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Mainstreaming the Culture of Eco-Industrial Parks (EIPs) in Kenya for the Sustainable Realization of the Country's Vision 2030

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ABSTRACT

Competitive and productive Special Economic Zones (SEZs)/ industrial Parks (IPs) of the future will be those that will abandon the wasteful linear development model and instead embrace a circular economy that is characterized with the circular flow of materials and energy. Doing this will not only lower pressure on the use of the country's virgin raw materials but also contribute to the reduced carbon footprint of the SEZs/IPs by helping to divert wastes from the landfill. This paper investigated the spontaneous evolution of waste and by-product exchange at the agro-processing and garment clusters of the Athi River SEZ. These cluster based material exchanges evolved on their own largely as a result of the prevailing forces of material supply and demand. Though at its infancy, this emergency of industrial symbiosis at the economic zone has helped to demonstrate the social inclusion dimension of green growth through the creation of decent green jobs. The practice has also enabled participating firms to reduce their GHG emissions and lower their operational costs. The economic zone's desire to fully embrace waste recovery, reuse and recycling as part of its deliberate efforts of advancing the ideals of a circular economy is currently being hampered by a lack of functional waste recovery, reuse, and recycling infrastructure. The proposed strengthening of University-Industry-Government (U-I-G) collaboration at the Athi River SEZ, will help promote eco-innovation that forms the cornerstone of the economic zone's improved productivity and competitiveness. The paper sought to unravel the enabling policy interventions that need to be put in place so as to accelerate the transformation of the country's economic zones into environmentally friendly Eco-Industrial Parks (EIPs) capable of attracting green foreign direct investments (FDIs). It also tackled the barriers that need to be overcome by key stakeholders so that the country's SEZs/ IPs can adopt a development trajectory that enjoys low-emission levels, efficiently uses its resources, and is socially inclusive through the creation of decent green jobs.

1. Introduction

Kenya's industrialization process has remained steady and promising since the country's independence in 1963. After the rebasing of its economy in 2014, Kenya ranks 9th in Africa in terms of Gross Domestic Product (GDP) size and is therefore classified by the World Bank as a "low-middle income" economy (GOK, Economic Survey, 2016). The manufacturing sector's contribution to the country's GDP has averaged 10% for close to two decades despite the country's weak manufacturing infrastructure. As a response to this shortcoming, the Kenyan Government is seriously investing in the construction of special economic zones (SEZs)/ industrial parks (IPs) that will enjoy superior infrastructure than the rest of the country. Because they concentrate industries in delimited areas, their strict adherence to resource use efficiency, the 3R philosophy of reducing, reusing, and recycling waste streams, and waste and by-product exchange through industrial symbiosis will enable them to lower their carbon footprints and remain competitive (World Bank, 2014). For Kenya, this might entail retrofitting existing economic zones/ industrial parks and designing new ones to be environmentally friendly eco-industrial parks (EIPs).

Promotion of the green economy has been high on Kenya's development agenda since the 2012 Rio+20 summit. Despite this intensified focus, very little is practically going on in this promising area of green growth promotion. Kenya can only successfully embrace a circular economic development model if all the provisions of its Green Economy Strategy and Implementation Plan (GESIP) are fully implemented. There is limited knowledge and awareness of the country's GESIP at lower Government and private sector levels. The Kenyan Government published its fifteen-year GESIP for 2016 – 2030 in August 2017. This strategy seeks to promote a low-carbon,

resource efficient, equitable and inclusive socio-economic transformation of the country. However, although high-level Government officials, policy makers and private sector players are aware of the GESIP provisions, there is apparently inadequate awareness of this strategy's provisions among middle-level and lower level Government officials and private sector players[1]. This is an important challenge that needs to be addressed, given the critical role of middle level and lower-level Government and private sector players in the design, implementation, operation, monitoring as well as the up scaling of these green strategy (UNECA I, 2016).

In the absence of an enabling policy and regulatory framework, this might prove to be expensive and unaffordable by most of the country's small-scale enterprises. The country is therefore at the beginning of a circular economy journey whose promising future largely depends on the establishment of an enabling legal, institutional, and regulatory framework. EIPs are those that subscribe to the ideals of sustainability by embracing resource use efficiency, cleaner production and residual waste and by-product exchange through industrial symbiosis. In this paper, an eco-industrial park is defined as a community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environmental and resource issues including energy, water, and materials (Lowe, 2001). By working together, the community of businesses seeks a collective benefit that is greater than the sum of the individual benefits each company would realize if it optimized its individual performance only (Erkman 2001; Lowe 1997). Through a set of well-planned activities, an existing economic zone can be transformed into a low-carbon and resource efficient zone (World Bank, 2014).

This paper seeks to establish what the government, regulators, developers and operators need to do with the support of academia so as to mainstream the culture of eco-industrial parks (EIPs) in Kenya for the sustainable realization of the country's vision 2030. The ultimate goal is to ensure that as the country industrializes through SEZs/ IPs, it does not repeat the mistakes that were committed by those countries that relied on the wasteful linear flow of materials with a trail of waste at each stage of their supply chains. The paper prioritizes a total switch from the linear and wasteful economic development model to a circular economy development model that is anchored on enhanced resource use efficiency, cleaner production, and industrial symbiosis. This will greatly contribute to the realization of the country's Green Economy Strategy and Implementation Plan (GESIP) that prioritizes low-carbon, resource efficient and socially inclusive growth. This is based on material flow investigations that were carried out at the Kenyan Athi River SEZ. The investigations sought to establish the existing possibilities for waste and by-product exchange and why the promising practice was not overwhelmingly being practiced.

2. Kenya's Special Economic Zones (SEZs)

The basis for the development of the country's SEZ regulations was the wasteful linear flow of materials where raw materials are mined, converted into products and consumed with the resultant wastes being landfilled. This means that the regulations do not treat waste as a resource that is valuable. As a consequence of this mindset, all the country's SEZs are designed to include massive end-of-pipe infrastructure in form of incinerators, effluent treatment plants, and landfills. These economic zones are not designed to include infrastructure for waste recovery, reuse and recycling. Such a wasteful approach can only be sustainable in an environment that has limitless resources. The country's SEZs can only green their operations if they were technically enabled to embrace a circular economy that treats waste as a useful resource that should not be landfilled but instead recovered and retained in the manufacturing value chain for as long as is practically possible. Although the country's waste management regulations of 2006 advocates for waste minimization at a source, these regulations fall short of treating waste as a resource that should not be landfilled at the earliest opportunity. The combined effect of the SEZ regulations, as well as that of the Environmental Management and Coordination Act (EMCA)'s waste management regulations, presents one of the greatest barriers to the accelerated adoption of waste and by-product exchange through industrial symbiosis. These two pieces of regulations should be revised to incorporate green growth ideas that can help advance a circular economy for the country's SEZs/ IPs.

The world over, Special Economic Zones (SEZs) play an important role in advancing industrial development, attracting foreign direct investments (FDIs), creating jobs, strengthening export capabilities and acting as experimental laboratories for the application of emerging policies and approaches (World Bank, 2014). Table 1 below shows the performance of the Kenyan special economic zone program over a five year period 2011- 2015 (Economic Survey, 2016). Whereas gazetted zones, zone enterprises, employment opportunities and export sales have shown an increasing trend, domestic sales registered a 34.5% decline. This justifies the country's determination to switch from export processing zones (EPZs) that have limited interaction with the domestic market to the wider scope special economic zones (SEZs) with an expanded interaction with the domestic market (Economic Survey, 2016). In order to promote EPZ-Local Economy interaction, the Ministry of Industry, Trade, and Cooperatives has granted duty exemption

[1] United Nations Economic Commission for Africa (UNECA) I, 2016. Inclusive Green Economy Policies and Structural Transformation in Selected African Countries,

to zone companies to sell 20% of their production in the domestic Kenyan market under the "Buy-Kenya-Build-Kenya" initiative.

Table 1: Kenyan SEZ Performance Indicators 2011 – 2015

	Unit	2011	2012	2013	2014	2015
Gazetted Zones	Number	44	47	50	52	57
Enterprises Operating	Number	79	82	85	86	89
Total Employment	Number	32,464	35,929	40,433	46,738	50,850
Export Sales	USD Million	391	400	444	514	603
Domestic Sales	USD Million	34	43	59	58	38

Source: Export Processing Zones Authority Report, 2015; Economic Survey, 2016

SEZs do concentrate industries in fenced geographical locations (Farole, 2011). As a result, zone-based companies, therefore, share infrastructure in form of roads, railway, waste management as well as effluent treatment (World Bank, 2008). The close proximity of zone-based industries and the diversity of actors creates an enabling environment for industrial ecology as it becomes easier to match exchanges of materials and energy (Lowe, 1997; Bermejo, 2014).

As climate change emerges as one of the greatest development challenges of our time, Governments, Developers, and Companies are increasingly demanding that SEZs contribute to environmental sustainability and greenhouse gas (GHG) mitigation by embracing resource use efficiency, cleaner production and industrial symbiosis (UNEP, 2011; World Bank, 2014). The manufacturing value addition activities at the Athi River SEZ are largely linear. The zone tenant companies are yet to fully embrace resource use efficiency, cleaner production, the 3Rs that prioritize reducing, reusing and recycling waste streams before engaging waste and by-product exchange through industrial symbiosis to deal with the inevitable residual waste. For the Athi River economic zone to fully adopt low-carbon and resource efficient status, its tenant companies must unanimously shift their production lines from linear to closed loop systems where wastes from one production line become raw material inputs for the other (Lowe, 1997). Doing this will reduce pressure on the use of virgin materials and also lower the carbon footprint of the economic zone by diverting vast amounts of waste from the landfill. The aim is to constantly keep valuable materials in the manufacturing value addition chain for as long as is practically possible. The paper reveals a spontaneous emergence of an agro-processing and a garment cluster network within the economic zone that are largely driven by the prevailing forces of supply and demand and an existing intercompany material flow system that is being hampered by a weak waste recovery and recycling infrastructure.

3. The spontaneous evolution of waste and by-product exchange at the Economic Zone.

Due to the prevailing market forces of supply and demand, proactive Kenyan enterprises operating within the agro-processing and garments cluster have started embracing waste and by-product exchange. This circular economic development model can be upscale to realize wider benefits if the economic zone invested in enabling waste recovery and recycling infrastructure. This revelation is backed up by a response from the Special Economic Zone (SEZ) Environmental Manager Mr. Mathew Were (pers. Comm.) who stated:

" ….This economic zone is not planned for Industrial Ecology, however, aspects of waste and by-product exchange among companies have evolved on their own due to the prevailing market forces of supply and demand. This spontaneous development of Industrial Ecology is pushing us to re-think our future expansion plans with a view to incorporating this important aspect…..".

This finding concurs with those of Chertow & Ehrenfeld, 2012; Ghali et al. 2014; Anbumozhi et al. 2013; and Mossard et al. 2014 on the spontaneous evolution of industrial clusters in Asia and Europe. Their mode of evolution is similar to how the other clusters also evolved in the EU, China, Japan, South Korea and South Africa as was pointed out by Chertow & Ehrenfeld, 2012; Ghali et al. 2014; Anbumozhi et al. 2013; and Mossard et al. 2014. These countries recognized the organic evolution of their clusters and then created enabling policies, institutions, and regulatory frameworks for their further growth and expansion. The Kenyan Government needs to similarly do more in terms of creating an enabling legal, institutional and regulatory framework if it has to harness fully the power of clusters and clustering as an economic development tool for its special economic zones (SEZs) (World Bank, 2009). Clusters once recognized, should be enabled to expand and grow within an enabling policy, legal, institutional and regulatory framework. This is an attribute that is yet to be embraced by the country's Zone Authority. Clusters do provide a powerful framework in which companies organize, work together and also work with the Government in promoting their growth interests (Chertow, 2007; Ghali et al. 2014). In order to cost effectively benefit from industrial ecology applications, a certain level of the geographical proximity of industries is required (UNIDO, 2015). The location of the companies within a gazetted

delimited area presents a great opportunity for waste and by-product exchange. However, experiences from China (Geng et al. 2012) and South Korea (Kim, 2006) show that identified clusters can only grow and mature into closed loop supply chains when there is an enabling policy, legal and institutional framework.

4. Barriers to the Accelerated Uptake of Resource Efficiency and Industrial Symbiosis

While industrial symbiosis has started being prioritized by European development partners that support Kenya, its widespread adoption and implementation will have to overcome a wide range of governance and operational barriers.

4.1. Weak Coordination, Harmonization, and Integration

Climate change issues are cross-cutting by their very nature, and this requirement is forcing Kenyan Ministries to start working together on joint projects, a development that is revolutionizing the country's mode of service delivery. More than ever before, the Kenyan Ministries of Finance, Planning, Energy, Environment, Industry, Education, Water, Trade, and Agriculture have found a common denominator of interaction through joint climate change projects. Such a joint approach benefits from synergies and helps to avoid the costly duplication of effort. Lack of coordination and integration among sectoral Ministries and overlapping powers and responsibilities among Government institutions hampers cost-effective project implementation[2]. It is against this background that the Kenyan Government published its Climate Change Act, 2016 that provides for the creation of the Climate Change Council that will be chaired by the President and Deputized by the Deputy President. Apart from assuring high-level political commitment, the Council will also help break the "silo" approach to project implementation that is the cornerstone of the Kenyan Ministry approach.

4.2 Lack of a Voluntary SEZ Green Rating Scheme

There was no voluntary SEZ green rating scheme that encourages companies resident in the economic zone to meet and even exceed the set environmental standards. This is the approach that has been used by the Indian Government in advancing the economic zone's green growth agenda. The Indian Government developed a green rating system for its SEZs that is designed to promote low-emission, resource use optimization and socially inclusive growth that is yielding positive results (GIZ, 2015a; 2015b). This green rating system encourages companies resident in the economic zone to not only meet their environmental standards but voluntarily exceed them for the sake of the environment and business competitiveness.

In order to enable the zone-based companies to be key players in this voluntary obligation, there is a need for an SEZ voluntary green rating scheme that the country's SEZ Advisory Committee should lobby for its development and operationalization. Such a voluntary rating scheme should help companies to address all aspects related to the environment. The green rating system encourages SEZ companies to surpass the requirements of set environmental standards while also cutting down on operational costs[3]. This SEZ green rating system should address the most important zone priorities that include site preservation and restoration, reduced use of fossil fuels, energy efficiency, water use efficiency, and environmentally sound handling of solid wastes[5]. Development of a voluntary code of conduct based on resource use efficiency and cleaner production (RECP) and waste and by-product exchange through industrial symbiosis that is enforced and supervised by the Zone Authority on behalf of NEMA will help the zone resident companies to meet and even exceed the set environmental standards on a sustainable basis. This is in fact the spirit of the amended Environmental Management and Coordination Act (EMCA, 2015) that permits NEMA to enforce the environmental law through its lead agencies.

4.3 Weak Triple Helix Collaboration

There was no evidence of triple helix collaboration between Universities/ Research Institutes-Industry-Government that creates an innovation ecosystem that is key in promoting eco-innovation within economic zones through research, demonstration and development (RDD). An in-depth examination of the economic zone activities revealed no evidence of the triple helix collaboration. As a result, the Kenyan economic zone companies cannot therefore benefit fully from research driven eco-innovation for increased productivity and competitiveness as was pointed out by Zeng in 2006. Triple helix collaboration forms the backbone of eco-innovation in European and Asian clusters (Anbumozhi et al. 2013). Further, the Athi River SEZ findings conform to Porter's and Zeng's observations that clusters do add economic, social and environmental value to the development of the economy by creating groups of networked businesses in specific sectors while improving their business capabilities through tailored support (Porter, 1990; Zeng, 2006). Given that the country's green growth agenda advocates for development pathways that are low-emission, driven by resource use optimization, and socially inclusive, the creation of a total of 20 waste recovery and material recycling jobs at the garment textile off cut cluster is a classic example of social inclusion (UNEP, 2014). The private sector alone cannot drive research as their core business is to make profits. Academia through Universities and Research Institutes should therefore partner with the private sector within the economic zones so that their

[2] United Nations Economic Commission for Africa (UNECA II), 2016. Integrated Assessment Methodologies and Tools for Inclusive Green Economy Analysis in Africa.

[3] India Green Building Council, 2010 – Green SEZ Rating System of 2010.

research programs are demand driven and targeted at solving the operational challenges of the private sector. Such meaningful partnerships will help raise the much needed research funds that are essential for breakthrough research. Through pilot level demonstrations, academia and research institutes can show the private sector that investing in energy efficiency, water use efficiency and waste minimization and management makes good business and economic sense. Although the Government has committed to be allocating 2% of its GDP to the National Research Fund (NRF) established by the Science Technology and Innovation (STI) Act of 2013, there has been little progress to its implementation.

Kenya's SEZ Act came into force in 2015. However, due to inadequate political will and commitment, this Act is yet to be fully operationalized in terms of putting in place the requisite institutions and accompanying regulations. This Act provides for the establishment of the Special Economic Zone Authority (SEZA) that is yet to be constituted. The regulations that are supposed to operationalize the Act are still at the draft stage. However, recent as the regulations are, they do not address the need for SEZ companies to embrace green growth as a way of responding to the zone's contribution to climate change. Inadequate political will also means that decision makers do not give priority to the allocation of funds necessary for the formation and implementation of policies that support industrial symbiosis (UNECA I, 2016). As a result, the country's SEZ draft policy is yet to be finalized.

4.4 Inadequate Infrastructure for Waste and By-Product Recovery

The exchange of wastes and by-products among the cluster companies not only lowers pressure on the use of virgin materials but also diverts waste from the landfill (UNIDO, 2011). A lot more can be realized if the economic zone invested in state-of-the-art waste recovery and recycling infrastructure. Progress towards the zone's full uptake of RECP and IS will be slowed down due to its weak waste recovery and recycling infrastructure. This means that a continuous flow of wastes and by-products from one company to the other and vice versa on a reliable and continuous basis might be in doubt if sound infrastructure is absent as was pointed out by Huber in 2012. The World Bank in 2014 pointed out that the absence of such waste recovery and recycling infrastructure compromises the economic and environmental viability of engaging in resource use efficiency, cleaner production and industrial symbiosis (World Bank, 2014). These study findings are similar to those of (Costa &Ferraro, 2010) in which they observed that this noble practice spontaneously manifests itself through the use of waste streams and by-products as alternatives to the use of virgin raw materials. The findings are further consistent with Chertow's observations that synergies are generally driven by economic advantages offered by prevailing market conditions with companies acting for their own benefit instead of responding to Government intervention (Lowe, 2001; Chertow, 2007). As was noted by (Erkman, 2001), and reinforced by the study findings, the systematic reuse of wastes and by-products will significantly reduce the need for virgin raw materials extraction, a development that leads a reduced carbon footprint of the zone. Such waste and by-product recovery infrastructure will ideally entail a movable conveyor system that facilitates waste recovery and segregation, Recycling Drop-off Centres (DDCs), Resource Recovery Centres (RRC), and Resource Recovery Parks (RRPark) that will need to be constructed within the Athi River SEZ if it has to fully embrace waste recovery and recycling reap the accompanying benefits.

4.5 Lack of Government Sponsored Demonstrations

There were no Government sponsored cluster based waste and by-product exchange demonstrations that seek to show that investments in material exchange makes good environmental and business sense while assisting the economic zone's conversion to a low-carbon zone that attracts green foreign direct investments (FDIs). It should the duty of the Kenyan Government through the Zone Authority to technically assist tenant companies to embrace low-carbon, resource efficient and socially inclusive development pathways. The best way of doing this is through pilot demonstrations that are non-existent at the Athi River SEZ. Once it is demonstrated that embracing resource efficient cleaner production (RECP), the 3Rs and industrial symbiosis (IS) makes good business sense, uptake by the private sector becomes automatic. The Kenyan Zone Authority's capability to offer technical advisory services in the broader area of green growth promotion needs strengthening. Improved environmental awareness is putting pressure on SEZs to lower their greenhouse gas (GHG) emissions as a way of lowering their contribution to climate change. To be able to do this, these zones need to develop their GHG inventories and start working towards meeting set targets for GHG reduction on a continuous basis. This effort though important, is yet to pick up at the Athi River SEZ.

Zone based companies had a weak input/ output measurement and record keeping culture. Even for those companies that kept records, they hardly analyzed and trended them to inform decision making. This means that these companies do not have accurate records of their quantified wastes and by-products streams that form the basis for industrial symbiosis. Kenya does not have a single national institution dedicated to promoting industrial symbiosis. Although the Kenya National Cleaner Production Centre (KNCPC) is now trying to venture into this domain, its official mandate at inception was to promote waste minimization at source within single company boundaries with limited end-of-pipe engagement in residual waste and by-product exchange among industries through industrial symbiosis. In order to avoid confusion, the country needs to establish a fully-fledged Industrial Symbiosis Promotion Center (ISPC). The proposed ISPC should work closely with the KNCPC in ensuring that zone companies only embrace industrial symbiosis to deal with the inevitable residual waste

that remains after resource efficient cleaner production (RECP) implementation. Such an approach will restrain companies from generating excess waste with the hope that it will be exchanged after all.

The World Bank recommends that for SEZs to graduate into low-carbon zones (LCZs) they should seek to (i) achieve resource use efficiency in energy; materials, and water, with the cost savings being gained through higher resource use efficiency; (ii) adopt cleaner production through good operation, source reduction, and substitution of waste materials, separation of by-products or residual materials for recycling; (iii) use of renewable energy and materials as a substitute to the use of fossil fuel sources and finite virgin material supplies; (iv) rehabilitation of existing buildings to higher energy and environmental standards and use of green architecture and engineering in new facility and infrastructure design; (v) continuous enhancement of resource and energy efficiency in unit processes, and at the plant and economic zone level through industrial symbiosis (World Bank, 2014). The zone based firms were mostly found to be in dire need of capacity enhancement in contemporary tools of environmental management such as resource use efficiency, cleaner production and industrial symbiosis (UNEP, 2015). The success of the zone's industrial symbiosis program will depend on active participation of all firms resident in the zone that will need to be thoroughly mobilized and coordinated as was observed earlier by (Saikku, 2006). As a result, production based waste volumes are generally high as there are no deliberate efforts aimed at minimizing their generation at source. This has led to significant waste accumulation within the zone with the bulk of it not yet engaged in industrial symbiosis exchange.

4.6 Limited Awareness of the Economic and Environmental Benefits of Resource Use Efficiency

The enterprises resident in the Athi River economic zone were not embracing resource use efficiency and cleaner production (RECP) ahead of adopting industrial symbiosis for low-carbon growth and increased productivity due to limited awareness and lack of technical know-how. Due to limited zone company awareness and insufficient R&D support for eco-innovation at the economic zone, the zone based enterprises were not actively embracing resource use efficiency and cleaner production in their operations for continual improvement. Such an initiative can only be successfully spearheaded by either an industry focused research institutes such as the Kenya Industrial Research and Development Institute (KIRDI), a university with programs that address the needs of industry or a national Cleaner Production Center such as the Kenya National Cleaner Production Center (KNCPC). The collaboration between industry, government and academia is just starting to take shape in Kenya with many universities establishing semi-autonomous business centers targeting to promote this linkage. As a result, the Kenyan cluster initiative is different from that of Europe, Asia and South Africa in the sense that its development lacks a structured evolutionary roadmap that is spelled out in a clear policy framework (Ketels et al. 2005). The World Bank points out that such a structured policy framework will constitute four sequential stages namely cluster mapping and initial company engagement, diagnostics and strategy formulation, implementation of strategic, policy and institutional initiatives, as well as post-project sustainability engagement (World Bank, 2006). According to the World Bank (2006; 2009), the Asian, European and South African clusters are guided by strategic initiatives, well-drafted policy initiatives, and established institutional frameworks that are not yet established in Kenya. Top management responses from zone companies revealed an inadequate understanding of what industrial symbiosis is, its associated benefits, and how it can be practically employed in a given business environment for increased productivity. The insufficient operational data, knowledge and information on the socio-economic benefits of industrial symbiosis amongst the zone operatives is likely to be the single most important reason for the concept's slow uptake. This underscores the need for awareness raising sessions through conferences, workshops, and study tours if the concept has to take root in our zone operations.

4.7 No inter-firm communication platform for the economic zone clusters

The Athi River special economic zone had no inter-firm communication platform that could be engaged in facilitating the matching of material and energy needs of zone based companies as was pointed out by (Lowe, 1997; Saikku, 2006; & Bermejo, 2014). There was no anchor tenant within the zone to aggressively advocate for the adoption of industrial symbiosis by the tenant companies of the zone as was justified by Anbumozhi et al. 2013. According to Chertow, (2008), mutual trust among participating cluster firms is of paramount importance in promoting industrial symbiosis. The culture of secrecy that is prevalent within the management ranks of the zone based companies is likely to frustrate this noble waste and by-product exchange scheme. The zone authority needs to develop a clear vision for its intentions of promoting industrial symbiosis on a cluster wise basis and championed by a motivated leader. These findings are largely consistent with the (World Bank, 2014), recommendation that the success of industrial ecology at the cluster level depends on the ability of the industrial symbiosis champion to keep on finding new waste and by-product exchange networks, enhancing dialogue between and among cluster-based companies, deliberately facilitating material and energy exchanges, and aggressively recruiting new industrial symbiosis players. The ultimate goal of the inter-firm communication is to help link up those with wastes and those who need the wastes for reuse and recycling. A clear database for waste and by-products exchange under the operational control of the zone authority and with easy access by resident companies of the zone is essential for promoting waste exchange synergies. Additionally, waste exchange

opportunity workshops can be organized so as to facilitate waste exchange negotiations and also help cement the requisite levels of trust among the players. Proper operationalization of industrial symbiosis within an economic zone setting will require a waste exchange clearing house. Such a clearing house will be equipped with waste and by-product database and an online interactive platform in which zone companies will be enabled to know who has and who wants a particular kind of waste or by-product. The clearing house will also help in arranging for negotiations and trust building sessions among zone companies.

4.8 No Cluster Development Road Map

There was no cluster development roadmap for Kenyan SEZs embedded in a development policy framework except for past studies and capacity building initiatives. For quick results, Kenya can learn from the successful European and Asian cluster development models in proactively developing its homegrown cluster enabling, policies, institutions, strategies and cluster growth development roadmaps. The adoption of the cluster initiative in Europe and Asia was accelerated by the setting up of cluster demonstration projects (EC, 2011); (Mossard et al. 2014); (Kim, 2006); and (Geng et al. 2012). These demonstrations were deliberately designed to show that clusters are key instruments for enhanced partnerships between different players of the same value chain; must be private sector driven in order to succeed; and should always consist of a well-balanced combination of companies, research institutes and academia. These cluster demonstrations enabled the private sector to appreciate the efficacy of embracing resource use efficiency and industrial symbiosis in China, the 4R philosophy of reducing, reusing, recovering and recycling wastes for a sound materials society in Japan, and the benefits of converting existing industrial parks into eco-industrial parks (EIPs) in South Korea and South Africa (Geng et al. 2012); (Mossard et al. 2014). The European Union is working towards resource efficiency through its flagship initiative, entitled "A Resource-Efficient Europe", as part of the Europe 2020 growth strategy (EC, 2011). A roadmap for a resource-efficient Europe, published in 2011 aims to help decouple economic growth from increased resource use, support the transition towards a low carbon economy, increase the use of renewable energy sources, modernize the transport sector and promote energy use efficiency (EC, 2011). Kenya should similarly develop a resource efficient roadmap based on RECP, the 3Rs, and IS to guide the country's Vision 2030 industrialization process. A detailed inclusive green economy roadmap should be developed for each priority economic, environmental and social sector, taking into account static and dynamic comparative advantages on international and regional markets (UNECA I, 2016).

5. Material Flows in the Agro-Processing Cluster

The zone's agro-processing cluster comprised of three companies namely oil extraction, manufacture of instant foods, and raw artemisinin extraction. Table 2 shows the quantified inputs and outputs of the Oil Extraction Company at the economic zone. Annually, the oil extraction company uses an average of 543.3 tons of raw materials that translate into 300.9 tons of desired product with raw materials to the desired product conversion ratio of 55%. The remaining 45% constitutes a by-product (seed cake) that is eventually used as a raw material for the manufacture of animal feeds. A seven-year production and waste trending shows a reliable source of the seed cake by-product that can be used as input feedstock (Figure 1).

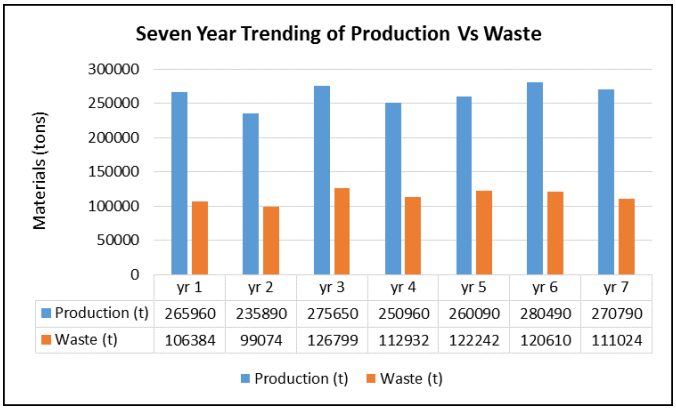

Figure 1: Seven-Year Trending of the Production and Waste Levels for the Oil Extraction Company (Source: Company Records).

Figure 1 above shows the trending of production and associated wastes for the oil extraction company over a seven-year period. The trending reveals a raw material to the desired product conversion rate of 55%. This means that 55% of the raw material inputs convert into the desired product with the rest 45% being classified as a by-product or a non-product output (NPO). Non-utilization of the NPO in another production process as feedstock will demonstrate wasteful use of the country's finite resources with associated environmental and social consequences. At a cost of KES 20 per kilogram, the primary edible oil processing company earns USD 48,000/ year from the sale of its 240.4 tons/year seed cake by-product to the Animal Feeds Manufacturing Company. The absence of this waste exchange network will have meant that the by-product is handled and managed at an added transport and disposal cost to the primary producer. Disposal of 240.4 tons/year of organic waste into the landfill will not only be a significant loss of useful material but also a significant source of methane that has a higher global warming potential than carbon dioxide. Manufacturing value addition of this by-product helped to create 5 green jobs and alleviated poverty amongst the Kenyan population.

This oil extraction company is one of the proactive companies that is successfully engaged in industrial symbiosis. It is doing this by ensuring that all its by-product stream that accounts for 45% of its raw material input is not landfilled but is instead used

as a raw material by an animal feeds manufacturing company. Doing this creates an additional revenue stream for the company and also assures prudent use of the country's scarce resources.

Table 2: Material Flow Balance for the Oil Extraction Company

Type of Raw Material	In put quantity (tons/year)		Desired Product (tons/ year)	Composite Seed Cake By-product (tons/ year)
Macadamia Kernels	200	Oil Extraction	126	74
Sesame Seeds	200		100	100
Moringa Seeds	91.3		43.7	45.6
Rosehip seeds	26		15.6	10.4
Pomegranate	26		15.6	10.4
Furnace Oil	**2**			Furnace oil particulates and emissions
Total	543.3		300.9	240.4
Raw material to product conversion			55%	

The oil extraction company extracts oils from a wide range of seeds and nuts that include macadamia, sesame, “moringa", rosehip and pomegranate mostly drawn from central and coastal regions of the country. The to and fro transport radius is approximately 200 km and 1000 km respectively for central and the coastal regions. The seed cake is the by-product that remains after the oil has been extracted by the primary firm. A secondary Animal Feeds manufacturing company uses this by-product as a raw material for the manufacture of its animal feeds leading to an 80% saving on long-haul transport costs of virgin raw material (David Njeru, pers. Comm.) Engaging in this waste exchange entirely diverts 300.9 tons/year of seed cake waste from being landfilled. Landfilling of such waste quantities would have led to serious environmental challenges associated with the generation of 126 tCO2e/yr (using UK Carbon Trust of 421 kgCO2e/ton of landfilled organic waste) and social problems such as increased organic loading of the zone’s storm water systems (Export Processing Zones Program Annual Performance Report, 2013; UK Carbon Trust, 2016).

Given that the Animal Feeds Manufacturer sources for his virgin raw materials from both central and the distant coastal region, availability of a nearby cost-effective seed cake alternative will for economic reasons make the manufacturer abandon the distant coastal region and instead focus on the locally available resource. This will not only cut the company's transportation costs but will also lead to avoided emissions and reduced raw material costs. The abandoned coastal farmers will lack a market for their produce and eventually abandon the agricultural practice. This will lead to increased poverty as their regular income will have been lost. The resultant raw material transportation radius will therefore reduce from an average of 1000 km to that of 200 km leading to a lower diesel fuel transportation cost with accompanying emission reduction benefits shown below:

Transportation radius reduces from an average of 1,000 km to 200 km per round trip using a 20-ton capacity Isuzu Diesel Truck. Therefore the avoided distance is (1000 less 200) km which is 800 km. Using the Kenya Automobile Association (AA) consumption rate of 1.5 litres of diesel per kilometer for a 20 ton lorry, and holding everything else constant (driving style, age of the truck, frequency of servicing, overloading, etc.), then the amount of avoided diesel use is 1,200 litres per round trip. This is equivalent to 3,201 kg CO_2 e of avoided emissions per round trip given that the emission factor for diesel is 2.6676 kg CO_2 e/ litre (UK Carbon Trust, 2011). The avoided diesel 1,200 litres will lead to a transport cost saving of USD 840 per round trip (1 litre of diesel costs KES 70; 1 USD = KES 100). Given that the annual raw material of the oil extraction plant is 543.3 tons, this translates into a total of 27 round trips in a year using a 20-ton lorry. Therefore the total annual savings will be USD 22,680. The total avoided annual emissions will be 86,427 kg CO_2 e. The only green jobs established by this development will be those related to the transportation of the seed cake from the oil extraction company to the animal feeds manufacturer. The coastal farmers lost markets for their 543.3 tons per year equivalent to an annual income loss of USD 434,640 (cost of 1 kg of assorted seeds put at KES 80; 1 USD = 100 KES).

Pre-processing of macadamia seeds at the Edible oil Factory generates macadamia kernel waste up to the tune of 200 tons/year. Use of this pre-processed seed cake as feedstock for the Animal Feed Manufacturing Company leads to a 20% electrical energy saving (equivalent to 30,250 kWh/year) as the seed cake is already pre-processed (David Njeru, pers. Comm.) This is equivalent to annual avoided emissions of 10,052 kg CO_2 e (Kenya’s Grid Emission Factor is 0.3323 kg CO_2e/ kWh). The findings are consistent with UNIDO, 2015 conclusion that localization of firms allows them to enjoy inputs in greater variety and at a lower cost. As a result, reduced transportation and distribution costs will give input suppliers a competitive edge to locate within the same region as their

customers (UNIDO, 2015). This reinforces the attractiveness of firms locating within the economic zone.

Ten Percent[4] of this macadamia kernel waste (equivalent to approximately 20 tons/year) is used by the oil extraction company to generate approximately 3 tons/day of on-site process steam that roughly displaces the company's use of 1.5 tons of fuel oil. This makes a monetary saving of USD 1,500 per year that is significant in resource use efficiency and cleaner production (RECP) terms. The associated respective carbon emissions reduction are as calculated below:

(i) 1.5 ton of Fuel Oil[5] generates (1.5 x 3,228) = 4,842 kg CO_2 e

(ii) 20 ton of Biomass Energy[6] generates (20 x 183.9) = 3,678 kg CO_2e

This leads to a CO_2 e reduction of (4,842 – 3,678) = 604 kg CO_2e (equivalent to 12% reduction) as a result of the fuel switch from the use of Fuel to the use of Biomass Energy (Figure 2). Excess macadamia shells (180 tons/year equivalent to 90%) are sold out to other companies within the economic zone as boiler fuel for steam generation. The results show that fuel substitution, in this case switching from the use of fuel oil to the use of biomass leads to a 12% reduced emissions (Figure 2). These findings are in tandem with (OECD, 2012) research conclusions that there is urgent need to accelerate the transition to a truly equitable, sustainable, post-fossil free carbon society. According to OECD, there is a need to develop bio-based economies that are characterized by both reduced dependence on fossil fuels and reduced emissions. These OECD conclusions are also similar to Kenya's low carbon development objectives that seek to reduce energy consumption, pollution, and the emissions of greenhouse gases (GHGs) (NCCAP, 2013). As a result of the need to promote sustainable consumption and production, (UNEP, 2015) is currently calling upon Governments to use energy and products efficiently, alongside the management of end-of-life products and materials through re-manufacturing, recycling, or recovery and reuse with the ultimate goal of realizing sustainable levels of GHG emissions.

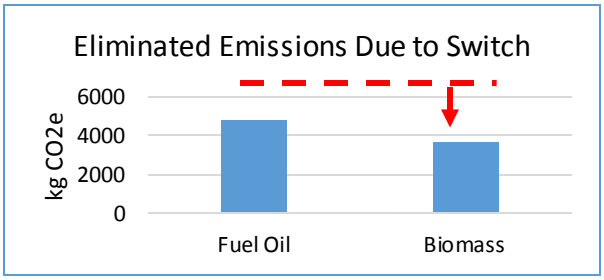

Figure 2: Reduced Emissions due to Fuel Switch

Some of the policy developments in the EU can help the Kenyan SEZ develop its own sustainable waste management response. The result of producer responsibility obligation policies in Sweden is a high level of material recycling with over 75% of glass, 90% of paper, 86% of cardboard, 68% of metal and 60% of batteries being recycled in Sweden at the moment (Kalmykova et al. 2016). However, plastic and organic waste recycling still remains a challenge, with 26% and 20% being recycled respectively (Kalmykova et al. 2016). Nonetheless, it is worth noting that higher recycling rates have not reduced the overall resource consumption in Sweden (EC, 2011). Moreover, waste generation is constantly increasing as a result of consumption growing faster than recycling capability (Kalmykova et al. 2016). As of today, no policies focusing on reducing the demand and final consumption of goods have been implemented in Sweden (Kalmykova et al. 2016). The ban on organic waste landfilling for all waste with >5% organic content in 2005 redirected almost all waste towards material and energy (incineration) recycling (Kalmykova et al. 2016). The ban is an implementation of the EU policy set out in Directive 99/31/EC, which demands that all EU Member States should introduce national strategies in order to progressively reduce the quantities of landfilled biodegradable waste (EC, 2011). Waste-to-energy "recycling" is currently the prevailing waste management method in Sweden (Kalmykova et al. 2016). Waste-to-energy "recycling" is currently the most prevalent waste management method in Sweden: more than half of all waste is incinerated and the use of incineration is increasing faster than recycling (EC, 2011). It has been argued that investments in incineration plants hinder further development of material recycling[7].

The material flow findings conform to (Kalmykova et al. 2016; UNIDO, 2016) observations that the unsustainable way in which we use resources has resulted in the insurmountable challenges we face as a globe today - climate change, environmental pollution, ecosystem degradation and raw materials exhaustion. These findings are congruent with Kalmykora et al. 2015 observations that when waste generation outpaces investments in environmentally sound recycling, the end result is waste accumulation. The resource consumption trends indicate that the implemented policies have failed to bring about significant reductions in resource and energy throughput (Kalmykova et al. 2016). Waste generation by far outpaces improvements in waste recovery and recycling (Kalmykova et al. 2016). In recycling, waste-to-energy is growing faster than material recycling, which impedes the development of a circular economy (Kalmykova et al. 2016).

The main limitation of the policies implemented to-date is that they only address efficiency of use, but do nothing to reduce the

[4] Source: Oil Extraction Production Manager Estimate
[5] Carbon Trust Emission Factor per ton of Fuel Oil
[6] Carbon Trust Emission Factor per ton of Wood Pellets

[7] Seltenrich, N., 2013. Incineration versus Recycling: in Europe, a Debate over Trash. Yale Environment 360.

demand for resources (UNEP, 2015). In addition, efforts have so far been restricted to energy consumption (Kalmykova et al. 2016). The reality is that we must urgently reduce the consumption of all resources, not just fossil fuels (Kalmykova et al. 2016; UNEP, 2015). Embracing industrial ecology is known to reduce pressure on the use of virgin materials and also diverts wastes from the landfill with the added benefit of avoided GHG emissions. Kalmykova, Rosado and Patrico jointly recommend for an urgent change to the way we use resources so as to avoid causing irreversible damage to our environment. Waste exchange through industrial symbiosis is proven and is a worthwhile response to these challenges. The findings are also consistent with (UNEP, 2011) key principles of sustainable consumption and product promotion that advocate for the decoupling of economic growth from further environmental degradation. The diverted wastes for use as feedstock for another company could otherwise have been landfilled if industrial symbiosis was not currently in practice. Industrial Symbiosis that focuses on waste and by-product exchange between two companies is a subset of industrial ecology and is the initial starting for the wider industrial ecology network (Ghali et al. 2014).

6. Garment Cluster

The Garment cluster comprises of 5 companies operating a cyclic resource economy. The cluster collectively generates an average of 255 tons/year of fabric textile offcuts from a combined raw material consumption of 9,000 tons/year. The management of fabric offcuts could be troublesome had it not been for the on-going waste recovery and re-use programs. The making of garments has a waste generation rate of approximately 3% (Source: Company Records). Twenty Five percent[8] of this generated waste offcuts (equivalent to 64 tons/year) are used as steam boiler fuel while the rest 75% (equivalent to 191 tons/year) is sorted out on the basis of size at a temporary waste transfer station within the zone for use in the manufacture of sofa sets and cleaning mobs (Table 3).

Table 3: Garment Cluster Material and Emissions Balance

Type of Raw Material	Quantity (tons/year)		Desired Product (tons/ year)	Composite Wastes (tons/ year)
Textile Fabric	9,000	Garment Cluster	8,500	255
Fuel Oil	4 (replaced by fabric off cuts)			

The re-use of 64 tons/year fabric offcuts will approximately cater for the clusters daily requirement of approximately 9 tons of steam/ day for the whole year. This fuel switch substitutes the cluster's reliance on approximately 4 tons of fuel oil in a year with the stated textile fabric offcuts. Given that over 25% of the garment offcut waste (equivalent to 64 tons/year) is cotton based, and is used as boiler fuel to generate 9% less greenhouse gas (GHG) emissions as compared to the use of fuel oil as demonstrated by the calculation below.

4 ton of Fuel Oil[9] generates (4 x 3.228) = 12,912 kg CO_2 e
64 ton of Biomass[10] generates (64 x 183.9) = 11,770 kg CO_2 e
This leads to a CO_2 e reduction of 1,142 kg CO_2e (12,912 – 11,770) (equivalent to 9% reduction) as a result of the fuel switch (Figure 3). Substituting the use of 4 tons/year of fuel oil with garment fabric offcuts will lead to an estimated annual monetary saving of USD 4,000.

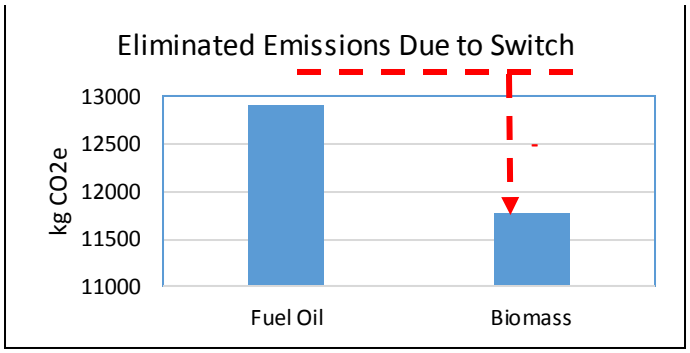

Figure 3: Reduced Emissions due to Fuel Switch

According to Porter, businesses are seen as prospering at the expense of society. Creation of Shared Value (CSV) can help reverse this perception (Porter, 2011). To achieve this, Porter says, there is a need for corporate policies and practices that enhance the competitiveness of companies while simultaneously advancing social and economic conditions in the communities in which it sells and operates. On this front, the economic zone supplies fresh water to the surrounding communities and also allows the Athi River residents to use its sewerage system. The Athi River residents feel that the economic zone owes them more. However, the Economic Zone - Community relationship has created an innovative "win-win" working relationship between zone garment factories and informal waste recyclers who reside in the surrounding community. These informal waste recyclers have agreed to be cleaning garment factories for free so that they can easily access the garment textile off cuts for their subsequent resource recovery and re-use. The win for the zone garment factories is that they no longer need to spend money on general factory clean up and waste management in general (leading to estimated savings of up to USD 6,000 per year). The win for the informal garment waste recyclers is that they get the garment textile off cut wastes for free, have them graded and

[8] Source: Garment Cluster Production Manager
[9] UK Carbon Trust Emission Factor per ton of Fuel Oil
[10] UK Carbon Trust Emission Factor per ton of Wood Pellets

sold out to sofa set and cleaning mob manufacturers. An estimated 15 tons/month of fabric textile waste offcuts are recovered for reuse. The fabric offcuts retail at KES 6 per kg, generating a monthly income of USD 900. By doing this, significant amounts of waste otherwise destined for the landfill are diverted for economic use with enormous environmental and socio-economic benefits.

This relationship has created a total of 15 direct "green jobs" and also improves the living standards of the surrounding community (improved incomes) who apart from hosting the zone employees also serve as customers and suppliers of the same zone. However, these green jobs are not decent due to the limited level of investments in the zone's waste recovery and recycling infrastructure. Proper investments in waste recovery and recycling infrastructure will help convert these green jobs into decent jobs as defined by UNEP below. Green jobs do reduce the environmental impact of enterprises and economic sectors, ultimately to levels that are sustainable[11]. Green jobs help to cut the consumption of energy, raw materials, and water through high-efficiency strategies, to decarbonize the economy and reduce GHG emissions, to minimize or avoid altogether all forms of wastes and pollution, to protect and restore ecosystems and biodiversity (World Bank, 2014). According to UNEP, decent work involves opportunities for work that is productive and delivers a fair income, security in the workplace, social protection for families, better prospects for personal development and social integration, freedom for people to express their concerns, organize and participate in the decisions that affect their lives and equality of opportunity and treatment for all women and men.

The results on the garment cluster demonstrate that cyclic waste management can create jobs and improve industry-community relations. All over the world industry-community relations are strained when industries use community territories as waste dumping sites. In this case, waste has created a symbiotic industry-community relationship that protects the environment, creates jobs, and a source of livelihood. The creation of 15 jobs at the economic zone's garment cluster reinforces (UNEP, 2015) argument that investments in green growth will lead to social inclusion and therefore developing countries should commit to working towards changing the way goods and services are produced and consumed so that human development, and the satisfaction of human needs, is decoupled from environmental degradation.

This is a classic green growth social inclusion exercise where waste from the garment cluster is used by the surrounding community members as a resource for job creation and improvement of quality of life and well-being. Apart from promoting a sustainable lifestyle, the practice also alleviates poverty.

[11] UNEP, 2010. ABC of SCP – Clarifying concepts on SCP

The findings also reinforce (UNIDO, 2015) position that firms are facing growing pressure to become "green" or more environmentally friendly. As a result, these garment cluster firms have had to review their production processes and procedures so that they can use textile fabric offcuts as boiler fuel and also allow the informal waste recyclers to recover and add value to their waste stream and prevent it from being landfilled. That is why UNEP and the EU are currently supporting industry, emerging green entrepreneurs, and policymakers through policy development, that supports the setting up of RECP and IS demonstration projects and other networking activities through the Switch Africa Green project being implemented by the Kenya National Cleaner Production Centre (KNCPC).

However, lack of solid waste recovery and recycling infrastructure (in terms of collection, transport, and disposal systems) at the zone hampers the zone's full exploitation of the garment cluster's waste recovery and recycling scheme (WBCSD, 2002). The findings also reinforce the country's goal of adopting a green development pathway that is spelled out in its Green Economy Strategy and Implementation Plan (GESIP). Figure 4 shows the trending of production and associated wastes for the Garment Cluster over seven years.

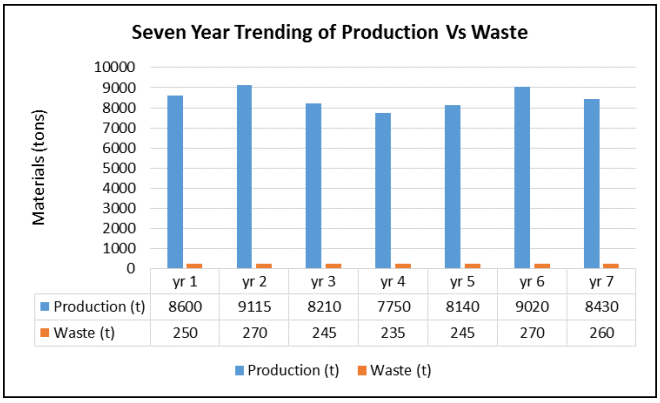

Figure 4: Seven Year Trending of Garment Production Vs Waste Generation

The trending reveals a raw material to desired product conversion rate of 97%. This means that 97% of the raw material garment inputs convert into the desired final product with the rest 3% being classified as a by-product or a non-product output (NPO). Non-utilization of the NPO in another production process for energy cascading and manufacture of sofa sets and cleaning mobs will demonstrate wasteful use of the company's limited resources with associated environmental and social consequences. Luckily, the textile waste offcuts are used both as boiler fuel and as feedstock for the manufacture of sofa sets and cleaning mobs.

7.0 Stakeholder Roles

7.1 The Role of Government

The main responsibility of Government through the Ministry of Industry, Trade and Cooperatives (MoITC) is basically to conduct strategic planning aimed at SEZ promotion (Farole, 2011). This entails selecting potential sites for SEZ location and execution of feasibility studies. In the Kenyan context, the devolved county governments should ideally set up land banks that will in the future be built into economic zones fitted with common use infrastructure for industrialization. The Government in consultation with key industrialization stakeholders constituting policymakers, regulators, academia and civil society should develop land use guidelines that facilitate enterprise zonation and cluster formation for enhanced waste and by-product exchange. Proper functionality of SEZ depends on both inside and offside infrastructural development. As a result, the Kenyan Government should in partnership with development partners develop capacity for the climate proofing of zone infrastructure and also build human capacity of its policymakers, regulators, consultants, and the private sector in the emerging areas of resource use efficiency; the 3Rs of reducing, reusing and recycling wastes, and waste and by-product exchange through industrial symbiosis. This effort will enable the listed stakeholders to appreciate that investing in resource use efficiency makes good business and environmental sense. The Kenyan Government through its economic zone authority should help regulate and administer the Athi River SEZ with a view to prioritizing the country's green growth agenda (Fang et al. 2007; Farole, 2011). This will entail strengthening the Zone's infrastructure for waste recovery, reuse, and recycling as well as providing a zone-wide on-line platform for matching those with wastes with those who need those waste streams as input raw materials.

7.2 The Role of the Regulator

The Kenyan SEZ Regulator, in this case, the Export Processing Zones Authority (EPZA) will be responsible for designating SEZs, facilitating government services, and monitoring compliance (Farole, 2011). It will be the duty of the Zone Authority to facilitate licensing, permitting, and regulatory services within the SEZs, particularly relating to land use, business licensing, environmental permitting, building permitting, labor regulations (including foreign work permits), and inspections (Fang et al. 2007; World Bank, 2014). This will at times include attempts at making it easy to do business within the economic zone, ensuring proper registration of all zone businesses, regulating the use of zone facilities with a view to promoting efficient use of resources, energy and water and acting as an arbiter in business disputes associated with disagreements resulting from waste and by-product exchange within industrial symbiosis networks. For example, increasing the fee for waste disposal will force zone enterprises to minimize waste generation at source and also look for innovative ways of diverting their wastes from the landfill.

It will also be the duty of the Zone Authority to monitor the zone's compliance with the SEZ Act of 2015, including the accompanying draft SEZ policy, performance standards and the adequacy of the zone's infrastructure for waste recovery, reuse and recycling (World Bank, 2014). The Zone Authority should be empowered to enforce compliance in all the country's gazetted SEZs through appropriate penalties for violating emission standards and rewards for meeting and even exceeding the set discharge standards (Farole, 2011). At the moment, the country's EPZA does not have the requisite human and financial capacity to execute effectively this mandate across the country. This same regulator, in partnership with academia and government under a functional triple helix collaboration framework should mobilize and rally the tenant companies around a mutually agreed SEZ promotion vision that prioritizes low-carbon, resource efficient and climate resilient development pathways (Fang et al. 2007; UNEP, 2011). The country's priority should be a shift from the traditional linear development model that is characterized by linear flows of matter, where raw materials are extracted, processed into products, consumed, and discarded with a trail of waste at every stage of the supply chain to the adoption of a circular economy driven by RECP, the 3Rs and IS. However, absence of an enabling policy framework for RECP and Industrial Symbiosis is frustrating the accelerated uptake of this emerging and promising green industrial revolution.

In order to strengthen the Zone Authority's capability in advancing low-carbon, resource efficient and socially inclusive development pathways, the creation of a "Green Cell" to strengthen its green growth capability is proposed. This "Green Cell" will be responsible for organizing awareness raising and capacity building sessions on resource efficient and cleaner production (RECP) and Industrial Symbiosis (IS) practices; introducing focused RECP and IS improvement programs; partnering with donor agencies to help zone companies conduct detailed energy, water, and material audits; developing new standards, protocols, and guidelines as necessary to improve energy, RECP, IS and resource performance; providing the necessary technical assistance, knowledge, and information support to industries for reviewing their RECP and IS improvement plans; facilitating access to finance for RECP and IS by partnering with banks/ national/ bilateral/ international green funds; and identifying potential options for IS and inter-company collaboration (World Bank, 2014).

Such promising sustainability endeavors the world over are normally promoted by respected personalities drawn from the private sector players of the economic zone who are fully convinced that investing in green growth makes good business and environmental sense. Popularly referred to as "green champions", their main assignment will be to help promote zone-wide peer-to-peer top management commitment and buy-in to promoting green growth. It will also be the duty of these "green champions" to rally the tenant companies of the zone

around a shared vision of enhancing the zone's competitiveness and productivity through enhanced resource use efficiency. The World Bank Group recommends that for green growth activities to be sustained at the zone level, the Zone Authority should constantly facilitate awareness raising sessions, focused trainings on resource efficient cleaner production (RECP), the 3Rs, and industrial symbiosis as well as capacity development programs for the zone authority staff and zone enterprises (World Bank, 2014). Recommended training for Zone Authority staff should focus on imparting operational and management practices on greenhouse gas (GHG) mitigation, energy savings, water and waste management, methods of conducting energy audits, and idea option generation for resource efficiency improvements (Fang et al. 2007; Farole, 2011). The Zone Authority should ideally develop a roadmap for a low-carbon transformation of Kenya's economic zones and be reviewing its progress annually based on specific emission reduction targets (World Bank, 2014).

7.3 The Role of Zone Developers

Zone developers operating under the general guidance of the Zone Authority will therefore be required to adhere to the laid down land use planning and zonation principles and practices while providing the requisite additional infrastructure through a functional private-public sector partnership (PPP) arrangement (World Bank, 2014). In other words, zone developers will be required to strictly adhere to the provisions of approved master plans in their development approach. Unfortunately, due to limited awareness, the master plans for SEZ/ IP development in the country are far from being categorized as "green" in terms of being enabled to embrace resource efficient cleaner production (RECP), the 3Rs, and industrial symbiosis. At the same time, the country's building code has not been modernized to incorporate the sustainability elements of green buildings. This will entail designing new buildings and workshops to be green and renovating existing zone buildings to optimize energy, water, and other resources and materials (World Bank, 2014). It should be the official policy of the zone authority working closely with the developers to ensure that new building designs should take into account energy and water use efficiency both from process energy/ water and facility energy/ water and also fully capture and use precipitation and stormwater run-off subject to their quality (UNEP, 2015). Until the country enacts its national green building code, it will be the duty of the Zone Authority to support the dissemination of international best practices on green/ energy efficient building designs or retrofits (World Bank, 2014).

8. The Country's Adopted Development Strategy

The culture of industrialization through special economic zones (SEZs) and industrial parks (IPs) is gathering momentum in Kenya. Increasingly, the Kenyan private sector is recognizing that SEZs/ IPs do provide an enabling environment for manufacturing through well managed solid, liquid, energy, and transport infrastructure that is not commonplace in the rest of the country. Plans are underway to establish a total of 10 industrial parks/ special economic zones (SEZs) along the country's major infrastructure corridors[12]. The planned industrial parks are the Mombasa Industrial Park (Dongo Kundu), Miritini Garment Industrial Park, Voi Industrial Park, Sultan Hamud Industrial Park, Athi River special economic Zone (SEZ), Naivasha Industrial Park, Nakuru Industrial Park, and Kisumu industrial park along the SGR and Lamu Industrial Park and Baringo-Silali Industrial Park on the Lamu Port South Sudan Ethiopia Transport (LAPSSET) corridor. It will be extremely important that these planned industrial parks/ special economic zones are designed to be green from the beginning. It is therefore instructive that deliberate efforts need to be taken to ensure that the master plans to guide their development are actually designed to be green in terms of seeking to promote energy efficiency, water use efficiency, waste minimization and management as well as the adoption of renewable energy solutions. All these requirements are spelled out in the country's GESIP for 2016-2030.

9. Conclusions

The country's National Climate Change Response Strategy (NCCRS) of 2010, the National Climate Change Action Plan (NCCAP) of 2013, the Green Economy Strategy and Implementation Plan (GESIP) of 2015, and the Climate Change Act of 2016 all underscore the need to promote low-carbon, resource efficient and climate resilient development pathways. By doing this, the Kenyan Government has created an enabling environment for green growth within its economic sectors. Industrial Parks (IPs)/ Special Economic Zones (SEZs) should not be left behind in this emerging green industrial revolution. It is anticipated that the level of industrialization envisioned by the Kenya Vision 2030 will put unprecedented pressure on the country's finite resources hence the need to embrace a circular economic development model that will help divert wastes and by-products from the landfill hence relieving pressure on the use of country's virgin raw materials. In practical terms, this will mean converting the country's existing industrial parks / special economic zones into environmentally friendly eco-industrial parks (EIPs) or designing new ones to incorporate sustainability elements from the very beginning. This can be achieved through the development of green master plans that prioritizes the adoption of resource use efficiency, cleaner production, and waste and by-product exchange through industrial symbiosis. The Export Processing Zones Authority (EPZA) will not do this alone. The Zone Authority will need to strengthen its internal green growth technical advisory capability by setting up a "Green Cell" that will help formulate

[12] GOK, 2015. Kenya's Industrial Transformation Program, Ministry of Industry, Investment and Trade.

green growth guidelines/ rules for zone enterprises, help them implement low-carbon and resource efficiency measures, and monitor progress towards the overall green transformation of the economic zone. Externally, the Zone Authority will need to partner with Academia, Industry and Government under a triple helix framework that will strengthen its eco-innovation capability for green growth promotion and demonstration. In spite of the challenges being faced by Kenyan SEZs in advancing industrial symbiosis, the culture of waste and by-product exchange is spontaneously evolving among the zone companies signifying the fact that industrial symbiosis makes good business and environmental sense.

References

- Anbumozhi, V., Thangavelu, S.M., & Visnathan, C. 2013. *Eco-Industrial Clusters: A Prototype Training Manual*, Asian Development Bank Institute, Japan;
- Bermejo, R. 2014. *Handbook for a Sustainable Economy*: Springer Science and Business Media Dordrecht;
- Chertow, M. R., & Ehrenfeld, J. 2012. Organizing Self-Organizing Systems: Toward a Theory of Industrial Symbiosis, *Journal of Industrial Ecology*, **16(1):** 13–27; Crossref
- Chertow, M.C. 2007. Uncovering Industrial Symbiosis. *Journal of Industrial Ecology*, **11(1):** 11-30; Crossref
- Costa, I., & Ferrao, P. 2010. A Case Study of Industrial Symbiosis Development using a Middle – Out Approach, *Journal of Cleaner Production* 18 (2010) 984 – 992; Crossref
- Erkman, S. 2001: *Industrial ecology: a new perspective on the future of the industrial system*. Swiss Medical Weekly 131, 531–538;
- European Commission (EC), 2011. *Roadmap to a Resource Efficient Europe*. COM (2011) 571 final;
- Export Processing Zones Program Annual Performance Report (EPZA), 2015 by the Export Processing Zones Authority (EPZA);
- Export Processing Zones Program Annual Performance Report, 2013 by the Export Processing Zones Authority (EPZA);
- Fang, Y., Cote, R.P., and Quin, R. 2007. Industrial Sustainability in China: Practice and Prospects for Eco-Industrial Development, *Journal of Environmental Management* 83 (2007) 315 – 328; Crossref
- Farole, T. 2011. Special Economic Zones in Africa: Comparing Performance and Learning from Global Experiences, World Bank; Crossref
- Geng, Y., Fu, J., Sarkis, J., & Xue, B. 2012. Towards a national circular economy indicator system in China: an evaluation and critical analysis. *Journal of Cleaner Production*.23: 216-224; Crossref
- Ghali, M.R., Frayret, M., & Robert, M. 2014. Green Social Networking Framework for Industrial Ecology Applications: Interuniversity Research Center on Enterprise Networks, Logistics and Transportation, Montreal - Canada;
- GIZ, (2015a). Planning of New Industrial Parks and Investment Zones, Indo-Germany Partnership on Sustainable Industrial Development;
- GIZ, (2015b). Planning and Design of ALEAP Green Industrial Park (A-GRIP), Nandigama: The Indo-Germany Environment Partnership (IGEP);
- GOK, 2013. National Climate Change Action Plan (NCCAP) 2013 – 2017; Ministry of Environment, Water and Natural Resources;
- GOK, Economic Survey, 2016 – Kenya National Bureau of Statistics;
- Huber, J. 2012. Industrial Symbiosis and Ecology – Inspiration for Sustainable Industrial Systems: Energy Delta Institute (EDI) Quarterly Publication, Vol 4, No. 3, October 2012, the Netherlands;
- Kalmykova, Y., Rosando, L., and Patrico, J. 2016. Resource Consumption drivers and pathways to reduction: economy, policy, and lifestyle impact on material flows at the national and urban scale, Journal of Cleaner Production 132 (2016) 70 – 80; Crossref
- Ketels, C., & Solvell, O. 2005. EU Clusters in the EU-10 New Member Countries. Europe Innova Cluster Mapping Report;
- Kim, C. 2006. Industrial Symbiosis Activity in South Korea: Report on the Third International Industrial Symbiosis Research Symposium, Birmingham, England, Report Number 12, August 5 – 6, 2006;
- Lowe, E. 2001. Handbook of industrial ecology. *Eco-industrial Park Handbook for Asian Developing Countries;*
- Lowe, E.A. 1997. Creating by-product resource exchanges: strategies for eco-industrial parks. Journal of Cleaner Production 5 (1-2), pp. 57 – 65; Crossref
- Mossard, G., Jacquat, O., & Zurcher, D. 2014. International Survey on Eco-Innovation Parks. Learning from experiences on the Spatial dimensions of eco-innovation. Federal office for the Environment and the ERA-NET ECO-INNOVERA, Bern. Environmental Studies no. 1402: 310pp;
- Porter, M. E. 1990. The Competitive Advantage of Nations. London, Macmillan; Crossref
- Saikku L. 2006: Eco-industrial parks: a background report for the eco-industrial park project at Rantasalmi, Publications of regional council of Etelä-Savo;
- UNEP, 2011. Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication;
- UNEP, 2015. Sustainable Consumption and Production: A Handbook for Policy Makers: Global Edition;
- UNIDO, 2011. Green Industry: Policies for Supporting Green Industry, Vienna – Austria;
- UNIDO, 2015. Economic Zones in the ASEAN: Industrial Parks, Special Economic Zones, Eco-Industrial Parks, Innovation Districts as Strategies for Industrial

Competitiveness, UNIDO Country Office in Vietnam, August 2015;

- UNIDO, 2016. Eco-Industrial Parks (EIP): Creating Shared Prosperity and Safeguarding the Environment, Toward Inclusive and Sustainable industrial Development;
- World Bank, 2008. Special Economic Zones: Performance, Lessons Learned, and Implications for Zone Development, Washington D.C;
- World Bank, 2009. "Clusters for Competitiveness: A Practical Guide and Policy Implications for Developing Cluster Initiatives." International Trade Department, PREM Network, Report, World Bank, Washington, DC;
- World Bank, 2009. "Clusters for Competitiveness: A Practical Guide and Policy Implications for Developing Cluster Initiatives." International Trade Department, PREM Network, Report, World Bank, Washington, DC;
- World Bank, 2014. Low-Carbon Zones: A Practitioner's Handbook, Washington, D.C, May 2014;
- World Bank, 2014. Low-Carbon Zones: A Practitioner's Handbook, Washington, D.C, May 2014;
- World Business Council for Sustainable Development (WBCSD), 2002. Industrial Ecology in the Cement Industry, Toward a Sustainable Cement Industry, WBCSD Business of Innovation;
- Zeng, D.Z. 2006. Africa: Knowledge, Technology and Cluster-Based Growth, World Bank Institute Development Study.