resource exchanges between.

[1] ***The development agent for the highly successful United Kingdom's National Industrial Symbiosis Programme***

WISP is delivered by the sector development agency GreenCape. GreenCape has been mandated by the Western Cape Government to assist in the growth of the Green Economy[2] in the Western Cape. GreenCape primarily assists businesses and investors focusing on green technologies and services to remove barriers to their establishment and growth, and has a number of programmes, such as WISP, and projects to support the growth of the green economy in the Western Cape. To this end, GreenCape has co-ordinated the application by the Western Cape Provincial Government, in collaboration with the City of Cape Town, to the national Department of Trade and Industry for the Atlantis industrial area to be declared a Greentech Special Economic Zone (SEZ). The intent is to enable both manufacturing associated with green technology value chains (e.g. manufacturing of components of renewable energy systems, secondary materials processing) as well as greener manufacturing (using cleaner and more resource efficient processes).To this end, WISP has been appointed to improve the resource efficiency of the industrial area, and to identify opportunities for green enterprise development - all with the ultimate goal of developing Atlantis, among others, as a processing hub for secondary resources and exemplifying resource efficient manufacturing.

WISP documented the outward flow of under-utilised resources from companies across a range of sectors, and analysed this data to identify actual material resource availability. Existing infrastructure and economic activities that could enable improved resource efficiency have been identified. Finally, the potential for prospective developments and business innovation that would enable greater resource efficiency have been noted.

The paper summarises the findings of the study and demonstrates how such an approach could be used to enable resource efficient regional development.

2. DATA COLLECTION AND ANALYSIS

2.1 Growing the WISP Network:

To obtain detailed resource information for the Atlantis area, companies were actively recruited to become WISP members. Such recruitment is typically done through meetings, site visits and business opportunity workshops (BOWs) (i.e. focused events involving a number of companies where resources and potential matches identified). WISP leveraged its relationship with the Atlantis SEZ team, as well as the City of Cape Town, to obtain a database of all companies within Atlantis and their contacts. Using this database, WISP managed to set up meetings/site visits and send invites to an Atlantis-specific BOW. This type of contact with companies allowed data on underutilised resources (types, tonnages / volumes, current solutions, frequency) and resources that companies may be able to utilise themselves to be gathered.

2.2 Storing Business Information:

All business and resource information obtained from meetings, site visits and BOW was uploaded onto a special purpose IS database platform called SYNERGie™ that allows company and resource information to be organised in a manner that enables potential identification and management.

2.3 Determining Resource Availability

In order to verify actual available waste streams within an organisation, WISP facilitators had to investigate whether companies were in fact reporting correctly on what was being done with their waste. This is because company representative's understood waste as a by-product of a process and not realising that the company did in fact have a solution for that waste, or sometimes companies were trying to get better prices for resources they already had.

To illustrate the availability of resources, these were categorised into three levels of availability: Available (resources that required a solution); Available with Barriers (resources that required solutions, but would require dealing with some hurdle), and Unavailable (resources that did not actually exist, or already had a solution, but better recycling prices were being sought).

Only those resources that were categorised as available or available with barriers were considered further.

[2] ***"One that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. It is low carbon, resource efficient, and socially inclusive" (UNEP, 2011)***

2.4 Prioritisation of Materials and Subsequent Opportunities:

The impact that WISP aims to make is to reduce the economic burden on companies and to divert waste from landfill. However, rather than assessing these directly, which would have made the analysis unduly burdensome, tonnages were used as the proxy. Tonnages were considered a good proxy, as landfill tariffs are based on the weight of the material, and tonnages are an easier indicator to estimate the potential financial burden of not diverting waste. However, not all resources are reported in tonnages, but rather in other units (items, cubic meters, litres etc.). As such, resource reported in other units had to be converted into tonnages using commonly available density databases.

Once all available resources were identified and compared it was possible to identify the largest waste streams in Atlantis[3].

Resource availability is either continuous or batch / once off. Those resources that are continuous were given greater priority. As such, batches were excluded from further analysis. Once all the continuous resources were identified, these were separated into services and materials. Once the tonnages of the various available material streams were obtained, the financial burden and opportunity associated with diversion as well as the potential economy value of the streams was estimated.

2.5 Valuing the Material Resources:

To determine the potential financial impact of diverting waste streams from landfill, two financial indicators were used: cost of disposal of resources to landfill and the potential market value of resources.

To estimate the cost of disposal, the City of Cape Town's 2016 disposal tariffs for landfill for general waste and hazardous waste were used. As the closest landfill to Atlantis is Vissershok, it is considered reasonable to assume all waste destined for landfill would be directed to the City of Cape Town's Vissershok landfill. Disposal of general waste and hazardous waste costs a company R395.40 (incl. VAT) and R524.00 (incl. VAT) per metric tonne, respectively. It should be noted that this cost of disposal is for the gate fee only and does not include the service fee that a waste management company may charge.

To determine the value of resources, the National Department of Science and Technology's 2014 report on the value of resources lost through landfilling was used (DST, 2014). Table 1 illustrates the suggested value of 13 selected waste streams.

Table 1: Unit value (R/tonne) for the 13 selected waste streams as per the DST's report on the value of resources lost through landfilling (DST, 2014)

Stream	Unit value (R/t)
Municipal waste (Non recyclable)	367.38
Municipal waste (Organics)	188.63
Biomass waste from industry	188.63
Construction / Demolition	87.50
Paper	744.47
Plastic	3119.54
Glass	490.00
Metals	2270.00
Tyres	367.00
WEEE	1000.00
Slag	175.00
Ash	3.00
Waste oils	2777.78

In situations where a material did not have direct value, a value was estimated from a material that had similar qualities as a material noted by the DST.

[3] ***When realising synergies, WISP focuses its efforts on high impact resources. However, this is not to say that WISP does not facilitate quick wins. Where fast and easy synergies are foreseen, WISP will also act to realise these synergies.***

It should be noted that the value of underutilised resources is always changing. As such, the value of the identified waste streams is not an absolute, but rather a rough indication on the value inherent in the material.

3. RESULTS OF THE ATLANTIS RESOURCE ANALYSIS

3.1 The Atlantis Network

The study identified 77 companies that would be suitable for industrial symbiosis as these companies had some form of material processing. The companies not included are predominately service-based, namely: education, finance, hospitality, landscaping, media, and personal care, although it is recognised that some of these would give rise to under-utilised resources. However, from experience, it is known that this is substantially less than from manufacturing facilities. In 2013, only one Atlantis company had joined the member network. In 2014, this number grew by 12 companies, due to increased facilitation capacity and a request from the WISP Steering Committee to expand facilitation into the West Coast and Cape Winelands. In 2015, Atlantis became a focus area for WISP, and as such, the Atlantis network grew by 33 companies. Overall, 29 companies were recruited via site visits and meetings, while 17 new companies were signed up via workshops. This resulted in 46 companies or over all or 60% of the suitable companies identified. The remaining 31 companies are companies that have not shown interest in the programme or that the WISP facilitators have not been able to meet with as yet. These are regarded as prospective members. Figure 1 illustrates the member and prospective member numbers and their respective sectors.

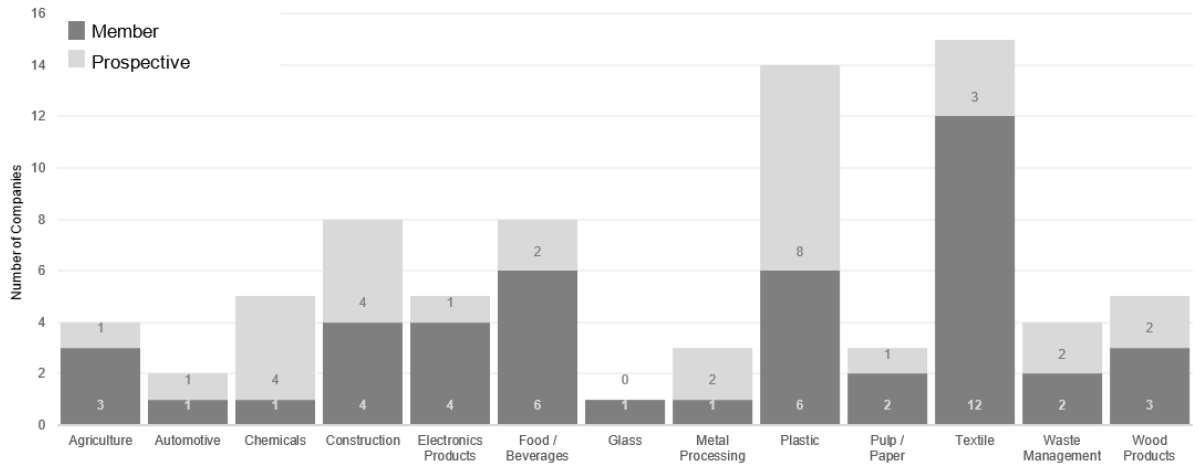

Figure 1: The number of Atlantis WISP member companies and prospective member companies and their sectors

3.2 Resource Frequency in Atlantis

From the business interactions, information 416 resources in total was collected. Of these, 209 resources were those that companies were interested in using in their own operations (called “wants”). The remaining 207 resources were resources that companies required a solution for (called “haves”). Figure 2 provides an illustration of the incidences of “have” and “want” resources discussed.

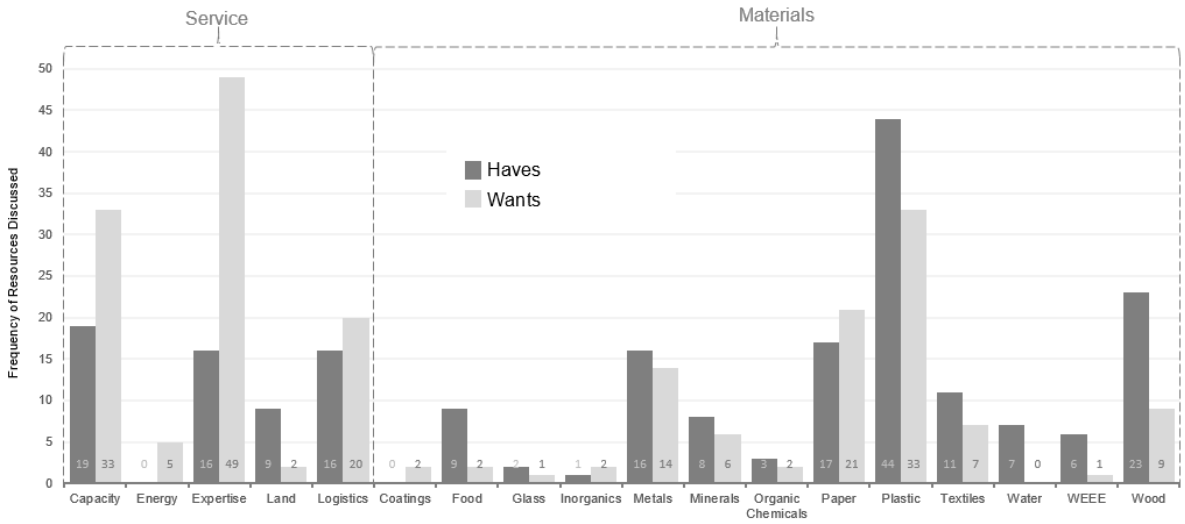

Figure 2: Resource frequency per type of resource collected during Atlantis WISP member interaction

The total resource were separated into two broad types' services and materials. Of the 169 resources categorised as services, 60 were services that companies had ("haves") whilst the remaining 109 were services companies were in need of ("wants"). Of the remaining 247 resources discussed, 100 were materials companies wanted and 147 were materials companies had.

3.3 Material Tonnages in Atlantis

Identifying resource frequency (e.g. Figure 2) allows WISP to understand how often a stream is being discussed, but it does not provide WISP with actual tonnages that provide a means of prioritising effort. After filtering the information into the three availability categories (available, available (barriers) and unavailable), it was possible to narrow the focus to a handful of resources that, if dealt with, would have the greatest impact in Atlantis and consequently on the City of Cape Town. The availability tonnages for each waste stream is illustrated in Figure 3.

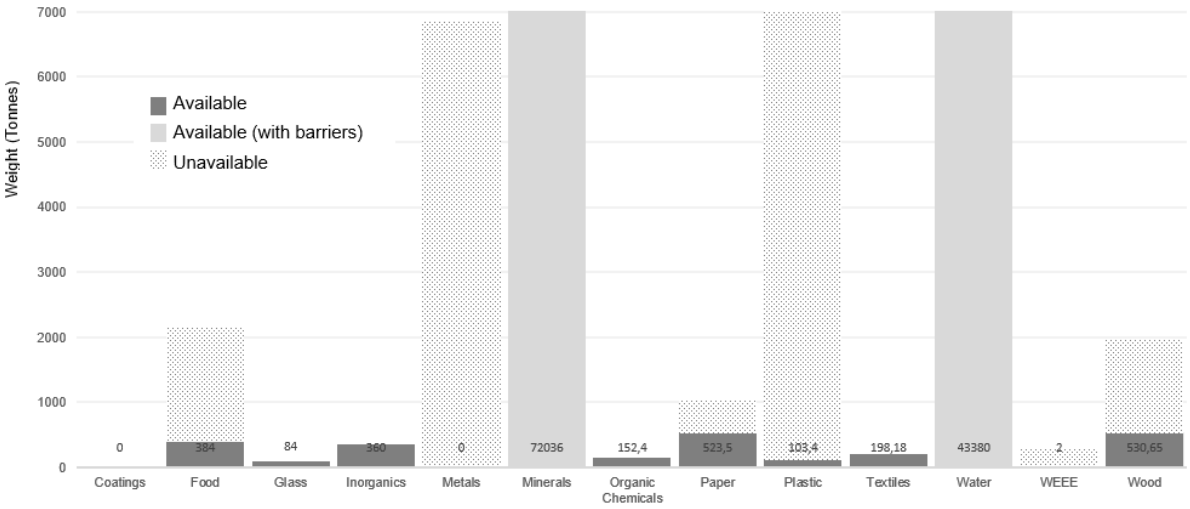

Figure 3: The availability and tonnages of resource streams in Atlantis[4]

The largest material stream identified came in the form of minerals and more specifically foundry sand. However, foundry sand is listed as a hazardous waste and, as such, requires hazardous waste licencing,

[4] The graph depicts the y-axis's as a maximum tonnages at 7000 tonnes. However, the maximum tonnage is 72036 tonnes (minerals). The reason this is not depicted is to eliminate the poor visual comparative between minerals and water with the other waste streams, which are significantly smaller in weight.

which is both expensive and time consuming. With this in mind, the resource is available, but has barriers and innovation that require investment.

Process water is also a large material stream, but instead of coming from one operation, it comes from a number of sources. The businesses as usual solution is to dispose of the water into the sewerage reticulation. This is an already paid for service and businesses are apprehensive to invest in solutions to wastewater.

Wood materials are prevalent in Atlantis and come in the form of pallets (broken and intact), and wood offcuts and sawdust from a local large-scale furniture manufacturer. These are potentially “quick wins”, but pallet collection requires a great deal of logistics as the sources of the pallets are scattered.

Textile processors are the most numerous of the industries in Atlantis. Many of the textile companies receive thread on industrial strength cardboard cores that also have a waxy layer. Both characteristics make it difficult to recycle. As a result, the cores are stockpiled and sent to landfill. Atlantis also has two paper processing plants. The paper processing companies have large volumes of paper sludge, a by-product of the recycling process. This sludge is predominantly water and fibres that are too short to use for products. As such, both materials require inward investment and innovation to realise.

The inorganics stream is all bentonite clay contaminated with PET fibres. This makes it impossible to reuse for the purpose that bentonite is intended. However, this comes from one source, which makes logistics an easier endeavour.

Many of the textile companies also have inefficient machinery or product design, and often produce thread material or products that are off spec. This is stockpiled and subsequently sent to landfill.

3.4 WISP’s Four Priority Materials in Atlantis

Through the prioritisation of the resources above, four broad resources types were identified as having potential to have the greatest estimated annual diversion impact and subsequently financial impact. These resources types include Inorganics, Wood, Paper and Cardboard, and Textile. Figure 4 illustrates these four streams, but also provides further details of what these types of resources are included in these streams. It is these resource streams that WISP estimates will have a greatest impact on landfill diversion, relieving financial burden and developing innovation within Atlantis. As such, WISP efforts will be focussed on finding solutions to these broad categories.

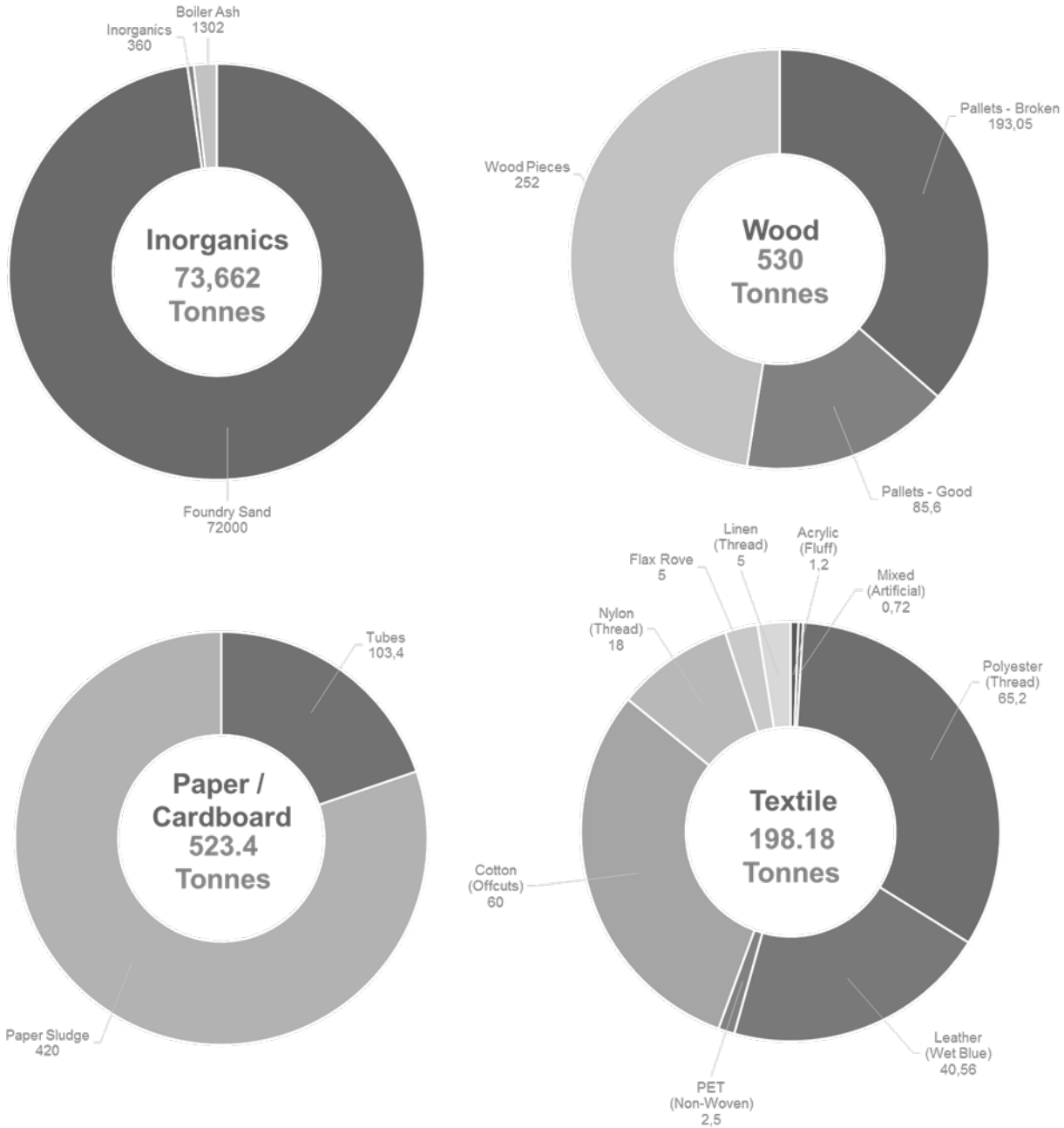

Figure 4: Priority resources[5] for landfill diversion and enterprise development in Atlantis and their material composition

3.5 Opportunities Identified By WISP

Through the analysis of the various available resources, and WISPs internal knowledge of the landscape, a number of potential impacts and their time horizons that could be achieved are illustrated in Figure 5. (This includes some non-material opportunities, but the impacts of these are not included in the total benefits indicated).

[5] The waste stream labelled “Inorgancis” includes a combination of minerals and inorganics.

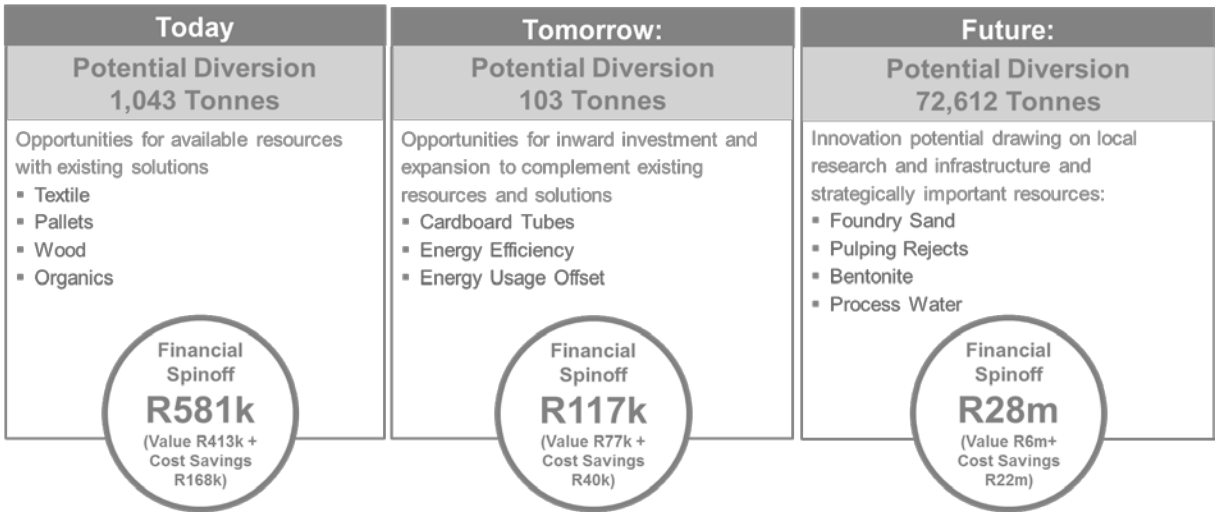

Figure 5: Potential impacts of enterprise development within the Atlantis SEZ

In the short term, there are opportunities to divert over 1000 tonnes of material (textile, pallets, wood and organics) from landfill per year using existing WISP solutions. Using the cost of landfill diversion, thus a potential financial spin-off in excess of R581,000 rand.

In the medium term, there are opportunities to divert 103 tonnes a year of material. However, this would require some inward investment by companies. It should also be noted that energy efficiency (service) and alternative energy are not valued, but have a potential to reduce costs.

Lastly, there are long-term solutions to extremely costly materials to divert from landfill. WISP is investing time in identifying solutions to divert this waste. Such solutions require innovation and investment by businesses. If WISP could facilitate these opportunities, it would result in over 72,000 tonnes a year of materials diverted from landfill, resulting in over R28 million in financial spinoffs, as a result of cost savings associated with landfilling.

Using its embedded knowledge, WISP has also identified 15 enterprise development opportunities available in Atlantis (Figure 6) which, if they came to fruition, could have a financial spinoffs greater than R28.5 million based on cost savings and the value of the material.

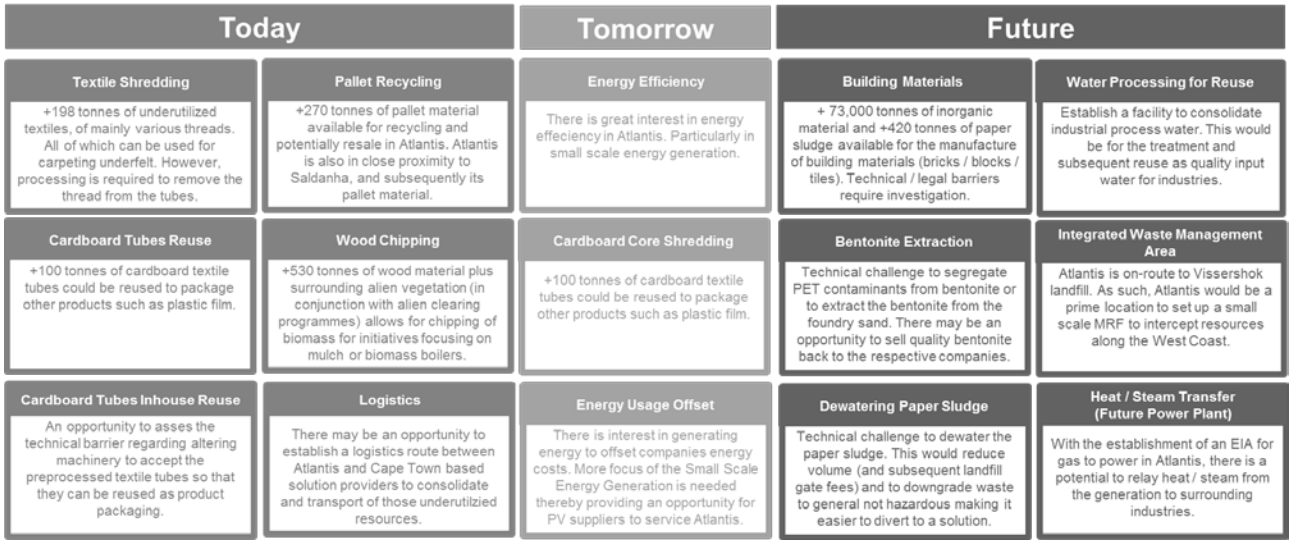

Figure 6: Opportunities Identified to Enhance or Develop Enterprises in Atlantis

However, this does not mean that other solutions will not be considered. As time goes by, new solutions and investors join the network, and as such are also given the opportunity to present their solutions to the respective companies.

4. WISP'S IMPACT IN ATLANTIS THUS FAR

WISP has already managed to facilitate synergies been ten businesses including energy efficiency technology expertise, textile recycling, pallet recycling, and polystyrene recycling. WISP has also facilitated the potential setting up of three businesses in the Atlantis Industrial area, one being a pyrolysis plant, another a pallet recycling operation and the third a textile recycler.

As for future innovation, WISP is currently facilitating a number of discussions between companies concerned with the largest waste streams in Atlantis; these being: foundry sand, waste water, and paper sludge.

In addition, WISP has been key agents in facilitating discussions between Atlantis Companies and GreenCape regarding setting up solar PV pilot projects that seek to utilise under-utilised roof space, as well as, informing businesses of the opportunities associated with Small Scale Embedded Generation whereby companies within the City of Cape Town are able to feedback excess energy back onto the grid with financial incentives. Both would not only increase the uptake of renewable energy in Atlantis, and potentially open up to new enterprise development in solar PV installation and maintenance.

5. CONCLUSION

5.1 WISP Facilitates Resource Efficiency and Innovation Opportunities at a Regional Level

IS, through WISP, has been recognised in the Atlantis Industrial Area as tool to grow resources efficiency and eco-innovation within the Atlantis area. It was WISPs task to identify what under-utilised resources existed in area; identify viable solutions for those resources, firstly within Atlantis and then beyond; and finally to identify innovation opportunities.

The benefits of WISP in Atlantis include:

- The materials that could not be matched with local businesses provide an opportunity for innovation, business growth and inward investment by companies.
- Atlantis lacks key solution providers. WISP has used its knowledge obtained through its extensive network of solution providers to identify businesses interested in expanding operations – some of this expansion will be in Atlantis. This has been as a result of the opportunities identified by WISP, as well as the benefits for setting up green business in the proposed Atlantis SEZ.
- WISP draws on existing industry knowledge through GreenCape and its network to identify solutions to the largest material streams in Atlantis, including foundry sand, waste water, paper sludge, pallets and wood chips, and textiles.
- WISP also draws on the Atlantis SEZ team to identify potential future developments that may require solutions to waste streams and also future solutions providers.
- WISP has also been able to disseminate useful energy focused information on behalf of GreenCape that would have businesses potentially investing in PV technologies and using their under-utilised roof space.

5.2 Industrial Symbiosis as a Tool for a Resource Efficient South Africa

Three key messages from UNEP's report Resource Efficiency: Potential and Economic Implications (UNEP, 2016): resource efficiency is crucial for reducing the rate of fininte resource extraction and meeting climate change targets; and resource efficiency can contribute to economic growth and job creation. Such facilitation can happen through a circular economy driven by models such as IS. As has been illustrated in this paper, IS programmes such as WISP can facilitate resource efficiencies at a regional scale. It is the intent that the results of this study be used to assist Atlantis in evolving into a resource efficiency region. However, this approach can be expanded used elsewhere nationally to assist in driving South Africa to a more sustainable, circular economy.

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