TRADE & INDUSTRIAL POLICY STRATEGIES

INDUSTRIAL DEVELOPMENT PROJECTS

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A contribution to South Africa's Post COVID-19 Recovery Plan: Tapping into new and unmet sources of demand to support the establishment of new companies, factories, value chains and employment opportunities

Trade & Industrial Policy Strategies (TIPS) is a research organisation that facilitates policy development and dialogue across three focus areas: trade and industrial policy, inequality and economic inclusion, and sustainable growth

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ABBREVIATIONS

AfCFTA	African Continental Free Trade Area
AIS	Automotive Incentive Scheme
AMID	Association of Motorcycle Importers and Distributors
APDP	Automotive Production and Development Programme
ARC	Agriculture Research Council
BDO	Butanediol
BRICS	Brazil, Russia, India, China and South Africa
CARG	Compound Annual Growth Rate
CBD	Cannabidiol
CBUs	Completely Built Units
CCAs	Chrome/Copper/Arsenic
CSI	Cement Sustainability Initiative
CSIR	Council for Scientific and Industrial Research
DEFF	Department of Environment, Forestry and Fisheries
DRC	Democratic Republic of Congo
DoH	Department of Health
DoT	Department of Transport
DSI	Department of Science and Innovation
DST	Department of Science and Technology
dtic (the)	Department of Trade, Industry and Competition
EAC	East African Community
ECOWAS	Economic Community of West African States
EU	European Union
GDP	Gross Domestic Product
GHG	Greenhouse gas
IDC	Industrial Development Corporation
IP	Intellectual Property
IPAP	Industrial Policy Action Plan
merSETA	Manufacturing, Engineering and Related Services Sector Education Training Authority
NAFTA	North American Free Trade Agreement
NTB	Non-Tariff Barrier
NWRS	National Water Resource Strategy
OEM	Original Equipment Manufacturer
PHA	Polyhydroxyalkanoate
PI	Production Incentive
PLA	Polylactic acid
RABD	Rotary Air Blast Drilling
SADC	Southern African Development Community
SAM	South African Motorcycles
SEZ	Special Economic Zone
SIC	Standard Industrial Classification
SMEs	Small and Medium Enterprises
SMME	Small, Medium and Micro Enterprises
SSA	Sub-Saharan Africa
SSS	Short Sea Shipping
SYM	Sanyang Motor Corporation
THF	Tetrahydrofuran
TEU	Twenty-Foot Equivalent Unit
UNICEF	United Nations Children's Fund
US	United States

1. INTRODUCTION

As South Africa responds to COVID-19 and aims to stimulate the economy and job creation post lockdown, an opportunity should not be missed to consider investing in new product markets which could increase the size and dynamism of the manufacturing sector. Such a package could contribute to arresting the current trend of deindustrialisation and shift the trajectory of the industrial base into new, sustainable growth areas and value chains. This would result in new factories, new downstream demand for primary and intermediate inputs, new export products, increased foreign exchange earnings, and importantly new direct and indirect long-term jobs.

During lockdown international economists were quick to suggest that governments consider Post COVID recovery programming that was “not business as usual”. Some suggested a “green recovery” in place of a traditional brown industry recovery (Hepburn, 2020; COP26 Universities Network, 2020). Others suggested a social and community driven agenda rather than a traditional high street, capitalist agenda (Open Government Partnership, 2020; UK Government Recovery Plan, 2020). Using the idea of “business *un*usual” TIPS economists have put together a Post COVID-19 recovery programme in South Africa that could provide the impetus to arrest the current trend of deindustrialisation and herald in the beginning of a new generation of industrial activity.

The project methodology, approach and substance is broadly supported by recent heterodox industrial policy thinking.[1] Rather than focusing on industrial renewal as a theoretical or policy exercise, TIPS understands that given the urgent needs of an immediate economic stimulus and job creation post lockdown, it would be appropriate to identify projects that could be immediately supported. Such projects would result in new real economy investments in factories, productive capital and job creation. In order to ensure that the projects were strategically and substantively aligned to key existing Department of Trade, Industry and Competition (the dtic) policies and programming,[2] opportunities were identified within research already completed by TIPS on behalf of the dtic over the past five years. Leveraging existing research facilitated the rapid identification of opportunities, the broad context and market background related to such opportunities, and a rapid test of the fit of the project with broader dtic policy, process and priorities.

Seven initial projects have been identified. They represent a wide array of economic activity in the special purpose machinery, agro-industries, bioplastics, shipping, alternative fuel, biochemicals and automotive component manufacturing sectors. Four of the seven already have some level of private sector buy-in. In principle offtake agreements exist in three projects. There are identified champions for five of the projects. All projects require some degree of financial support and unblocking of bottlenecks to be realised. As such these projects represent real opportunities which could be immediately leveraged and supported by the government in the short term to add new stimulus to the domestic industrial sector. Implementation of such projects would not only deliver gross domestic product (GDP) and job growth but could pave the way for entirely new and sustainable areas of industrial economic activity in the country. Project implementation would be facilitated by the dtic leveraging existing institutional and governmental resources and processes (as discussed in the last section of this overview).

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[1] Three key influences are: Mariana Mazzucato’s thinking on the Entrepreneurial State (2015); Dani Rodrik’s thinking on a product identification process based on joint industry-government collaboration (2008a; 2008b); and the work by Barbara Geddes on islands of excellences as a means of implementing projects in the face of restrained government capacity (1994).

[2] Including, inter alia, the National Development Plan; the Re-Imagined Industrial Strategy; various previous iterations of the Industrial Policy Action Plan (IPAP); sector desk priorities and programming; and policy-related to regional value chains and industrial development.

1. THE PROJECTS

The project opportunities were identified based on previous completed economic research and new demand opportunities instead of more specific *a priori* qualification criteria. The projects differ in size and scale; complexity; industry; market readiness; required support and buy-in. Some projects may be appropriate and eligible for existing programming (such as the planned upcoming Investment Conference or the Industrial Development Corporation's (IDC) Black Industrialists Programme); while others (based on in-principle interested party agreements, buy-in and propriety knowledge) would require bespoke facilitation and support.

The portfolio of seven projects (an overview of which is provided in Table 1) is presented as supportable economic ideas which could catalyse the renewal of the country's industrial base in line with the dtic sector research and policy. Each project profile contains a short one-page summary of the commercial idea behind the project, a ballpark budget and anticipated outcomes. This is followed by a brief (six page) extraction of the key economic research which contextualises and provides key research that supports the opportunity in terms of demand, supply and market dynamics. The project profiles *do not* include sufficient information on which to make an investment decision. The aim is to generate interest in the opportunity and a desire to see them taken forward through a variety of facilitation and implementation activities.

Table 1: Summary of initial projects

Description	Untapped/New demand	Industrial policy rationale	Key outcomes
The production of 100% local content borehole drilling rigs specifically engineered for small and medium enterprise (SME) drillers to service increased investment in groundwater access in South Africa and the African export market.	Estimated that over 100 million boreholes need to be drilled in Africa over the next 15 years.	Import substitution of cheap, inferior quality drilling rigs from India and China. Leveraging proposed infrastructure investment in water and sanitation proposed under the COVID recovery plan.	✓ Creation of local SME borehole drilling companies. ✓ Downstream demand for fabricated metal and plastic inputs and specialised engineering services. ✓ Export of drilling machinery to international agencies undertaking water access programmes in Africa.
Commercial scale cultivation and production of de-hulled hemp seeds for human consumption for the export market.	Excess demand in North America (especially Canada) for new super food produced from hemp plant.	Leveraging South Africa's cultivation climate and Good Manufacturing Practice agro-industries to competitively beneficiate hemp seed for export.	✓ Job creation in cultivation. ✓ Job creation in processing. ✓ New export product. ✓ New forex earnings.
Supporting the sugar industry through the domestic production of polylactic acid for export and	Excess local and global demand for polylactic acid (PLA) to be used in plant based	Provision of an alternative revenue stream for the sugar industry. Entry into new	✓ Protection of sugar industry jobs and profitability. ✓ New export. products.

downstream domestic value addition. Part (a) Polylatic plant. Part (b) downstream diversification and scaling up.	biodegradable green packaging.	international growth. market for sustainable biochemicals. Domestic PLA beneficiation.	✓ New export revenue streams. ✓ New downstream production facilities ✓ New downstream direct and indirect jobs.
Creating a short sea shipping service to increase containerised intra-regional trade between South Africa, Mozambique, Tanzania, Kenya and their hinterlands.	Demand for a more efficient and cost effective intra-regional mode of transport.	Creating a new market (containerised shipping) alternative to expensive road-based intra-regional trade as a means of facilitating increased intra-regional trade and regional value chains.	✓ Improved competitiveness of certain South African exports to Sub-Saharan Africa (SSA) countries. ✓ Improved competitiveness (in landed price) of certain SSA country exports to South Africa.
Extablishing a co-processing facility at a cement plant as a means to catalysing a broader waste beneficiation industry in South Africa.	Demand for alternative fuels in energy intensive industries in order to meet greenhouse gas (GHG) emissions legislation.	Waste beneficiation and alternative fuels are two growth markets given global (and South African) commitments to climate change.	✓ New co-processing plant and associated job creation. ✓ Downstream job creation and valorisation of general industrial waste. ✓ Improved GHG performance for the cement industry.
Commercial scale production of furfural and furfuryl alcohol from sugarcane bagasse for the local foundry industry and broader export market.	Global excess demand for plant-based furfural; especially for use in foundry industry sand moulding resins.	To provide an alternative revenue stream for the sugar industry. To enter the high growth new bio-chemicals market. To improve local foundry competitiveness by potentially reducing the cost of sand mould resins.	✓ New export product. ✓ New export earnings. ✓ New production facility and associated direct and indirect jobs. ✓ Potential increase in the competitiveness of a small sector of the foundry industry.
Production of Class A motorcycle components (ONLY) for export to the African assembly and after-sales market.	Unmet demand in Africa for Class A motorcycle parts and spares at the same time as the Class A motorcycle demand increases.	Leverage the country's capabilities in automotive component manufacture to include servicing the African motorcycle market.	✓ New export products. ✓ New export earnings. ✓ New component manufacturing firms and associated direct and indirect jobs.

3. FACILITATION AND IMPLEMENTATION

Consideration has been given to how the dtic could most effectively and efficiently support the seven (or a subset of the seven) identified projects as a catalyst for post-lockdown economic stimulus and job creation. In addition, thought has also been given to how a broader and more representative scheme based on this approach could be rolled out. This facilitation and implementation thinking is based on a few key principles.[3]

The first principle is that any such facilitation and implementation should be led by the dtic as the championing department. This means that the dtic would need to co-ordinate and leverage relevant public sector departments (such as Department of Agriculture, Land Reform and Rural Development, DEFF, National Treasury and the President's Office) and institutions (such as Southern African Development Community (SADC), Development Bank of Southern Africa, IDC, Transnet).

Second, although the dtic is not structured around project implementation capacity, capacity to facilitate and implement the projects should not result in new permanent structures, personnel or overheads within the dtic. It is proposed that existing structures, processes and relationships should be leveraged. Following on from this, any facilitation and implementation option should be time limited (e.g. five years) and have specific upfront deliverables.

The third principle considered crucial to a successful facilitation and implementation approach is that the implementing capacity is equipped with the necessary skills, tools, mandates and operational support to act in a transparent, compliant and accountable manner, while enjoying the flexibility necessary to deal with a highly diverse number of issues and parties in a timeous manner.

A facilitation and implementation plan based on these principles would be drafted if the dtic finds the ideas contained in this proposal and its portfolio of projects compelling.

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[3] The proposed facilitation and implementation design has been strongly influenced by: the Islands of Excellence work undertaken in Brazil in the 1990s (Geddes, 1994); and the Gauteng Provincial Government's Blue IQ Programme, which was responsible for the building of the Gautrain, the Automotive Supplier Park in Rosslyn, the Cradle of Humankind, the Innovation Hub and the Nelson Mandela Bridge (Lowitt, 2003).

PROJECT ONE: BOREHOLE DRILLING RIGS

PROJECT SUMMARY SHEET

TITLE	The production of 100% local content borehole drilling rigs specifically engineered for SME drillers to service increased investment in groundwater access in South Africa and the African export market.
LEAD DEPARTMENT	Department of Trade, Industry and Competition. Other Departments: Department of Human Settlement, Water and Sanitation; Department of Small Business Development.
PROJECT SUMMARY	The project in contextualised in terms of the National Water Resource Strategy's (NWRS) support for the further development of groundwater in meeting South Africa's water needs, and a proposed increase in water infrastructure investment as part of a post-COVID recovery package. The project is the production of 100% local content borehole drilling rigs. The rigs have been designed to be village level operated and maintained, meaning that they can be repaired and serviced even in remote areas. Parts and spares are readily available and are generic and standard. The project also incorporates the training of a new cohort of SME drillers and operators in support of an expanded groundwater industry both locally and in the rest of Africa.
APPROXIMATE BUDGET	R15 million to R20 million for an assembly facility. All locally produced parts to be outsourced to specialist engineering firms with a strong track record. R3 million to R5 million for institutes course development and accreditation through the Manufacturing, Engineering and Related Services Sector Education Training Authority (merSETA).
STAKEHOLDERS	• Current intellectual property (IP) holder and producer of the rig; • A black industrialist partner with business and especially export market knowledge; • Department of Small Business Development to assist in the development of the training institute and setup capital for SMEs; • MerSETA to approve training content; • Department of Human Settlements, Water and Sanitation to set regulations and processes for additional sustainable borehole development, and to ensure that contracts are given to drillers not briefcase companies with no experience; • The dtic to support capital equipment production of rigs and downstream inputs.
CAPITAL INVESTMENT	• Factory space to assemble drilling rigs (some manufacturing on certain parts) • Basic assembly equipment including milling machines, lathes, hoist, welding and other basic fabricator equipment.
OUTCOMES	• Job creation: Each new SME drilling company will employ at least 10 to 12 full-time workers. The assembly of the drilling rigs will employ between 20 to 40 people directly. Indirect jobs downstream will be created in the iron and steel sector, the plastic extrusion sector, metal fabrication sector, specialist engineering sector and piping and hose manufacturing sectors. In time, compressors can also be produced locally. • Entirely new export product and export revenue stream. Research suggests that Africa requires over 100 million boreholes to be drilled in the next 15 years. The proposed rig meets all international specifications, hence global organisations such as the World Bank, United Nations Children's Fund (UNICEF) and the Red Cross can be approached to source their rigs from South Africa. • Increased access to sustainable water supply.

The production of 100% local content borehole drilling rigs, specifically engineered for SME drillers to service increased investment in groundwater access in South Africa and the African export market.

Introduction

Infrastructure investment has dominated the government's thinking regarding a post COVID-19 recovery strategy. TIPS 2020; Water Research Commission 2020; and Green Cape 2020 have all written that investment in South African water and sanitation should form an important part of this package. They argue that such investment will positively contribute to: the protection of existing agricultural employment and livelihoods; enhance productive opportunities and livelihoods in unserviced and underserviced areas; reduce poverty and inequality; enhance the country's responsiveness to current and future pandemics; and stimulate industrial development. In terms of industrial development it is argued specifically that South Africa should roll out locally manufactured solutions that allow for: import substitution; strengthening of the country's global competitiveness; and the increase of exports. The proposed project meets all these industrial development goals while in addition facilitating local black SME mainstream economic opportunities in a growth sector through training and reduced barriers to entry.

Water scarcity is a major challenge in South Africa and elsewhere on the African continent. Freshwater exists in two forms: surface waters (lakes and rivers) and groundwater, which is water that soaks into the earth when it rains and is stored in underground cracks and chambers (called aquifers). Surface water accounts for only 3% of global fresh water supplies. Ninety-seven percent of global fresh water is groundwater. Ground water may discharge naturally at surface level in the form of springs, seeps and wetlands. Most commonly, however, groundwater is mechanically withdrawn by constructing and operating a well or a borehole.[4] Accessing groundwater is therefore seen as a central part of resolving water access in Africa.

Three hundred million Africans currently lack access to clean drinking water. UNICEF estimates that 67 million boreholes need to be drilled in Africa to meet the Millennium Development Goals related to accessing clean drinking water (UNICEF 2016). In Mozambique alone, it is estimated that 1 000 boreholes have to be drilled per year for 15 years to meet these goals (Dovi 2007). If groundwater access for industrial and agricultural use is also factored in, the required number of boreholes needed in Africa exceeds 100 million in the next 15 years.

A borehole is a narrow shaft drilled vertically into the ground for the purpose of extracting groundwater. Once the shaft is drilled, a casing is used to line the shaft to prevent it from caving in. A screen is then placed atop the shaft to prevent pollution of the borehole water and finally a pump is installed to raise the water to the surface for use. Pumps may be electric, solar or manual. To drill a standard water borehole (which varies anything from 50m to 200m depending on geological formation) a piece of specialised capital equipment known as a drilling rig is used (Standard Industrial Classification (SIC) 357).

Drilling rigs vary in size from massive rigs used to drill kilometre deep mine shafts to small portable rigs which can be pulled and positioned by a single person. In order to reach a reasonable depth for a standard water borehole, a drill rig needs a minimum weight (four tons) and a minimum torque (4 000 newton meters[5]). Currently there are no locally produced borehole drilling rigs that meet such

[4] UNICEF and the World Bank use the words well and borehole interchangeably.

[5] These standard specifications are set out by UNICEF and are adopted by most aid and development programmes internationally. As such, to access internationally funded projects in the rest of Africa the drilling rig needs to meet UNICEF standards.

specifications[6] and which are designed specifically for use in remote areas where access to parts, spares, and repair and maintenance services are hard to access. In addition, no local rigs meet the above specifications which are also reasonably priced in terms of the setup costs of a new SME drilling company.

The 100% local content drilling rig for which the IP has been registered has a key market differentiator in the fact that it is designed to be "village level operated and maintained". This means that the rig is simple to use and hence capacity can be ramped up more readily than with more complex rigs. In addition (and more importantly) a huge problem with borehole drilling in Africa is the difficulty in getting rigs serviced, repaired and maintained in remote settings. The project rig is designed specifically to be self-maintained by the driller and all parts are either standard and generic parts easily attainable across most countries (in hardware stores or from car dealerships), or locally produced in South Africa. There are no original equipment manufacturer (OEM) or imported parts in the rig itself.

The 100% local content of the drilling rig will catalyse demand along multiple value chains servicing the downstream activities of the capital equipment sector. Most demand will be for parts fabricated by specialist engineering firms (such as steel rods, braided high pressure plastic piping and chassis[7]). While the drilling rig is 100% local content, the other pieces of equipment required to drill a borehole (engine, motor, compressor, truck and some consumables) are not based on local content. It is possible that, if export demand for drilling rigs increases, market size will be sufficient to allow a second wave of import substitution when non rig parts and equipment (such as compressors or hammers) can begin to be produced locally.

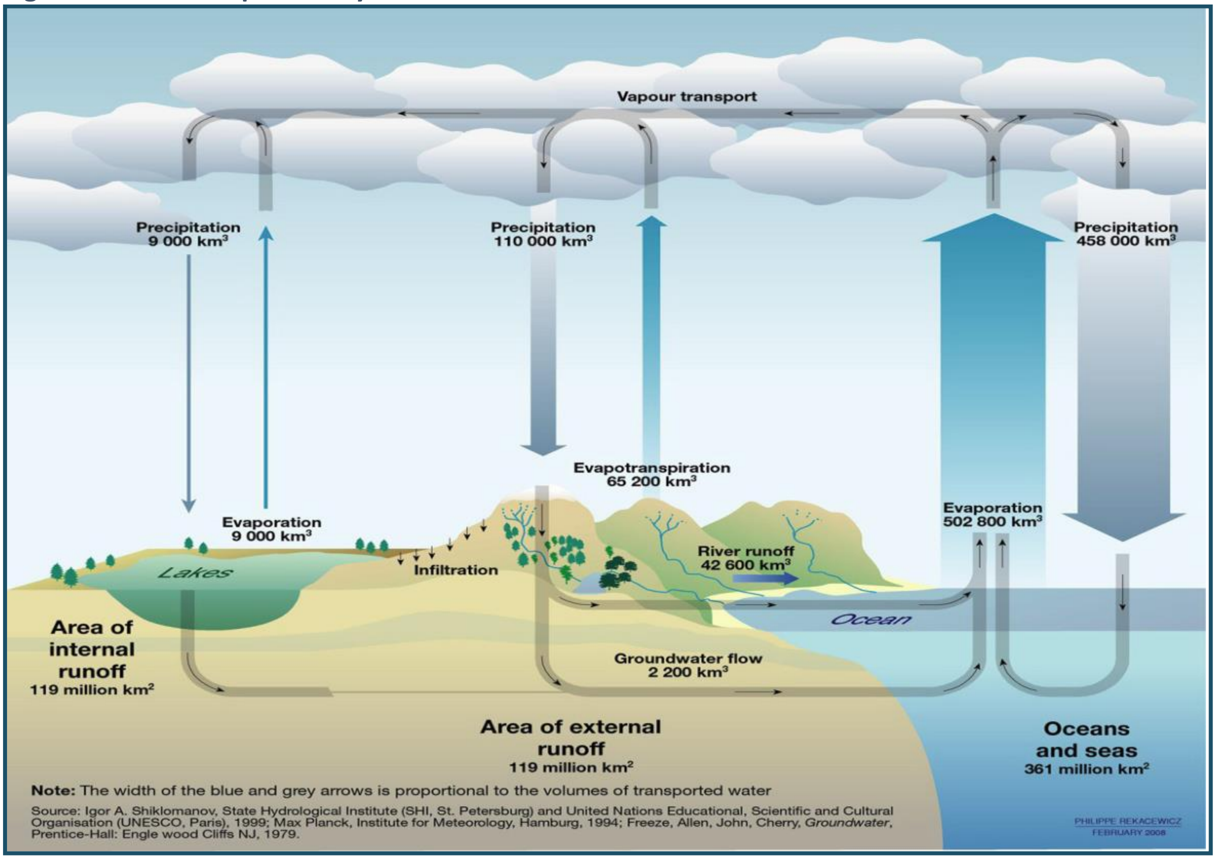
The project to produce cost effective and technologically appropriate borehole drilling rigs is premised on the need for Africa (and South Africa in particular) to improve access to drinking and productive water by drilling into and extracting groundwater. The NWRS states that groundwater will play an increasingly important role in the supply of water in South Africa. To achieve increased usage of groundwater at scale will require a new and extended cohort of drillers of boreholes. As the individuals responsible for the design and building of the project rig are drillers themselves, the rig production company plans to also operate a training institution. In the institute prospective black, SME drillers from all over Africa can be trained on: placing a borehole; drilling a borehole; maintaining a borehole; and maintaining their drilling equipment. The project is thus an industrial production project as well as a capacity building project.

Groundwater and national policy

Groundwater is a renewable resource which operates in a closed loop system (Figure 1). Heat results in water evaporation from the land and water resources. As the water vapour rises, it cools and condenses to form clouds. When conditions are appropriate, the water in the clouds is released as precipitation (rain, hail, snow or sleet). This precipitation evaporates back into the atmosphere, infiltrates the ground to become soil moisture or groundwater, or runs off into surface water resources such as rivers, estuaries and wetlands. Plants take up water from the soil and transpirate some of it into the air, contributing to the return of moisture into the atmosphere, and back into the cycle of evapotranspiration and precipitation. As such groundwater is replenishable and sustainable.

[6] The local market is positioned towards larger drilling rigs. Smaller rigs imported from India and China are available but lack the weight and torque to be able to reach required depths to find water. Most locally produced rigs are attached to 10-ton trucks, making them expensive and ill-suited for remote access sites.
[7] The chassis is also known as the skid steer and is the wheels/tracks on which the rig sits. To date, most locally produced rigs are attached to imported skid steers – usually the well-known yellow bob cat.

Figure 1: Closed loop water cycle



Source: Department of Water, 2012

Ground water is the water that soaks into the soil from precipitation, rivers and lakes. It moves downwards to fill cracks and other openings in beds of sand and rock. A unit of rock with cracks and fractures that can yield a usable quantity of water is called an aquifer. The characteristics of aquifers vary with the geology and structure of the substrate and topography in which they occur. Generally the most productive aquifers occur in sedimentary geological formations.

Groundwater is usually: cheaper to access; more convenient; and less vulnerable to pollution than surface water. Globally groundwater is commonly used for public water supply (UNICEF 2016).

The 2012 NWRS states that groundwater in South Africa is an important resource for all sectors ranging from agriculture to domestic water supply. It states that groundwater will make greater contributions to the national water supply in years to come as surface water gets closer to the limits of its development and availability. Currently surface water in South Africa (rivers, lakes) accounts for 9 500million cubic meters of water per annum. It is estimated that groundwater of 7 500 million cubic meters per annum exists at a high level of assurance. Currently only 2 000 million cubic meters per annum of this groundwater is exploited (27%), leaving a substantial 5 500 cubic meters per annum available to supplement dwindling surface water in the future.

The NWRS thus argues that there is extensive potential available for the further development of groundwater resources; and that the development of this resource will be crucial for sustaining water security of small towns and villages as well as augmenting water supplies to larger urban centres and agriculture (Department of Water, 2012). To support this usage, development of the borehole drilling and borehole development sector will need to grow.

Borehole drilling

There are many types of drilling techniques. Each technique requires a different type of associated drilling rig. The most common method of mechanical borehole drilling in South Africa and the rest of Africa is known as percussion rotary air blast drilling (RABD). In RABD the drill uses a pneumatic piston-driven “hammer” to energetically drive a heavy drill bit into the rock. The drill bit has very hard buttons on the end made of tungsten carbide, which pulverise the rock as the hammer strikes the bit down against the rock. The drill bit is hollow. Compressed air sucks up the pulverised rock which is then blown up the outside of the drilling bit and collected at the surface. As the bit eats through the rock, rods are added above the hammer so that depth can be achieved. The bit, the hammer and the rods used in drilling are consumables and have a limited lifespan requiring regular replacement.

The drilling rig itself must provide the hammering motion to pulverise the rock, but also a rotating motion to create a round shaft. There are three crucial systems in a drilling rig. The first comprises an engine which drives hydraulic pumps to create high pressure hydraulic fluid which drives a motor. The motor turns the rods above the drilling hammer adding a rotating motion to the hammer like striking motion so as to produce the actual round shaft. This is known as the hydraulics of the drilling rig. Second the drilling rig needs to produce the hammer like up and down movement to fracture and break up the rock. This is achieved by connecting the rig to a compressor. The compressor pushes air down the rods and lifts the piston up and down to make the hammer move and to push up pulverised rock to the service. The third important function of a drilling rig is known as pullback power. This provides the power to pull rods back out of the hole once water has been reached. This pull back strength is created using the hydraulic power from the rig’s engine. As such in engineering terms the hydraulic system of a rig is central to its operation and functionality. In this project, the hydraulic system is 100% local content and specifically devised to be easily operated and maintained even in remote areas. It is robust and high quality reducing downtime.

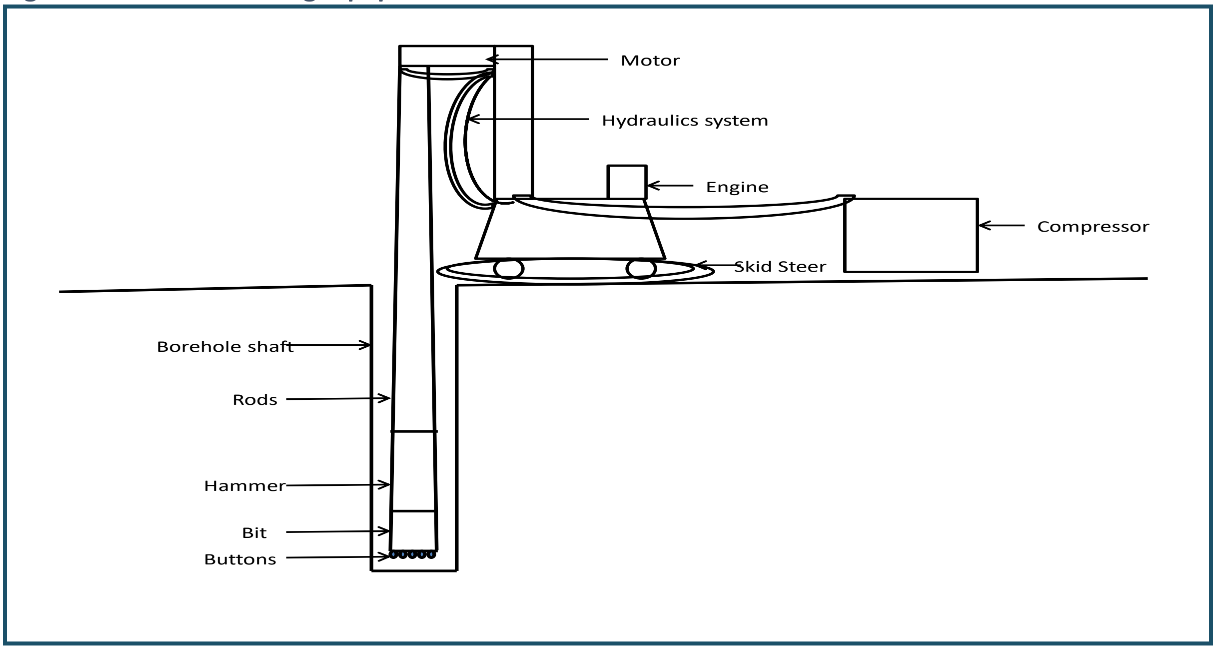
Inputs and value chain

Production of a drilling rig falls within SIC code 357 – the manufacture of special purpose machinery. The key components required for a drilling rig are: an engine, a hydraulic motor, a hydraulics system, a hammer, a drill bit, rods, piping metal, piping plastic, casings (metal and plastic[8]), bearings, nuts, bolts, hoses and skid steers (chassis upon which everything is attached). All of these inputs are locally produced excluding: the engine, the hammer and the drill bit. Engines are not currently made in South Africa, but Toyota engines are used as spares and are easily accessible in most African countries. The hammer is made of hardened steel and could in principle be manufactured locally, although currently no steel mills produce the grade of steel necessary to meet hammer specifications. Drill bits are imported because no-one in South Africa produced tungsten carbide buttons.

The downstream industries which would benefit from the production of local content driven drilling rigs would be specialised engineering firms, metal piping firms, plastic extrusion companies, plastic piping companies, hose manufacturers, rig engineers and skid steer manufacturers. Both the metal fabrication and plastics sectors would enjoy increased upstream demand.

[8] 8-inch steel casings and 6-inch PVC casings.

Figure 2: Borehole drilling equipment



Source: Author's own design

In addition to a drilling rig, a compressor and transport equipment are required to successfully drill a borehole. Compressors are crucial to the operation of a drilling rig and differ in size depending on their air pressure and movement of air per minute. Typically, to drill a standard borehole requires 21 bar of pressure and air movement of 850 cubic feet per minute. Compressors meeting these specifications are large and heavy weighting up to 6.5 tons. There are locally produced compressors which are also designed specifically to be village level operated and maintained. It would be beneficial for local drillers to have access to such compressors to complement their easy to maintain rigs. Unfortunately, South African compressors remain uncompetitive in price compared to Indian and Chinese imports. In the short run it is therefore likely that compressors for this project will be imported but local compressors could be produced to substitute imports if industry development and economies of scale occur.

Finally a drilling rig and compressor are useless unless they can be transported onto site. A drilling operation thus requires a truck (to carry the compressor and rods) and a trailer to pull the rig. Standard heavy duty trailers produced locally in South Africa can be used and a 4x4 10 ton truck with a double axle would be required for the compressor.

Capacity building and SME establishment

The United Nations and the International Red Cross reports on borehole drilling and development all raise the issue of increasing the standards of boreholes which have been drilled to increase functionality and decrease failure (which is currently at more than 26% across 20 surveyed African countries); increasing maintenance of boreholes and borehole pumps; and the need to manage groundwater resources to prevent over abstraction. To this end, the reports document a cross-cutting approach to groundwater development in a developing country including: establishing a strong institutional framework; collating and disseminating groundwater information; capacity building; project design, implementation and monitoring; dialogue awareness and financial investment (UNICEF 2016). They also both provide specifications and minimum standards for drilling, casing, water development, testing, and pumps.

Poor borehole drilling and development and borehole mechanical failures are attributed to: a lack of access to spare parts; a lack of basic maintenance; operation and management which is deemed “too difficult”; and a lack of finance (UNICEF 2016). In the same year, the International Water Agency stated that “there are not enough appropriately skilled water professionals to support the attainment of universal access to safe drinking water and sanitation....the developing world alone will need an additional 3.3 million professionals to achieve universal coverage” (IWA 2016).

Based on this inclusive and 360 degree approach to growing the groundwater development sector, the producers of the local content drilling rigs will offer a complete training course to newly established drilling SMEs in South Africa and abroad. This will cover all the aspects highlighted in the UNICEF standardisation of borehole drilling issues especially: how to site, drill, construct, develop, operate and maintain a borehole; and, how to operate, service, maintain and fix the drilling rig.

It is hoped that existing or new SME development programming can be leveraged to assist prospective drillers to enter the local groundwater development market. Current and future demand locally and across the rest of the continent is substantial and hence offers a new and sustainable growth opportunity. A new drilling SME could be established for approximately R3 million and would create sustainable direct employment for a minimum of 10 people. Indirect job creation through the value chain would also be supported.

Table 1: Start-up capital and consumable costs

ONCE-OFF COSTS	RANDS	
Drilling Rig	1 200 000	
Compressor	450 000	
10t truck (used)	450 000	
Heavy Duty Trailer	80 000	
	2 180 000	
Consumables		
Bit	7500	Replaced about every 1 000m of drilling
Rods	3 200	Each rod is 2m long – need at least 50 to drill a 100m borehole
Hammer	3 000	Usually replaced every 18 months

Source: Author’s own calculations

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PROJECT TWO: INDUSTRIAL HEMP

PROJECT SUMMARY SHEET

TITLE	Commercial scale cultivation and production of de-hulled (possibly organic) hemp seeds for human consumption for the export market.
LEAD DEPARTMENT	Department of Trade, Industry and Competition. Other Departments: Department of Health (DoH), Department of Science and Innovation (DSI) and Department of Agriculture, Land Reform and Rural Development, (also Agriculture Research Council, ARC).
PROJECT SUMMARY	The project is to cultivate industrial hemp in the Eastern Cape at a commercial scale as an agricultural (possibly organic) crop and to beneficiate the crop in the agro-processing sector to produce de- hulled hemp seeds for human consumption for export to the United States (US) and Canada in the short run; and Europe and (possibly) Australia in the medium term. To deliver the project, organic farming skills will need to be developed and supported, Good Harvesting Practices will need to be used to gather the crop and Good Storage and manufacturing standards (international) applied in the production of seed for export. Capacity, capabilities, auxiliary and support activities developed to service this initiative will provide strategic and competitive positioning as future industrial hemp value chain market opportunities become more commercially
APPROXIMATE BUDGET	R20 million to R40 million (cost of land hard to estimate)
STAKEHOLDERS	• A black commercial farmer to develop and operate the farm; • ARC to assist and support in terms of appropriate seed cultivar, crop density and other agronomic and cultivation parameters; • Possibly the Land Bank in relation to identification and procurement of suitable land and relevant extension services; • The Department of Health (DoH), which need to fast-track permit and regulatory approvals; • International firm (probably Canadian) which will sign an offtake agreement and provide upgrading and capacity building for the black commercial farmer; • A local agro-processing company with Good Manufacturing Practice accreditation to undertake de-hulling and or oil extraction;
CAPITAL INVESTMENT	• Physical infrastructure fencing and securing site as per South African Health Products Regulatory Authority/DoH guidelines and regulations; • Capital equipment: irrigation (if necessary); tractors and trailers (for harvesting). No combine harvester required as seed better picked by hand (also more labour intensive).
OUTCOMES	• Job creation: Main job creation occurs at the farm in terms of crop planting, crop maintenance and harvesting (twice a year). Additional job creation in auxiliary services and support service, agro-processing and transport. International studies suggest 12% of jobs are in agriculture, 16% in manufacturing, 15% in management and administration. As there is no industry in South Africa it is hard to estimate actual numbers but harvesting is labour intensive. • Entirely new export product and export revenue stream. Global market is growing, hence seen as a good export basket diversification strategy. Potential to create South African brand globally. • A strategic intervention to start creating capacity and capabilities in an agricultural crop which will inevitably face increasing demand over time as the uses of industrial hemp in mainstream products is extended.

Commercial scale cultivation and production of de-hulled (possibly organic) hemp seeds for human consumption for the export market

Introduction

There is a growing international trend towards decriminalising the cultivation and beneficiation of industrial hemp and/or marijuana. This has led to a nascent market for hemp and marijuana crops and a wide range of new and novel beneficiated products. These market opportunities have attracted substantial hype across social and popular media. The so called "Green Rush" is equated to the American "Gold Rush" of the 1850 and perpetuates the idea of limitless opportunities for individual wealth generation, economic growth and job creation. Actual returns and growth have, however, fallen significantly below expectations and in many circumstances substantial losses have been incurred.[9] Careful economic consideration of market fundamentals and existing operating environments support the idea that some future growth potential undoubtedly exists and as such it is worthwhile developing South Africa's capacity and capability to leverage such opportunities when they materialise or gain momentum. In the short run, however, commercially viable and legal options for a South African industry are narrowly defined. The most attractive and seemingly feasible opportunity currently is the commercial scale cultivation of industrial hemp for the production of seed for human consumption. (Lowitt 2018; 2019).

The proposed project is based on research conducted as part of a SA-TIED initiative (Lowitt 2019) to create an inter-regional industrial hemp value chain between South Africa and Malawi.[10] The project is to cultivate industrial hemp in the Eastern Cape as an agricultural (possibly organic) crop and to beneficiate the crop in the agro-processing sector to produce de-hulled hemp seeds for human consumption for export to (among others) the US and Canada in the short run; and Europe and (possibly) Australia in the medium term.[11] To deliver the project, organic farming skills will need to be developed and supported, Good Harvesting Practices will need to be used to gather the crop and Good Storage and Processing standards (international) applied in the production of seed for export. Capacity, capabilities, auxiliary and support activities developed to service this initiative will provide strategic and competitive positioning as future industrial hemp value chain market opportunities become more commercially viable. The project thus offers an immediate labour-intensive new commercial opportunity in a value chain which has strong long-term growth potential. The project also creates the opportunity to support the development of black commercial farmers, and create an anchor industry which can crowd in small businesses and small growers over time.

The project proposal is a major departure from all local industrial hemp initiatives to date. Previous work by the Agricultural Research Council, Council for Scientific and Industrial Research, House of Hemp, Department of Agriculture, Fisheries and Forestry and the IDC have all considered growing the industry based on small, rural emerging farmers growing hemp at a small scale. The project suggested in this proposal is for a large-scale commercial operation to be supported, which would enjoy economies of scale and be commercially viable. The key outcome of the project would be: the

[9] For example. in 2018 Canada legalised the recreational use of marijuana. In 2020 demand for recreational marijuana was substantially below projections while supply was substantially greater than projected. A resultant excess mountain of marijuana has been created and the price of marijuana has plummeted below the cost of production (Financial Times, 2020),

[10] The project was predicated on the ratification of new legislation in Malawi to legalise industrial hemp cultivation. Unfortunately disputed election results have resulted in political instability in Malawi and the legislation has not been ratified making the project not feasible as a joint country initiative. The research is thus applied to South Africa.

[11] Currently hemp seed is not allowed for human consumption in Europe or Australia but in both regulations are being changed to allow its consumption. Australia is planning to establish a domestic hemp seed industry but whether this will be sufficient to meet local demand is unknown at this time.

creation of a large numbers of jobs in rural Eastern Cape, substantial new exports, increased activity and jobs in the agro-processing sector and agronomy support sector; opportunities for black large-scale farmers and an anchor on which to support small growers and businesses in the future.

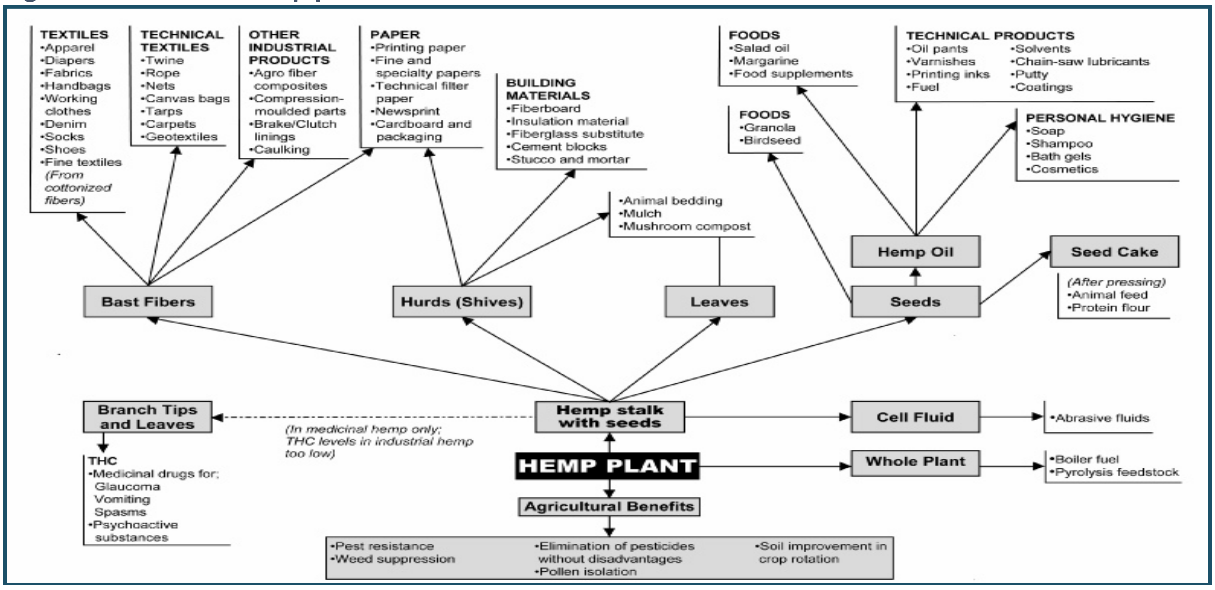
Industrial hemp

Industrial hemp and marijuana are genetically and chemically distinct forms of the Cannabis Sativa plant. Plants are covered in tiny hairs called trichomes which secrete a resin containing chemical compounds known as cannabinoids.

There are two kinds of cannabinoids. THC (tetrahydrocannabinol) is a psychoactive chemical and is responsible for the narcotic "high" experienced when consuming marijuana. CBD (cannabidiol) is a non-psychoactive cannabinoid and has no narcotic properties and cannot produce any form of "drug high". The key differentiator between industrial hemp and marijuana (legally and chemically) is that industrial hemp has very low levels of THC. It is generally accepted that plants with less than 0.3% THC do not have narcotic properties and can therefore be grown commercially in countries that allow hemp cultivation. More specifically, in terms of legislation Canada, the US, South Africa and most non-European Union (EU) countries define industrial hemp as any cultivar of Cannabis Sativa with a THC level below 0.3%. In the EU, industrial hemp must have a THC level of not greater than 0.2%.[12]

The industrial hemp plant is a fast growing, annual herbaceous plant with a deep tap root. It can grow up to 5m depending on cultivar and growing conditions. The plant has a slender main stem and when grown at commercial densities the stems are almost unbranched. The stem comprises two parts: the bark or bast which contains the long fibres used in textiles (about 1/3 of the stem) and the woody inner portion of the stem known as the hurd. The hurd has much shorter fibres than the bast and accounts for approximately 2/3rds of the stem. At the end of the growing cycle the plant forms seed heads which contain seeds, seed oils and the cannabinoid CBD. Different cultivars have different characteristics in terms of hurd, bast and seed properties; and different planting densities are adopted to encourage desired characteristics. As such the end use of a hemp crop needs to be determined before sowing.

Figure 1: Industrial hemp plant uses



Source: Cornell Cooperative Extension of Tompkins County. From seed to market. http://ccetompkins.org/

[12] As the project foresees the EU as an important future export market, locally cultivated industrial hemp should contain no more than 0.2% THC.

Industrial hemp has multiple uses based on which portion of the plant is utilised. Different uses require different seed varieties, growing conditions, planting conditions, plant densities and harvesting. As such, industrial hemp is usually grown as a mono crop with a primary market in mind. Secondary income streams related to residual plant material can be enjoyed. For example if a crop is grown primarily for seed for human consumption, the stalks and leaves available after the seeds have been harvested can be processed and sold as animal bedding or mulch.[13]

There are four key categories of uses of industrial hemp: i) a green substitute for various industrial products; ii) a food for human consumption; iii) an input (oil extracted from seeds) to personal care and cosmetic products; and iv) therapeutic products.

Climate change proponents and environmentalists emphasise the potential of industrial hemp bast fibres and hurds to provide green, sustainable and renewable alternatives to traditional building materials, paper products, textiles and industrial products such as plastics. For example, motor vehicle dashboards can be made from hemp based bio-composite products instead of fossil fuel based injection moulded plastic; hemp based fabrics can be substituted for synthetic fibres and use 70% less water than cotton; and hemp can be used to produce insulation material which does not involve fibreglass or asbestos. Industrial hemp is strongly positioned to be a green substitute for multiple industrial products; however, current market demand and price differentials are insufficient to make such products commercially viable at scale.

Industrial hemp seeds have fundamentally different applications and uses than bast fibres and hurds. Seeds can be used as a food for human consumption or the oil from the seeds can be extracted and used in the production of personal care products or for therapeutic preparations. These three uses collectively account for 64% of current industrial hemp product sales in the US retail market[14] (Johnson 2018).

As food industrial hemp seeds offers the second highest source of protein in the plant kingdom (soybeans are 7% richer). They contain eight essential amino acids, high levels of omega-3 and polyunsaturated fats. This chemical composition provides the seed's nutritional and health credentials and its acceptance as the wellness and health market's latest super food. Raw (and sometimes roasted) seeds are predominantly sold de-hulled as a standalone product in health food stores. Seeds are also increasingly demanded as part of cereals, mueslis and other processed snacks manufactured for the wellness and health market. Industrial hemp seed is legal for human consumption in the US and Canada (the largest current markets) but not in Australia and Europe where it is currently used only as bird seed. In both the EU and Australia, legislative changes to allow human consumption are in progress (EIHA 2018) in line with new health findings and trends. Hemp seed for human consumption should be legalised in the EU and Australia by 2021. Trade volumes in industrial hemp seed for human consumption have been increasing consistently over the past 10 years with prices also rising substantially as demand outstrips supply (Johnson 2018).

The fatty acids which contribute to hemp seeds being a super food also play a role in the suitability of the seed oil as a natural and sustainable input into a range of personal care and cosmetic products. Hemp seeds fatty acids are high in linoleic and alpha linoleic acid, both of which are crucial to skin care. This combined with a shift towards sustainable, natural and environmentally conscious personal care products in developed countries has resulted in hemp oil based shampoos, soaps, bath

[13] The residual would not, however, be suitable for use in the textile or biocomposite industry as the plant was not bred and grown to produce long bast fibers.
[14] The US is currently the largest consumption market for industrial hemp products other than hemp for textile use.

gels, lip balms, body lotions, massage oil and colour cosmetics gaining market share in developed countries. Personal care products account for 24% of total industrial hemp retail product sales in the US (Johnson 2018).

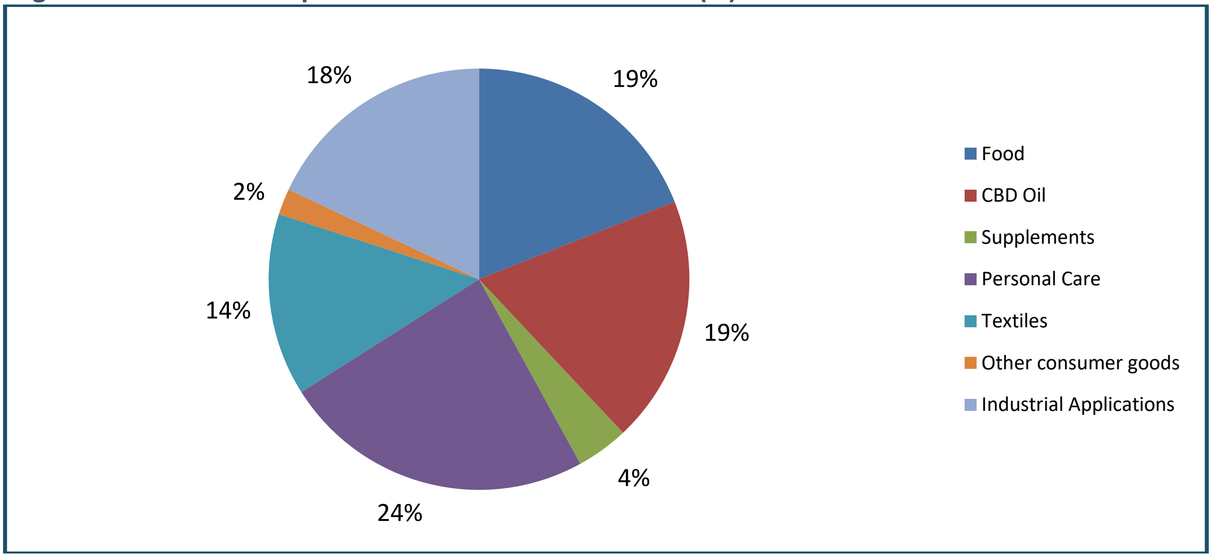
Once the oil has been extracted from the seed for use in the personal care market the residual matter is known as oilseed cake. Because of its high residual protein content and amino and polyunsaturated fatty acids, oilseed cake makes an especially good animal feed and existing research shows that cows, sheep, fish and egg laying chickens all thrive on the product.

The final use of the hemp plant is as an input for therapeutic products. A key perceived demand for industrial hemp is argued to derive from the massive global demand for CBD oil (which is extracted from the trichomes covering the flowers, leaves and stalks of the industrial hemp plant). This use is characterised as the medicinal or therapeutic use of the plant. CBD oil is claimed to be a "wonder" natural medicine/therapy with strong anti-inflammatory, anti-seizure and anti-nausea properties. In addition it is claimed that the oil is able to lower blood pressure and cholesterol, strengthen the immune system and work as a sleep aid. Unfortunately, the industrial hemp plant contains about 3% CBD while a marijuana plant contains 18% to 20% CBD. This means it is commercially more viable to produce CBD oil from a marijuana plant than an industrial hemp plant. Other limitations to the potential of this opportunity include the existence of cheap synthetic CBD oils which compete positively with plant based CBD oil on consistency and price; and a massive global oversupply of CBD oil which has seen international prices plummet.[15]

Markets and prices

The US market is the most developed industrial hemp market currently. The personal care market is particularly strong in the United States due to consumer demand for natural products and chemical free cosmetics. The use of industrial hemp as a super food and medicinal product is also strong. Industrial application demand lags behind consumer consumption uses at present but with R&D and increased climate change pressure for substitute products, applications and demand are expected to increase in the long term.

Figure 2: Industrial hemp retail sales United States 2016 (%)



Source: Hemp Industries Association, https://www.thehia.org

[15] Market conditions are different for medical grade CBD oil, but such product is based on genetically and chemically fingerprinted plants cultivated in strictly controlled indoor greenhouses. Medical grade CBD oil is also sourced from marijuana plants not hemp plants.

The US, besides being the largest retail market in the world, also accounts for 60% of global trade in industrial hemp products. Imports of seed for human consumption comprises the largest category of imports by some margin.

Table 1: US Imports of industrial hemp (US$ '000)

	2013	2014	2015	2016	2017
Seeds	26 942	29 326	54 191	51 018	42 897
Oils	2 264	3 446	4 836	6 142	7 603
Oil Cake	6279	8 159	16 281	8 620	11 494
Fibres	78	114	292	690	780
Yarn	482	909	1 497	1 867	2 739
Woven fabrics	1 057	900	1 020	744	1 819
Total	37 102	42 854	78 117	69 081	67 322

Source: Hemp Industries Association, https://www.thehia.org

The market in the EU is somewhat different and less sophisticated. Market volumes and values are not available but usage of tonnes of industrial hemp cultivated are available as are their downstream uses. In Europe, in 2016, 85 000 tonnes of industrial hemp was harvested comprising 25 000 tonnes of fibres, 43000 tonnes of hurd (woody inner portion of the stem), 11 5000 tonnes of seeds and 240 tonnes of leaves and flowers.

With regard to industrial hemp seeds harvested: 44% was used in animal feed, 43% for human consumption in various foods, only 0.3% was used to extract oils for cosmetic and personal care products and 13% was used to extract oil for human consumption (food application not CBD). Only 240 tonnes of the 85 000 tonne crop in Europe was used for medicinal and therapeutic applications. This accounts for only 0.003% of usage compared to 23% in the US.

That the uses of industrial hemp are so different in the US and Europe creates the widest possible array of potential market opportunities for any country thinking of pursuing commercial scale cultivation of industrial hemp as an input or intermediate product in the global market.

Despite industrial hemp cultivation being legal in up to 30 countries, at present there are less than half a dozen dominant producers globally. Data are a problem but it appears that China is the dominant global supplier of industrial hemp producing roughly 70% of global output. China's production at present is focused on fibre production only. Canada is said to be the second largest producer at roughly 15% of the global market; however, it produces only for seed for human consumption. EU countries account for the majority of the remaining share of global production with France being the single largest EU producer at around 9% of global production. France produces industrial hemp almost exclusively for the paper industry and more specifically paper to be used in cigarette production.

Crucial to any industrial hemp project is a view on commercial viability along the value chain. As expected with any agricultural crop or feed stock, market prices increase as value is added down the value chain. Different price levels are shown for South Africa, the US and Australia.

Table 2: Relative prices for downstream hemp products in South Africa Rand/kg (2015)

PRODUCT	PRICE
Stalk fibre	9.00
Stalk hurd	6.00
Oil	100.00
Seedcake	50.00
Dehulled seeds	115.00

Source: **Coogan (2016)**

Table 3: Relative Prices for downstream hemp products in the US US$/kg (2003-2013)

PRODUCT	2003	2009	2013
Hemp Seeds		5.47	9.08
Hemp Oil	6.36	8.14	5.03
Seed cake		9.01	10.45
Fibres and waste	0.87	1.36	1.08
Yarns	7.02	7.47	6.89
Woven fabric	1.65	3.4	4.72

Source: Fortenbery (2014)

Table 4: Relative prices for upstream and downstream hemp products in Australia US$/ton (1995)

PRODUCT	PRICE
Raw Stalks	55.00
Dry Stems	125.00
Raw fibres	647.00
Dry Fibres	800.00
Bast fibres	630.00
Hurds	55.00
Dry hurds	40.00
Seeds	1200.00
Organic Seeds	1680.00

Source: Crawford et al. (2012)

The tables show a high level of variation in absolute values for different products but are consistent in relative values for different downstream uses. In terms of primary processing, hurd (the woody core of the plant used predominantly for animal bedding) is the least valuable processed output. This is followed by fibres and oil. Seed command the highest price. In South Africa there is little value attributed to the less beneficiated products of the industrial hemp value chain. Prices for fibre, hurd and even seedcake as an alternative source of protein for animal feed suggest low market knowledge, acceptance and interest compared to higher value added uses. Hemp oil (used for human food consumption and as an input to cosmetics and personal care products) and shelled seeds are relatively equal in value and demonstrate that there is market knowledge and interest in the health and wellness aspects attributed to industrial hemp.[16]

Planting, growing and harvesting

Industrial hemp is grown by seed with virtually every regulatory body responsible for licensing insisting on the use of certified seeds bought annually. This is to ensure low THC and plant characteristics are maintained over time. Seeds are developed through breeding programmes to meet specific characteristics needed for the dominant use of the plant. In South Africa, this service is provided by the ARC unit for Industrial Crops. Seeds are usually planted between September and November on beds prepared in a manner similar to other row crops. Soil with a pH of 6 to 7.5 is recommended and the soil should offer good water retention properties with sandy loam and clay loam being the two preferred soil types. If sowing for commercial purposes, it is suggested that potassium, nitrogen and phosphorus be added before seeds are planted, although this is contested by some agronomists who argue additional nutrients are not in fact required. Germination occurs within three to five days of planting, and it is recommended that at this stage if there is no rainfall, the crop be watered at a rate of 3ml to 6ml per hectare. Optimum growth temperatures are 15 to 27 degrees Celsius. The crop will grow rapidly for three to four months, creating branches and leaves in its vegetative phase of growth before forming seed heads as the length of the day begin to decrease.

[16] Although a dynamic market in South Africa is a bonus, the project is focused on meeting international demand for the primary crop. Secondary market revenue from plant residuals after seed has been harvested will improve the return on investment for the project.

Planting density differs fundamentally depending on the end use of the plant and the variety. Different densities impact the diameter of the stem, the fibre length, fibre content, fibre yield, number and density of branches and hence seed heads and quantity of seeds and oil content. Essentially, closely planted crops will produce long, tall plants with a few side branches, which are preferred for fibre production. Plants cultivated for seeds will be planted less densely so that more side branches develop as this is where flowers and hence seeds are produced. As such, plants cultivated for seed and oil will be shorter squatter plants with a fuller vegetative pattern. Amaducci et al. (2015) recommend that when growing for fibre for textile use, a density of 150 to 200 plants per square meter be sown; for non-textile fibre at 250 to 350 a square meter; for paper and pulp at 90 a square meter; for essential oil at 15 a square meter and 12 square meter for seed. These fundamentally different densities suggest that different scales of farming and different yields and commercial feasibility will differ depending on the end use of the crop.

Different end uses also respond differently to variable input conditions. For example, higher temperatures and lower rainfall conditions will accelerate flower development and seed production but will delay vegetative plant growth and fibre maturation[17]. Additional fertilisers are found to improve yields when grown for seed but not when grown for fibre.

The method and timing of harvesting are also impacted by the envisaged end use of the plant. When harvesting for fibre the whole plant needs to be harvested. This is traditionally done by hand in developing countries and using modified combine harvesters in developed countries. If the plant is being grown for seed or oil, harvesting is a bit of an art. Seeds are formed in flower heads. Seed maturation starts at the bottom of the flower and moves upwards so that a flower will have mature seeds at the bottom while still having green seeds at the top. Once the seed is mature the nut soon comes loose from its shell, called shattering. During shattering the useful part of the seed falls to the ground and is lost in terms of yield. As such, timing when to harvest is crucial for seed. The optimal window for seed harvest is when only 70% of the seed is ripe and seed moisture is at 20% to 30%. Delaying harvesting may increase yield but quality will decrease as the seeds dry out further. Harvesting for seed and oil only requires the harvesting of flowers and not the whole plant. Handpicking is the best option to ensure quality and reduce seed damage but is labour intensive.

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[17] This strengthens the case to be made for South African growers to concentrate on seed production.

PROJECT THREE: POLYLACTIC ACID (BIOPLASTICS)

PROJECT SUMMARY SHEET

TITLE	Supporting the sugar industry through the domestic production of polylactic acid for export and downstream domestic value addition. Part (a) PLA plant; Part (b) downstream diversification and scaling up.
LEAD DEPARTMENT	Department of Trade, Industry and Competition.
PROJECT SUMMARY	The project is strategic with respect to diversifying the revenue streams of the sugar industry and removing sugar surpluses from the domestic market so as to secure profitability and employment in the sugar sector. At the same time the project allows the country to enter into the green economy with the creation of bioplastics and downstream products for the domestic and export market. PART (a): To convert an existing sugar mill into a PLA production plant using excess sugarcane as a feedstock. The 75 000 ton turnkey operation utilising imported technology is cutting edge and has already been demonstrated to work. There is a global shortage of PLA. Output will be for downstream domestic beneficiation with excess output exported to Europe. PART (b): To support the small number of PLA converters operating downstream with capital expansion and diversification support to produce PLA value added products for the local and export market. Part (b) is crucial to ensure that the PLA plant does not become another commodity exporter but assists in supporting downstream value chain beneficiation.
APPROXIMATE BUDGET	Part (a) 75 000 ton PLA plant turnkey solution US$380 million Part (b) R80 million-R100 million
STAKEHOLDERS	• Several large players in the sugar milling industry are interested in the project and would like to convert their mills into a PLA plant; • At least one firm has progressed as far as to have in principle offtake agreements for the total output of a 75 000 ton plant from the European market. • At least one converter currently producing downstream PLA products domestically would be interested in an in principle offtake agreement for value added production and to scale up production if PLA becomes locally available. The converter currently produces for the domestic and export market.
CAPITAL INVESTMENT	• Part(a) construction of new facility; utilisation of existing energy and transport infrastructure. • Part (b) expanding scale of existing converter operations and possibly putting up new factories for diversified product lines.
OUTCOMES	• Stabilisation of sugar industry profitability and employment through value stream diversification. • Job creation: Part (a) PLA plant will employ approximately 400 direct workers with about 100 indirect jobs. Existing employment is safeguarded. Part (b) Downstream production is also capital intensive with 10 to 15 jobs per production line of medium volume converter – total of maybe 150 direct jobs. • Foreign Revenue generation: Part (a) Export of PLA surplus to domestic market downstream requirements – main market Europe (b) Export of value added downstream packaging products – main markets Europe and the US. • Contribution to national climate change commitments, reduction of GHGs, supporting the growth of the green economy and catalysing the bioplastics industry. • Possible small decrease in importation of plastic polymers, but establishes industry to increase this trend in time.

Supporting the sugar industry through the domestic production of polylactic acid for export and downstream domestic value addition

Introduction

Sugar is the second largest field crop in South Africa after maize. It generates R14 billion revenue annually and as a labour intensive industry employs 85 000 workers. This accounts for 10% of all local agricultural employment. On average South Africa produces two million tons of sugar from a crop of 20 million tons of sugar cane per annum (1% of global production). Global leaders Brazil (39 million tons) and India (25 million tons) dominate the world market and what happens in these two markets directly impacts global market prices. The South African sugar industry faces a systemic challenge. With gross sugar production averaging two million tons per annum but local market demand only requiring 1.14 million tons, for the past 10 years average exports of over a million tons have been sold on the free market through the South African Sugar Association. As most worldwide sugar sales are conducted under lucrative regional trade and preferential trade agreements, and with numerous countries supporting their sugar industries, the global free market for sugar is invariably a low-value market. South African growers and millers are finding that returns from sugar sales are falling as free market global prices decrease due to excess supply while production costs at home have been rising. In response to this, the local sugar industry is investigating how to diversify its revenue streams to maintain profitability and current employment levels.

In recent decades, the global industry has embraced the concept of multiple value streams. Although many producers still rely heavily on sugar sales alone, industries that have embraced diversification have experienced increased revenue stability and overall revenue growth. Brazil and Mauritius are cited as the most successful examples of this approach. South Africa with its single revenue stream model is behind the global curve in terms of diversification. The new sugar industry business model is a triple stream model made up of: sales of sugar, co-generated electricity and biofuel/biochemical production. The traditional sugar mill in these instances has evolved into a bio refinery, with revenue from the streams cushioning producers from the vagaries of the sugar market. A bio refinery is any facility that integrates biomass (in this case, sugarcane crop residue) conversion processes and equipment to produce fuels, power and value added chemicals from the biomass. In this way the value derived from the biomass feedstock is maximised (Zafar 2019).

Power co-generation occurs when the waste product left over after sugar production (called bagasse) is used to fire the boilers of the sugar mill. All sugar mills in South Africa are energy self-sufficient and room exists to increase electrical production and export it to the national grid. Biofuel is produced when during the sugar production process a portion of production is diverted into the creation of ethanol. This ethanol can be used as a fuel. A range of biochemicals can also be produced, either based on ethanol which is a versatile and dynamic base product or through other chemical processes which do not require the production of ethanol first. A broad range of bio chemicals can be produced based on sugar as a feedstock. Currently the most pervasive bio chemicals produced internationally relate to bioplastics. Bioplastics are plant based, non-petroleum based plastic products which may also be completely biodegradable. Bioplastics are more sustainable and eco-friendly than their fossil fuel based equivalents. Bioplastics can be used for packaging, bottles, bags, vehicle components, cutlery and smaller retail plastic items. As the market and technology grows, additional uses and applications are being created.

This proposal, based on research conducted on behalf of dti by TIPS on the sugar value chain (Braude and Montmasson-Clair, 2019) and a report on the biomaterials sector (PAGE, 2019) for the Department of Trade and Industry, Department of Science and Technology (DST) and the Department of Environmental Affairs suggests that an alternative revenue stream for the sugar industry be established through an investment in a bio plastic production plant in Kwa-Zulu Natal.

The plant will produce PLA using the surplus sugar cane produced annually in the local market. The PLA will be used as an input to grow the nascent domestic downstream industry of bio plastic value added products, which will be sold locally and exported. Any excess PLA not consumed in the domestic market will be exported as a raw material. In principle, offtake agreements for both local and international sales from the proposed PLA plant support the view that there is a robust local and global demand for the product and its beneficiated downstream products. This proposal fits into both the Re-imagined Industrial Strategy prioritisation of supporting the sugar industry and green economy and the general direction of the Sugar Master Plan.[18]

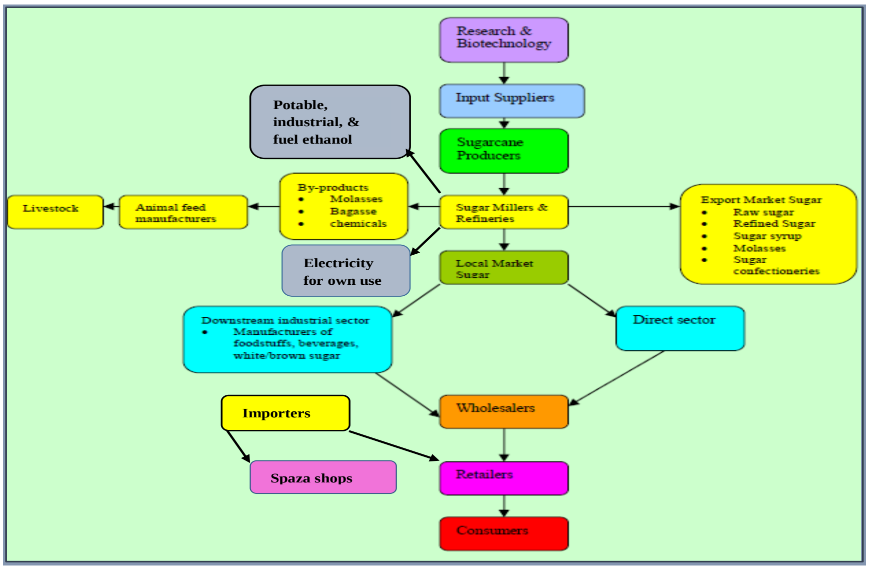
The sugar value chain

There is a symbiotic link between sugar growers and their local mill. A decrease in the supply of sugar cane endangers the viability of the mill; while an unviable mill endangers the viability of growers within the supply area. Growers and millers must by default work closely together to ensure their mutual survival.

Sugarcane is a bulky commodity that must be processed quickly. It should not be transported over long distances as the sucrose content starts to drop post-harvest, decreasing the value of the cane to the grower and miller. This means mills must be in rural areas close to cane growing areas, giving the industry a unique role as a provider of rural jobs and as a source of investment. There are 21 889 registered growers in South Africa: 94% of these growers are small growers who collectively account for 10% of the annual crop; 1 327 large-scale growers account for 80% of production while the remaining 10% is grown by sugar mills with their own estates (Braude and Montmasson-Clair 2019). Collectively growers employ about 78 000 people. On the processing side there are 14 sugar mills, based mainly in Kwa Zulu Natal and Mpumulanga employing about 7 000 people.

Figure 1 shows the multiple uses of sugar cane and its numerous by-products. Sugar cane is cut and harvested and transported to the mill. At the mill, cane juice is extracted, purified, filtered and then crystallised into raw sugar. Raw sugar is known to consumers as brown sugar. Raw sugar can be further refined and made into refined sugar known as white sugar or table sugar. White and brown sugars are then packaged either for direct consumption through the retail market or for indirect consumption through the industrial food and beverage market (jam, cool drinks, chocolates).

Figure 1: Sugar value chain



Source: Braude and Montmasson-Clair (2019)

[18] The Master Plan was still being drafted when this proposal was written.

The three most important by-products of sugarcane and sugar processing are: molasses, bagasse and biochemicals. Molasses is the syrup from the final stage of crysallisation. It is mainly sold for animal feed and fertiliser. This use is well developed in South Africa. Bagasse is the dry pulp that remains after sugar cane is crushed and the juice extracted. It is a biowaste and can be used as a substitute for coal or oil in mill boilers. This opportunity is also well developed in South Africa and all mills are self-sufficient in electricity. Additional co-generation is possible (Braude and Montmasson-Clair 2019). Finally, sugarcane can be used as the basis for a range of biochemicals, of which bioplastics is a particular example. Chemical by-products are not widely produced across the local industry at present. However, most mills have the potential to manufacture such products if the mill is adapted for biorefining. Currently a small range of products are produced in the local market, including potable alcohols for human consumption, industrial alcohols for solvents and some furfural and xylitol. No local bioplastic production exists to date.

One of the difficulties related to growing the biochemical sector based on sugar as a feedstock relates to the sugar regulatory environment and legislation related to competition. Essentially a Sugar Industry Agreement (SIA) and the Sugar Act (9 of 1978) harmonise the miller-grower relationship in South Africa and protects growers from the millers which operate as monopsonists. Under the SIA, proceeds from local sugar sales, sugar exports to the world market and molasses sales are added together to determine total industry proceeds. Once industry costs have been deducted the remaining net divisible proceeds are divided in a fixed ratio between growers (64.3675%) and millers (35.6325%). If the industry diversified into biochemicals there would need to be agreement on how additional revenue streams would be divided as both growers and millers would have a claim.[19]

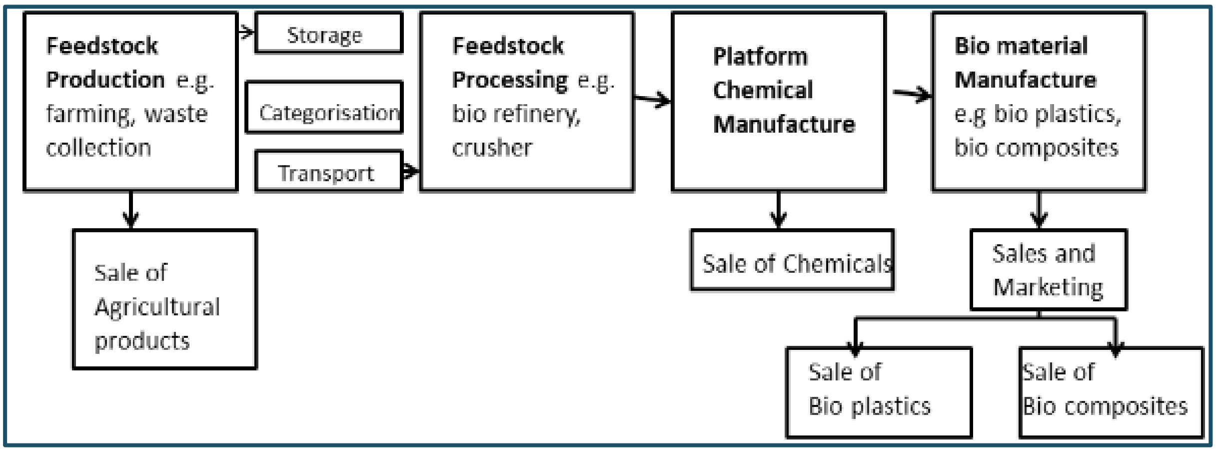
Bioplastics

Bioplastics are just one example of biomaterials. Any biotechnology requires four productive stages, as shown in the simplified biomaterial value chain in Figure 2 below.

The first step is the collection of appropriate feedstock. This could be primary agricultural products (such as sugarcane or maize), agricultural waste (such as bagasse or maize stalks), or other waste (such as municipal wastewater or solid waste). After this feedstock is collected, categorised and stored, it is transported for processing. During processing feedstock is broken down to its constituent components. This is the most basic chemical parts such as starch, cellulose and saccharose. Processing can be done in several ways. The most common is the biorefinery approach in which feedstocks are fed into a specialised boiler to extracts their basic components. These basic components are then combined into various platform chemicals. Many of these plant-based (bio) chemicals are chemically identical to petroleum based chemicals and can be “dropped into” existing processes for plastics or related products.[20] These chemicals can be sold or processed to produce a finished product.

[19] See Braude and Montmasson Clair (2019) for a fuller explanation of the legislative and regulatory challenges.
[20] Other chemicals and compounds are not chemically identical but substitutes which cannot be dropped into existing production processes without modification of the production process.

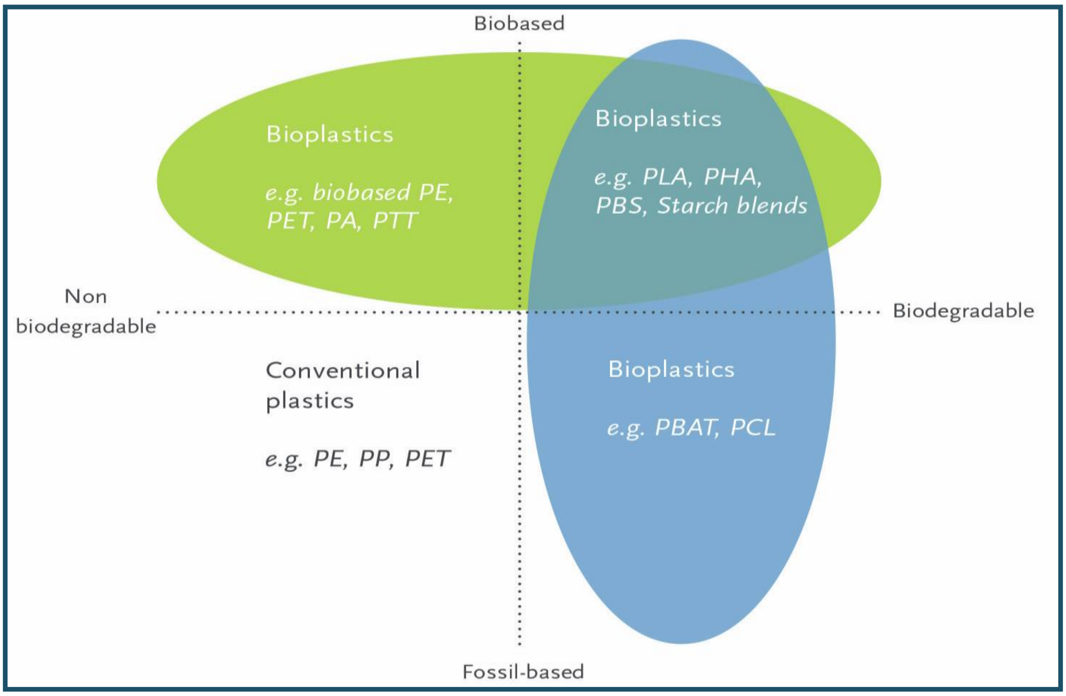
Figure 2: Biomaterials value chain



Source: PAGE (2019)

Bioplastics is a family of products. To understand the different types of bioplastics, a distinction must be made between bio-based plastics and biodegradable plastics. Bio-based simply means the product is wholly or partially derived from plants (biomass). Biodegradation is the chemical process during which microorganisms convert materials into natural substances such as water, carbon dioxide and compost. Biodegradation does not depend on the resource basis of a material but rather its underlying chemical structure. In other words, 100% bio-based plastics may not be biodegradable while 100% fossil-based plastics can biodegrade. Figure 3 illustrates conventional plastics (bottom left quadrant) and the three main categories of bioplastics.

Figure 3: Conventional and bioplastics



Source: European Bioplastics (2020)

The first category of bioplastics are bio-based but non-biodegradable plastics (top left quadrant). Examples are bio-based PE (polyethylene), PP (polypropylene) or PET (polyethylene terephthalate). These bioplastics are known as “drop ins” as they can be dropped into existing production processes without any additional investment and the final product (e.g. a plastic bottle) remains identical to the fossil version, i.e. non-biodegradable. This category of bioplastics allows firms such as Coca Cola to market "plant bottles" which appeal to environmentally conscious consumers without changing the performance and properties of the bottle.

The second category of bioplastics are biodegradable fossil-based plastics (bottom right quadrant). This is a comparatively small market segment and is mainly used in combination with starch or other bioplastics because they improve the application specific performance of the latter by their biodegradability and mechanical properties.

The third bioplastic category includes plastics that are both plant-based (bioplastics) and biodegradable (top right quadrant). These plastics reduce the carbon footprint and GHG emissions of final materials and products by not using fossil resources, and are environmentally friendly in that they are 100% biodegradable and become compost, which can then be used in the agricultural sector. Biodegradable bioplastics reduce the volume of waste going to landfill and are produced using a sustainable and 100% renewable feedstock. The two most common bioplastic biodegradable polymers are PLA and PHA (polyhydroxyalkanoate). PLA is the dominant bioplastic produced globally (see following section) and is mainly used for short-lived products such as packaging (bottles, carrier bags, plastic film) and plastic cutlery. European Bioplastics (2020) identifies this category as a large and innovative area of the plastics industry, not only because of the introduction of new bio-based monomers such as succinic acid, butanediol and propanediol, but because PLA (especially) is striking a new path away from biodegradation towards end of life solutions such as recycling. This would further improve the green credentials of the product by making it a contributor to a circular economy.

The market

Data related to bioplastics is difficult to collect and as such many core data points such as global trade trends and price differentials are not readily available. This makes market analysis difficult to complete. What is known is that currently bioplastics represent just 1% of the 360 million tons of plastics produced annually. Demand is rising steadily, and with new applications and products emerging the market is continually growing (Plastics Europe 2020; European Bioplastics 2020). Current global bioplastic production capacity is only 2.11 million tons (2019). This is expected to increase to 2.43 million tons by 2025. Currently 45% of global bioplastic production takes place in Asia, 25% in Europe, 18% in North America and 12 % in South America. Of the 1.4 billion hectares of arable land available globally, less than 0.79 million hectares are currently used to produce feedstock for bioplastics. This amounts to just 0.02% of global agricultural land.[21]

Plastic packaging is almost exclusively single-use, especially in business-to-consumer applications. As this will be a difficult relationship to change, it is likely that the future will see a determined drive to make these materials from a more sustainable or bio-based process. The challenge of ''end of life" plastic the industry faces is playing an important role in the growth of a preference for bio-based plastics and as PLA is one of the few commercially available bio-based and biodegradable polymers. PLA has four times less GHG emissions compared to other conventional polymers and it has been adopted by many large companies producing plastic-based products to show their commitment towards sustainability and providing them the benefit of having "green credentials". PLA production also requires 30%-50% less fossil fuel than polymers synthesized from hydrocarbons and thus has a relatively positive impact on the environment by reducing global CO2 emissions. While PLA is classified as biodegradable, it is the renewable origin of PLA which is the primary driver of the growth of the material worldwide. Sixty-one percent of current usage of PLA is for packaging.

[21] These figures are important as critics of bioplastics are concerned with the diversion of agricultural land to non-food use and its impact on food production, food prices and food security.

Figure 4: Global production capacities of bioplastics (2019)

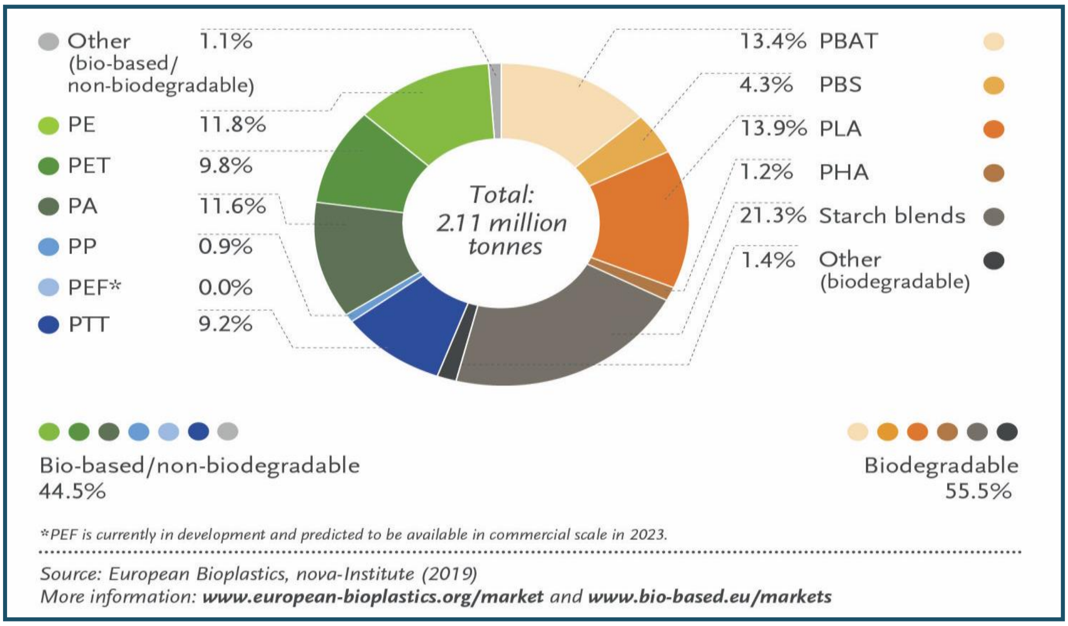


Figure 4 shows that currently the supply of, and demand for, biodegradable bioplastics (55.5%) outweighs bio-based non-biodegradable plastics (44.5%). Of the different types of bio-based, biodegradable plastics, PLA ranks second in terms of installed capacity and is forecast to be the third fastest growing bioplastic after bio polypropylene (not biodegradable) and PHA. PLA plants globally are running at 100% capacity utilisation and industry experts suggest that market demand for PLA is potentially as much as 58 million tons. Given that current global production is a mere 300 000 tons, massive excess demand exists. Other data provided by Sulzer[22] indicates that at a current level of 600 to 900 kilo tons, the global level demand for PLA exceeds twice the volume of material on offer and the estimated current worldwide usage growth rate of 5%-20% per annum is likely to drive the construction of 5-10 new large PLA plants by 2025. No production facility currently exists in Africa, and certainly South African converters verify that accessing PLA inputs on the global market is extremely difficult.

Based on these broad market dynamics of excess demand and limited installed capacity, as well as evolving government regulations which favour the circular economy, sustainable production, movements away from fossil based resources, climate change initiatives to decrease GHGs and more specifically end of life, waste management and single use plastics regulations – demand for bioplastics is seen as a high-growth industry. In Europe it is estimated that bioplastics account for around 23 000 jobs across the EU. This is anticipated to increase tenfold by 2030 with up to 300 000 jobs being created along the value chain in the next 10 years (European Bioplastics, 2020).

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[22] A Swiss company currently leading in PLA plant technology and fluid engineering

PROJECT FOUR: CONTAINERISED SHORT SEA SHIPPING SERVICE

PROJECT SUMMARY SHEET

TITLE	Creating a short sea shipping (SSS) service to increase containerised intra-regional trade between South Africa, Mozambique, Tanzania, Kenya and their hinterlands.
LEAD DEPARTMENT	Department of Trade, Industry and Competition and Department of Transport (DoT).
PROJECT SUMMARY	The project is a strategic intervention to catalyse and facilitate increased intra-regional trade between South Africa, Mozambique, Tanzania, Kenya and the fast-growing hinterlands of Zambia, Uganda, Burundi, South Sudan, Eastern Democratic Republic of Congo (DRC) and Rwanda. The project is based on the idea that port infrastructure in Southern and Eastern Africa performs well against international benchmarks and that shipping offers economies of scale and distance, lower maintenance costs and fewer border delays than road or rail transport. Intra-regional trade of containerised products has been increasing over the past five years and is expected to continue growing as industrialisation, beneficiation and value adding activity increase across Africa. Currently intra-regional containerised shipping along the Eastern coast of Africa is uncompetitive in terms of cost, frequency of port calls, scheduling and volume of cargo. This project is about creating a containerised intra-regional trade market. It is proposed that the governments of South Africa, Mozambique, Tanzania and Kenya establish a jointly owned short sea shipping service. The service would charter a 1 000 twenty-foot equivalent unit (TEU) container ship and run a subsidised service every 12 days along the coast calling at Durban to Maputo, Beira, Dar es Salaam and Mombassa initially.
APPROXIMATE BUDGET	Working capital costs are estimated at R900 million over three years. The sum is to be divided between the four countries equally. Each country would have to invest R75 million per annum for a three-year period.
STAKEHOLDERS	• The governments of South Africa, Mozambique, Tanzania and Kenya. • The Port Authorities and operators in South Africa, Mozambique, Tanzania and Kenya. • A champion with knowledge and contacts in ports and shipping to spearhead the creation of the jointly-owned charter company and service. An appropriate person is on board.
CAPITAL INVESTMENT	None. As the project is based on developing a market which currently does not exist, the most prudent and financially responsible route to supporting the project is to subsidise working capital and avoid the costs of any acquisition of capital or assets. There is currently an oversupply of smaller containerised vessels worldwide and competitive prices for a three-year charter from India or China (inclusive of crew) has been budgeted for.
OUTCOMES	• Increased intra-regional trade volumes • Increased competitiveness of regional products in all markets • Increased opportunity to substitute regional products for currently imported deep harbour products • Increased growth and development of regional economies

Creating a short sea shipping service to increase containerise intra-regional trade between South Africa, Mozambique, Tanzania, Kenya and their hinterlands

Introduction

There is a well-established relationship between trade and economic development. African states through regional integration initiatives such as SADC, East African Community (EAC), Economic Community of West African States (ECOWAS) and more recently the African Continental Free Trade Area (AfCFTA) are committed to leveraging the economic advantages of higher levels of intra-regional trade.

Intra-regional trade across SSA has grown faster since 1990 than at any time in the past 50 years. It has increased from 10% in 1990 to 22% in 2018. Nevertheless these values remain below those of globally successful regional blocs such as the North American Free Trade Agreement (NAFTA) (40%) and the EU (60%). In addition southern, eastern and western African blocs trade predominantly within their own geographic regions and on average trade just 5% of their exports with adjacent regional blocs. In terms of composition of trade: extra-regional exports from SSA remain dominated by primary commodities; however, 42% of intra-regional trade is manufactured goods[23] (Naidoo 2018; PwC 2018). Increasing the intra-regional share of manufactured goods and addressing the trade imbalance between South Africa and regional countries is a priority and one which is supported by (among other initiatives) attempts to increase the operation of regional value chains. Intra-regional value chain growth and development is, and will continue to be, constrained by the weakest link in the chain – transport and logistics.

Teravaninthorn and Raballand 2009; Vilikazi and Paelo 2017; World Bank 2007, 2012, 2016; Havenga 2011; and Lowitt 2018 all find that the key impediment to improved intra-regional trade and value chain creation in SSA is the prohibitively high cost of transportation.

SSA transport is 40% to 100% more expensive per unit than in Southeast Asia (Vilakazi and Paelo 2017) and three to four times greater in landlocked SSA countries than developed countries. Limoa and Venables (2008) calculate that a 10% decrease in transport costs leads to a 25% increase in trade.

While trade liberalisation across SSA has been largely successful it has not been matched by an equivalent reduction in non-tariff barriers (NTBs). SSA countries often use NTBs, especially those at ports and border posts as barriers to protect local markets (especially from the perceived mercantilism of South Africa). These NTBs, poor infrastructure and the trade imbalances[24] in the region are the key reasons driving uncompetitive transport pricing.

General policy consensus suggests that there is little political will across SSA to address these NTBs. Lowitt 2018 and Hartzenberg and Katenga 2015 suggest that future progress in this area may not lie in the linear integration approaches currently adopted by SADC, EAC and ECOWAS, which are based on a governance model that transcends member states sovereignty. Rather it is suggested that

[23] Skewed by exports of South Africa to the rest of SSA.

[24] Most SSA countries import manufactured and consumer goods from South Africa and export raw materials to the rest of the world. As such road traffic, for example, suffers from full loads on the South to North leg of the journey but empty load on the return leg. This basically doubles the transport cost of goods exported from South Africa to SSA as with no backhaul the outward legs goods must carry the complete roundtrip costs.

future progress is more likely to be achieved by an approach which avoids supranational institutions and focuses more on a bottom-up, project by project approach.[25]

The proposed project is one such bottom-up idea and aims to reduce transport costs between SSA countries and thereby increase intra-regional trade through the development of a short sea shipping service along the East coast of Africa. Although a coastal service would link South Africa, Mozambique, Tanzania and Kenya, it would also access the hinterland markets of DRC, Rwanda, Burundi, Zambia, Malawi and South Sudan. The project is not about serving an existing market but about creating a new market for intra-SSA containerised trade. The project is based on two pillars.

The first is shifting appropriate landlocked central, southern and eastern SSA regional trade from road (currently accounting for 90% of transport) to containerised sea transport. Sea transportation is preferred to road transport for a number of reasons including: substantial economies of scale for shipping and ports; lower environmental impact; less infrastructure investment and maintenance[26]; and fewer border posts and delays.

The second is lowering the cost of intra-regional SSA containerised trade to be able to compete with deep sea containerised pricing, thereby improving the competitiveness of intra-regional exports.

Transport costs currently negatively impact competitiveness of SSA country exports within the region compared to deep sea products. This limits the potential to increase intra-regional trade. For example, the farm gate price of soya beans in Zambia is lower than that of Brazil, yet the landed cost of soya in Durban harbour from Brazil is lower than the cost of soya arriving from Zambia because of uncompetitive road transport costs between Zambia and South Africa. As such, South Africa buys its soya from Brazil (Roberts 2017). Similarly South Africa is the only producer of glass in SSA. Glass traders in South Africa produce glass at a lower cost (and better quality) than Indian producers. Despite this, the landed cost of glass from South Africa in Kenya and Tanzania is uncompetitive with the Indian product because a container of glass from India to Dar es Salaam costs only US$800 while a container of glass from Durban to Dar es Salaam costs approximately US$2,400. In these examples Zambia could increase its exports of soya to South Africa[27] and South Africa could increase its exports of glass to Kenya and Tanzania if containerised transport costs across the region were competitive with global shipping routes.

Coastal shipping routes, with small to medium-sized containerised vessels, stopping at multiple regional ports along a multi-country coastline is known as short sea shipping. It is also known as the motorway of the sea as it provides a direct, easy to access and easy to use service. SSS is commonplace and found in the EU along the Western European coastline as well as in South America and the American/Canadian/Mexican east and west coasts.

This project is based on TIPS research conducted on transportation and logistics costs in SSA. It proposes that the governments of South Africa, Mozambique, Tanzania and Kenya establish a jointly-owned short sea shipping service by chartering a 1 000 TEU container ship and running a subsidised service every 12 days along the coast from Durban to Mombassa calling in at Dar es Salaam, Beira and Maputo.[28]

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[25] This does not suggest that formal regional integration institutions and processes are not crucial but makes the point that, given political will, space for specifically negotiated projects and solutions may be more likely to succeed in the short run.

[26] A 1 700 km road needs maintenance along its entire length. A 1 700 km sea voyage requires maintenance only at the port of origin and destination.

[27] Increasingly agricultural and mineral products are being containerised.

[28] Initial route suggestion, other ports can be added.

The jointly-owned company, run as a commercial enterprise, will guarantee a maritime route and schedule and take the risk of poor volume take-up for a period of three to five years, after which it should be viable without subsidy.[29] More importantly, over time, as the trade route develops and becomes more viable new players will be attracted, further reducing prices. At that point, a permanent commercially based company can be formed or an outsourced service can be negotiated with an existing shipping line. It is expected that the idea of an African-owned shipping service would be appealing and could cement intra-regional ties.

The shipping industry and the rise of short sea shipping

Maritime trade accounts for 70% of global trade with 95% of the worldwide fleet of ships owned by just six countries and no more than a dozen large shipping lines. The global shipping industry has always been highly concentrated and over the past few years declining traded volumes have seen increased mergers and acquisitions leading to further consolidation and concentration. At the same time, deep sea liner companies seeking economies of scale and distance have: increased the size of their ships; decreased the number of ports of call; and decreased the frequency of their visits to hub ports. This has created a cascading effect whereby smaller ships and operators enter the market to complement and fill the gaps of the deep sea liners. These smaller operators offer: feeder services for deep sea liner companies[30]; domestic transport along a single country's coast; and regional services where short sea shipping supports intra-regional trade by linking ports across multiple countries in a given region.

The strength of SSS lies in its economies of scale, economies of distance, energy efficiency and (importantly in the Southern and East African context) its low associated infrastructure maintenance cost. In terms of economies of scale and distance in shipping port charges and loading and unloading, charges are unaffected by distance. As such total transport costs per ton per kilometre decrease as a trips distance increases (Konstantinus et al, 2019).

In terms of infrastructure, the advantage of sea transport versus road or rail is that shipping lines enjoy the freedom to navigate the seas and oceans at no cost and with no maintenance required. The only infrastructure and maintenance costs pertain to ports. Carruthers (2013) shows that to build a 300m container berth at a port would cost US$16 million. This is compared to building a road at US$3.5 million per kilometre and US$1.0 million per kilometre of rail. Maintenance per annum costs are: US$1 million per berth for shipping, US$125 000[31] per kilometre for road and US$3 000 per kilometre for rail. As transport infrastructure is a major bottleneck in Southern and Eastern Africa, transport infrastructure expansion at a lower cost than road or rail would be an appealing option.

Maritime ambitions exists in all coastal nations of East and Southern Africa, especially those which service substantial hinterlands (Kenya and Tanzania). In 2010, a continental African Maritime Transport Charter was adopted calling on all African countries to "promote cabotage (the right to offer a transport service in another country) and effective participation of private sector operators at national, regional and continental levels".

[29] The creation of Dubai as a regional air hub is an example of government subsidising a route until sufficient volume accumulates to allow transportation at commercial rates.
[30] Cargo is collected from multiple smaller ports and fed to a hub port where it is collected by the deep sea liner company once a sufficient volume has been amassed.
[31] SSA road maintenance costs exceed those of developed countries due to massive and sustained overloading.

Eastern and Southern African intra-regional trade and shipping

Trade flows in Eastern and Southern Africa are dominated by intercontinental trade. Most Eastern and Southern African countries import manufactured goods from overseas markets in containers while exporting agricultural commodities and raw materials on bulk carriers to deep seaports (especially in China and South East Asia). Intra-regional trade accounts for just 22% of total trade.

Intra-regional trade flows (Table 1) show the substantial imbalance between South Africa and regional players: Mozambique, Kenya and Tanzania. Not only is South Africa a net regional exporter by a substantial magnitude but the values of exports to South Africa include products entering South Africa for transhipment to the Far East and other deep sea destinations. As such the market penetration of Mozambican, Kenyan and Tanzanian products into the South African market are even smaller than suggested by the figures.

Table 1: East and Southern African trade volumes ('000Rands)

TOTAL VALUE OF EXPORTS IN 2019				
	Mozambique	**South Africa**	**Kenya**	**Tanzania**
Mozambique		1,285,878	132,482	4,756,239
South Africa	53,287,041		11,355,813	6,906,048
Kenya	516,982	468,256		4,756,239
Tanzania	125,553	9,794,740	2,922,192	

Source: Trade Map, https://www.trademap.org/stDataSources.aspx (Accessed 2020)

Trends show that East and Southern Africa's trade volumes have been growing at 9% per annum for the past 10 years with transit consignments to landlocked countries growing at 16.5% per annum over the same period (World Bank 2018). Containerised trade in Eastern and Southern Africa has been increasing in line with global trends. This is largely due to a shift from bulk cargo to containerised cargo of sugar, malt, paper, chemicals and cosmetics. Increasingly metals and minerals and more agricultural products are being shifted from bulk carriers to containers. Data from private sector operators suggest that about 5% of all Southern and Eastern regional containerised cargo is destined for intra-regional markets. Growth has been strong. In 1995 containerised intra-regional trade was 1.8 million TEUs. This grew to six million TEUs in 2011 – a 230% increase (albeit off a low base). As industrialisation, beneficiation and value addition grows in the region so will demand for containerised transport on an intra-regional basis.

A requirement for such demand, however, requires cost competitive containerised shipping. Currently the containerised cost of imports entering the region from Southeast Asia, the EU, the US and South America are between 1.5 and 3.5 times more expensive than containerised prices in developed countries (PwC 2018). This is due to low volumes, some of the highest port charges in the world and the fact that 80% of containers leaving Southern and Eastern Africa on their return legs are empty (compared to just 30% unloaded TEUs on transpacific routes and 40% unloaded on Asian European routes). These high unloaded return rates mean that roundtrip costs are borne disproportionately by the incoming leg resulting in high containerised costs. It is estimated for example that one third of the cost of a bag of fertiliser in the Malawian market is due to shipping costs alone (World Bank 2018).

Over and above inflated containerised import prices – intra-regional containerised costs are even higher than those on intercontinental shipping routes. A TEU container from China to Dar es Salaam costs on average US$850 to US$950 and as little as US$700 to US$800 dollars from Mumbai to Dar-es-Salam. An equivalent container from Durban to Dar es Salaam would cost between US$2 200 and US$2 400 dollars; while a short haul container from Mombassa to Dar es Salaam costs between US$1 700 and US1 950 dollars. With such price differentials, intra-regional trade will consistently be unable to compete with products from China, India and the rest of Southeast Asia. A similar trend is found for South America (Roberts 2017; Lowitt 2018).

In addition to the lack of price competitiveness of intra-regional containerised shipping several other inhibitors exist. These include: infrequent port service; routes which are not routinely scheduled; and intra-regional ship handling and port services which are inferior to those offered to deep sea liners. As such, an exporter seeking to send goods from Mombassa to Durban would have no guaranteed pickup service and hence no definite delivery date, would face unanticipated port side delays at multiple ports, and have to pay shipping costs higher than those from deep water ports on other continents. These barriers all add to the perception and reality that short sea shipping between Eastern and Southern African countries is not feasible as an alternate to rail and/or road.

Status quo

The East and Southern African region is dominated by foreign shipping lines. The market is dominated by Maersk, MSC, Hamburg Süd, Grindrod, K Line and CMA CGM. There are two ships under the South African flag (Kline and Vuka JV), which are both bulk carriers, and MC5 is a new BEE shipping company but only operates in the oil and gas market. Coastal shipping does not exist a present in SSA or Eastern and Southern Africa due predominantly to insufficient cargo volumes and no economic interest from the large shipping lines (Mabiletsa 2016). What little containerised cargo does move along the coast is serviced by feeder ships servicing deep sea liner hubs (Durban, Mombassa and Port Louis in Mauritius). Feeder ship services are unscheduled, infrequent and uncompetitively priced as deep sea shipping lines create “conferences” whereby they collaborate to supply feeder services to hubs and agree not to compete on price.

Although SSA and Eastern and Southern African transport and logistics are characterised by low levels of infrastructure, surprisingly the region’s ports are relatively strong performers compared to equivalent performance on road and rail. Figure 2 highlights a range of important indicators of port performance.

Table 2: Performance indicators of ports 2015

	MOMBASSA	DAR ES SALAAM	SOUTHERN AFRICA	GLOBAL BEST PRACTICE
Container dwell time (days)	5	7	4-8	<7
Truck processing time	5	5	2-12	1
Containers per crane per hour	10	20	8-22	20-30
Container handling charge US $/TEU	68	275	110-243	80-150
General Cargo handling US$/ton	7	14	11-15	7-9

Source: World Bank, 2018

All main ports on the Southern-Eastern coast of Africa have seen increases in container traffic and have invested in upgrading infrastructure to handle increased TEU traffic. The table below shows strong growth in TEU throughput, a trend which is expected to continue and accelerate.

Table 3: Containers per annum (‘000) and Compound Annual Growth Rate (CAGR) (%)

	2012	2013	2014	2015	2016	CAGR 2012-2016
Mombassa	903	894	1012	1076	1091	4.84%
Dar es Salaam	562	601	665	659	622	5.43%
Nacala	65	83	97	79	71	2.2%
Beira	171	185	207	211	197	7.39%
Maputo	88	111	125	123	97	11.82%
East London	52	44	42	66	72	8.28%
Durban	2568	2633	2664	2770	2620	0.5%

Source: World Bank, 2018

An important point to mention is that while Eastern and Southern African port infrastructure stands up well to international comparison, SSS still needs to compete with the door-to-door service offered by road. This means that intermodal transfer of containers from ships to rail and road will be required to be upgraded and that road and rail services will need to improve in reliability and cost. This could be achieved by breaking the road and rail infrastructure challenges facing SSA countries into smaller pieces and dealing with containerised movement from SSS as a demonstration model of how broader increased efficiency and effectiveness can be achieved.

Making markets

In 2005 the EU declared that SSS was the only freight mode that could offer realistic prospects of a substantial modal shift away from road, as well as improve competitiveness and reduce environmental damage.

Table 4: European Union advantages, disadvantages and goals of SSS

Advantages
Sustainability: efficient and environmentally friendly transport mode
Cost effective: to shift long distance traffic off roads
Flexibility: increase in volume does not require infrastructure improvement
Attracts freight from other modes
Stimulates additional shipping
Reduces pressure on other modes
Disadvantages
Lower frequency than road and rail
Lower reliability: departure and arrival times
Quality and safety: higher risk of damage to goods
Complicated logistics to ensure integration for door to door service
Efficiency of ports, port services and hinterland connections need to be strengthened
Goals
Reduce costs and times of nodes
Standardise cargo
Improved integration of shipping into door to door service
To be both substitute and complement of other transport modes

Source: EU Commission, 2005

The report found that no matter how desirable SSS was as a means of getting cargo off roads, it "would not develop by itself" and required government assistance. The EU set up the Marco Polo programme[32] to develop this new substitute and complementary transport mode. A wide variety of support was offered including: start up aid for maritime operators; awarding of routes to experienced operators through specific criteria; trade facilitation support at ports in relation to e-documentation and one stop administrative stops; aid and support to upgrade ports and port services; and "a host of support for private modal shift actions and catalytic actions", to move cargo off Europe's roads.

In a 2011 study looking at the Maritime Transport Sector undertaken on behalf of DoT it was recommended that South Africa consider developing a coastal shipping service and that such a goal be formalised in an appropriate maritime policy.[33] In order for such a service to be created the study recommended that "SSS be assured of tariff and port facilities that will support the industry to

[32] Supported by four additional programmes in later years.

[33] The report dealt only with SSS along South African coastline but given that the authors raise the issue of low cargo volumes it makes sense that their recommendations would apply equally to a system that extends beyond the countries' borders and which supports increased throughput and volume.

develop as an alternative mode of transport ... to a greater extent than in the past (NDoT, 2011). By this the authors meant that a SSS would require: i) concessionary port charges that are lower than deep sea liner charges; ii) prioritised service at ports and for container handling services so as to maintain schedules and instil a perception of reliability to positively compare to road transportation; iii) concessions and startup capital and financial support for SSS operators; and iv) a revision of cabotage restrictions. Interestingly the report suggests that the dispensation proposal "should only apply to ships operating on the coast in which South Africans have a genuine beneficial interest irrespective of ship registration". If the idea was expanded to be a regional initiative instead of a South African initiative, the same support would be required in each participating country and each country would need to have a meaningful financial interest in the SSS. Very rough estimates based on chartering a 1000TEU vessel for three years, operating a service every 12 days and running on north bound volumes of 85% and return volumes of 50% would require approximately R300 million working capital per annum for three years. This amounts to R900 million over three years divided across four nations which would each own an equal share of the service.

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PROJECT FIVE: ALTERNATIVE FUEL

PROJECT SUMMARY SHEET

TITLE	Establishing a co-processing facility at a cement plant as a means to catalyse a broader waste beneficiation industry In South Africa.
LEAD DEPARTMENT	Department of Trade, Industry and Competition. Other Departments: Department of Science and Innovation and Department of Environment, Forestry and Fisheries
PROJECT SUMMARY	To build a co-processing facility at a cement plant. The plant will receive non-hazardous general industrial waste and will process the waste on site (sorting, screening, shredding, drying, grinding, mixing, testing/analysing) into a homogenous alternate fuel which can be used as a substitute for coal in the cement plant's kiln, pre-heating chamber or pre-calciner. The alternate fuel will also be a source of substitute raw materials needed in the production of clinker. Co-processing must comply with the strict end user requirements of the fuel, specifically the fuels calorific content and chemical composition.
APPROXIMATE BUDGET	R30 million to R35 million.
STAKEHOLDERS	• A cement company which will sign an offtake agreement (in principle one has agreed to participate). • An established large waste collection company to provide reliable feedstock (only one existing waste company has experience in RDF (refuse derived fuel) and should be approached). • A co-processing technical operator familiar with the chemical and thermal requirements of cement plants and some knowledge of waste regulations and policies (an individual with relevant skills and connections has been identified through the Association of Cementitious Material Products). • A black industrialist to build and operate the company.
CAPITAL INVESTMENT	• Physical infrastructure, building, utilities, docking station. • Capital equipment: shredders, separators, conveyor belts, grinders, mixers, balers/shapers, trucks, fuel injection system. • Laboratory equipment: services can be in house or can be outsourced.
OUTCOMES	• Job creation: eight to 10 employees at processing plant; 30 to 40 employees at waste collection facility; two or three laboratory jobs; temporary construction jobs and engineering jobs to produce and maintain the feeder system. As all cement plants are located in rural areas adjacent to limestone quarries processing plant jobs will be created in areas where there are currently limited economic opportunities. • Decrease carbon footprint of cement industry and a contribution to the GHG commitments made by the National government, decreased amount of waste being land filled • Most importantly – a strategic intervention to start creating waste value chains that are able to valorise waste and allow beneficiation. The project will be an essential step for the dtic understanding the pricing, market transactions, price differentials, value chain participants, new product and technology development opportunities and the commercialisation thereof. Research suggests that the waste economy's contribution to local GDP is 0.62% at present and that this could rise to 1.5% in 10 years if the growth of the industry is supported, and that 127 000 jobs could be created.

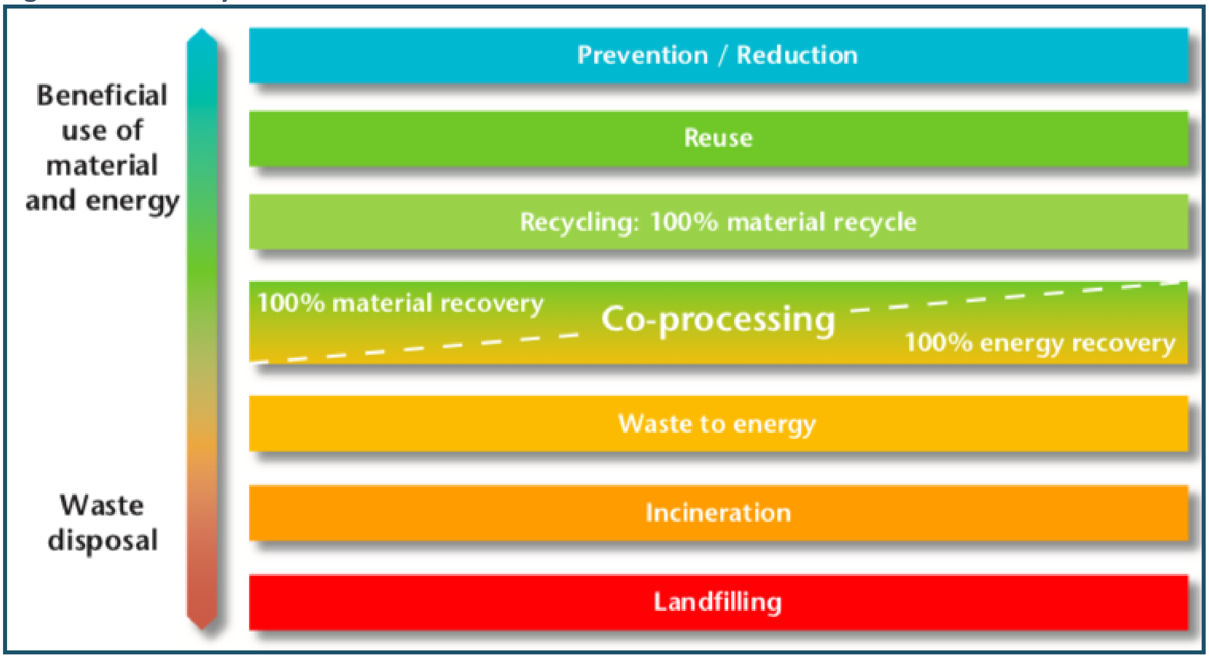
Establishing a co-processing facility at a cement plant as a means to catalyse a broader waste beneficiation industry in South Africa

Introduction

South Africa produced 108 tons of waste in 2017 and 75% of this was landfill. The remaining 25%, which was recycled, reused, reprocessed or co-processed, supported 35 000 formal sector jobs, 60 000 to 90 000 livelihoods for informal waste pickers and a private sector waste economy that has been growing on average at 10% per annum over the past seven years (Waste and Chemical Phakisa, 2019). Discussions and projects to ramp up the move away from landfill in South Africa stall because of the cost differential between landfill cost and the cost of processing waste into a useful format. The Council for Scientific and Industrial Research (CSIR) and DEFF suggest this will change as landfill costs increase in the future either as a result of government policy or due to increased municipal sanitary engineering standards which will increase both the Capex and Opex costs of landfill sites and lead to increased gate prices.[34]

Developed countries have shown that as landfill costs and policy and regulations decrease, the volume of waste which can legally or economically be discarded to landfill increases so the private sector adapts and develops technologies and uses for waste which valorise waste streams. As such, in time the view of waste changes from something which is discarded and is an expense to the producer to something which has value and can be additionally valorised through sale or various beneficiation options and uses.

Figure 1: Hierarchy of waste



Source: IFC, 2017

[34] Most municipal landfill sites in South Africa are in fact technically dump sites where waste is simply disposed of in a designated area. Dumps are not regulated by government and in most countries are illegal. A proper landfill site is regulated by government and is well-researched and specifically engineered to minimise environmental impact and to improve sanitary conditions. So, for example, landfills are situated only at sites with specific geographic and hydro-physical properties, they are lined with a membrane which prevents leeching, they are serviced and managed. Daily operations include controlling what can be disposed of, dealing with rodents, and covering and compacting waste. Most municipalities in South Africa do not have the budget to design and operate a landfill and instead essentially provide dumps.

Viewing waste as a resource is nascent in South Africa. This is essentially driven by low landfill prices (between R100 and R200 a ton in South Africa versus R1 500 to R2 000 a ton in Europe), but more importantly by a lack of knowledge and development of upstream and downstream waste value chain activity. Waste value chain activity is hard to catalyse because of the inherent complexities of waste. The waste market is highly heterogeneous (for example hazardous waste, non-hazardous waste, industrial waste, municipal waste, wet waste, dry waste). Waste is also collected through multiple channels (large formal sector waste management companies, informal pickers, municipal services, sewage works, direct relations between industrial producers and recyclers). Waste transactions occur at multiple points with varying levels of price transparency and competition (for example large waste management companies buy waste from some industrial waste generators but are paid by other waste generators to remove their waste for them; equally there are sales between waste pickers, collection companies, recyclers and downstream processors.) Finally waste in South Africa is highly politicised, especially access to municipal waste, waste ownership and the livelihoods of informal pickers. Local experts interviewed all agree that South African waste value chains and their operations are not well documented, quantified or understood and this undermines any efforts to create commercial enterprises based on waste as a valuable resource.

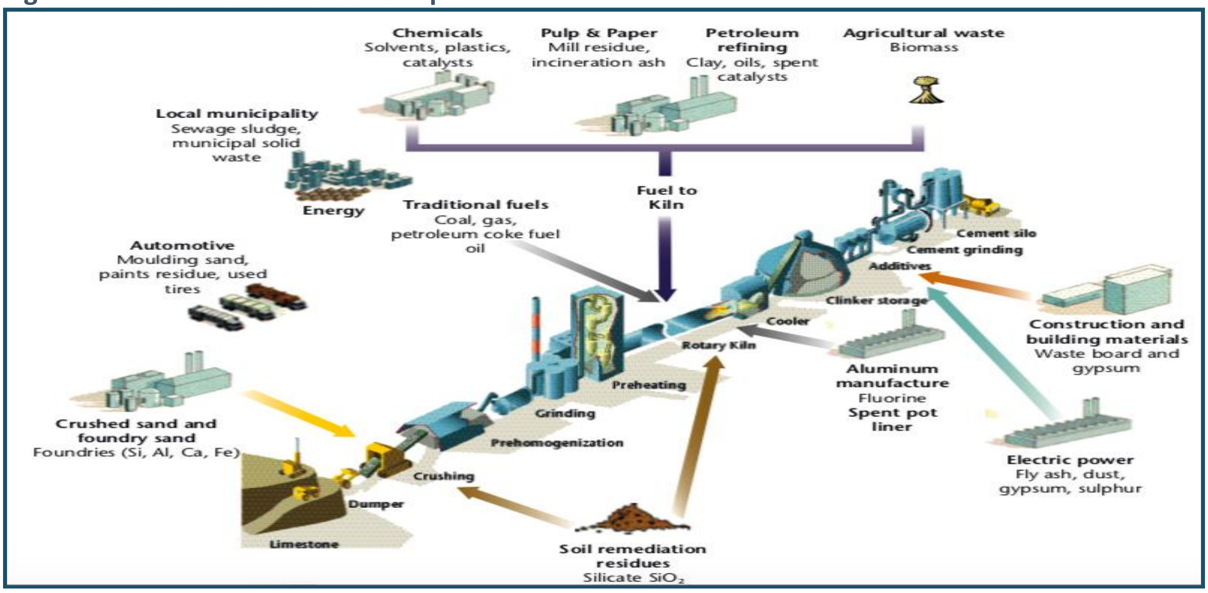
To create a future vibrant waste economy which increases the sector's contribution to GDP and job creation it is necessary for the dtic to become involved in a sector which has traditionally been the purview of environmentalists and waste management experts in DEFF and technology and innovation scientists at the DSI and the CSIR. While the former can provide an enabling regulatory and statutory environment for growth and the, latter, the know-how and technology to support new businesses, processes and products – the dtic alone can bring opportunity and knowledge together in a commercially feasible manner and catalyse a range of new economic beneficiation opportunities for the national economy. Global experience suggests that the knowledge necessary to support the growth of the waste economy comes partly from research and lessons learned from other countries, but more importantly from supporting initiatives in the commercial space and learning from their experience. This project feedback and learning paradigm is the most effective manner by which to support a new collection of economic activities, markets, value chains, prices and enterprises.

This proposal suggests one such project – establishing a co-processing facility at a cement plant to replace coal with an alternate fuel made from general industrial waste. The alternate fuel will provide the cement plant with thermal energy as well as some substitute chemicals to replace virgin raw materials. This opportunity was identified in research undertaken by TIPS in 2020 for the Green Industries Desk which looked at how cement plants can become more climate compatible and reduce their carbon footprint. Through conversations with waste experts the project is slightly repositioned as not only an intervention for the cement industry but as a broader strategic intervention to improve the dtic's understanding and development of general industrial waste value chains so as to support the future growth of the waste sector as a contributor to GDP and job creation.

The cement industry

To make cement, limestone and other minerals are quarried and crushed. Other minerals are added to this crushed stone and ground into a raw meal. This raw meal is pre-heated and then fed into a large rotary kiln where the raw meal is heated to 2 000 degrees centigrade through the burning of coal or coke. As the crushed meal moves through the kiln, some chemical elements are driven off in the form of gasses and the remaining elements combine in a process called calcination to form clinker. Clinker emerges from the kiln in the form of grey marbles where it is rapidly cooled, gypsum is added and it is finely ground into a powder known as cement. Cement is mixed with sand, water and stone to form concrete, which is the second most consumed product in the world after water and the most consumed man-made product in the world. Unfortunately during the calcining process the cement manufacturing process gives off very high levels of process CO_2 which are greenhouse gasses and contribute to global warming. In 2016 South Africa's six cement companies produced around 18 million tons of cement. Every ton of cement creates 0.87 tons of CO_2 and local industry alone contributed more than 1% of the total country's GHGs. Through the implementation of the Carbon Tax in 2020 and a commitment made by the industry to reduce its carbon footprint, local firms have been looking at ways to decarbonise the industry. The TIPS Report considered all the possible options available to the industry using best available technology and global best practice to decrease its carbon footprint. One such option is for cement kilns to burn alternate fuels instead of fossil fuels. International literature shows that alternative fuel usage can decrease carbon emissions from the industry by 40% of the total decrease required in the two degree climate change scenario (WWF, 2017; Leanne and Preston 2018; Zero Carbon Australia, 2017). The substitution rate of alternative fuels for fossil fuels in cement plants differs across the world depending on environmental policies and the availability and cost of waste. Substitution rates in Germany are 65%, 60% in Belgium, 45% in Sweden and Poland, 30% in France, 20% in the UK, 15% in Japan and just 8% in Brazil (IFC, 2017). Eighty-eight percent of South African cement plant energy is provided by burning coal (Vosloo and Mathews, 2017). Currently alternate fuel is not used in the local cement industry except in two plants where very small quantities of tyres were burned when DEFF paid the plant to dispose of them.[35]

Figure 2: Use of waste at a cement plant



Source: WWF (2017)

Alternate fuels in the cement industry

Chemically and technically almost all types of waste can be used to generate some thermal energy which is measured by the waste's calorific value when burned. So, for example, a ton of coal generates 29 gigajoules (gj) of energy while used tyres generate 36 GJ/t and biomass on average just 17 gJ/t. Moisture content impacts calorific value and most waste streams are dried to minimise moisture content before being processed or burned. The most typically classified waste streams are: hazardous waste; general industrial waste; municipal solid waste; municipal sewage sludge; biomass; and unclassified other wastes (which is usually a category dominated by used tyres). Non-hazardous general industrial waste and tyres are the most valuable and viable waste streams for cement firms

[35] DEFF has subsequently changed its policy and no longer pays firms to dispose of used tyres.

to consider as sources of alternative fuels. The main local industries producing non-hazardous industrial waste are: wood and furniture; paper and cardboard; metallic equipment; automotive; food; rubber and plastics; electrical and electronic equipment; and the footwear and textile sectors (IFC 2017).

Table 1: Non Hazardous Industrial general waste in South Africa 2011

WASTE STREAM	VOLUME (Million Tons per annum	RECYCLING RATE (%)	AVERAGE CALCULATED VALUE[1] (Rand per Ton)
Paper	1.7	57	744
Plastic	1.3	18	3119
Glass	0.9	32	490
Metals	3.1	80	2270
Tyres	0.64	4	367
Oil	0.12	44	2777

Source: DST (2014) [1] For methodology of calculated prices see DST, 2014. Average prices quoted in the table hide large price diversity within a given waste stream, for example plastics waste prices vary from R1 900 to R4 000 depending on the type of plastic.

The attraction of general industrial waste and tyres is that they are available in large and usually predictable quantities, security of supply is high, ownership is clear and the quality of the waste is good and relatively reliable. This is crucial because cement plants have very specific requirements concerning the chemical composition and calorific value of any alternative fuel they introduce into their manufacturing process. Calorific value of the fuel will determine whether it will be used to fuel the main flame burner in the rotary kiln, the pre-calciner or just the pre-combustion chamber. This will impact the amount of coal burned at the plant and its carbon footprint.

Besides calorific value, the chemical composition of the waste is crucially important as resource recovery of raw materials occurs when wastes are burned. As explained, a homogenised raw meal of inputs is heated in the manufacturing of cement and the composition of this raw meal is carefully controlled as it determines the chemical composition of the final cement product produced and hence its performance characteristics and quality. This is crucial as poor quality cement can cause concrete to fail and buildings to collapse. When waste is burnt in a kiln, chemical compounds from the waste are released and bind with the compounds in the raw meal thus becoming part of the final chemical composition of the cement. As such, if an alternate fuel is going to be utilised in the kiln the initial raw meal mix must be changed to accommodate and allow for the chemicals which will be released during the burning of waste. Similarly the chemical composition of the waste has to be consistent so that the final cement product meets chemical composition specifications and quality standards. The chemicals most often sought and recovered are: alumina, silica, calcium and iron.

Using waste as an alternative fuel and simultaneously as a source of recovered raw materials is known as co-processing. Co-processing valorises waste in two ways: as a substitute for coal as a source of energy; and as a substitute for certain chemical virgin raw materials. The aim of co-processing is to produce a specifically engineered alternative fuel with a uniform source of chemical materials and a constant thermal output which meets the specifications of the cement plant. Co-processing requires sorting, primary and secondary shredding, grinding and ultimately blending. Laboratory services to deal with chemical composition and testing are required at the sorting and blending stage.

Activities and facilities required to establish a cement co-processing plant

A co-processing plant must have a specific site set aside for receiving and sorting waste. Global best practice suggests that all waste for co-processing should be traceable. The site and facility must have a waste treatment permit and should have environmental and quality management systems which comply with local regulations and ensure the health and safety of workers. Once sorting is completed, waste materials need to be screened and analysed at a dedicated testing station which will determine levels of moisture, calorific value, chlorine, alkali and sulphur content, metals (and especially non-volatile heavy metals) and ash content. This analysis can be completed on-site or in a suitably qualified and accredited laboratory offsite.

Once the chemical and thermal parameters of the waste have been established, waste is sent to a shredding line. The degree of shredding and the final size of the shredded waste will be determined by where in the manufacturing process the alternative fuel will be burned. If the fuel is to be used in the pre-calciner, pieces of 50mm to 80mm are required, which can usually be achieved with only a single shredding. Waste passes along a conveyer belt and is shredded by passing through large rotating blades. A separator then differentiates between large and small pieces and pieces which have not been reduced to the required sized are re-circulated for a second pass through the blades. Once shredded, the waste moves through a magnetic separator. If the fuel is to be burned in the main kiln, the waste needs to be more finely ground to pieces between 20mm and 35mm big. This requires a second shredding process.

Once the fuel is of a uniform and appropriate size it may pass through a drying phase (if necessary) and then move along the facility to the inline mixing station. Mixing is crucially important to ensure uniformity of calorific value and chemical composition that conforms to the specifications of the end user. Once a homogenised product has been created, it needs to be stored until required at the cement plant. Usually a shed or silo is sufficient for storage. When required the co-processing firm will need to load the homogenised waste into suitable trucks for delivery to the cement plant. The cement plant will need to be engineered to accept and introduce the fuel into their manufacturing process. A docking station will need to be erected to take delivery of the processed waste. From the truck the waste will need to be transported to the burning location via a mechanical conveyor. At the end of the conveyor a pneumatic feeding system will need to be installed to allow feeding through a rotary valve and closing system.

To set up a co-processing plant will require i) acquisition of or access to a suitable site at or near a cement plant; and ii) civil works and utilities installation for physical infrastructure such as buildings to house the receiving station, sorting station, shredder, laboratory (if in-house), drying shed (if necessary), storage facility and docking station for delivery of processed waste. The physical infrastructure portion of a co-processing plant is a small portion of the overall project and requires basic construction materials and building techniques. For some portions, a simple metal shed will suffice. Capital equipment is the largest component in the setup cost of a co-processing facility. Depending on the use of the waste and where in the cement process it is added, one or two shredders will be required. Drying equipment may be necessary depending on the composition and source of the waste. Conveyor belts, separators and mixing equipment and balers or shapers will be required, and a fleet of trucks to move the waste from storage to the cement plant will need to be acquired. All of this capital equipment exists in the current market and overseas sourced capital equipment may need to be retrofitted or adjusted to take into account local differences and requirements. Delivery systems into a specific kiln at a specific cement plant will need to be locally produced according to site specific specifications and requirements but such engineering capacity exists in the domestic market.

If waste analysis is to be done in-house at the co-processing facility, a laboratory will need to be built and equipped. Necessary equipment for such analysis exists in the overseas market and would need to be imported.

Physical infrastructure construction and capital costs obviously depend on the size and scale of the plant and the tonnage of waste to be processed per hour. The International Finance Corporation (IFC) categorises plants with a throughput of less than five tons an hour as small facilities and plants processing more than five tons an hour as large facilities. It estimated in 2017 in Europe the capital and physical infrastructure costs for a small plant would be approximately €2 million and a large facility up to €5 million. Based on European costs of labour, electricity, waste and given health and safety requirements it estimates operational expenditure at a small plant to be approximately €40 per ton compared to €75 Euros per ton for a large facility. South African stakeholders interested in such a facility broadly anticipate an establishment cost of R30 million to R38 million for a small facility located on the premises of a cement plant. This is roughly in line with international estimates.

Key success criteria

The Cement Sustainability Initiative (CSI), which is part of the World Economic Forum's World Business Council on Sustainable Development and the IFC are both committed to providing inputs which assist the cement industry globally to decrease its carbon footprint. Co-processing is seen as one important contributor to greening the industry and to this end both organisations have researched key success factors of co-processing facilities around the world.

Not all cement firms are equal in terms of their process and their capital equipment. As such their ability to substitute co-processed waste for fossil fuels will differ. A precondition for a co-processing project is an analysis and understanding of a cement plant's kiln and its operating parameters.

A second requirement is good knowledge of various local waste streams, their availability, through what channels they can be accessed, and at what price. All research suggests that selection of waste should not be made by the cement company as they are not experts in the field. Rather it is suggested that the cement company should partner with a player from the waste industry, rather than the cement company attempting to develop its own supply chain.

Third, and crucially, control of the waste treatment process is critical to the quality and regularity of the product produced as an output of the co-processing facility. The operator of the facility must manage its operations and outputs with a strong knowledge of the operations and constraints of cement kilns. To strengthen the quality of the output the cement company must develop knowledge and procedures to check the input received from the co-processor. The CSI note that the quality of the dialogue between the operator of the co-processing facility and the cement company as the final user of the processed waste is one of the most important keys to the success of such a facility.

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PROJECT SIX: FURFURAL AND FURFURYL ALCOHOL PLANT (BIOCHEMICALS)

PROJECT SUMMARY SHEET

TITLE	Commercial-scale production of furfural and furfural alcohol from sugarcane bagasse for the local foundry industry and broader export market
LEAD DEPARTMENT	Department of Trade, Industry and Competition.
PROJECT SUMMARY	The project is to construct a new 20 000 ton furfural and furfural alcohol plant which would be integrated into an existing sugar mill in the Nkomazi district in Mpumalanga. Raw materials and services would be transferred between the sugar mill and the furfural plant. A separate plant using utilities (steam and electricity) provided by the sugar mill will convert the furfural into furfuryl alcohol. Furfuryl alcohol is used in the production of resins mainly for large steel castings in the foundry industry. The location of the Mill on the Maputo corridor also provides a strategic export benefit along with being able to supply local South African foundries.
APPROXIMATE BUDGET	R675 million (initial estimate)
STAKEHOLDERS	• Private cane farmers that operate the farms and maintain steady cane supply who may participate through an investment offering. • Community members who participate in the industry through their shareholding in the agricultural joint ventures supplying sugar cane to the mill if their JV agrees to an equity share of the new business. • South African Sugar Research Institute, which assists and provides ongoing support in terms of appropriate seed cultivar, crop density and other agronomic and cultivation parameters for the region. • International firm (potentially identified) which will sign an offtake agreement; • Local and international engineering and construction companies to execute the building of the production plant. • Logistics company to facilitate export of the product via Maputo or alternatively a suitable harbour in KwaZulu-Natal. • Local agro-processing company (identified) with Good Manufacturing Practice accreditation to undertake the plant operation.
CAPITAL INVESTMENT	• Physical infrastructure of the complete production facility integrated with the sugar mill. This includes *inter alia* upgrades of the existing boilers to improve efficiency, hydrogen generation, upgraded effluent treatment and tank storage. • Capital equipment will be for the processing plant.
OUTCOMES	• Job creation: Main job creation is at the farm and this project will secure existing jobs in rural Mpumulanga. If additional cane is planted new jobs will be created. Mill and auxiliary services and the support service will also increase employment. • New export product and export revenue stream. Product to be sold locally but mainly to US and European market. • A strategic intervention to bolster the country's efforts to become a green economy and be the leader in Africa in green chemicals. • May assist in decreasing input costs to foundries of resins for sand moulds which currently decreases their competitiveness vis-a-vis BRICS (Brazil, Russian, India, China and south Africa) competitors and allows increased import penetration in castings.

Commercial scale production of furfural and furfural alcohol from sugarcane bagasse for the local Foundry Industry and broader export market

Introduction

The sugar industry plays an important role in South Africa due to its labour intensity and the rural location of the industry. The sugar growing and milling industry, which creates 92 000 jobs, supports nodes of rural economic development and opportunity mainly in Mpumalanga and KwaZulu-Natal. Industry experts suggest that these jobs and nodes of economic development are at risk due to the oversupply of sugar cane in the domestic market. Excess supply of domestic sugar is sold on the world market at prices which currently barely cover production costs. In response, the local sugar industry is investigating how to diversify its revenue streams to maintain profitability and current employment levels.

The new sugar industry business model is a triple stream model made up of: sales of sugar; co-generated electricity; and biofuel/biochemical production. The traditional sugar mill in these instances has evolved into a bio refinery, with revenue from the streams cushioning producers from the vagaries of the sugar market. A bio refinery is any facility that integrates biomass conversion processes and equipment to produce fuels, power and value added chemicals. Interest in bio refineries is growing as producers increasingly seek environmentally friendly chemicals manufactured from renewable resources as substitutes for fossil-based chemicals. This demand is driven by consumer demand, social expectation and more immediately increasing government regulation and intervention related to climate change and end-of-life product legislation. The biochemical industry is growing rapidly and such growth is expected to increase and accelerate.

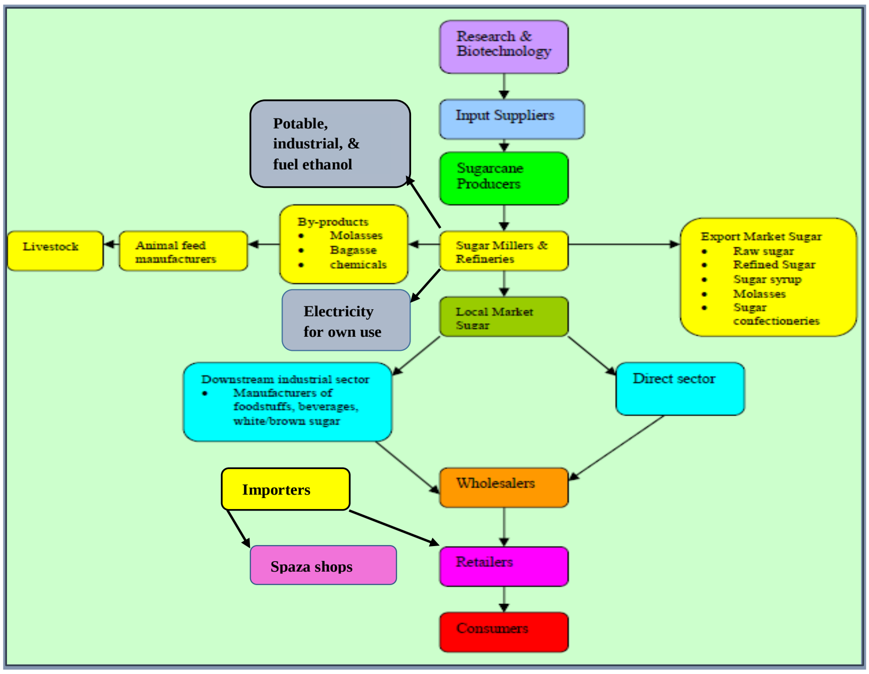
The waste product left over after sugar production is called bagasse. It is currently used to fire the boilers of sugar mills, making them energy self-sufficient. It is possible that this bagasse can be diverted on its way to the boilers and a chemical called furfural extracted from it before it is returned to the boilers for fuel (explained in more detail below). Furfural and furfuryl alcohol have multiple uses including providing an input substitute for high growth fabrics such as Spandex and as a basis for resins used in sand moulds in the foundry industry. This latter use is of particular interest as research in 2019 (Braude and Montmasson-Clair 2019) showed that high sand and resin input prices were a major explanatory variable in the lack of competitiveness of South African foundries in comparison to the BRIC's countries whose cheap imports are penetrating the domestic market and resulting in foundry closures and job losses.

This proposal, based on research conducted on behalf of the dti by TIPS on the sugar value chain, a report on the biomaterials sector for dti, DST and DEAT (Braude and Montmasson-Clair, 2019) and a report for the dti covering the international competitiveness of the South African Foundry Industry. As such the project potentially ticks three boxes: it aides the sustainability of the sugar sector; it potentially increases the competitiveness of the foundry industry and supports job retention in that sector; and it positions South Africa favourably in terms of moving into the biochemicals and green economy space and its potential high growth markets.

The sugar value chain

Figure 1 shows the multiple uses of sugar cane and its numerous by- products. Sugar cane is cut and harvested and transported to the mill. At the mill, cane juice is extracted, purified, filtered and then crystallised into raw sugar. Raw sugar is known to consumers as brown sugar. Raw sugar can be further refined and made into refined sugar known as white sugar or table sugar. White and brown sugars are then packaged either for direct consumption through the retail market or for indirect consumption through the industrial food and beverage market (jam, cool drinks, chocolates).

Figure 1: Sugar value chain



Source: Braude and Montmasson-Clair 2019

The three most important by products of sugar cane and sugar processing are: molasses, bagasse, and biochemicals. Molasses is the syrup from the final stage of crystallisation. It is mainly sold for animal feed and fertiliser. This use is well developed in South Africa. Bagasse is the dry pulp that remains after sugar cane is crushed and the juice extracted. It is a biowaste and can be used as a substitute for coal or oil in mill boilers. This opportunity is also well developed in South Africa and all mills are self-sufficient in terms of electricity. Finally sugar cane can be used as the basis for a range of biochemicals of which bioplastics is a particular example.

Furfural and furfuryl alcohol are particularly interesting biochemicals from an economic and commercial perspective as they are derived using bagasse (a waste product) as a feedstock. This means that production costs are extremely low within a sugar mill and allows the South African industry to potentially compete successfully again Chinese furfural and furfuryl alcohol which has a higher cost structure.

Furfural and furfuryl alcohol production

As part of the sugar production process the sugar mill generates a residual waste product from the sugar cane called bagasse. This is a fibrous material remaining after the sugar rich juice has been extracted. Some of this material is blended into animal feed, while the bulk of it is burned in the sugar mill boilers to produce energy for the mill. In the proposed project, the chemical constituents of the bagasse will be extracted and converted into furfural before returning a combustible residue to the sugar mill. As the furfural can be extracted and the bagasse returned for combustion with little energy depletion the marginal cost of producing the biochemical from the sugar mills perspective is virtually zero.

This understanding of the dynamics and economics of furfural production is important in determining the scale of the market opportunity. With the exception of one small plant in Austria, where furfural is produced in the process of cleaning up the effluent stream from a dissolving pulp mill, all other furfural is produced from agricultural residues, mainly corncobs. All Chinese furfural plants use corncobs as their raw material. There are currently two operating furfural plants, one in the Dominican Republic and one at Sezela in South Africa, which are attached to sugar mills and which use bagasse as their raw material. While agricultural residues are relatively inexpensive, the yield of furfural from these residues is very low. It takes 12 tonnes of corncobs to produce one tonne of furfural and about 34 tonnes of bagasse to produce one tonne of furfural. The critical issue is that furfural plants in China that use corncobs have to purchase them from local corn farmers. Market forces push corncob prices in China up to around US$120 per tonne in times of high demand, but because farmers have an alternative use for these corncobs as domestic heating during winter or as a natural mulch on their fields, corncob prices never fall below the effective coal equivalent price. When the cost of gathering these corncobs and transporting them to the nearest furfural plant are included, the raw material cost to these plants rarely falls below US$60 per tonne. Thus, the corncob cost alone contributes at least around a minimum of US$720 per tonne to the cost of the production of furfural.

In contrast, if bagasse that is en route to the sugar mill boilers to be burned as fuel to power the mill is diverted to a furfural plant for processing before being replaced by the residue from the same furfural plant at a very similar energy value, it can be said that the marginal furfural raw material cost to the sugar mill is very low or approaching zero. Then, although it takes 34 tonnes of this bagasse to produce 1 tonne of furfural, the raw material cost remains very low. It is important to note that once furfural is produced from bagasse, the residue from the furfural plant retains 95% of the energy value of the original bagasse. However, a furfural plant itself needs steam and the fuel cost to generate this additional steam needs to be factored into the cost of production. This gives furfural plants attached to a sugar mill, and operated as part of the overall sugar mill, an operating cost advantage with which Chinese furfural plants using corncobs cannot compete.

Uses of furfuryl in the foundry and textile industry

Although both furfural and furfuryl alcohol are flammable industrial chemicals, they are essentially environmentally friendly chemicals manufactured from renewable resources and leave no harmful residues when they decay. A wide range of chemicals are currently produced from oil that could equally well be produced using furfural as the raw material. As a chemical intermediate, at the current oil price, furfural is not competitive, but should the oil price rise again to around US$100 per tonne, or should consumer pressure for environmentally friendly solutions increase further, furfural could find a whole new range of uses and demand could expand significantly beyond its present level. Two key examples and markets for furfuryl and furfuryl alcohol are the textile industry (and particularly the green fashion industry); and the foundry industry (sand mould castings).

The South African foundry industry is characterised by two types of foundries: smaller, low volume, sand mould foundries which account for 80% of the sectors employment but only 20% of its output; and large, high-volume foundries which use permanent dies and produce 80% of the countries casting output. In a study to determine why small scale foundries were struggling to compete with cheaper imports from China and India, *one* of the explanatory variables related to the input prices faced by small foundries which utilise sand mould techniques.

Table 1 shows the key input costs facing foundries in BRICS nations. South African foundries enjoy the cheapest alloy input costs, and scrap metal costs in South Africa are roughly in line with BRICs competitors. Where South Africa is totally uncompetitive is in relation to plain sand and resin costs. Furfuryl alcohol is used in the production of resins for sand moulds and more importantly furfuryl alcohol based resins allow for sand to be reused after moulding. One of the key reasons why these input costs are so high in South Africa is because of the lack of competition on the supply side. As such increased furfuryl production could increase competition and decrease prices in the domestic resin market and could decrease the demand for plain sand forcing producers to offer more competitive prices.

Table 1: Input costs (US$ per ton)

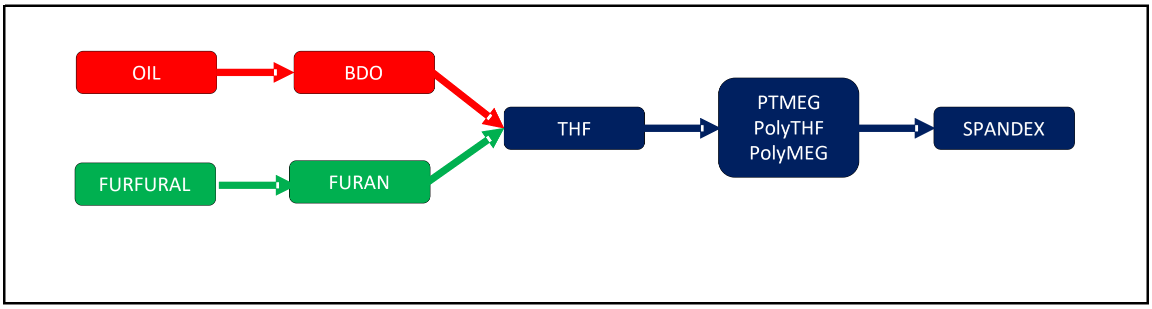
	ALLOYS	SCRAP METAL	PLAIN SAND	RESIN
Brazil	2025	380	20	3350
Russia	2600	370	50	2100
India	1213	462	793	1565
China	1588	543	481	1579
South Africa	1080	481	861	3633

Source: SAIF (2017)

Furfuryl alcohol is the chemical most used in the manufacture of resins, known as furan resins, which are used in foundries. Furan resin manufacturers use furfuryl alcohol to make a wide range of furan resins, all having somewhat different properties when used in foundries. The furfuryl alcohol content of a furan resin can vary from around 10% to as much as 90% but typically averages around 70%. In foundries, molten metal is poured into moulds where it solidifies in the shape required. Most steel castings are made by pouring molten steel into sand moulds. As the size of the casting increases, so does the stress on the mould and, in order to stabilise the sand, furan resins are used for all but very small castings. There are a wide range of resins available on the market, but furan resins have a niche in the market for the manufacture of moulds for larger castings weighing many tonnes. For these castings, the resin used needs to be able to withstand high temperatures and pressures, needs to set in a slow and controlled manner allowing for some manual shaping of moulds, and needs to be stable such that no gas bubbles damage the casting. From an economic point of view, the resin allows the casting to be stripped from the mould and the sand to be reused. This could increase the competitiveness of the domestic industry substantially. Furan resins thus have unique characteristics and are viewed as the superior option to meet the criteria required for the manufacture of moulds for large steel castings such as wind turbine components and ships engine blocks. They have practically no competition in this market.

A second use for plant-based furfuryl is in the textile and fashion industry. The most well-known example of the potential of green biochemicals in fashion is the product Spandex. Spandex is a very popular material which adds an element of stretch to most modern clothing and almost all sportswear. Spandex contains a thread which can be spun from PTMEG, PolyTHF or PolyMEG, depending on whether it is produced by DuPont, BASF or Lyondell, and which gives it its stretchy quality. All three are trade names for a polymer of tetrahydrofuran (THF). THF can in turn be manufactured from either butanediol (BDO) which is oil based or furfural which is plant based. Although almost all Spandex is currently produced using oil-based BDO, the increased momentum and activism in relation to green fashion in developed countries suggests that THF produced using plant-based furan is likely to be a future growth industry.

Figure 2: Plant based versus oil based production of Spandex



Source: Apparel Resources (2020)

As demand for green biochemicals increases so do the applications and opportunities related to products such as furfuryl. For example, in Europe soft woods which have for many years been treated with CCAs (Chrome/copper/arsenic) to prevent moisture and insect attack are now being treated with furfuryl alcohol. Although more expensive, furfuryl alcohol polymerises in the pores of the timber making it suitable for uses traditionally reserved for hard woods such as teak and mahogany. It also eliminates the danger that CCAs pose to people and the environment when timber treated in this way reaches the end of its life cycle.

Market

The total world market for furfural is around 400 000 tonnes per annum. The major use of furfural is for the manufacture of furfuryl alcohol and this consumes some 350 000 tonnes of furfural per annum. The largest direct consumption of furfural is for the refining of base oils. Some 50 000 tonnes per annum is used in this way. The proposed project would supply 20 000 tonnes into the global marketplace. Global reports suggest that the current furfuryl market was valued at US$551 million in 2019. It is expected to grow to US$700 million by 2024, a 4.9% CAGR.

Currently global leading players are: Transfuran Chemicals (Belgium), Central Romana Corporation (Dominican Republic), Pennakem (US), Silvateam (Italy), Illovo Sugar (South Africa), Hongye Holding Group Corporation (China), KRBL (India), Lenzing (Austria), Tanin (Slovenia), and Shandong Crownchem Industries (China). Only the plants in Dominican Republic and South Africa are sugar based and enjoy the cost advantaged explained above.

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PROJECT SEVEN: MOTOCYCLE COMPONENTS

PROJECT SUMMARY SHEET

TITLE	Production of Class A motorcycle components (ONLY) for export to the African assembly and after-sales market.
LEAD DEPARTMENT	Department of Trade, Industry and Competition
PROJECT SUMMARY	The project aims to establish black-owned, local small, medium and micro enterprises (SMMEs) to manufacture component parts for the Class A motorcycle and scooter market. New production facilities will leverage off the capacity and capability of existing automotive component manufacturers. Production should qualify for the Automotive Incentive Scheme (AIS) and earn a Production Incentive (PI) in line with the benefit level applied to light vehicle component production. As production will be for the African export market new production facilities should be situated in a Special Economic Zone (SEZ) to increase commercial viability. The project will create new jobs, increase the value added component manufacturing industry as per the Automotive Master Plan and Re-Imagined Industrial Strategy and more importantly can play a leading role in establishing the first regional automotive value chain. It is proposed that Class A motorcycle assembly activity be undertaken by non-South African countries (probably initially Ghana, Kenya and Nigeria) and that South Africa provide components to these assemblers and the spares distribution network throughout Africa.
APPROXIMATE BUDGET	R40 million to R60 million
STAKEHOLDERS	• Chinese OEM producer with largest African market share; • Small South African automotive component manufacturing firms; • Existing South African stakeholders to assist South African SMMEs through supplier development schemes; • Existing South African stakeholders to assist non-South African assemblers with skills and capacity accumulation as part of the Automotive Master Plan's long-term automotive sector goals[36] and the dtic's commitment to regional value chains.
CAPITAL INVESTMENT	• Physical infrastructure to build factory space in SEZ • Capital production equipment
OUTCOMES	• Job creation: The Automotive Master Plan calls for the doubling of the sector's employment by 2035. This new component manufacturing product line will contribute to that employment goal, especially as production to be SMME based. • Entirely new export product and export revenue stream for South Africa. • Implementation of a regional value chain and opportunity for increased inter-African trade and co-operation. (South Africa: Component manufacture; Other African countries: Class A motorcycle assembly) • A strategic intervention to assist in achieving the aims of the Automotive Master Plan.

[36] It is suggested by industry experts that South Africa would need to support some automotive sector involvement in Africa in order for African countries to change policies on cheap cars from the EU entering their markets and decreasing sales from South Africa. As the African motorcycle market dwarfs that of South Africa, supporting motorcycle assembly outside of South Africa will be a strategic intervention in line with the broader ambitions of South Africa's automotive industry.

Production of Class A motorcycle components (only) for export the African assembly and after-sales market

Introduction

Forty years ago the motorcycle market was a small, niche market in both developed and developing countries. The market was dominated by a handful of OEMs, notably upmarket well-known brands from Japan, Germany and Italy. At that time, some mopeds and motor scooters were used in urban areas, medium-sized Japanese "trail" bikes were used by agricultural extension workers and non-governmental organisation personnel in rural areas, and a small number of powerful motorcycles were used by the police and rich enthusiasts. The market changed in the 1990s when China, India and some other Asian countries (Indonesia, Vietnam, Thailand, Cambodia) began the mass production of medium-sized motorcycles (defined as Class A scooters and motorcycles with an engine capacity lower than 150cc). Creating a mass market and enjoying economies of scale, these new producers brought down entry-level product prices from US$2 000 in 1990 to US$600 in 2010 and current prices as low as US$420 (Starkey 2016; Mtanga and McCamel, 2019).

At these reduced prices, demand for Class A motorcycles in rural and urban areas in Latin America, Africa and Southeast Asia rocketed such that in many developing countries motorcycles are now the dominant mode of transport. Researchers (Olurinola 2010; Starkey and Hine, 2014; Bray and Holyoak 2015; Starkey 2016; Pochet, 2017) show that rural adoption is driven by low volume road infrastructure (tracks and trails) and a lack of public or private transport services due to low population densities and poor access. Urban adoption occurs rapidly, especially where there is a lack of public transport, high levels of congestion, and poor quality road infrastructure. In both urban and rural settings there are two submarkets that characterise the demand for motorcycles: sales for private household usage; and demand for cycles to be used as motorcycle taxis that convey passengers and goods as a transport service business (commercial usage). Across Africa the commercial use of motorcycles dominates private household usage which is very low.

In Africa, the earliest adoption of Class A motorcycles is traced back to the West African nations of Burkina Faso, Benin, Nigeria and Cameroon. Later adoption spread to the East with Uganda, Kenya and Rwanda seeing a substantial rise in the demand for motorcycles around the turn of the century. Interestingly, acceptance and adoption in SSA has failed to achieve critical mass. This is attributed to the role of South Africa and the legacy of apartheid. It is essentially argued that under apartheid the norm was for private car ownership for the white elite and only formally state sanctioned public transport (train and bus and later minibuses) for the black majority. This established "norm" influenced neighbouring countries. Starkey (2016) and the Research for Community Access Partnership (2014) suggest that motorcycle usage behaviour from the north will eventually spread to Southern Africa and that the take-up rate will be rapid, spontaneous and unplanned. They cite as an example the amazing case of Tanzania which had only 2 000 registered motorcycles in 2003 and 800 000 in 2014 (a growth rate of 40 000%). Some South African experts disagree that motorcycle usage will gain momentum in SSA.

In 2019, 89.7% of all motorcycles imported onto the African continent were Class A motorcycles. The majority of these are imported from India or China and arrive as Completely Built Units (CBUs). In the SADC market China has a 49% market share and India a 15% market share. In terms of motorcycle parts China commands 57% of the SADC market and India 7% (TIPS, 2019). Most importing African countries do not have automotive sector capabilities either for the production of components or the assembling of semi knocked down or completely knocked down motorcycle kits. There is, however, a strong desire for the creation of African regional value chains which would support the broadening of African economies' industrial bases and propel economies up the value addition and technology ladders. Assembling Class A motorcycles has been identified as one such opportunity.

Given South Africa's existing capacity and capability in the manufacture of components for light, light commercial, medium and heavy commercial, passenger and sports utility vehicles it has been proposed that South Africa could expand its automotive component manufacturing base to include Class A motorcycle and scooter parts. These components could be exported to African markets which are currently (or interested in establishing) motorcycle assembly industries, and to supply replacement parts in the after sales and service markets in non-assembling countries.

In a Final Recommendations document prepared for the dtic on a Post-2020 Automotive Production and Development Programme (APDP) Automotive Master Plan it is proposed that from 2021 to 2035 motorcycle component manufacturers should qualify for the AIS and earn a PI in line with the benefit level applied to light vehicle component production. The recommendations further argue that no Volume Assembly Localisation Allowance be applied so as NOT to encourage domestic motorcycle assembly (Barnes et al, 2017).

The proposed project is a catalyst for the implementation of such a regional value chain approach and would see new economic activity and job creation in the South African economy while simultaneously supporting value added activity and industrial broadening in other African countries assembling motorcycles. In countries without assembly capacity or ambition, such a project would substitute African manufactured parts for Asian manufactured parts in line with continental and regional approaches to increase inter-African integration, trade and co-operation. As will be shown, the SADC market is likely to be too small to support such a project and a broader continental view (or at a minimum a SADC and East African collaboration) would need to be considered. The proposal is based on research conducted by TIPS in 2017 on the motorcycle industry in Africa as part of the SA-TIED project supported by UNU-Wider.

Urban and rural demand for Class A motorcycles

Research by UN-Habitat, the Partnership on Sustainable, Low Carbon Transport and DIFID (2014), Research for Community Access Partnership (2016), Pochet et al. (2017) and Ehebrecht et al. (2018) all show that most of the world's poor people live in rural areas isolated by distance, terrain, basic or non-existent infrastructure (paths, trails) and no (or limited) access to transport services. This rural isolation is associated with low agricultural productivity (linked to poor market access and usage of fertilisers and modern agricultural technologies), poor health care and low school enrolment. The main way rural people access markets and services is through tracks and trails that connect rural communities to feeder roads which service market towns. Rural communities typically have to walk (sometimes up to a whole day) to reach a feeder road or market town. The research shows that investments in low volume, all-season rural roads (even unsophisticated substitutes for roads such as trails and tracks) supports the creation of rural transport solutions, most notably the use of motorcycle-based taxi services which offer transport of passengers and goods.

Rural transport services are most often provided by informal sector entrepreneurs using buses, trucks, rural taxis (minibuses or estate cars), motorcycles, bicycles, tricycles, animal drawn carts and pack animals. In most countries these "intermediate means of transport" provide most access between villages and market towns. In many rural areas, infrastructure is too poor for conventional transport (trucks, minibuses, buses). Market concentration of potential passengers is too low to make regular transport routes commercially viable. As such the formal private sector and the public sector tend not to service this market. In these cases the research shows that motorcycle taxi services are a good solution to rural transportation access. These taxi services offer door to door service, are highly flexible, can operate on remote and poor quality tracks and difficult terrain and can move passengers and goods either from villages to main feeder roads (where public transport can be accessed) or from villages to market towns. Besides providing a crucial service to rural communities, motorcycle taxis also offer employment opportunities for young men in rural areas. Barriers to entry are low and bikes can be bought or hired from operators (details below).

Improved rural access via increased infrastructure and access to transport services has been shown to increase the usage and decrease the cost of agricultural inputs (especially fertiliser) which has been shown to increase yields, enhance production and increase living standards. Similarly access to rural transport allows greater access to markets and is shown to increase household income and reduce poverty. Evidence from Southeast Asia and some African country studies also support the link that improved basic rural infrastructure and access to transport services improves access to health services and allows community health workers to access more remote rural areas. The literature shows a direct correlation between rural access to transport infrastructure and services and improved health outcomes and healthier rural communities. Similarly improved rural access to transport services improves school enrolment and increases teacher access to rural communities, resulting in improved learner outcomes. As such, motorcycle taxis are on the whole seen as improving the quality of life of rural communities and supporting improved health, educational and livelihood outcomes.

In the urban context, the emergence and use of the motorcycle follows a different logic. Ehebrecht et al. (2018) argues that historically public transport in most African countries was provided by large private companies during the colonial era. In post-colonial times new independent nation states often nationalised these companies and formed state or municipal public transport providers which subsequently gained monopoly status. During the fiscal crises of the 1980s and 1990s, and due to mismanagement, corruption and a lack of ability of the state to continue to provide subsidies, these monopolised state run companies started declining and reducing their service offering. This resulted in un-met demand. Invariably this has led to the rapid growth of non-conventional means of public transport such as shared taxis and vans and more recently motorcycle taxis. These alternative modes of transport provide important complementary services, and in many countries represent the only mobility option for those who would otherwise be excluded from access to public transport.

Pochet et al. (2017) shows that private use of motorcycles in Africa is limited. Motorcycles are seen as an inferior substitute to a car in an urban setting but are still socially selective and preferred to dependence on public transport. The research goes on the show that those who can afford to buy a Class A motorcycle for personal use are relatively limited and includes the upper middle classes, employees in the formal sector and those with public administration jobs, and students with sufficient financial means. Private ownership and usage for personal means is thus a tiny fragment of the market as even with price decreases overtime the cost of a Class A motorcycle is beyond the reach of most lower-class and poor urban residents. Instead the bulk of the motorcycle market in African urban areas is for commercial use – commonly referred to as the motor taxis.

Demand arises both from pull and push factors. On the demand pull side, consumers demand motor taxi rides because of failing public transport supply; traffic congestion which makes travel by motor taxi faster and more convenient than minivan, car or bus; poor road quality which again makes travel by motor taxi faster than by four-wheeled conveyance; and personal choice. With regard to personal choice, in most African countries motor taxis are hailed using a mobile phone and requesting a pickup. This allows flexibility in time and removes the need to wait in line for scheduled public transport or minibus taxis. In addition, motor taxis provide a door to door service which negates the need for walking the first and last mile which most often occurs with public transport. Most people using motor taxis in Africa are: people who are unemployed; people working in the informal economy; and people getting off public transport and needing transport to their final destination. More than half the trips taken by motor taxi in Africa in 2015 were between one km and three km and only one third of trips were more than three km to five km. As such motor taxis are focused on short trips with longer trips being undertaken by more conventional forms of public transport.

There is also a very strong push component to the creation of the motor taxi industry. Operating a motor taxi is an attractive option for unemployed youth who want to establish some form of livelihood. Barriers to entry into the sector tend to be very low. Capital costs are low for a Class A bike, maintenance and running costs are low, there are often no regulations or if there are there is little enforcement of them and motorcycles (and specifically scooters) are easy to drive and require no training or experience. Almost all motor taxi activity is informal sector activity.[37] There are three models in the industry: owner/drivers who own their own cycle and drive it for fares which they keep; driver renters who rent a bike from an owner and pay a rental fee to the owner and then keep a portion of the fares; and the owner/manager who has a small or large fleet of motorcycles and earns a living by hiring a workforce to operate his cycles. In a range of studies it is shown that although working conditions are poor and hours long, riding a motor taxi can provide a subsistence living for the unemployed and in most cases (Ehebrecht et al, 2018) provides an income greater than that which could be earned at a job paying national minimum wage. In Kenya, authorities have argued that the creation of the motor taxi industry has had a positive socioeconomic effect.[38]

Importantly, all the literature points out that motorcycle usage for private and motor taxi use is not without its negative externalities. Motor taxis are often vilified for driver's aggressive driving behaviour, failure to follow the rules of the road, adding to congestion, taking up parking places, increasing air pollution[39] and very importantly increased road accidents and fatalities. In Accra, 72% of all motor taxi passengers reported that they had been involved in a traffic accident on a motor taxi and in 2013 Tanzania documented 1 000 deaths and 6 000 serious injuries related to motor taxis. Due to this, as well as the informal nature of the sector, motor taxis are not seen by most African countries as a long-term solution to urban public transport. Rather they are seen as a short- to medium-term solution which will partially or totally be replaced by mass transit systems developed and implemented by the public sector over time. Researchers show that in Tanzania for example, where 800 000 motor taxis are registered, motor taxis and motorcycles in general are absent in any official transport policy and no consideration of motorcycles is included in any account of either public transport planning or urban or town planning.

The African market

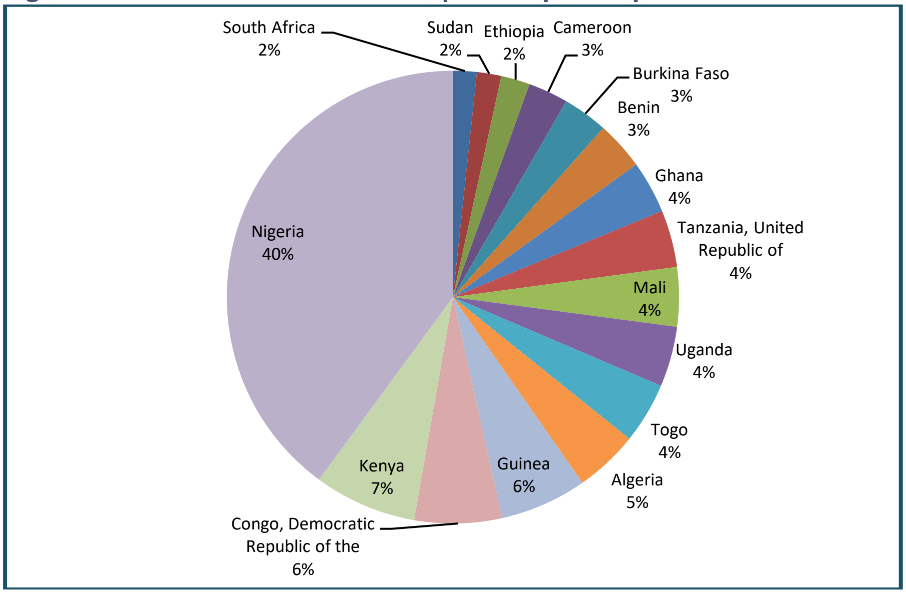
The Class A motorcycle market is dominated by Nigeria, followed by Kenya, Guinea and the DRC. South Africa and SADC countries collectively are small and insignificant sources of demand at present. As there are no continental producers of motorcycles all motorcycles are imported at present.

[37] Rwanda is one of the few African countries which has strongly regulated the motor taxi industry.

[38] Kenya has put in place support systems to encourage the growth of the industry including negotiating with banks to increase access to funding for new operators.

[39] Options regarding electric motorcycles are not considered in this proposal because higher unit prices, limited travel distance and long charging times, and access to recharging points and reliable electricity access make such products poor substitutes for petrol bikes.

Figure 1: African market share of imports Top 15 importers



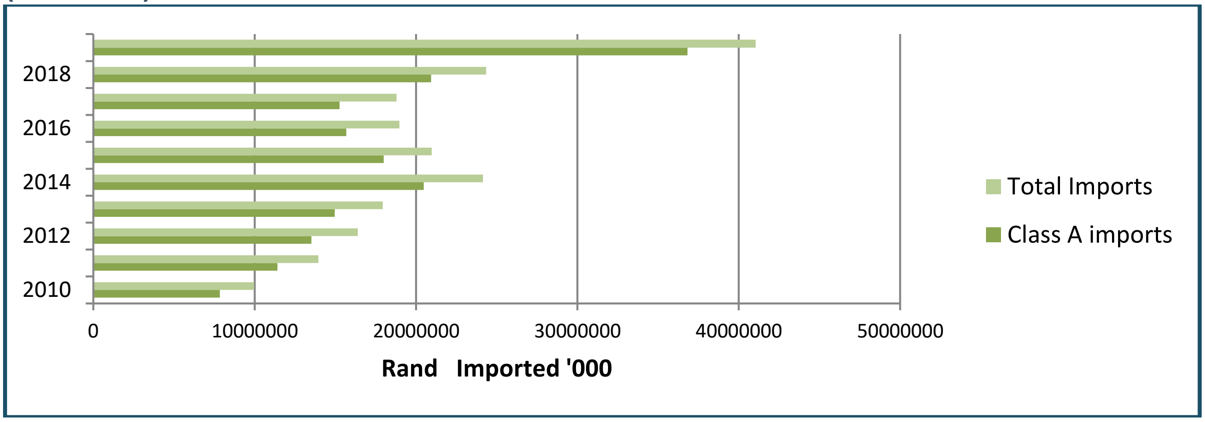
Source: Trade Map, https://www.trademap.org. (Accessed August 2020)

The motorcycle market is divided into four classes. D Class motorcycles are made up of quad bikes which have four wheels. Class C motorcycles are competition and off road bikes. B Class bikes are road bikes between 151cc and 800cc as well as cruisers. Class A are motorcycles with an engine between 0 cc and 150cc.

The Class A market is further broken down into five subcategories based on use: commercial use; agricultural use; personal use; scooters; and speciality motorcycles (kids bikes). The difference between a Class A motorcycle and a Class A scooter is that a scooter is an automatically operated vehicle with a constant velocity transmission and no gears or clutch. An A class motorcycle is a manually operated vehicle and has gears and a clutch. Scooters are thus easier to ride and control, require less experience to operate and tend to be lower maintenance than motorcycles as clutches are not worn out.

As no African country manufactures motorcycles, trends in the market are seen in terms of importation statistics. Figure 2 shows the African continental market is dominated by Class A imports which accounted for 89.7% of all motorcycle imports in 2019. This trend has been maintained as the market size has grown since 2010. In 2019 over R410 million of Class A motorcycles were imported into the African market. The two important trends shown in the Figure are the fact that imports have been growing strongly since 2010 and that the dominance of Class A imports has been maintained since 2010.

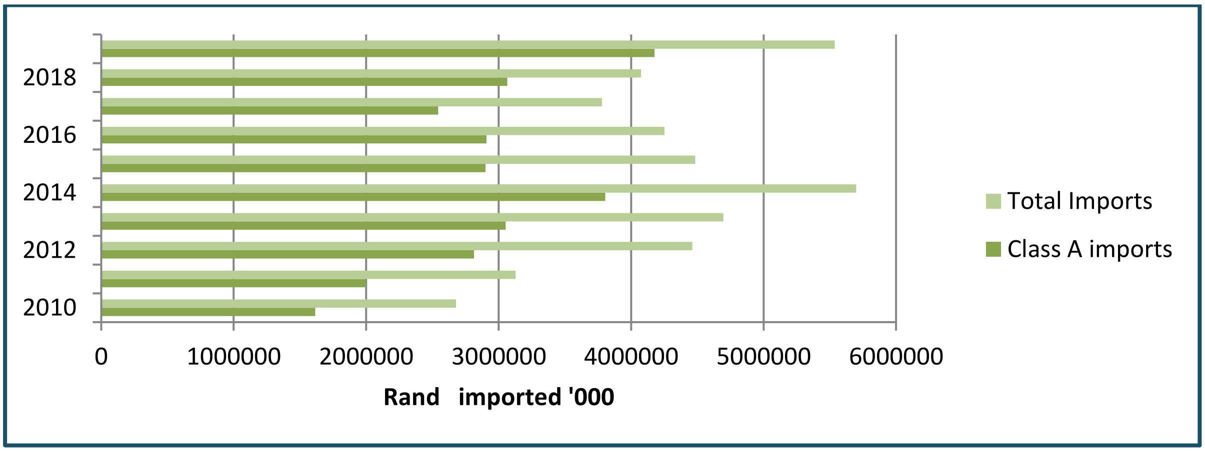
Figure 2: African continental imports of Class A motorcycles and total motorcycle imports (2010-2019) South African Rand



Source: Trade Map, https://www.trademap.org. (Accessed August 2020)

The market for imported Class A motorcycles in SADC in 2019 was approximately R50 million. SADC trends are similar to continental trends where Class A motorcycles dominate imports – but to a lesser extent than at the continental level (75% in 2019). The reason for this lower trend relates to the absence of a large motor taxi industry in South Africa and neighbouring countries and the existence of strong demand for 800cc Class B motorcycles for the wealthy leisure user and a strong demand for quad bikes (Class D) for the tourism industry. Interestingly (and importantly) the percentage of Class A imports to total imports is increasing over time (60% in 2010). This is due mainly to increased demand of Class A cycles in South Africa and a decrease in demand for Class D and Class B cycles due to poor economic growth. Detailed South African trends are shown below.

Figure 3: SADC imports of Class A motorcycles and total motorcycle Imports (2010-2019) South African Rand

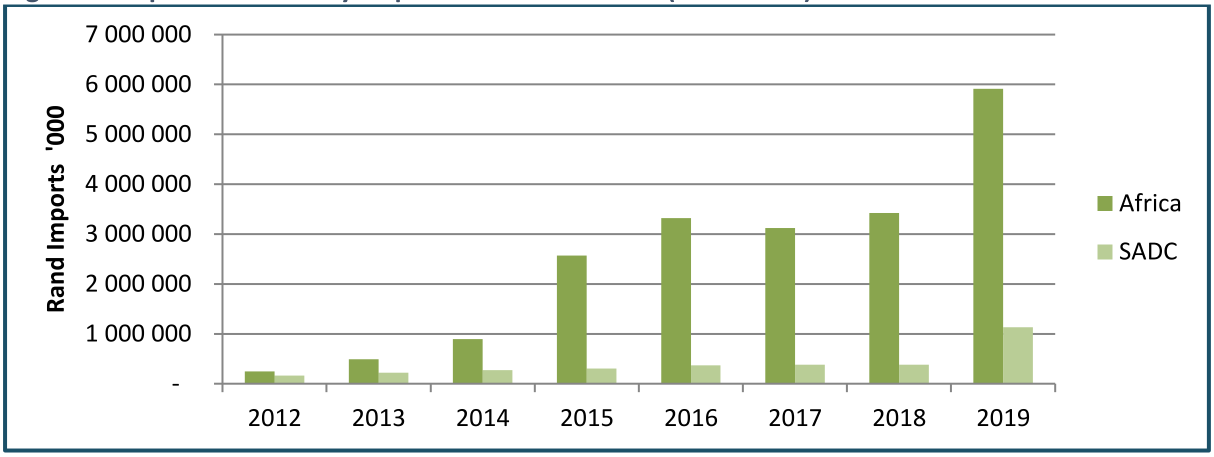


Source: Trade Map, https://www.trademap.org. (Accessed August 2020)

Compared to the value of the motorcycle market, the market for spare parts is significantly smaller. In 2019 the spares market in Africa was R59 million and in SADC just R13million. Both trends are, however, on an upward trajectory and have shown consistent growth over time. Industry experts suggest that these low absolute levels characterise user behaviour of not regularly servicing their motorcycles; homemade and backyard fixes and the approach of running bikes "into the ground" and eventually replacing them. Access to spares is also a contributing problem (particularly for

Chinese made bikes[40]). Some interviewees have suggested that if access to spare parts were more readily available in Africa demand would probably be higher.

Figure 4: Imports of motorcycle parts Africa and SADC (2012-2019)

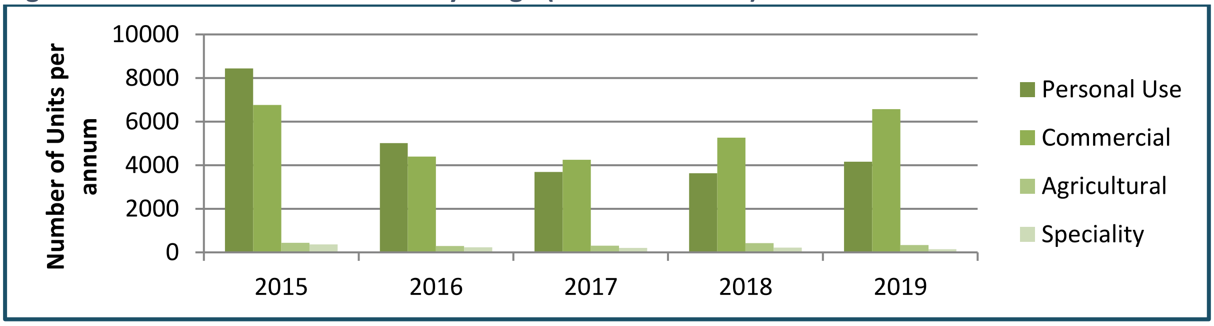


Source: Trade Map, https://www.trademap.org. (Accessed August 2020)

South African market

As mentioned, the SADC market for Class A motorcycles and scooters is small compared to the rest of Africa. There is no detailed data for the SADC motorcycle market. South African data is collected by the Association of Motorcycle Importers and Distributors (AMID). AMID's members are well-known global OEM distributors of well-known brands such as Honda, Suzuki, BMW and Yamaha. AMID's member sales accounted for approximately 90% of all motorcycle sales in South Africa 2010. In 2020 AMID's sales accounted for just 65% of domestic market sales.[41] The difference is explained by the growth of the importation of motorcycles by companies which are not members of AMID. These companies on the whole only import and operate in the Class A segment of the market and almost all import from four factories in China. This trend shows the absolute and relative increase in the Class A non AMID market over the past decade (this is the low price, mass market for commercial use).

Figure 5: South Africa Class A sales by usage (number of units): AMID and non-AMID



Source: AMID, 2020

After a decrease in 2015-2016, the sales of Class A cycles and scooters has been recovering. Figure 5 draws attention to the usage of Class A motorcycles and scooters and shows clearly that purchases for personal use have fallen while sales for commercial use have increased strongly and substantially

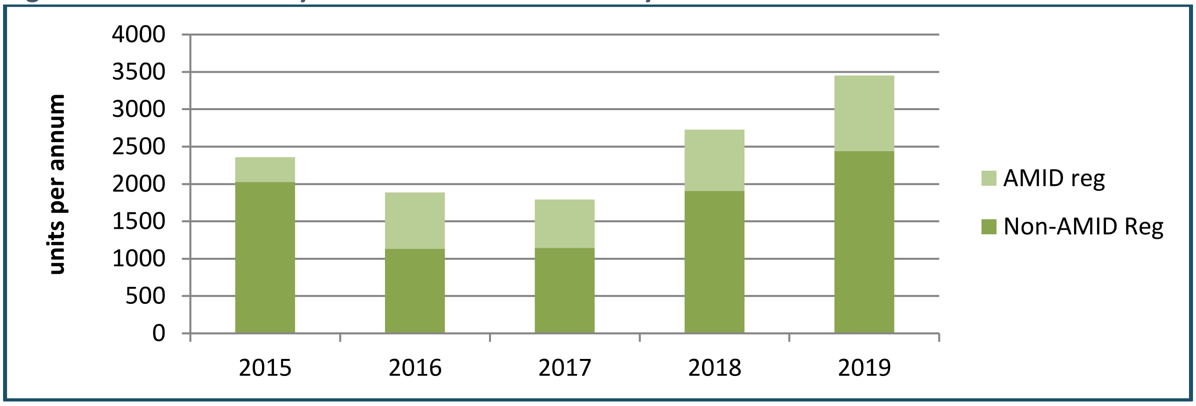
[40] Chinese OEMs will only provide spare parts to distributors in bulk, e.g. 200 clutch cables in a box. As most distributors are SMMEs, have a small client base and cash flow limitations holding such large amounts of stock are not feasible. As such there is a shortage of spare parts of Chinese made bikes in most African markets.

[41] Non-association members sales figures are deduced based on eNatis registrations.

over the past four years. Based on these short-term trends it appears that commercial use of Class A motorcycles and scooters is picking up in South Africa albeit off very low levels.

Figure 6 shows that much of the growth in these A Class cycles for commercial use has been satisfied by non-AMID members and not by well-established global brands. In 2019 non-AMID sales accounted for 71% of all sales of motorcycles and scooters for commercial purposes. Almost all of these non-AMID importers buy from China.

Figure 6: Class A motorcycles for commercial use only: AMID and non-AMID sales



Source: AMID, 2020

The South African Class A market is dominated by two players. South African Motorcycles (SAM) has a 50% market share and is not an AMID member. Sanyang Motor Corporation (SYM) from Taiwan enjoys a 30% market share and is an AMID member. Honda has 10% share with the remaining 10% of the market serviced by other AMID members. SAM is the dominant player in the market because the Class A commercial market is driven by price and SAM offer the cheapest cycles and scooters in the domestic market.

SAM was created in 1998 and provides a wide range of Class A motorcycles and scooters for private, commercial and agricultural use. SAM's bikes are fully imported from Chinese OEMs and arrive as CBUs. They offer 35 different models including on and off road bikes, petrol and battery operated bikes as well as three-wheeler options including tuk-tuks, box loaders and bikes with built-in trailers. Chinese OEMs provide house-branded products for SAM under the name (badge) Big Boy[42] which is the leading brand for commercial cycles and scooters in South Africa. Big Boy entry-level commercial motorcycles are R15 999, and an entry-level commercial scooter is R18 999. Both offer ecofriendly four stroke engines which offer amazing fuel efficiency of 37 kilometers per one litre of petrol. Interviewees suggest that accessing parts for Chinese OEM cycles and scooters is a problem, but SAM dispute this. SYM's entry-level products are in the same price range (slightly higher) and offer similar fuel economy as SAM's. SYM parts are more readily and easily available.

The demand for spares and parts for SAM's and SYM's Class A motorcycles and scooters are low in South Africa as with the rest of Africa. There is typically no appetite for regular servicing and maintenance and bikes are typically "ridden into the ground" and then replaced. Component parts are model specific and unique to each design so cannot be mass produced as substitutability is a problem. The only highly substitutable parts[43] which could be fitted to all cycles and scooters interchangeably would be sprockets and chains (cycles) and air and oil filters (cycles and scooters). The latter are classified as consumables and not components.

[42] SAM also sells GoMoto, Jonway and Bajaj Class A cycles and scooters.

[43] This is based on interviews with industry members but has not been proven. It is a crucial area of research which would be required if the proposed project is further developed.

With the Coronavirus pandemic increasing the demand for delivery services for goods bought online (e-commerce), and the demand for private transport options instead of riskier public transport options, the upward trend of Class A motorcycles and scooters in South Africa (and SADC) is expected to show strong growth moving forward. This trend is likely to take hold in the rest of Africa as well.

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