TRADE & INDUSTRIAL POLICY STRATEGIES

INDUSTRIAL DEVELOPMENT PROJECTS
POLYLACTIC ACID (BIOPLASTICS)

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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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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.

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.

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.

This project looks at supporting the sugar industry through the domestic production of polylactic acid for export and downstream domestic value addition.

For more information on this or other projects please contact Sandy Lowitt at 082 373 1150.

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[1].

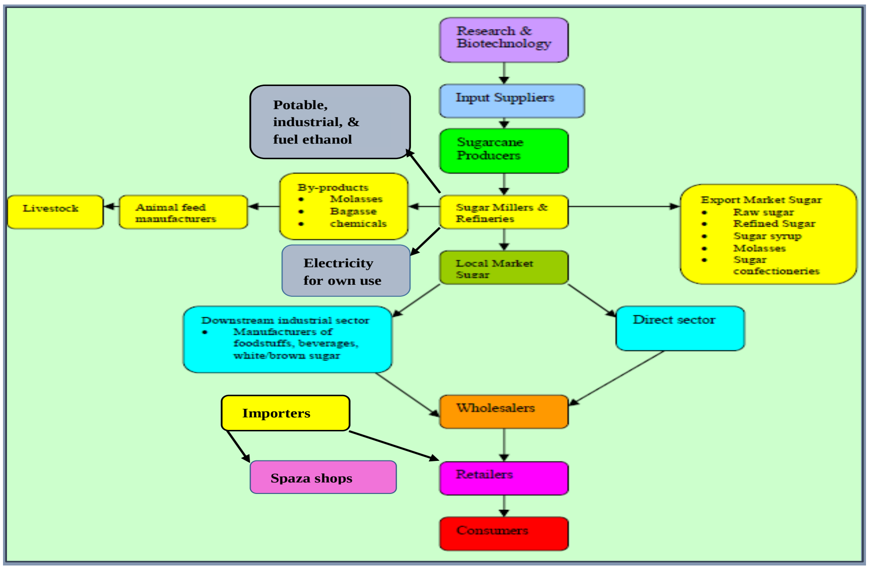
The sugar value chain

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)

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[1] 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.[2]

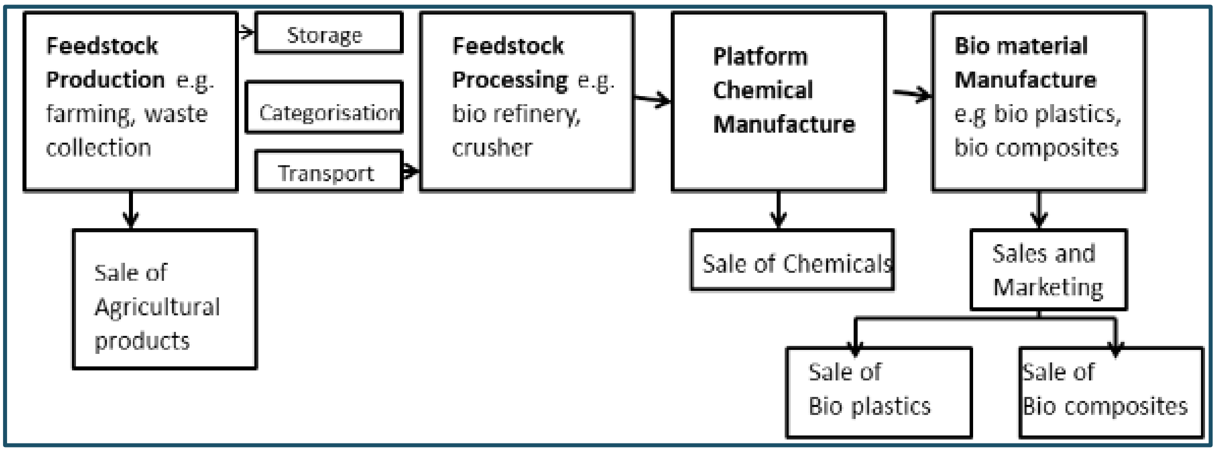
Bioplastics

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.[3] These chemicals can be sold or processed to produce a finished product.

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

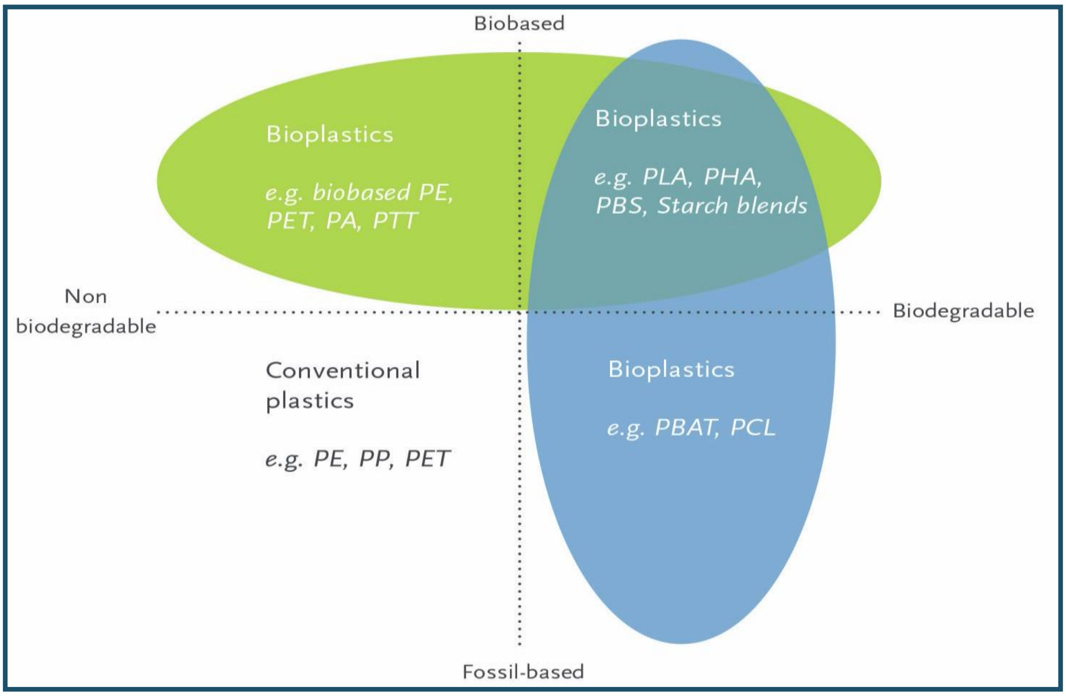
Figure 2: Biomaterials value chain



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[4].

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.

[4] 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)

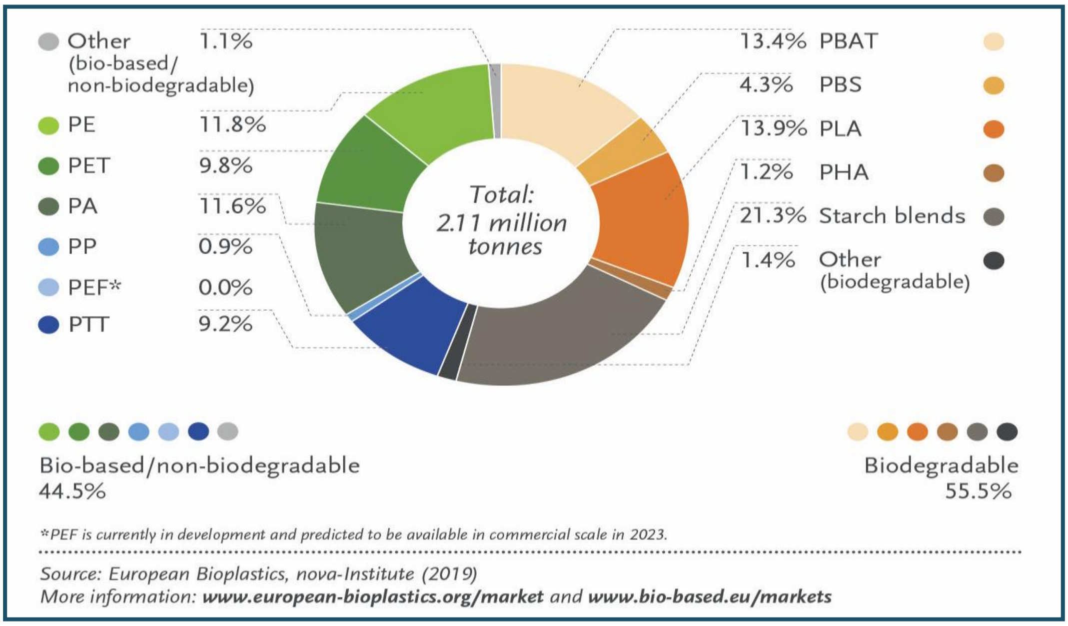


Figure 4 shows that currently the supply of, and demand for, biodegradable bioplastics (55.5%) outweighs bio-based non-biodegradable plastics (44.5%). Of the different types of bio-based, biodegradable plastics, PLA ranks second in terms of installed capacity and is forecast to be the third fastest growing 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[5] 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).

References

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