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

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Abstract

The predicted uptake of electric vehicles (EVs) around the world will continue to increase the demand for lithium-ion batteries. At the same time, the electrification of transport is estimated to create 10 million jobs worldwide. The SADC region is endowed with all the raw minerals required to produce lithium-ion batteries. However, most of the minerals that are being mined are exported as raw materials, causing member states to miss opportunities for earning increased revenue from producing and exporting value-added products for the lithium-ion battery manufacturing value chain. The current battery manufacturing landscape in SADC shows potential for the development of raw material beneficiation, cell component manufacturing and cell manufacturing. Recommendations to develop the lithium-ion battery manufacturing value chain in SADC include: member states aligning their policies to the SADC Industrialisation Strategy Roadmap and SADC Vision 2050 to fast-track the adoption of EVs in the region; forming a regional battery alliance; instituting capacity development interventions in the private and public sectors and establishing a regional body for the testing and accreditation of lithium-ion cells and batteries. A just transition also needs to be at the forefront of all regulatory frameworks for lithium-ion battery manufacturing in SADC.

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 (ICS) 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 EVs during the post-COVID-19 green economic recovery is forecasted to grow and capture at least half the market share from ICE vehicles by 2040.[2] The underlying reason is the adoption and ratification of the Paris Agreement by 197 countries under the UN Framework Convention on Climate Change.[3] The countries that have adopted and ratified the Paris Agreement have submitted Nationally Determined Contributions (NDCs), which communicate the actions they will take to reduce greenhouse gas (GHG) emissions.[4] The lithium-ion battery of an EV is its defining

1 Lauri Myllyvirta, "11 000 Air Pollution-Related Deaths Avoided in Europe as Coal, Oil Consumption Plummet", Centre for Research on Energy and Clean Air, April 30, 2020, https://energyandcleanair.org/air-pollution-deaths-avoided-in-europe-as-coal-oil-plummet/.

2 "A Bright Future Awaits Electric Vehicles", *International Banker*, October 13, 2020, https://internationalbanker.com/brokerage/a-bright-future-awaits-electric-vehicles/; International Energy Agency, *Global EV Outlook 2020*, Technology Report (Paris: IEA, 2020), https://www.iea.org/reports/global-ev-outlook-2020; BloombergNEF, *Electric Vehicle Outlook 2020* (New York: BloombergNEF, 2020), https://about.bnef.com/electric-vehicle-outlook/.

3 UN, *Paris Agreement to the United Nations Framework Convention on Climate Change*, TIAS No. 16-1104 (New York: UN, December 12, 2015), https://unfccc.int/sites/default/files/english_paris_agreement.pdf.

4 Mengpin Ge and Kelly Levin, "Insider: What's Changing as Countries Turn INDCs into NDCs? 5 Early Insights", World Resources Institute, April 18, 2018, https://www.wri.org/blog/2018/04/insider-whats-changing-countries-turn-indcs-ndcs-5-early-insights.

component because, through its recharging mechanism, the battery is able to store energy that allows the car to be driven. EVs 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 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).

TABLE 1 ELECTRIC VEHICLES' CONTRIBUTION TO THE SDGs

UN SDG	Electric vehicles
SDG 7: Affordable and clean energy	**Energy efficiency**: The use of a battery-operated vehicle instead of an ICE vehicle. **Energy security**: Lithium-ion batteries improve a country's energy security as they reduce reliance on fossil fuels (eg, 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.[a]
SDG 9: Industry, innovation and infrastructure	**Sustainable industrialisation**: Developing the lithium-ion 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.

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

Source: Adapted from International Energy Agency, *Global EV Outlook 2019*, Technology Report (Paris: IEA, 2019)

Southern Africa is endowed with all the raw minerals required to produce lithium-ion batteries. The minerals that are currently being mined in the region are predominantly exported as raw material to countries outside of the continent for the manufacture of lithium-ion batteries. The price of these exported raw materials is minimal compared to when they are beneficiated and used in a commercial product. The reliance on export rather than beneficiation has left SADC member states stuck at the beginning, or bottom, of the lithium-ion battery manufacturing value chain. If, for example, the raw materials

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

were given added value through processing (beneficiation) to develop battery-grade material that could 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 were used to manufacture single cells in member states, 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-ion battery manufacturing value chain, they could potentially earn higher revenues from increased export earnings. Increased profits could lead to job creation and economic growth, which would allow businesses to employ more skilled people at higher wages.

It is against this backdrop that this paper briefly unpacks the benefits, opportunities and barriers to accelerating the lithium-ion battery manufacturing value-chain in Southern Africa.

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 eliminated.[6] The plan highlights key strategies and actions within the energy, transport, manufacturing and mining sectors. These include supporting the development of green manufacturing sectors; promoting green public transport networks and multimodal transport; promoting energy efficiency; and supporting renewable energy.[7]

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.[8] 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'.[9] 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

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

7 SADC, *Green Economy Strategy*.

8 SADC, "Communiqué of the 40th Ordinary Summit of the SADC Heads of State and Government", August 17, 2020, https://www.sadc.int/files/8115/9767/2537/Communique_of_the_40th_SADC_Summit_August_2020_-ENGLISH.pdf.

9 SADC, *SADC Vision 2050*, SADC/SOM/1/2020/1A (Gaborone: SADC, February 29, 2020), https://imanidevelopment.com/wp-content/uploads/2020/03/4th-Draft_SADC-Vision-2050.pdf.

10 SADC, "Communiqué"; SADC, *RISDP 2020–2030 Blueprints 4th Draft* (SADC, Gaborone, 2020), https://imanidevelopment.com/wp-content/uploads/2020/03/4th-Draft_RISDP-2020-30-Blue-Prints2.pdf.

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 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 this is done, the transition from commodity-based exports to manufacture-based exports will 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 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:[12]

> 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 offers 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.

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-ion battery manufacturing value chain. Sustainable development must be the basis of these strategies to allow all citizens to enjoy the sustained economic well-being of SADC.

It is important for stakeholders from the public and private sectors to collaborate and develop practical strategies that will accelerate the lithium-ion battery manufacturing value chain

11 SADC, *40th SADC Summit Maputo – Mozambique 17 August 2020*, Report (Gaborone: SADC, 2020), https://www.tralac.org/documents/resources/sadc/4020-40th-sadc-summit-brochure-2020-sardc-net/file.html.

12 SADC, 40th SADC Summit, 46.

Figure 1 SADC Vision 2050

Source: SADC, *SADC Vision 2050*, SADC/SOM/1/2020/1A (Gaborone: SADC, February 29, 2020), https://imanidevelopment.com/wp-content/uploads/2020/03/4th-Draft_SADC-Vision-2050.pdf

Why are lithium-ion batteries receiving exceptional global attention?

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 SDGs. This resulted in automotive manufacturers producing zero emission battery EVs.

Over the last decade, there has been exponential growth in the production of EVs. The global EV car stock increased from 17 000 units in 2010 to 7.2 million units in 2019 and is

13 Ritchie, "Sector by Sector".

forecast to grow to at least 140 million units by 2030.[14] The lithium-ion battery is a critical part of an EV 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-ion batteries, as seen in Figure 2, is expected to grow in line with the demand for EVs, reaching 2 600 GWh in 2030. During this time the average price of EV battery packs is expected to decrease, reaching price parity with ICE vehicles by the mid-2020s.[15] The lithium-ion battery will most likely be the dominant battery within EVs until at least 2030 due to large global investments in the research and development (R&D) of lithium-ion battery technologies, its manufacturing processes and supply chains. The dominance of lithium-ion 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]

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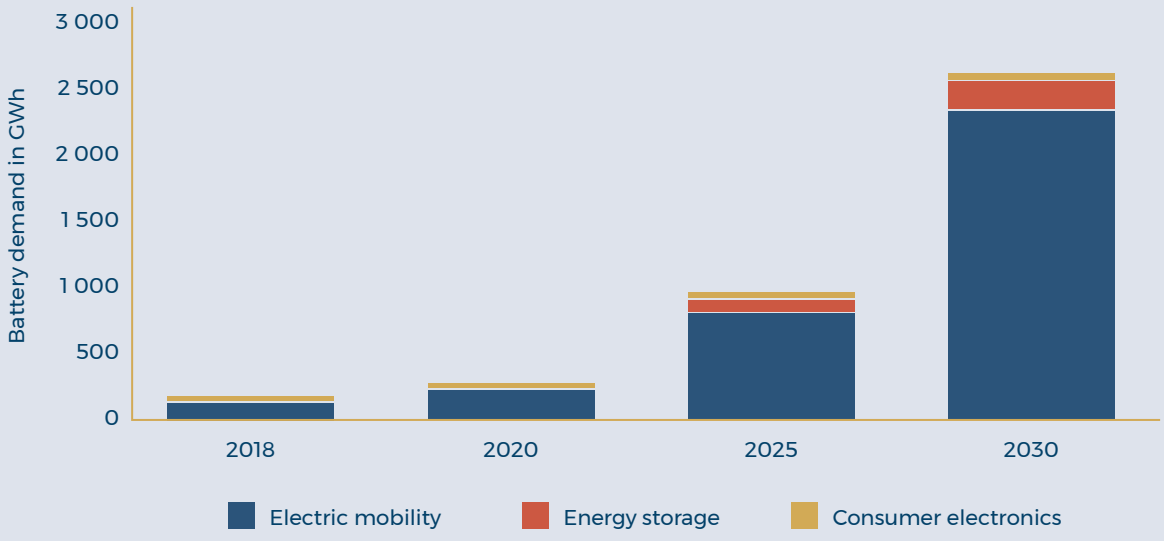
Figure 2 Global battery demand by application between 2018 and 2030



Source: Statista, "Global Battery Demand Between 2018 and 2030, By Application", October 21, 2020, https://www.statista.com/statistics/1103218/global-battery-demand-forecast/

14 IEA, *Global EV Outlook 2020*.

15 BloombergNEF, *Electric Vehicle Outlook 2020*; World Economic Forum, *A Vision for a Sustainable Battery Value Chain in 2030*, Insight Report (Geneva: WEF, 2019), http://www3.weforum.org/docs/WEF_A_Vision_for_a_Sustainable_Battery_Value_Chain_in_2030_Report.pdf.

16 IEA, *Global EV Outlook 2020*; BloombergNEF, *Electric Vehicle Outlook 2020*; WEF, *A Vision for a*.

Currently, the manufacturing costs of lithium-ion batteries are high, with the beneficiation and manufacturing of the cathode electrode accounting for about 60% of the cost of the battery.[17] This can be lowered by reducing the amount of cobalt used in the electrode and improving other types of chemistries that can effectively be used to replace the common lithium cobalt oxide layered structured material. One way is to move towards the use of the well-known manganese oxide spinel material.[18] Cobalt is, at present, the most expensive of all the raw materials used in the manufacturing of lithium-ion batteries and by changing the type of cathode material used, the cost can be significantly reduced.[19] However, the use of the manganese spinel does have a number of drawbacks in terms of its comparative power performance and capacity cycle stability, which can be improved with dopants such as nickel, aluminium and cobalt. In addition, there are global pressures to ensure the use of 'fair trade' practices in the value chain of manufactured goods. Currently, the mining of raw materials often uses unconventional and unfair labour and environmental practices, which is sometimes the case in cobalt mining operations.[20] These consortiums also monopolise the supply of cobalt to the market, which then drives the commodity prices up. In addition, South Africa supplies about 32% of the global manganese-based ore.[21] By ensuring the mineral beneficiation process is done locally, it would reduce not only the raw material cost of the spinel manufacturing but also its carbon footprint.

Southern Africa can use its wide chemistry expertise, coupled with the availability of manganese in the region, to conduct R&D work towards the use of manganese spinel material as a replacement for cobalt-based chemistries

Southern Africa can use its wide chemistry expertise, coupled with the availability of manganese in the region, to conduct R&D work towards the use of manganese spinel material as a replacement for cobalt-based chemistries. The region can also make use of its expertise in powder x-ray and neutron diffraction, linked to in-situ instrumentation, to understand the unique phase transitions that occur in the material process to reduce its thermal manufacturing costs. This would ultimately reduce the overall price of the lithium-ion batteries that can be supplied to the unique African consumer market.

17 Marc Wentker, Matthew Greenwood and Jens Leker, "A Bottom-Up Approach to Lithium-Ion Battery Cost Modeling with a Focus on Cathode Active Materials", *Energies* 12, no. 3 (2019): 504.

18 Junxiang Liu et al., "Spinel/Lithium-Rich Manganese Oxide Hybrid Nanofibers as Cathode Materials for Rechargeable Lithium-Ion Batteries", *Small Methods* 3, no. 12 (2019), https://onlinelibrary.wiley.com/doi/10.1002/smtd.201900350.

19 University of Texas at Austin, "New Cobalt-Free Lithium-Ion Battery Reduces Costs Without Sacrificing Performance", *ScienceDaily*, July 16, 2020, www.sciencedaily.com/releases/2020/07/200716101612.htm.

20 Cornelia Lichner, "The Weekend Read: Ethical Strategies for Cobalt Supply", *PV Magazine*, February 1, 2020, https://www.pv-magazine.com/2020/02/01/the-weekend-read-ethical-strategies-for-cobalt-supply/.

21 International Manganese Institute, *IMnI Statistics 2019* (Paris: International Manganese Institute, 2019).

The current state of lithium-ion battery manufacturing in the SADC region

Currently, battery manufacturing in SADC concentrates on lead-acid batteries. 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 EVs becoming more evident it is imperative that the industry incorporates lithium-ion battery manufacturing into its portfolio.

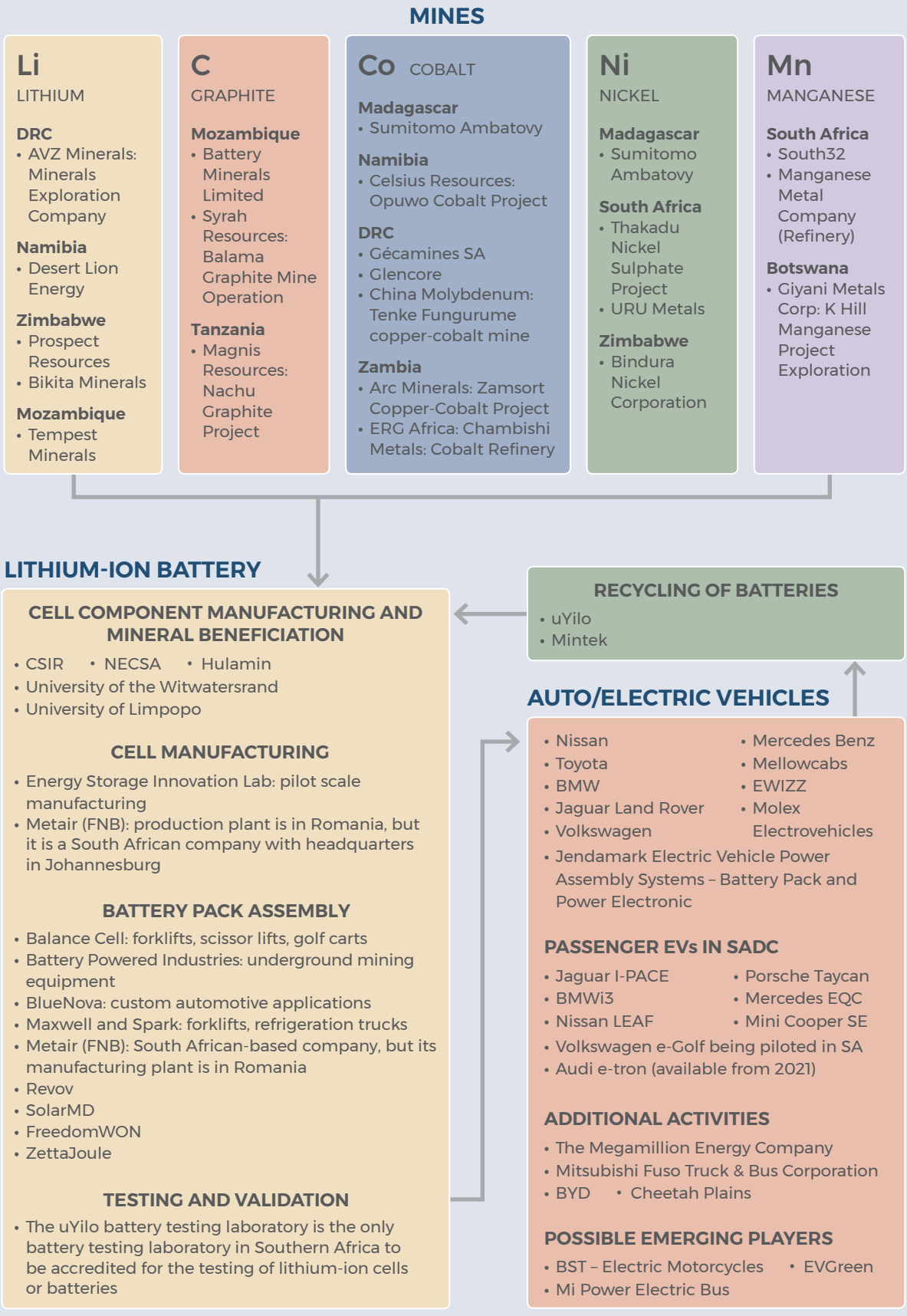
In order to analyse the state of lithium-ion battery manufacturing within SADC, the composition of an EV battery pack, together with the business model that explains the activities required for the production of the battery, needs to be illustrated. An EV battery pack is made up of modules, which are composed of cells. The lithium-ion cells consist of active electrodes that include cathode and anode materials. Cathode materials include lithium cobalt oxide, lithium manganese oxide, lithium nickel cobalt aluminium 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-ion cells.

As seen in Figure 3 (see page 10), the first step in the value chain is the mining of raw materials, followed by raw material beneficiation. Once the cell components have been manufactured they are used to manufacture lithium-ion cells (cell assembly process). The lithium-ion 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 EV, in what is considered its 'first life'. The last step in the value chain is the re-purposing and re-cycling of the battery pack.

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 micromobility applications. When the battery pack is spent (ie, can no longer be used for any other applications) the materials are recycled. The spent cells or battery must be made safe for recycling and processed accordingly. An aged or damaged lithium-ion 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, most activities take place at the start of the value chain, mainly with the mining of raw materials. Some member states 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

Figure 3 The battery value chain in Southern Africa



Source: uYilo e-Mobility Programme, Nelson Mandela University, South Africa

also several industry players in SADC that assemble lithium-ion battery packs. They import the lithium-ion cells mainly from Asia. Electric bicycles are also gaining popularity in SADC, which has seen the establishment of many electric bike manufacturers, including Relectro, Momsem and Chilled Squirrel. In addition, there are customised specialty utility vehicle retrofitters for safari vehicles to be used in the tourism sector.

There are currently no battery EV assembly or manufacturing plants in SADC

The major automotive original equipment manufacturers (OEMs) that make EVs have made a selected number of battery EV models available to consumers in SADC. However, all these vehicles are imported. There are currently no battery EV assembly or manufacturing plants in SADC. The reasons for this include a lack of manufacturing incentives; no coherent enabling policy to facilitate the uptake of EVs (eg, EVs carry high import duties, making them very expensive and thus inaccessible to the average consumer); EV infrastructure (eg, 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-ion battery technology if there is no local market.

Mining of EV-related minerals and metals

The SADC region is endowed with all the EV-related minerals and metals (EVMMs) that are needed to manufacture lithium-ion 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, Gécamines SA and China Molybdenum the key role players with established cobalt mining operations.[22] Manganese mining activities include Giyani Metals Corp (manganese exploration) in Botswana and the South32 mining operation in South Africa.[23] Bikita Minerals in Zimbabwe is currently the only operating lithium mine in SADC.[24] Companies involved in lithium mining exploration and development activities include Desert Lion Energy in Namibia, Prospect Resources in

22 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; Gecamines SA, "Our Activities", https://www.gecamines.cd/prospection.html; Glencore, "Democratic Republic of the Congo", https://www.glencore.com/ask-glencore/democratic-republic-of-the-congo.

23 Giyani Metals Corp, "Emerging Battery Grade Manganese Opportunity", https://giyanimetals.com/; South32, "South Africa Manganese", https://www.south32.net/our-business/southern-africa/south-africa-manganese.

24 Golden Sibanda, "Zimbabwe: World Lithium Deficit a Boon for Zimbabwe", *AllAfrica*, October 1, 2020, https://allafrica.com/stories/202010020414.html.

Zimbabwe and Tempest Minerals in Zimbabwe and Mozambique.[25] Sumito Ambatovy has a nickel and cobalt mining operation in Madagascar.[26] URU Metals in South Africa has a nickel exploration project, while Bindura Nickel Corporation mines nickel in Zimbabwe.[27] 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.[28] Botswana, the DRC, Namibia and Zambia have also joined the US's Energy Resource Governance Initiative aimed at promoting best practices and resilient energy mineral supply chains in the mining sector, particularly for EVMMs.[29]

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 a precursor in 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-ion batteries.[30] 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.[31] ERG Africa: Chambishi has a cobalt processing plant in Zambia and Sumito Ambotovy processes nickel and cobalt in Madagascar, but neither of these plants produce battery-grade material for export.[32]

25 Bloomberg, "Desert Lion Energy Inc.", https://www.bloomberg.com/profile/company/DLI:CN; Prospect Resources, "Arcadia Lithium Project", https://www.prospectresources.com.au/projects/arcadia-lithium-project; Reuters, "Tempest Minerals Ltd LIFG.F", https://www.reuters.com/companies/LIFG.F.

26 Yuka Obayashi, "Sumitomo Predicts Record Loss As Covid-19 Hits Nickel Project", *Mining.Com*, August 7, 2020, https://www.mining.com/web/sumitomo-predicts-record-loss-as-covid-19-hits-nickel-project/; Ambatovy, "Overview", http://ambatovy.com/ambatovy-html/docs/index.html%3Fp=110.html.

27 URU Metals, "Nickel", http://www.urumetals.com/portfolio/projects/nickel; African Financials, "Bindura Nickel Corporation Limited (BIND.zw)", https://africanfinancials.com/company/zw-bind/; Syrah Resources, "Balama Graphite Operation", http://www.syrahresources.com.au/balama-project.

28 Magnis Energy Technologies, "Nachu Graphite Project", https://www.magnis.com.au/nachue-project; Syrah Resources, "Balama Graphite Project", http://www.syrahresources.com.au/balama-project.

29 US Department of State, 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; Reuters, '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.

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

31 Owen Murphy, "Battery Tech in Electric Cars Presents a Huge Opportunity to SA Mining", *Business Day*, 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", https://www.mmc.co.za/; Mintek, *2019 Integrated Annual Report* (Randburg: Mintek, 2019), https://www.mintek.co.za/2019/10/17/2019-annual-report/; DTIC, "Mineral Beneficiation".

32 ERG Africa, "Chambishi Metals", https://www.ergafrica.com/cobalt-copper-division/chambishi-metals/; Sumito Corporation, "The Ambatovy Project, One of the World's Largest Nickel Projects", https://www.sumitomocorp.com/en/jp/business/case/group/235.

Battery Minerals Limited has established a joint venture with Urbix for processing mined graphite in Mozambique.[33] In 2018, Magnis Technologies received a Special Economic Zone licence from the government of Tanzania for the operation of a graphite processing plant to produce value-added graphite products.[34] In an effort to develop its lithium-ion battery manufacturing industry, the government of Zimbabwe is planning to establish a lithium ore processing plant in Bulawayo to produce value-added lithium products.[35]

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-ion battery packs. The Mega Million Energy Company is planning to establish a large-scale battery manufacturing plant for the production of lithium-ion cells and batteries.[36] Metair has also partnered with the University of the Western Cape (UWC) to establish a pilot-scale lithium-ion assembly plant at UWC's Energy Storage Innovation Lab in Cape Town.[37] 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.[38] This is to allow the country to compete in the battery manufacturing value chain for EVs and energy storage applications.[39] Members of the consortium include the University of Limpopo, University of the Witwatersrand, Council for Scientific and Industrial Research (CSIR), South African Nuclear Energy Corporation (NECSA, whose activities are related to electrode materials development), UWC Energy Storage Innovation Lab (whose activities include cell assembly and validation) and the uYilo e-Mobility Programme (uYilo) hosted at Nelson Mandela University (whose activities include

33 Adrian Frey, "Battery Minerals to Process Graphite in Mozambique", *Club of Mozambique*, October 14, 2019, https://clubofmozambique.com/news/battery-minerals-to-process-graphite-in-mozambique-144311/; "Battery Minerals, Urbix Partner for Graphite Processing JV in Mozambique", *NS Energy*, October 10, 2019, https://www.nsenergybusiness.com/news/battery-minerals-graphite-processing-jv/#.

34 Richard Jansen van Vuuren, "Magnis Resources Reaches Consensus in Tanzania", *Mining Review Africa*, March 9, 2018, https://www.miningreview.com/battery-metals/magnis-resources-reaches-consensus-in-tanzania/; Megan van Wyngaardt, "Tanzania Grants Magnis Approval to Operate a Graphite Processing Plant", *Mining Weekly*, March 9, 2018, https://www.miningweekly.com/article/tanzania-grants-magnis-approval-to-operate-graphite-processing-plant-2018-03-09.

35 Laurence Stevens, "Zimbabwe's Lithium Mine is Attracting Global Attention", *African Mining Market*, October 14, 2019, https://africanminingmarket.com/zimbabwes-lithium-mine-is-attracting-global-attention/4906/; "Govt to Pursue Local Lithium Beneficiation", *The Herald (Zimbabwe)*, April 25, 2019, https://www.herald.co.zw/govt-to-pursue-local-lithium-beneficiation/.

36 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; The MegaMillion Energy Company, https://www.tmec.africa/.

37 BJ Bladergroen, "Li-ion 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; 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.

38 Republic 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.

39 DSI, "Minister Nzimande Calls for"; Henry Roman, "The Contribution of the DST to the Transition to a Greener Economy" (presentation, Parliamentary Portfolio Committee: Science and Technology, Cape Town, October 25, 2017), https://static.pmg.org.za/171025DST.pdf.

the testing and validation of cells, modules and battery packs).[40] The CSIR, Hulamin, NECSA and Sasol have the facilities and capability to make cell components for lithium-ion batteries.[41] However, there is currently no market in SADC for them to adapt their processes to make lithium-ion battery-related components.

Battery pack assembly

The main lithium-ion battery pack assemblers in SADC are currently based in South Africa. Maxwell and Spark is a manufacturer of lithium-ion battery packs used in forklifts and refrigeration trucks.[42] Battery Powered Industries assembles lithium-ion battery packs for underground battery-operated mining equipment.[43] Other companies, including Balancell, BlueNova, Revov, SolarMD, FreedomWON and ZettaJoule, assemble lithium-ion battery packs.[44]

Repurposing and recycling

Although there is a well-established lead-acid battery recycling industry in Southern Africa, lithium-ion battery recycling initiatives are in their infancy. The advantage of an EVs lithium-ion battery pack is its lifespan of 7–10 years.[45] From its seventh 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.[46] This enables the battery pack to be repurposed for other applications such as stationary energy storage and micromobility (eg, electric bicycles, electric 3-wheelers). uYilo has a pilot facility on the smart grid that includes the re-purposing of automotive OEMs' EV battery packs for use in stationary storage within the electrical grid.

The Energy Storage RDI Consortium has initiated activities towards lithium-ion battery recycling. Mintek is conducting electronic waste research that includes the recovery of valuable metals from lithium-ion batteries and the preparation of a business case

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

41 Sasol, "Chemicals: Carbon", https://products.sasol.com/pic/products/home/carbon/index.html; Hulamin, "Unaudited Interim Results for the Half-Year Ended 30 June 2019", August 23, 2019, http://ir.hulamin.com/static-files/2d5e60d5-1c3d-490d-baea-257d646a2d59; NECSA, "NECSA Technologies", http://www.necsa.co.za/necsa-technologies/; 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#.

42 Maxwell and Spark, https://maxwellandspark.co.za/.

43 Battery Power Industries, "Our Products", https://www.batterypowered.co.za/our-products/#1551257474048-c928304b-3712.

44 Balancell, "Lithium Ferro Phosphate (LFP) Battery Packs", https://www.balancell.com/lfp-battery-packs; BlueNova, https://www.bluenova.co.za/; Revov, "Revov LiFe Battery Range", https://revov.co.za/life/; Solar MD, "Our Story", http://solarmd.co.za/about-solar-md/; ZettaJoule, "Energy Storage", https://www.1zettajoule.com/energy_storage.html.

45 Anika Neitz-Regett and Sebastian Fischhaber, "Second-Life Concepts for Lithium-Ion Batteries from Electric Vehicles", *Forschungsstelle für Energiewirtschaft e.V.*, February 17, 2020, https://www.ffe.de/publikationen/vortraege/620-second-life-konzepte-fuer-lithium-ionen-batterien-aus-elektrofahrzeugen.

46 Neitz-Regett and Fishhaber, "Second-Life Concepts".

to establish a lithium-ion battery recycling facility in South Africa.[47] uYilo, the Energy Waste Association of South Africa 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 the lithium-ion 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 Battery Testing Laboratory is currently the only accredited ISO 17025 laboratory for lithium-ion cell and battery testing in Southern Africa and it 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.[48] The uYilo Battery Testing Laboratory is establishing itself to evaluate manufactured cells for abuse and damage, according to UN38.3 guidelines.

Skills development

The South African Minerals to Metals Research Institute 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.[49] Higher education and learning institutions across South Africa, in collaboration with industry and South Africa's Sector Education and Training Authorities, are supporting training and skills development interventions to assist the battery energy storage sector. Some of these initiatives include internships, graduate training and short learning programmes.

The SADC political economy of battery manufacturing and energy storage

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 also for the sustainability of their investment. Potential investors view corruption as a disease, 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

47 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.

48 The transport of lithium batteries is subject to national and international regulations as detailed by the UN Manual of Tests and Criteria, Sub-section 38.3 (UN 38.3), Lithium Battery Testing Requirements. See Battery Standards Info, "UN38.3", https://www.batterystandards.info/node/917.

49 Cyril O' Connor, V Ross and JR 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 (2019): 62–64.

commodity exports to sustain their economies. Unfortunately, the prices of commodity exports are volatile as they rely on average world prices at any given point in time and there is 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 its commodities than country y. SADC is also a carbon-intensive region where three of its key sectors, namely mining, 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.[50] Although the civil war in the DRC ended in 1999, armed conflict and human rights violations in some provinces have continued.[51] The peace and stability of Mozambique is also being threatened by militia attacks in the Cabo Delgado province.[52]

Corruption

Corruption in SADC member states is another issue that inhibits economic growth and development. Corruption negatively affects investor confidence and 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.[53] 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%. 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%. South Africa, SADC's most industrialised economy, scored 44%.[54]

50 Kudzai Chimhangwa, "War in Mozambique: A Natural Gas Blessing, Turned Curse", Open Democracy, June 26, 2020, https://www.opendemocracy.net/en/oureconomy/war-mozambique-natural-gas-blessing-turned-curse/; SADC, "Member States", https://www.sadc.int/member-states/.

51 Kathryn Reid, "DRC Conflict: Facts, FAQs, and How to Help", *World Vision*, July 23, 2019, https://www.worldvision.org/disaster-relief-news-stories/drc-conflict-facts; "Fragile Hopes of Peace in DRC's Conflict-Scarred Ituri Province", *Aljazeera*, September 28, 2020, https://www.aljazeera.com/features/2020/9/28/fragile-hopes-in-dr-congos-ituri-province-scarred-by-conflict.

52 "The Conflict in Mozambique Is Getting Worse", *Economist*, August 26, 2020, https://www.economist.com/middle-east-and-africa/2020/08/26/the-conflict-in-mozambique-is-getting-worse; Alex Vines, "As Conflict in Cabo Delgado Increases, Will Frelimo Learn From Its Mistakes?", *Mail & Guardian*, June 24, 2020, https://mg.co.za/africa/2020-06-24-as-conflict-in-cabo-delgado-increases-will-frelimo-learn-from-its-mistakes/; Institute for Peace and Security Studies, *Mozambique Conflict Insight*, Peace and Security Report (Addis Ababa: Institute for Peace and Security Studies, 2020), https://media.africaportal.org/documents/MOZAMBIQUE-Conflict-Insights-vol-1-Conflict-Insight-and-Analysis-1.pdf.

53 Transparency International, "Corruption Perceptions Index 2019", https://www.transparency.org/en/cpi/2019/results.

54 Transparency International, "Corruption Perceptions Index 2019".

Commodities

All 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, most 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, where the manufacturing sector has made significant contributions to their GDP.[55] However, because most member states' economies rely on commodity exports, the manufacturing sector contributed only 10.7% of the SADC region's GDP in 2019.[56]

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.[57] 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.[58]

55 SADC, "Member States"; SADC, *Selected Economic and Social Indicators 2019* (Gaborone: SADC, 2020), https://www.sadc.int/files/2916/0102/7136/Selected_Indicators_2020_September_11v2.pdf.

56 SADC, "Selected Economic and Social Indicators".

57 SADC, "Climate Change Mitigation", https://www.sadc.int/themes/meteorology-climate/climate-change-mitigation/; Robert McSweeny and Jocelyn Timperly, "The Carbon Brief Profile: South Africa", *Carbon Brief*, October 15, 2018, https://www.carbonbrief.org/the-carbon-brief-profile-south-africa; Daniel Workman, "Coal Exports by Country", *World's Top Exports*, July 11, 2020, http://www.worldstopexports.com/coal-exports-country/.

58 SADC, "Energy", https://www.sadc.int/themes/infrastructure/en/.

Large-scale lithium-ion battery manufacturing in SADC: Barriers and opportunities

Barriers

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

Shortage of skills

A major barrier to establishing SADC's competitive advantage is the shortage of skills in the region. An analysis of the lithium-ion 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, as well as 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 are needed for the development of entrepreneurial skills to sustain the profitability and viability of the stakeholder businesses that would form part of the value chain. Lithium-ion battery technology and manufacturing for EV 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 in the manufacturing sector in SADC has remained low.[59] Development and progression along the lithium-ion battery manufacturing value chain requires financing for 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-ion battery manufacturing value chain within the region is largely underdeveloped. Energy, transport and information and communications technology (ICT) infrastructure remains a challenge. Electricity shortages continue to affect SADC and inadequate regulatory frameworks inhibit investment in the energy sector.[60] Funding shortages are also inhibiting the maintenance, renovation

59 SADC, *Action Plan for SADC Industrialization Strategy and Roadmap* (Lozitha: SADC, 2017), https://www.sadc.int/files/4514/9580/8179/Action_Plan_for_SADC_Industrialization_Strategy_and_Roadmap.pdf.

60 SADC, "Energy".

and expansion of the region's roads, railways and ports of entry, while rural communities struggle with access to transport.[61] ICT infrastructure needs to be developed for reliable and affordable Internet connectivity in the region.[62] 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 grid to increase generation capacity, but there was still a deficit of 1 904 MW in the region. Projects to improve transport and ICT infrastructure and water supply are also needed, with some underway.[63]

Slow implementation of industrial policies

The SISR 2015–2063 was adopted in April 2015 with the purpose of encouraging 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 SISR seeks to increase the SADC region's competitive participation within global value chains while reducing carbon emissions in line with the Paris Agreement and SDGs. Unfortunately, the implementation of the SISR has been slow. However, in light of the COVID-19 pandemic, there have been calls by ministers of member states to accelerate its implementation.[64] This 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-ion 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 and lack of infrastructure (eg, public EV charging stations) and price.

Opportunities

The number of EVs in the world will increase from 8 million cars in 2020 to 380 million cars by 2030,[65] which will continue to drive the demand for lithium-ion batteries. Battery manufacturing capacity will need to increase from 300 GWh in 2020 to at least 2 023 GWh

61 SADC, "Transport", https://www.sadc.int/themes/infrastructure/transport/.

62 SADC, "ICT and Telecommunications", https://www.sadc.int/themes/infrastructure/ict-telecommunications/; "Call for Improved ICT Infrastructure in SADC Region", *South African Government News Agency*, September 16, 2017, https://www.sanews.gov.za/south-africa/call-improved-ict-infrastructure-sadc-region.

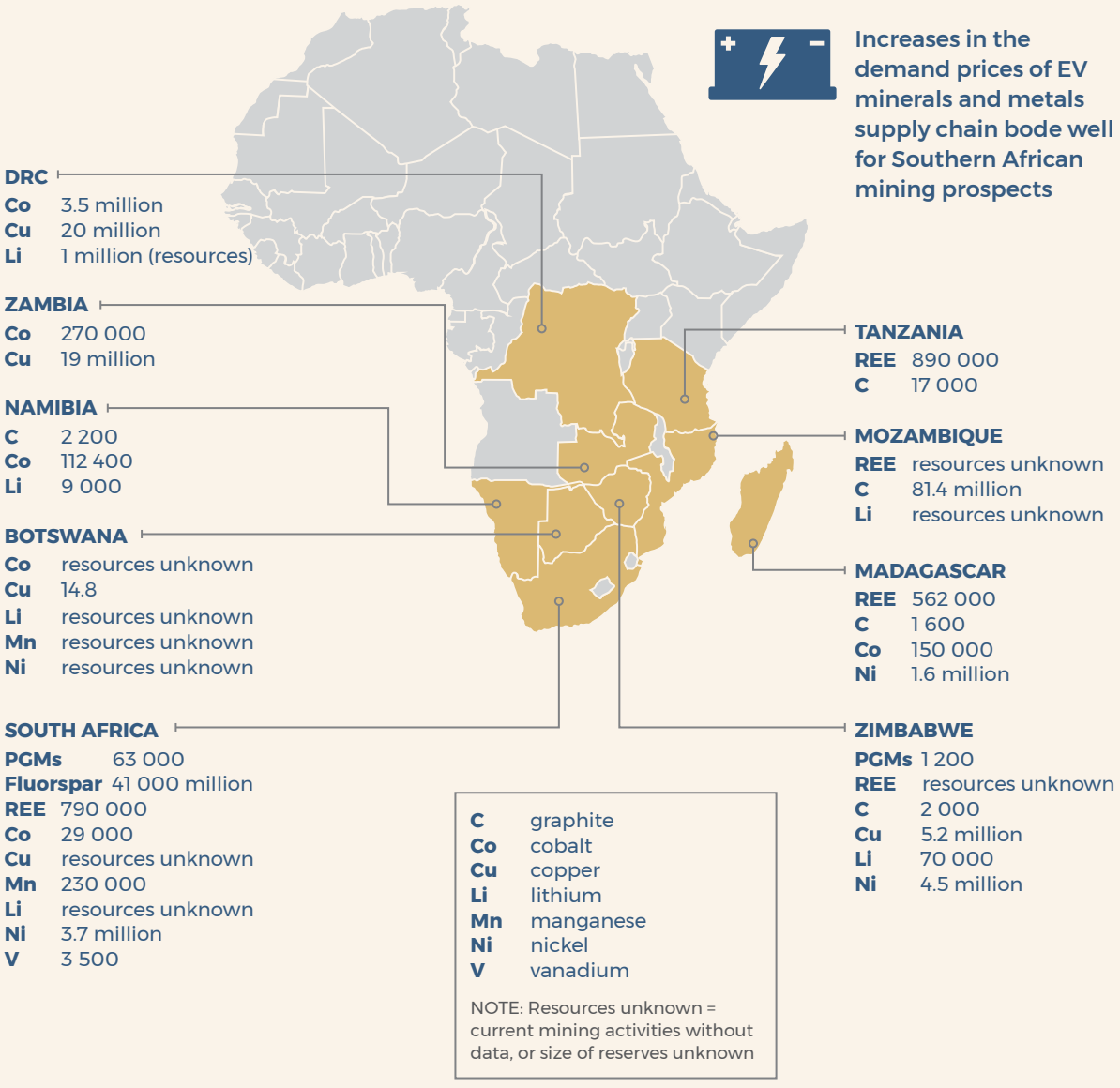
63 SADC, "40th SADC Summit".

64 "SADC Member States Urged to Remain Vigilant Amid Covid-19", *Economist (Namibia)*, June 1, 2020, https://economist.com.na/53287/special-focus/sadc-member-states-urged-to-remain-vigilant-amid-covid-19/.

65 IEA, *Energy Technology Perspectives 2020* (Paris: IEA, 2020); International Renewable Energy Agency, *The Post-COVID Recovery: An Agenda for Resilience, Development and Equality* (Abu Dhabi: IRENA, 2020).

by 2030 to meet the demand for EVs.[66] As seen in Figure 4, Southern Africa is endowed with all the raw materials needed to manufacture lithium-ion batteries. It is estimated that battery manufacturing facilities will require an investment of approximately $120 million per GWh per year by 2025 to meet global capacity requirements.[67] 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-ion battery manufacturing value chain.

Figure 4 EVMM supply chain reserves in Southern Africa (metric tons)



Source: U.S. Geological Survey, *Mineral Commodity Summaries 2020*, https://pubs.usgs.gov/periodicals/mcs2020/mcs2020.pdf

66 IRENA, *The Post-COVID Recovery*.

67 IRENA, *The Post-COVID Recovery*.

> Investing in energy transition technologies creates close to three times more jobs than fossil fuels do, for each million dollars of spending

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 SDGs, are critical to secure economic growth and prosperity. As stated, 'Investing in energy transition technologies creates close to three times more jobs than fossil fuels do, for each million dollars of spending.'[68] A report by the International Labour Organization estimates that the transition of the transport sector from fossil fuels to electrification could create up to 10 million jobs worldwide.[69] Employment opportunities within the EV battery manufacturing value chain will surge while there will be a decrease in employment within the traditional ICE value chain. SADC member states, in consultation with the private sector, have conducted a profiling assessment on the battery energy storage sector, which has identified investment opportunities across the entire lithium-ion battery manufacturing value chain. Some of these opportunities include raw material beneficiation into battery-graded material, cell component manufacturing and battery pack assembly.[70] There is an opportunity to gain a competitive advantage, since all the materials required for the production of lithium-ion batteries are found within the SADC region. This means that the raw materials do not have to be shipped outside of the continent for beneficiation, and creates easier access to the rest of the continent for the supply of lithium-ion batteries. Therefore, if SADC member states do not capitalise on the opportunity to manufacture lithium batteries for EVs, they will lose the opportunity for job creation in this value chain to other countries and regions. Potential investors for developing the lithium-ion battery manufacturing value chain in SADC will be encouraged by policies, regulations and incentives that incentivise the uptake of EVs in the region. South Africa, as a leader in automotive manufacturing and export in SADC, should assume responsibility for the transition away from the ICE vehicle value chain towards the EV manufacturing value chain.

> If SADC member states do not capitalise on the opportunity to manufacture lithium batteries for EVs, they will lose the opportunity for job creation in this value chain to other countries and regions

68 IRENA, *The Post-COVID Recovery*, 56.
69 ILO, "Jobs in Green and Healthy Transport".
70 SADC, "40th SADC Summit".

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-ion battery manufacturing value chain. They should develop a roadmap in consultation with relevant stakeholders, including the private sector, for the development of battery manufacturing that clearly outlines specific areas of the value chain they can potentially participate in and what capabilities are needed for participation. Governments also need to review their skills development frameworks, RDI investment frameworks and technology investment initiatives that 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 accelerate the lithium-ion 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. Table 2 sets out practical steps that member states can undertake to accelerate the lithium-ion battery manufacturing value chain. Areas of suggested support from the private sector are 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; • mineral beneficiation; • pharmaceuticals; • consumer goods; • capital goods; and • services.	Regional/ global value chain and value addition strategies for each of the six areas developed and implemented by 2020.	• Number 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-ion battery manufacturing by: • investing in supporting infrastructure; • developing bankable value chain projects; and • facilitating the financing of feasibility studies, projects and start-ups.	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;

Outcomes	Targeted outputs	Key performance indicators	Main activities	Suggested practical steps by member states	Suggested support from private sector
				Possible activities to support: • mineral beneficiation through the processing of manganese, lithium, nickel, cobalt, and graphite to produce battery-graded material for the manufacturing of cell components.	• Battery pack manufacturing; and • 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, mineral beneficiation and downstream processing value chain development					
Higher level of mineral 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'. Regional mining vision in place.	Develop and implement the SADC Mineral Beneficiation Plan.	Approval and adoption of the SADC Mineral Beneficiation Plan.	Provide input for the plan and implement.
II. 1.10: Ensuring greater environmental sustainability (Green and Blue Economy)					
Environmental standards, SDGs and Paris Agreement mainstreamed into industrial development in line with the Protocol on Environment for Sustainable Development.	Green Economy and climate change strategies implemented by 2020.	• Number of member states with Green Economy and climate change strategies. • Level of gas/ carbon emissions. • Number of industries utilising cleaner production technologies. • Number of industries producing cleaner technologies. • Level of energy efficiency in production % of renewable energy to total energy usage.	Implement the SADC Green Economy and climate change strategies and action plans 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 maximise resource use efficiency.	Comply with Paris Agreement and resolutions of the Future We Want, Agenda 2063 and Agenda 2030.	Comply with Paris Agreement 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
		• Compliance with Paris Agreement, the Future We Want, Agenda 2063 and Agenda 2030.			
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-ion batteries. Invest in RDI projects that support the re-purposing and re-use of second-life EV batteries within stationary storage and micromobility applications.	Comply with waste management regulations for e-waste. Exploit opportunities available within the re-purposing and re-use of second life EV 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-ion battery technology and entrepreneurship. Implement skills development programmes for battery manufacturing industry. Establish, support and promote battery industry and academia linkages. Monitor effectiveness of industry-academia linkages. Establish education management information systems (EMISs).	Provide input and information on industry skills requirements in fields of raw material beneficiation, cell component manufacturing, cell manufacturing, battery pack manufacturing and recycling. Provide information on skills requirements for battery manufacturing industry and invest in skills development. Participate in industry-academia linkages. Monitor effectiveness of industry-academia linkages. Provide input on the development of education curricula in support of lithium-ion battery manufacturing.

Outcomes	Targeted outputs	Key performance indicators	Main activities	Suggested practical steps by member states	Suggested support from private sector
Improved micro-economic environment for firms and enterprises.	Rankings on Global Competitive-ness 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 EVs and competitive participation in the global lithium-ion 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 EVs and competitive participation in the global lithium-ion 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 measure (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.	Number of functional quality infrastructure institutions internationally recognised.	Improve quality infrastructure services that support industrialisa-tion and enhance competitive-ness.	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-ion 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					
Centres of Excellence (CoE) and Centres of Specialisation (CoS) for selected priority sectors (eg, engineering, ICT, pharmaceuticals) identified/ strengthened/ established.	Regional industrial CoE and CoS for priority sectors identified and/or strengthened by 2030.	Number of CoE and CoS 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-ion battery technology.	Participate in identification/ proposal/ strengthening/ establishment of energy storage CoE/ CoS with expertise in lithium-ion battery technology.

Outcomes	Targeted outputs	Key performance indicators	Main activities	Suggested practical steps by member states	Suggested support from private sector
Enhanced innovation and business sophistication to advance technological readiness.	Government investment in R&D increased to 2% of GDP. Commercialisation of innovative products and services in SADC.	Percentage increase of GDP invested in R&D. Number of innovative products and services.	Promote investment in R&D and innovation. Establish/ strengthen national and regional innovation systems.	Invest in energy storage R&D and innovation programmes. Develop energy storage R&D and innovation and commercialisation support programmes for SMEs.	Invest in energy storage R&D and innovation programmes. Invest in energy storage R&D and innovation programmes.

Source: SADC, *Action Plan for SADC Industrialization Strategy and Roadmap* (Lozitha: SADC, 2017), https://www.sadc.int/files/4514/9580/8179/Action_Plan_for_SADC_Industrialization_Strategy_and_Roadmap.pdf

What clear indications are there that governments are seriously considering a battery manufacturing roadmap 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 adopted regional policies 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'.[71] The SADC Protocol on Industry, 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 to have done so.[72]

South Africa

As mentioned previously, the South African government is involved in a number of collaborative projects with higher education and training institutions, R&D institutions and the private sector to develop the country's lithium-ion battery manufacturing industry. This was enabled through comprehensive action plans outlined in its industrial and innovation

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

72 SADC, "SADC 40th Summit".

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-ion 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.[73] His address also mentioned that climate action could support infrastructure development, local production and the development of expertise in e-mobility.[74]

Zambia

Zambia's National Industrial Policy highlights mineral (metallic and non-metallic) processing, product beneficiation and engineering products as one of the manufacturing sub-sectors that are a priority for driving industrialisation in the country.[75] The Zambian government has also aligned its industrial policy to the SISR. Although there is no specific mention of battery manufacturing in its industrial policy, there is an existing policy framework that the Zambian government can use to initiate activities towards developing its lithium-ion battery manufacturing value chain. A possible starting point could be in cell component manufacturing, as there are already companies such as ERG Africa in Zambia that are processing cobalt. President Edgar Chagwa Lungu's address to Zambia's Parliament emphasised that the Zambian government would continue to promote value addition in the mining sector.[76]

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 the SISR. Within the mineral beneficiation and value addition section of this, Zimbabwe has mentioned lithium production and motor vehicle manufacturing as offering opportunities for the country to participate further along global value chains by adding value to the mineral resources mined in the country.[77] On 4 May 2020 the government of Zimbabwe published a $50 billion economic recovery and stimulus package. However, battery manufacturing was not specifically mentioned in the document.[78]

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73 Cyril Ramaphosa, "From the Desk of the President", Government of South Africa, August 24, 2020, https://www.gov.za/blog/desk-president-34.

74 Ramaphosa, "From the Desk of the President".

75 Government of Zambia, Ministry of Commerce, Trade and Industry, *National Industrial Policy* (Lusaka: Ministry of Commerce, Trade and Industry, 2018), https://www.mcti.gov.zm/?wpfb_dl=51.

76 Edgar Lungu, "Speech for the Official Opening of the Fifth Session of the Twelfth National Assembly", http://www.parliament.gov.zm/sites/default/files/images/publication_docs/Speech_1.pdf.

77 Republic of Zimbabwe, Ministry of Industry and Commerce, *Zimbabwe National Industrial Development Policy 2019–2023* (Harare: Paragon, 2019).

78 Republic of Zimbabwe, *Details on the COVID-19 Economic Recovery and Stimulus Package* (Causeway: Office of the Minister of Finance and Economic Development, 2020), https://www.veritaszim.net/node/4112.

Towards a just battery manufacturing transition

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 world. A strong industrial policy should include technology and innovation: '[T]o sustain growth, a country needs to constantly introduce new goods and adopt and develop new technologies.'[79] South Korea, Singapore and Taiwan, for example, have succeeded in moving away from commodity-driven 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 in the successful implementation of their industrialisation policies were 'ambition', 'accountability' and 'adaptability'.[80] 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.[81] The industrial policies implemented by South Korea enabled companies such as Hyundai Motor Corporation to become one of the most successful car manufacturers in the world using its own technology.[82] Singapore and Taiwan have had similar success, with their manufacturing sectors (eg, electronic components, transport engineering, chemical manufacturing) being the key drivers of their economy.[83] SADC member states can use the opportunities available within the lithium-ion battery manufacturing value chain to begin their trajectory towards becoming manufacturing-based economies. Table 3 gives a summary of how executing interventions similar to those adopted by Asian economies can assist in accelerating the lithium-ion battery manufacturing value chain in SADC.

79 Reda Cherif and Fuad Hasanov, "The Return of the Policy That Shall Not Be Named: Principles of Industrial Policy" (Working Paper 19/74, International Monetary Fund, Washington DC, 2019), 21, 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.

80 Cherif and Hasanov, "The Return of the Policy", 23.

81 Worldometer, "GDP by Country", https://www.worldometers.info/gdp/gdp-by-country/; GlobalEconomy.com, "South Korea: Exports, Percent of GDP", https://www.theglobaleconomy.com/South-Korea/exports/.

82 Cherif and Hasanov, "The Return of the Policy", 23; Group1 Hyundai, "The History of Hyundai", https://www.group1hyundai.co.za/history-of-hyundai/; Hyundai, "The History of Hyundai Motor Company", https://www.earnhardthyundai.com/hyundai-history; Ana Maria Santacreu and Heting Zhu, "How Did South Korea's Economy Develop So Quickly?", Federal Reserve Bank of St. Louis, March 20, 2018, https://www.stlouisfed.org/on-the-economy/2018/march/how-south-korea-economy-develop-quickly.

83 Sharon Omondi, "What Are the Biggest Industries in Taiwan?", World Atlas, June 7, 2019, https://www.worldatlas.com/articles/what-are-the-biggest-industries-in-taiwan.html; 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; World Bank, "The World Bank in Singapore", https://www.worldbank.org/en/country/singapore/overview.

TABLE 3 SYSTEMIC INNOVATIONS FOR A SUSTAINABLE LITHIUM-ION BATTERY MANUFACTURING VALUE CHAIN		
Industrial policy/state intervention		**Intervention required to accelerate lithium-ion battery manufacturing value chain**
Create capabilities in sophisticated industries	Implement policies that allow for a transition from commodity-driven production to technology-driven production that drives innovation beyond current capabilities to compete in the advanced stages of value chains.	Create capabilities within the lithium-ion 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.
Export	Focus on exporting the new industrial product immediately by paying close attention to the needs of the export market and quickly adapting as conditions change.	Use capabilities created to manufacture high-quality, competitive cell components, cells and battery packs that can be exported globally.
Encourage 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.	Account for funds invested in businesses and organisations to facilitate the development of the lithium-ion battery manufacturing industry through performance assessment, return on investment and ethical practices.

Source: Reda Cherif and Fuad Hasanov, "The Return of the Policy That Shall Not Be Named: Principles of Industrial Policy" (Working Paper 19/74, International Monetary Fund, Washington DC, 2019)

Creating capabilities in lithium-ion 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 need re-training and/or re-skilling. Some examples include skills in high-voltage battery technology and safety, material scientists, battery scientists, systems and software integration. A 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-ion 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-ion 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; all products manufactured within the lithium-ion battery value chain must thus 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 adapt quickly to the changing needs of the export market.

The sourcing of financing to develop the lithium-ion 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 to build capacity in budgeting and managing 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-ion battery manufacturing value chain and a sustainable export market for locally manufactured lithium-ion battery products, while promoting competition and accountability, require a key qualitative ingredient: continuous transformational change.[84] SADC member states have been trapped in the cycle of commodity-driven economies for over 100 years. Transitioning to a manufacturing-driven economy that is both green and low carbon requires a complete paradigm shift for many stakeholders. Continuous capacity-building initiatives will enable stakeholders to quickly adapt to market and technology changes.

Recommendations for accelerating the SADC battery manufacturing value chain

All SADC member states should create policies that fast-track the adoption of EVs in the region. An increasing demand for EVs will create an appetite for investment in lithium-ion battery manufacturing in SADC.

Member states should align their national policies with SADC's Vision 2050 and the SISR in order for the region to work collectively towards accelerating the lithium-ion battery manufacturing value chain. Regional integration is necessary. Member states should develop mechanisms for continuous engagement with the private sector and so promote collaborative efforts in developing the industry.

A regional battery alliance should be formed, comprised of stakeholders and representatives from each member state. The battery alliance should also 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 to review the skills needed

84 Catrien JAM 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), 558–576.

to be a competitive player within the lithium-ion battery global value chain. Thereafter, a skills plan that promotes gender equality as well as the opportunity for re-skilling should be developed. STEM 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 give them the tools and know-how to implement policies aligned to SADC's 2050 Vision and the SDGs. Once the mutual and sustainable benefits are properly articulated and become apparent, it will encourage stakeholder buy-in towards working together to accelerate the lithium-ion battery manufacturing value chain.

Governments should encourage local small and medium-sized enterprises (SMEs) to participate at higher levels of the battery manufacturing value chain by eliminating regulatory barriers and providing commercialisation support programmes. Member states should incentivise SMEs to establish mineral beneficiation plants and processes that can produce battery-grade material.

Member states should provide incentives to investors and businesses to establish operations in less industrialised and/or rural areas to alleviate unemployment and improve living standards. They can establish special economic zones for lithium-ion battery manufacturing with tax incentives that encourage local and regional employment. Investors should also be incentivised to promote local participants in the value chain.

National regulatory, accreditation and standards bureaus should establish a regional body for the testing and accreditation of lithium-ion cells and batteries in the SADC region. Quality assurance is vital for competing in the global battery manufacturing value chain as it will ensure competitiveness is maintained.

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-ion battery manufacturing value chain in the region.

SADC member states can set up a single market mechanism to strengthen the region's global bargaining power within the lithium-ion battery manufacturing value chain. The battery energy storage 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-ion 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-ion battery manufacturing in the region. Governments can also use green stimulus packages that support investment in lithium-ion battery manufacturing through post-COVID-19 green economic recovery plans.

The SADC region should develop a regulatory framework for the recycling of lithium-ion batteries. Lithium-ion battery recycling is an important part of the value chain as it supports

sustainable consumption patterns via the circular economy concept by encouraging the recycling of raw materials that are traditionally mined for lithium-ion batteries. The recycling of lithium-ion batteries needs to be regulated for safe disposal to reduce possible hazards that can occur at landfill dumpsites, for example. National regulatory bodies from all member states (for example, South Africa's National Regulator for Compulsory Specifications) should work together to develop a regulatory framework for the recycling of lithium-ion batteries.

A just transition should be at the forefront of all regulatory frameworks for lithium-ion battery manufacturing in SADC. Ethical organisational practices that are underpinned by the 3Ps of sustainability (Planet, People, Profit) should be at the forefront of all regulatory frameworks for lithium-ion battery manufacturing. A just transition occurs when economic growth is not at the cost of people's livelihoods, workers' income and the environment. Within a just transition, companies' production patterns utilise clean technologies to mitigate pollution. The circular economy concept for the re-use, re-purpose and recycling of manufactured goods also forms part of the just transition process as it promotes sustainable production practices. Businesses should put their employees and their community's well-being at the forefront of all decision-making processes. Businesses should also be compelled to pay fair wages and provide healthy and safe working conditions for their employees.[85] Women, youth and people with disabilities should be included in the employment and entrepreneurial opportunities provided by the lithium-ion battery manufacturing value chain. This can be done through deliberate training inventions, from encouraging the uptake of STEM subjects at school and tertiary level to 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-ion battery manufacturing value chain. Lithium-ion batteries are a low-carbon transport solution and can provide a source of energy storage for renewable energy solutions. Member states should recognise that compelling businesses to follow a just transition will create a sustainable battery manufacturing value chain. This 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 fossil fuels do: the electrification of transport is expected to create up to 10 million jobs worldwide.[86] Future employment opportunities within EV battery manufacturing

85 University of Wisconsin, Sustainable Management, "The Triple Bottom Line", https://sustain.wisconsin.edu/sustainability/triple-bottom-line/.

86 ILO, "Jobs in Green and Healthy Transport".

are predicted to surge, and battery energy storage has been identified as an untapped opportunity for SADC owing to the increasing demand for EVs.[87]

SADC member states should incorporate the development of the lithium-ion battery value chain into their post-COVID-19 economic recovery plans. This will require implementing policies that promote the development of the EV industry in SADC, which in turn will encourage investment in the development of lithium-ion battery manufacturing in the region. The SISR and Costed Action Plan have given member states a framework for the policies required to accelerate the lithium-ion battery manufacturing value chain in Southern Africa. Those member states that have not aligned their industrial policies to the SISR should fast-track the policy adoption and ratification process in their respective countries.

SADC member states such as South Africa, Zambia and Zimbabwe that have adopted sound industrial policies aligned to the SISR need to accelerate the implementation of those policies and drive SADC's competitive participation in the global value chain for lithium-ion battery manufacturing. SADC member states should use this opportunity to determine where key early initiatives could be piloted to evaluate possibilities of public-private investment and linkages to the global lithium-ion battery value chain for EVs.

The region can use its battery-related 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.

87 SADC, "40th SADC Summit", 46.

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