SADC e-Mobility Outlook: Accelerating the Battery Manufacturing Value Chain

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The uYilo e-Mobility Programme

The national uYilo e-Mobility Programme, at Nelson Mandela University, was established in 2013 as an initiative of the Technology Innovation Agency (Act 26 of 2008) to enable, facilitate and mobilise electric mobility in South Africa. As a multi-stakeholder programme, the uYilo Programme has various activities that include government lobbying, industry engagement, pilot projects, capacity development, enterprise development and thought leadership. Supporting expertise and facilities extends across national accredited battery testing, material testing, vehicle systems, and a smart grid ecosystem that serves as a live testing environment for interoperability of the various system components of the smart grid.

Introduction

The range of lockdown measures experienced in Europe, during the COVID-19 pandemic has revealed how much cleaner the air can become when fewer internal combustion engine vehicles are on the road. A study conducted by the Centre for Research on Energy and Clean Air showed that, due to strict lockdown measures, there were 11 000 fewer deaths, related to air pollution, in Europe, supporting the case for a cleaner, sustainable transport system.[1] The demand for electric vehicles (EVs) during the post COVID-19 green economic recovery is forecasted to grow and capture at least half the market share from internal combustion engines (ICE) vehicles by 2040.[2] The underlying reason is the adoption and ratification of the Paris Agreement by 197 countries.[3] This agreement forms part of the United Nations Framework Convention on Climate Change. The countries that have adopted and ratified the Paris Agreement have submitted Nationally Determined Contributions (NDCs) which communicate the actions that they will take to reduce greenhouse gas (GHG) emissions in their respective countries.[4] The lithium battery of an electric vehicle is its defining component, because through its recharging mechanism, the battery is able to store energy that allows the car to be driven. Electric vehicles are vital for reducing GHG emissions as they eliminate the need for fossil fuels such as petrol or diesel in the transport sector, which contributes 16.2% of global GHG emissions.[5] As seen in table 1, the adoption of EVs contributes to the United Nations (UN) Sustainable Development Goals (SDGs) namely: SDG 7: Affordable and Clean Energy; SDG 8: Decent work and Economic Growth; SDG 9: Industry, Innovation and Infrastructure; SDG 11: Sustainable Cities and Communities and SDG 13: Climate Action.

Southern Africa is endowed with all the raw minerals required to produce lithium batteries. The minerals that are currently being mined in the region are predominantly exported as

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1 Lauri Myllyvirta, '11,000 air pollution-related deaths avoided in Europe as coal, oil consumption plummet', April, 30, 2020, https://energyandcleanair.org/air-pollution-deaths-avoided-in-europe-as-coal-oil-plummet/ (accessed: October,17,2020)

2 International Banker, 'A Bright Future Awaits Electric Vehicles', October, 13,2020, https://internationalbanker.com/brokerage/a-bright-future-awaits-electric-vehicles/ (accessed: October, 13,2020); IEA, *Global EV Outlook 2020*, (Paris: IEA,2020), https://www.iea.org/reports/global-ev-outlook-2020 (accessed: September, 29, 2020); BloombergNEF, *Electric Vehicle Outlook 2020* https://about.bnef.com/electric-vehicle-outlook/ , May, 19,2020, (accessed: September, 30, 2020)

3 Editors of Britannica, 'Paris Agreement', December, 16, 2019, *Encyclopaedia Britannica,* https://www.britannica.com/topic/Paris-Agreement-2015, (accessed: October, 14, 2020)

4 Mengpin Ge and Kelly Levin, 'Insider: What's Changing As Countries Turn INDCs into NDCs? 5 Early Insights', April, 18, 2018, https://www.wri.org/blog/2018/04/insider-whats-changing-countries-turn-indcs-ndcs-5-early-insights (accessed: October, 14,2020)

5 Hannah Ritchie, 'Sector by Sector: Where Do Global Greenhouse Gas Emissions Come From?', September, 18, 2020, https://ourworldindata.org/ghg-emissions-by-sector#:~:text=To%20prevent%20severe%20climate%20change,equivalents%20(CO2eq)%5D (accessed: October, 13, 2020).

raw material to countries outside of the continent for the manufacture of lithium batteries. The price for these exported raw materials is minimal to when they are beneficiated and used in a commercial product. The reliance on export rather than beneficiation has caused Member States (MS) who form part of the Southern African Development Community (SADC) to be stuck at the beginning, or bottom, of the lithium battery manufacturing value chain. If, for example, the raw materials were given added value through processing (beneficiation) to develop battery-grade material that can be used to manufacture the components for single cell manufacture, the battery-grade material could be exported at a higher price than the raw material. Furthermore, if that battery-grade material was used to manufacture single cells in MS, then an even higher price could be charged when exported. More value is added to a product as it moves further along the value chain, allowing the producer of the product to charge higher prices. If businesses in SADC were to become key players in areas at higher levels of the lithium battery manufacturing value chain, they could potentially earn higher revenues and profits from increased export earnings. Earning higher revenues and profits could lead to job creation and economic growth, which would provide an opportunity for businesses to employ more skilled people at higher wages. It is against this backdrop that this paper attempts to briefly unpack the benefits, opportunities and barriers to accelerating the lithium battery manufacturing value-chain in Southern Africa. An overview of the international landscape of lithium battery manufacturing together with its relationship to electric vehicles will be given. The current landscape of lithium battery manufacturing in SADC will also be discussed alongside practical steps that need to be taken to accelerate SADC MSs participation in the global manufacturing value chain. The paper concludes with recommendations to donors, policymakers and the private sector on what is needed to grow and develop the industry.

Table 1 Electric Vehicles' Contribution to UN SDGs

UN SDG	Electric Vehicles
SDG7: Affordable and Clean Energy	Energy Efficiency: The use of a battery operated vehicle instead of an internal combustion engine vehicle. Energy Security: Lithium batteries improves a country's energy security as it reduces the reliance on fossil fuels (e.g. oil and coal) to produce energy.
SDG 8: Decent Work and Economic Growth	Green Economic Recovery Post COVID-19: The transition of the transport sector from fossil fuels to electrification could create up to 10 million jobs worldwide.[6]
SDG 9: Industry, Innovation and Infrastructure	Sustainable Industrialisation: Developing the lithium battery manufacturing value chain will improve a country's manufacturing sector's contribution to its GDP.
SDG 11: Sustainable Cities and Communities	Sustainable Transport: EVs provide sustainable transport solutions in cities and communities through the electrification of public transport and micro-mobility modes of transport such as e-scooters, e-bicycles and three-wheelers.
SDG 13: Climate Action	Air Pollution: EVs reduce air pollution due to zero exhaust pipe emissions GHG Emissions: The adoption of EVs together with the decarbonisation of electricity generation will make a significant contribution to the reduction of GHG emissions. Noise Pollution: EVs are relatively silent in comparison to ICE vehicles.

Source: Adapted from International Energy Agency (IEA)

Background

The SADC Green Economy Strategy and Action Plan for Sustainable Development, initiated in 2015, acted as a catalyst for SADC's transition "towards a resource efficient, environmentally sustainable, climate resilient, low-carbon" region where poverty has been

6 International Labour Organization, *Jobs in Green and Healthy Transport: Making the Green Shift*, 2020, (Geneva: International Labour Organization, 2020)

eliminated.[7] The SADC Green Economy Strategy and Action Plan for Sustainable Development highlights key strategies and actions within the energy, transport, manufacturing and mining sectors which include: supporting the development of green manufacturing sectors, promotion of green public transport networks and multimodal transport, promoting energy efficiency and support of renewable energy.[8]

The SADC Vision 2050 and the SADC Regional Indicative Strategic Development Plan (RISDP) 2020-2030 were approved by SADC Member States at the 40th SADC Summit on 17 August 2020.[9] As seen in figure 1, this vision states that by 2050 the SADC region will be "A peaceful, inclusive, middle to high income industrialised region, where all citizens and Member States enjoy sustainable economic growth, well-being, justice and freedom". Industrialisation, regional integration and climate change resilience form an integral part of achieving this vision. The SADC RISDP actions the SADC Vision 2050 by providing a blueprint for its implementation.[10] The SADC Industrialisation Strategy and Roadmap (SISR) 2015-2063 was adopted by all Member States in April 2015. The roadmap provides a comprehensive blueprint for fast-tracking Member States' participation in global value chains. The SADC Protocol on Industry, adopted at the 39th SADC Summit supports the SADC Industrialisation Strategy Roadmap (SISR) together with its Costed Action Plan. The Protocol on Industry is currently awaiting ratification by all Member States and it is envisaged that once ratified by all Member States, the transition from commodity-based exports to manufacture-based exports would accelerate.[11]

Mineral beneficiation, through the promotion of the development of global and regional value chains, is a key feature within the SISR. A sub-activity within the SISR's Costed Action Plan was to conduct profiling assessments in consultation with Member States and the private sector, to identify priority value chains in the area of mineral beneficiation. At the 40th SADC Summit held in August 2020, it was noted that the profiling assessment was complete and the battery energy storage sector was identified as an investment opportunity for increased participation in global value chains. The reasons for its identification were summarised as follows:

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7 SADC, *Green Economy Strategy and Action Plan for Sustainable Development*, July, 2015, (Gaborone: SADC, 2015), https://www.sadc.int/files/4515/9126/1250/SADC_Green_Economy_Strategy_and_Action_Plan-English.pdf (accessed: October, 10, 2020, p. 9.

8 SADC, *Green Economy Strategy*

9 SADC, 'Communique of the 40th Ordinary Summit of the SADC Heads of State and Government, 17 August 2020 https://www.sadc.int/files/8115/9767/2537/Communique_of_the_40th_SADC_Summit_August_2020_-ENGLISH.pdf (accessed: October, 10, 2020)

10 SADC, 'Communique', SADC, 'RISDP 2020-203 Blueprints 4th Draft,'27 March 2020

11 SADC, *40th SADC Summit Maputo - Mozambique 17 August 2020*, (Gaborone: SADC, 2020)

"Energy Storage/Battery - The SADC region contains over 50 percent [of the] global reserves of cobalt, which accounts for as much as 60 percent of the lithium-ion battery weight. The current demand for renewables and electric vehicles offer considerable opportunity which remains untapped. Opportunities exist for the production of batteries, as well as battery components and other key inputs for the value chains. The development of batteries is particularly attractive because the region already has mining activities for many of the key minerals required for *battery manufacture, as well as minerals that are undergoing research to assess their performance as new battery materials*[12]*"*

As SADC has listed the battery energy storage sector as a priority value chain, it is important for stakeholders from the public and private sectors to collaborate and develop practical strategies that will accelerate the lithium battery manufacturing value chain. Sustainable development must be the basis of these strategies to allow all citizens of to enjoy the sustained, economic well-being of SADC.

Figure 1 SADC Vision 2050

Source: SADC

12 SADC, *40th SADC Summit,* p.46

Why are lithium batteries receiving exceptional global attention?

The 2015 Paris Agreement, which forms part of the United Nations Framework Convention on Climate Change, propelled countries around the world to fast-track the implementation of policies that enable a transition to low carbon industrialisation. The transport sector, accounting for 16.2% of the world's GHG emissions (with road transport accounting for 11.9%),[13] was obliged to develop innovative low carbon technology solutions aligned to the UN's 2030 sustainable development goals. This resulted in automotive manufacturers producing zero emission battery electric vehicles.

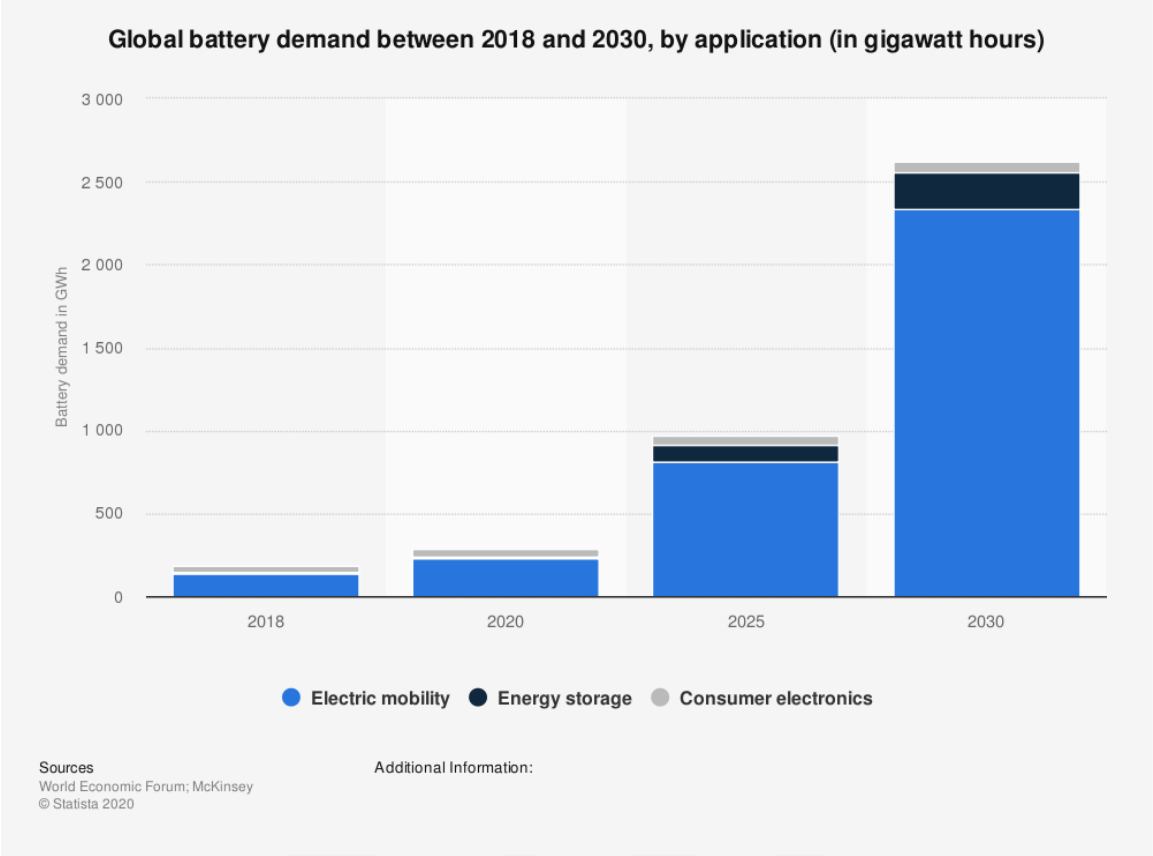
Over the last decade, there has been exponential growth in the production of electric vehicles. The global electric vehicle car stock has increased from 17 000 units in 2010 to 7.2 million units in 2019 and is forecast to grow to at least 140 million units by 2030.[14] The lithium battery is a critical part of an electric vehicle and is often referred to as the 'heart' of the vehicle as it is responsible for giving 'life' to an electric car. The demand for lithium batteries, as seen in figure 2, is expected to grow in line with the demand for electric vehicles, reaching 2600 GWh in 2030. During this time the average price of electric vehicle battery packs is expected to decrease, reaching price parity with internal combustion engine vehicles by the mid-2020s.[15] The lithium battery will most-likely be the dominant battery within electric vehicles until at least 2030 due to large global investments in the research and development (R&D) of lithium battery technologies, its manufacturing processes and supply-chains. The dominance of lithium batteries will lead to exponential demand for the raw materials, such as cobalt, lithium, manganese, nickel and graphite, that serve as inputs into these batteries.[16]

Figure 2: Global Battery Demand by application between 2018 and 2030

13 Hannah Ritchie, 'Sector by Sector'
14 IEA, *Global EV Outlook 2020*, (Paris: IEA,2020), https://www.iea.org/reports/global-ev-outlook-2020 (accessed: September, 29, 2020).

15 BloombergNEF, *Electric Vehicle Outlook 2020,* May, 19,2020, https://about.bnef.com/electric-vehicle-outlook/ (accessed: September, 30, 2020); World Economic Forum, *A Vision For a Sustainable Battery Value Chain in 2030,* September, 2019, (Geneva: World Economic Forum, 2019), http://www3.weforum.org/docs/WEF_A_Vision_for_a_Sustainable_Battery_Value_Chain_in_2030_Report.pdf (accessed: October, 14,2020).

16 IEA, *Global EV Outlook 2020;* BloombergNEF, *Electric Vehicle Outlook 2020; World Economic Forum A Vision.*



Source: Statista 2020

The current state of lithium battery manufacturing in the SADC region

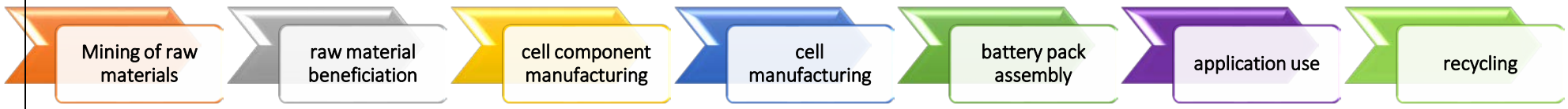
The current state of battery manufacturing in SADC is heavily concentrated within lead-acid battery manufacturing. There are a significant number of lead-acid battery manufacturers in SADC, including market leaders such as AutoX, First National Battery and Dixon Batteries in South Africa and Chloride Exide in Botswana. AutoX, First National Battery and Dixon Batteries' products are exported to countries within Africa and globally, while Chloride Exide's products are exported mainly within the SADC region. Although SADC has a well-established lead-acid battery manufacturing value chain, with the transition to electric vehicles becoming more evident, it is imperative that the Southern African battery manufacturing industry incorporates lithium battery manufacturing into its portfolio.

In order to analyse the state of lithium battery manufacturing within SADC, the composition of an electric vehicle battery pack, together with the business model that explains the activities required for the production of the battery, needs to be illustrated. An electric vehicle battery pack is made up of modules which are composed of cells. The

lithium cells consist of active electrodes that include cathode and anode materials. Cathode materials include lithium cobalt oxide, lithium manganese oxide, lithium nickel cobalt aluminum oxide, lithium nickel manganese cobalt oxide and lithium iron phosphate. Anode materials include graphite/carbon-based materials, lithium titanate and silicon alloys. Raw materials such as lithium, nickel, cobalt, graphite and manganese are mined and then beneficiated (processed) so that they can be used to manufacture the anode and cathode material that is found in lithium cells.

As seen in figure 3, the first step in the value chain is the mining of raw materials, followed by raw material beneficiation. The raw materials which are used within battery cell components are mined. After they have been mined, these materials go through processing (beneficiation) where they can be used to manufacture the components found within battery cells. Once the cell components have been manufactured they are used to manufacture lithium cells (cell assembly process). The lithium cells are assembled into modules and those modules are assembled to create battery packs (battery pack manufacturing process). The battery pack is subsequently fitted into an electric vehicle, in what is considered as its “first life”. The last step in the value chain is the re-purposing and re-cycling of the battery pack.

Figure 3: The Battery Value Chain in Southern Africa



Mining of raw materials such as lithium, nickel, cobalt, graphite, manganese.	Raw materials are processed so that they can be used to manufacture cell components	Manufacture of cell components. Examples include: anodes (graphite carbon), cathodes (lithium-ion phosphate), electrode materials (lithium metal oxides), electrolytes (lithium salt, organic solvents)	Cell components are used to manufacture single cells	Cells are assembled to manufacture battery packs	The battery pack is integrated into an application or service for a specific use. Examples include: electric vehicles including e-bikes, e-scooters and 3-wheelers, stationary energy storage, consumer electronics.	Re-purpose, re-use, recycle
Botswana Manganese Giyani Metals Corp: K. Hill Manganese Project **Democratic Republic of Congo** Cobalt GECAMINES SA Glencore China Molybdenum Lithium AVZ Minerals **Madagascar**	**South Africa** Manganese Battery-Grade Processing University of Limpopo Pilot Plant Manganese Processing Project Manganese Metal Company Nickel Sulphate Battery Grade Processing Project Thakadu Nickel Sulphate Project **Zambia**	**South Africa** Cell Component Manufacturing R&D CSIR Hulamin NECSA Cell Component Manufacturing Capabilities CSIR Hulamin NECSA SASOL	**South Africa** Pilot Plant Scale University of the Western Cape: Energy Storage Innovation Lab Pilot Plant, Laboratory Scale CSIR Nelson Mandela University: uYilo e-Mobility Programme University of the Witwatersrand	**South Africa** Battery pack assemblers* Balancell, BattCo, Battery Power Industries, Blue Nova, EV Dyanmics, FreedomWON, Maxwell and Spark Mellowcabs, Revov, Solar MD, ZettaJoule, Power Extreme, TrailerSol, Energy Partners **Cells are imported, mainly from Asia.* **Local, Regional, International Markets** 3-wheelers, e-scooters Mellowcabs e-bikes Relectro, Momsen, Chilled Squirrel, etc. Special Utility Vehicles Retro-fit safari vehicles for the tourism sector Automotive Battery Electric Vehicle (BEV) Manufacturers* BMW Group (BMW, Mini)	**South Africa** R&D Mintek (electronic waste recycling) uYilo (re-purposing and re-use, disassembly of second-life depleted modules and packs),

Cobalt and Nickel Sumitomo Ambatovy **Mozambique** Graphite Battery Minerals Limited Syrah Resources: Balama Graphite Mine Lithium Tempest Minerals **Namibia** Lithium Desert Lion Energy Cobalt Celsius Resources **South Africa** Manganese South32 Nickel URU Metals **Tanzania** Graphite Nachu Graphite Project **Zimbabwe** Lithium Bikita Minerals Prospect Resources Nickel Bindura Nickel **Zambia** Cobalt Arc Minerals: Zamsor Copper-Cobalt Project	Cobalt Processing ERG Africa: Chambishi Metals (does not produce battery-grade material) **Madagascar** Nickel and Cobalt Processing Sumitomo Ambatovy (does not produce battery-grade material)				Jaguar Land Rover Mercedes-Benz Porsche Nissan Volkswagen Group (VW, Audi) **All their BEVs are imported. There are currently no BEV assembly or manufacturing plants in SADC*	

At this stage the battery pack can enter its "second-life" where it is re-purposed for use in other applications such as stationary energy storage and micro-mobility applications. When the battery pack is spent (i.e. can no longer be used for any other applications) the materials are recycled. The spent cells or battery have to be made safe for recycling and processed accordingly. An aged or damaged lithium battery can cause explosions and fires, releasing unwanted toxins into the atmosphere such as hydrofluoric acid. It is therefore critical to ensure that aged or damaged cells are disposed of safely and correctly and do not cause any injuries to the consumers of such systems.

Within SADC, the majority of activities take place at the start of the value chain mainly with the mining of raw materials. Some MS such as South Africa have begun research, development and innovation (RDI) activities across the value chain to enable raw material beneficiation, cell component manufacturing, cell manufacturing and recycling. There are also a number of industry players in SADC who assemble lithium battery packs. They import the lithium cells mainly from Asia. Electric bicycles are also gaining popularity in SADC, which has seen the establishment of many electric bike manufacturers. Some of the electric bike manufacturers in SADC include Relectro, Momsem and Chilled Squirrel. There are also customised specialty utility vehicle retro-fitters for safari vehicles to be used in the tourism sector.

The major Automotive Original Equipment Manufacturers (OEMs) that make EVs have made a selected number of battery electric vehicle models available to consumers in SADC, however, all these vehicles are imported. There are currently no battery electric vehicle assembly or manufacturing plants in SADC. The reasons for this include a lack of manufacturing incentives; a coherent enabling policy to facilitate the uptake of EVs (e.g. EVs carry high import duties, making them very expensive and thus inaccessible to the average consumer); electric vehicle infrastructure (e.g. charging points, reliable electricity) and consumer awareness. The lack of adoption of EVs in SADC has a knock-on effect on the earlier stages of the value chain as business does not have a sense of urgency to invest or develop expertise in lithium battery technology if there is no local market.

Mining of (EV)-related Minerals and Metals (EVMM)

The SADC region is endowed with all the EVMMs that are needed to manufacture lithium batteries. Figure 3 shows the mining activities currently taking place in the region. The Democratic Republic of Congo (DRC) is the region's leader in cobalt mining, with mining companies such as Glencore, GECAMINES and China Molybdenum as the key role-players

with established cobalt mining operations.[17] Manganese mining activities include Giyani Metals Corp (manganese exploration) in Botswana and the South32 mining operation in South Africa.[18] Bikita Minerals in Zimbabwe is currently the only operating lithium mine in SADC.[19] Companies involved in lithium mining exploration and development activities include Desert Lion Energy in Namibia, Prospect Resources in Zimbabwe and Tempest Minerals in Zimbabwe and Mozambique.[20] Sumito Ambatovy has a nickel and cobalt mining operation in Madagascar.[21] URU Metals in South Africa, has a nickel exploration project while Bindura Nickel Corporation mines nickel in Zimbabwe.[22] Graphite mining activities in the region include The Nachu Graphite Project (owned by Magnis Energy Technologies) in Tanzania and Syrah Resources' Balama Graphite Mine operation in Mozambique.[23] Botswana, the DRC, Namibia and Zambia have also joined the United States of America's Energy Resource Governance Initiative (ERGI) aimed at promoting best practices and resilient energy mineral supply chains in the mining sector, particularly for EVMMs.[24]

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17 Tom Daly, 'China Moly Shrugs off South African Port Disruption as DRC Cobalt Sales Rise' *Reuters,* April, 30, 2020, https://www.reuters.com/article/us-cmoc-cobalt-drc-idUSKBN22C1KG (accessed: October, 3, 2020); The General of Quarries and Mines Gecamines SA, 'Our Activities', *The General of Quarries and Mines Gecamines SA, https://www.gecamines.cd/prospection.html,* (accessed: October, 3, 2020); Glencore, 'Democratic Republic of the Congo', *Glencore, https://www.glencore.com/ask-glencore/democratic-republic-of-the-congo* (accessed: October, 3, 2020).

18 Giyani Metals Corp, 'Emerging Battery Grade Manganese Opportunity', *Giyani Metals Corp,* https://giyanimetals.com/ (accessed: October, 3, 2020); South32, 'South Africa Manganese', *South32,* https://www.south32.net/our-business/southern-africa/south-africa-manganese (accessed: October, 3, 2020).

19 Golden Sibanda, 'Zimbabwe: World Lithium Deficit a Boon for Zimbabwe', October, 1, 2020, https://allafrica.com/stories/202010020414.html (accessed: October, 14, 2020)

20 Bloomberg, 'Desert Lion Energy Inc.', *Bloomberg,* https://www.bloomberg.com/profile/company/DLI:CN (date accessed: October, 3, 2020); Prospect Resources, 'Arcadia Lithium Project' *Prospect Resources,* https://www.prospectresources.com.au/projects/arcadia-lithium-project (date accessed: October, 3, 2020); Reuters, 'Tempest Minerals Ltd LIFG.F', *Reuters,* https://www.reuters.com/companies/LIFG.F (accessed: October, 3, 2020).

21 Yuka Obayashi, 'Sumitomo Predicts Record Loss As Covid-19 Hits Nickel Project', https://www.mining.com/web/sumitomo-predicts-record-loss-as-covid-19-hits-nickel-project/ (date accessed: October, 10, 2020); Ambatovy, 'Overview', http://ambatovy.com/ambatovy-html/docs/index.html%3Fp=110.html (accessed: October, 3, 2020);
22 URU Metals, 'Nickel', http://www.urumetals.com/portfolio/projects/nickel (accessed: October, 3, 2020); African Financials, 'Bindura Nickel Corporation Limited (BIND.zw)', https://africanfinancials.com/company/zw-bind/ (accessed: October, 3, 2020). Syrah Resources, 'Balama Graphite Operation', http://www.syrahresources.com.au/balama-project (accessed: October, 3, 2020).
23 Magnis Energy Technologies, 'Nachu Graphite Project', https://www.magnis.com.au/nachue-project (accessed: October, 3, 2020); Syrah Resources, 'Balama Graphite Project', http://www.syrahresources.com.au/balama-project (accessed: October, 3, 2020).

24 Government of the United States of America, Bureau of Energy Resources, 'Energy Resource Governance Initiative (ERGI)', https://www.state.gov/wp-content/uploads/2019/06/Energy-Resource-Governance-Initiative-ERGI-Fact-Sheet.pdf (date accessed: October, 3, 2020); Mining Weekly, 'US Hopes to Expand Strategic Minerals Initiative', *Mining Weekly,* June, 3, 2020, https://www.miningweekly.com/article/us-hopes-to-expand-strategic-minerals-initiative-2020-06-03 (date accessed: October, 3, 2020).

Raw Material Beneficiation

There are limited raw material beneficiation initiatives taking place within the SADC region. Most of the raw material mined in the region is exported to Europe, Asia and North America for beneficiation or processing into battery-grade material. Battery-grade material is a high-purity product that is used as a precursor for making the battery materials needed to produce cell components. There are some battery-grade material beneficiation projects running in South Africa, such as the Manganese Metal Company's precursor project for lithium batteries.[25] The Thakadu Nickel Sulphate Project forms part of South Africa's Black Industrialists Programme and involves the construction of a pure nickel sulphate plant aimed at producing battery-grade material, using Mintek's proprietary process, for the export market.[26] ERG Africa: Chambishi has a Colbalt processing plant in Zambia and Sumito Ambotovy processes nickel and cobalt in Madagascar, however neither of these plants produce battery-grade material for export.[27]

Battery Minerals Limited has established a joint venture with Urbix to for processing mined graphite in Mozambique.[28] In 2018, Magnis Technologies received a Special Economic Zone license from the Government of Tanzania for the operation of a graphite processing plant to produce value-added graphite products.[29] In an effort to develop its lithium

25 Government of South Africa, Department of Trade, Industry and Competition, *Mineral Beneficiation: Portfolio Committee on Trade and Industry*, June,19, 2020, http://www.thedtic.gov.za/wp-content/uploads/Beneficiation19-June2020.pdf (accessed: October, 15,2020)

26 Owen Murphy, 'Battery Tech in Electric Cars Presents a Huge Opportunity to SA Mining, February, 3 2020, https://www.businesslive.co.za/bd/opinion/2020-02-03-battery-tech-in-electric-cars-presents-a-huge-opportunity-to-sa-mining/ ; Manganese Metal Co, 'About Us', *Manganese Metal Co,* https://www.mmc.co.za/ (date accessed: October, 3, 2020); Mintek, *2019 Integrated Annual Report,* (Randburg: Mintek, 2019), https://www.mintek.co.za/2019/10/17/2019-annual-report/ (date accessed: October, 3, 2020) ; Government of South Africa, Department of Trade, Industry and Competition, *Mineral Beneficiation.*

27ERG Africa, 'Chambishi Metals', *ERG Africa,* https://www.ergafrica.com/cobalt-copper-division/chambishi-metals/ (date accessed: October, 3, 2020); Sumito Corporation, 'The Ambatovy Project, One of the World's Largest Nickel Projects', *Sumito Corporation,* https://www.sumitomocorp.com/en/jp/business/case/group/235 (date accessed: October, 3, 2020).

28 Club of Mozambique, 'Battery Minerals to Process Graphite in Mozambique', October, 14, 2019, https://clubofmozambique.com/news/battery-minerals-to-process-graphite-in-mozambique-144311/ (date accessed: October, 14,2019); NS Energy, 'Battery Minerals, Urbix Partner for Graphite Processing JV in Mozambique, October, 10,2019, https://www.nsenergybusiness.com/news/battery-minerals-graphite-processing-jv/# (accessed: October, 11,2020)

29 Richard Jansen van Vuuren, 'Magnis Resources Reaches Consensus in Tanzania', March, 9, 2018, https://www.miningreview.com/battery-metals/magnis-resources-reaches-consensus-in-tanzania/ (accessed: October, 10, 2020); Megan van Wyngaardt, 'Tanzania Grants Magnis Approval to Operate a Graphite Processing Plant', March, 9, 2018, https://www.miningweekly.com/article/tanzania-grants-magnis-approval-to-operate-graphite-processing-plant-2018-03-09 (accessed: October, 10,2020).

battery manufacturing industry, the government of Zimbabwe is planning to establish a lithium ore processing plant in Bulawayo to produce value added lithium products.[30]

Cell Component Manufacturing

Most activities related to cell component manufacturing are presently taking place in South Africa where local businesses have begun to see the value of investing in the assembly and manufacturing of lithium battery packs. The Mega Million Energy Company is planning to establish a large-scale battery manufacturing plant for the production of lithium cells and batteries.[31] Metair (FNB), has also partnered with the University of the Western Cape (UWC) establishing a pilot-scale lithium-ion assembly plant at UWC's Energy Storage Innovation Lab in Cape Town, South Africa.[32] The South African Department of Science and Innovation has established an Energy Storage Research, Development and Innovation (RDI) Consortium for the purpose of developing cell components through the beneficiation of raw materials available in South Africa.[33] This is to allow the country to compete in the battery manufacturing value chain for electric vehicles and energy storage applications.[34] Members of the consortium include the University of Limpopo (UL), University of the Witwatersrand (Wits), Council for Scientific and Industrial Research (CSIR), NECSA (whose activities are related to electrode materials development), University of the Western Cape (Energy Storage Innovation Lab, whose activities include cell assembly and validation) and the uYilo e-Mobility Programme (hosted at Nelson Mandela University whose activities

30 Laurence Stevens, 'Zimbabwe's Lithium Mine is Attracting Global Attention', October, 14, 2019, https://africanminingmarket.com/zimbabwes-lithium-mine-is-attracting-global-attention/4906/ (date accessed: October, 11, 2020), The Herald (Zimbabwe), 'Govt to pursue local lithium beneficiation', April, 25, 2019, https://www.herald.co.zw/govt-to-pursue-local-lithium-beneficiation/ (accessed: October, 11,2020).

31 Irma Venter, 'Local Lithium-ion Battery Plant to Open its Doors this Year', *Engineering News,* January 26, 2020, https://www.engineeringnews.co.za/article/coega-based-lithium-ion-battery-plant-to-open-its-doors-this-year-2020-01-20 (accessed : October, 10, 2020); The MegaMillion Energy Company, https://www.tmec.africa/ (accessed: October, 19,2020)

32 BJ Bladergroen, 'Li-on Battery Development in South Africa, *EE Publishers,* December, 2017, *https://www.ee.co.za/wp-content/uploads/2017/12/Bernard-Bladergroen_UWC_Li-ion-battery-development-in-SA.pdf* (date accessed : October, 10, 2020); Bernard Bladergroen, 'Explainer: Why Lithium ion Batteries Could be a Game Changer', *The Conversation*, September,18 2018, https://theconversation.com/explainer-why-lithium-ion-batteries-could-be-a-game-changer-in-africa-65168 (date accessed: October, 10, 2020)

33 Government of South Africa, Department of Science and Innovation, 'Minister Nzimande Calls for Roadmap to Support Battery Electric Vehicle expansion', https://www.dst.gov.za/index.php/media-room/latest-news/2891-minister-nzimande-calls-for-roadmap-to-support-battery-electric-vehicle-expansion (accessed: October, 3, 2020)

34 Government of South Africa, Department of Science and Innovation, 'Minister Nzimande Calls for Roadmap'; Henry Roman, 'The Contribution of the DST to the Transition to a Greener Economy', October, 25, 2017, https://static.pmg.org.za/171025DST.pdf (accessed: October 3, 2020).

include the testing and validation of cells, modules and battery packs).[35] The CSIR, Hulamin, NECSA and SASOL have the facility and capability to make cell components for lithium batteries.[36]. However, there is currently no market in SADC for them to adapt their processes to make lithium battery related components.

Battery Pack Assembly

The main lithium battery pack assemblers in SADC are currently based in South Africa. Maxwell and Spark is a manufacturer of lithium battery packs used in forklifts.[37] Battery Power Industries assembles lithium battery packs for underground battery operated equipment.[38] Other Companies, including Balancell, BlueNova, Revov, SolarMD, FreedomWON and ZettaJoule assemble lithium battery packs.[39]

Repurposing and Recycling

Although there is a well-established lead-acid battery recycling industry in Southern Africa, lithium battery recycling initiatives are in their infancy. The advantage of an electric vehicle's lithium-ion battery pack is its lifespan. The battery pack has a lifespan of 7-10 years for use within an electric vehicle.[40] From its 7th year the battery pack could enter its second-life application, depending on its state of health, which is specified to be around 80% of its original capacity.[41] This enables the battery pack to be repurposed for other

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35 Olivier Kasikala, "Growing Pains in Manufacturing 18650 Li-ion Battery" (presentation, uYilo Electric Vehicle and Batteries Conference 2019, Nelson Mandela University, Port Elizabeth, 30-31 October 2019)

36 Sasol, 'Chemicals: Carbon', https://products.sasol.com/pic/products/home/carbon/index.html (accessed: October, 10,19,2020); 'Unaudited Interim Results for the Half-Year Ended 30 June 2019' August, 23,2019 http://ir.hulamin.com/presentations (accessed: October, 19, 2020); NECSA, 'NECSA Technologies' http://www.necsa.co.za/necsa-technologies/ (accessed: October, 19,2020); CSIR, 'The Battery Research Centre: Developing Materials-Based Technologies For Energy Storage Systems' https://www.csir.co.za/battery-research-centre-developing-materials-based-technologies-energy-storage-systems# (accessed: October, 19,2020).

37 Maxwell and Spark, 'Maxwell and Spark a Greentech and Electric Vehicle Company', https://maxwellandspark.co.za/ (accessed: October 3, 2020)

38 Battery Power Industries, "Our Products", https://www.batterypowered.co.za/our-products/#1551257474048-c928304b-3712 (accessed: October 3, 2020)

39 Balancell,'Lithium Ferro Phosphate (LFP) Battery Packs', https://www.balancell.com/lfp-battery-packs (accessed: October, 3, 2020); BlueNova, 'Welcome to BlueNova, the Home of High Performance, Ultra-Reliable Energy Storage Solutions', https://www.bluenova.co.za/ (accessed: October, 3, 2020); Revov, 'Revov LiFe Battery Range', https://revov.co.za/life/ (accessed: October 3, 2020); Solar MD, ' Our Story', http://solarmd.co.za/about-solar-md/ (accessed: October, 3, 2020), ZettaJoule, 'Energy Storage', *ZettaJoule,* https://www.1zettajoule.com/energy_storage.html (date accessed: October, 3 2020).

40 Forschungsstelle für Energiewirtschaft e.V. ,'Second-Life Concepts for Lithium-Ion Batteries from Electric Vehicles', February, 17, 2020, https://www.ffe.de/publikationen/vortraege/620-second-life-konzepte-fuer-lithium-ionen-batterien-aus-elektrofahrzeugen (date accessed: October, 19,2020)

41 Forschungsstelle für Energiewirtschaft e.V. ,'Second-Life Concepts'

applications such as stationary energy storage and micro-mobility (e.g. electric bicycles, electric 3-wheelers). The uYilo e-Mobility Programme, has a pilot facility on the smart grid that includes the re-purposing of automotive OEMs' electric vehicle battery packs for use in stationary storage within the electrical grid.

The Energy Storage RDI Consortium has initiated activities towards lithium battery recycling. Mintek is conducting electronic waste research that includes the recovery of valuable metals from lithium batteries and the preparation of a business case to establish a lithium battery recycling facility in South Africa.[42] The uYilo e-Mobility Programme, the Energy Waste Association of South Africa (EWASA) and Mintek
are looking at the value chain of e-waste management for lithium-ion batteries.

Quality Assurance, Standards and Accreditation

It is important that lithium batteries that are produced in the SADC region adhere to international quality standards and safety requirements in order to compete in global value chains. The uYilo e-Mobility Programme's (uYilo) Battery Testing Laboratory, hosted at Nelson Mandela University, in Port Elizabeth, South Africa is currently the only accredited ISO 17025 laboratory for lithium-ion cell and battery testing, in Southern Africa. They can evaluate the performance of cells used in modules and packs. One of the critical international regulations is UN38.3 for the transportation of batteries.[43] The uYilo Battery Testing Laboratory are establishing themselves to evaluate manufactured cells for their abuse and damage testing according to UN38.3 guidelines.

Skills Development

The South African Minerals to Metals Research Institute (SAMMRI), is a mineral processing initiative that was established to promote the sustainable development of South Africa's mineral beneficiation industry by ensuring the availability of highly skilled engineers and scientists to support the mining industry.[44] Higher education and learning institutions across South Africa, in collaboration with industry and South Africa's Sector Education and Training Authorities (SETAs), are supporting training and skills development interventions to support the energy storage/battery sector. Some of these initiatives include internships, graduate training and short learning programmes.

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42 Government of South Africa, Department of Mineral Resources and Energy, 'Shareholder Performance Agreement 2020/21 Entered into by and between the Mintek Board",
https://static.pmg.org.za/Mintek_Compact_2020_16042020.pdf (accessed: October, 3 2020).

43 The transport of lithium batteries is subject to national and international regulations as detailed by the UN (United Nations) Manual of Tests and Criteria, Sub-section 38.3 (UN 38.3), Lithium Battery Testing Requirements which can be found here: https://www.batterystandards.info/node/917

44 Cyril O' Connor, V. Ross, J.R. Mann 'SAMMRI: Working Towards the Sustainability of the South African Mineral Processing Industry', *Journal of the Southern African Institute of Mining and Metallurgy* 119, no.8 (Aug/July 2019):62-64

How has the political and economic background and history impacted on the manufacturing sector and possibilities to transition to battery manufacturing connected to e-mobility and energy storage systems?

The political and economic woes of Southern Africa are based on an uneasy mix of conflict, corruption, commodities and carbon. Conflict in any region makes potential investors uneasy as they fear not only for their safety but the sustainability of their investment. Corruption is viewed as a disease to potential investors as it implies that the cost of doing business in a specific country will be higher and plagued by dishonesty and unethical practices. Commodities refers to the fact that all SADC Member States are heavily reliant on commodity exports to sustain their economies. Unfortunately, the prices of commodity exports are volatile as they rely heavily on average world prices at any given point in time and there are limited differentiation between commodities derived from different places. For example, gold, diamonds, oil, tea, coffee, maize or chicken derived from country "x" is relatively similar to gold, diamonds, oil, tea, coffee, maize or chicken derived from country "y". It therefore is very difficult for country "x" to charge higher prices for their commodities than country "y". SADC is also a carbon intensive region where two of its key sectors, namely transport and energy, are reliant on fossil fuels.

Conflict

Angola, the DRC and Mozambique's economies were negatively affected by civil wars. The DRC suffered from two civil wars between 1960 and 1999 while Angola and Mozambique's civil wars began in the 1970s and ended in the 1990s.[45] Although the civil war in the DRC ended in 1999, armed conflict and human rights violations in selected provinces have continued.[46] The peace and stability of Mozambique is also being threatened by militia attacks in the Cabo Delgado province.[47]

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45 Kudzai Chimhangwa, 'War in Mozambique: A Natural Gas Blessing, Turned Curse', June, 26, 2020, https://www.opendemocracy.net/en/oureconomy/war-mozambique-natural-gas-blessing-turned-curse/ (date accessed: October 4, 2020); SADC, 'Member States' https://www.sadc.int/member-states/ (date accessed: October, 3, 2020).

46 Kathryn Reid, 'DRC conflict: Facts, FAQs, and how to help', July, 23, 2019, https://www.worldvision.org/disaster-relief-news-stories/drc-conflict-facts (date accessed: October, 3,2020); Aljazeera, ' Fragile Hopes of Peace in DRC's Conflict-Scarred Ituri Province', September,28,2020, *Aljareeza News,* *https://www.aljazeera.com/features/2020/9/28/fragile-hopes-in-dr-congos-ituri-province-scarred-by-conflict* (date accessed: October, 4,2020).

47'The conflict in Mozambique is getting worse', August,26, 2020, *Economist, https://www.economist.com/middle-east-and-africa/2020/08/26/the-conflict-in-mozambique-is-getting-worse* (date accessed October, 3, 2020), Alex Vines, 'As conflict in Cabo Delgado increases, will Frelimo learn from its mistakes?' , June, 24, 2020, *Mail and Guardian Online (South Africa), https://mg.co.za/africa/2020-06-24-as-conflict-in-cabo-delgado-increases-will-frelimo-learn-from-its-mistakes/* (date accessed; October, 3, 2020); Institute for Peace and Security Studies, *Mozambique Conflict Insight,* peace and security report, April, 2020, 1 (Addis Ababa: Institute for Peace and Security Studies),

Corruption

Corruption in SADC member states is another issue that inhibits economic growth and development. Corruption negatively affects investor confidence and also hampers development when key decision makers use revenues gained from Member States' commodity exports for personal financial gain instead of investing the funds in the country's health, education and infrastructure, for example. The 2019 Corruption Perceptions Index highlights the extent of perceived corruption in SADC Member States.[48] To put the results into context, Denmark, which is perceived as the least corrupt country in the world, received an overall score of 87% while Somalia perceived as the most corrupt country in the world, received an overall score of 9%.[49] Only four out of the 16 SADC Member States received scores above 50%. Botswana's and Seychelles' scores were 61% and 66%, respectively, while Mauritius and Namibia scored 52%.[50] South Africa, SADC's most industrialised economy scored 44%.[51]

Commodities

All the SADC Member States were under some form of colonial rule before gaining independence. During this period the commodity export industry was constructed according to the demands of the commodities needed to industrialise the West. Unfortunately, after independence, SADC Member States continued to rely heavily on revenue from the export of commodities and failed to use the revenue gained from commodity exports to invest efficiently in the infrastructure and skills required for the export of manufactured products. Therefore, while economic regions in Asia, Europe and North America are gaining revenues from exporting manufactured products such as automobiles, electronic equipment, appliances and furnishings, the majority of SADC Member States are exporting commodities such as raw materials (minerals and metals) and agricultural products such as tea, coffee, fruit, meat and maize. The problem with this is that additional value cannot be added to a commodity, therefore the prices paid for them are minimal when compared to the value that can be added to a manufactured product. There are SADC Member States, such as South Africa, Mauritius and Zambia

https://media.africaportal.org/documents/MOZAMBIQUE-Conflict-Insights-vol-1-Conflict-Insight-and-Analysis-1.pdf (date accessed: October, 4,2020).

48 Transparency International, 'Corruption Perceptions Index 2019', https://www.transparency.org/en/cpi/2019/results (date accessed: October, 3, 2020).

49 Transparency International, 'Corruption Perceptions Index'.

50 Transparency International, 'Corruption Perceptions Index'.

51 Transparency International, 'Corruption Perceptions Index'.

where the manufacturing sector has made significant contributions, to their GDP.[52] However, because most Member States' economies rely mostly on commodity exports, the manufacturing sector contributed only 10.7 % of the SADC region's GDP in 2019.[53]

Carbon

The SADC region is carbon intensive and lags behind in the implementation of policies that support the manufacturing sector's low carbon transition. SADC is one of the main contributors of atmospheric carbon, including the sale of coal and the cutting down of trees in forested regions.[54] Some of SADC's key sectors, namely transport and energy, are also reliant on fossil fuels. For example, South Africa's automotive sector is still configured to the production of ICE vehicles, while coal is also a primary source of power used to generate electricity in the SADC region.[55]

The barriers and opportunities to large-scale lithium battery manufacturing in SADC

Barriers

The main barriers to large-scale lithium battery manufacturing in SADC are a shortage of skills, limited financing, inadequate infrastructure, limited market, and slow implementation of industrial policies.

Shortage of Skills

An analysis of the lithium battery manufacturing value chain, shows that participation further along the value chain beyond the mining of raw materials, requires training and skills development, mainly within STEM (science, technology, engineering and mathematics) sectors and also within business and economic sciences. Some examples of workforce requirements are: scientists; chemists; chemical, electrical, materials and industrial engineers; technicians and software developers. Business and economic sciences

52 SADC, 'Member States', https://www.sadc.int/member-states/ (date accessed: October, 3,2020); SADC, *Selected Economic and Social Indicators 2019,* September, 2020, (Gaborone: SADC 2020), https://www.sadc.int/files/2916/0102/7136/Selected_Indicators_2020_September_11v2.pdf (date accessed: October, 4,2020).

53 SADC, *Selected Economic and Social Indicators 2019,* September, 2020, (Gaborone: SADC 2020), https://www.sadc.int/files/2916/0102/7136/Selected_Indicators_2020_September_11v2.pdf (date accessed: October, 4,2020)

54 SADC, 'Climate Change Mitigation', https://www.sadc.int/themes/meteorology-climate/climate-change-mitigation/ (accessed: October, 17, 2020); Carbon Brief, 'The Carbon Brief Profile: South Africa', October, 15,2018, https://www.carbonbrief.org/the-carbon-brief-profile-south-africa (accessed: October, 17, 2020); Daniel Workman, 'Coal Exports by Country', July, 11,2020 http://www.worldstopexports.com/coal-exports-country/ (accessed: October, 17, 2020).

55 SADC, 'Energy', https://www.sadc.int/themes/infrastructure/en/ (date accessed, October, 4, 2020),

are required for the development of the entrepreneurial skills to sustain the profitability and viability of the stakeholder businesses that would form part of the value chain. Lithium battery technology and manufacturing, for electric vehicle applications, form part of an emerging industry and as a result new training programmes will be needed at tertiary institutions together with training interventions to re-skill the existing workforce.

Limited Financing

The private sector's investment into the manufacturing sector in SADC has remained low[56]. Development and progression along the lithium battery manufacturing value chain requires financing towards research, development and innovation (RDI), raw material beneficiation and the commercialisation of regionally manufactured cell components, cells, battery packs and recycling. The building of strong public private partnerships across Member States will be needed in order to pool the funding required for such initiatives.

Inadequate Infrastructure

Key infrastructure needed to accelerate the lithium battery manufacturing value chain within the region, is largely underdeveloped. Energy, transport and ICT infrastructure remain a challenge. Electricity shortages continue to affect SADC and lacking regulatory frameworks inhibit investment in the energy sector.[57] Funding shortages are also inhibiting the maintenance, renovation and expansion of the region's roads, railways and ports of entry, while rural communities struggle with access to transport.[58] ICT infrastructure also needs to be developed for reliable and affordable internet connectivity in the region.[59] At the 40th SADC Summit it was noted that progress had been made towards the implementation of projects, such as connecting Angola, Malawi and Tanzania to the Southern African Power Pool (SAPP) grid to increase generation capacity, however there was still a deficit of 1904MW in the region.[60] Projects to improve transport and ICT infrastructure and water supply are also needed with some underway.[61]

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56 SADC, Action Plan for SADC Industrialization Strategy and Roadmap (18 March 2017), https://www.sadc.int/files/4514/9580/8179/Action_Plan_for_SADC_Industrialization_Strategy_and_Roadmap.pdf (accessed: October, 6, 2020)

57 SADC, 'Energy' https://www.sadc.int/themes/infrastructure/en/ (accessed: October, 6, 2020)

58 SADC, 'Transport' https://www.sadc.int/themes/infrastructure/transport/ (accessed: October, 6, 2020)
59 SADC, 'ICT and Telecommunications' https://www.sadc.int/themes/infrastructure/ict-telecommunications/ (accessed; October, 6, 2020), SAnews.gov.za, 'Call for improved ICT infrastructure in SADC region' (September, 16,2017) https://www.sanews.gov.za/south-africa/call-improved-ict-infrastructure-sadc-region (accessed: October, 6, 2020)

60 SADC, *40th Summit*

61 SADC, *40th Summit*

Slow Implementation of Industrial Policies

The SADC Industrialisation Strategy and Roadmap (SISR) 2015-2063 was adopted in April 2015. The purpose of the SISR is to encourage the development of value chains in six key areas, one of which is mineral beneficiation, to compete in the global energy storage/battery value chain. The other areas are agro-processing, pharmaceuticals, consumer goods, capital goods and services. The ISR seeks to increase the SADC region's competitive participation within global value chains while reducing carbon emissions in line with the Paris Agreement and UN SDGs. Unfortunately the implementation of the ISR has been slow. However, in light of the COVID-19 pandemic, there have been calls by Ministers of Member States to accelerate its implementation.[62] Accelerated implementation will require the implementation of coherent national policies by Member States that are aligned to the outcomes of the SISR.

Limited Market

Due to the slow adoption rate of EVs, there is no incentive for business to develop or invest in skills, equipment and infrastructure to manufacture lithium batteries. The slow implementation of policies that create an enabling environment for the adoption of EVs is one of the key reasons for a limited market. Other reasons for the slow adoption of EVs include a lack of consumer awareness, lack of infrastructure (e.g. public EV charging stations) and price.

Opportunities

The predicted uptake of electric vehicles around the world will continue to increase the demand for lithium batteries. The number of electric vehicles in the world will increase from 8 million cars in 2020 to 380 million cars by 2030.[63] The lithium battery is the primary component of an electric vehicle. Battery manufacturing capacity will need to increase from 300 gigawatt hours in 2020 to at least 2,023 gigawatt hours by 2030, in order to meet the demand for electric vehicles.[64] As seen in figure 4 Southern Africa is endowed with all the raw materials needed to manufacture lithium batteries. It is estimated that battery

62 Economist (Nambia), 'SADC Member States Urged to Remain Vigilant Amid Covid-19' June, 1, 2020, https://economist.com.na/53287/special-focus/sadc-member-states-urged-to-remain-vigilant-amid-covid-19/ (accessed: October, 6, 2020)

63 International Energy Agency, *Energy Perspectives 2020,*September 2020 (France: IEA Publications,2020), International Renewable Energy Agency, *The Post-COVID Recovery: An Agenda for Resilience, Development and Equality,* 2020, (Abu Dhabi: International Renewable Agency: 2020)

64 International Renewable Energy Agency, *The Post- COVID Recovery.*

manufacturing facilities will require an investment of approximately 120 million USD per gigawatt hour per annum, by 2025, in order to meet the global capacity requirements.[65] There is a window of opportunity, over the next five years, for SADC Member States to collaborate on initiatives and interventions that will enable them to competitively participate in value-added manufacturing across the entire lithium battery manufacturing value chain.

The COVID-19 pandemic has caused governments to examine their policies related to sustainable growth and development through the exploration of dynamic mechanisms to fast-track sustainable green economic recovery. The impact of COVID-19 has resulted in the acknowledgement by key decision makers that consumption and production patterns, aligned with the UN's SDGs, are critical to secure economic growth and prosperity. "Investing in energy transition technologies creates close to three times more jobs than fossil fuels do, for each million dollars of spending.[66]" A report by the International Labour Organisation estimates the transition of the transport sector from fossil fuels to electrification could create up to 10 million jobs worldwide.[67] Employment opportunities within the electric vehicle battery manufacturing value chain will surge while there will be a decrease in employment within the traditional ICE value chain. Therefore, if SADC Member States do not capitalise on the opportunity to manufacture lithium batteries for electric vehicles they will lose the opportunity for job creation in this value chain to other countries and regions. Potential investors for developing the lithium battery manufacturing value chain in SADC will be encouraged by policies, regulations and incentives that incentivise the uptake of electric vehicles in the region. South Africa, as a leader within automotive manufacturing and export in SADC should assume the responsibility of the transition away from the ICE vehicle value chain towards the electric vehicle manufacturing value chain.

Practical steps governments can take to accelerate the battery manufacturing value chain

Governments need to examine their country-specific industrial policy frameworks to assess how they can enable capabilities within the lithium battery manufacturing value

65 International Renewable Energy Agency, *The Post- COVID Recovery.*

66 International Renewable Energy Agency, *The Post- COVID Recovery,* p: 56.

67 International Labour Organization, *Jobs in Green and Healthy Transport*

chain. They should develop a roadmap, in consultation with relevant stakeholders including the private sector, for the development of battery manufacturing which clearly outlines specific areas of the value chain that they can potentially participate in and what capabilities are needed to participate within those areas. Governments also need to review their skills development frameworks, RDI investment frameworks and technology investment initiatives which enable the funding of equipment and infrastructure in alignment with quality standards.

The SISR provides a comprehensive blueprint for increasing Member States participation in global value chains. The first step is for Member States to actively implement the roadmap in each of their countries. Table 2 outlines key elements of the roadmap's Costed Action Plan where practical steps to accelerating the lithium battery manufacturing value chain in the region, can be taken. The Energy Storage/Battery Sector has already been assessed and profiled as a sector to increase SADC participation in global value chains. Below are some suggested practical steps that Member States can undertake to accelerate the lithium battery manufacturing value chain. Areas of suggested support required from the private sector is also listed.

Table 2 *SADC Industrialisation Action Plan and Suggested Activities by Member States and Private Sector*

Outcomes	Targeted Outputs	Key Performance Indicators	Main Activities	Suggested Practical Steps by Member States	Suggested support from Private Sector
II. 1.3 Increased participation in global value chains					
Increased participation in value chains for regional value addition Areas indicated by the Industrialisation Strategy: – agro-processing – minerals beneficiation – pharmaceuticals – consumer goods – capital goods – services	Regional/global value chain and value addition strategies for each of the 6 areas developed and implemented by 2020	No. of specific area value chain strategies developed and implemented. Value/volume of value added products and services	Develop and implement value chains and value addition strategies for each priority value chain identified and selected.	Establish a conducive environment for lithium battery manufacturing by: – Investing in supporting infrastructure – Developing bankable value chain projects – Facilitating the financing of feasibility studies, projects, start-ups. Possible activities to support: – Minerals beneficiation through the processing of manganese, lithium, nickel, cobalt, graphite to produce battery graded material for the manufacturing of cell components	Exploit opportunities within: – Raw material beneficiation for battery graded material for the manufacturing of cell components – Manufacturing of cell components such as anodes, cathodes, electrode materials and electrolytes – Cell manufacturing – Battery pack manufacturing – Battery pack re-use, re-purposing and recycling Collaborate with Government and Energy Storage Centres of Excellence and Centres of Specialisation on battery R&D and technological support.
II 1.4 Agro-Processing, Minerals Beneficiation and Downstream Processing Value Chain Development					
Higher level of minerals beneficiation and downstream processing	Higher levels of beneficiation and industrialisation and an improved system for the management of resources and the rents that accrue	Active implementation of the SADC "Mineral Linkages and Beneficiation Plan"	Develop and implement the SADC Mineral Beneficiation Plan	Approval and adoption of the SADC Mineral Beneficiation Plan Adopt the SADC Mineral Beneficiation Plan	Provide input for the plan and implement the plan

Outcomes	Targeted Outputs	Key Performance Indicators	Main Activities	Suggested Practical Steps by Member States	Suggested support from Private Sector
		Regional Mining Vision in place			
II. 1.10: Ensuring Greater Environmental Sustainability (Green and Blue Economy)					
Environmental standards, SDGs and Paris Accord 2015/16 mainstreamed into industrial development in line with the Protocol on Environment for Sustainable Development	Green Economy and Climate Change Strategies implemented by 2020	No. of Member States with Green Economy and Climate Change Strategies Level of gas/carbon emissions No. of industries utilising cleaner production technologies No. of industries producing cleaner technologies Level of energy efficiency in production % of renewables energy to total energy usage Compliance with Paris Declaration 2015, the Future we Want, Agenda 2063 and Agenda 2030	Implement the SADC Green Economy and Climate Change Strategies and Action in line with internationally agreed commitments	Consider, adopt and implement the Climate Change and Green Economy Strategies and Action Plans in line with internationally agreed commitments.	Participate in Green Economy Programmes
			Align production technologies and consumption patterns to promote environmental sustainability and maximize resource use efficiency	Comply with Paris Declaration 2015 and resolutions of the "Future we Want", Agenda 2063 and Agenda 2030	Comply with Paris Declaration 2015 and resolutions of the "Future we Want", Agenda 2063 and Agenda 2030

Outcomes	Targeted Outputs	Key Performance Indicators	Main Activities	Suggested Practical Steps by Member States	Suggested support from Private Sector
Manage Environmental Impacts of Industrialisation	Provision of the SADC Regional Waste Management Programme related to industrial waste implemented	% waste reduction % of waste reuse and recycled % contribution to the energy consumption of the Industry	Implement the Waste Management Programme (2013) in particular focusing on waste Reduction, Reuse and Recycling at source	Develop and implement an e-waste management plan that includes lithium batteries. Invest in RDI projects that support the re-purposing and re-use of second-life electric vehicle batteries within stationary storage and micro-mobility applications	Comply with waste management regulations for e-waste. Exploit opportunities available within the re-purposing and re-use of second life electric vehicle batteries within stationary storage and micro-mobility applications.
II.2.1 Creation of a business-friendly and conducive environment for competitiveness					
Improved skills relevant for industry	Share of skilled personnel in industrial workforce increased by 50% by 2030	% of skilled personnel in industrial workforce	Develop and implement relevant skills programmes for industry	Develop programmes to increase access to training facilities within lithium battery technology and entrepreneurship	Provide input and information on industry skills requirements in fields of raw material beneficiation, cell component manufacturing, cell manufacturing, battery pack manufacturing and recycling.
				Implement skills development programmes for battery manufacturing industry	Provide information on skills requirements for battery manufacturing industry and invest in skills development
				Establish, support and promote battery industry and academia linkages	Participate in industry-academia linkages
				Monitor effectiveness of industry-academia linkages	Monitor effectiveness of industry-academia linkages

Outcomes	Targeted Outputs	Key Performance Indicators	Main Activities	Suggested Practical Steps by Member States	Suggested support from Private Sector
				Establish education management information systems (EMISs)	Provide input on the development of education curricula in support of lithium battery manufacturing
Improved micro-economic environment for firms and enterprises	Rankings on Global Competitiveness and Ease of Doing Business (World Bank) indices significantly improved by 2030	Global Competitiveness Index (GCI) rankings Ease-of-Doing Business index rankings	Undertake the necessary policy reforms to create a business enabling environment	Through policy and regulatory reform, create an enabling environment for the adoption of electric vehicles and competitive participation in the global lithium battery manufacturing value chain	Provide feedback and input on key aspects of policies and regulations that will create an enabling environment for the adoption of electric vehicles and competitive participation in the global lithium battery manufacturing value chain
II.2.3: Improving Regional Standards, Quality Assurance, Accreditation and Metrology (SQAM)					
Industrialisation supported by strengthened Regional SQAM and Sanitary and Phytosanitary Measures (SPS) infrastructure (especially standards, quality assurance, accreditation, metrology and technical regulations) to enhance competitiveness of the region	Regional SQAM and SPS infrastructure strengthened by 2020	No. of functional Quality Infrastructure institutions internationally recognised	Improve quality infrastructure services that support industrialisation and enhance competitiveness	Lead and fund strengthening of SQAM and SPS programmes to facilitate conformance of enterprises to international standards Monitor compliance with standards Develop and adopt regulatory frameworks and standards for the testing and validation of lithium cells and batteries that are aligned to international standards	Utilise services of SQAM and SPS programmes to enhance international competitiveness Comply with standards
II.2.4: Establish and Invest in Innovation and Technology Transfer Programmes in support of Industrialisation					

Outcomes	Targeted Outputs	Key Performance Indicators	Main Activities	Suggested Practical Steps by Member States	Suggested support from Private Sector
Centres of Excellence (CoE) and Centres of Specialisation (CoS) for selected priority sectors (e.g. engineering, ICT, pharmaceuticals) identified/ strengthened/ established	Regional industrial Centres of Excellence (CoE) and Centres of Specialisation (CoS) for priority sectors identified and/or strengthened by 2030	No. of Centres of Excellence and Centres of Specialisation identified/ strengthened/ established	Identify existing CoE and CoS Strengthen existing CoEs and CoS to serve the region Establish new CoE/CoS, leveraging on comparative advantage	Participate in and support the identification/ proposal/ strengthening/ establishment of Energy Storage CoE/CoS with expertise in lithium battery technology	Participate in identification/proposal strengthening/ establishment of Energy Storage CoE/CoS with expertise in lithium battery technology
Enhanced innovation and business sophistication to advance technological readiness	Government investment in R&D increased to 2% of GDP	Percentage increase of GDP invested in R&D	Promote investment in R&D and Innovation	Invest in Energy Storage R&D and Innovation programmes	Invest in Energy Storage R&D and Innovation programmes
	Commercialisation of innovative products and services in SADC	No. of innovative products and services	Establish/ strengthen national and regional innovation systems	Develop Energy Storage R&D and Innovation and commercialisation support programmes for SMEs	Invest in Energy Storage R&D and Innovation programmes

Source: Adapted from SADC's Costed Action Plan for the SADC Industrialisation Strategy Roadmap

What clear indications are there that Governments are seriously considering a battery manufacturing road map to boost a post-COVID-19 green recovery response?

Apart from South Africa, Zimbabwe and Zambia, there are no clear, signed or ratified Industrial Policies in other SADC Member States that are easily accessible or available to the public for review. The SADC secretariat has highlighted that one of the key stumbling blocks to regional integration is the length of time that it takes some Member States to integrate regional policies, which were adopted, into their national policy and legal frameworks, noting that "for some countries, the process of getting a regional protocol through their internal processes takes several years, hence delaying regional programmes in the process".[68] The SADC Industry Protocol, which legalises the SADC Industrialisation Strategy and Roadmap has not been ratified by all Member States and as at 17 August 2020, Seychelles was the only Member State who had ratified the Industry Protocol.[69]

South Africa

As mentioned previously, the South African government is involved in a number of collaborative projects with higher education and training institutions, research and development institutions and the private sector to develop the country's lithium battery manufacturing industry. This was enabled through comprehensive action plans outlined in its Industrial and Innovation Policy Frameworks which were developed in consultation with industry stakeholders. However, limited funding is a stumbling block that prevents the country from expanding and scaling its lithium battery manufacturing efforts. In an address to the nation on 24 August 2020, President Cyril Ramaphosa highlighted that South Africa's post-COVID-19 economic recovery plan would include green growth and green economic development and that research and development activities within the green economy would continue.[70] His address also mentioned that climate action could also support infrastructure development, local production and the development of expertise in e-mobility.[71]

Zambia

68 SADC Secretariat, *Status of Integration in the Southern African Development Community*, April 2019, (Gaborone: SADC, 2019) p 6.

69 SADC, *SADC* 40th Summit

70 Cyril Ramaphosa, *From the Desk of the President,* August,24,2020, https://www.gov.za/blog/desk-president-34 (date accessed: October, 10, 2020)

71 Cyril Ramaphosa, *From the Desk of the President*

Zambia's National Industrial Policy highlights mineral (metallic and non-metallic) processing and products beneficiation and engineering products as one of the manufacturing sub-sectors that are a priority for driving industrialisation in the country.[72] The Zambian government has also aligned its industrial policy to the SISR. Although there is no specific mention of battery manufacturing within its industrial policy, there is an existing policy framework that the Zambian government can use to initiate activities towards developing its lithium battery manufacturing value chain. A possible starting point could be within cell component manufacturing as there are already companies such as ERG Africa in Zambia that are processing cobalt. President Edgar Chagwa Lungu's address at the fifth session of the twelfth national assembly of Zambia's parliament emphasised that the Zambian government would continue to promote value addition in the mining sector.[73]

Zimbabwe

Mineral beneficiation and the development and strengthening of industrial value chains form part of the key pillars of Zimbabwe's National Industrial Development Policy (2019-2023), which is also aligned to SADC's ISR. Within the mineral beneficiation and value addition section of its National Industrial Development Policy, Zimbabwe has mentioned lithium production as well as motor vehicle manufacturing as offering opportunities for the country to participate further along global value chains by adding value to the mineral resources that are mined in the country.[74] On 4 May 2020, the Government of Zimbabwe published an 18 billion ZWL (approximately 50 million USD) economic recovery and stimulus package, however, battery manufacturing was not specifically mentioned in the document.[75]

What are the systemic innovations that governments need to create to enable a green and just battery manufacturing transition, and how can key change agents identify and act on leverage points to enable policy action?

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72 Government of Zambia, Ministry of Commerce, Trade and Industry, *National Industrial Policy,* March 2018, https://www.mcti.gov.zm/?wpfb_dl=51 (date accessed: October, 9, 2018)

73 Government of Zambia, Edgar Lungu, 'Speech for the Official Opening of the Fifth Session of the Twelfth National Assembly', September, 11, 2020, http://www.parliament.gov.zm/sites/default/files/images/publication_docs/Speech_1.pdf (date accessed: October, 9, 2020)

74 Government of Zimbabwe, Ministry of Industry and Commerce, *Zimbabwe National Industrial Development Policy 2019-2023*,(Harare: Paragon, 2019).

75 Government of Zimbabwe, 'Details on the COVID-19 Economic Recovery and Stimulus Package', 4, May 2020, https://www.veritaszim.net/node/4112 (accessed: October, 19,2020)

To ensure sustainable economic growth, SADC Member States need to become vigorous in implementing policies that create booming, competitive manufacturing industries with export products that are in high demand around the rest of the world. *"To sustain growth, a country needs to constantly introduce new goods and adopt and develop new technologies".*[76] Nations such as South Korea, Singapore and the Province of Taiwan, China, have succeeded in moving away from commodity driven economies to manufacturing driven economies through setting and, most importantly, following through on ambitious industrialisation targets and goals that enable the development of selected industries. In these countries, government spearheaded policies that facilitated the creation of markets to export manufactured goods to the rest of the world. The determining factors for successful implementation of their industrialisation policies was "ambition", "accountability" and "adaptability."[77] South Korea, like SADC Member States today, was a commodity-based economy in the 1960s and managed to transform into a manufacturing driven economy by the beginning of the 21st century, becoming the 12th largest economy in the world (measured by GDP) in 2017, with exports contributing 39.83% of GDP in 2019.[78] The industrial policies implemented by South Korea enabled companies such as the Hyundai Motor Corporation to become one of the most successful car manufacturers in the world using their own technology.[79] Singapore and Taiwan have had similar success with their manufacturing sectors (e.g. electronic components, transport engineering, chemical manufacturing) being the key drivers of their economy.[80] SADC Member States can use the opportunities available within the lithium battery manufacturing value chain

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76 Reda Cherif and Fuad Hasanov, "The Return of the Policy That Shall Not Be Named: Principles of Industrial Policy" (WP/19/74, International Monetary Fund, March 2019,) https://www.imf.org/en/Publications/WP/Issues/2019/03/26/The-Return-of-the-Policy-That-Shall-Not-Be-Named-Principles-of-Industrial-Policy-46710 (accessed: October, 6, 2020).

77 Reda Cherif and Fuad Hasanov, "The Return of the Policy", p. 23.

78 Worldometer, 'GDP' by Country', https://www.worldometers.info/gdp/gdp-by-country/ (accessed: October, 8, 2020), GlobalEconomy.com, South Korea: Exports, percent of GDP, https://www.theglobaleconomy.com/South-Korea/exports/ (accessed: October, 8, 2020).

79 Reda Cherif and Fuad Hasanov, "The Return of the Policy", p. 23; Group1 Hyundai, 'The History of Hyundai', https://www.group1hyundai.co.za/history-of-hyundai/ (date accessed: October, 8,2020); Hyundai, 'The History of Hyundai Motor Company', https://www.earnhardthyundai.com/hyundai-history (date accessed: October, 8, 2020); Ana Maria Santacreu and Heting Zhu, 'How Did South Korea's Economy Develop SO Quickly?', March 20, 2018, https://www.stlouisfed.org/on-the-economy/2018/march/how-south-korea-economy-develop-quickly (accessed: October, 8, 2020).

80 Sharon Omondi, 'What Are The Biggest Industries In Taiwan?', June, 7, 2019, https://www.worldatlas.com/articles/what-are-the-biggest-industries-in-taiwan.html (date accessed: October, 8, 2020); GuideMeSingapore, What Makes the Singapore Economy Tick?, https://www.guidemesingapore.com/business-guides/incorporation/why-singapore/singapore-economy---a-brief-introduction#:~:text=Today%2C%20the%20Singapore%20economy%20is,the%20world's%20busiest%20cargo%20seaport. (accessed: October, 8, 2020); World Bank, 'The World Bank in Singapore', https://www.worldbank.org/en/country/singapore/overview (accessed: October, 8, 2020);

to begin their trajectory towards becoming manufacturing-based economies. Table 3 gives a summary of how executing similar interventions adopted by Asian economies can assist in accelerating the lithium battery manufacturing value chain in SADC.

Table 3 Systemic Innovations for a sustainable lithium -ion battery manufacturing value chain

Industrial Policy/ State Intervention		Intervention required to accelerate lithium battery manufacturing value chain
1. Create Capabilities in Sophisticated Industries	Implement policies that allow for a transition from commodity driven production into technology driven production that drives innovation beyond current capabilities to compete in the advanced stages of value chains.	Create capabilities within the lithium in the battery manufacturing industry, by improving capabilities further along the value chain namely: mineral beneficiation for producing battery-grade material, cell component manufacturing, cell manufacturing, battery pack assembly and recycling.
2. Export	Focus on exporting the new industrial product immediately by paying close attention to the needs of the export market and being able to quickly adapt as conditions change.	Use capabilities created to manufacture high-quality, competitive cell components, cells and battery packs that can be exported globally.
3. Cut-throat Competition and Strict Accountability	Establish public private partnerships with conditional investment support based on performance assessments and encourage competition among domestic businesses for regional and international market share.	Funds invested in businesses and organisations to facilitate the development of the lithium battery manufacturing industry are accounted for through performance assessment, return on investment and ethical practices.

Source: Adapted from Reda Cherif and Fuad Hasanov, 2019[81].

Creating capabilities in lithium battery manufacturing will lead to job creation. The development of capabilities further along the value chain in cell component manufacturing, cell manufacturing, battery pack assembly and recycling will allow the industry to create more employment opportunities. Skills development will be required for new entrants while existing employees will require re-training and/or re-skilling. A

81 Reda Cherif and Fuad Hasanov, "The Return of the Policy"p.24

comprehensive skills development framework should be developed in consultation with institutions of higher learning, ministries of labour and education as well as industry role players. Industry is key to providing critical information on specific human resource capability requirements to grow and develop lithium battery manufacturing in the region.

To ensure a successful and sustainable export market, the beneficiation of raw materials into battery-grade material should occur in SADC. This is a crucial step to ensuring that lithium battery manufacturing can take place in the region. Member States can incentivise mining companies to process raw materials in their existing localities instead of transporting them overseas for processing. Producing products that are internationally competitive is vital for a sustainable export market thus all products manufactured within the lithium battery value chain must adhere to international quality and safety standards. National and regional quality assurance and regulatory bodies need to develop and enforce quality standards regulations. Quality assurance and regulatory bodies, together with industry, also need to remain agile in order to quickly adapt to the changing needs of the export market.

The sourcing of financing to develop the lithium battery manufacturing industry has been highlighted as a barrier to accelerating progression along its value chain. While finding the capital to scale projects is a challenge, managing the capital once it has been received can be far more challenging. A strategy towards capacity building for budgeting and management of finances for large-scale projects for government officials and investees needs to be created and implemented. The funds invested must also be clearly accounted for while re-investment must be performance-based. This strategy will encourage healthy competition and ethical business practices.

Creating sophisticated capabilities across the entire lithium battery manufacturing value chain and a sustainable export market for locally manufactured lithium battery products while promoting competition and accountability within industry, require one key qualitative ingredient to attain this future: continuous transformational change.[82] SADC Member States have been trapped in the cycle of commodity-driven economies for over 100 years and transitioning to a manufacturing-driven economy that is both green and low-carbon require a complete paradigm shift for many stakeholders. Continuous capacity-building initiatives will enable stakeholders to quickly adapt to market and technology changes.

82 Catrien J.A.M. Termeer, Art Dewulf and G.Robbert Biesbroek, 'Transformation Change: Governance, Interventions for Climate Change Adaptation from a Continuous Change Perspective, *Journal of Environmental Planning and Management* 60, no.4 (2017) p. 558-576.

Recommendations to donors, policymakers and the private sector for accelerating the battery manufacturing value chain in SADC

All SADC Member States should create policies that fast-track the adoption of electric vehicles in the region. An increasing demand in EVs will create an appetite for investment in lithium battery manufacturing in SADC.

Regional Integration is necessary. Member States must align their national policies with SADC's Vision 2050 and the SADC Industrialisation Strategy and Roadmap in order for the region to work collectively towards accelerating the lithium battery manufacturing value chain.

Member States should develop mechanisms to allow for continuous engagement with the private sector to promote collaborative efforts in developing the industry.

A top priority should be the formation of a regional battery alliance with stakeholder representatives from each Member State. The battery alliance should develop a regional battery roadmap for advancing battery technology, competitiveness and skills in the region.

Each member state should conduct a skills gap analysis in collaboration with industry stakeholders and higher education training institutions. The analysis should review the skills needed to be a competitive player within the lithium battery global value chain.

Thereafter, a skills plan that promotes gender equality as well as the opportunity for re-skilling should be developed. Science, Technology, Engineering and Mathematics should also be promoted at school level up to grade 12 to ensure a sustainable pipeline of human capital.

Member States should conduct continuous capacity development interventions for stakeholders within the public and private sector that gives them the tools and know-how to implement policies aligned to SADC's 2050 Vision and the SDGs.

Once the mutual sustainable benefits are properly articulated and become apparent, it will encourage stakeholder buy-in towards working together to accelerate the lithium battery manufacturing value-chain.

The development of SMEs is key to job creation.

Governments should encourage local SMEs to participate at higher levels of the battery manufacturing value chain by eliminating regulatory barriers and providing commercialisation support programmes.

Mining companies should be incentivised to establish mineral beneficiation plants that can produce battery-grade material.

Member States can offer incentives to mining companies operating in their countries. These include establishing special economic zones for lithium battery manufacturing with tax incentives that also encourage local and regional employment. Investors should also be incentivised to promote local participants in the value chain.

Member States can also provide incentives to investors and businesses to establish operations in lesser industrialised and/or rural areas to alleviate unemployment and improve living standards.

Quality assurance is vital for competing in the global battery manufacturing value chain.

National regulatory, accreditation, and standards bureaus should establish a regional body for the testing and accreditation of lithium cells and batteries in the SADC region.

The SADC Business Council can be used as an engagement platform for stakeholders from the private and public sector to initiate forums for accelerating the development of the lithium battery manufacturing value chain in the region.

The energy storage/battery sector has been officially profiled and assessed by the SADC Secretariat as a key investment opportunity, thus current funding mechanisms can be leveraged to develop the lithium battery manufacturing value chain.

SADC's cooperation with the African Development Bank, EU, Germany and China can be leveraged to support projects that will accelerate lithium battery manufacturing in the region. Governments can also use green stimulus packages that support investment in lithium battery manufacturing through post COVID-19 green economic recovery plans.

SADC Member States can set up a single market mechanism to strengthen the region's global bargaining power within the lithium battery manufacturing value chain.

Lithium battery recycling is an important part of the value chain as it supports sustainable consumption patterns via the circular economy concept.

The SADC region should develop a regulatory framework for the recycling of lithium batteries.

Ethical organisational practices that are underpinned by the 3Ps of sustainability (Planet, People, Profit)[83] should be at the forefront of all regulatory frameworks for lithium battery manufacturing.

Businesses must put their employees and their community's well-being at the forefront of all their decision-making processes. Businesses should be compelled to pay fair wages and provide healthy and safe working conditions for their employees.[84] Women, youth and people with disabilities should be included in the employment and entrepreneurial opportunities provided by the lithium battery manufacturing value chain.

This can be done through deliberate training inventions from encouraging the uptake of STEM subjects at school to tertiary level and re-skilling the existing workforce through practical training interventions within battery technology.

Capacity building programmes that promote the development of entrepreneurs and innovation should also be implemented. Environmentally-friendly and sustainable business practices should be mandatory at all levels of the lithium battery manufacturing value chain.

Lithium batteries provide a low-carbon transport solution and can also provide a source of energy storage for renewable energy solutions.

Member States should recognise that compelling businesses to follow the concept of People, Planet, Profit will create a sustainable battery manufacturing value chain which will result in sustainable job creation and sustainable economic growth while contributing to the alleviation of poverty.

Conclusion

Post COVID-19 economic recovery has given SADC Member States a golden opportunity to invest in energy transition technologies that can create close to three times more jobs than

83 University of Wisconsin Sustainable Management, 'The Triple Bottom Line', https://sustain.wisconsin.edu/sustainability/triple-bottom-line/ (accessed: October, 13, 2020)

84 University of Wisconsin Sustainable Management, 'The Triple Bottom Line'

fossil fuels do.[85] The electrification of transport is expected to create up to 10 million jobs worldwide.[86] Future employment opportunities within electric vehicle battery manufacturing is predicted to surge.[87] Battery Energy Storage has been identified as an untapped opportunity for SADC due to the increasing demand for electric vehicles.[88]

Member states must incorporate the development of the lithium battery value chain into their post COVID-19 economic recovery plans. This will require implementing policies that promote the development of the electric vehicle industry in SADC which in turn will encourage investment towards the development of lithium battery manufacturing in the region. The SADC Industrialisation Strategy and Road Map and Costed Action Plan has given Member States a framework of the policies required to accelerate the lithium battery manufacturing value chain in Southern Africa. Those Member States that have not aligned their industrial policies to SADC's Industrialisation Strategy and Road Map must fast-track the policy adoption and ratification process in their respective countries.

SADC Member States, such as South Africa, Zambia and Zimbabwe, who have adopted sound industrial policies that are aligned to the SADC Industrialisation Strategy and Road Map need to accelerate that implementation of the policies and drive SADC's competitive participation in the global value chain for lithium battery manufacturing. The region has the opportunity to use its mineral resources to transform from a commodity-driven economy to an industrialised manufacturing-driven economy that creates jobs and alleviates poverty for its citizens. It will be a tragedy to let this opportunity slip away.

85 International Labour Organization, *Jobs in Green and Healthy Transport*

86 International Labour Organization, *Jobs in Green and Healthy Transport*

87 International Labour Organization, *Jobs in Green and Healthy Transport*

88 SADC, *40th SADC Summit,* p.46

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