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GENERAL

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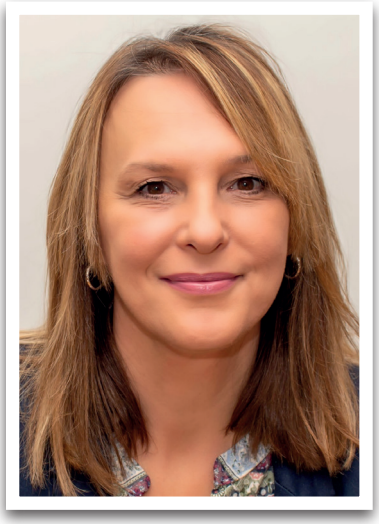

Dear **watt**now reader,

This issue features manufacturing. As we know, manufacturing is crucial for economic growth globally, especially in South Africa. It has to be healthy, and thus its competitiveness in a globalised world becomes crucial.

Since our manufacturing industry has been introduced to this competitive environment, restructuring within industries has necessitated a long-term vision to be developed.

The South African Government has long highlighted localisation and industrialisation as critical policy aims during the economy's recovery from the COVID-19 crisis. It is such a hot topic that organised business in Nedlac has recently been requested to substitute 20% of non-petroleum goods imports for domestically produced goods as soon as possible. Read more in our first features article, "Localisation and Industrialisation", on page 22.

The circular economy is a concept gaining widespread traction globally as an effective approach to achieving a sustainable, resource-efficient, and low-carbon economy, with the added potential to unlock new jobs and businesses. Read more in "Manufacturing and the Circular Economy" on page 26.

Page 52 features "Unlocking Business Model Innovation through Advanced Manufacturing" and discusses that manufacturing and supply chain leaders need to enhance their efforts to remain competitive in the current environment.

The September issue features Lightning. Please send your articles or papers to minx@saiee.org.za. The deadline is 15 August.

Herewith the August issue; enjoy the read!

Africa Research Journal

Research Journal of the South African Institute of Electrical Engineers
Incorporating the SAIEE Transactions

As of January 2019, the *SAIEE Africa Research Journal* is indexed by IEEE / IET Electronic Library (IEL) (popularly known as Xplore)

Manuscripts can be submitted by visiting the IEEE Xplore website: www.saiee.org.za/arj

Further training material on compiling manuscripts is provided online.

We call upon researchers to consider the *SAIEE Africa Research Journal* as a medium for publishing their novel scholarly research, and in this way, contribute to the body of published knowledge.

We are grateful to the leadership and support of the IEEE Foundation and IEEE Africa Council; through the partial sponsorship and support of these groups, the journal continues to be available as open access.

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INDUSTRY AFFAIRS

SAIEE CGC Activism Engineering Event

Newspiece by: Mantsie Hlakudi, TK&L Lead for SAIEE CGC

The SAIEE Central Gauteng Centre (CGC) recently hosted a hybrid event on Activism Engineering at SAIEE House in Observatory, JHB.

The primary goal was to bring about awareness on how can engineers practice activist engineering. Engineers should engage in reflection, debates, and idea sharing that will result in more organised efforts to shift the culture and motives for engineering.

The event began with the felicitation of the guest speaker- Engineer Refiwe Buthelezi: ECSA President, by Kgomotso Sethlapelo, Deputy Chairman, SAIEE CGC.

The Key takeaways from Engineer Refilwe Buthelezi: Engineers must be change activists by enabling and delivering sustainable solutions for humanity.

Engineers must be aware of the Global Challenges, particularly the United Nations Sustainable Development goals, as we play a significant role in shaping the world around us.

In executing our role, we must encompass the social, ethical, environmental and economic challenges. Engineers must play a leadership role in sustainable development and overcoming global challenges.

In conclusion, Engineer R. Buthelezi said, "Companies need to support, encourage, and grow mindsets that allow the engineering community to incorporate sustainability in every solution, product, or service, redefining what it means to be a force for good. The UN Sustainable Goals are not achievable if we as the engineering fraternity are not consciously driving the plan for sustainable growth."

It was truly an eye-opening experience for all the participants, and the participant vowed to heed the call of action for Engineers. The event ended with a round of questions from the participants. wn

From left: Sicelo Mabuza, CGC Chairperson; Lehlohonolo Mashego; Sharon Mushabe; Neo Mapapanyane, Leader: Education and Training Portfolio; Wandile Nhlapo, Leader: Events and Communications Portfolio; Refilwe Buthelezi, ECSA President; Teboho Machabe; Mantsie Hlakudi, Leader: Technology and Leadership Knowledge Portfolio; Kgomotso Setlhapelo, CGC Deputy Chairperson; and Christinah Mohloki, Leader: CSI Portfolio.

DCC wins at APC for Cchneider Electric MEA awards

From left to right: Sinan Kinder, senior distribution director, MEA at Schneider Electric, Alexandra Thin, VP: Transactional and Edge line of business, Schneider Electric, Pieter Gouws, , APC product specialist at DCC, Gina Santos, distribution manager at Schneider Electric and Michel Arres, VP: IT Channel and Alliance: Schneider Electric

Drive Control Corporation (DCC) has been awarded the highly contested Leading Edge Award for Distribution 2021 at the recent APC by Schneider Electric MEA Secure Power President's Club Partner Awards held in Slovenia.

The ICT distributor's APC by Schneider Electric sales continue to show tremendous growth in South Africa. The award is undoubtedly indicative of the team's hard work and dedication in a very competitive marketplace.

"It is a wonderful recognition by APC by Schneider Electric and certainly demonstrates that we're on the right track by providing comprehensive edge solutions to the local channel," says Pieter Gouws, APC product specialist at DCC. "The team worked incredibly hard, and with APC by Schneider Electric, we continue to deliver solutions that meet our customer's expectations."

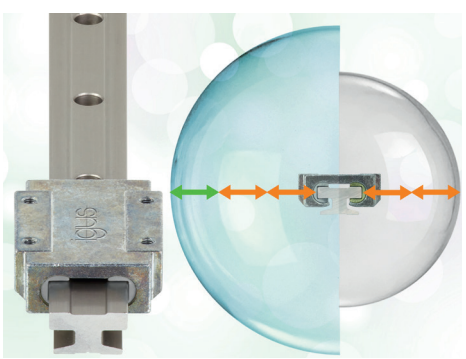
DCC has been an official APC distributor for almost 20 years and is responsible for the company's range of secure power technologies, single-phase UPSs and edge computing solutions such as racks, PDUs (power distribution units) and NetBotz access control sensors. wn

Breakthrough in linear technology

Whether in an industrial environment or a coffee machine, it is important to reduce friction and wear as much as possible to maximise the service life of a linear guide and keep the required drive energy low.

German manufacturer ***igus***, a motion plastics specialist, has now achieved a breakthrough in tribological plastics with iglidur E3. ***igus*** has developed a new sliding material with a friction coefficient of up to 40 per cent better and can open up the flexibility of design in linear technology and expand the coefficient from the classic 2:1 rule expanded to 3:1. "Our drylin T miniature linear slide offers extremely smooth running and new design freedom thanks to the newly developed iglidur E3 sliding material. Depending on the operating point, this has a friction coefficient of around 0.16 and thus achieves up to 40 per cent less friction than the igus standard materials, measured on hard-anodised aluminium, and even less compared to commercially available sliding materials. This also means that manual adjustment requires 40 per cent lower displacement forces.

"This is an important step towards greater design freedom, as it enables us to expand design leeway for the first time," says Stefan Niermann, head of ***igus***' Linear and Drive Technology business unit. The traditional 2:1 rule, which generally applies to linear plain bearings, states that the distance between the driving force and the fixed bearing should not be more than twice the bearing clearance. Otherwise, an uneven movement sequence could jam the system. wn



The newly developed iglidur E3 ensures 40 percent less friction and new design freedom in linear technology – without lubricant pollution.

For more info, visit www.igus.co.za

INDUSTRY AFFAIRS

Put People First for AI Success - Technology Expert Advises

Johan Steyn at the 2022 SAPICS Conference

Artificial intelligence (AI) is a hot topic and a big buzzword in business today. Infoholic Research predicts that AI in the logistics and supply chain markets will grow at a compound annual growth rate of 42.9% until 2023.

Technologies like artificial intelligence (AI), smart sensors providing real-time insights, autonomous decision making and predictive analytics will play an increasingly important role in the profession. According to author AI and automation expert Johan Steyn, everyone wants AI, but there are pitfalls to avoid. In his compelling keynote presentation at the 2022 SAPICS Conference, Steyn explored how intelligent technology will impact supply chains.

He cautioned the 600 supply chain professionals who met in Cape Town for the event to start any automation journey with a clear understanding of business objectives and customer needs.

Steyn said he spoke to executives who wanted AI but could not explain their basic business processes. "Consultants will never tell you this, but use your technology," he advised SAPICS attendees. "Start with what you have got and how you can use it. Don't listen to consultants that want to buy shiny stuff. You may not need it," he asserted and added that partnering with the right vendors in a win-win relationship is critical.

The importance of automating the right things for the right reasons in the right way was another key message in his presentation, and he also noted that the best way to approach AI is to automate value chains, not tasks. "Automating certain tasks in isolation will not deliver value," he stated.

Steyn stressed the importance of a "people-first initiative". "The approach should never be technology first. Start with considering whether your people can do it. Do you need to recruit people? Consider your organisational design, career planning and the need for upskilling your people," he urged SAPICS delegates. "Most AI conversations start with technology. They should always start with people," Steyn said.

"Many technology initiatives in business don't live up to expectations or flatly fail because we often underestimate the impact it will have on people and how they will respond. Technology is advancing rapidly, but there are things that it cannot do. We must remember that we cannot automate human nature and common sense. The value of people should always be our main focus, and ethics should underpin all our technological endeavours. The disruptive power of new technologies needs a new breed of ethical, human-centric leadership in business," Steyn said. wn

New ventures are on the horizon for Enel Green Power SA with its new Country Manager

Newly Appointed: Manuele Battisti , Country Manager, Enel Green Power South Africa (EGP SA)

As of 1 June 2022, Manuele Battisti is the new Country Manager for Enel Green Power South Africa (EGP SA), taking over from William Price. His mandate will be to manage South African operations, maintain and expand the business, and diversify the company's client base. Under his leadership, EGP SA will continue to support the country toward stabilising the energy market and a just transition.

Battisti joined Enel Group in 2008, first in a technical role, as he held a degree in mechanical engineering and had completed a PhD in renewable energy and energy efficiency in building. He fulfilled this role for a few years before moving into business development, where he occupied different roles, such as supporting the head of business development in global activities, market analysis and intelligence.

In 2014, he took the reins as a middle manager in Africa, leading the business development activities for East and West Africa. After this, he was appointed Head of Business Development for Southern Africa and moved to South Africa with his family in 2019.

As the new Country Manager of EGP SA, he will be responsible for the three business lines in the value chain, namely Development (creating opportunities up to the construction stage); Engineering & Construction (supporting business development and operation whilst leading the construction of power plants); and Operations & Maintenance, which represents the core business of the company as an Independent Power Producer (IPP).

In the beginning stages of its journey in South Africa, EGP SA focused mainly on business development and expansion, achieved through rounds three and four of the country's Renewable Energy Independent Power Producer Programme (REIPPP) and the construction and implementation of the projects it was awarded.

In 2022, with all projects about to be completed, the company will be focusing its attention on the effective production of electricity from the existing 1,200MW in operation from its current wind and solar PV projects, as well as expansion into new business opportunities.

In addition, the organisation is preparing its submission to round six of the REIPPP for IPPs. At the same time, it is negotiating PPAs with large private consumers to diversify its client base, as allowed by the new regulatory policy.

One challenge facing the renewables sector is the country's limited grid capacity. Like all countries, the grid was designed to deliver electricity from centralised generation centres to large centres of consumption, which in South Africa's case have traditionally been concentrated in the same area. On the contrary, the best solar and wind resources are concentrated in areas where the population and consumption are limited.

Supporting the country toward stabilisation of the energy market and a just transition, as well as broadening EGP SA's client base, are firmly within Battisti's scope of responsibilities. With his solid experience in the renewables sector and his knowledge of the African markets, he is well positioned to meet the company's business objectives in his new role as Country Manager. wn

INDUSTRY AFFAIRS

Skyriders makes easy work of E Cape gas sphere inspection project

The benefit of rope access for routine industrial inspection work was again demonstrated when leading rope access specialist Skyriders Access Specialists Pty Ltd successfully completed a project for Easigas in Gqeberha in the Eastern Cape.

Specialising in mega projects such as petrochemical tank farms, towering smokestacks for mines, and gigantic boilers for power stations, Skyriders is increasingly finding applications for its services in the burgeoning industrial maintenance and inspection market, highlights Marketing Manager Mike Zinn.

"While our bread-and-butter work remains largescale projects in the power generation and petrochemical industries, we find that smaller companies like Easigas are turning to us to provide unique, cost-effective solutions for their inspection and maintenance needs," says Zinn.

Statutory requirements mean that the two gas spheres operated by Easigas in Gqeberha have to be inspected routinely by an independent authorised inspection authority. Here Skyriders' scope of work was simply to fit the inspector into a harness and rig a rope access system so he could be manoeuvred into position inside each of the spheres to carry out his duties safely and efficiently.

The project took two short days to complete for both gas spheres, with a Skyriders rope access team travelling directly from Johannesburg. "The major benefit for the client is a significant saving in time and money, especially when you consider it takes five to eight days simply to erect the scaffolding necessary to provide access to the gas spheres," notes Zinn. On the other hand, Rope access is a faster and more responsive access method with less risk.

While Skyriders does not have an operational base in the Eastern Cape, Zinn says it is definitely a market the company is looking to make inroads in due to the presence of the Port of Ngqura and a major automotive industry.

"It is a competitive sector in terms of access service providers, but our teams' high quality and safety standards set us apart. The fact that Easigas approached us in Johannesburg is a testament to our extensive reach throughout South Africa at present," concludes Zinn. wn

Zest WEG Develops Robust Local Supply Chain

Zest WEG manufacturing facility for large transformers in Heidelberg.

Generator manufacturing facility in Cape Town.

Zest WEG, the South African subsidiary of Brazilian motor and controls manufacturer WEG, has progressively increased its level of local manufacturing over the past decade and now boasts six manufacturing sites – four in the Gauteng region and two in Cape Town.

A key aspect of this manufacturing drive has been the development of local suppliers by Zest WEG; an effort which has met with considerable success. "Building up our local supply chain is important, of course, in terms of meeting targets for black empowerment stipulated by the government and the mining industry, which is one of our main markets. Having said this, local sourcing is a value that is built into WEG's culture globally and is nothing new for us," says Eduardo Werninghaus, newly appoint Group CEO of Zest WEG.

Werninghaus notes that WEG started up in 1961 in the southern Brazilian state of Santa Catarina which was then very undeveloped with the local economy relying primarily on agriculture. "WEG really had no choice but to develop local suppliers, given the distance of its factory from Brazil's main industrial centres. This programme met with such success – and made such economic sense – that it has now become the standard practice for WEG companies around the globe."

Commenting on the benefits of local sourcing, Werninghaus says that it gives Zest WEG enhanced control over the production process and helps keep down costs. It also allows short delivery times, as there is less reliance on global markets for parts and componentry, a huge advantage currently given the constraints of the global supply chain. He adds that it has also made a major contribution to Zest WEG achieving its current Level 1 B-BBEE status.

Zest WEG gives considerable assistance to emerging companies that it brings into its supply chain, upgrading their skills so that they are able to produce to the demanding standards of the WEG Group. "We're a very aggressive company when it comes to manufacturing and very focused on efficiency and productivity. This same culture has been successfully instilled into our South African operations, including our local suppliers," he says.

In Gauteng Zest WEG has two transformer factories. One is in Wadeville and the other in Heidelberg. Also in Gauteng, Zest WEG – through its WEG Automation division (previously Shaw Controls) – produces a wide range of electrical panels in Robertsham and E-Houses and other electrical enclosures in Heidelberg. In Cape Town, the company has two production facilities, one producing engineered gensets and the other focused on panel production. Discussing how far local manufacture has advanced, Werninghaus says that the transformers can have more than 90% local content and panels and E-Houses close to 70% depending on the specifications.

"It's virtually impossible to get to 100 % local content on any of the product lines we manufacture in South Africa, as there will always be certain things that have to be imported due to technical and economic reasons," he comments. "Nevertheless, we are constantly looking for opportunities to replace imported componentry with locally produced parts so our level of local content will certainly increase further with time." wn

INDUSTRY AFFAIRS

LOCAL MANUFACTURING AT ITS BEST

The Tshwane Automotive Special Economic Zone (TASEZ) has selected Vikinduku Engineering & Projects as the preferred service provider to design, build, deliver, operate, and maintain the 20MW Gas to Power Generation Plant. The new Ford Manufacturing plant and Ford Suppliers for the next-generation Ford Ranger are housed here.

The TASEZ 20MW Cleaner Energy Centre (CEC) project is expected to assist TASEZ as its aims to create over 20 000 new jobs once fully financed and operational in 2024. TASEZ CEC will also provide year-round energy equivalent to over 200 000 homes while producing 70% fewer carbon emissions than Eskom's (coal-based) electricity. The expected TASEZ CEC's total carbon footprint reduction is 142 500tons CO2e annually and 4.27 MTons CO2e over the CEC lifetime. Ford will become the cleanest (car manufacturing plant with the lowest carbon emissions) in South Africa.

The Special Economic Zone (SEZ) is a driver of employment, transformation, and socioeconomic growth. TASEZ is Africa's First Automotive City, located in Gauteng Province. President Ramaphosa established the Special Economic Zone in 2019 as part of the Department of Gauteng Economic Development's growth ambitions, enabling more than R20.3 billion in manufacturing investment.

TASEZ CEC intends to assist Ford Motor Company as it aspires to become a global carbon-neutral carmaker by 2035, proving its commitment to sustainability. The embedded TASEZ CEC located at TASEZ makes the site energy self-sufficient, with increased energy security. The TASEZ site may have a smart Micro-grid.

Soon, TASEZ CEC technology will create CO2e-free energy when using hydrogen as a fuel instead of methane-based natural gas.

Vikinduku Engineering is a sustainable engineering design and engineering solutions company specialising in improving and operating buildings/cities with increased energy efficiency established in 2005. It also offers green solutions to the mining, buildings, transportation, and construction sectors.

Vikinduku is a member of leading associations, including the Green Buildings Council of South Africa (GBCSA), the SA Association of Energy Services Companies (SAAES) and the South African Oil & Gas Alliance (SAOGA). At the same time, its professionals are members of the SA Institute of Electrical Engineers (SAIEE), the South African Institution of Mechanical Engineering (SAIMechE), the international Association Energy Engineers (AAE, Atlanta-USA), the SA Association of Energy Efficiency (SAEEC) and Boards of the Green Building Council of SA (GBCSA). wn

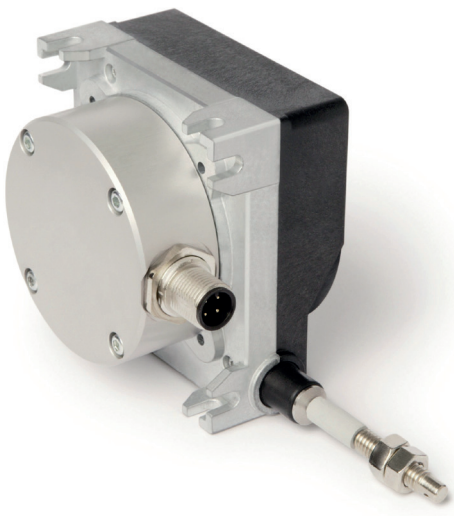
PRECISION MEASUREMENT FOR HEAVY WEIGHTS

SIKO SG 30 Wire-actuated Encoder for crane arms and lifting platforms

Millimetres can make all the difference when it comes to the stability of cranes and lifting platforms. When safety is jeopardized, cranes can tilt or even topple over. If loads are lifted unevenly, this can result in strain and damage. What is needed in these cases are easily integrated measurement solutions with a good price-performance ratio and first-class product quality? SIKO has solved this task by developing the impressive SG 30 wire-actuated encoder with its extremely compact yet robust design and wide range of applications.

INSTROTECH is offering Siko innovative wire-actuated encoders for a wide spectrum of applications with measurement lengths ranging from 600 millimetres to 40 meters. The functional principle of the wire-actuated encoders is fairly simple: A measurement wire is wound onto a drum. When the wire is pulled out, it causes the drum to rotate. A sensor connected to the drum axle records this rotation and generates a measurement signal proportional to the wire movement of the drum, which indicates the position. wn

For more info, visit www.instrotech.co.za



SIKO SG30

Alternative Engineering for today's economic climate

Every South African reading this article is well versed with the daily challenges faced by our state-owned entities, specifically our electricity supplier; tight budgets coupled with aging infrastructure makes for challenging environments to execute engineering projects. This also provides an opportunity for engineers to look for alternatives to the obvious "rip-out-and-replace" projects commonly executed.

At one of the 3.6GW coal-fired power stations, the original control system, installed in 1985, is still running, controlling and protecting the main equipment of the power station. The control system still uses hard-wired relay technology and therefore, all alarm and protection signals have to be wired to a centralised separate system for a sequence of events. The system's mainframe PC with CPU has become unreliable over the years and is essential for all the units of the power station to safely produce power.

The evident solution is a total system replacement, but costs were estimated at several hundred million rands. Given the budget constraints, innovative solutions had to be explored to execute a partial system replacement. The I/O cards of the alarm system were reverse engineered up to the component level to develop a new hardware interface to the cards, where after the mainframe and configuration were replaced with modern-day servers.

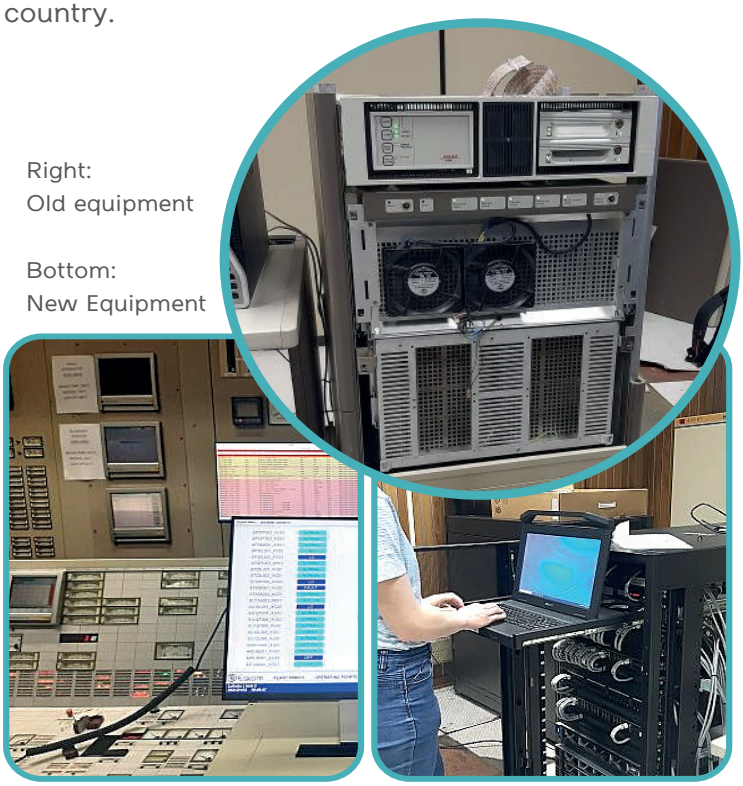
"...South African Engineers are often overlooked and not as highly regarded as other European countries' engineers."

The result was a cost-effective, easy-to-use system, using modern SCADA programs for consolidation of the events and alarms. The replacement of only the mainframe and CPU and not the controller cards, cables, or the base-level control system, amounted to significant cost savings and could be implemented in a reduced time frame during plant outages.

Proconics

South African Engineers are often overlooked and not as highly regarded as other European countries' engineers.

But the tenacity of the people of South Africa brings a contextual dimension to the engineering discipline and makes South African engineering unique. Local engineers in South Africa have adapted to the constraints present in a unique environment and are best suited to solve the local problems of our country.



Right:
Old equipment

Bottom:
New Equipment

"...the tenacity of the people of South Africa brings a contextual dimension to the engineering discipline and makes South African engineering unique"

Marita van den Bergh
Group Executive: State-owned Entities, Pr.Eng
marita.vandenbergh@proconics.co.za

INTRODUCING COMMITTEE MEMBER OF THE SAIEE

Women in Engineering Chapter

The SAIEE Women in engineering are proud to introduce their 2022/2024 chapter committee.

CHAIRPERSON: MAITE SAKO

Maite Sako started her career as an Engineer in Training at Eskom Distribution in 2010. She was appointed Network Operations engineer in 2011. In 2016, she was appointed senior engineer in Eskom, System Operator. Currently, she is the Chief Engineer at the System Operator leading the Conventional section in the Grid Code Management department.

She is registered as a Professional Engineer (Pr. Eng) with the Engineering Council of South Africa (ECSA). She is also a member of CIGRE. Maite volunteers as a peer assessor at ECSA, assisting with the registration process of professional engineers. She holds a Master's degree in Engineering Management, BEng in Electrical Engineering and a Certificate in Business Management.

Some of the highlights in her career include:

- Winning the Millenial Leader award in 2020
- Featured in the Eskom EWAP Nickel of democracy book in 2016
- Attended a training course on clean energy in China (Beijing) in 2015
- Attended a study tour on grid integration for renewable energy in Germany (Berlin) in 2013
- IEEE WIE award for community service in 2009

Maite has been a member of the South African Institute of Electrical Engineers (SAIEE) since 2016 and participates in SAIEE Central Gauteng Centre (CGC) activities. She is currently the Chairperson for the SAIEE Women in Engineering (WIE) chapter.

Maite is very passionate about serving and community engagement activities. She is also passionate about women empowerment and mentoring young girls in township high schools.

DEPUTY CHAIRPERSON: MANTSIE HLAKUDI

Mantsie Hlakudi is a professionally registered (ECSA) and certificated (GCC) Electrical Engineer with over 12 years of experience in Military, Distribution and Transmission, specialising in Specialised Plant Equipment Failure Investigations, Renewable Energy, Transformers and reactors. She is currently a Chief Engineer for Transformers and

Reactors with a specific focus on transformer specifications, design reviews, factory capability assessment, factory acceptance testing, failure investigations, asset health appraisal and technical support throughout the transformer's lifespan. She holds a BSc(Honours) from UCT and is currently busy with MEng Electrical Engineering.

She is a member of the Cigre A3 Study Committee, Cigre Utility Advisory Board Member and expert on International Electrotechnical Commission (IEC) C SEG 10 Ethics in Autonomous and Artificial Intelligence Applications.

She serves as the Vice-Chairperson for SAIEE Women in Engineering Chapter and the Portfolio Leader for Technology Knowledge & Leadership for the SAIEE Central Gauteng Centre (CGC). She is

a passionate community servant who can motivate and inspire individuals to identify their potential to continue and share this passion for serving others. Some of her highlights in her career include:

- Young Professional to represent South Africa in South Korea 82nd IEC General meeting
- Best Student in Leadership and Management and Best Naval Engineering Student
- Eskom Inspiring Women Award 2021- 1st Runner Up
- Accenture Rising Star 2021 Winner
- Inspiring Fifty (Women in STEM) 2021 Winner

TREASURER: CHANTYLE SHONGWE

Chantyle Shongwe started her career as an Electrical Engineer in Training at Eskom Distribution in 2010. She was appointed Protection Settings engineer in 2011.

In 2017, she joined Eskom Transmission as System Operator. In 2019 she was appointed Chief Engineer at eThekwini Municipality.

She led the Planning and Distribution of electricity section within the North Western area. She is the Senior Infrastructure Development Specialist at the Development Bank of Southern Africa, responsible for the electricity infrastructure-related project development.

Chantyle has been a member of the South African Institute of Electrical Engineers (SAIEE) since 2015 and is currently part of the SAIEE Women in Engineering (WIE) chapter leadership.

She holds a Master's degree in Engineering Management, BEng Electrical Engineering and a Government Electrical Engineer's Certificate of Competency (GCC). She is registered as a Professional Engineer (Pr. Eng) with the Engineering Council of South Africa (ECSA) and is actively involved as an assessor and mentor.

Chantyle has a passion for the empowerment of women and children. She serves underprivileged community activities and planning infrastructure to improve living conditions.

COMMUNICATIONS AND MARKETING PORTFOLIO LEAD: SMANGELE PLAATJIES

Simangele Plaatjies is an Electrical Engineering honours student at the University of Johannesburg with an academic and extracurricular success record.

Simangele has been a member of the South African Institute of Electrical Engineers since 2019. She has extensive leadership experience, especially in a setting related to higher education.

Adept at collaborating with academics, administrators, and students across departments. In 2019 she was the deputy chairperson of the Electrical and Computer Systems Forum at the University of Johannesburg (UJ) and the Events Coordinator for the SAIEE UJ Student Chapter.

EVENTS AND PROJECTS PORTFOLIO LEAD: SIHLE LADYFAIR GOQO

Sihle started her engineering journey in 2001 as an Eskom bursar at TUT and was appointed a Technician in 2003.

Her experience includes involvement in the various roles in a technical space and making a difference in ensuring that Eskom delivers a reliable, qualify of supply to its customer through maintaining networks according to the prescribed standards. It has been nineteen years of diverse working experience on various projects, which developed her technical, innovative, systematic and logical thinking skills.

She is capable of conducting equipment failure investigations whereby the findings are tabled, getting to the root cause of failure leads to prescribing the remedial solution to ensure no repeat failures. In this way, power outages are minimised.

She consistently translates business needs into technical operations (through analysis), both creative and pragmatic.

In 2003, she completed her National Diploma at Tshwane University of Technology and her BTech in 2010. In 2004, she completed her Project Management Programme at the University of Pretoria.

Sihle is registered as a Professional Engineering Technologist and Technician with ECSA and a senior member of the SAIEE.

She is actively pursuing a career path that demonstrates growth with a natural inclination to the pioneering fields of engineering and project management. She mentors young professionals starting their careers and provides career guidance to male and female high school learners.

EVENTS AND PROJECTS PORTFOLIO LEAD: MPAI LETEBELE

Mpai Letebele is a senior engineer at Eskom with 12 years of experience in the design of Transmission Substations nationally.

She is a professionally registered engineer with the Engineering Council of South Africa (ECSA). She volunteers as a peer assessor, reviewer and moderator at ECSA, assisting with the registration process of professional engineers. At ECSA, she is also a member of the team that assists in accreditation of universities representing the electrical engineering industry.

She is an active member of the South African Institute of Electrical Engineers (SAIEE), assisting SAIEE in the CPD evaluation of courses, workshops and technical tutorials. She also represents SAIEE in SABS/TC 0064/SC 01 technical committee. She holds a BSc in Engineering (Electronics) degree from the University of KwaZulu-Natal. She is pursuing an MSc in Electrical Engineering (Research) degree at the University of Witwatersrand. She is an external moderator for Design Projects at Tshwane University of Technology (TUT).

Mpai is passionate about inspiring young professionals to realise their full potential and helping them progress in professional careers. Technical skill transfer and imparting knowledge are what fulfil her. She offers her professional knowledge and expertise to young professionals to successfully launch their careers by offering them guidance, mentorship and advice regarding their professional registration. She is a loving mother of two girls and enjoys running in her spare time. wn

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High Tech launches from SEW-Eurodrive at Electra Mining

Visitors to this year's Electra Mining Africa exhibition in Johannesburg will be spoilt for choice as SEW-EURODRIVE South Africa unleashes more technology to drive productivity and efficiency.

Addressing growing demand for reduced total cost of ownership (TCO), SEW-EURODRIVE South Africa will launch its DriveRadar® solution for remote condition monitoring and maintenance forecasting. An extensive package of sensors captures all operationally relevant physical parameters including vibration behaviour, oil level, oil temperature, ambient temperature and input speed.

Gear unit data is digitally recorded and automatically assessed. Results can be used to evaluate the unit's condition and predict future changes in condition, providing a firm basis for predictive maintenance.

Also on the Electra Mining Africa launch pad is the single-stage M1 series industrial gearbox, for high speed and high power applications – relevant to pumping duties in mining as one example.

"We will be demonstrating our girth gear capability, with a 3,5 metre diameter static model specially imported for the show," says Jonathan McKey, national sales and marketing manager at SEW-EURODRIVE South Africa. "Visitors can experience how the model reflects both the mill and kiln application."

Four of these girth gears have already been supplied to a large mining operation in Limpopo province. At the SEW-EURODRIVE South Africa stand will also be the company's purpose-built gearbox solution for air-cooled condensers (ACCs) used for driving fans in power stations.

"Our SEW MACCs will be locally assembled, which differentiates us from competitors," he says. "No-one else stocks these components, and we will be able to slash the lead times of other OEMs by a multitude of weeks."

McKey says the new Aeroton production facility could deliver at a rate of three units a week. High efficiency IE3 SEW electric motors will also be on show, as examples of the extensive range from 0,75 to 335 kW rating.

"An important benefit of our electric motors is that SEW-EURODRIVE designs and supplies the add-ons, such as encoders and braking systems," he says. "Customers can source add-on accessories from us, which ensures them of world class quality and accountability."

He notes that customers will also appreciate the different ways that SEW-EURODRIVE strives to reduce total cost of ownership on its motors. For instance, in contrast to competitors, the motor casing design features a detachable foot. If this is broken, it can be easily replaced, rather than forfeiting the whole casing or motor.

The MOVIGEAR® mechatronic drive system will also be there, comprising motor, gearbox and VSD. This is designed for flexible use across various communication infrastructures, making it ideal for decentralised applications

Maxolution®'s automated guided vehicles.

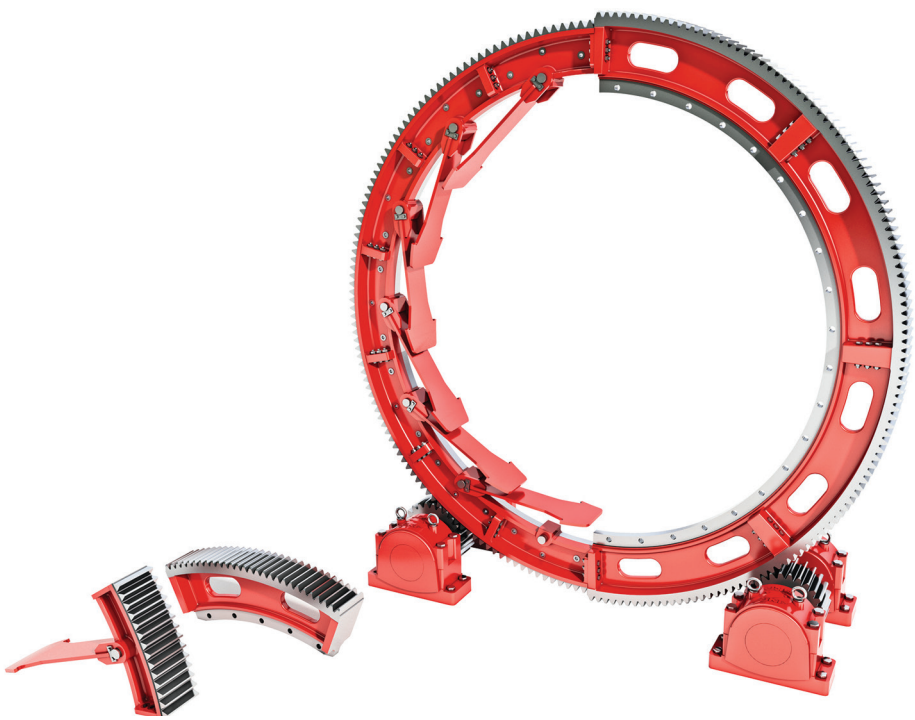
in the field. MOVIGEAR® is especially tailored for efficient use in the general materials handling sector.

Customers will be exposed to SEW's new electronic drive – the MOVI-C® – which will soon be one of the key product lines to be locally assembled. This suite of modular products will allow SEW-EURODRIVE to offer better-than-ever capabilities to control the speed, acceleration, position and torque of multiple motor-driven axes of control systems.

"Another exciting innovation is our automated guided vehicle systems (AGVs), which we will also want to exhibit at Electra Mining Africa," says McKey. "These are valuable assets in any automated process, and they are typically used for logistics and in the automotive industry."

He says they can be programmed by a SEW mechatronics engineer to perform many different tasks of a frequent and repetitive nature. These AGVs will be able to be locally assembled, supplied and supported from the new Aeroton factory, he explains. wn


The new range of SEW-EURODRIVE's MoviGear®.


A rendering of SEW-EURODRIVE's segmented girth gears with flange and tangent plated.

THE GREEN, THE BAD AND THE UGLY:

The Risks of Greenwashing

Greenwashing is misleading the public about an organisation's environmental or sustainability practices or deceiving the public about how eco- (and ESG-) friendly a product or practice is. Environmental or sustainability claims have been "greenwashed" if they are vague, false, omit important information, or misleading or deceptive.

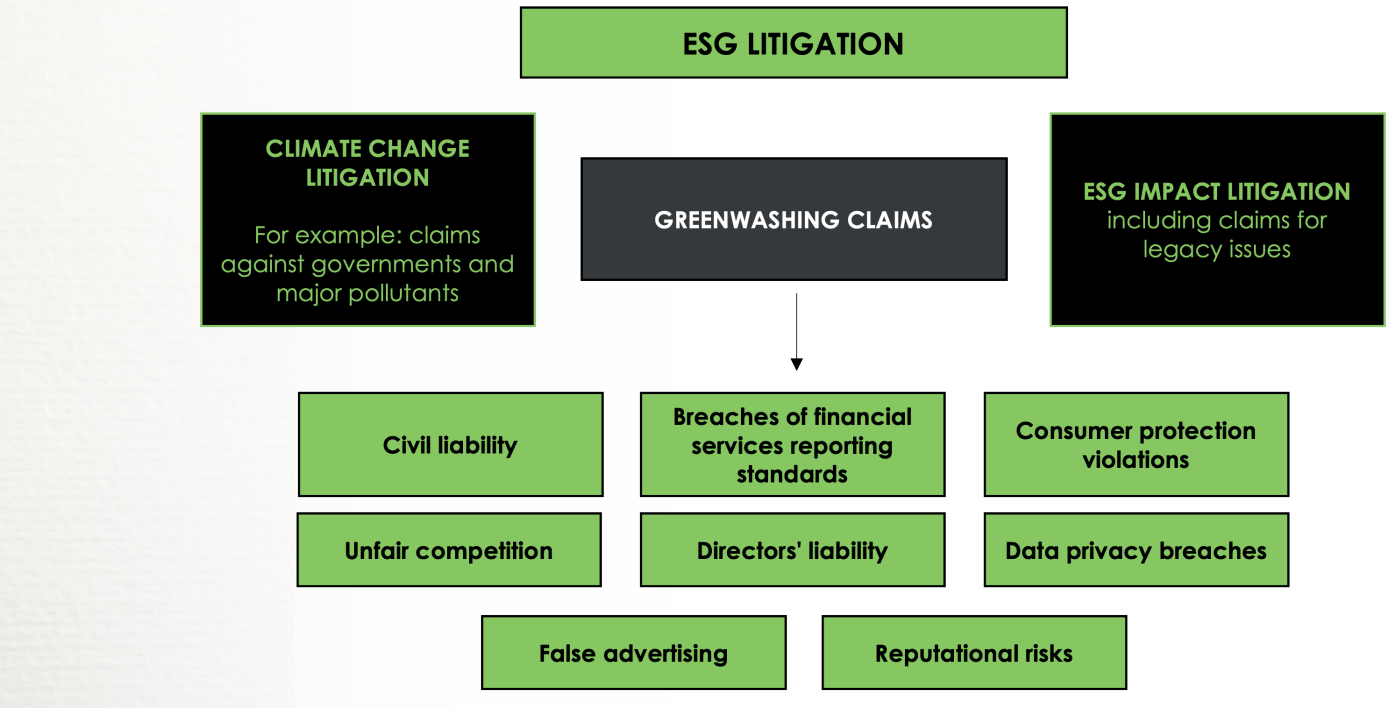
By Merlita Kennedy, Partner, Pooja Dela, Partner, Ziyanda Sibeko, Senior Associate, Bernadette Lötter, Senior Associate, Jared Ishmael, Associate & Tobia Serongoane, Associate from Webber Wentzel

Greenwashing is a way to convince the public, such as customers, investors, or regulators, that an organisation, whether a juristic person or the government, is making positive environmental or sustainability choices when this is not the case. This is often done through the use of eco-conscious buzz words such as "environmentally friendly", "reduced footprint", "green", and "sustainable" to convince the public that the relevant product or practice is more natural, wholesome, or free of toxins than that of competitors, or that the organisation involved is doing more for the environment or sustainability than it is.

The need to combat greenwashing came under the spotlight at the United Nations COP26 summit in November 2021. It was highlighted that countries worldwide are likely to see an increase in action against greenwash organisations. This is additional potential risk organisations face as they undertake their sustainability journeys.

Perhaps the best-known example of greenwashing is "Dieselgate", the 2015 emissions scandal which resulted in action being taken against Volkswagen in several countries after it installed emissions-cheating devices in its vehicles. In 2022, several greenwashing cases have come to light that organisations increasingly face risks because of greenwashing. These risks do not only arise in the environmental context. Companies may face claims due to greenwashing social and governance practices, too. For instance:

- In January 2022, the UK Advertising Standards Authority banned adverts by Oatly, the Swedish oat milk company after it was found to have overstated claims about its environmental impact;
- On 31 May 2022, German prosecutors raided asset manager DWS and its majority shareholder Deutsche Bank following allegations of greenwashing. A whistleblower had claimed that DWS misled investors about ESG investments;
- In June 2022, it was reported that Japan's financial regulator intends to introduce measures, such as disclosure requirements, to oversee ESG products and curb greenwashing;
- In early July 2022, it was reported that litigation had been instituted



against Dutch airline KLM for alleged greenwashing in that the adverts promoting its sustainability initiatives are misleading; and

- In early July 2022, HSBC's global head of responsible investing, Stuart Kirk, resigned. He was suspended in May 2022 after giving a presentation where he said climate change was not a financial risk that should concern investors.

South Africa currently has no laws or guidelines in force against greenwashing. Recent events have shown, however, that a shift in accountability standards is underway. For example, the JSE released its Sustainability and Disclosure Guidance in June 2022. It aims to assist listed companies with their ESG reporting by enabling more useful, consistent, and comparable sustainability disclosure to inform better decision-making and action.

The guideline draws from and is aligned with international sustainability and climate change disclosure initiatives. It guides organisations on what and how they should report in line with international trends. Although the guideline states that it does not constitute disclosure or reporting obligations according to the JSE Listings Requirements – and therefore, non-compliance does not amount to a breach – its release indicates what the public expects from organisations in terms of environmental and sustainability reporting. It is in this context that the risk of greenwashing becomes apparent.

The public wants organisations to do more for the environment and sustainability, but to do so honestly.

Like the rest of the world, the South African public has become hyper-vigilant about sustainability. Most of us have refused a plastic straw or swiftly placed an animal-tested product back on the shelf. As sustainability concerns grow, so does our desire to hold organisations to account, particularly if they are dishonest about their sustainability practices.

Greenwashing may lead South African companies to face civil liability claims before the courts, criminal complaints, or a wide range of other regulatory complaints if their greenwashing is considered. For example, to amount to a breach of reporting standards, constitute false advertising, violate consumer protection laws, amount to unfair competition or constitute a breach of data privacy laws.

The risks do not end there. Directors of companies may face personal consequences for failing to act in good faith or in the company's best interests. In the age of social media, any allegations of greenwashing will probably receive local (and even international) airtime, creating reputational risks for the organisation involved.

Over the next few months, we will be unpacking greenwashing risks in these contexts and highlighting the trends we see in different sectors of the economy.

The message is clear: people are watching, and they demand accountability. The only way to avoid landing in hot water is to ensure that ESG reporting, and any environmental or sustainability-related statements made by an organisation, are accurate and supported by objective and verifiable evidence. wn

Localisation and Industrialisation – the domino effect

The South African Government has long highlighted localisation and industrialisation as critical policy aims during the economy's recovery from the COVID-19 crisis. It is such a hot topic that organised business in Nedlac has recently been requested to substitute 20% of non-petroleum goods imports for domestically produced goods as soon as possible.

So, why is localisation touted as the siren song of the South African economy?

In simple terms, since the Gross Domestic Product (GDP) is made up of the sum of consumption, investment, and exports less the cost of imports, anything that reduces imports raises GDP if nothing else changes. In this way, localisation promotes growth, industrialisation, and employment.

It is no secret that South Africa's current economic trajectory is unsustainable: economic growth has stagnated, unemployment is rising, and inequality remains high. The government should urgently implement a series of reforms that can boost South Africa's growth in the short term while also creating the conditions for higher long-term sustainable growth. These reforms should promote economic transformation, support labour-intensive growth, and create a globally competitive economy.

In practical terms, localisation implies local procurement by the government and the private sector alike. The overarching vision is not to localise everything but to localise where possible.

Mervyn Naidoo, ACTOM CEO, feels passionate about localisation and designation, that all thirteen of ACTOM's divisions are actively involved in localising their products. "What is important is that you need government spend to localise. Localisation has an impact on the whole supply chain. When you localise manufacturing, all the sub-components of manufacturing fall into place and benefit communities," Mervyn said.

In many respects, South Africa appears to be at a tipping point. Record levels of unemployment, rising poverty levels, increasing political uncertainty and the large-scale diversion of resources away from inclusive growth to the beneficiaries of state capture have created an environment in which investors are understandably cautious and seek investment opportunities abroad.

Suppose we continue our current low road, the prospect of an IMF intervention beckons, with the associated loss of sovereignty determining our economic future. Against this backdrop, we risk a toxic cocktail of continued further de-industrialisation and job losses.

"We have to take an inward look – look at ourselves and see how we can revitalise manufacturing in our country and employ local people to assist in manufacturing", said Mervyn. "International companies working on projects in South Africa bring their own people to work on projects locally, resulting in job losses for the indigenous population, which leads to xenophobic behaviour. Nobody is listening to the locals when they ask who is taking our jobs", he added.

In recent years, the municipal entity market segment requirements for localisation compliance have taken shape under the Preferential Procurement Regulations of 2017. There are two central tenets in construction-related works typical to our environment: skills development and small businesses alike.

South Africa has the funding channels to support large industrial projects, such as banks and the development finance sector. Industrial financing support such as government schemes, development finance and tax incentives, and the country's 13 special economic zones (SEZ) can reduce project risks and raise returns on investment.

In a society with extraordinary levels of unemployment and poverty, all efforts will need to be made to find commercially sustainable ways to create new jobs in the private sector, to complement what can be done through public employment opportunities. New job growth will be stimulated by the demand for the production of goods and services, which can come from a combination of expanded domestic demand and increased exports. To create jobs on a scale, we must pursue these drivers of new private-sector job growth.

John McClure, General Manager of ACTOM Power Systems, added, "at the outset of a new contract, we get in touch with the local ward councillor to collaborate and strategise on the embedded localisation potential within the contract's scope of supply. With the councillor's guidance, a Community Liaison Officer (CLO) serves as a conduit within the ward.

A labour histogram is drafted to forecast the project's human resources requirements, with the CLO performing an agency function to attain our fluctuating resource requirements. Additionally, we compile a list of subcontract opportunities circulated amongst local business forums to assist in identifying fledgling ventures for participation".

Conscripts are appointed under the Expanded Public Works Programme (EPWP) initiative, primarily focused on providing poverty relief and skills development through temporary work for the unemployed.

On-the-job training is given on construction skills, including bricklaying, plastering, painting, concrete formwork, cable terminating and electrical wiring. At any given time, there is usually a team of eight to fifteen EPWP personnel working alongside a site crew at each substation, with wages set at the prescribed rate. Thus, while their engagement is only transitory, the skills transferred can improve their future employability prospects and possibly even inspire some to go into business themselves.

All such work is performed under the supervision and assistance of ACTOM'S in-house site management structure as we ultimately assume accountability for overall contract delivery irrespective of whom performed each task. Often special arrangements are required to facilitate such works in terms of procurement assistance or preferential payment terms.

With ACTOM's John Thompson division, most construction, maintenance, repair and services projects for large SOE, government, quasi-government, and private organisations require that they complete one or more of the following with their project scope:

- Skills development of locals
- Enterprise Development of local small black-owned businesses
- Supplier Development of local small black-owned businesses
- Corporate Social Investment in local communities
- Subcontracting to local black-owned Emerging Micro Enterprises (EME) and Qualifying Small Enterprises (QSE) businesses

"The localisation obligations are intended to benefit local communities which generally have high unemployment rates, widespread poverty, low education qualifications and which communities are rural or peri-urban in nature", said Shardanand Seeth, Business Development Executive of John Thompson Division.

"All SOE and large corporate clients impose these requirements on us as contractual obligations – and our performance is measured against these commitments. Non-compliance generally carries a financial penalty for the company", he added.

Genlux Lighting, an ACTOM Business Unit, uses a programme whereby sub-assembly and supply are done through two local SMME companies under Enterprise development and Supplier development. "This is hugely beneficial to both Genlux Lighting and the SMME companies", said Sello Tsoai, General Manager, Genlux.

The SMME companies are set up with all required equipment, tooling, and systems relevant to Genlux Lighting's production requirements according to their specification.

As a manufacturer of traditional electric elements and thermostats for domestic use, Satchwell came under severe price pressure in the early 2000s due to imports from the Far East. Many of Satchwell's Original Equipment Manufacturers (OEM) customers could not sustain their businesses due to the imported completed product (small household appliances). Certain large household appliance manufacturers (kitchen stoves and domestic hot water cylinder manufacturers) were bought over by overseas enterprises with their own supply chains.

Localisation is a word that appears in each of the economic recovery strategies published by the Presidency, Nedlac, numerous political parties and Business SA. "Localisation will benefit Satchwell extensively by creating employment opportunities for its support industries, supplying a vast array of raw material and componentry to the organisation. For Satchwell, as for many other businesses, it can only be a good thing", said Arno Muller, General Manager, Satchwell.

According to Cashbah Zwane, CEO of ACTOM High Voltage Equipment, "I want to see us manufacture better and efficiently and have advanced our products, bringing it into the 4th Industrial Revolution arena. Industry 4.0 enables continuous resource productivity and efficiency gains to be delivered across the entire value network."

The Fourth Industrial Revolution is more than just technology-driven change; it is an opportunity to help everyone, including leaders, policymakers and people from all income groups and nations, harness converging technologies to create an inclusive, human-centred future. "If companies can just buy local and refrain from importing, South Africa might have a chance", he concluded.

The responsibility to drive the South African economy lies squarely on our shoulders. The government must adopt the appropriate structures and controls. The private business sector must locally source, manufacture, produce, and encourage skills development, whilst the public must buy locally produced products and services. wn

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Manufacturing and the Circular Economy

A MORE COMPETITIVE SOUTH AFRICAN MANUFACTURING SECTOR THROUGH A CIRCULAR ECONOMY

The circular economy is a concept gaining widespread traction globally as an effective approach to achieving a sustainable, resource efficient, and low-carbon economy, with added potential to unlock new jobs and businesses. According to the South African government, the circular economy represents a new growth opportunity for South Africa. The implementation of which will require an innovative, transdisciplinary, science, technology and innovation-based strategy, to reduce costs, and create jobs and industries that benefit the economy, citizens and the environment.

In this regard, the CSIR initiated a study to evidence South Africa's transition towards a more circular economy.

The study aims to identify opportunities offered by the transition towards a circular economy, by addressing the following research questions:

1 What is the current development path for the South African manufacturing sector?
2. What could a circular development path for the manufacturing sector look like?
3. What are the business opportunities presented by a circular development path?

An overview of the circular economy concept and key underlying principles are discussed in this report from a manufacturing perspective. A synopsis of the current status of the South African manufacturing sector, as well as challenges and opportunities are presented. This is followed by the proposal of specific circular economy interventions through which the resilience, competitiveness and growth of the South African manufacturing sector can be improved. A range of circular economy related business opportunities within the South African manufacturing sector are also highlighted as a means for the sector to embrace circular economy thinking and practices and grow existing businesses.

The methodology employed included an initial desktop study aimed at understanding the relevance of the circular economy to the manufacturing sector. This was followed by a more in-depth study which involved collating secondary data through literature review, gathering primary data through stakeholder engagements, survey questionnaires, and stakeholder workshops / focus group discussions.

The combined outcomes of the desktop study, data collection and stakeholder engagements allowed the project team to answer the research questions from a manufacturing sector perspective.

The analysis of the current development path of the South African manufacturing sector confirms its strong dependence on the access to resources such as

energy, water, and materials, making it highly vulnerable to insecurity in supply. The South African economy is heavily dependent on the export of un-beneficiated minerals and unwrought base metals linked strongly to resource extraction from the mining sector. There is also a strong dependence on the import of finished products due to a lack of value addition and localisation in the South African manufacturing sector.

An evaluation of circular economy principles and practices, including an assessment of global case studies, highlighted the potential for the circular economy to transform the sector in terms of resilience, competitiveness and sustainability, with the added potential for economic growth and job creation in line with global trends.

Stakeholder engagement provided valuable insights into the current status of the sector with respect to the circular economy, revealing a relatively mature level of development and implementation in certain industries, but much room for expansion and scaling of circular economy interventions overall. The extent of sectoral readiness in embracing circular interventions varies widely, with some measures at a more advanced stage (e.g. material looping; resource efficiency and cleaner production; and renewable energy technologies) while certain interventions are considered to be at a lower level of readiness (e.g., green steel manufacturing, chemical leasing, circular design and manufacturing, circular business models, and bio-based fuels / materials) and will require greater action to fast-track.

Stakeholders also highlighted the challenges the sector faces in attempting to roll-out circular economy interventions, including the lack of awareness; the cost of implementing and the lack of sustainable financing mechanisms; lack of appropriate skills and local case studies / demonstration projects; and the lack of available markets.

The stakeholder feedback provides an important industry perspective regarding the South African manufacturing sector's circular economy development path, measures already implemented or planned, as well as opportunities to grow circular economy interventions within the sector. The evaluation provides clear evidence that the circular economy offers the sector opportunities to enhance its sustainability in terms of resource utilisation, water and energy consumption, greenhouse gas emissions reduction, and waste valorisation, all of which would contribute to the sector and economy as a whole in achieving climate and sustainability goals.

1. INTRODUCTION

1.1 BACKGROUND

The Circular Economy (CE) is a concept gaining widespread traction as an effective approach for achieving a sustainable, low-carbon economy, with added potential to unlock new job opportunities and business enterprises.

Decarbonising the global economy is a necessary transformation for mitigating environmental challenges due to population growth, carbon-intensive technologies and the predominant linear 'take-make-waste' economic model.

The Department of Science and Innovation's (DSI) White Paper on Science, Technology and Innovation (STI), approved by Cabinet in March 2019, is one of the first South African policy documents to consider the circular economy in terms of its long-term economic growth potential (DST, 2019). The National Advisory Council on Innovation (NACI), an entity of the DSI, listed the circular economy as one of nine priority STI domains for South Africa.

According to the DSI, the circular economy represents a new trajectory for South Africa, the implementation of which will require an innovative, transdisciplinary, STI-based strategy to reduce costs, create jobs and industries that benefit the economy, citizens and the environment. According to the DSI's Deputy Director- General, Mr Patel, "the circular economy is a very important element of a concept we are taking forward in the innovation policy space, namely innovation for transformative change. It is aimed at a deep-seated change that re-orientates societies to a much more sustainable, fairer world." (DSI, 2019).

1.2 OBJECTIVES

In this regard, the CSIR initiated a study to evidence South Africa's transition towards a more circular economy through STI. The study aims at mapping an appropriate development path for the local economy and, to identify business opportunities offered by the local transition towards a circular economy.

A strong evidence base, combined with circular technological and social innovations, is intended to inform good policy- and strategy-making for both government and the private sector, and support the local transition to a more circular economy. The first phase of this study focussed on three key industrial sectors, namely mining, agriculture and manufacturing.

Circular economy related business opportunities are explored within each sector as well as cross-cutting activities between these sectors. This report presents the findings on the role of the South African manufacturing sector (SAMS) in a circular economy.

The following research questions were addressed:

1. What is the current development path for the South African manufacturing sector?
2. What could a circular development path for the manufacturing sector look like?
3. What are the business opportunities presented by a circular development path for the sector?

An overview of the circular economy concept and key underlying principles are discussed in this report from a manufacturing perspective. A synopsis of the current status of the South African manufacturing sector, challenges and opportunities are then presented. This is followed by the proposal of specific circular economy interventions (CEIs) through which the resilience, competitiveness and growth of the South African manufacturing sector can be improved. A range of circular economy related business opportunities within the South African manufacturing sector are also highlighted as a means for the sector to embrace circular economy principles and practices, grow existing businesses, and unlock new business opportunities.

1.3 METHODOLOGY

The methodology employed to answer the above research questions, included an initial desktop study aimed at understanding the relevance of the circular economy to the manufacturing sector. This culminated in the publication of a short, introductory briefing note entitled "Supporting the development of a globally competitive manufacturing sector through a more circular economy" (Fazluddin et al., 2021). The initial concepts of the research that were documented in the briefing note were presented at the CSIR Circular Economy project launch held in November 2021 and published by the CSIR in a book entitled "The circular economy as development opportunity" (Godfrey, 2021).

This was followed by a more in-depth study which involved collating secondary data through literature review, gathering primary data through stakeholder engagements, survey questionnaires, and stakeholder workshops / focus group discussions, which allowed the project team to answer the above research questions for the manufacturing sector.

1.3.1. CIRCULAR ECONOMY INTERVENTIONS FOR THE SOUTH AFRICAN MANUFACTURING SECTOR

In order to assess the validity, or relevance of the proposed interventions, an external stakeholder survey was conducted whereby an online questionnaire was designed using LimeSurvey. Following a team review and approval of the questionnaire, the online survey went live on the 25 January 2022, and remained active until the 18 February 2022. A selected list of key, external stakeholders were invited to participate in the survey based on their role and experience in the sector. A total of 65 external stakeholders were invited to participate, spread across the private sector, government and non-governmental organisations (NGOs).

The survey questionnaire was divided into 3 parts: Part 1 capturing respondent demographics, Part 2 capturing prior/

current involvement with circular economy related projects including affiliations to organizations such as the African Circular Economy Network (ACEN), African Circular Economy Alliance (ACEE), Ellen MacArthur Foundation (EMF), etc. Part 3 assessed stakeholder opinions on the proposed circular economy interventions. Participants were also prompted for more detailed comments on specific questions to gain further insights and opinion.

In parallel with the online survey, participants were invited to a virtual webinar-based workshop entitled "Circular economy interventions for the South African Manufacturing Sector" held on the 24 February 2022. A key focus of the workshop was a presentation of the survey results, with the aim of further assessing the relevance of the proposed circular economy interventions, the perceived sectoral readiness to implement these measures, and a gauge of the extent to which stakeholders considered specific interventions already implemented, or in progress of implementation.

Based on the combined outcomes of the survey responses and workshop participation, a shortlist of 14 key stakeholders were invited for one-on-one interviews aimed at gathering more detailed insight regarding circular economy opportunities in the South African manufacturing sector. Of the total invited, six stakeholders accepted the invitation and were interviewed. Pertinent points arising from the one-on- one discussions are discussed in Section 4.

This report is presented in three sections. Section 2 reviews the current development path for South African manufacturing sector. Section 3 presents an outline of the circular economy from a manufacturing perspective. The final section, Section 4 explores the circular economy development path for the South African manufacturing sector.

2 CURRENT DEVELOPMENT PATH FOR SOUTH AFRICAN MANUFACTURING SECTOR

2.1 OVERVIEW OF THE SECTOR

The South African manufacturing sector (SAMS) has suffered from de-industrialisation over the past two decades, mimicking global trends (Buchholz, 2020). There is a need for systemic shifts in production and consumption patterns so as to enable effective resource utilisation to achieve sustainable economic growth, preserving natural capital and improving socio-economic wellbeing. However, the local manufacturing sector continues to operate predominantly on the linear 'take- make-dispose' economic model, plagued by excessive resource demand, unsustainable production and consumption patterns, and high levels of wastage (Nahman et al., 2021).

Various policy and economic drivers have resulted in a declining demand from South Africa's main export markets, which has seen the sector's GDP contribution fall from over 20% in 1993 to 13% in 2020 (IDC, 2021). The SAMS, despite its decline, remains a sizeable contributor to national greenhouse gas (GHG) emissions, largely through the sector's fossil-based energy use, and liquid fuel demand (DFFE, 2021).

The heavy economic dependence on resource extraction in favour of exports is well recognised (Khan et al., 2022). Despite massive inputs of natural resources, productivity within the manufacturing sector remains low, while significant volumes of waste and pollution are generated (Von Blottnitz et al., 2021).

2.1.1 ECONOMIC SIGNIFICANCE OF THE SECTOR

The SAMS ranks fourth in GDP contribution, embodying a diverse list of sub-sectors, each demanding a broad range of resources, processed materials and finished products. The main sub-sectors by contribution (%) are as follows (StatsSA, 2018):

- food and beverages (26%)
- petroleum and chemical products (including plastics and plastic products) (24%)
- basic iron and steel (19%)
- wood products, paper and printing (11%)
- motor vehicles, parts and accessories (7%)
- glass and non-metallic mineral products (4%)
- textiles and clothing (3%)
- furniture and other manufactured products (3%)
- electrical machinery (2%)

The three largest sub-sectors account for over two thirds of manufacturing activity (IDC, 2021). Despite the sectoral GDP doubling since 1994, its contribution to national GDP has declined, forcing labour migration towards the services industry (Buchholz, 2020).

The manufacturing sector has high resource demands, relying strongly on primary and secondary processing of extracted resources (e.g. base metals) and other feedstocks. These finite resources face increasing risk from over-exploitation (Khan et al., 2022).

Moreover, the country mostly exports un-beneficiated ores and unwrought base metals, apart from motor vehicles, and associated spares and accessories.

The lack of local beneficiation is exacerbated by high levels of manufactured imports (>80% in 2020), comprising (IDC, 2021):

- motor vehicles, parts and accessories (13.6%) ▪ machinery and equipment (11.9%)
- chemical products (8.9%)
- basic chemicals (5%)

In addition, the sector draws 52% of national energy demand (DoE, 2019) (Figure 1) and 3% of the national water allocation (Figure 2) (GreenCape, 2021). Electricity costs have outpaced inflation for over a decade, exceeding R9Bn by Q3 2019 for the iron and steel subsector alone (Creamer, 2019). Blackouts have led to production losses, rising costs, reduced competitiveness and investment. Over 80% of sectoral energy is sourced from coal-fired utilities, a major source of GHGs for South Africa (USAID, 2021).

2.1.2 HISTORICAL TRENDS AND RESOURCE DEMANDS

The strong dependence on resource extraction and base metal exports is a long-standing issue as reflected by the multi-decadal trends shown in Figure 3. It is evident from these trends (Figure 3) that metals and mining have collectively contributed the major share of South Africa's total export basket for several decades, with a decline in output of gold but an increase in iron ore and PGMs over this period (IDC, 2021).

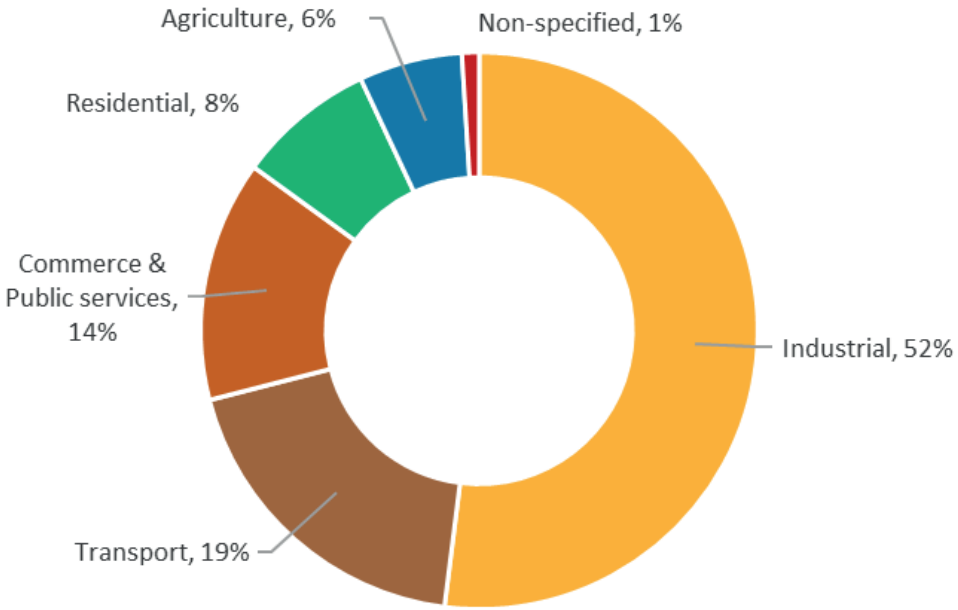


Figure 1: Energy demand in South Africa (DoE, 2019)

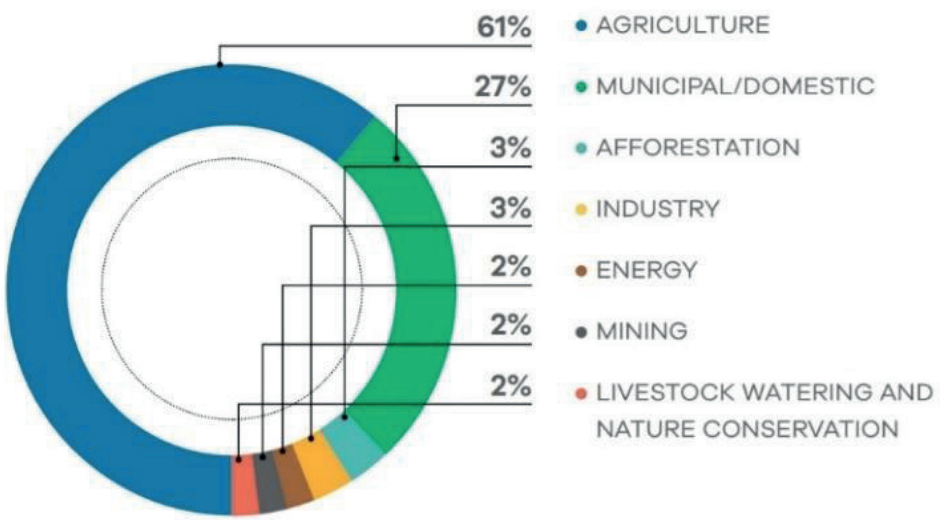
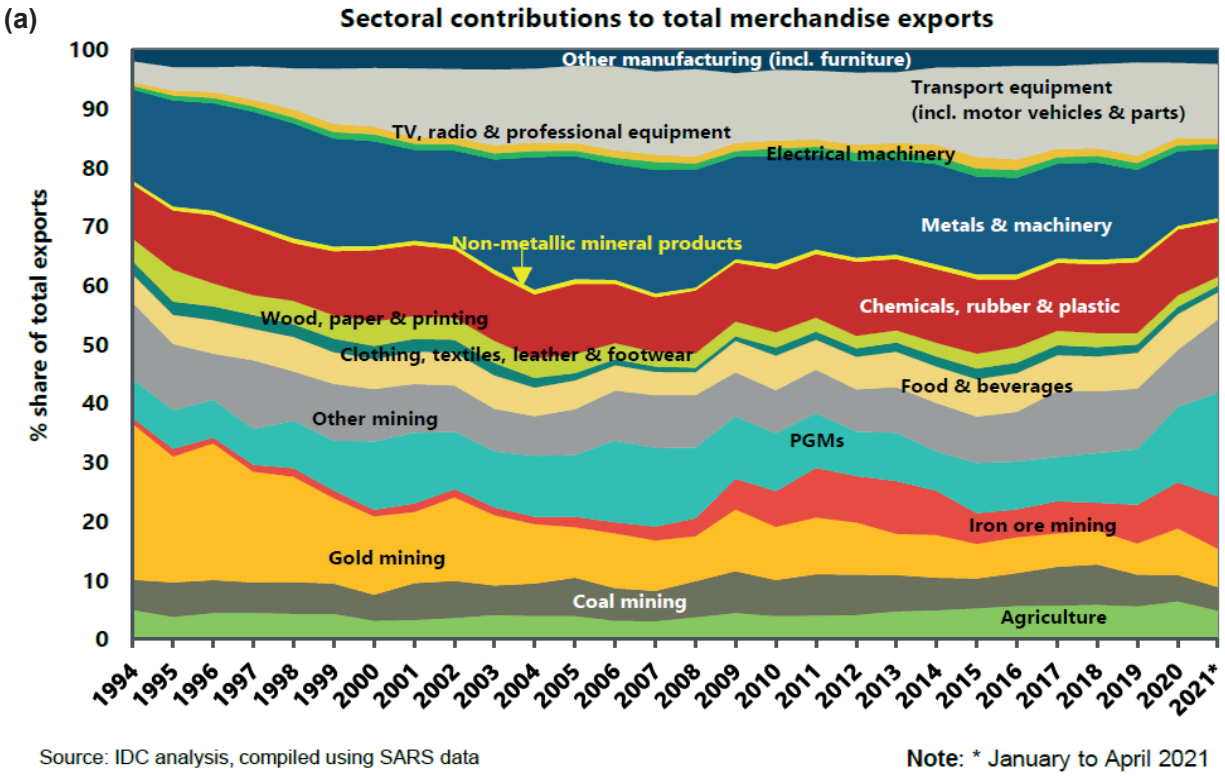


Figure 2: Water allocations in South Africa (GreenCape)

It is important to note that the extraction of resources under 'other' mining includes additional minerals such as ferrochrome, manganese, vanadium and titanium-bearing ores. Some differentiation is also necessary given the fact that PGMs include smelted and base metals (unwrought), which are essentially under-beneficiated. Iron and steel, as well as other base metals are included under 'metals and machinery' and are exported as unwrought product.

Thus, sectoral exports are strongly dependent on resource extraction exported without significant local beneficiation. Figure 3 also confirms this as a long- standing historical issue with PGM exports appearing to have returned to pre-1994 levels. Demand is likely to exceed these levels due to global demand for PGM base metals for a wide variety of applications such as catalysts, transport, telecoms, etc. (Khan et al., 2022). The export of 'Other Mining' products also shows a rising trend signifying a rise in export demand for these minerals.

A positive trend which cannot be ignored is the massive growth in the export of transport equipment, the bulk of which is made up of motor vehicles, parts and accessories. Whilst this has contributed positively to the growth of the South African manufacturing sector, it is important to note that almost all of the motor vehicle exports are driven by overseas-based Original Equipment Manufacturers (OEM) and their respective markets.



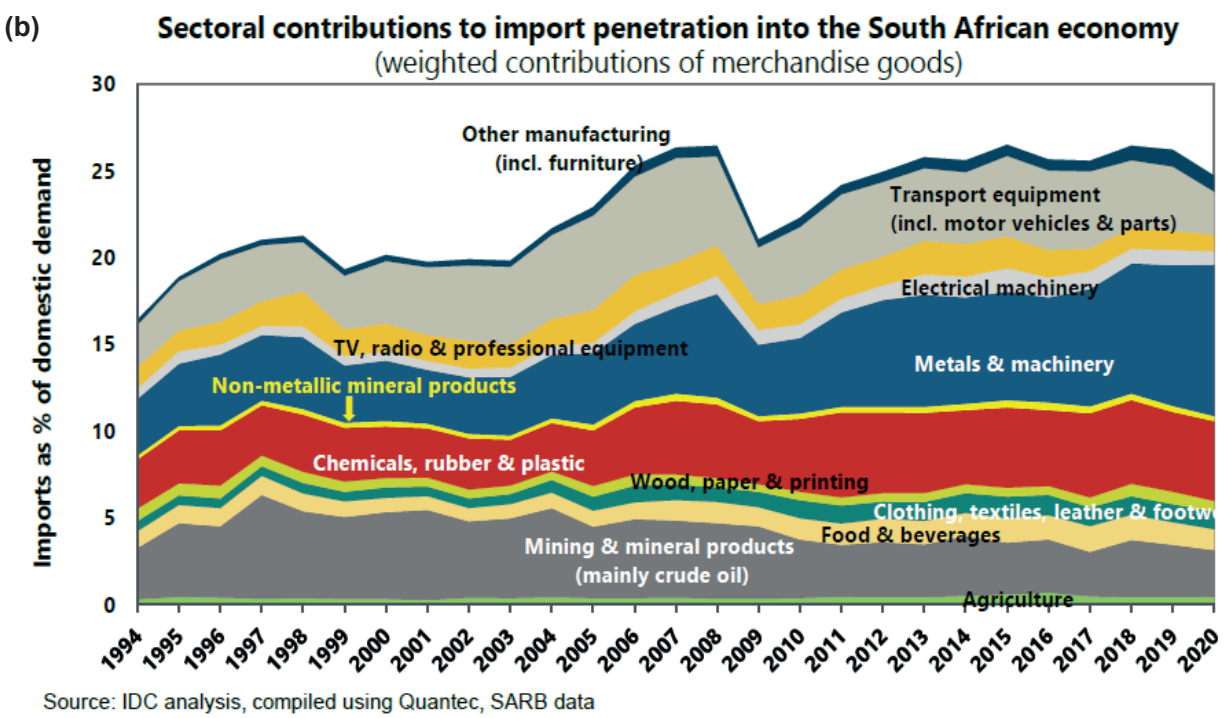


Figure 3. Sectoral contributions (a) % of exports; (b) imports (% of demand) (IDC, 2021)

Sectoral imports since 1994 highlight the strong dependence on petroleum, chemicals, machinery and transport equipment. It is clear that the growth in the export of transport equipment has corresponded somewhat with a growth in the import of transport equipment, parts and accessories. This is likely to relate to the local, OEM based manufacture of motor vehicles for which import of parts are a requirement. Metal and machinery imports also grew

notably, signifying a heavy dependence on base metals, including wrought metal products for manufacture of finished goods, particularly where the local manufacture of such materials may be limited or non-existent. The trends also indicate a growing dependence on imports of machinery and equipment needed for the local manufacturing sector. The import of 'mining and mineral products' refers mainly to crude oil and appears to have been stable over the period shown.

2.2 CURRENT ECONOMIC STATUS AND RESOURCE DEMANDS

The provincial contribution to manufacturing is represented in Figure 4. The figure highlights the dominant role of mining in geographically endowed provinces and the significant contributions to provincial GDP from the financial and government services sectors. An evaluation in terms of provincial sectoral contributions reflects again the heavy dependence on resource extraction driven by the dire economic need to generate revenue and balance fiscal deficit. Manufacturing is surprisingly strong in some less urbanised provinces which enjoy contributions from the automotive industry (Eastern Cape) and, Paper & Pulp industry (Mpumalanga). The performance of the manufacturing sector remains curtailed by the low demand in South Africa's main export markets in the developed world (TIPS, 2021).

The manufacturing sector labour intensity is indicated in Figure 5. The largest sub-sector in terms of employment, is the food and beverage sub-sector, followed by chemicals and petroleum, and metals and metal products. Notably, the metals sub-sector exceeds both these in terms of employment, an indication of a higher labour intensity for this sector. Importantly, the automotive sector employs fewer workers but exceeds the metals and metal products sub-sector with respect to income, highlighting the economic significance of the transport segment.

Despite GDP doubling since 1994, growth has largely been outside of manufacturing with the sector suffering persistent decline across sub-sectors and corresponding job losses. The resultant loss in manufacturing jobs has had a serious impact with labour shifting to the services industry and unwanted de-industrialisation. The end of the super-commodity cycle, global steel glut, and poor policy-making has seen sectoral GDP falling from over 20% in 1993 to about 13% in 2021 (TIPS, 2021).

The manufacturing export basket has changed over the years, with notable growth in motor vehicle exports, including parts and accessories. This sub-sector contributes a third of sectoral GDP and produced over 500,000 vehicles on an annual basis by 2020. The main destinations are

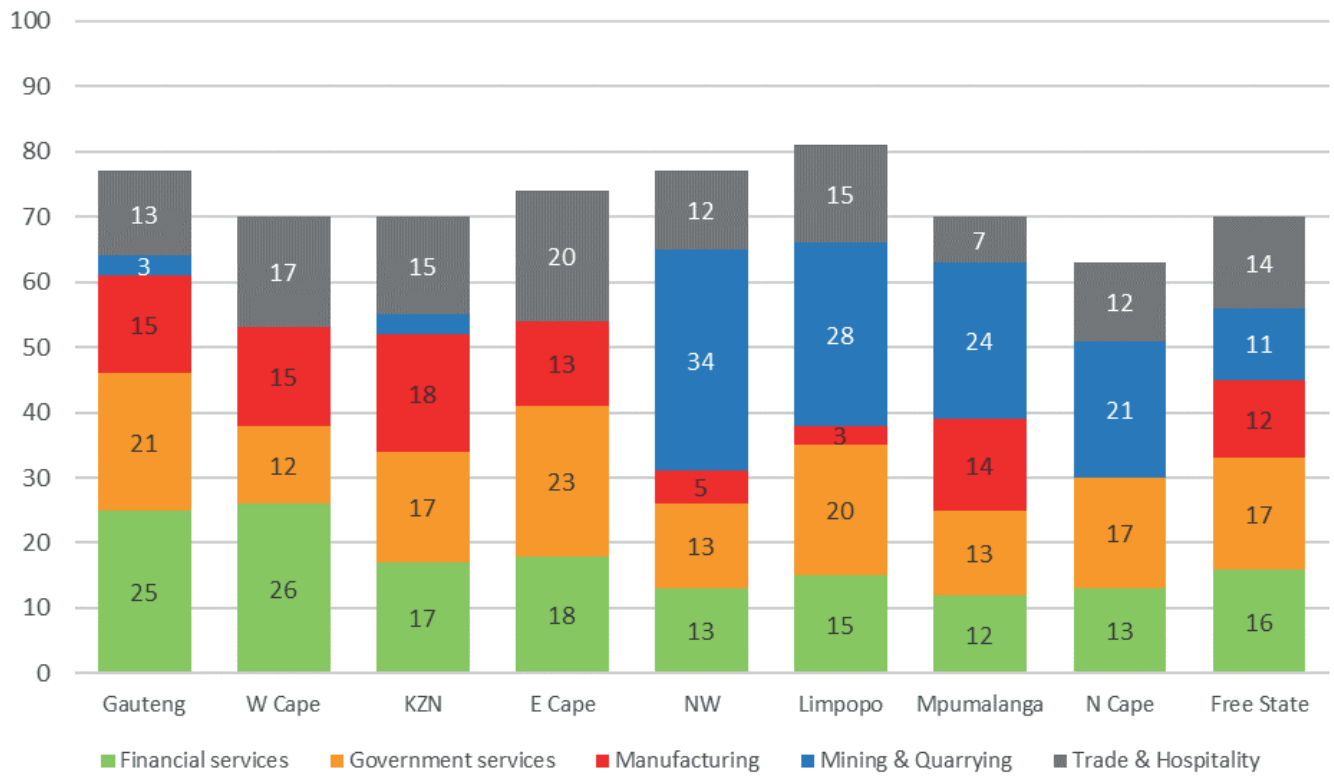


Figure 4. South Africa's provincial contribution to manufacturing sector (red) (% Revenue, RBn) (TIPS 2021)

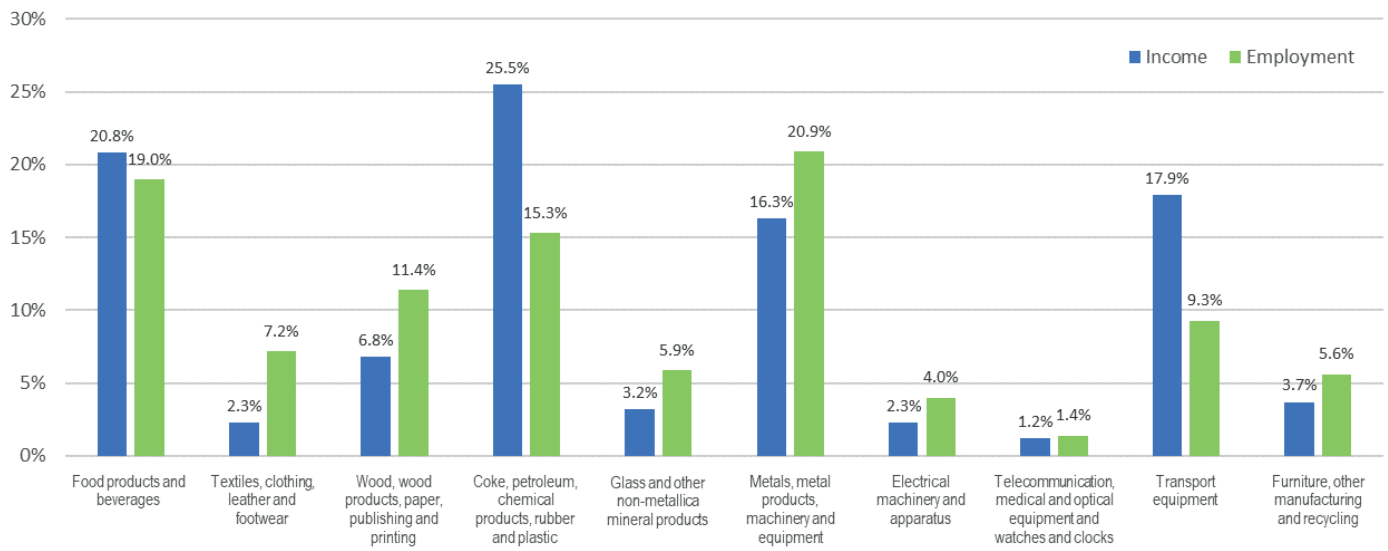


Figure 5. Manufacturing sub-sector contributions to income and employment, Q4 2019 (SAMI, 2019)

Asia, Eurozone and USA, but Africa represents the biggest export market for SA- manufactured goods, with Botswana, Namibia and Zambia as key SACU members. Whilst the strength of auto exports is viewed as an indicator of international competitiveness, there is underlying risk given that sectoral investment is mainly from foreign-based OEMs, whose global outlook is veering sharply towards Electric Vehicles (EVs) and Fuel cell electric vehicles (FCEVs).

Under-utilisation of manufacturing capacity has also been a challenge due to weak economic demand, persistent causes being insufficient demand, a shortage of raw materials, and labour. Increasing levels of imports may also contribute to under-utilisation due to a reduction in the need for local manufacturing. Energy supply and security remains a critical challenge as costs have outpaced inflation over the past decade. Electricity costs in the basic iron and steel subsector exceed R9Bn, and R2Bn in the basic non-ferrous metals industry. Blackouts contribute to lost production, raising costs and lowering competitiveness which has dampened investment in the sector. Despite recovery, trends remain volatile, due to fluctuating input costs, increasing fuel and energy costs, impending carbon border-taxes and exchange rate volatility. There is a skills shortage, regarding education levels and required mix of soft and hard skills the industry demands (Creamer, 2019).

2.3 POLICY LANDSCAPE

In shifting local industry towards the circular economy, numerous government policies, industry master plans, and strategic plans need to be considered. According to Creamer (2019), industrialisation coupled with increasing investment are a key focus of government policy, focusing on sectors with greatest potential for growth: automotive, textiles, leather and footwear, gas, chemicals and plastics; renewable energy, including steel and metal fabrication.

Massive potential for job creation is foreseen in small- and medium-sized enterprises which must be included in manufacturing value chains. Circular economy opportunities arise based on the call towards enhanced localisation, energy efficiency coupled to GHG mitigation and fossil-fuel abatement, waste reduction and recycling.

In May 2018, government released the 10th Industrial Policy Action Plan (IPAP) (dtic, 2018), designed to tackle the decline in manufacturing and focus on transformation. Since inception, the IPAP has seen notable success, doubling production and job creation in the automotive sector, reviving the ailing tooling industry and boosting the clothing, textiles, leather and footwear sectors. Importantly, the IPAP exploits public procurement by designating certain sectors or products for local procurement based on preferential procurement regulations, viz. rail rolling stock, transformers and power pylons, transport equipment and vessels. The Black Industrialists Scheme (BIS) launched under IPAP (2015) has realized over 100 projects, R13Bn in private investment and 9000 jobs.

Circular economy opportunities also reside in the development of Special Economic Zones (SEZ Act, RSA 2014) given the massive investment and job creation potential. Eleven SEZs have been designated nationwide, some of

the more pertinent zones being the following: OR Tambo SEZ announced recently for the manufacture of fuel cells; Platinum Valley SEZ (Bojanala, NW) is earmarked for auto-catalyst manufacture and platinum recycling; Northern Cape SEZ (solar PV and renewables) and Tshwane Automotive SEZ. The Coega SEZ has developed into the largest with 43 operational investors worth R10Bn and 8000 direct jobs created. The Dube TradePort (KZN) is forecast to attract R18Bn of investment in its second phase of expansion, generate 12,000 jobs and R3Bn in private investment (Creamer, 2019). The African Continental Free Trade Agreement (AfCFTA) came into effect from May 2019 creating the largest global free-trade zone with a consumer market exceeding a billion consumers. South Africa is thus uniquely positioned to benefit from the increased continental trade and deeper regional integration. A priority is the listing products to be covered under AfCFTA, and 'rules of origin' as to what qualifies as a locally manufactured article.

The launch of several industry Master Plans presents further opportunities for sectoral growth and enablers towards a more circular economy. A strategic mandate of the Master Plans is localisation driven by preferential government procurement and security of raw materials, chemicals and equipment supply for local industry. The Steel Industry Master Plan (dtic, 2021) mandates locally manufactured primary steel for all key infrastructure programs including value-chain development in capital equipment, construction, transport equipment and automotive, including a Transnet roadmap for procurement of rolling stock for rail infrastructure. Cross-border carbon taxes will penalise local manufacturing, unless applied equally to imported products, hence the target for local industry on carbon neutrality by 2050. Particular emphasis is placed on power-intensive industries such as steel mills, foundries, and smelters typically reliant on fossil-fuels. Increasing use of renewable power, gas, coupled to water efficiency, waste reduction and recycling, and the hydrogen economy form a collective part of the circular economy initiatives.

Emerging manufacturing development in the green-tech market (estimated at R30Bn) presents circular economy opportunities as well. NERSA exemption on self- generation up to 100MW enables embedded generation projects under a revised IRP, addressing not only energy security through regenerative approaches, but also making local solar panel, wind tower and turbine manufacture feasible. This provides opportunities for the development of circular products in renewable energy, water recycling and desalination plants. This transition will be accelerated by a more agile government trade and industrial policy framework to lower the embedded carbon in manufactured exports. The plans call on national R&D organisations to assist in developing the green industry and "implement circular processes."

2.4 SUMMARY

The South African manufacturing sector has seen a decline over recent decades in line with global trends however this has been exacerbated by several additional factors within the sectoral context. A heavy reliance on the export of un-beneficiated mineral resources and base metals, coupled with a weak demand for South African manufactured finished products as well as poor policy making, instability of energy supply, and lack of skilled labour. Long-term sustainability of the local manufacturing sector remains an ongoing challenge particularly given its predominant linear economic manufacturing approach. These factors have had a compounding effect in promoting under-utilisation of manufacturing sector capacity as well.

The sectoral contribution to GDP is dominated by three main sub-sectors, namely food and beverages (including tobacco), petroleum products and chemicals (including plastics and rubber), and metals, metal products, machinery and equipment. These being the largest in terms of both revenue and employment making up over 60% of the total sectoral contributions.

The metal and metal products sub-sector exceeds both the former sectors with regard to number employed. The particular economic significance of the transport (automotive) sector was noted based on the higher relative contribution to sectoral GDP against number employed. This possibly relates to a higher level of automation and mature technologies adopted by foreign OEMs that are incentivised to manufacture motor vehicles locally.

Importantly, the sectoral overview reveals that despite the weakened status of the South African manufacturing sector relative to other economic sectors such as finance, there are growing opportunities to improve the status quo via a circular economy approach. The IPAP calls for enhanced beneficiation of local resources and localisation of manufacturing capability to address ongoing socio-economic and sustainability issues, disregarding the fact that its implementation has already seen notable progress towards revitalising local manufacturing, driving preferential procurement policy and supporting black industrialists. The establishment of SEZs has also seen substantial investment towards manufacturing. The thematic manufacturing setup within these designated zones opening up substantial scope for implementation

of circular economy principles, as a means of enhancing resilience and competitiveness, creating sustainable jobs, and at the same time achieving climate and sustainability goals.

Coupled to these policy interventions promoting circular economy are various industry Master Plans and the drive by government towards the greening of the manufacturing sector and economy as a whole. The emphasis on security of supply of raw materials, preferential local procurement and infrastructure development towards locally established manufacturing value chains offer strategic levers by which a vibrant South African circular economy can be established. To cap these circular economy offerings in the making, developments in the renewables energy industry present a myriad of additional options for the application of circular manufacturing processes aimed at recycling, remanufacturing materials and components within the solar and wind energy sector, and decoupling of fossil-based energy demand via the hydrogen economy, including the adoption of EV's and FCEV's.

3 THE CIRCULAR ECONOMY - A MANUFACTURING PERSPECTIVE

3.1 INTRODUCTION

Circular solutions can be leveraged locally to fulfil national development objectives, climate obligations and Sustainable Development Goals, with emphasis on economic growth, poverty alleviation, infrastructure development and job creation (WEF, 2021).

The manufacturing sector has a pivotal role to play in driving re-industrialisation and the transition to a more circular economy. Indeed, the manufacturing sector, in close collaboration with other economic sectors, is centrally placed to design and implement the circularity of resources, with positive impacts on the economy, society and the environment. Manufactured products, chemicals, plastics and industrial machinery play a key role in the productivity and growth of both upstream and downstream economic sectors, such as mining, agriculture, mobility, energy, and water. Applying circular principles from the design of products, manufacturing companies can influence the production process, and indeed the entire product life cycle, including usage and end-of-life scenarios.

3.2 KEY PRINCIPLES

The World Economic Forum (WEF, 2021) defines a circular economy as:

"...an industrial system that is restorative or regenerative by intention and design. It replaces the end-of-life concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse and return to the biosphere, and aims for the elimination of waste through the superior design of materials, products, systems, and business models."

The circular economy is based on three key principles which collectively provide a systemic approach to addressing the challenges of resource extraction and demand, waste and pollution, as well as economic growth, helping to achieve economic resilience in the local manufacturing sector, as noted below:

1. Designing out waste and pollution: redesign manufacturing processes and products to enhance resource efficiency, coupled with sharing economy business models.
2. Keeping materials in use: remanufacture, refurbish, repair and recycle materials and products across value chains.
3. Regenerating natural systems: transition to green energy (solar, wind, hydrogen) and decouple resource utilisation.

It is important to differentiate circular economy thinking from the more well-known ideas of the green economy, waste recycling, etc. Conventional approaches to addressing environmental challenges (GHGs, climate change, habitat destruction, etc.) tend to focus on reducing impacts based on predominant linear production and consumption systems. Typical examples are improving production efficiencies and reducing material impacts to mitigate GHGs and improve resource utilisation.

This overlooks systemic flaws in the 'take- make-dispose' linear model, viz. product design and use, material choices, through to low utilisation and recycling rates of products and their component materials at end- of-life. Tight product cycles are a key differentiating factor of the circular economy, circumventing the loss of embedded energy, resources and labour that occurs with simple recycling and disposal (Figure 6).

Preservation of natural capital by controlling finite stocks and balancing renewable resource flows is key.

The circular economy model further distinguishes between technical and biological cycles, where biological materials (food, wood, etc.) are designed to feed back into the system via processes like anaerobic digestion and composting, regenerate living systems, such as soil or the oceans, which in turn provide renewable resources for the economy.

Technical cycles recover and restore products (e.g. appliances), components (e.g. printed circuit boards), and materials (e.g. steel) through strategies like reuse, repair, remanufacture or recycling.

Ultimately, the circular economy aims to optimise resource use by constantly circulating products, components, and

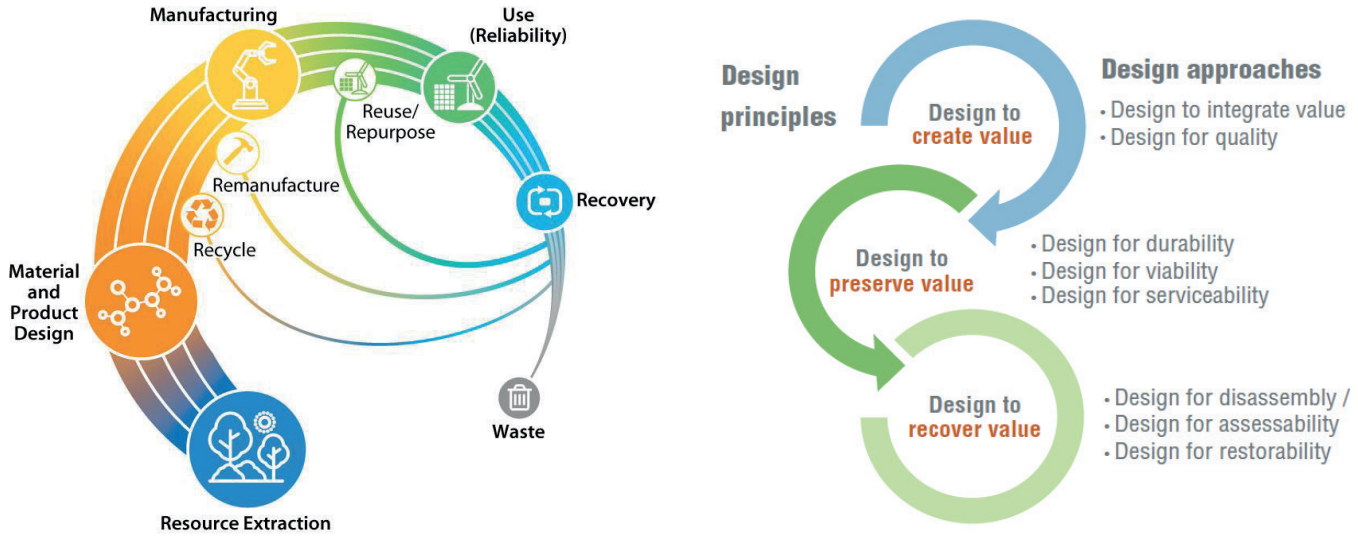


Figure 6. Integration of circular economy into manufacturing (NREL)

materials at their highest utility in both cycles (Valencia, 2017).

An ideal circular economy aims to benefit business, environment and society collectively, maintaining natural resources at highest value ensuring re-entry into the economy, never ending up as waste. This implies a fundamental shift in thinking by regenerating natural capital, designing for zero waste and using renewable energy and resources.

This idealised model demands co-ordination across value chains, including public and private sectors to achieve the desired transformation.

The transition to a circular economy relies on a new approach to product and system design, founded on three requirements:

- The ability to create value
- The ability to protect and preserve value
- The ability to easily and cost-effectively recover value

The way products are designed, produced, sold, used and re-used, collected, and reprocessed must be re-invented by design to distribute value across the entire industry, enabling a systemic approach to mitigate the growing challenges of resource extraction and consumption, waste generation and environmental impacts.

3.3 GLOBAL TRENDS

Global trends demonstrate that the circular economy offers a framework for sustainable economic growth and human prosperity, as well as a means to enhance innovation and competitiveness. Local and international case studies highlight the benefits reaped by many countries that have implemented circular economy programs as part of national policy and economic framework.

The newly adopted EU Circular Economy Action plan is one example, forming one of the main anchors for a regional, sustainable growth agenda in the form of the European Green Deal. The plan focuses on design and production for a circular economy ensuring that resources are continuously recirculated within the economy (EC, 2021). Additional examples are the Euro Commissions' Circular Economy Package (2016), Netherlands' nationwide program for a circular economy (2016) and China's 13th 5 Year Plan (2017).

The following sections highlight three disruptive global trends in the manufacturing sector:

- Remanufacturing
- Renewable energy technologies
- 4IR technologies

3.3.1 REMANUFACTURING

The UNEP report on remanufacturing (IRP, 2018) calls for a revolution in the way of producing and consuming, so as to move away from resource-intensive production and consumption models, towards low carbon, efficient processes, where innovation will be the motor of change. Remanufacturing and refurbishment are intensive, standardised industrial processes that provide an opportunity to add value and utility to product service life.

Repair, refurbishment, and arranging direct reuse represent maintenance processes that typically occur outside of industrial facilities, providing the opportunity to extend the products useful life. The report views this as essential for achieving the Sustainable Development Goals, specifically Goal 12: Sustainable Consumption and Production, given the contributions of such processes to climate goals.

The report showcases the merits of value-retention processes (VRPs) such as remanufacturing, refurbishment and reuse within three industrial sectors, and the benefits relative to the original manufactured product. Requirements for VRPs and VRP products must be built- into early-stage product specifications, planning and business case development, well before product designers are involved in the process.

For the circular economy to thrive, industry members must focus on design practices that create, preserve, and enable the recovery of value. In this manner, the material requirement, the energy used, the waste, but also the costs and the generation of jobs can be measured through first hand data from selected industries.

Relative to virgin production, VRPs require less new material and energy, generating less production waste and emissions per-unit. Studies suggest that at product- level, remanufacturing and comprehensive refurbishment can reduce GHG emissions between 79% - 99% in relevant sectors. Material savings via VRPs is also significant such that remanufacturing can reduce new materials required by 80% - 98% whilst direct reuse does not require any new materials input. Cost advantages of VRPs range, conservatively, between 15% - 80% of the cost of an OEM version of the product. VRPs rely on high-quality, durable products and components as inputs: there will always be a need for original manufacturing activity alongside VRPs and other circular economy practices.

Caterpillar's (CAT) remanufacturing program returns components at end-of-life to same-as new condition, reducing carbon, waste and raw material inputs. Caterpillar has developed a unique set of world-class salvage techniques and are able to remanufacture to the latest performance specifications, which is a crucial differentiator in the sector. Profit margins on remanufactured goods, up to 40%, can make this commercially viable, depending on the product. A challenge to the uptake of remanufacturing can be the lower cost of original goods (disregarding embedded costs). In some cases, repair, remanufacturing requires subsidisation as incentive.

3.3.2 RENEWABLE ENERGY TECHNOLOGIES (RET)

A truly circular economy demands a comprehensive approach to resource efficiency, one that not only addresses the use of raw materials, but also energy sources. It is important to note the significant investments being made towards renewable energy echnology (RET) projects in sub-Saharan Africa, as listed in Table 1 (Hundermark, 2021).

Dealing with the end-of-life waste that will emanate from these large-scale RET developments is an important future challenge. In this regard, important lessons for Africa reside in EU developments in the area of RETs. Whilst the EU considers RETs essential for Europe's transition to climate neutrality, there are notable challenges. Deployment, maintenance and replacement of this infrastructure requires significant resources, including many substances included in the EU's list of critical raw materials (CRMs).

Waste arising from end-of- life clean energy infrastructure is projected to grow up to 30-fold over the next 10 years, presenting significant opportunities to reduce the consumption of scarce raw materials by recycling metals and other valuable resources back into production systems (Figure 7). Circular economy approaches such as repair and upgrading of equipment and recycling of end-of-life infrastructure can underpin the sustainability credentials of the renewable energy transition (EEA, 2021).

Table 1. Current investments in RET Projects (sub-Saharan Africa)

Country	Source	Scale (MW)	Description of RET Development Project
Ghana	Solar	10-100	Government and Bui Power Authority announced plans to construct eight solar plants in Ghana (10MW-100MW size).
DRC	Solar	200	SNEL, state-owned utility signed power purchase agreement for two solar plants (100MW each) in copper belt region (> $300m)
Botswana	Solar	100	Shumba Energy secured $950k of $80m, 100MW solar project in Botswana - full funding expected by Q2 2022.
South Africa	Solar	100	Pele Green Energy-EDF Renewables consortium to construct 100MW plant as part of Anglo Platinum's broader strategy to integrate renewable energy with mining operations.
South Africa	Solar, wind	1000 wind 1600 solar	DMRE awards 5th bid of Renewable Energy Independent Power Producer Procurement Program (REIPPP).
Namibia	Green H2	5000	HYPHEN Hydrogen Energy selected as preferred bidder for first-ever large-scale green hydrogen project. (valued at $9.4Bn)

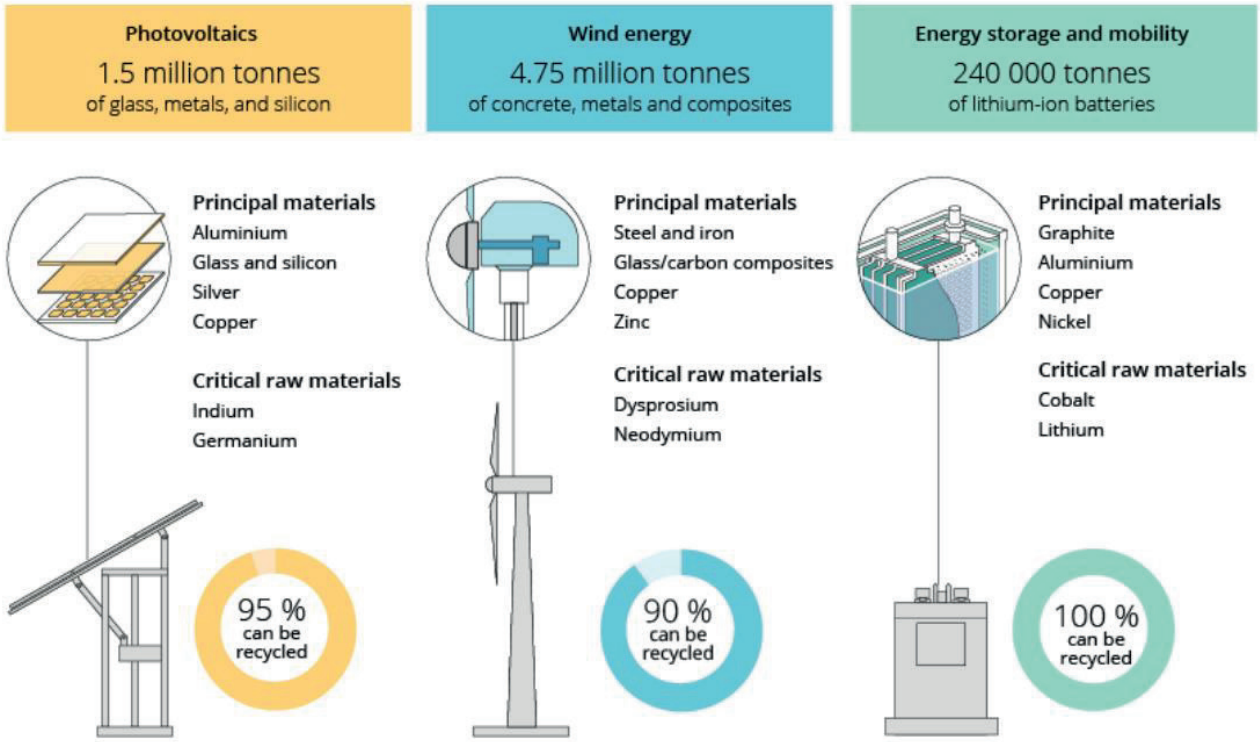


Figure 7. Material recovery opportunities from clean-energy sector by 2030 (EEA 2021)

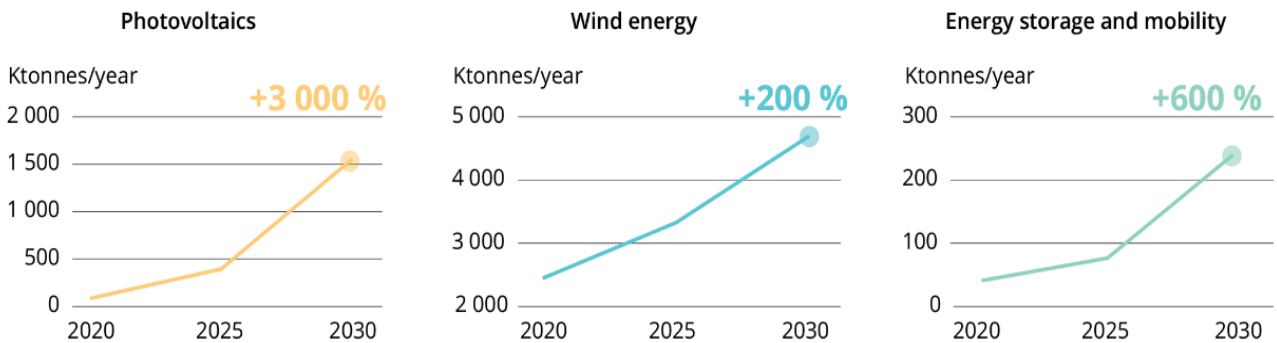


Figure 8. Expected growth of waste materials from the clean-energy sector (EEA, 2021)

Waste generation in the renewable energy sector is expected to undergo a dramatic increase in future (Figure 8) and will require attention from policy-makers. This increase will be challenging to manage, as end-of- life products may be widely distributed geographically. However, there are strong benefits as much of the wastes arising either belong to established recycling systems (e.g. steel, glass, aluminium); or are high-value critical raw materials.

The recovery of materials from renewable energy technologies and their reintroduction to production cycles, presents challenges such as (EEA, 2021):

- processing difficulties due to: use of composite materials; presence of hazardous substances; and low concentrations of more-valuable elements;
- equipment not designed to facilitate end-of- life/recyclability aspects;
- under-developed recycling capacity and technologies;
- market conditions do not properly price externalities of using virgin materials vs recycled;
- logistical issues due to remote locations, scale, and safety requirements on infrastructure.

Implementing innovative circular business models is often impeded because the ecological and climate benefits of using recycled materials are

not yet fully accounted for in the costs of the materials. Therefore, suitable secondary materials regularly have to compete on price with primary materials that are often cheaper. Timeframes are also important in developing policies and protocols for dealing with the future wastes generated by this sector. Much of the infrastructure being installed will have a relatively long service life, and as such provisions are required to plan now for the environmental and financial impacts of dealing with these wastes as they arise in future.

Applying circular economy principles in the design, manufacturing and application of renewable energy technologies will mitigate the impacts by:

- applying circular business models to maintain producer responsibility
- designing infrastructure in a circular manner to facilitate reuse of components
- supporting the development of recycling to maximise recovery of materials

3.3.3 4IR TECHNOLOGIES

The Fourth Industrial Revolution (4IR) presents unique opportunities for innovation in advanced manufacturing, while enhancing company competitiveness and contributing to the fulfilment of societal and environmental commitments. Scaling circular manufacturing will require disruptive, as well as digital technologies such as Internet-of-Things (IoT), digital twinning, big data, and blockchain, which allow for advanced tracking and monitoring of resource utilisation and waste.

A study by WEF (2019) on 4IR technologies in the Indian state of Andhra Pradesh identified six 4IR related interventions that could unlock $5Bn a year of sustainable value for its fast-growing automotive and electronics sectors. The Andra Pradesh manufacturers envisage 200,000 new jobs being created, thanks to existing and upcoming projects across various automotive segments. In the US State of Michigan, four 4IR technologies show potential to add $7Bn annually to its automotive sector. Andhra Pradesh and Michigan State are hubs for the Indian and US automotive sectors.

The WEF (2019) study showed that new mechanisms are being developed to facilitate the adoption of 4IR technologies by bringing key stakeholders together to exchange knowledge and launch new public-private partnerships. The platforms would be integrated in a Global Centre for Sustainable Production that would provide further strategic guidance, encouraging innovative action that makes manufacturers more competitive and manufacturing more sustainable. The next step is to drive on-the-ground action and facilitate the implementation of 4IR technologies for competitiveness and sustainable growth.

Three technologies were specifically identified for the automotive sectors (Andra Pradesh, Michigan):

- Cobotics 2.0 (collaborative robots): Robots designed to collaborate with human beings to execute tasks are used in manufacturing to remarkable efficiency gains
- Augmented workforce: Augmented reality (AR) layers computer-generated graphics on top of an existing reality to deliver information. In AP's automotive sector, AR/VR could help to skill the 200,000 employees predicted to join the sector
- Bio-based plastics: Heavy metal and plastic components can be replaced with high- performance elastomers, thermoplastics and composites made partially or wholly using plant feedstock and nanotechnologies making vehicles lighter and more fuel-efficient

For the electronics sector (Andra Pradesh), the following technologies were identified:

- 3D-printed electronics: 3DP components with metal substrates allows designers to build faster prototypes, reducing time to market and using resources more efficiently.
- Digital traceability of minerals: Blockchain-enabled software for precious and industrial metal markets can prevent "conflict minerals" from entering the value chains of electronic products.
- Advanced electronic design automation (AEDA): Simulation of electronics design that predicts material and component performance to optimise designs, in combination with machine learning can increase both design and production efficiency.

According to WEF (2019), these six technologies have the potential to create more than $5 billion in annual value whilst also supporting commitments to sustainability and circularity. There are however some risks associated with the adoption of 4IR technologies, some having a high energy footprint; others may lead to unemployment. Businesses must account for such potential negative externalities before implementing the technologies.

Additive manufacturing (AM) as a 4IR technology has clearly disrupted traditional manufacturing processes (machining, casting, injection moulding) enabling reductions in development costs, resource utilisation, waste and energy consumption. Its on-demand, digitally distributed manufacturing, allows for reduced physical inventories and more resilient supply chains. This enabling reductions in development

costs and time to market, resource utilisation, waste and energy consumption, with the potential to substitute or even replace traditional processes. These unique capabilities and the rapid product design and manufacture capability without the need for centralised facilities, independent of geographic location can support the circular economy in numerous ways. These advantages are highlighted in Figure 9.

According to Hendrixson (2020), *"The circular economy needs additive manufacturing as no other method offers the design freedom, or has the ability to produce in as small a footprint, spread around the globe, sending products through numerous small supply chains. Perhaps no other method is so capable of turning production on its head, and forcing manufacturers, designers, inventors and even consumers to think differently about what gets made, bought and used"*

Some key benefits of AM that support a economy include (Hendrixson, 2020):

- *New material options:* Ability to manufacture with renewable feedstock (recycled metal powder or bio- polymers)
- *Design freedoms*: Allow complex geometries without moulds or other incumbent tooling, parts can be designed using less material, reducing or eliminating in-process waste, and processing time. Consolidated assemblies save time and labour in production.
- *Sustainable manufacturing:* Digital platform offers more sustainable and efficient manufacturing, avoiding the incumbent costs of conventional manufacturing such as mould tooling, jigs and fixtures, oversized stock material, etc. On-demand manufacturing allows for reduced stock held in inventory with potentially smaller footprint than conventional injection moulding or machining; this fact along with the easy mobility of digital files makes

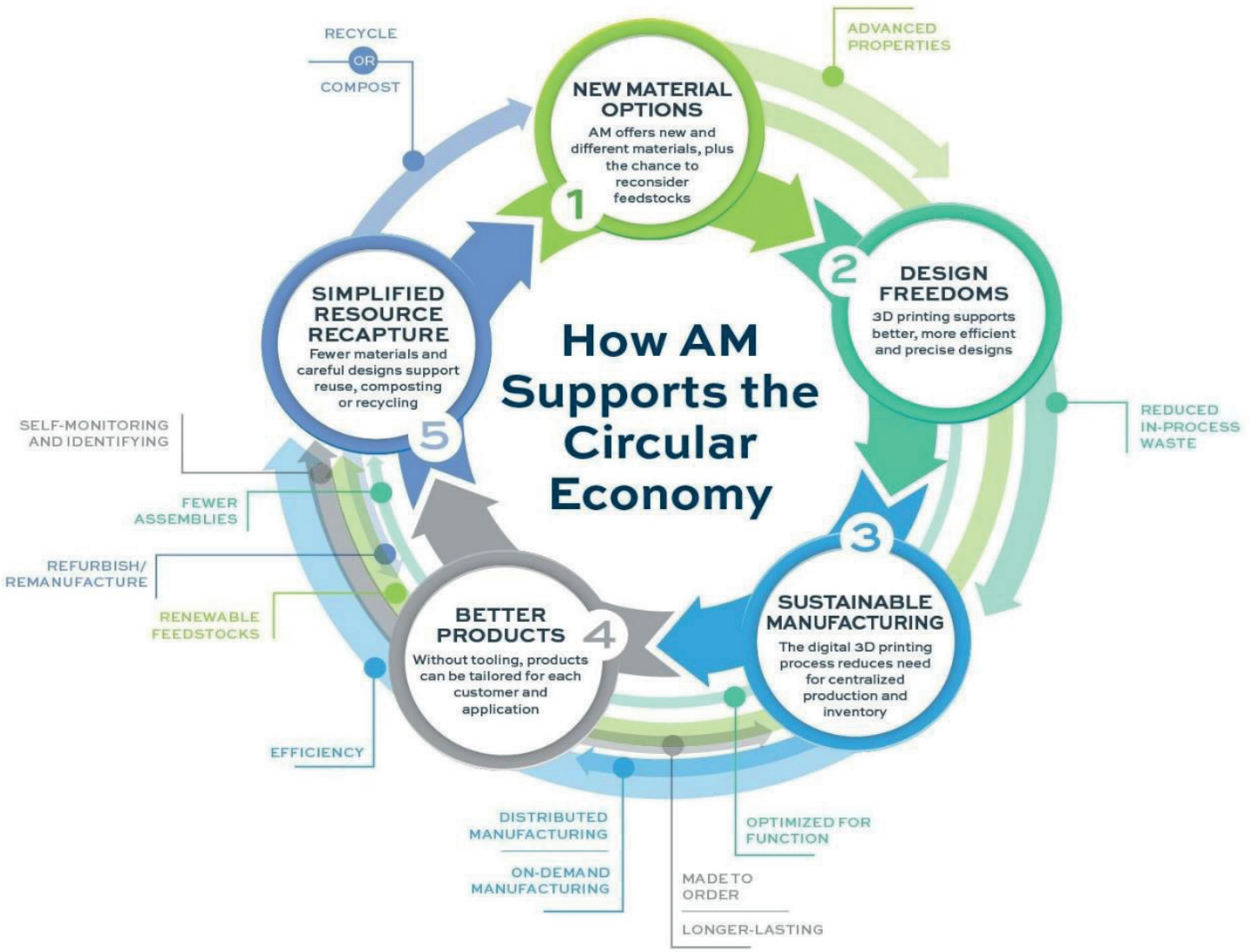


Figure 9. How Additive Manufacturing supports a circular economy (Hendrixson, 2020)

distributed manufacturing possible.

- *Smarter products:* Customised parts incorporating sensors, monitoring devices, RFID tags and QR codes to identify and monitor product over lifecycle.
- *Simplified resource:* Consolidated assemblies simplify material recovery and reuse. Recycled materials from other processes, scrap metal, etc. can be transformed into 3D printing feedstock.

AM products provide added value for responsible manufacturing, offering lightweight designs, functional integration and product designs able to solve complex manufacturing challenges, while still minimising waste. Studies also show the potential to reduce energy and carbon emissions using AM in place of conventional methods.

Energy consumption of 3D printing technologies is significantly lower than conventional machining (Digital Alloys, 2019). The CO_2 emissions between AM and conventional machining are important for carbon taxes. In Europe, this is currently about $30/ton or $0.02/lb of emissions which are not yet significant to manufacturing process selection. However, any future increase renders metal additive manufacturing even more valuable against energy-intensive conventional manufacturing processes (Digital Alloys, 2019).

3.3.4 CIRCULAR TEXTILES DESIGN AND MANUFACTURING

Currently, less than 20% of textile waste is recycled globally despite a massive environmental burden posed by current manufacturing processes. Over 1Bn tonnes of CO_2 is emitted annually from textile production, 100M tonnes non-renewable resources and 100Bn m^3 of water consumed, with over 80% of waste fibre landfilled or incinerated ($100Bn in value lost). Added to this negative environmental burden is the consumption of some 340M barrels of oil per year for plastics-fibre production, 200k tonnes of pesticide and 8M tonnes of fertilizer use for cotton production.

The textiles industry presents valuable circular economy trends from which important lessons can be derived for other industries or manufacturing sub-sectors. The value chain approach towards implementing circular economy interventions within this industry is noteworthy in the manner in which this seeks to address all three circular economy principles. In so doing, the industry seeks to ensure its sustainability, minimise waste and emissions to ecosystems, whilst simultaneously developing materials that are more eco-friendly and re-usable or recyclable (EMF 2017).

Collaborative efforts across the value chain, involving private and public sector actors, are vital for transforming the way clothes are designed, produced, sold, used, collected, and reprocessed. The burden can be mitigated via circular economy interventions that phase out hazardous substances, increase utilisation, implement renewable resources, and radically improve recycling along the value chain.

3.3.5 CIRCULAR BUSINESS MODELS

The shift to a circular economy is encouraging companies to adopt new business models in which the performance and the service component of products provide the added value to customers. Performance-based business models facilitate take-back, reuse, refurbishment and recycling, improving product design and manufacturing for greater use and longevity, helping to reduce resource consumption and waste and emissions. At the same time, these models can contribute to greater cost-efficiency for businesses. ENEL (2022) describes the circular economy as a strategic ally of sustainable development with a shared vision on redesigning how we address resource scarcity, global warming and waste management.

Circular business models are playing an increasingly important, and disruptive role towards the circular economy transition globally. Their significance cannot be over-emphasised given their importance toward manifesting the full potential of a circular economy transition. Some of the more commonly adopted circular economy business models (product-as-service, sharing platforms and circular supplies) are described in Figure 10.

Circular economy business models, such as "product life extension" and "product-as-service" can help manufacturers tap into a $4.5 trillion global economic opportunity, but requires new technologies and processes. By developing new 4IR-enabled capabilities around the sustainable design, manufacture and servicing of products, manufacturers can grow revenues by accessing new markets and customers with new business models (WEF, 2021).

Chemical leasing is a state-of-the-art circular economy business model which targets more efficient use of chemicals in the production process, redefining the business relationship between chemical user and supplier. This business model has been implemented by UNIDO since 2004 and has grown substantially internationally but does not appear to feature significantly within the local industry.

Chemical users are mainly interested in ensuring that the chemicals deliver the best solutions for their product and/or processes.

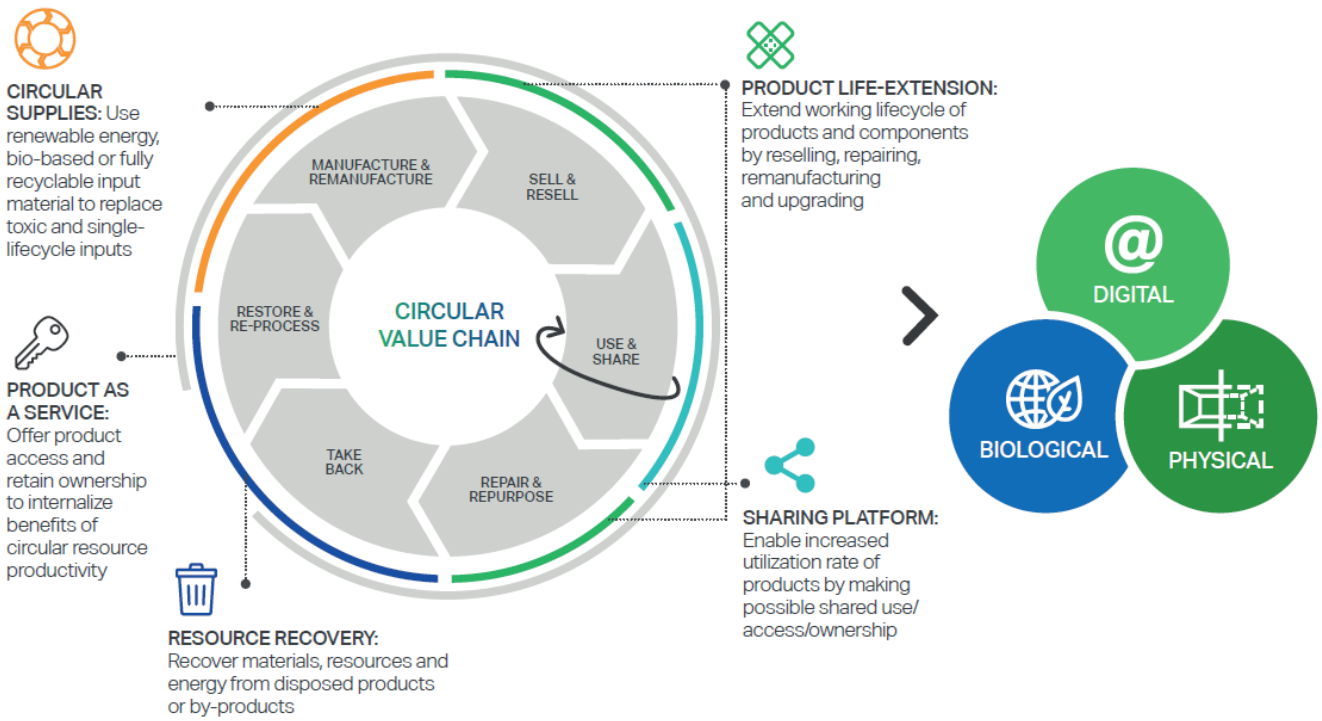


Figure 10. Circular economy business models and associated disruptive technology (WBCSD, 2017)

By shifting focus to the performance, the user only pays per functional unit of chemical employed, thus reducing the chemical footprint along the value chain.

The life cycle of chemicals is prolonged, waste is minimised, and resources used more efficiently. Application of this business model often leads to reductions in the use of other resources such as water and energy, contributing to the achievement of circular economy goals. Supplier and user both benefit because less chemicals are used when payment is linked to the functions performed. This changes the business paradigm, i.e. the utility of a chemical and desired performance of a process/ product become the centre of the buying process.

Example include: a producer of automotive parts uses solvents to clean and degrease and pays the chemical supplier based on the per part cleaned to requisite quality levels, not volume of solvent used. An automaker needs surface protection for its parts, i.e. car body pre- treatment, surface activation and the application of a system of coatings, and by chemical leasing pays per car body protected not amount of chemicals used. Chemical leasing can be applied in many industries and processes, ranging from the textile industry to car manufacturing to agriculture.

Industrial Symbiosis (IS) is a circular economy business model wherein unused or residual resources of one company are recovered for use by another company thereby creating opportunities for keeping materials in use. By utilising waste or by-products of an industry or industrial process as raw materials for another, the model allows materials to be used in a more sustainable and efficient way. IS can support economic development and service delivery by lowering costs for waste and effluent management and creating opportunities for SMME's.

In developing circular economy business models, the importance of specific modelling and/or analytical tools such as Life Cycle Analysis (LCA) and Value Chain Analysis cannot be overlooked. Both tools form an important part of circular economy modelling and analysis. LCA, for example, can assist brand owners understand the environmental footprint of their product and make smarter choices across its entire lifecycle, including early-stage material choices and end-of-life options (UNEP, 2021).

3.4 SUMMARY

The manufacturing sector has the potential to play a pivotal role in transitioning South Africa to a more circular economy. Based on its diversity of resources and products, the

manufacturing sector is centrally placed towards the attainment of effective resource decoupling, with positive impacts on the economy, society and the environment. Applying circular principles in the design of products, manufacturing companies can influence the production process, and indeed the entire product life cycle, including usage and end-of-life scenarios.

A review of global trends identified a variety of innovative circular economy interventions with the potential to disrupt the sector. These include remanufacturing of machinery and equipment, a relatively well-established methodology in the automotive sector. Remanufacturing, together with other value-retention processes (VRPs) such as refurbishment and reuse, create, preserve, and enable the recovery of value. Other trends include the substantial investments towards the development of large-scale renewable energy technologies across the sub-Saharan region as a means to counter climate change and decouple from fossil-based fuels, mainly coal. However, studies highlight the longer-term challenge regarding the end- of-life waste projected from these clean energy technologies, which creates significant circular economy opportunities for reducing consumption of scarce raw materials by recycling back into production systems, and repair and upgrading of equipment.

Unique opportunities for innovative circular economy interventions also lie in the adoption of disruptive 4IR technologies such as digital twinning, big data and blockchain, cobots in the workforce, the exploitation of augmented reality for training and operations, and the application of bio-based materials in the manufacture of advanced, lightweight components. Included in the suite of 4IR technologies advancing circular economy implementation is additive manufacturing, which creates opportunities to reduce energy consumption, development costs, resource utilisation and wastage. Its on-demand, digitally distributed manufacturing, allows for reduced physical inventories and more resilient supply chains.

Chemical leasing and Industrial Symbiosis are two important circular economy business models that have been adopted globally, helping to achieve more sustainable resource and energy use and waste reduction.

Importantly, 4IR-enabled capabilities around sustainable design, manufacture and servicing of products, can help producers grow revenues by accessing new markets and customers with new business models.

4 CIRCULAR ECONOMY DEVELOPMENT PATH FOR THE MANUFACTURING SECTOR

This section explores the development of a circular economy path for the South African manufacturing sector. In so doing, the study attempts to address specific questions regarding appropriate circular economy interventions (CEIs) for the sector; the sector's readiness to adopt the envisaged CEIs; obstacles towards their implementation in South Africa; and potential business opportunities arising from the implementation of the CEIs. Each of the research questions is distinctly addressed in the following sections below based on engagement with sector stakeholders.

4.1 CIRCULAR ECONOMY INTERVENTIONS

Based on the current status of the local manufacturing sector and the associated challenges, as well as a survey of circular economy practices, global case studies, and emerging trends, several CEIs were identified as relevant to the manufacturing sector. These interventions are based on the ability to decouple resource demands from growth, their impact towards improving sectoral resilience and competitiveness, meeting climate and sustainability commitments, as well as growth in revenue and sustainable jobs. The identified CEI's are listed in Table 2.

Each of these CEIs have been discussed in some detail in the preceding section. Their merits have been highlighted on the basis of local and international case studies as embodying the key principles of circular design and manufacturing, material looping, and regeneration, as well as considering innovative circular economy development opportunities.

It was important to assess the relevance of the proposed CEIs, their sectoral readiness and obstacles towards their implementation, amongst other considerations, based on independent feedback from external stakeholders. The validity of the stakeholder assessment thus forms an important weighting factor based on the survey demographics, having targeted experienced, senior, sector stakeholders.

The response to the survey therefore represents a very important outcome given the strong representation from Senior Management / Executive (66% of respondents). In addition, 68% of the respondents had over 10 years of experience in the manufacturing sector, with 42% of participants having more than five years of prior or current experience in circular economy related projects. External stakeholders have therefore brought a deep understanding of the South African manufacturing sector, and the potential for circular economy interventions, to the discussion. In addition, these are stakeholders that have the ability to drive and influence change in the manufacturing sector and unlock circular economy opportunities.

Table 2. Proposed circular economy interventions (CEIs) for South African manufacturing sector

CE Intervention	Description & Benefits
4IR Technologies	Fusion of technologies: AI, robotics, IoT, quantum computing, etc
Additive Manufacturing	Making of products by adding consecutive layers of material (3D printing)
Bio-based fuels / materials	Renewable fuel or materials derived from biomass feedstock, e.g. wood
Chemical Leasing	Value-addition model where client pays per functional unit of chemical used
Circular Business Models	Manages product lifecycle and associated costs by changing usage patterns
Circular Design & Manufacturing	Optimise material use, durability & repairability to design out waste
Circular Textiles Design & Manufacturing	Use durable, eco-friendly textiles & processes to avoid harmful chemicals
Green Steel Manufacturing	Use of renewable energy to generate hydrogen to replace fossil fuels
Industrial Symbiosis	Processing waste/by-products of one process as raw material for another
Material Looping	Converting products/materials to new products whilst retaining properties
Remanufacturing	Optimise resources by recirculating products/materials at highest utility
Renewable Energy Technology	Energy production via renewable sources (solar, wind, hydro & biomass)
Resource Efficient & Cleaner Production	Integrated approach to enhance efficiency of process, product & service

4.2 APPROPRIATENESS OF CIRCULAR ECONOMY INTERVENTIONS FOR SOUTH AFRICA

This section highlights the outcomes of the stakeholder engagement process which was aimed at assessing the appropriateness of the proposed CEIs for the South African manufacturing sector. Select comments and observations from stakeholders on the appropriateness of CEIs are also included below.

4.2.1 STAKEHOLDER ENGAGEMENT

When asked to what extent stakeholders agree that these CEIs can benefit the South African manufacturing sector, the results showed a high level of agreement for most of the interventions, with an emphasis on the more commonly practiced interventions. High levels of agreement on the benefit of CEIs were noted for Resource Efficiency & Cleaner Production; Materials Looping; Renewable Energy Technologies; and Circular Design & Manufacturing (Figure 11). There was some level of uncertainty with regards to the less familiar CEIs such as Chemical Leasing; Industrial Symbiosis; Additive Manufacturing; and Circular Textiles Design & Manufacturing (Figure 11). The level to which stakeholders agreed that specific interventions are appropriate, i.e. will benefit the sector, directly corresponded with their level of familiarity with specific interventions, this being most evident for chemical leasing where over 75% of respondents were unfamiliar with the concept, suggesting that chemical leasing is a relatively new concept to the sector. Green steel manufacturing was another CEI for which stakeholders had a generally low level of familiarity.

Stakeholders agreed (93% of respondents) that the SAMS is strongly dependent on access to resources such as energy, water, and materials, making it highly vulnerable to insecurity in supply. There was strong agreement (81% of respondents) that the South African economy is currently heavily dependent on imports of finished goods and high value products, and adversely affected by un-beneficiated material exports (80% of respondents). As noted by a participant "there is a need for policy against imports. High-value imports work against South Africa, since cheap imports are encouraged whilst valuable materials are exported." There was overwhelming agreement (97% of respondents) on the need for CEIs to improve sectoral competitiveness and resilience. Similarly a high level of agreement (87% of respondents) that the implementation of CEIs in the South African manufacturing sector could lead to inclusive growth and decent jobs, while also mitigating environmental pollution (97% of respondents).

There was some debate around the issue of 'green steel' and its consideration as a circular intervention. It was reconfirmed that green steel relates to the use of green hydrogen as a substitute for carbon-based resources and fuels in

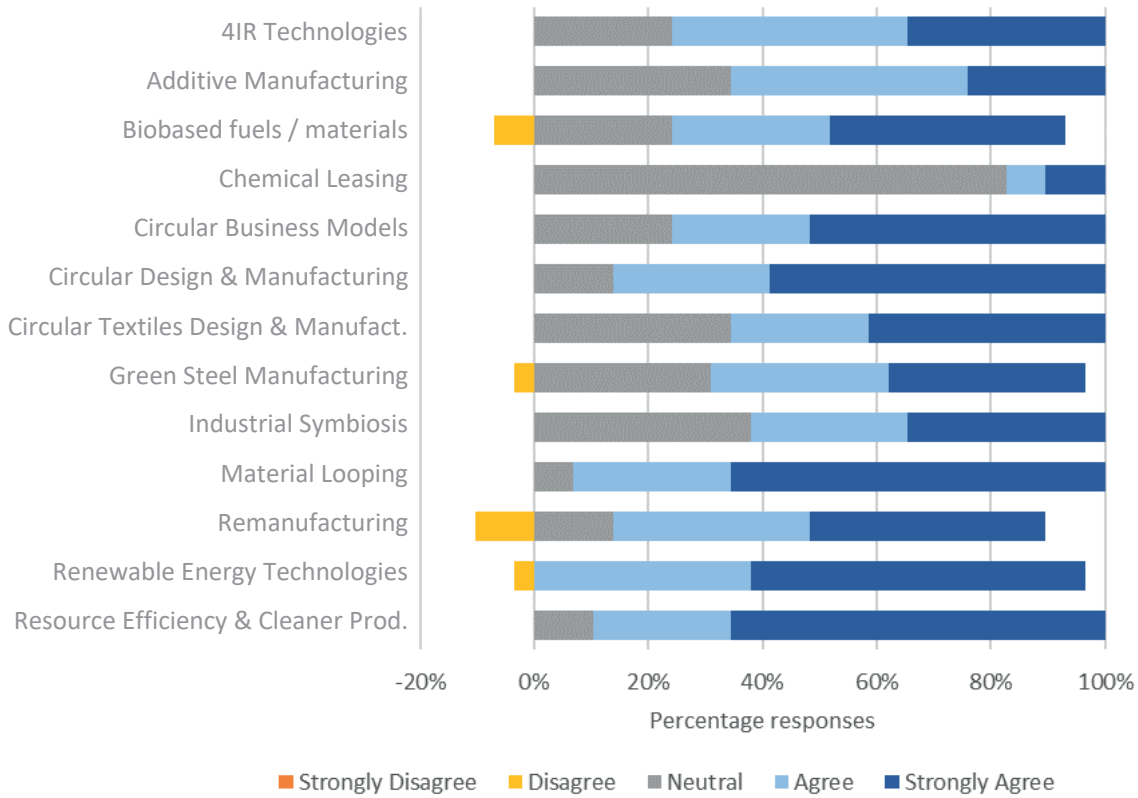


Figure 11. Extent to which circular economy interventions can benefit the South African manufacturing sector

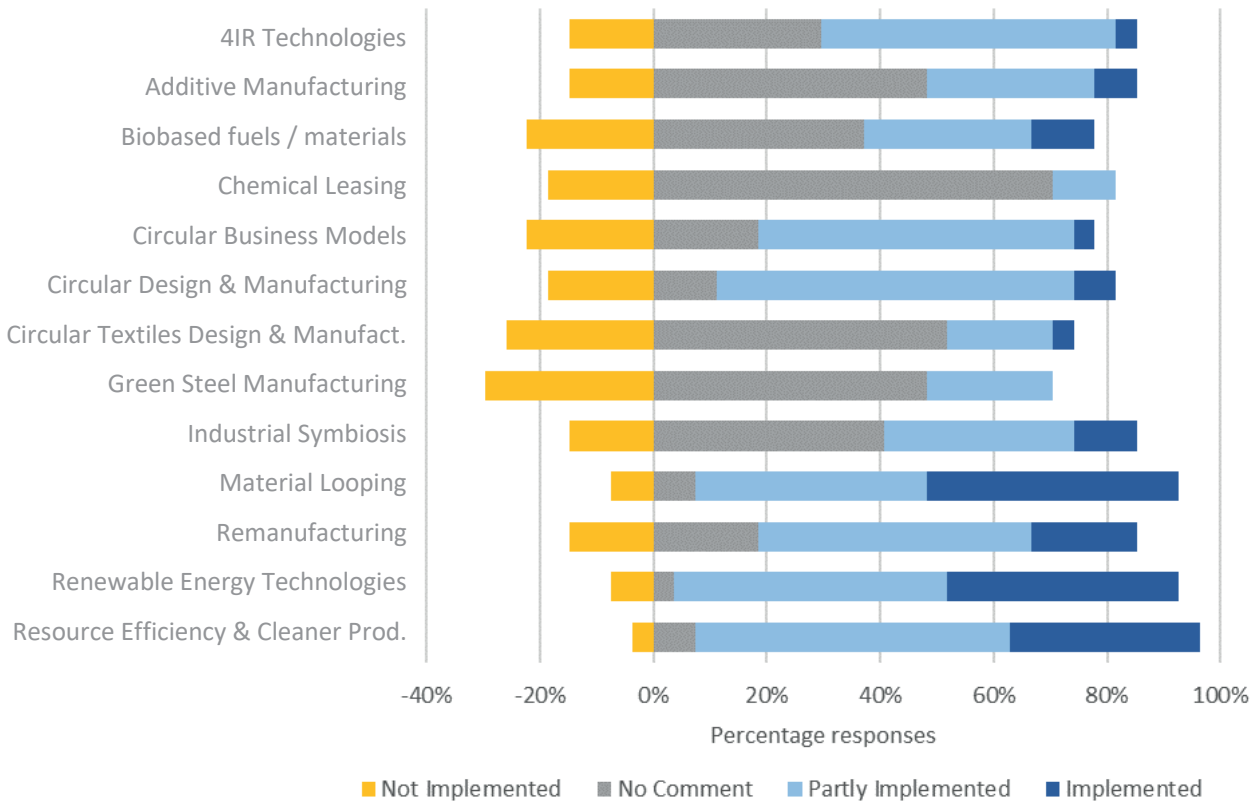


Figure 12. Level of implementation of circular economy interventions in South African manufacturing sector

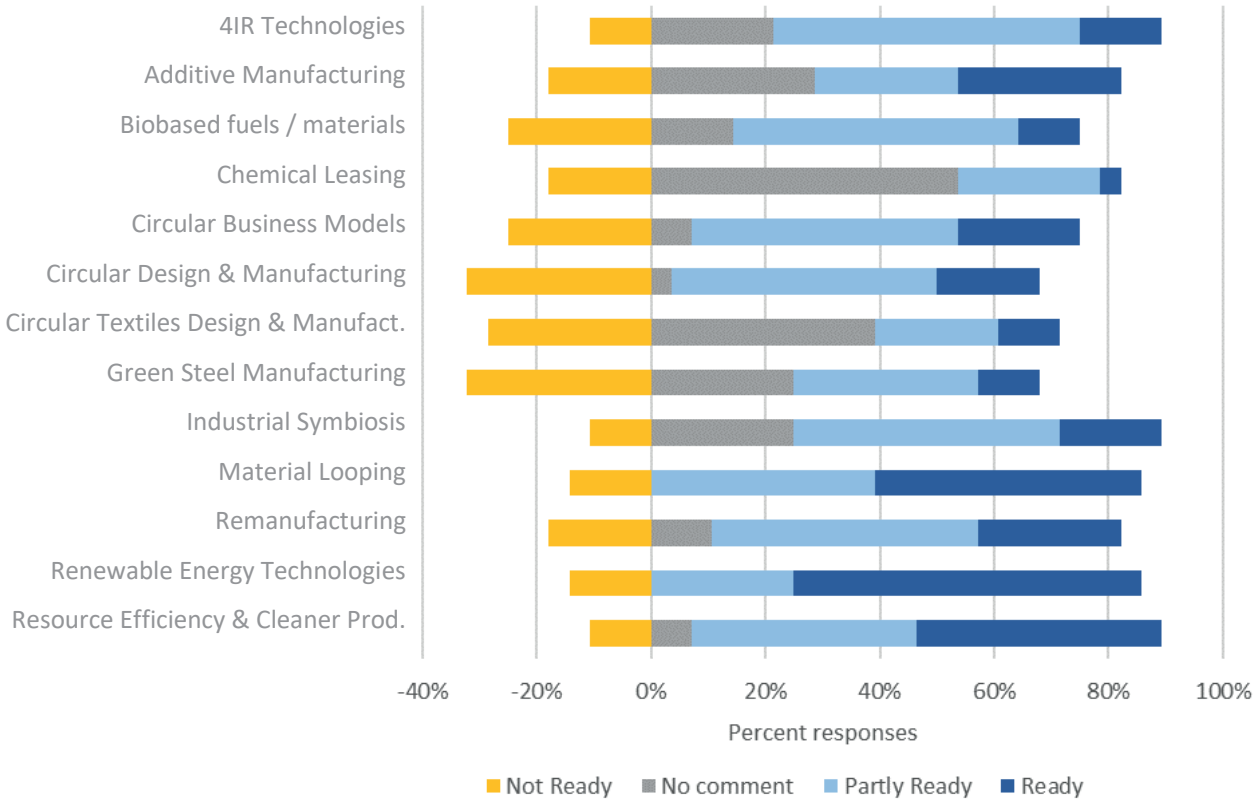


Figure 13. State of readiness to implement circular economy interventions in South African manufacturing sector

steel manufacturing, as well as the use of renewable energy across the steel manufacturing value chain. Waste steel also has very high levels of circularity through reuse and recycling.

A key point raised by stakeholders was the need for a common, and improved, understanding of the circular economy and the need to work across sectors. A need was stressed that this CSIR study move stakeholders towards a Circular Economy Roadmap or strategic pathway that is cross-cutting and that can directly benefit the South African manufacturing sector.

4.3 READINESS TO IMPLEMENT THESE INTERVENTIONS

Many circular economy interventions have found application in the global north, but are yet to find scale or application in developing countries that face their own unique circumstances. Stakeholders were asked to rate the current level of implementation of the proposed CEIs in South Africa (Figure 12) and the sectoral readiness to implement these interventions (Figure 13).

4.3.1 STAKEHOLDER ENGAGEMENT

The results showed high levels of implementation for Materials Looping; Renewable Energy Technologies; and Resource Efficiency & Cleaner Production (Figure 12) in the SAMS. These are well known interventions with South Africa having established a relatively successful materials recycling industry over the past 40-50 years for e.g., metals, plastic, paper, etc. (Godfrey & Oelofse, 2017). Renewable energy technologies have emerged in response to South Africa's loadshedding, climate commitments and policy interventions, while the National Cleaner Production Centre (NCPC-SA) has been successfully implementing Resource Efficiency and Cleaner Production programmes in the South African Manufacturing Sector for the past two decades (NCPC- SA, 2020). Importantly, the extent to which respondents considered specific CEI's already implemented suggests that there is significant room for strengthening and scaling these CEIs given that the bulk of the responses were 'partly implemented' as opposed to 'implemented.'

Similarly, the sector showed a high level of readiness to implement Materials Looping; Renewable Energy Technologies (RETs); Resource Efficiency & Cleaner Production; and Remanufacturing (Figure 13). The notably high readiness ranking by respondents on RETs was unexpected given this sub-sector has only come to the fore in recent years. The reason may lie in the fact that many companies are investing in RET's for business efficiency (energy security), but price remains a constraint for many. The relatively high readiness to implement 4IR technologies was also surprising given the apparent lack of sectoral familiarity with the technology.

CEIs such as Green Steel Manufacturing, Circular Design and Manufacturing, Circular Textiles Design & Manufacturing, and Bio-based fuels / materials, were seen to be at lower

levels of readiness. Perhaps as longer-term interventions, more will need to be done to raise the level of awareness regarding these interventions and prepare the sector for the adoption of these technologies, including piloting / demonstration. Several constraints were highlighted as obstacles to fast-tracking the implementation of CEIs in the South African manufacturing sector. These included:

- Lack of awareness of circular economy opportunities and associated business case
- Cost of implementing CEIs, especially for SMMEs, many of whom are operating in 'survival mode'
- Lack of sustainable finance mechanisms, investment incentives and unattractiveness of South Africa as an investment destination
- Difficulty in accessing funding
- Long lead time to obtain management approval and necessary capital investment
- Lack of skills, knowledge and capacity on CEIs
- Lack of case studies or demonstration projects on successful projects that have improved business (including the cost of such demonstration)
- Lack of an enabling legislative environment
- Lack of access to export markets that drive CEIs
- Lack of downstream infrastructure and markets to absorb secondary materials (waste)
- Poor understanding of life-cycle impacts of products
- Local industries have not invested in updated technologies

As noted by one stakeholder "Most business owners in South Africa don't have the luxury to explore change." Despite having some of the leading scientists and engineers in South Africa, there has been a failure to implement CEIs in South Africa.

There were also obstacles to specific CEIs. As noted by a representative from the foundry industry with respect to Additive Manufacturing "We have invested in a small production unit, but we have seen the constraint brought about by limited embracing of the technology by our people. We are examining the possibility of producing patterns for the foundry using additive manufacturing and produced castings and recognise the opportunity of printing moulds and cores, but the costs of the capital equipment are prohibitive". Despite additive manufacturing being recognised as a significant growth industry globally.

One idea put forward in the sector engagement to address many of the listed obstacles, was to establish local technical support services / institutions for industry, based on the model of Energy Service Companies (ESCOs) that support uptake of energy efficiency interventions.

The detailed stakeholder responses indicate a diverse range of opinions, ideas and recommendations concerning the appropriateness of the proposed CEI's, and the sectoral readiness to implement. Many valuable insights have been captured regarding the readiness and the perceived obstacles towards an effective roll-out of a circular economy approach within the South African manufacturing sector. At the same time, these obstacles present certain opportunities for improvement, growth and innovation in circular economy, including business opportunities.

4.4 BUSINESS OPPORTUNITIES TO IMPLEMENT CIRCULAR ECONOMY SOLUTIONS

The overview of the circular economy principles and their application across local and international markets, and the various interventions identified, highlight a diverse range of interventions that offer the local economy a basket of potential business opportunities. These offer the means to address ongoing sectoral challenges in terms of resilience, competitiveness, unemployment, and export dependence. This section provides a more in- depth view of the potential circular economy related business opportunities for the manufacturing sector, as aligned to the key circular economy principles below.

4.4.1 DESIGN OUT WASTE AND POLLUTION

Circular business models have come to the fore in recent years, e.g. product-as-service, product sharing, remanufacturing and circular supplies. Changing usage patterns via the sharing economy and product-as-service models can realise significant economic and environmental gains. Tata Steel and the Indian Steel Authority set up mjunction, for example, an e-market for steel waste, allowing traders transparent access. mjunction has evolved into the world's largest e-market for steel, with trade volumes increasing from $13.8m in 2002 to $9.45Bn in 2016 (WBCSD, 2016). By selling product functionality or services rather than products per se, companies can manage an entire product life cycle, and associated costs, by developing closed material flow loops (EMF, 2017). Renault, for example extends and optimises the EV battery lifecycle by selling it as a service. Since starting, battery leasing is now preferred by over 90% of customers. Renault further extended its EV battery lifecycle by cascading to energy storage applications (WBCSD, 2016). In the case of chemical leasing, this circular model shifts focus from increasing sales volumes to value-addition, where the client pays per functional unit, ensuring that both supplier and end-user achieve reductions in chemical use (UNIDO, 2016).

Manufacturing product design must consider optimising materials, durability, and repairability to design out waste. In the textiles industry, there is increased focus on design of more durable, re-usable and eco-friendly textiles. Natural fibre development can help avoid use of harmful chemicals in the textiles value chain, a global problem. Improved textile design would reduce the level of hazardous chemicals and micro-fibre waste entering ecosystems (EMF, 2017). In the plastics industry, the South African Plastic Pact calls for zero waste by redesigning problem packaging such that 100% of plastics are reusable, recyclable, or compostable by 2025 (SAPP, 2020).

Improved resource efficiency in manufacturing is critical to the South African manufacturing sector's global competitiveness. The NCPC-SA, tasked by the dtic, fulfils a vital role in helping reduce energy, water and materials use across various manufacturing sub-sectors. Over the period 2010-2020 the NCPC's industrial energy efficiency program has worked with 274 large companies and 180 manufacturing SMEs, saving over 6500 GWh in energy and R5.275 Bn in direct costs (NCPC 2021). The recent NCPC I-GO (Integrated Greening Operations) initiative, facilitated on behalf of UNEP aims to scale-up resource efficiency efforts of SMEs in Africa. Scaling up resource efficiency and cleaner production (RECP) measures across the local manufacturing sector is an urgent requirement, that provides significant business and labour opportunities.

4.4.2 KEEP PRODUCTS AND MATERIALS IN USE

A circular economy aims to optimise resource yields by constantly circulating products, components, and materials at highest utility. Tight product cycles are a key circularity trait, circumventing a loss of embedded energy, resources and labour from simple recycling and disposal.

The remanufacture of industrial equipment by Value Retention Processes (VRPs) can reduce virgin material usage by 80-98% and cost by 15-80% over Original Equipment Manufacturer (OEM) products (IRP 2018). Globally, remanufacturing is dominated by the automotive and aerospace sectors, as well as construction, electrical equipment, heavy machinery and medical devices. However, local uptake remains low due to a lack of infrastructure, supply chains and investment in remanufacturing technologies (Nasr, 2018). Remanufacturing of internal combustion (IC) engines is a well-established industry within the local automotive sector. In contrast to simple reconditioning, local ICE remanufacturers adopt industry standards to guarantee used engines are returned to OEM approved specifications through an extensive and audited process. Remanufactured engines provide levels of performance, reliability and lifespan that equal, and, in many instances exceed the original (REMTEC, 2021). Scaling South Africa's remanufacturing capability, as a buffer to manufacturing sectors at risk, e.g. the local automotive industry, needs to be further explored.

Caterpillar, the global heavy machinery OEM has been remanufacturing components since 1973. Caterpillar's dedicated remanufacturing arm (CAT Reman) is now a leader in developing value recovery processes and technologies, profitably growing to nine locations worldwide (>3500 employees) based on its component recovery business model. Durable parts enjoy repeated remanufacturing, e.g. gearboxes, drivetrains and brakes (IRP, 2018). The circular framework of designing for multiple remanufacturing cycles has been increasingly used by CAT given that major costs lie in materials (65%).

Local manufacturing features an established recycling industry across various sub-sectors, although the need to scale this is recognised. The South African metals sector has established a mature scrap metal recycling industry, achieving a recycling rate of 80% (DEA 2018). Continued recycling is necessary to maintain steel scrap in a constant loop, and to supplement primary steel production, given the insufficiency to satisfy rising world demand.

Almost half of EU steel originates from secondary processes and end-of-life (EoL) scrap (Eurofer, 2015). A strategic value chain with opportunity for closing resource loops is the primary processing of local platinum group metals (PGMs). The reliance on exports of unwrought PGM base metals mandates the need for local beneficiation. Dedicated SEZs for fuel cell and auto- catalyst manufacture present opportunities for refurbishment and recycling of components at EoL, enabling beneficiation and retention of extracted precious metals within the local economy.

The South African plastics sector, despite implementing voluntary Extended Producer Responsibility (EPR) two decades ago, has only achieved a 43% collection rate (input), with much lower recycling (output) rates. Plastics recycling is an important local industry with opportunity for businesses to actualise the SA Plastic Pact target: all packaging to contain 30% recycled content with 70% of packaging effectively recycled by 2025 (SAPP, 2020). New EPR regulations for paper and packaging, e-waste and lighting are expected to significantly scale up the collection, reuse, repair and recycling

of these goods in line with mandated targets (DFFE, 2021).

The clothing and textiles sector requires significant circular interventions given its impacts in terms of resource demand and resultant wastage. Currently, less than 20% of textiles are recycled globally, despite a massive environmental burden. As a developing country, end-of-life clothing in South Africa often finds reuse opportunities driven by high levels of poverty and unemployment. Locally, organisations such as The Clothing Bank, and Rewoven, have partnered with major local retailers to drive greater textile reuse of excess stock, customer returns, store damages, end-of-season and bulk rejections. The textile sector can phase out hazardous substances, enhance resource utilisation, adopt renewable resources and inputs, and radically improve recycling along the value chain via circular interventions. Cascaded recycling allows re-use of textiles in lower value applications (insulation, cleaning materials, etc) (EMF, 2017). NCPC-SA has partnered under the UNEP's InTEX project in developing Innovative Business Practices and Economic Models across the local textiles value chain (NCPC, 2020).

As noted by an industry stakeholder "textile recycling and re-processing is still in the pilot phase in South Africa and limited to one fabric base. There is potential to scale up if all CTFL-Masterplan participants get on board."
NCPC and GreenCape have championed Industrial Symbiosis (IS) to close resource loops, with opportunities to scale up and lower material input costs, whilst addressing resource scarcity and waste (WCG, 2021). Over the period 2015-2020, NCPC assisted 80 companies through IS, diverting 215,000 tonnes of waste resources from landfill and saving R17.7m in landfill diversion (NCPC, 2020).

Case studies from India and China (IRP, 2017) highlight the environmental impact from fossil-based energy and material use in cement and steel production, including resource depletion and air pollution by particulate matter (PM). This can be reduced through beneficial exchange and reuse of materials across energy and construction sectors focusing on two key material exchanges (a) reuse of fly ash from power plants in lieu of cement (beyond current reuse levels) in the construction sector, (b) reuse of steel slag that enables both heat recovery and material substitution of cement. Low polluting construction materials such as green bricks and green cement avoids PM2.5 emissions from brick and cement factories.

4.4.3 REGENERATE NATURAL SYSTEMS

In addition to the manufacturing sector adopting more renewable energy solutions, the emerging green energy market (estimated at R30Bn) offers new circular manufacturing opportunities for South Africa. NERSA's exemption on self-generation (up to 100MW) renders embedded generation via local solar panel, wind tower and turbine manufacture feasible. A 1GW/yr solar PV market is sufficient for five manufacturers to set up local facilities of 200MW each, providing opportunities for circular renewable energy products (Creamer, 2019). Policies call on national R&D organisations to assist in developing a green, circular industry (DTIC, 2018). Bio-based energy and materials, including bio-catalysis, can also help in moving away from fossil-based resources.

The REIPP program was highlighted in the previous section indicating the level of investment towards solar, wind, hydro in the sub-Saharan region. This commitment brings with it the challenges identified from EU studies on the EoL waste to be generated from RETs and the requisite measures to be put in place to manage the broad spectrum of materials and products to be recovered, re-used, or recycled including some CRMs.

It is clear that the application of circular economy principles is not new to the South African manufacturing sector, with activities being driven locally, regionally and internationally to decouple growth from resource consumption and transition to alternative circular economy business models. However, while many of the underlying principles are already being applied in the local manufacturing sector, more needs to be done in achieving the scale required for meaningful impact. Collaboration at all levels is vital, and companies can employ the ReSOLVE framework (regenerate, share, optimise, loop, virtualise, exchange) to navigate the complexities in transitioning to a circular economy (McKinsey, 2016).

Scaling circular manufacturing will require disruptive technologies, including digital technologies such as Internet-of-Things (IoT), big data, and blockchain, which allow for advanced tracking and monitoring of resource utilisation and waste capacity. Additive manufacturing for instance, has disrupted traditional manufacturing processes (machining, casting, injection moulding) enabling reductions in development costs, resource utilisation, waste and energy consumption. Its on- demand, digitally distributed manufacturing, allows for reduced physical inventories and more resilient supply chains.

4.5 POTENTIAL FOR CLIMATE CHANGE MITIGATION

Various CEIs in the manufacturing sector have the potential to reduce GHG emissions. These include (a) changes in energy usage (energy efficiency, fuel switching, combined heat and power,

use of renewable energy), (b) more efficient use and recycling of materials.

However, as noted by stakeholders, many companies are committed to Science Based Targets (SBTi) to achieve a net-zero target by 2050, and might become overly focused on addressing emissions without necessarily understanding that many CEIs can support emissions reduction. "Time and resources get devoted to 'traditional' GHG emissions mitigation interventions with little consideration for circular economy interventions."

The electrotechnical sector , for example, is one of the fastest growing sectors globally, with high resource demands and high levels of waste electrical and electronic equipment (WEEE). Since 2014, e-waste has grown by 9Mt globally.

Currently, <10% of locally generated WEEE is recycled, mostly pre-processed with export for metal recovery, resulting in the loss of resources. Increasing the local WEEE recycling rate would provide local job opportunities (DEA 2018), but also, GHG mitigation potential through recycling common industrial materials and products.

It is recommended that further modelling be undertaken to quantify the climate mitigation potential of CEIs in the South African manufacturing sector, as a driver for supporting a circular economy transition. This may also create an opportunity to access climate finance to finance circular economy initiatives in the South African manufacturing sector.

4.6 SUMMARY

Based on the stakeholder engagements, the evaluation of the local manufacturing sector in terms of circular economy practice, as well as a survey of global trends and case studies, it is evident that the implementation of the circular economy within the South African manufacturing sector presents both opportunities and challenges. The sectoral analysis along with stakeholder inputs clearly indicates that there are numerous circular economy related measures that have already been implemented. In addition, there are a multiplicity of ongoing activities within private companies, government, NGOs/NPOs specifically dedicated to circular economy. In many instances, there is notable collaboration within the industry or sub-sector regarding circular economy practices.

Immediate circular economy related business opportunities lie in the extension and scaling of current activities within the sector. This study provides substantial evidence by way of data gathered, global trends and benchmark studies of the collective benefits that the proposed CEIs would afford the sector.

Each of the CEIs evaluated presents significant potential for local manufacturers to unlock new business opportunities, and enhance existing processes in terms of efficiency, waste management, resource use and emissions. As noted in the report, some of these interventions have already developed to a relatively mature stage, e.g. Materials Looping; Renewable Energy Technologies; and Resource Efficiency & Cleaner Production, and can now be scaled to achieve greater impact in terms of the benefits that the circular economy approach offers.

Disruptive technologies associated with 4IR (IoT, Additive Manufacturing, digital twinning, etc.) are helping to achieve impact in the implementation of innovative manufacturing process and business models. Global trends indicate a rapid uptake of 4IR related technologies to enhance manufacturing capability, productivity and efficiency, enabling massive gains in resource optimisation, reducing energy and material consumption, upskilling of the workforce, and tracking of materials and waste throughout the circular economy value chain. These technologies present notable opportunities for the South African manufacturing sector to enhance its competitiveness and sustainability.

Notwithstanding the positive outlook presented above, it is clear from the engagement with stakeholders that significant challenges remain towards enhancing the implementation of circular economy within the sector, as well as scaling of circular economy measures across the sector and broader economy. Many of the obstacles to circular economy implementation raised by stakeholders appear to be common with those experienced in other countries, and in other sectors, e.g., agriculture. A vital issue for effective circular economy roll-out at scale is clearly collaboration across all sectors of the economy from government, private sector and supporting organisations. Stakeholder concerns highlight the need for increased support for SMMEs within the local context, improved infrastructure for waste handling and recycling, and access to markets.

Funding for CEIs was a key issue raised by many stakeholders who noted that financial institutions and models currently are not geared towards funding CEIs, in part due to a lack of awareness and understanding of the business case. Similarly, companies may be reluctant to fund circular economy projects due to a lack of awareness of the business case, or more so this not being clearly defined at the outset. There was strong agreement on the need for policy interventions, which is a global trend with circular economy implementation, as well as the need for incentivising companies that promote circular economy.

5 CONCLUSION

This study has addressed the main research questions by showing that the current development path of the South African manufacturing sector is still dependent on resource extraction, export of base metals and minerals, and imports of finished products, notwithstanding its predominant linear 'take-make-waste' economic approach. Detailed evaluation of the circular economy principles and practices, including global trends and case studies clearly shows that the circular economy approach can help the South African manufacturing sector mitigate many of its challenges regarding resource extraction, efficiency, productivity, competitiveness, waste and emissions.

Based on the review of global trends and case studies, as well as engagement with key sector stakeholders, it can be concluded that most, if not all, of the proposed circular economy interventions outlined in this study can benefit the South African manufacturing sector, and are appropriate for transitioning the sector towards a circular economy. Uncertainty regarding the benefits of chemical leasing, industrial symbiosis, remanufacturing and bio-based fuels / materials to the local manufacturing sector are noted, although this may have more to do with lower levels of familiarity than with the technology. Highlighting the need for improved awareness regarding the circular economy opportunities and their benefits to the South African manufacturing sector.

The extent of sectoral readiness in embracing these circular interventions varies widely, with some measures at a more advanced stage (e.g., material looping, resource efficiency and cleaner production, and renewable energy technologies) while certain interventions are considered to be at a lower level of readiness (e.g., green steel manufacturing, circular design and manufacturing, circular business models and bio-based fuels / materials) and will require greater action to fast-track.

The stakeholder engagements provided valuable insights regarding the current status of development of the sector with respect to the circular economy, revealing a relatively mature level of development and implementation in certain industries, but much room for expansion and scaling of circular economy interventions overall. Stakeholder feedback also highlighted the extent of challenges and obstacles the sector faces in attempting to roll-out circular economy initiatives, especially for smaller manufacturing businesses that struggle to access funding.

The obstacles and challenges noted by stakeholders were very similar to those observed in other economic sectors, e.g., agriculture. Major obstacles to transitioning the South African manufacturing sector to a more circular economy, and unlocking associated benefits, included lack of awareness of circular economy interventions and the associated business case; the cost of implementing and the lack of sustainable financing mechanisms; lack of appropriate skills; lack of local case studies or demonstration projects; lack of available markets for circular products and services. In principle, an increased awareness and understanding, upgrading of skills and knowledge base, creation of support platforms and organizations, and collaboration across all sectors of the economy appear to be universal challenges to effective circular economy implementation.

Apart from the more conventional circular economy practices, a circular development path for the South African manufacturing sector would need to embrace a host of innovative, disruptive technologies (e.g., 4IR) in order to achieve maximum benefit and ensure sustainability and competitiveness in the long-term. In this regard, the localisation of manufacture of materials, products and components for the emerging local markets in renewable energy technologies (solar panels, wind towers), electric vehicles and hydrogen fuel cells (including FCEVs) presents an important opportunity for the sector to leverage the circular economy. Remanufacture, re-use and refurbishment of end-of-life materials and components from these applications can enable the sector to retain materials within the local economy, prevent the export of valuable, un- beneficiated resources, whilst ensuring that climate and sustainability commitments are met. In particular, high value critical raw materials (CRMs) would also be recovered, an important consideration in the beneficiation of local resources such as platinum group metals (PGMs).

It is also evident from the study outcomes that there is significant opportunity for research and development into innovative manufacturing processes and materials that enable resource decoupling, energy and water savings, including reduced waste and emissions.

Light-weighting and innovative design via processes like additive manufacturing open up new avenues for resource optimisation, supply chain resilience, zero inventories and waste minimisation, not to mention rapid, lower cost product development. The local industry has already seen some investment in additive manufacturing with CSIR hosting the national programs in Additive Manufacturing, providing an important platform from which to enhance additive manufacturing capability that supports the transition to a more circular, efficient and competitive South African manufacturing sector. wn

Unlocking Business Model Innovation through Advanced Manufacturing

The COVID-19 pandemic has highlighted the critical role manufacturing and supply chain systems play in powering the global economy. But while most companies have been able to adapt to the unprecedented disruptions by leveraging and deploying technologies across factory sites, manufacturing and supply chain leaders need to enhance their efforts if they want to remain competitive in the current environment.

The new challenges posed by consumers and society at large require leaders to go beyond operations, productivity and efficiency improvements (Section 1).

The most successful companies will be those able to leverage their investments in advanced manufacturing not only to optimize operating models, but also to unlock new business models that create and deliver new value to all stakeholders, including the companies themselves, workers, society and the environment. Three essential stages, from point solutions to end-to-end digital infrastructure and integration to new business models, are necessary for the transformation (Sections 2 and 3).

Given the complexity of the journey towards business model innovation, five key strategies most commonly used by leading players illuminate the way forward: 1) start with leadership and culture shifts; 2) forge system-wide collaborations; 3) adopt new metrics to measure success; 4) leverage core manufacturing strengths to close the gaps with digital natives; and 5) relentlessly pursue the broader purpose (Section 4).

This White Paper aggregates the views of over 50 leaders from manufacturing companies, services providers and academia, and highlights successful case studies from those who have already started to unlock business model innovation by adopting advanced manufacturing. The objective of this paper is to inspire manufacturing and supply chain leaders to start or accelerate the business model innovation journey and ensure it can achieve and deliver its full potential for driving responsible industry transformation and growth.

IT IS TIME TO THINK BEYOND MANUFACTURING OPERATIONS

The COVID-19 pandemic provided a vital reminder of the importance of supply chains and the role of advanced manufacturing. Companies in the production ecosystem had to quickly pivot and accelerate digital transformation to keep operations up and running, serve their consumers in a fast- changing environment, and support the needs of their employees and communities.

While companies have used technologies for decades to optimize production processes, the most forward-looking organizations have been taking advantage of advanced manufacturing not only to drive efficiency across their operations and supply chains, but also to bring a more innovative, sustainable and inclusive approach to value creation, benefiting customers, workers, society and the environment.

Three main trends are pushing companies to go beyond the transformation of manufacturing operations and to leverage investments in technology to reinvent their business models (figure 1).

1 New customer needs and a constantly changing demand environment:

The pandemic has deeply changed how consumers select, buy and interact with products, and how they expect to be engaged by the companies producing them. Customers are now looking for frictionless purchases, transparency of product information, and personalized products, which require new levels of agility and flexibility across manufacturing and supply chains for companies to meet new needs.

2 Climate change and the imperative of a net-zero-emissions world:

Current planetary challenges have elevated the importance of manufacturing companies cutting CO2 emissions and creating circular business models where supply chains can recover or recycle the resources used to create their products.

3 Digital transformation is here to stay, and disruption will further accelerate:

To remain competitive in markets increasingly threatened by digital players and new entrants, manufacturing companies must go beyond digitalizing their operations and leveraging their investments in advanced manufacturing to transform and innovate their operating and business models.

Figure 1: Three main trends for companies to reinvent their business models.

While the case for change is clear, most companies lack clear strategies and are struggling to execute. The journey is complex, so to unpack what it takes to successfully transform operating and business models, the World Economic Forum Global Future Council on Advanced Manufacturing and Value Chains conducted in-depth interviews with over 50 leaders from manufacturing companies as well as technology and services providers. The results of this effort highlight the lessons from those who have already started to unlock business model innovation by adopting advanced manufacturing technologies.

This White Paper presents:

- Concrete examples of how leading companies are leveraging advanced manufacturing to drive business model innovation
- Tailored guidance on key enablers and strategies, as well as guiding questions, that can help accelerate this transformation
- A call to action for scaling innovation across industrial players by stepping up collaboration to address systemic failures

The findings and lessons captured in this paper will serve as a concise reference guide for manufacturing companies to inform their strategies and go beyond the digitalization of operations by leveraging advanced manufacturing to enable new business models.

Done rightly, this will give companies a new competitive edge and help accelerate responsible industry transformation and economic growth by creating and delivering new value to address the challenges of the triple bottom line for profit, people and the planet.

THE BUSINESS MODEL INNOVATION OPPORTUNITY FOR MANUFACTURING COMPANIES

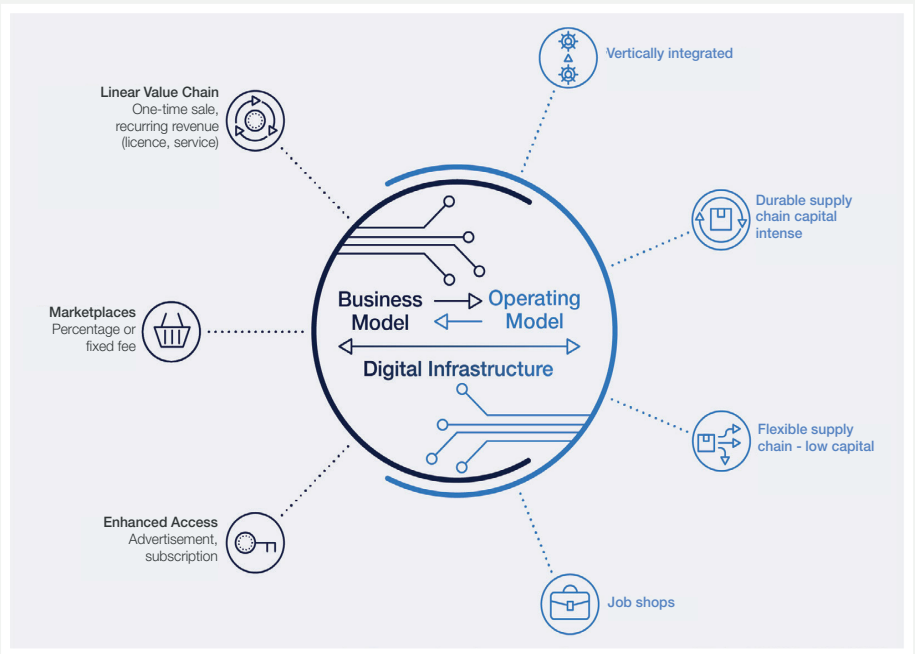
While business model innovation is not a new concept, it remains a nascent topic for many production companies. Most of them are still in the early stages of their digital transformation journeys, often focusing on step-changing the efficiency of their manufacturing operations. To compete with digital native players and new entrants, however, a narrow focus on transforming manufacturing operations is no longer enough.

A common theme from this study is that leading companies are embracing technology to drive innovations that transform how they deliver and capture value – in other words, that transform their business models. The findings highlight four clear benefits of business model innovations:

1. Leveraging technology to address market and/ or climate change disruptions
2. Anticipating and meeting customers' new needs
3. Enabling agile, co-created innovation for new products, processes and services
4. Developing new revenue models

Although the terms "operating model" and "business model" are often used interchangeably, and the two are indeed tightly interconnected and mutually reinforcing, they embody very different concepts:

- The *operating model* refers to how an organization and its supply network operate to create and deliver value for customers.
- The *business model* refers to how an organization and its supply network capture the value it has created.



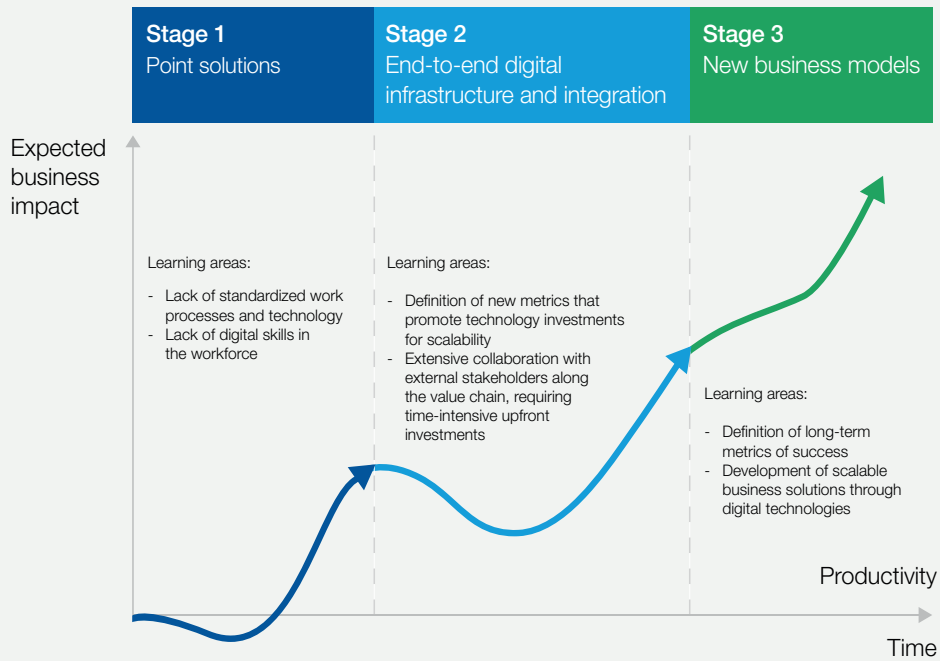
Operating model vs business model: Definitions

1. LEVERAGING TECHNOLOGY TO ADDRESS MARKET AND/OR CLIMATE CHANGE DISRUPTIONS

An increasing number of manufacturing companies are starting to address system-wide failures, such as climate change or trade conflicts, through business model innovations. These include multi-sided platforms, marketplaces or ecosystems that are enabled by advanced manufacturing technologies and that allow companies to collaborate with a broader set of partners on the supply and demand sides. Thus, the companies can scale innovations faster.

For climate change, as the race to net-zero emissions becomes an imperative, companies are starting to move from linear to circular value chains to try to generate and deliver more value with the continuous recycling and reuse of the same resources. A good illustration of this is how Ralph Lauren is championing a multistakeholder collaboration to invest in solutions for true reuse, upcycling and life-cycle extension of natural fibres, which currently cannot be easily reused due to their structure. Through circular business models, the life cycle of natural-fibre products can be extended several times.

Further, Procter & Gamble's Fabric & Home Care division will start producing its first paper bottle in 2022 in partnership with Paboco, a company that produces paper bottle technology. Paboco resulted from a collaborative project developed through an ecosystem of leading consumer goods companies, including Carlsberg Group, BillerudKorsnäs, The Coca-



Notes: [x-axis] Productivity improvement over time: for example, labour, machine or material is measured at a whole-system level incorporating the full manufacturing value chain. The x-axis therefore spans from a single-point solution application at a particular point in the system (e.g. a machine within a factory) to the extended factory network and supply chain, through to a system-wide perspective incorporating suppliers and end users.

[y-axis] Expected business impact: in terms of margin improvement and revenue uplift, but also broader measures on sustainability/environmental, social and governance, as well as inclusivity.

The learning curves can be accelerated by leveraging the key strategies learned from leading companies and summarized in this White Paper (Section 4).

Figure 2: Main stages of the journey – from point solutions to new business models

Cola Company, The Absolut Company, L'Oréal and ALPLA, with the aim of manufacturing "green fibre" bottles. It will enable a carbon footprint reduction of 90% compared to a glass bottle, and 30% compared to a polyethylene terephthalate (PET) bottle.

2. ANTICIPATING AND MEETING CUSTOMERS' NEW NEEDS

Several organizations have recognized the imperative of responding to fast-changing customer demands for customized products. They are leveraging advanced manufacturing to address this need by gaining greater insights into buying behaviours and customer choice, and innovating their business models.

Johnson & Johnson is enabling patients around the world to gain personalized and universalized access to healthcare by supplying surgeons with operating room material that meets the needs of each patient and intervention. It is also helping hospitals to optimize operations and asset management with the use of on-site 3D printing, smart cabinets and insights-as-a-service, among other solutions enabled by advanced manufacturing.

3. ENABLING AGILE, CO-CREATED INNOVATION FOR NEW PRODUCTS, PROCESSES AND SERVICES

By bringing buyers, sellers and enablers together, companies that use digital platforms amplify the possibilities to interact, learn and participate with all players in a given production and business ecosystem.

Some companies are experimenting with marketplaces to address fragmented, non-transparent and complex value chains. They are also promoting the sharing economy to improve the use of their assets.

Marketplaces are unlocked by advanced manufacturing solutions including digital platforms, end-to-end supply chain connectivity, a robust cloud infrastructure and secure data privacy to build trust and help companies scale solutions fast. Schneider Electric recently launched the Exchange Platform, where technology providers, system integrators and end-users can collaborate and co-innovate for building digital solutions.

Participants can meet remotely with experts in various locations and access online digital assets such as products, data and interfaces. They gain visibility and can create, collaborate and scale business solutions to meet customers' needs.

Lanxess built an independent and neutral digital marketplace and was able to shift a traditional industry (chemicals) with a very complex value chain to a more seamless ordering process and user experience for both buyers and sellers.

This allowed the company to increase efficiency and transparency in the ordering process, creating value for both customers and suppliers.

4. DEVELOPING NEW REVENUE MODELS

Some companies have transformed the buyer- seller relationship into a partnership, which requires greater collaboration and sees performance as a shared responsibility.

An example of a new revenue model is a new service from UPS, which outfits certain stores with 3D printers to provide on- demand services for manufacturers and consumers.

UPS plans to use its investments in 3D printing to lay the groundwork for a network of on-demand print shops, bringing manufacturing capacity closer to consumers and thereby increasing resiliency, flexibility and reach.

New revenue models have the potential to provide manufacturers with recurring cash inflows, offer more flexibility, engage directly with customers and make the supplier a true partner in ensuring the customer's success.

HOW TO UNLOCK BUSINESS MODEL INNOVATION THROUGH ADVANCED MANUFACTURING

While transformation and innovation vary in pace, scope and approach, the common element from the case studies is that they all leverage advanced manufacturing to first-step-change operating models, and then enable business model innovation.

They followed a journey of three main stages:

- Stage 1 – Point solutions: Advanced manufacturing boosts factory productivity
- Stage 2 – End-to-end digital infrastructure and integration: New infrastructure and strategy drive impact
- Stage 3 – New business models: Transformation at scale unlocks growth
- Progress made at each stage paves the way for the following phase.

STAGE 1: POINT SOLUTIONS - ADVANCED MANUFACTURING BOOSTS FACTORY PRODUCTIVITY

In this first stage, companies look for ways to optimize their manufacturing operations and operating models by piloting and deploying promising point solutions in a given factory site or value chain.

Point solution applications are usually created in close collaboration with a technology provider. These pilots are often focused on validating the benefits of the new solution (typically reduced operating costs and improved productivity) and testing its ease of adoption and potential to be deployed across more sites or value chains.

The business impact includes reduced operating costs and improvements in speed. The case studies from Siemens and Foxconn (Appendix, p. 18) are good examples of such point solutions, which show how advanced manufacturing, such as artificial intelligence (AI), virtual reality and predictive analytics, can fast-track throughput, support new product functionality and reduce material consumption.

While manufacturing companies are generally able to demonstrate productivity improvements through point solutions, they often face two challenges that prevent them from deploying point solutions at scale:

- A lack of work processes, data layering and technology standards across the network of factory sites and value chains, leading each site to request highly customized and expensive solutions
- A lack of digital skills in the workforce, constraining the overall roll-out timeline of new solutions based on the availability of qualified operators and new upskilling and reskilling programmes

Critically, manufacturing companies must assess their capability gaps as they move to Stage 2. Tools such as the Smart Industry Readiness Index were created in partnership with leading industry and technology companies to help manufacturers assess their level of maturity and results of the Stage 1 transformation.

STAGE 2: END-TO-END DIGITAL INFRASTRUCTURE AND INTEGRATION - NEW INFRASTRUCTURE AND STRATEGY DRIVE IMPACT

In this stage, companies aim to enable seamless end-to-end data flows and supply chain integration. For this, companies must go through a comprehensive and integrated transformation that addresses technology infrastructure and capability gaps.

These include the following:

- Significant investments should be made in technology upgrades to build a solid technology infrastructure. The investments must be closely linked to the organization's business strategy.
- Strategic choices need to be made for defining clear data platform standards, implementing modern operational technology (OT)

architecture, and launching new reskilling and upskilling programmes. For instance, to create clear data platform standards and integrate the diverse technologies used across all product lines (which involves discrete, batch as well as continuous processes), Johnson & Johnson has been investing for five years in building data science expertise to develop a data layering strategy closely linked to the organization's business strategy.

These infrastructure and capability investments enable organizations to:

- Roll out and scale point solutions at a low cost and reduced time across their factory network, and by integrating them across value chains
- Seamlessly connect and leverage data across the whole production ecosystem, from suppliers to customers, thus enabling breakthrough innovation and improvements in supply chain agility, cost and sustainability footprint.

A good example of the benefits of such end-to-end digital integration can be found in the Schneider Electric case study (Appendix, p. 18). Its approach towards scaling and integrating solutions across networks of factory sites has helped reduce total energy consumption by 26%.

Yet, and despite the promise of significant benefits, many companies struggle to complete their move to Stage 2. Their challenges include the following:

- Technology investments are often not easily justified by short-term return-on-investment (ROI) metrics, as they normally lead to significant upfront investments in capital and human resources. Supply chain leaders struggle to make the case for the new OT infrastructure needed to scale up the deployment of solutions.
- Upfront and time-consuming investments are often required to allow for collaboration with external stakeholders along the value chain, who are critical to connecting end-users with producers and suppliers.

Those who persist and manage to make the right infrastructure investments through Stage 2, however, not only boost the efficiency and productivity of their overall operating models, but also pave the way to Stage 3, in which access to new business models is then unlocked.

STAGE 3: NEW BUSINESS MODELS TRANSFORMATION AT SCALE UNLOCKS GROWTH

The breakthrough progress made on processes and technologies during Stage 2, with the untapped data available across the wider ecosystem of supply chains, can now be leveraged to unlock business model innovation. This final stage has no prescribed journey. Indeed, not all organizations start by operating a marketplace or orchestrating ecosystems. Depending on their business contexts, some companies experiment with multiple opportunities in parallel, while others focus on operating model innovation by learning how to accelerate the delivery of solutions at scale that are built on the new Stage 2 infrastructure. Others work to operate within new business models orchestrated by other organizations. An example of such orchestration can be found in the discussion of RIZE's microfactories together with Microsoft's at-home manufacturing network.

As mentioned, organizations that learn to effectively use new infrastructure to improve operations and develop new business models could generate major new sources of value. That value can be created and delivered not just for companies and customers, but also for workers, society and the environment. To do so, companies must shift their attention from an internal focus (factory orientation) to an external one. This involves developing a system-wide perspective that spans factory networks, multi-actor supply chains and a wider set of business ecosystems in which they operate. Key strategies to accelerate operating and business model innovation, as emerging from the examples collected, are presented in the following section. Value generated in unlocking new business models can be transformational and has the power to shift traditional industries at scale.

FIVE STRATEGIES TO ACCELERATE AND CAPITALIZE ON BUSINESS MODEL INNOVATION

Given the complexity of the Stage 3 transformation, only a few leading organizations have been able to realize the full potential of their investments in advanced manufacturing to date. Despite the clear benefits and pressure to change, the journey towards business model innovation is often challenging and frustrating, and the literature is filled with examples of failed efforts.

If a company is experiencing roadblocks, it can be reassured that it is far from alone. In fact, challenges are the norm. The innovation chasm is real; traditional manufacturing organizations cannot circumvent it but must go through it.

To accelerate their transformation, most advanced companies commonly leverage the following five key strategies:

1. Start with leadership and culture shifts
2. Forge system-wide collaborations
3. Adopt new metrics to measure success
4. Leverage core manufacturing strengths to close the gaps with companies with a digital core
5. Relentlessly pursue the broader purpose.

1. START WITH LEADERSHIP AND CULTURE SHIFTS

- **Align the leadership team on the vision, goals and strategies:** The three stages of the transformation outlined in the previous section – point solutions, end-to-end digital infrastructure and new business models – are normally owned by different leaders who need to be aligned on the overall vision and approach. Point solutions are often owned by the manufacturing and supply chain functions; data infrastructure is typically owned and operated by information technology services; and overall investment or business model innovation is owned by business unit executives. This is why some companies, such as Schneider Electric, have chosen to appoint a digital transformation leader to ensure a consistent enterprise-level approach and to accelerate learning and reapplication across business units and functions.

- **Call out the cultural changes needed:** Leaders must not only advocate, but also serve as role models, for the behavioural changes expected to support the transformation journey. For example, Hyperloop, an American transportation technology company, is enabled by an open consortium where all participants and team members have direct access to leadership at all times, enabling real-time guidance and strategy pivots.
- **Drive digital capabilities across the enterprise:** This should also occur at the executive level, as part of the challenge may lie in senior leaders operating in functional silos and thus taking a siloed view of the opportunities. To accelerate the transformation journey, leading players typically leverage a blend of centres of expertise to develop new digital skills and digital academies to ensure digital upskilling across all employees; this ensures that key competences are not isolated in one division but are present through all teams in charge of operations.

2. FORGE SYSTEM-WIDE COLLABORATIONS

- **Scale the depth and breadth of collaborations:** Internal and external collaborations are essential at all stages of the transformation journey. As it progresses, the number of partners and the depth of the collaborations need to scale. During the point solutions stage, companies need to collaborate deeply with best-in-class solution providers while already bearing scale and integration in mind. In the end-to-end data integration stage, companies must collaborate with increasingly more parties internally and externally across the entire value chain. During the business model innovation stage, companies need to bring together new sets of partners and players to create a common value proposition, build trust, overcome not-invented-here biases, break old paradigms and shape win-win situations.

- **Engage with diverse partners in different ways:** Successful companies nurture fruitful collaborations with a diverse set of partners fast-paced and unorthodox start-ups, large solution providers, universities, non-governmental organizations, suppliers, former competitors and end consumers. Managing numerous and often fluid relationships simultaneously requires collaboration intelligence at all levels and on all partners. Companies also need to build different formats to interact with diverse actors and allocate the sufficient internal resources and clear external communication of formats and channels.

3. ADOPT NEW METRICS TO MEASURE SUCCESS

- Use metrics suitable for each stage of the transformation: Metrics need to evolve depending on the transformation stage (e.g. point solutions, infrastructure development, markets, platforms) and the life cycle of the initiative (launch, growth, maturity). This requires companies to go beyond ROI metrics as their transformation evolves:

Stage 1 – Point solutions: ROI metrics (e.g. payback periods, product improvement, internal rate of return) can remain central, as point solutions are related to an organization's current activities.

Stage 2 – End-to-end digital infrastructure and integration: Leaders must focus on the capabilities being created, and the full potential for both operating and business model transformation, instead of just measuring ROI against the current footprint of activities. Speed of infrastructure development provides an example of an alternative approach to track progress.

Stage 3 – New business models: The metrics needed vary depending on the type of operating and business model the firm is launching. Platform metrics are required for marketplaces and ecosystem business models; those metrics evolve as the business model matures. At the initial stages, the volume of interactions and their value must be considered. During the growth phase, monetization becomes critical, while at the maturity stage looking at who, what and how to innovate is essential to compete with other platforms' business models.

The introduction of such new metrics is challenging as goals, compensation and status are deeply tied to historical metrics, and

changing metrics is often perceived as too difficult. Successful firms are doing the following:

- **Adopt new metrics in parallel with the existing key performance indicator (KPI) framework:** The firms anticipate the metrics and allow them to evolve until they are sufficiently accepted as the primary measure of performance.

- **Act despite the lack of complete information:** Firms will frequently have only some of the necessary data, but they can still proceed and iterate. As new data becomes available, they can be used to refine the metrics.

- **Make it safe to accept and pursue the implications of new KPIs:** As with the introduction of new KPIs, the performances recorded might change drastically. For example, when judged by production against output goals, a plant may score 99%. But when overall equipment effectiveness (OEE) is accurately measured in real time using digital technologies, the plant may well be performing at an OEE level of 50-60%.

  This KPI of course suggests great opportunity for improvement, but only if the company's leadership is prepared to encourage adherence to accurate reporting and to support change.

4. LEVERAGE CORE MANUFACTURING STRENGTHS TO CLOSE THE GAPS WITH COMPANIES WITH A DIGITAL CORE

- **Maximize the use of competitive advantage:** Although manufacturing companies face the tough challenge of competing with an increasing number of digital native players, they can leverage their sources of competitive advantage.
- **Enhance the customer experience:** Deep product, market and consumer expertise can be used. It can focus on decreasing complexity and offering innovative, frictionless experiences, and on understanding and addressing customers' unmet and emerging needs.

- **Leverage a broad and diverse supplier base:** This base can serve as a source of ideas for product and technology innovation (in the automotive industry, for example, 80% of an assembled car comes from suppliers' parts).

- **Benefit from dedicated workforces:** They can adapt to new technology investments and have the critical product knowledge and resilience to operate through a changing environment.

5. RELENTLESSLY PURSUE THE BROADER PURPOSE

- **Go beyond profit maximization to create new value for all stakeholders:** Leading companies in the production ecosystem are going beyond one-dimensional cost- or profit-maximizing strategies, striving to create value for all their stakeholders (e.g. shareholders, customers, workers, society, the environment).

- **Solve a real customer, societal or environmental need:** These companies maximize the use of their experience, expertise and connections not just to drive new business models but to do so while solving a real customer, societal or environmental need.

- **Envision impact already in Stage 1 of the transformation and see it through to Stage 3:** Identifying the ultimate goal behind the transformation should be the approach followed right from the beginning and not undertaken as an afterthought. It is important to have business-savvy supply-chain leaders and to approach the transformation in close partnership with business leaders within the organization. This comes with a double benefit: externally, the chances of success increase as innovation solves a real problem; and internally, the whole organization becomes further proud and inspired to take an active part in a broader purpose-driven transformation journey, significantly boosting results and impact.

1 Start with leadership and culture shifts	- Align the leadership team on the vision, goals and strategies - Call out the cultural changes needed - Drive digital capabilities across the enterprise
2 Forge system-wide collaborations	- Scale the depth and breadth of collaborations - Engage with diverse partners in different ways
3 Adopt new metrics to measure success	- Use metrics suitable for each stage of the transformation - Adopt new metrics in parallel with the existing KPI framework - Act despite the lack of complete information - Make it safe to accept and pursue the implications of new KPIs
4 Leverage core manufacturing strengths to close the gaps with companies with a digital core	- Maximize use of competitive advantage - Enhance the customer experience - Leverage a broad and diverse supplier base - Benefit from dedicated workforces
5 Relentlessly pursue the broader purpose	- Go beyond profit maximization to create new value for all stakeholders - Solve a real customer, societal or environmental need - Envision impact already in Stage 1 of the transformation and see it through to Stage 3

Figure 3: Five strategies to accelerate and capitalize on business model innovation

Key questions CEOs should ask their executives	Key questions supply chain executives should ask their CEOs	Key questions corporations should ask academia and institutions
1. What and whose problem are we trying to solve?	1. Do you understand the cultural change needed?	1. What new technologies are being developed in university laboratories that have the potential to drive operating or business model innovation?
2. What new strategic options does the initiative create?	2. Do you know which transformation behaviours we need to role model?	2. What new trends are reshaping supply chains, and what assumptions are no longer true?
3. How do we know if the transformation is working?	3. Are you aware that we need to adopt new metrics?	3. Where can universities and industry organizations help to solve standards challenges that might be slowing the adoption of new infrastructure technology?
4. How strong is our end-to-end supply chain data backbone strategy?	4. Do you know the required investments in people, processes and technology?	4. What are some out-of-the-box operating and business models that can help address current system failures, such as resilient supply or climate change?
5. Do we have a clear view of emerging cybersecurity threats?	5. Are you willing to make investments in new infrastructure (change the organization) while also maintaining existing systems (run the organization)?	5. How should the new types of digital infrastructures and partnership opportunities that are emerging at speed be assessed and leveraged?
6. How do we ensure that the sustainability aspect rather than the financial one is driving the new business model opportunity?		
7. Are you and your teams comfortable with the language you use to communicate new business model concepts, such as "platform governance" and "network effects"?		

GUIDING QUESTIONS TO HELP STAKEHOLDERS DRIVE THEIR TRANSFORMATION JOURNEY

A set of questions for CEOs, supply chain leaders and corporations to keep in mind can help them accelerate the three stages of the transformation and ensure it can deliver and achieve its full potential.

CONCLUSION: THE PATH FORWARD, A CALL TO ACTION

Using advanced manufacturing to change operations and foster new business models is a journey, often made treacherous by the challenges of the significant investments required, by the need to align across functions, both horizontally and vertically, and by the imperative to collaborate with a broad set of actors in the production and business ecosystem in which manufacturing companies operate.

CEOs and their executive teams must lead this journey, putting their weight behind the deep and abiding changes required and enabling the reallocation of resources as needed. While ensuring holistic coordination and ongoing dialogue across all functions and business units, they must also actively encourage and reward a growth mindset at all levels of the organization.

The biggest rewards await those who are able to leverage the transformation of operating and business models to help solve system failures. By collaborating across the ecosystem while transforming their own business models and those of others – be they competitors, suppliers or customers – the most successful companies create and deliver new value to all stakeholders. Those stakeholders include the companies themselves, workers, society and the environment. Leaders in manufacturing should put system failure, such as resilient supply or climate change, at the centre of their transformation journeys.

Compared to certain other sectors (e.g. finance), manufacturing and supply chain organizations are just starting to explore new types of operating and business models.

This means a window of opportunity is available to ensure the transformation can achieve and deliver its full potential.

For this, the World Economic Forum Global Future Council on Advanced Manufacturing and Value Chains proposes the creation of a cross-company accelerator to bring together actors from across the manufacturing ecosystem to incubate and pilot new business models aimed at driving responsible industry transformation and growth. wn

Analysis of Integrated South African Nuclear Industry Economics

The current debate on the viability of the use of nuclear power to support SA industrial growth is, to a large part, focused on the affordability of any nuclear build program.

BY| Prof David Nicholls

This paper aims to consider the overall South African nuclear industry and the degree to which it can fund a proposed new build program. The paper looks to propose a model for consideration that allows such an assessment.

This analysis assumes actual ringfencing of the nuclear industry with a single financial account, but it could also be seen as the assessment of the actual net value of the state nuclear industry to the country while leaving the elements as they are with the Treasury providing the funds.

WHAT IS INVOLVED IN THE SOUTH AFRICAN NUCLEAR INDUSTRY?

The South African nuclear industry consists largely of the activities of Eskom in relation to the Koeberg nuclear power station and to NECSA. There are other activities (such as the National Nuclear Regulator) but these are largely funded from the operations of Koeberg and NECSA.

HOW DO YOU MODEL THE OVERALL INDUSTRY?

The overall industry can be modelled by looking at the income and expenses of these operations as well as the funding requirements of future capital expenditures (e.g., the Multi-Purpose Reactor to replace Safari-1, the decommissioning of the Koeberg plants etc.). To allow a coherent analysis all values are based on current year values.

WHAT IS THE FINANCIAL POSITION OF KOEBERG?

Koeberg has a nominal end of life of 2024 but there is a program in place to extend this (in line with international practice) by 20 years to 2044/45. Eskom has stated that the total cost to upgrade Koeberg for this extension is R20bn, which includes the Steam Generators Replacement (SGR) and a Thermal Power Uprating (TPU) of the reactors by 10%. At present the Eskom's accounts show a provision for Koeberg's decommissioning in 2024, but this is currently unfunded as is the provision for spent fuel disposal (also on Eskom balance sheet).

The publicly stated[1] operating costs of Koeberg equate to some R0.40c/kWh and this value will be used in the balance of the discussion.

Given Koeberg's 20 year life extension is nominally a new decision in IRP 2019 then it can be argued that all historical Koeberg costs are accounted for by 2024. This would include a full decommissioning provision by that date but not the R20bn that has been spent or committed to achieve the life extension.

From a logical point of view the operation of Koeberg beyond 2024 would justify a 20 year Power Purchase Agreement (PPA) in line with those

granted to IPPs (such as those under the RMIPPP). It could therefore be argued that the correct price for this PPA would be linked to the values for dispatchable power in the RMIPPP, which range from R1.49/kWh to R1.86.kWh (DMRE data) with a weighted average of R1.60/kWh. This can be compared with the current standard generation cost in the system of some R0.90/kWh.

If Koeberg is considered to have a value of R0.90/kWh, with an expected load factor of 85% then the free cash generated by Koeberg from 2024 to 2044 would be R7.2bn per year if the net output of 965 MW per unit is considered (the expected output after the SGR). If the TPU is considered the output could be 1060 MW per unit, leading to a free cash flow of R7.9bn.

While Eskom has an accounting provision for the decommissioning of Koeberg this is not an actual cash provision. It can be assumed that Koeberg's decommissioning costs will be incurred over a ten year period following shutdown and would total some R24bn (based on 15% of the EPC[2] costs of $5,500/kWe).

Therefore the financial cash flow of Koeberg can be considered to include a net income of some R7.2bn per year for twenty years from 2024, a net payment of R2.4bn for ten years following shutdown in 2045 and the repayment of some R20bn life extension costs over the twenty years of operation.

WHAT ARE THE FINANCIAL DEMANDS FOR OTHER NUCLEAR ACTIVITIES?

While the operation of the Koeberg nuclear power station can clearly be seen to be a cash generating operation the same is not true of the activities by NECSA. At present NECSA receives an annual operating grant of some R1bn.

This will be modelled to continue indefinitely for the purpose of this analysis. The other two large cash requirements for the nuclear industry are the funding of the replacement for the Safari-1 research reactor (which produces some 20% of the world's radio pharmaceuticals) with a new Multi-Purpose Reactor (MPR) and the potential to build (with a foreign OEM) a lead unit of a Small Modular Reactor (SMR) fleet at Pelindaba to allow replacement of the current Eskom coal stations in Mpumalanga. This lead unit would then form the basis for a fully commercial roll out on Eskom coal station sites as they decommission.

For the purpose of this analysis the funding for the MPR is presumed to be some R1bn per year from 2024 to 2033 (ten years) and the SMR to be some R1bn per year from 2024-2031 (eight years). There is no extra income assumed from these activities. The MPR is replacing the existing revenue from Safari-1 operations and the SMR, which should have significant upside from electricity and reactor sales is conservatively assumed not to succeed.

WHAT IS THE IMPACT OF NEW CONSTRUCTION NPPS?

The construction of new nuclear power plants similar to the Koeberg units is clearly the largest element in this analysis. The key assumption is that

the new power station will be procured under an EPC type contract with Export Credit Agency funding. This ECA funding is expected to cover 85% of the project costs and to be at a rate of 4% in US$ (with the US inflation over the last ten years at some 2%). This is fully in line with the financing of recent nuclear export deals, in particular the Egyptian purchase of 4 x 1200 MW VVER1200 from Russia. The capital costs of such a procurement are assessed at $5,500/kWe with the owner's costs (that is those over and above the EPC costs) being some 10% of the EPC costs. The standard ECA repayment terms (in line with OECD rules) is over 18 years starting after the plant comes into service.

The model assumes that the balance of the capital costs (15%) is capitalized during construction at a NDR[3] of 8.3% and then paid on unit start-up.

In terms of operating costs the assumption is that the total recurring costs would amount to $20/MWh, which is in line with US expectations and slightly lower than Koeberg's current values. This is logical as the nuclear program overheads are already accounted for in Koeberg and the new units should have greater operating efficiency. Similarly an operating load factor of 90% could be used.

In terms of the tariff for the new units it would be logical (as they are new plant) to allow them a PPA for the first 10 years of operation at R1.50/kWh (aligned to other new entrants), followed by a R0.90/kWh market tariff thereafter.

In terms of timing the assumption is that there are four new units constructed, spaced one year apart. The first unit is commercial by 2033.

WHAT ARE THE INTEGRATED RESULTS OF THIS APPROACH?

The model assumes a South African inflation rate of 5% and an interest rate of 11% nominal. The two graphs below show the outcome of this approach. As can be seen the "SA Nuclear Industry" maintains a positive cash balance throughout the program. Due to the assumption that the new power stations capital expenditure (non-ECA) is paid out as a single payment on handover the cash position in 2032 is over emphasized. In reality the expenditure on the new build during construction will significantly reduce the peak seen in 2032, however the low figure in 2034-36 will not be affected as it is only a timing issue.

CONCLUSION

This analysis shows that a nuclear build program can be fully supported and justified by the existing value of Koeberg's life extension. Eskom would be able to move R20bn from its debt obligation and to remove its decommissioning provision for the Koeberg power station. The funding obligation on the National Treasury for the operation of NECSA (and the support of the MPR) would also be removed.

Clearly there would be need for some form of guarantees to support the ECA loans, but these would be of the same type as offered to the current IPP programs, being a guarantee against a change in state policy and a guarantee that the PPAs would be honoured. wn

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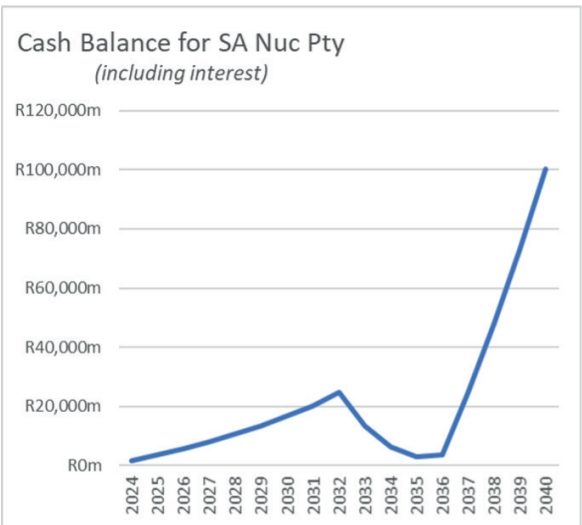

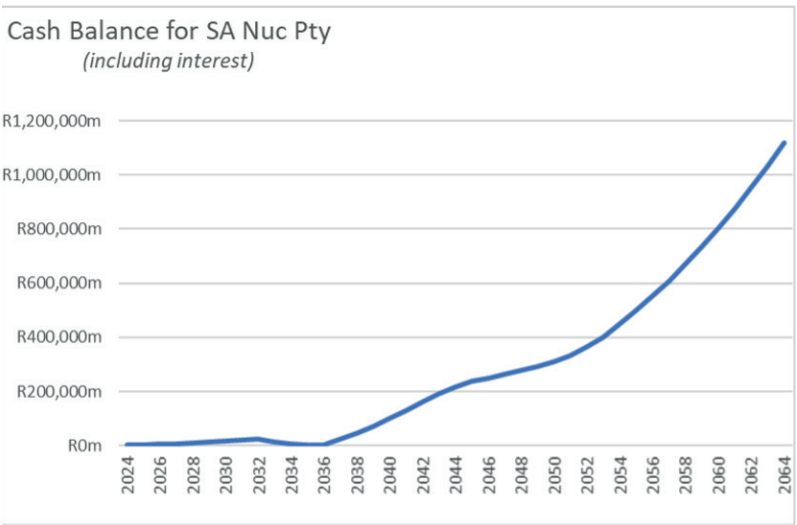

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How Africa is leading the way in dealing with 'e-waste'

With the ICT boom has come a huge increase in discarded electrical and electronic equipment, or 'e-waste'. A record 53.6 million metric tonnes (Mt) of e-waste was generated worldwide in 2019, which is rising. Experts predict that the annual generation of e-waste will reach 74.7 Mt by 2030.

By: Doreen Bogdan-Martin
Director, International Telecommunication Union (ITU)

Manufacturers must develop a new approach and take responsibility for a product's entire lifecycle. Tackling this challenge will require a concerted and coordinated effort from all the organisations and individuals across the electronics value chain.

African nations are showing the way to deal with e-waste. According to the Global E-waste Monitor 2020, 13 countries in Africa have an e-waste policy, legislation or regulation. Their efforts can be a lesson to other nations looking to improve their e-waste management systems.

CLEARLY DEFINING VALUE CHAIN ACTORS

Long-term solutions to e-waste management will require a fair and economically viable approach to extended producer responsibility (EPR). EPR requires that producers – such as manufacturers, importers or distributors – take responsibility for the end-of-life management of electronics sold on the market. This includes taking items back, recycling them and eventually disposing of them.

Regulation must contain clear and easy-to-understand definitions of the different e-waste stakeholders to avoid confusion. Many African countries have defined their regulations covering e-waste management and EPR. For example, Côte d'Ivoire, Cameroon, Ghana, Madagascar, Nigeria, Rwanda and South Africa emphasise a person or persons – rather than entities - introducing, importing and manufacturing electronics.

This makes it more efficient to identify who must register with the associated EPR scheme. For example, Côte d'Ivoire, Cameroon, Ghana, Madagascar, Nigeria, Rwanda and South Africa emphasise that 'producers' include importers, distributors and manufacturers of electronics. This efficiently identifies who must register with the associated EPR scheme.

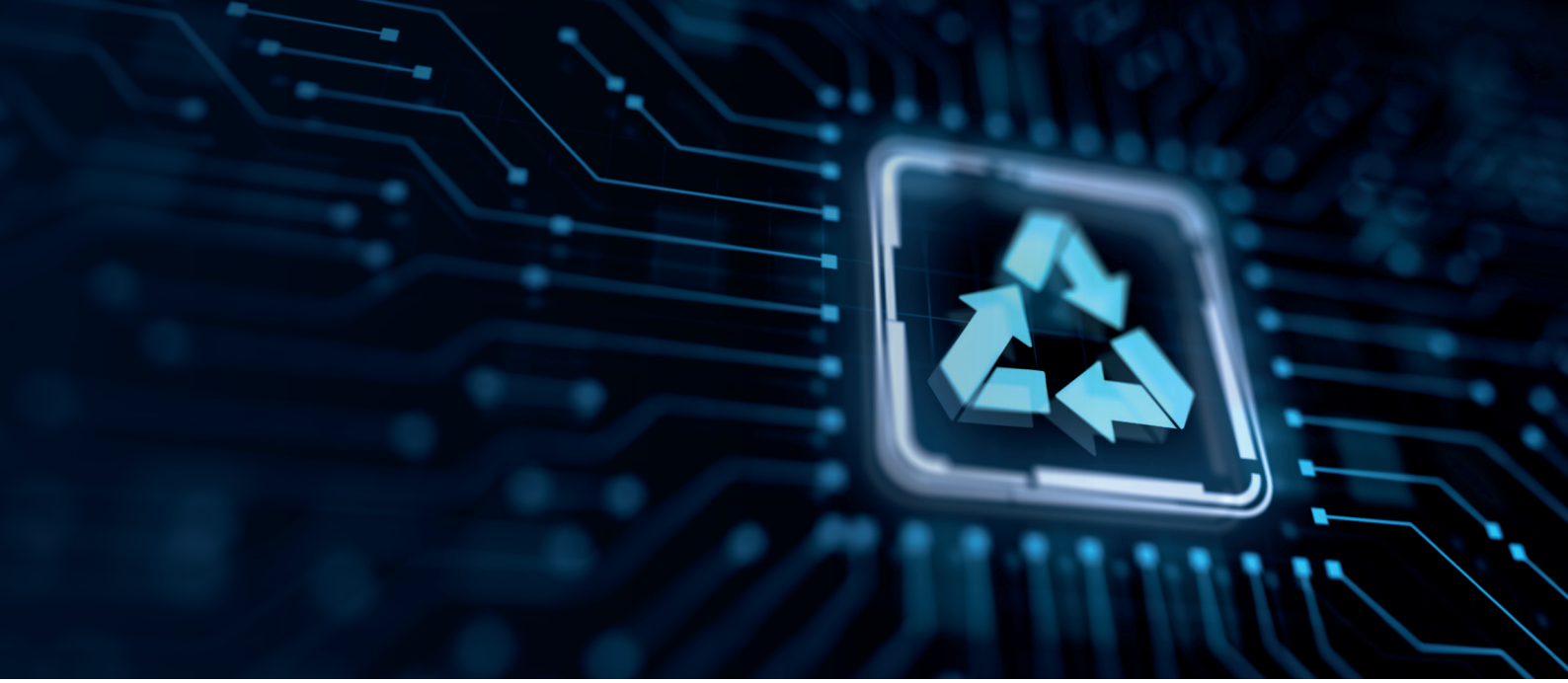
ENSURING SUSTAINABLE FINANCING

The most sustainable system is self-financing, which is why the role of businesses and entrepreneurs in e-waste management is essential.

In Nigeria, producers help cover the cost of e-waste management – including waste collection, separation and transfer, treatment and recycling and final disposal, public information, awareness campaigns, and training programmes.

These manufacturers, assemblers, importers and distributors pay a fee to the not-for-profit E-waste Producer Responsibility Organisation Nigeria, ensuring shared responsibility and funding for e-waste processing. This approach also ensures the EPR scheme remains resilient.

Ghana introduced an e-waste eco-levy on importing used and end-of-life electrical and electronic equipment. The Customs Division of the Ghana Revenue



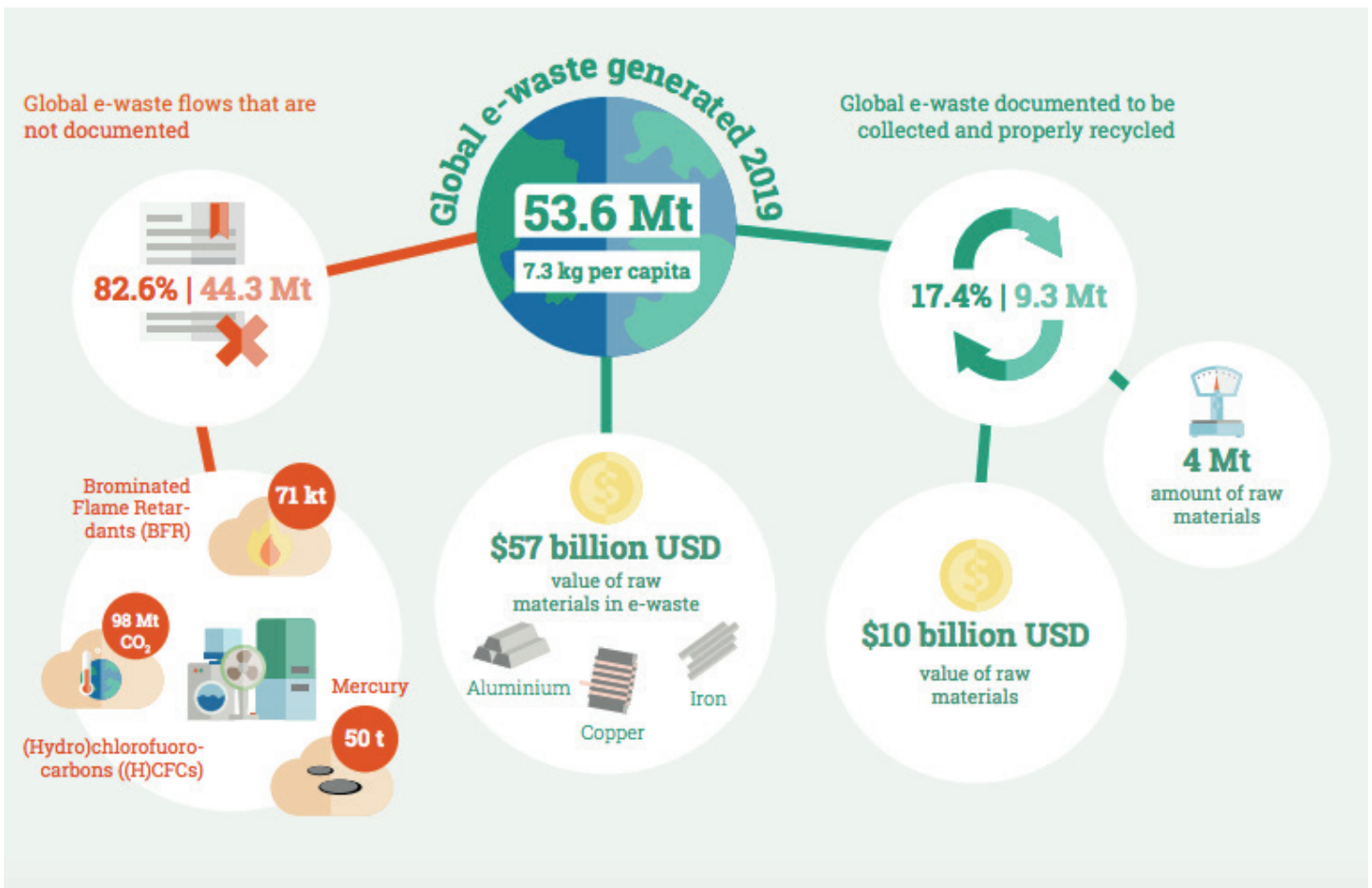


Figure 1: A record 53.6Mt of e-waste was generated in 2019, and the quantity is set to rise further Image: Global E-Waste Monitor 2020

Authority spearheads enforcement of the eco-levy, which makes the system more resilient and ensures the cost of e-waste management remains covered. Regulation can help protect these financing schemes.

COLLABORATING WITH THE PRIVATE SECTOR

Several African countries have chosen policy approaches to establishing Producer Responsibility Organisations (PROs) to implement EPR schemes. PROs provide a mechanism for producers to help them fulfil their obligations under the EPR scheme, such as providing the necessary funds to employ professional e-waste collectors and recyclers.

South Africa has adopted a PRO model across various waste streams such as lighting, electric and electronic equipment and packaging. This demonstrates how an EPR scheme can be adapted to meet the needs of different industry sectors. In Rwanda, the government has invested directly in large-scale e-waste collection and recycling by establishing a successful public-private partnership with Enviroserve, a large e-waste recycling company. Although this approach differs slightly from PROs, it has the potential to scale up and serve countries neighbouring Rwanda.

ENFORCING THE SYSTEM

Streamlining enforcement for e-waste systems is also key. For example, counterfeit equipment can become e-waste much quicker due to faulty parts and non-conformity towards certain technical standards, among other things.

To combat the importation of counterfeit equipment, the Zambia Information and Communications Technologies Authority (ZICTA) enforces the responsible importation of technology equipment through type approval, which means checking that a product meets a minimum set of technical regulations and safety requirements.

The ZICTA works with the Zambia Revenue Authority (ZRA) to ensure that imported technology equipment meets these standards.

In addition, all licensed technology dealers in Zambia must submit annual statistics on the equipment they imported the previous year. This helps track the amount of equipment being put on the market and forecast the amount of e-waste likely to be generated.

The Zambian example shows the importance of collaboration among government authorities for effective enforcement. Existing processes in other countries, such as type approval for technology equipment, could be adjusted to support the control and management of this equipment towards the end of its life or use.

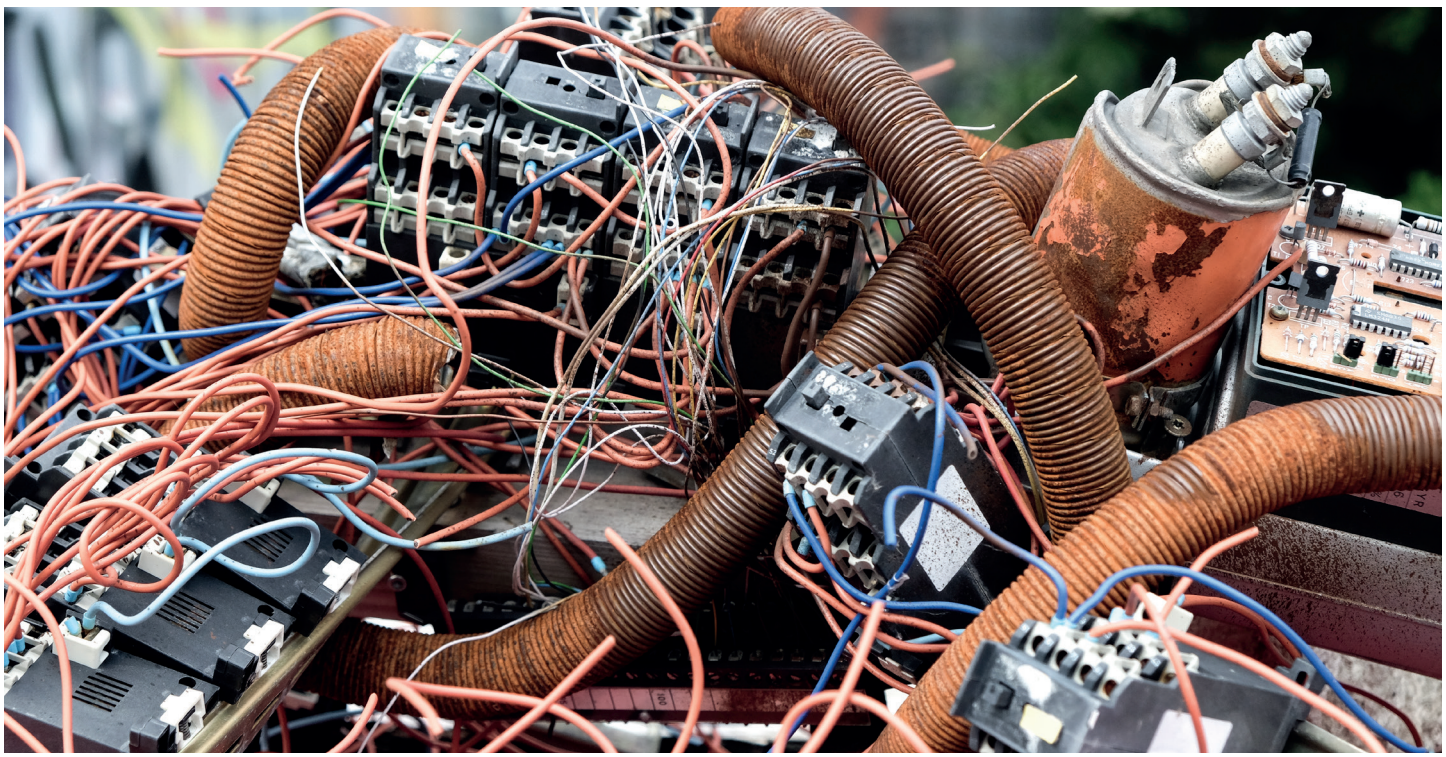
LESSONS LEARNED

Africa's experience managing e-waste provides interesting approaches for all countries to consider when building an e-waste management system.

Of course, continuous improvement is necessary to ensure that the e-waste management system can adapt as needed. Governments should use existing networks – for example, existing collection systems for other waste streams – to ensure the systems remain relevant.

They must also encourage data sharing among stakeholders and establish national working groups on e-waste and EPR.

Such steps made by the government help set standards for new ways of working, living and doing business. Critically, they also highlight a key message: that all stakeholders should value electronics reuse and recycling. wn



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The Local Economy is Key to Business Success

INTERVIEW WITH COBUS OELOFSE, CEO OF THE ILEMBE CHAMBER OF COMMERCE, INDUSTRY AND TOURISM

It is at local economic level that a business can thrive or die. Local authorities must heed business communities' pleas for progressive policies, says Cobus Oelofse, CEO of the iLembe Chamber of Commerce, Industry and Tourism

The saving grace of our country will lie in the well-being of our local economies because business happens locally. It is in the local economy where the business environment is either made or broken. Local and district municipalities across South Africa deliver the utility services that businesses require, maintain such infrastructure, enforce by-laws and determine tariffs and tariff structures that aid competitiveness.

This was the nub of a discussion with Cobus Oelofse, CEO of the iLembe Chamber of Commerce, Industry and Tourism, on the role of business within iLembe, key concerns of the business sector and how the business environment can be enhanced to unlock economic growth.

Oelofse stressed that business chambers should not be seen as pressure groups but rather, in the South African context, as social partners that promote and protect the interests of business and the business community. Government in local, provincial and national spheres exert a great deal of influence on how business is conducted through policies, rules and regulations.

Focus, time and interest seldom allow individual businesses to engage on behalf of the collective on, for example, matters of policy or process. Therefore, the Chamber promotes the collective interests of business through engagement with and representation to relevant government departments - often not only addressing concerns but also making suggestions to promote and safeguard the interests of the business community.

THE VISION

The iLembe Chamber of Commerce, Industry and Tourism's vision is to represent, promote and energise local business, fostering a healthy economic environment that will make the iLembe district the preferred place to do business.

The iLembe District - the smallest district municipality in KwaZulu-Natal - wedged between Durban and Richards Bay, consists of four local municipalities, viz. KwaDukuza, Mandeni, Maphumulo and Ndwedwe. The Chamber has great confidence in the economy of iLembe District and hence pushes for an environment that attracts and retains investors.

"The iLembe Business Confidence Index (iBCI) consistently highlights concerns about infrastructure failings and decay and the need for policies that create an environment conducive for business," said Oelofse.

INVESTOR-FRIENDLY POLICIES

He said there was a need for policies that keep abreast of what investors are looking for.

He recently had an enquiry from a significant business about which KZN municipalities offer rebates for energy-efficient or green businesses - a future-proofing approach that would economically benefit any of the iLembe local municipalities if it was in place.

"Hence, as a Chamber, we endeavour to influence policy to ensure that our district remains attractive and appealing. The lifestyle of iLembe District, our KZN North Coast beaches, weather and sought-after lifestyle are all important and positive factors. But we also need to be obsessed with looking after our economically-critical infrastructure.

It is not only the roads that must be maintained. The state of our beaches is also paramount if we want to attract, especially overseas visitors. The high-spending visitors we need to target do not wish to deal with anti-social behaviour, disorderly informal trading or filthy beaches.

Urban-Econ Development Economists recently conducted a comparative study into municipal rates and tariffs to ascertain the competitiveness of the KwaDukuza commercial property sector when measured against the Johannesburg and eThekwini Metropolitan Municipalities and the George and Stellenbosch Local Municipalities.

The commercial property sector is viewed as the backbone of local economic growth and development within the KwaDukuza Local Municipality, currently and in the future.

The competitiveness and long-term sustainability of this economic sector are fundamental to the socio-economic well-being of the KwaDukuza region and its surrounds, as well as the financial viability of the local authorities that benefit from property rates and municipal service/ utility revenues.

A region's business value proposition often depends on competitive municipal tariffs and charges. If not, this catalytic regional economic sector will be vulnerable to investor rejection and business value destruction, making it unsustainable in the long term," said Oelofse.

The study ascertained that KwaDukuza Local Municipality is the most expensive municipal area for the development of retail property among the study subjects and the second most for the development of office and industrial property, after the eThekwini Metro.

This represents a significant challenge in efforts by the public and private sectors to retain and attract new investment and development into this municipality.

REMAIN COMPETITIVE

Oelofse said rapid growth within the iLembe district has often resulted in infrastructure lagging and a need to play "catch up continuously". He hailed the construction of the Dukuza substation as a significant step in reassuring new business investors and residents.

"We are well-positioned as a relatively new and fast-growing area to develop new, modern infrastructure, although the upgrade of ageing or infrastructure not fit for purpose remains a challenge for our authorities."

Oelofse said approaches and policies must be implemented to enable iLembe District to remain competitive in the long term.

Voicing disappointment, he said the Isithebe Industrial Estate, employing more people than all the Special Economic Zones (SEZ) in the country, sits between the Dube TradePort SEZ and the Richards Bay SEZ, is not adequately attended to, protected and promoted.

"This is hugely frustrating, especially considering the hard work put in by the Mandeni municipal leadership and the iLembe Chamber's Isithebe Business Cluster. I am afraid that it feels like Isithebe is always sucking the hind tit – it is a significant economic asset, not only for iLembe and KZN but for the whole country," said Oelofse.

Ease of doing business, in line with the Vuthela iLembe LED Programme intentions, remains front of mind for the Chamber. In addition to policy, policy implementation and associated processes need to be streamlined for it to be a unique selling point in luring investors to iLembe.

"The cost of doing business must be simple. It must be fair, easy to administer and most importantly, transparent. Too often, investors are caught off-guard by charges they were not aware of when wooed. Businesses need to know what they are in for from the outset."

"The local business community also shares the common national concern around corruption and value for money delivery of services and infrastructure," Oelofse said.

Oelofse indicated that the iLembe district was the second most impacted area, after the eThekwini Metro, by the April and May 2022 KZN floods, with 35 people sadly losing their lives in the disaster. The iLembe District should be prioritised for the restoration of especially road infrastructure that has rendered the municipality isolated from an access point of view.

Oelofse said that the economic infrastructure in iLembe should be repaired without delay.

ILEMBE BUSINESS CONFIDENCE INDEX

Turning to the impact of Covid-19 on the business sector, he said the resilience of iLembe's local economy was severely tested.

"We hope we can quickly recover to pre-pandemic levels, especially in the tourism and hospitality sectors."

Oelofse said the 2021 iBCI demonstrated the hardiness of the iLembe District's economy during the pandemic and a turn on a positive trajectory aided by the region's economic recovery strategy.

He said the iBCI was set against the backdrop of more relaxed economic restrictions associated with the Covid-19 Risk Adjusted Strategy. The global negative reaction to the fourth wave in South Africa was attributed to the Omicron variant, and the destruction of businesses and business confidence during the violent civil unrest that engulfed KwaZulu-Natal, and parts of Gauteng, in July 2021.

According to the iBCI, political volatility in KwaZulu-Natal was also a debilitating factor for economic activities. The July 2021 unrest had badly dented investor confidence and required greater political stability to restore business assurance.

The iBCI said iLembe-based businesses came back to life during the second half of 2021 with 52.7 index points (an index at 0 indicates an extreme lack of confidence, 50 indicates neutrality, and 100 indicates extreme confidence).

All the business indicators included in the iBCI Survey Index improved against the levels recorded in the previous six and 12-month periods. As a measure of business performance, return on sales efforts and trading location, sales volumes were at their best levels in six years.

As a measure of joblessness, the persistent negative sentiment around employment levels was symptomatic of the dilemma of employment stagnation in the iLembe District, with more effort being required to eliminate barriers to job creation and the constraints to conducting business according to the iBCI.

"One of the biggest risks for us as a district and country is that unemployment becomes normalised. If we do not create an economy that can accommodate the disenfranchised and unemployed, our social cohesion will be compromised," said Oelofse.

This urgency, he says, should not be pursued at the expense of an environment that favours business, i.e., compliance with standards, rules, policies and regulations.

"Being able to comply is a real frustration for emerging businesses. The Chamber's Business Support Unit helps SMMEs, among others, to get on their feet by also providing a mentoring role."

BUSINESS IS KEY

Commenting on the relationship between business and local government, Oelofse said there was an open acknowledgement of the importance of the business sector to the economic well-being of the district as a whole.

He said responses to the Chamber's lobbying and advocacy efforts had been a mixed-bag. He hoped some of the overtures at a national level concerning a re-energised commitment to the social compact between business and government would filter through strongly to district and local spheres of government.

"Some of our municipalities can identify and acknowledge the concerns of business and are willing to do something about the trepidations of the business community."

Looking to the future, Oelofse said the Chamber's role in maintaining and improving the confidence of existing businesses and drawing future investors has never been more important.

"We must prepare and position ourselves to be competitive, especially with new opportunities that present themselves when there is a disruption in global trade, as currently is the case. We must ensure that iLembe District is ready to embrace future technologies and encourage the rethinking of what our economy and sectors will be like 20 years from now so that we can keep abreast," said Oelofse.

In conclusion, Oelofse acclaimed the Vuthela iLembe LED Support Programme, promoting sustainable, inclusive growth and job creation through a comprehensive approach to local economic development by focusing on the five elements of municipal finance, municipal infrastructure, private sector development, building inclusive growth and partnerships.

"The goal of the Vuthela Programme to build capacity to aid the ease of doing business is global best practice. As such, this support intervention is welcomed by the business community.

"The Chamber believes that the success of the Vuthela Programme will lie not only in the exposure to improved and best practices but also in the extent to which it will embed practices and processes behaviourally.

"The depth of focus by the implementation partners is also a key to the success of this unique intervention," Oelofse said. wn

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SAIEE CALENDAR

AUGUST 2022

04/08/2022	Construction Regulations from a Legal Perspective
11/08/2022	LV/MV/HV Switch Gear Operation, Safety, Maintenance and Management
16/08/2022	WiE Chapter presents: Women in Engineering: Closing the gender gap
17/08/2022	Technical Report Writing
17/08/2022	Project Management for Engineers
17/08/2022	Fundamentals of Medium Voltage Protection
18/08/2022	Energy Storage Chapter presents: Understanding the standards governing Energy Storage Systems
18/08/2022	Hack Lab
24/08/2022	An introduction to Artificial intelligence for Professionals
25/08/2022	ARC Flash
30/08/2022	Computing Chapter presents: Quantum Computing
30/08/2022	New Engineering Contract (NEC)
30/08/2022	SANS 10142-1 Edition 3

SEPTEMBER 2022

01/09/2022	Legal Liability: Occupational Health and Safety Act (OHS Act)
01/09/2022	Blockchain and Money
06/09/2022	Fibre Optics
08/09/2022	President's Invitational Lecture - Hybrid Event
13/09/2022	Design of Economical Earthing Systems for Utility Installations
13/09/2022	KZN Centre presents: eThekwini's Independent Power Producer Procurement Programme
14/09/2022	Finance Essentials for Engineers
14/09/2022	Select, Maintain & operate your Rotating Electrical Machines like a Pro
15/09/2022	Anatomy of Wind Turbines
20/09/2022	Fundamentals of Developing Renewable Energy Plants
21/09/2022	Writing Good Technical Specifications
29/09/2022	Earthing and Lightning Protection
29/09/2022	Hack Lab

To organise a webinar on the SAIEE Platform, please complete the **Webinar Booking form.**

- Section & Chapter, Centre Webinars
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